Unconventional Oil & Gas as a Case Study for a New Framework on Strategic Natural Resource Development

PhD Doctoral Dissertation

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Abstract

In this dissertation, I introduce a new framework for analyzing strategic natural resource development for use across countries, resource bases, and technologies. This new framework, the "Strategic Resource Development Framework" (SRDF) builds on the Varieties of Capitalism framework by Peter Hall and David Soskice (2001), which analyzes comparative advantages across political economies. The SRDF provides a method for inferring how strategic resource development might unfold in Liberal Market Economies (LMEs), Coordinated Market Economies (CMEs), and Mixed Market Economies (MME).

Through my literature review, I show there are three primary drivers for nations to pursue strategic resource development, which are: 1) energy security, 2) economic interests, and 3) environmental considerations. I incorporate these three primary drivers into the SRDF as the reasoning behind national strategic resource development. Through secondary research, I draw on the works of Ikenberry (1986, 1988), Keohane (1978, 1984), Tugwell (1988), Katzenstein (1977), and Hughes (2014) as it relates to national-level comparative analysis energy policy research stemming from the 1970s energy crises, which explores how countries with different market structures have responded to past energy challenges.

With resource development deemed nationally strategically important, I then build on Wang and Krupnick's (2013) work "A Retrospective Review of Shale Gas Development in the United States", by accessing four key Independent Variables, which are: 1) Political Opportunity Structure, 2) Government, 3) Capital Markets & Market Structure, and 4) Geology & Infrastructure. Notably, I include Political Opportunity Structure in the SRDF versus Wang and Krupnick's earlier research, which explores the other Independent Variables.

My research analyzes unconventional oil and gas as a case study for strategic resource development utilizing the SRDF approach. As a result, this dissertation shows how the SRDF affirms Hall and Soskice's argument that LMEs have a comparative advantage for radical innovation. However, this dissertation also shows that the incorporation of POS in the SRDF can negate the very same comparative advantage that LMEs have for radical innovation.

Through primary research, I show that the polycentric governance nature of LMEs provides POS access points for opposition groups to slow or stop development in the event a fit-for-purpose regulatory framework is not in place. Interviews with various stakeholders from the U.K. and New York, which have

both experienced unconventional development bans, illustrate the importance of POS as an Independent Variable for LMEs in the SRDF. These experiences are juxtaposed to other states, where regulatory frameworks were enacted early, and Argentina, where opposition groups struggle to access the POS in the MME country.

The SRDF provides a tool to analyze and infer the potential outcomes for strategic resource development across political economies and market structures. It is my hope future policy makers will incorporate the SRDF approach for the advancement of sustainable development, economic prosperity, and energy security, and that future researchers utilize and optimize it for the specificities spanning countries, resources, and technologies, to better understand and infer strategic resource development outcomes.

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Glossary

Abbreviation	Definition
bbl	Barrel
bcm	Billion cubic meters
CME	Coordinated Market Economies
DEC	New York Department of Environmental Conservation
DECC	U.K. Department of Energy & Climate Change
DOE	U.S. Department of Energy
E&P	Exploration & Production
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Statement
HVHF	High-volume hydraulic fracturing
IEA	International Energy Agency
IOC	Integrated Oil Company
IPE	International Political Economy
LME	Liberal Market Economies
LNG	Liquified Natural Gas
MME	Mixed Market Economies
NEC	China National Energy Commission
NETL	National Energy Technology Laboratory
NOC	National Oil Company
OPEC	Organization of the Petroleum Exporting Countries
POS	Political Opportunity Structure
SOE	State Owned Enterprise
SRDF	Strategic Resource Development Framework
TES	Total energy supply
VoC	Varieties of Capitalism

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Eliza, my wife, has been an unwavering source of support and encouragement. Her partnership has made this pursuit possible. Eliza provides me, and all who know her, a major source of inspiration due to her love of nature. My gratitude to her and appreciation for the care she has given to our family throughout this process is immeasurable.

I am extremely grateful for the support and guidance my primary advisor Professor Paul Heywood has provided throughout my studies. Professor Heywood has pushed me to explore the big picture and interconnections spanning energy, the environment, government, markets, and communities, positioning me to make a contribution to the field of strategic natural resource development.

I am also very grateful for the additional support and guidance from my advisor Professor Mathew Humphrey, who has also challenged and guided me throughout my research process. Importantly, Professors Heywood and Humphrey have encouraged me to crystalize my views into a framework for the benefit of future use within this field. It has been a pleasure and an honor learning from them.

Lastly, special thank you to all the industry experts I interviewed. The collective commitment from these individuals to improve the way the world develops natural resources is hopefully captured in this dissertation.

Thank you all. I am extraordinarily grateful.

Chapter 1: Introduction

1.1. Introducing a New Framework for Strategic Resource Development

In this dissertation, I introduce a new framework for analyzing strategic resource development for use across countries, resource bases, and technologies. This new framework, the "Strategic Resource Development Framework" (SRDF) provides a method for inferring how strategic resource development might unfold in Liberal Market Economies (LMEs), Coordinated Market Economies (CMEs), and Mixed Market Economies (MMEs). This framework provides a tool to analyze and infer potential outcomes for nations in developing strategic natural resources across political economies and market structures. The SRDF is built on the Varieties of Capitalism (VoC) framework by Peter Hall and David Soskice (2001).

This dissertation affirms that LMEs have a comparative advantage for radical innovation in strategic resource development, but shows other markets offer solutions for strategic resource development as well. This conclusion is based on primary and secondary research into unconventional oil and gas, which I utilize in this dissertation as a case study for the SRDF.

1.2. Overview of the Argument

In this chapter, I summarize my dissertation and provide an overview of my argument, as detailed in the various chapters. Further, in this chapter, I provide an overview of the U.S. and global unconventional development experience and landscape. In doing so, I explain why unconventional oil and gas development (shale development, hydraulic fracturing, or "fracking") provides a useful case study to analyze strategic resource development through my new framework, the SRDF. I also discuss what my findings suggest and how my work builds on the literature.

In Chapter 2, I present the design and methodology for my dissertation. Chapter 2 comprises two parts. The first part outlines my dissertation's design, methodology, and layout. The second describes the strategic rationale for the various countries studied to develop unconventional oil and gas.

In Chapter 3, I provide a literature review spanning energy policy and International Political Economy (IPE) theory. It has two sections that further explore the energy policy and theoretical literature, respectively. The first section is focused on the three key and reemerging themes spanning roughly the last century of energy policy, which I identify as 1) Energy Security, 2) Economics, and 3) the Environment. The second

section focuses on the various IPE theories, in particular Historical Institutionalism, the theoretical lens I have chosen for the SRDF.

Chapters 4-7 constitute the bulk of my primary research and data. These chapters explore the four Independent Variables for the SRDF ("Political Opportunity Structure" in Chapter 4, "Government" in Chapter 5, "Capital Markets & Market Structure" in Chapter 6, and "Geology & Infrastructure" in Chapter 7). Chapters 4-7 utilize my primary research from 25 semi-structured elite interviews to build on the secondary research relevant to each of the four Independent Variables.

In Chapter 8, I synthesize my findings and present my conclusions. I also provide suggestions for future researchers who may wish to utilize the SRDF approach to infer development outcomes across various technologies, countries, and market structures.

1.3. Successful Strategic Resource Development - Unconventional Oil & Gas; A Case Study for the SRDF

The U.S. has capitalized on the potential presented by unconventional oil and gas, bringing significant economic, energy security, and environmental benefits, as a result. In "A Retrospective Review of Shale Gas Development in the United States", Wang and Krupnick (2013) analyze the various factors that "led to the boom" in U.S. oil and gas production, including: 1) government policies, 2) geology, 3) water availability and natural gas pipeline infrastructure (infrastructure), 4) market structure, and 5) capital markets. My research analyzes these attributes in addition to Political Opportunity Structure in countries that are pursuing unconventional development ("unconventionals") for various strategic reasons, and includes a chapter dedicated to each of the four key Independent Variables for development.

Unconventionals is "an umbrella term for oil and natural gas that is produced by means that do not meet the criteria for conventional production" such as shale and tight oil and gas, and other hydrocarbon resources with low porosity or permeability (Schlumberger 2023). Metze and Dodge (2016) explain, "High volume horizontal hydraulic fracturing is a relatively new technique used to produce shale oil and gas. It involves injecting large quantities of water and chemicals under high pressure down a wellbore to cause fractures in rock formations, for example deep shale layers, enabling extraction of previously inaccessible resources".

The practice of fracturing rocks to stimulate oil and gas production dates back to the 1860s, with additional developments introduced around World War II (Gold 2014; Zuckerman 2013). However, the "modern fracks" which unlocked the U.S. shale experience are characterized by new techniques which utilize high-pressure and high volumes of water (ibid). As a result, these modern fracks are sometimes distinguished as "high-volume hydraulic fracturing" (HVHF), as the practice was referred to by regulators in New York (NYS Department of Environmental Conservation 2023). As detailed in Chapter 3, the commercialization of the modern fracks in the U.S. during the 1990s-2000s stemmed from U.S. policy initiatives in response to the 1970s natural gas crisis (NETL 2007).

There has been a large divergence in the technological uptake and success of shale between the U.S. and other countries pursuing its development, despite the widespread abundance of unconventional oil and gas globally. However, there is little research explaining this, particularly utilizing primary research. As a result, I look at the underpinning aspects and overarching questions theoretically and empirically, drawing from fragmented research and sources as well as first-hand interviews.

Through utilizing the SRDF approach, my research indicates the U.S. model is not the only recipe for success; however, it suggests the U.S. model presents advantages that if capitalized on provide a significant first mover advantage, affirming Hall and Soskice's (2001) Varieties of Capitalism (VoC) framework. My hope is that this study provides a foundation for future research as international unconventional development unfolds and helps inform future strategic resource development decisions spanning various end-markets, with particular near-term interest for the critical minerals and emerging energy fields.

Historical Institutionalism is the theoretical approach I use to view the divergence in uptake between countries, with process tracing explaining some of the variance in institutional directions for the four elements under review for each of the countries studied. Importantly, Historical Institutionalism shows that *how* the Independent Variables have developed is important for shale development outcomes. For example, as discussed in Chapter 7, the manner in which Geology & Infrastructure has been developed across the various countries studied is a key determinant as to how it has been utilized in the various market economies endeavoring to develop shale. As such, the evolution of the Independent Variables is informed through institutional arrangements and in-turn informs development outcomes.

Empirically, my research is based on 25 expert interviews (*n*=25) I conducted with professionals spanning the four countries of focus and specializations across the four independent variables analyzed.

An illustrative overview of my new framework, the SRDF, is shown in Figure 1. As mentioned, the research was designed to build on three key recurring themes that have dominated energy policy literature: 1) Economics, 2) Energy Security, and 3) the Environment, to provide a foundation for decisions on pursuing strategic resource development. Key works from the literature include Ikenberry (1986, 1988), Keohane (1978, 1984), Tugwell (1988), and Hughes (2014). I also use these three recurring themes to consider the strategic imperatives of the countries studied that are pursuing unconventional development. From a theoretical standpoint, my research builds on Wang and Krupnick's (2013) early work and incorporates Hall and Soskice's (2001) VoC framework. Primary research from my interviews informs the Independent Variables and provides new empirical data for the literature to build on for future strategic resource development inquiry.

Figure 1: Research Framework Overview - Strategic Resource Development Framework (SRDF)

<table>
<tr><td colspan="3">Varieties of Capitalism for Strategic Resource Development</td></tr>
<tr><td colspan="3">Primary Research: Interviews with 25 experts spanning indpendent variables and countries being studied</td></tr>
<tr><td colspan="3">Secondary Research: Energy Policy (energy security, environment, economics); International Political Economy theory</td></tr>
<tr><td>Countries Studied:</td><td colspan="2">Independent Variables:</td></tr>
<tr><td>Argentina
China</td><td>Government</td><td>Capital Markets & Market Structure</td></tr>
<tr><td>U.K.
U.S.</td><td>Geology & Infrastructure</td><td>Political Opportunity Structure</td></tr>
<tr><td colspan="3">Primary Theory: Historical Institutionalism</td></tr>
<tr><td colspan="3">International Political Economy framework: Varieties of Capitalism (Hall and Soskice)</td></tr>
</table>

Source: Zachary F. Sadow

1.4. What My Findings Suggest

My findings suggest all of the independent variables are important, with a unique mix of the variables also key, versus a prevalence or dominance of any one variable. However, it seems likely that the unique Capital Markets & Market Structure in the U.S. most substantially contributed to the country's success in

development, building on Wang and Krupnick's (2013) initial work on "what led to the boom". However, as some argue in my interviews, Geology & Infrastructure are critical components. Notably, the inclusion of Political Opportunity Structure in the SRDF builds on Wang and Krupnick's work and provides new insights into the challenges and opportunities actors and political economies face at the local level in developing natural resources that are strategically important at the national level. Due to this unique contribution, I place this chapter first (Chapter 4) among the Independent Variable chapters (Chapters 4-7).

As I show in Chapters 6 and 7 (Capital Markets & Market Structure, and Geology & Infrastructure, respectively), the evolution and underpinning factors of these Independent Variables carry critical importance. For example, the manner in which the U.S. infrastructure was built by private market participants is significant for shale development. As discussed in Chapters 3 and 7, this development was private-sector led in spite of energy security concerns at times, including immediately following World War II. The polycentric governance structure in the U.S. was also a key enabling factor, as argued by Ilia Murtazashvili and Ennio Piano in *The Political Economy of Fracking* (Murtazashvili and Piano 2019). However, I argue the importance of exploring the downside of polycentric governance for resource development, as discussed in Chapters 4 and 5, which provides opposition groups POS access points, one of the critical elements of the SRDF and a key addition to the literature.

My primary research and framework highlights how development can be hampered by the absence of any one variable, highlighted by weak geology in China and challenged capital markets in Argentina. However, it also highlights how CME structures can overcome these challenges through state support and reorganizing Market Structures for broader national strategic objectives, as discussed in relation to China's infrastructure reorganization in Chapter 7. Further, my findings suggest a highly fragmented and competitive market structure could be a key underappreciated independent variable for unleashing a comparative advantage for radical innovation, which could be unique to unconventionals and other resources that can be developed with a decentralized approach, building on similar assertions by Murtazashvili and Piano (2019). My incorporation of interviews with leading financial market participants provides retrospective insights into how the VoC framework played a role in unlocking or hampering development across the countries studied.

However, similar capital markets, industry structures, and market conditions in the U.K. did not result in a similar outcome, while development was blocked in the state of New York as well, suggesting Political Opportunity Structure is an underappreciated variable, providing the foundation for some of my most significant findings, and one of the key components to my new framework. As such, first-hand accounts in Chapter 4 provide insights into the paradoxical role of polycentric governance for LMEs in the SRDF, presenting both opportunity and risks to achieving the first-mover advantage that LMEs can have.

In addition to the earlier work on unconventional development by Wang and Krupnick (2013), Murtazashvili and Piano's (2019) retrospective review of unconventional development provides a provoking account of shale gas development in the U.S., primarily looking at the Appalachian Basin. Institutional property rights and polycentric governance are shown to be key components behind U.S. shale gas development for Murtazashvili and Piano. My work affirms Murtazashvili and Piano's argument. However, the incorporation of POS as a primary component in the SRDF illuminates some of the state-level variance as well as country-to-country LME differences in unconventional development approaches and outcomes, as shown by New York state, Pennsylvania, New Mexico, and the United Kingdom. As a result, the SRDF builds on the shale-specific inquiry of Wang and Krupnick (2013), and Murtazashvili and Piano (2019). This is discussed in greater detail in Chapter 3.

Notably, my findings highlight how strong POS coupled with strong local government autonomy and institutions outweighs the prevalence of other variables, as highlighted in the parallels between the bans on unconventional development imposed in the State of New York and in the U.K. This shows the access points that polycentric governance can award to opposition groups. Detailed first-hand accounts of these two historic resource-related events (New York and U.K. shale experiences) provide contrasting experiences against different mixes of independent variables, but similar ill-fated outcomes for development in LMEs with polycentric governance. A first-hand account on POS from Argentina shows how the absence of polycentric governance with strong local representation can lead to opposition groups struggling to influence development outcomes.

My research also illuminates my initial question of whether "there is something unique about the U.S. and shale development", and "if the U.S. has the only compatible mix of variables to successfully develop

shale". It does not. However, my research has strengthened some of the concepts developed by Hall and Soskice (2001) and could provide an appropriate framework to view future strategic resource development across various industries and regions.

The U.S., supported by its LME nature, has enjoyed an open and fragmented market structure, as development has successfully unfolded with the support of thousands of independently owned and operated exploration and production (E&P) firms. However, Argentina and China have steadily grown unconventional development, albeit through phases of stops and starts, utilizing MME and CME approaches characterized by quasi-state-led and state-led development approaches, respectively.

The slow and steady development of Argentina and China juxtaposed with the U.S.'s rapid response shows the U.S. model is not the only viable one for developing unconventional oil & gas. As a result, my research builds on Hall and Soskice's (2001) work on institutions and market structures and shows that certain types of strategic resource development that requires radical innovation has a comparative advantage in LMEs, while incremental innovation is better for CMEs. My first-hand accounts with various industry experts and practitioners in Chapters 4-7 show that while the U.S. experience has also driven significant incremental improvement, its global head-start for unconventional development was obtained through its LME structure, in accordance with the SRDF.

Further, the moderate and measured development experience in Argentina and China reinforces Hall and Soskice (2001) work on institutions, markets, and economies and affirms the SRDF's ability to access the development outlooks for MME and CMEs as well. The continued production growth and technological advances as well as the recent restructuring of the Chinese oil and gas market structure shows that China could be on the cusp of realizing a comparative advantage for incremental improvement, as discussed in Chapter 7, as a result of its CME structure. Argentina, however, through its MME structure continues to struggle to formulate the appropriate development approach, falling between the dynamic LME development experience (as realized by the U.S.), and the state-supported CME approach (which is beginning to show promise for China).

1.5. The Proliferation of Unconventional Oil & Gas in Retrospect

In this section, I look at the rise of unconventional oil and gas development in the U.S., discuss the evolution of the global unconventional resource experience, and the various phases of U.S. shale development in relation to the Independent Variables for the SRDF. I also discuss how the SRDF was tested for my case study and make some recommendations for how the SRDF can be applied at the start of similar strategic resource development cycles.

Leading Energy Investor & Expert (a code-name for one of my interviewees, as described in Figure 4), summed up the U.S. unconventional development experience in my interviews. Leading Energy Investor & Expert told me the U.S. "had the amazing confluence of geology that was opening up because of the technology…land that you can own, a very expansive infrastructure of service companies…rigs and equipment, plus pipelines, an ability to own and a capital market that is very willing to support new growth opportunities. Put all that together, and it was an explosion of activity."

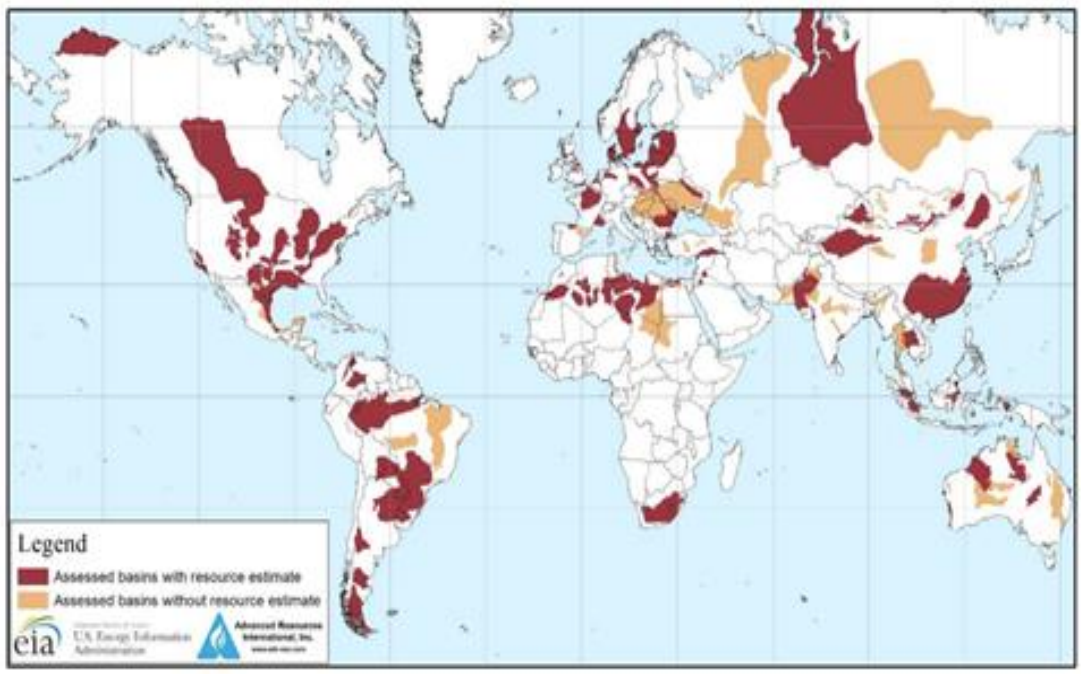
Since 2005, U.S. oil and gas production has increased over 115% and 105% (by year-end 2022), respectively, driven by unconventional oil and gas (US EIA 2023a; US EIA 2023b). With the rise of shale production in the U.S., there has been a wide range of support and opposition. The opposition points to a variety of risks and adverse impacts, including various environmental dangers, a rise in local congestion, traffic, and noise, and causality with earthquakes around certain geological formations (Than 2015; Jacquet 2014). However, unconventional production in the U.S. has created a number of strategic benefits, for: 1) the economy, 2) energy security and geopolitics, and 3) the environment (IHS 2014; O'Sullivan 2014; The White House 2015, US EIA 2013). My dissertation does not endeavor to weigh the reasoning for or against unconventional development. Rather, it presupposes the countries studied are pursuing unconventional development as a means of replicating the benefits the U.S. is currently realizing for their own unique strategic reasons.

In the early 2010s, national excitement over the potential from unconventional oil and gas led to speculation and inquiry into international shale development (PWC 2013). However, the scope of this study is limited to researching four countries (including the U.S.), where unconventional development has

been pursued for various broader strategic reasons. These countries are Argentina, China, and the U.K. ("International Sample Set").

In 2011, the U.S. Energy Information Administration (EIA) published a seminal report detailing global shale gas resources in response to growing global interest in shale development (EIA 2011). The report was updated and expanded in 2013 with the notable addition of shale oil (EIA 2013), as shown in Figure 2. These reports provide a snapshot of resources in place and global shale potential at the beginning of the shale revolution, highlighting the widespread potential for unconventional development and providing ample inquiry opportunities for additional retrospective research.

Figure 2: Map of basins with assessed shale oil and shale gas formations, as of May 2013



Source: U.S. EIA 2013

1.6. Testing the Strategic Resource Development Framework (SRDF)

Each of the countries in the International Sample Set has a unique combination of the Independent Variables in the SRDF, potentially challenging or supporting prospects for success. As a result, this study

explores various sub-topics in each component of the framework to identify potentially incompatible elements with shale development, and insights into other types of strategic resource development.

Leading Energy Investor & Expert noted during my interview with him that with the U.S. unconventional development boom, “if somebody could be replicating us, why haven't they done it? And so it must be hard for some reason. And I tend to think it's the combination of infrastructure, ingenuity, assets, willingness, bureaucracy, regulation. I mean, all the things you're working on says it's really unique, thank God for the USA.” However, the U.S.’s success in unconventionals is not without lessons learned. Success has been highly cyclical and volatile, fueled by loose credit followed by a large bankruptcy cycle, as discussed in Chapter 6, and included local environmental pushback, earthquake and water concerns, and the rise of sustainability-focused activist investor involvement, as discussed in Chapter 4 (Azar 2017; Hayes Boone 2022; Goldman Sachs 2022; Cotton et al. 2014; Williams and Sovacool 2019, 2020; Evensen et al. 2014; Ashmoore et al. 2016; Metze and Dodge 2016; Hedding 2017; Zanocco et al. 2020; Dokshin 2021; Dodge 2017).

John Kemp (2023), former commodities trader turned Reuters Senior Market Analyst, summarized that the U.S. shale experience has unfolded in three phases in a retrospective editorial titled “Is the U.S. shale oil revolution over?”. Kemp stated, “The first phase, focused on gas, lasted between 2005 and 2008, when it was cut short by the global financial crisis and the ensuing recession”. The emergence of this stage is detailed in the literature review with inquiry into some of the pioneering individuals that led the shale revolution, which I explore through a Constructivist theoretical lens in Chapter 3.

Kemp added, “The second focused on oil and lasted between 2009 and 2019, punctuated by a short-lived slump and recovery between late 2014 and early 2016” (ibid). My primary research and interviews mostly cover this period, with a notable focus on the debt-fueled growth cycle of the early 2010s, particularly in Chapter 6 on Capital Markets & Market Structure, as well as on the struggle between industry and opposition groups in Chapter 4 on Political Opportunity Structure.

Kemp concludes, in “the post-revolutionary phase, shale firms have become incumbents, focused on consolidation, eliminating excess capacity, avoiding over-production, controlling costs, increasing profit

margins and returning capital to shareholders" (ibid). At this point, the first-mover advantage for LMEs has already been realized. The technology and processes have proliferated to other markets with Argentina and China's slow and steady approach also standing to benefit. The U.S.'s first-mover advantage has brought geopolitical, economic, and environmental (through decarbonization) benefits; however, at this point in the post-revolutionary phase (as Kemp puts it), the SRDF shows that the comparative advantage begins to shift from LMEs to CMEs.

As such, with the maturity of the U.S. unconventional oil and gas market, the period in which the U.S. utilized its LME structure to realize its comparative advantage for radical innovation is now over. As a result, the benefits from this head-start to the U.S. have been secured and should continue to be realized. With the industry now in maturity, I argue that the period of incremental innovation has begun, and the U.S. should move to institute its comparative advantage for radical innovation elsewhere (or within sub-components of the shale industry which unlock new growth opportunities).

With the benefit of hindsight from incubation to maturity over a roughly 20-year development cycle, my hope is that my research can present questions for future research into the strategic resources of the future, including critical minerals such as lithium, cobalt, and rare earth elements, and how these resources can be sustainably developed with the benefit of better understanding of the unconventional development experience and the incorporation of the SRDF approach.

Breaking down the various Independent Variables of the SRDF and exploring the phases of the sub-cycles of the broader shale development cycle provides insights into how the U.S. achieved its LME-based first-mover advantage. This includes inquiry into which Independent Variables were particularly enabling and how these same Independent Variables have either helped or hurt development across the other countries studied (spanning LMEs, CMEs, and MMEs).

In retrospect, the U.S. has been successful in developing unconventional oil & gas from a production growth standpoint, propelling it to the largest oil and gas producer in the world and bringing a plethora of economic, environmental, and energy security benefits with it. With the benefit of the unconventional

oil and gas experience now available and first-hand accounts into the Independent Variables that unlocked it, the SRDF has now been tested on this strategic resource and is available for future inquiry.

1.7. Conclusion of Introduction Chapter

Suggestions for Future Research - Testing the SRDF Across Countries, Technologies, and Resource Bases

In this Chapter, I introduced the SRDF and its initial use on unconventional oil and gas as a case study. I highlighted how the comparative advantage for LMEs for radical innovation has applied to shale with disproportionate benefits realized by the U.S. through the shale development cycle. However, I also highlight that there is now an opportunity for CMEs, which have a comparative advantage for continual improvement, to begin to realize the benefits of unconventional development, at a time when the U.S. shale industry has reached maturity and a point of diminishing returns. In the conclusion portion of this chapter, I also make suggestions for future research based on my findings and research experience, as well as on the availability of the SRDF.

Of the countries studied, China and Argentina have continued to make progress but have underperformed expectations and have not been able to replicate the U.S.'s success in unconventional development, in-line with the expectations of the SRDF based on Hall and Soskice's (2001) VoC framework. I also introduce the importance of including Political Opportunity Structure in the SRDF, as the U.K. and New York halted development efforts show the paradoxical nature of LMEs for strategic resource development.

Looking back since the start of the shale development cycle starting in the mid-2000s, few other countries have meaningfully pursued unconventional development, and less are now still pushing forward. This dissertation provides insights into this by viewing the countries explored through the SRDF.

As I discuss in Chapter 4, the U.K. struggled to align local and national interest and garner the required community support where drilling took part. Murtazashvili and Piano's (2019) work on the importance of institutional property rights for unconventional development is at play here, but my primary research into the U.K. via a first-hand account by UK Oil & Gas Executive, former executive at Cuadrilla Resources, as well as my interview with NY Fracking Opposition Leader on the New York experience suggests more than

just property rights impacts development in LMEs. Alternatively, China has struggled with challenging geology and its CME approach, but continues to make progress, reinforcing its market structure's benefits for continual improvement, as well as highlighting the benefits of longer-term strategic alignment between national and local governments.

This introduction also shows how the SRDF has strengthened the VoC framework and created a tool for strategic resource development. For example, despite a highly attractive resource-base, Argentina, an MME, has had limited success attracting outside capital due to domestic economic and fiscal policy concerns, as discussed in Chapter 6, which has resulted in the dominance of the larger Major oil & gas companies as part of the market structure, an absence of leading-edge technology, and has limited unconventional development. The continued upward trajectory of Argentina and China's unconventional production argues the importance of property rights could be overstated for longer term development and is only more of an enabling aspect of the rapid-development comparative advantage awarded to LMEs, strengthening Hall and Soskice's (2001) VoC arguments with the introduction of the SRDF.

Further exploration of each of the Independent Variables in each of the countries is suggested. Notably, what has the experience been for the development of other strategic resources in these countries? How were the Independent Variables different for those development experiences? For example, how is the Political Opportunity Structure different for geothermal development in the U.S. or U.K., and how might this affect the outlook for the proliferation of geothermal technology and its practice in these country, or other LMEs? Like hydraulic fracturing, the drilling of geothermal wells has shown to induce seismicity, a key issue for shale opposition groups, as discussed in Chapter 4. Is there something unique about fracking or geothermal that has provided different Political Opportunity Structure foundations, or is the geothermal industry learning from the shale experience?

Also, for example, how has capital availability and market structure for wind and solar development in Argentina differed from shale development? Or hydrogen or lithium development in Chile, for example. These are some of the countless questions and examples of how the SRDF approach can be applied across economies, technologies, and resource bases for the benefit of better understanding outcomes for the future.

Finally, how have local and national government views aligned or deviated for these and other strategic resource development initiatives in the countries studied and other ones utilizing fracking or introducing new extraction or energy technologies, is an important question. This question can provide a baseline starting point for Political Opportunity Structure inquiry using the SRDF across various countries, technologies, and resources. The juxtaposition of the U.S. unconventional development experience versus other countries' shale development experiences provides ample questions of national importance across regions, economies, and technologies, with widespread and important implications for security, economics, and the environment.

Applying the SRDF across new energy technologies, resources, and countries will lead to 1) economic benefits, 2) enhanced energy security, and 3) better environmental outcomes. These three outcomes are derived from the energy literature and discussed in detail in Chapter 3.

Chapter 2: Design & Methodology

2.1. Introduction

This chapter has two parts, with the first part describing my research design, methodology, and this dissertation's layout, and the second describing the rationale for the countries studied to develop shale.

The first part details how I constructed the SRDF, how I approached oil & gas as a case study for the SRDF, how the SRDF Independent Variables were formulated and then analyzed, how I conducted my primary research (interviews), and how I incorporated my primary and secondary research into my general findings and conclusions.

The second part discusses the strategic rationale to develop shale for the countries that I examine, as a major part of the SRDF is the strategic component and that countries have a national priority to develop the resource of interest, including high-level support for various strategic considerations. As such, the SRDF is a tool to infer resource development outcomes where a government deems doing so a national priority in support of broader strategic objectives.

As a result, the second part of this chapter discusses the country-specific strategic rationale to develop shale and breaks down the three underpinning strategic variables (economics, energy security, and the environment), as uncovered in my literature review in Chapter 3.

2.1.1. Part One - Dissertation Design & Methodology

I began my research with my in-depth literature review, spanning energy policy themes over the past century and exploring how my research relates to the various Political Economy theoretical approaches (Chapter 3). The literature review provides a foundation for my dissertation, with my new framework built on Hall and Soskice's (2001) VoC framework (grounded in Historical Institutionalism) and the Independent Variables built on the energy policy literature, notably Wang and Krupnick (2013), and Murtazashvili and Piano (2019).

The literature review is thematic in nature, as opposed to geographic. As a result, the literature review is more geared to the U.S. relative to the other countries studied due to: 1) the U.S.'s role as an energy supplier during World War II, 2) the U.S.'s role in the Middle East during the 1970s oil price shocks, 3) the U.S.'s role in incubating fracking technology through government programs during the 1980s and 1990s in response to the U.S. natural gas crisis in the 1970s, and 4) the U.S. being home to the shale revolution following the commercialization of fracking in the 2000s.

As discussed in detail in the literature review (Chapter 3), there are three main and recurring themes that have dominated energy literature and have driven much of the various cycles of investment and policy. These are 1) economics, 2) energy security, and the environment. I utilize these three themes as the reasoning for countries' decision to pursue natural resource development, potentially deeming them strategic or not, irrespective of if they are publicly deemed as such. All of the countries I studied deemed shale a strategic priority at one point; however, I note that a government might not publicly state a resource is strategic (it is up to future researchers utilizing the SRDF to decide as part of their research process).

With my literature review largely conducted and informing both my theoretical lens and the construction of the SRDF (through the Independent Variables), I then conducted secondary research on each of the Independent Variables by sub-themes and country. This secondary research is woven throughout Chapters 4-7. Following my in-depth energy policy and theoretical literature reviews, I then conducted my primary research interviews in-parallel with additional country-specific Independent Variable secondary research, in-line with suggestions from the IPE interviewing literature (Richards 1996). As such, my interviews led to more research, which in-turn further informed my conclusions.

Importantly, as it relates to my theoretical lens, the Historical Institutional elements to the Independent Variables and countries studied provided critical insights and helped inform development outcomes. Said differently, *how* a part of a country's political economy was formed helped inform how that country's shale development experience might have unfolded. Specifically, how a country developed their infrastructure (no matter how long ago), provided insights to how they utilize it today. Over and over again, my dissertation shows that past policy commitments helped form today's natural resource strategy and can inform tomorrow's development outcomes (Ikenberry 1988). This is prevalent throughout chapters 4-7.

As such, my research design is meant to be self-reinforcing, with the Independent Variables informing each other, and with country-specific Historical Institutional foundations impacting development outcomes. As a result, the SRDF is a dynamic tool for researchers to utilize across countries, natural resource bases, and technologies.

2.1.2. Independent Variables: Deconstructing the Components which Made U.S. Development Successful

The research provides in-depth analysis into the four key components that influenced unconventional development in the U.S., and which determine a country's ability to successfully develop unconventional resources. These include: 1) Government, 2) Geology & Infrastructure, 3) Market Structure & Capital Markets, and 4) Political Opportunity Structure. Each of these Independent Variables are discussed in their own chapters (chapters 4-7).

The Independent Variables were built on Wang and Krupnick's (2013) work on the U.S. shale experience and aim to isolate the key political economy components of the countries studied in order to infer shale development outcomes. Each of the four variables have multiple sub-elements and are influenced by various distinct actors that are incentivized differently, and different institutional arrangements that are influenced by governments and past policy promises (Ikenberry 1986).

The variables are underpinned by the VoC framework, which is actor-centered and "seeks to advance [actor] interests in a rational way with strategic interaction with others" (Hall and Soskice 2001; Scharpf 1997). Hall and Soskice add that these actors can be "individuals, firms, producer groups, or governments" (ibid). This allows for the Independent Variables to influence development outcomes by the strength of the institutions in which these actors operate through and interact with. In addition to the groups Hall and Soskice list, the SRDF includes opposition groups, as shown in Chapter 4 on Political Opportunity Structure, as these groups are critical stakeholders that can affect development outcomes, particularly depending on governance structures and political economy backdrops, as my primary research affirms.

Overview of the Independent Variables for the SRDF

Each country has a unique mix of the Independent Variables, as highlighted in Figure 3. Chapters 4-7 explore each variable in-depth by country. As discussed in Chapter 4, POS is a critical aspect of the SRDF,

with LMEs more at risk from opposition groups hindering development before a fit-for-purpose regulatory regime is enacted. The LME economies of the U.S. and U.K. are polycentric in nature, with overlapping governance at the national, central, state, and local levels, despite the U.K. "being much less decentralized" than the U.S. (Evensen et al. 2017).

While POS presents a challenge for LMEs, as detailed in the cases of New York and the U.K. in Chapter 4, the Capital Markets independent variable present benefits in these economies, as detailed in Chapter 6. Azar (2017) argues ample debt capital stemming from low interest rates in the aftermath of the 2008 financial crisis paired with American entrepreneurship, "created the conditions for a surge in production that ranks among the biggest oil booms in history". My primary research reinforced Azar's argument with support from various financial market participants.

Regarding the Geology & Infrastructure variable, the fragmented nature of the U.S.'s competitive landscape coupled with the access to capital from infrastructure investors through multiple investment cycles created legacy infrastructure and a digital sub-surface library which was leveraged by the U.S. companies and helped to catalyze unconventional development growth, as detailed by my primary research in Chapter 7.

As shown below, MME-based Argentina has both strong national and local Government variables, making it more unicentric than the U.S. and U.K., and providing limited POS access points. Research shows limited POS access at the national and local levels can lead to confrontational and non-conventional protest measures (Garland et al. 2023). My primary research in Argentina supports Garland et al.'s argument, as shown in Chapter 4. Particularly hindering for development in Argentina's MME is the lack of state support and international institutional investor interest, as detailed in Chapter 6. Argentina's middle-of-the road MME approach juxtaposes with China's strong state-led support for its infrastructure build-out over multiple investment cycles, as Francisco (2013) details, and the loose monetary conditions Azar (2017) argues created the U.S. shale boom. A summary of the Independent Variables by country, based on my primary and secondary research, is shown in Figure 3 below.

Figure 3: Overview of Independent Variables of Sample Set for Unconventional Oil & Gas Development

Country & Market Economy Type	Government	Capital Markets & Market Structure	Geology & Infrastructure	Political Opportunity Structure
Argentina Mixed Market Economy (MME)	Polycentric governace with strong federal and provincial influence, limiting local Political Opportunity Structure access.	Weak capital markets challenged by in-country credit and monetary concerns. Somewhat developed in-country credit system. Market structure includes quasi-NOC, Majors, and some Independents. Market participants limited by liquidity challenges.	Highly attractive geology from permeability and porosity perspective characterized by multiple layers of economically extractable resourses. Decent understanding of resource through legacy conventional oil and gas operations. Some legacy infrastructure, but inadequate to maintain production growth.	Strong labor support outweighs local opposition access to Political Opportunity Structure (POS). Indigenous groups struggle to gain POS access. Opposition group demonstrations have failed to achieve more than "transactional" relationship with industry and government over development.
China Coordinated Market Economy (CME)	Unitary governance with strong alignment at national, regional, and local levels.	Strong state financial support. Market led by small group of State Owned Entities (SOEs).	Significant resource but highly challenged geology from permeability and porosity perspective characterized by jagged and inconsistent layers of resource. Challenging geology has limited development; however, there are indications these challenges are being overcome. SOE owned infrastructure (developed by NOCs but recently reorganized for broader industry efficiencies).	Unitary governance structure coupled with limited national-led regulatory structure provides low levels of local Political Opportunity Structure access. Limited local POS access has led to demonstratoins focused on water and earthquakes.
U.K. Liberal Market Economy (LME)	Polycentric governance with strong local representation.	Established capital markets most similar to U.S., and potential for fragemented market structure as well (also like U.S.).	Challenged geology characterized by inconsistent formation and prevelance of fault lines. Limited understanding of geology due to little legacy onshore development in shale areas. Overestimation of relevance of onshore oil & gas infrastructure.	Polycentric governanace and strong local representation led to opposition groups stopping development by influencing the regulatory framework. POS access of regulatory regime ahead of "fit-for-purpose" local and regional regulatory framework being enacted led to fracking ban.
U.S. Liberal Market Economy (LME)	Polycentric governance with strong local representation.	Deep and dynamic capital market systems, with significant equity, debt, and reserve-based lending. Highly fragmented market structure characterized by over 9,000 independent oil and gas companies.	Vast resource spanning multiple basins with attractive geological characteristics coupled with significant understanding of resource base due to prolific legacy production. Substantial legacy infrastructure built over multiple decades of industry-led development.	Polycentric governanace and strong local representation led to New York fracking ban as the result of a coordinated and systematic opposition effort. Scope for high levels of POS access ahead of "fit-for-purpose" state level regulatory regimes enacted.

Source: Zachary F. Sadow, Researcher's findings

2.1.3. Interview-Based Research Design

Primary research was conducted through interviews of individuals with relevance to the themes for the Independent Variables in each respective country. Literature on conducting elite, semi-structured interviews informed my approach to the process (Berry 2002; Harvey 2010; Richards 1996; Kannemeyer 2011).

As detailed in Figure 4 below, 25 interviews (*n*=25) were conducted with industry experts and participants, utilizing a purposive sampling method. All interviews were conducted and recorded via Zoom, except for one which was conducted by telephone. Interviews took place from May 2020 to February 2021, following the majority of my secondary research, as suggested by Richards (1996), who states, "In the vast majority of cases, elite interviewing is probably most productive in the latter stages of your work".

Interviews were transcribed and analyzed using Nvivo software and organized by sub-themes within the Independent Variable chapters. Findings from interviews led to additional secondary research.

Interviews came to fruition through a combination of purposive sampling and network snowballing. Snowballing was particularly prevalent in Argentina leading to a higher number of interviews relative to the other countries (*n*=11), compared with China where purposive sampling was utilized with little snowballing (*n*=3). Snowballing was prevalent in my interview process, reinforcing Richards' argument that conducting interviews later in the research process can help with snowballing (ibid).

Interviewees ranged from industry participants (company executives) to current and former government regulators and officials, to country-specific industry observers, to engineers and geologists, to academics and think-tank researchers, to members of the financial community, including leading investors and analysts in the energy industry.

There were notable absences from my interviews that could present unique opportunities for future scholars to build on my research. In Argentina, I was unsuccessful in reaching members of the Mapuche indigenous peoples, as well as union representatives. In China, my interviews were limited to academics and think-tank specialists, due to challenges in accessing potential interviewees. These interview limitations in Argentina and China provide an opportunity for future researchers to build on my work and

conduct additional interviews to the point of saturation. The breadth of my research made achieving the point of saturation for all Independent Variables and countries challenging and presents an opportunity for follow-up research.

All 25 interviews were conducted in English, presenting a limitation for my interviews in Argentina, as many of the interviewees spoke English as their second language. Conversely, all of the U.S., U.K., and China focused interviewees spoke English as their first language to my knowledge.

In the U.K., it would also be beneficial to speak with a member of the grassroots opposition (similar to NY Fracking Opposition Leader), to complement the detailed U.K. Political Opportunity Structure account from the industry perspective by UK Oil & Gas Executive.

In the U.S., the interviews covered the span of the Independent Variables; however, future researchers could benefit from additional discourse by speaking with opposition leaders in other left-leaning resource-rich states (similar to New York), such as New Mexico and Colorado.

All of the interviewees were informed the interviews would be recorded and on-the-record prior to the interviews commencing, as suggested by Richards (1996). As also suggested, all interviewees were asked permission to record the interviews and had the opportunity to have certain insights not attributed to them (ibid). To provide transparency, as suggested, I provided each interviewee with the context of my research and studies (Harvey 2010). While only one interviewee asked that I conceal their identity for professional purposes, I have concealed the identities of all 25 interviewees for standardization.

As such, I refer to the interviewees by their code names, as shown in Figure 4, which are professional descriptions or abbreviations.

Figure 4: Interview Breakdown for Dissertation Research

Code Name / Professional Abbreviation	Country Focus	Independent Variable of Focus
Argentina Big Four Accountant	Argentina	Capital Markets & Markets Structure
Argentina E&P Executive	Argentina	Infrastructure & Geology
Argentina Community Engagement Executive	Argentina	Political Opportunity Structure
Argentina Oil & Gas Consultant	Argentina	Capital Markets & Markets Structure
Argentina Oil & Gas Investment Banker	Argentina	Capital Markets & Markets Structure
Argentina Oil & Gas Lawyer	Argentina	Government
Argentine Oil & Gas Investor	Argentina	Infrastructure & Geology
China Energy Analyst	China	Government
China Oil & Gas Geologist	China	Infrastructure & Geology
Former Development Bank Energy CIO	Argentina	Capital Markets & Markets Structure
Global Oil Service & Clean Energy Analyst	U.S.	Capital Markets & Markets Structure
Former IEA Energy Analyst	China	Capital Markets & Markets Structure
Former U.S. Oil & Gas Regulator	U.S.	Government
Integrated Oil Energy Analyst	U.K.	Capital Markets & Markets Structure
Argentina VP of Exploration	Argentina	Infrastructure & Geology
Argentina E&P Executive	Argentina	Infrastructure & Geology
Leading Energy Investor & Expert	U.S.	Capital Markets & Markets Structure
New Mexico Cabinet Level Secretary	U.S.	Government
NY Fracking Opposition Leader	U.S.	Political Opportunity Structure
International Oil Service Analyst	U.K.	Capital Markets & Markets Structure
Private Equity Energy Investor	U.S.	Capital Markets & Markets Structure
Retired Argentina Oil Executive	Argentina	Infrastructure & Geology
Seasoned Permian Basin Entrepreneur	U.S.	Infrastructure & Geology
UK E&P Analyst	U.K.	Capital Markets & Markets Structure
UK Oil & Gas Executive	U.K.	Capital Markets & Markets Structure

Source: Zachary F. Sadow

2.1.4. What did I want to get out of the interviews? What actually came out?

The interviews sought to help determine some of the most challenging sub-topic elements to overcome in each country. There were four sets of interview questions, corresponding to the various elements of the U.S. Model. Interviewees whose experience and expertise most matched that of a particular component of the U.S. Model were given the corresponding interview (ie, a petroleum engineer would undergo the "Geology" interview, while a corporate executive or capital markets professional would undergo the "Capital Markets & Market Structure" interview).

Despite aiming to maintain continuity in the questions across the Independent Variables in the interviews, many conversations took organic turns, particularly when interviewees focused more on a specific narrative or story. Harvey (2010) argues, "interviewers should avoid asking too many formulaic questions and instead focus more on achieving a conversational flow". This was notably the case with three of the Political Opportunity Structure interviews, particularly for the U.S. (New York experience), U.K. (Cuadrilla experience), and Argentina (Argentina Community Engagement Executive and the Mapuches experience). In these instances, I aimed to allow the interviewee the space to relay the events that unfolded for the relevant Independent Variable but tried to address the questions at-hand without disrupting the conversation. This is in-line with Berry's (2022) suggestion. Berry argues, "For projects where depth, context, or the historical record is at the heart of data collection, elite interviewing using broad, open-ended questioning might be the best choice".

As a result, the POS chapter deviates from the other chapters in that it reads more as a narrative of separate events for key opposition events told by individuals with unique perspectives and first-hand accounts. Alternatively, the other three Independent Variable chapters are more intertwined and thematic, underpinned and guided by the literature review, as was the intention.

Overall, the interviews were intended to deconstruct the various sub-topic issues in an effort to uncover common themes, challenges, obstacles, and risks that could constitute a particular International Sample Set country incompatible to unconventional development under the U.S. Model. All of the chapters provide unique insights based on the first-hand accounts for future research into strategic resource development.

2.1.5. Broad Research Themes

1) Is unconventional resource development possible for countries with different components than the U.S. Model?

2) Are there elements of the U.S. model that are critical to successful development, while others are "nice to have"?

3) Is there something unique about unconventional resource development (relative to conventional) that the U.S. model needs to be followed?

4) Is unconventional resource development incompatible with any of the political structures in the "International Sample Set"?

5) Will the pursuit of unconventional oil and gas development lead to national energy reform, or material changes to any of the elements in the U.S. model?

2.2.1. Sample Selection Rationale: Shale as a Strategic Priority

Part 2 of this chapter details the strategic rationale behind each of the International Sample Set countries in their quest to develop unconventionals against various unique domestic energy mixes. Further, it explores the domestic considerations related to each of the three Strategic Rationale's found in the literature review (Energy Security, Economics, and the Environment), highlighting different countries' decisions to pursue unconventionals.

In addition to the U.S., the countries chosen, Argentina, China, and the U.K., all positioned unconventional development as a strategic priority, driven by one or more of the key themes found in the energy policy and economics literature review. As noted, many more countries have unconventional resources, and some are pursuing development. However, the selection of Argentina, China, and the U.K., is based on their national strategic priority for development. I also explore why some shale-rich countries were omitted from my research, such as Poland, South Africa, Russia, and Saudi Arabia.

Most of the data from this section comes from the mid-2000s to early 2010s, when governments utilized this data to formulate views on if shale was a strategic resource or not (however, I do mix in some newer data, such as the IEA Total Energy Supply charts by country, for a wholistic energy mix snapshot).

I do not retrospectively validate the forecasts made from the decade or so ago, but rather include it to show the motivations for developing shale within the historical context of the period in which it was deemed a strategic priority.

2.2.2. The U.S.'s Strategic Rationale at a Glance

The U.S. was chosen as the baseline case to measure the International Sample set against. This section explores the Strategic Rationale for the U.S. (and the other countries), pursuing unconventionals. Of the three identified Strategic Rationale points identified in the literature (Energy Security, Economics, and the

Environment), the U.S. has pursued unconventionals for all three, leveraging its unique Independent Variables to affect the outlook of these three dependent variables.

There has been substantial inquiry into shale's effects on the three Strategic Rationale points (Bilgili et al. 2016; Fleming et al. 2015; Cooper et al. 2015).

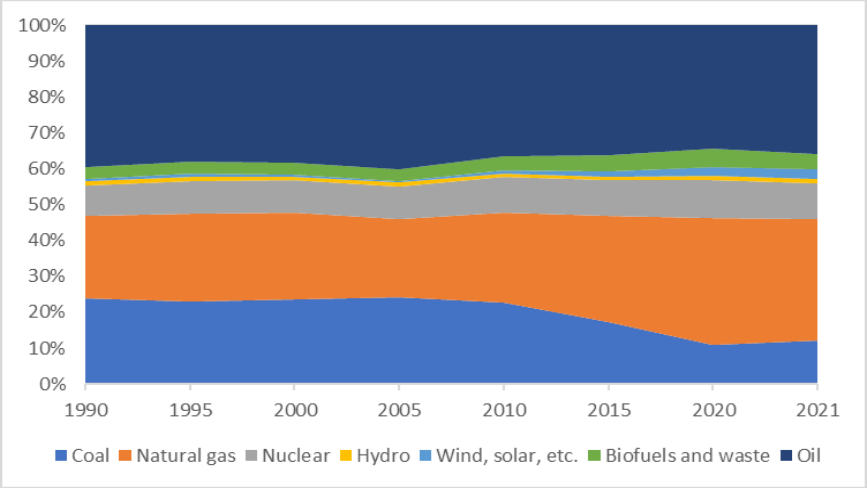
As Gamber-Rabindran (2017) argues, the alignment of the Strategic Rationale in the U.S. facilitated development, stating "the US strategy of expanding domestic oil and gas production to secure energy resources created a supportive political, economic, and legal environment for the oil and gas industry and its offspring, the shale industry".

More broadly and looking back, the U.S. benefited from an increase in unconventional development economically, geopolitically, and environmentally, as O'Sullivan (2017) details stating, "energy has long been a driver of international affairs". This came at a time when economic growth has slowed following the financial crisis, political appetite for American military activities abroad has waned following the Iraq War, and heightened efforts were being made to address climate change. As such, the U.S. strategic rationale for shale fits all three of the key criteria uncovered in the literature review.

As shown in Figure 5, the share of natural gas in the energy mix has increased substantially at the expense of coal, supporting the U.S.'s decarbonization efforts. Shirazi and Šimurina (2022) argue this coal to natural gas substitution lowers carbon in the short and medium term, but that it could hinder longer term decarbonization efforts by discouraging investment in renewable and other low-carbon technologies.

Figures 5-8 shows Total energy supply (TES) by country for the U.S., Argentina, China, and the U.K., respectively. TES is defined as "all the energy produced in or imported to a country, minus that which is exported or stored", representing total energy required to supply end users domestically (IEA 2024).

Figure 5: Total energy supply (TES) by source, United States 1990-2021



Source: IEA, United States, Available from: https://www.iea.org/countries/united-states

2.2.3. Argentina's Strategic Rationale at a Glance

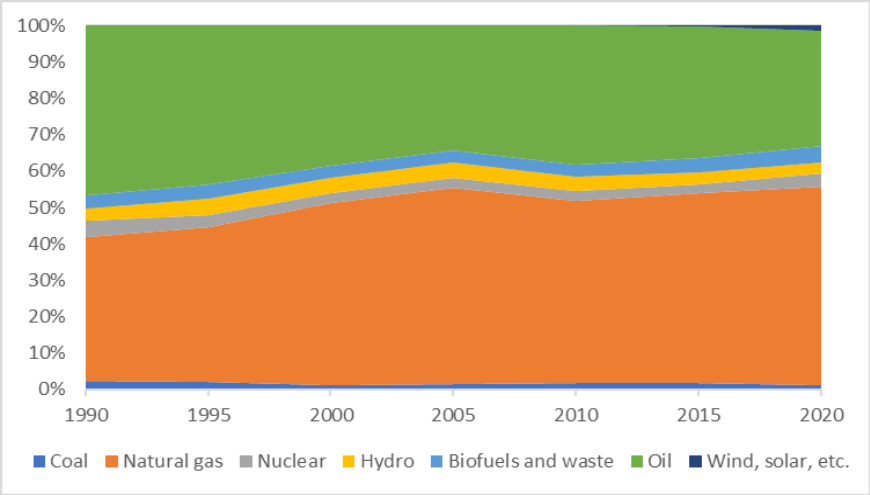
Argentina was chosen due to its strategic interest in developing shale oil and natural gas. This strategic interest is driven by economic and energy security considerations to a lesser extent. As an MME, Argentina provides a case for inquiry for the SRDF between the liberal market U.S. and U.K. shale experiences and the state-led CME Chinese experience. Collins et al. (2021) argues "Argentina is a risky place for foreign investors, with frequent political swings from right to left, weak enforcement of contracts and property rights, endemic corruption, combative unions and a volatile macroeconomic environment". However, Collins highlights that despite these concerns, Argentina still attracted significant foreign direct investment for shale development in the 2010s (ibid). My primary research reinforced these concerns.

In 2011, following YPF's shale gas discovery in the Neuquén basin, O'Neill (2011) argued "If exploited it would easily cover domestic demand for gas for the foreseeable future and end the recurring and unpopular gas crises that force factories to shut down at times during the winter months. Argentina would become energy self-sufficient for the first time in nearly a decade". As discussed in the Energy Security section of this chapter, in 2012, the unconventional shale assets were nationalized as a result of national security interests. Piragine et al. (2018) argued shale "represents a huge opportunity for the country to recover energy self-sufficiency and its exporter position.

As a result of the transformative potential shale presents to Argentina, and the government's stated strategic interest in developing it, I include the country in the International Sample Set for my research.

Argentina faces various economic challenges, including slow growth, slowing investment, and high inflation. These economic factors are compounded by the lack of investor confidence as a result of the various concerns Collins et al. (2021) articulated. Security of supply is also an important consideration as the country has a high dependence on oil and natural gas, as illustrated in Figure 6. Price caps imposed on natural gas in 2003, following the country's default in 2002, led to natural gas proved reserves falling significantly as investment declined (Mares 2013). These price caps were often cited during my primary research as a meaningful challenge for efficient economic development, as discussed in Chapters 5 and 6.

Figure 6: Total energy supply (TES) by source, Argentina 1990-2020



Source: IEA, Argentina, Available from: https://www.iea.org/countries/argentina

2.2.4. China's Strategic Rationale at a Glance

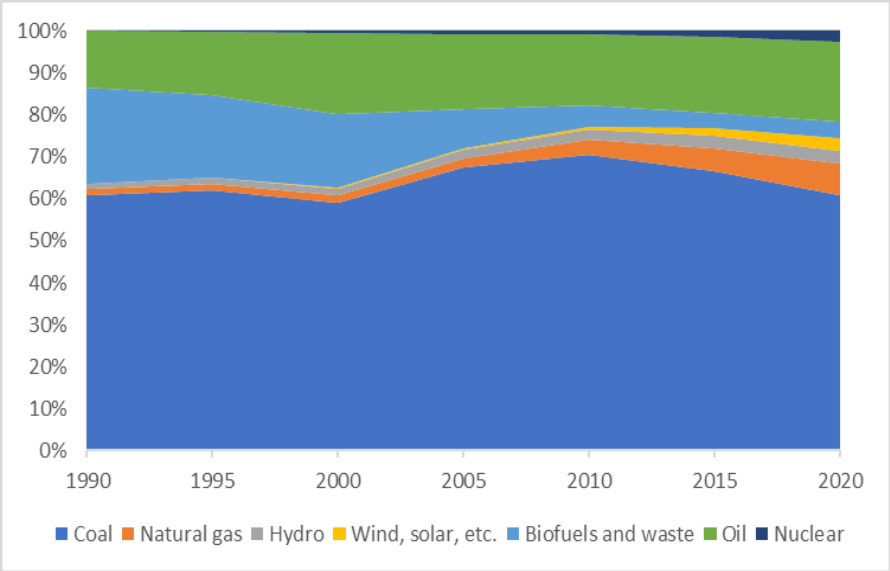
China was chosen in the International Sample Set of my research due to shale being explicitly deemed of national strategic importance by the country's leadership and being included in China's 12th and 13th Five-Year Plans (Asia Pacific Energy Portal 2011; Asia Pacific Energy Portal 2016).

China's strategic interest in developing unconventional resources spans economic, geopolitical and energy security, and environmental considerations, but led by security. Economic considerations include helping

lower global and domestic energy prices, creating rural jobs, and helping develop new technology-focused manufacturing and service industries to support unconventional operations. Geopolitically, the country is highly focused on promoting security of supply through resource diversification and developing domestic energy sources. Environmentally, the country has been combating high levels of pollution and smog and has looked for ways to lower its carbon footprint to meet climate and carbon reduction targets. As illustrated in Figure 7, domestic energy production is dominated by coal, necessitating power alternatives.

The Chinese government expressed its support for domestic shale gas development and stated its guiding policies for supporting shale gas in a development plan for Chinese shale gas jointly issued by the National Development and Reform Commission (NDRC), the Ministry of Finance, the Ministry of Land and Resources (MLR), and the National Energy Administration (Kwok and Li 2015).

Figure 7: Total energy supply (TES) by source, China 1990-2020



Source: IEA, People's Republic of China, Available from: https://www.iea.org/countries/china

2.2.5. The U.K.'s Strategic Rationale at a Glance

The U.K. was chosen in the International Sample Set for my research due to the national government's strong support for shale development and its stated strategic intent on developing the country's shale resources. As an LME, the U.K. shale experience complements the U.S.'s successful shale experience and

provides insights into the importance of incorporating POS inquiry into national strategic resource development considerations.

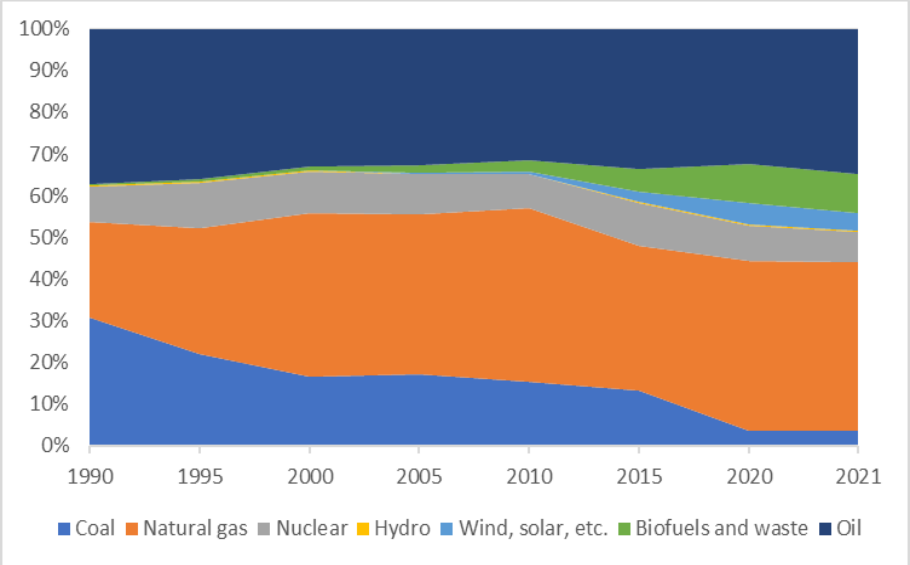
Strategic interest in developing unconventional resources in the U.K. has been fueled by concerns around energy security as North Sea production declines, hopes for economic growth and tax revenues, lowering domestic energy prices, and interest in further industrial competitiveness. As such, there was strong support for shale gas development in the national government.

While shale gas development in the U.K. could help support a cleaner, cheaper, and more secure energy system, it was not seen to be a game changer in the U.K., like in the U.S. (White, Fell, and Smith 2015; Parliament 2012). However, as illustrated in Figure 8 below, natural gas TES has risen substantially in the U.K. over the past three decades.

Roughly 98% of the U.K.'s oil production and substantially all of its natural gas production comes from the U.K. North Sea (DECC 2015). Oil and gas production had dropped to under 950 thousand barrels per day, and ~1.04 bcm annually, respectively, 65-70% below peak levels of in 2000 (BP 2015).

The Russia-Ukraine war and corresponding energy crisis has resurfaced new arguments for unconventional gas development (Lawless 2022).

Figure 8: Total energy supply (TES) by source, United Kingdom 1990-2021



Source: IEA, United Kingdom, Available from: https://www.iea.org/countries/united-kingdom

2.2.6. Shale-Rich Countries not Explored

Other countries have explored and endeavored to pursue unconventionals for various strategic purposes, such as Mexico, Algeria, Saudi Arabia, Poland, Japan, New Zealand, South Africa, Colombia, Egypt and others. However, my research design would not facilitate analyzing the full set of countries pursuing unconventionals.

Of the countries that have been omitted from the International Sample Set, I would anticipate questions around the exclusion of Russia, Saudi Arabia, Poland, Canada, and South Africa. These countries have had some strategic initiatives around developing unconventionals and have an interesting set of key components as well.

Initially, my research included Russia in the International Sample Set; however, it was removed as shale has not been as much of a strategic priority in the country due to its ample conventional resources. Potential challenges conducting primary research due to deteriorating diplomatic relations, as well as band-width constraints, also contributed to the exclusion of Russia from my research. Further, western sanctions targeting oil service technologies inhibited unconventional development in Russia's Bazhenov shale (Mitrova 2016). As a result, the Russian unconventional experience has been slow to start; however, development has moved forward albeit at a small-scale (Astakhova 2021). As a result, evaluation of Russia's shale experience and potential utilizing the SRDF by future researchers could provide unique insights when viewed over a longer time horizon.

Poland held high hopes and expectations to follow in the U.S.'s shale experience, with a claim from the country's foreign minister, Radoslaw Sikorski, that the country was set to become "a second Norway" (Kenarov 2013). Further, framing analysis on fracking in Poland from two leading Polish newspapers from 2010 to 2012 showed, "The coverage is overwhelmingly positive and the hegemonic representation of fracking suggests that it will solve all of Poland's economic and political problems and actively bolster the future and wellbeing of the country" (Jaspal et al 2014).

However, despite the high hopes and in-country support, the country saw an exodus of oil & gas companies from Poland from 2011 to 2015, including ExxonMobil, Marathon, Total, Talisman Energy, Chevron ConoccoPhilips (Reuters 2015; Nelsen 2015).

Following over 30 interviews with "energy experts, industry representatives, geologists, environmentalists, politicians (from high-ranking government ministers to small-town mayors), as well as numerous local residents affected by the drilling", the major problem facing Poland's shale sector was deemed "the lack of scale, both technical and financial" (Kenarov 2013).

As a result, the Polish shale experience was omitted from my research as exploration was largely abandoned by industry participants early in my research process around 2015. This differs from the New York and U.K. shale experiences, where development was being pursued by industry but halted by this time as a result of Political Opportunity Structure considerations. As a result, Kenarov argued "The shale gas bubble in Poland has burst under the pressure of its own economic contradictions" (ibid).

A more nuanced analysis of why Poland fell short in realizing its early shale expectations could be considered by future researchers utilizing the SRDF, with particular focus on the Geology & Infrastructure, and Capital Markets independent variables. Scholars could specifically analyze variance in these two independent variables for the SRDF between Poland and China, as China has slowly overcome geologic challenges.

South Africa, while also rich in shale resources, was omitted due to a lack of a strategic interest, similar to Russia and Saudi Arabia. In a retrospective analysis into South Africa's early shale experience, Andreasson (2018) states, "While government seeks to proceed with exploration, a dominant coal industry and other alternatives including renewables and nuclear compete for attention, and there are increasing concerns about the size and economic viability of South Africa's shale gas deposits".

Andreasson highlights some of the key concerns and differences between the U.S. shale experience, such as ownership of the minerals at the national government level, lack of pipeline and infrastructure, and an absence of local support. However, most importantly for my research is the general lack of federal cohesion in support for shale development in South Africa. Andreasson states, "vocal government support for SGD (shale gas development) has primarily been associated with a narrow group of actors, centred on former President Jacob Zuma and his closely affiliated departments of Energy and Mineral Resources. The departments of Environmental Affairs and Water Affairs have generally opposed SGD, due in particular to the risks posed by SGD to underground water" (ibid).

As stated, the countries chosen for the international sample set for my research all had national governments which viewed developing shale resources as a national strategic priority, a key aspect of the SRDF. As a result, South Africa has been omitted from research.

Saudi Arabia, while rich in unconventional resources, was also omitted due to a lack of strategic interest at the national level. At the start of the international shale race in the early 2010s, Saudi Oil Minister Ali Al-Naimi highlighted the promise from unconventional development publicly but showed little interest in making shale a near-to-medium-term national priority or strategic endeavor. In 2013, Al-Naimi stated Saudi Aramco, the state oil company, "will drill only around seven shale gas test wells". Former Aramco executive, Sadad al-Husseini, stated "This is not a major effort by industry standards", but noted the longer term potential and interest of unconventional development in Saudi Arabia (Fineren and Shamseddine 2013).

Due to Saudi Arabia's ample conventional oil and gas resources coupled with its moderated approach to developing unconventionals in the 2013 to 2015 timeframe (early in my research), I omitted Saudi Arabia as a result of shale not being a strategic national resource priority.

Canada was omitted due to the substantial similarities with the U.S. model, such as resource, open capital markets, fragmented and plentiful private sector participants, legacy infrastructure, private property rights (in Alberta), and a national history and culture around oil and gas development. The literature on global unconventional development would benefit from scholars doing additional research on Canada as well. Murtazashvili and Piano (2019) include Canada in their book, *The Political Economy of Fracking*, providing future researchers a good reference point to explore Canada using the SRDF approach.

Diving into the Strategic Drivers

2.2.7 Economics

In this section, I highlight how high-level economic considerations played a part in determining governments' views of shale as a strategic resource at the start of the development cycle.

Throughout most of the twentieth century, Argentina's economy has been subject to various economic crises, high inflation, foreign direct investment challenges, and sovereign defaults. However, there is hope

that “the discovery (of the country’s shale resources) offers Argentina a chance to escape its cycle of widening deficits” (Serkin 2015). Several interviewees reinforced this view and highlighted how shale still has the potential to alleviate the country’s ongoing economic challenges.

China is expected to overtake the U.S. as the largest oil consumer by the early 2030’s, heightening its incentive to bring about increased supply globally to lower prices. China’s shale gas policy, set out in its 12th Five-Year Plan for Shale Gas, “affirms that shale gas falls within China’s strategic emerging industries”, a group of industries that “officials hope will become the backbone” of the country’s next industrial development phase (Sidley Austin LP 2013; IEA 2014).

Various studies attempted to measure the potential economic impacts to the UK from unconventional development, forecasting job growth and higher wages (DECC and AMEC 2013; EY 2014; IoD 2013; Tovey 2014). From 1996 to 2005, the UK consistently enjoyed lower natural gas prices than the U.S. (BP 2015). However, in 2014, natural gas prices in the UK averaged nearly twice as high than in the U.S. In 2013, the IEA published a report stating that up to 10% of Europe’s market for energy-intensive industrial products could go to competing economies within the next decade (IEA 2013).

Declining production from the North Sea should have also impacted tax revenues and could have equated to a tax gap of roughly 1.25% of GDP emerging over the next two decades (IoD 2013). Further, oil and gas revenues as a percentage of GDP were expected to drop to 0.1% in 2028, from 0.9% in 2012 (Office for Budget Responsibility 2012).

In the U.S., “Unconventional oil and gas resources are perhaps the single largest opportunity to improve the trajectory of the U.S. economy, at a time when the prospects for the average American are weaker than we have experienced in generations” (Porter, Gee, and Pope 2015). A separate report found “the overall quality of America’s business environment has eroded in key areas, including skills, infrastructure, costs of doing business, and corporate tax structure” (Porter 2014). Following the Great Recession, the “new normal” U.S. economic growth rate was expected to be at around 2.0%, down from over 3.0% from the mid 1990’s to mid-2000’s, with risks for higher unemployment (U.S. Bureau of Labor Statistics 2013). As such, fracking offered a new growth opportunity in the U.S.

2.2.8. Energy Security

In this section, I focus on high-level energy security considerations for the countries studied as part of governments' decisions to develop shale as a strategic priority.

In April 2012, Argentina's state-owned YPF nationalized Repsol, effective through the Cristina Kirchner Administration seizing control of YPF following approval from the Chamber of Deputies and Senate (Bronstein 2012, Romero and Minder 2016). Argentina's Economy Minister stated the decision was "about energy self-sufficiency, which is very important for our country" (Burke and Morales 2012). Oil consumption topped production in 2013, the first time since 1987. Argentina's oil and natural gas production has dropped 27% and 21% to 35.5 billion cubic meters (bcm), from 44.9 bcm in 2004, and to 635 thousand barrels per day from 868 thousand barrels per day, respectively (BP 2015).

"China has many reasons to worry about its energy security" (Zhang 2011). There are concerns among Chinese observers that the U.S.'s growing energy independence (as a result of the shale revolution), could allow the U.S. to take a step back from security issues and energy disruptions in the Middle East, or according to Wang Haiyun (2013), senior adviser at the China Institute for International Strategic Studies, even "create problems in the Middle East, in order to prevent the rise of emerging countries", while China "will have to make greater effort and take more responsibility in carefully tackling international issues".

This statement is underpinned by over 50% of China's crude oil imports coming from the Middle East (U.S. EIA 2014a). Separately, Chinese interest in developing shale gas could also be viewed as "partly a hardball tactic for negotiating with Russian suppliers", but it is also viewed as "acting as a catalyst for the Sino-Russian gas cooperation" (Swann 2011; Skalamera 2014).

The U.K. imported roughly half of its natural gas in the early-to-mid 2010s, up from ~14% in 2000 (BP 2015). By 2030, net natural gas imports were expected to increase to roughly 76% of demand (IoD 2013). Prime Minister David Cameron pushed for energy security to be taken into consideration as part of the EU's 2030 climate change and energy package in 2014. At a G7 meeting following the Russian annexation of Crimea, Cameron called Russia's actions a "wake-up call" for states reliant on Russian gas and pointed to European shale gas reserves as a "good opportunity", adding "energy independence, using all of these different sources of energy, should be a tier one political issue from now on, rather than tier five" (James 2014).

In January 2014, Cameron stated “we're going all out for shale” (Watt 2014). In the Queen’s speech to parliament in June 2014, the Queen announced the government would introduce a bill to bolster investment in infrastructure, supporting shale gas development, adding that the bill will “enhance the United Kingdom’s energy independence and security by opening up access to shale and geothermal sites” (GOV.UK 2014).

In the U.S., the energy security benefits were recognized as substantial in the early-to-mid 2010s, with shale driving down U.S. oil imports (U.S. EIA 2015a; U.S. EIA 2015b). While the U.S. was expected to continue importing oil for the foreseeable future, it was expected to be “energy self sufficient” by 2020, according to Morse (2012). Further, also in 2012, the same year as Morse’s outlook on the transformative role of shale for North America, the IEA estimated the U.S. would overtake Saudi Arabia in oil production by 2020 and become a net oil exporter by 2030 (IEA 2012).

The geopolitical implications of the growth in U.S. unconventionals have attracted less attention than the economic benefits, according to O’Sullivan (2014), who sited Russia’s annexation of Crimea as launching “the first earnest debate about how the U.S. might harness its new energy strengths to drive not only its economic agenda, but also its global one”. The Obama Administration highlighted the energy security benefits and highlighted its support for the shale revolution in its 2015 National Security Strategy, stating:

> “The United States is now the world leader in oil and gas production. America’s energy revival is not only good for growth, it offers new buffers against the coercive use of energy by some and new opportunities for helping others transition to low-carbon economies” (The White House 2015).

2.2.9. Environment

In this section, I highlight how Environmental considerations affected governments’ view of shale as a strategic resource.

There are limited indications Argentina is pursuing unconventional oil and gas development for strategic environmental reasons. Argentina has been hesitant to put forth binding climate or carbon reduction targets, as it “sees international (climate) negotiations as a trap”, according to Carl Villalonga, president of the Environmental Protection Agency in Buenos Aires (Aizen 2015). This posturing dates back to 1999,

when Argentina was the first to set fluctuating greenhouse gas reduction targets (based on changes in economic activity, rather than absolute targets), in the aftermath of the Kyoto Protocol, a move later followed by the United States (Herzog, Baumert, Pershing 2006).

By contrast, it is clear China has deemed natural gas a key part of its decarbonization efforts. In January 2013, residents of Beijing and other cities were warned to stay inside due to high pollution levels, as Beijing's particulate matter (PM2.5) reached over 35 times levels the World Health Organization considers safe (NASA 2013). In 2014, Chinese President Xi Jinping called preventing air pollution the "most prominent" challenge Beijing faces. Environmental concerns were viewed to be impeding development during this time, underscored by at least seven provinces lowering their economic growth goals in 2014 as a result of public pressure for air pollution controls (Bloomberg 2015; IGU 2015).

China is the largest emitter of CO2 (by over 50% in 2012), and the country is the largest producer and consumer of coal globally, by a factor of over 4-fold (IEA 2021). A shift to natural gas and the development of shale gas is central to the government's plan in "promoting the clean utilization of fossil fuels" (The National Development and Reform Commission 2013). In November 2014, in a joint climate agreement with the U.S., China announced targets to peak CO2 emissions around 2030 (The White House 2014).

From a macro energy and climate standpoint, China has sought to align its shale development strategy with its broader energy transition plan, which is underpinned by its commitment to the Paris Climate Agreement for carbon emissions to peak by 2030 and for the non-fossil fuel energy mix to stand at 20% by 2030 (Climate Action Tracker 2018).

In the U.K., the Climate Change Act 2008 set a legally binding framework to reduce carbon emissions by 80% by 2050 from 1990 (GOV.UK 2008). The Committee on Climate Change stated that shale gas production "can be consistent with meeting UK carbon budgets" if production is regulated and "accompanied by a strong commitment to reduce all greenhouse gas emissions" (Committee on Climate Change 2015). Further, the Committee on Climate Change stated, "if environmental and other impacts can be addressed, use of shale gas rather than imported gas in meeting residual gas demand in a decarbonizing energy system could enhance security of supply", and that "there is a potentially complementary role for investment in low-carbon technologies and shale gas in improving security of supply" (Climate Change Committee 2013).

In the U.S., the increase in unconventional production has led to the exacerbation of the coal-fired power plant fleet retirement, as low natural gas prices and slow electricity demand growth have adversely impacted economics for coal plants in the U.S., providing a clear decarbonization benefit (U.S. EIA 2014b). As discussed in Chapter 3, the prospect of decarbonization by increased natural gas production in the U.S. provided an argument for fracking by early supporters of the technology.

In his 2014 State of the Union address, President Obama defended his "all-of-the-above" energy strategy, including support for natural gas, stating, "One of the reasons why is natural gas – if extracted safely, it's the bridge fuel that can power our economy with less of the carbon pollution that causes climate change" (The White House, State of the Union 2014).

In 2015, COP 21 established a "legally binding international treaty on climate change", presenting quantifiable decarbonization goals for the U.S. and other countries, and strengthening the case for unconventional development (United Nations 2015; United Nations Climate Change N.D.). This provided further support for the decarbonization argument in support of natural gas.

However, with the intergovernmental macro decarbonization role for shale gas established, scope for a divergence in views between national and local governments, particularly as it related to the environment, only increased during this period, as my primary research shows. As a result, the duality of the environmental benefits and risks from unconventional development, due to the risks to local ecosystems and water scarcity versus broader climate and decarbonization goals, has been a critical consideration for the U.S. discourse around fracking (Thomas et al. 2017; Absar et al. 2021).

2.2.10. Chapter Conclusion

In this chapter I showed how I constructed my overall research design, detailing my primary and secondary research methods, and also discussed how I utilized the findings from my literature review as the basis for my country-specific sample set.

Following a detailed review of the energy policy literature, it was clear to me that the three recurring themes (economics, energy security, and the environment) were constants and often the driving forces behind policy decisions throughout the various waves of the century of energy cycles I analyzed. As such, it was a natural selection for these themes to provide the basis of my sample set selection.

As shown, the countries chosen have a stated priority to develop unconventionals in pursuit of national objectives related to these three themes. As a result, shale should be viewed as a strategic resource in these countries. I detail in this chapter why that is, on both a country-specific basis and in discussing the three themes.

Importantly, my research shows that future researchers should analyze and determine if a resource is strategic for the country it is set to be developed in *irrespective* of if a government deems it strategic or not. This is the first step in utilizing the SRDF to infer outcomes for strategic resource development.

By relying on the energy literature review as a key input for my sample-set selection, I acknowledge the cyclical nature of energy policy. As such, my primary research into the shale development experience shows that many of the pressing themes that countries, firms, investors, and stakeholders focus on today are similar to and are influenced by the ones that have been found in the literature over the past hundred years or so. This reinforces Historical Institutionalism as my theoretical lens (which I discuss in the next chapter).

Through Historical Institutionalism, I connect many of the variables studied in my primary research chapters (Chapters 4-7) to the literature review (both the energy policy and theory portions), highlighting how the institutional foundations of the market structures have informed these countries' shale development experiences. As discussed, I do this by grounding the literature review in the three recurring themes, 1) Energy Security, 2) Economics, and 3) the Environment, as detailed through: 1) oil's role in conflict over the past century, 2) the 1970s energy crises and the race to buffer economies from the associated price spikes, and 3) the duality of addressing climate change and decarbonization (through increased natural gas) and local stakeholder development concerns.

This tying of the shale development experience to the historical literature can be seen throughout the chapters. For example, it can be seen in my connection to the U.S. independent oil companies (Independents) to the post-World War II pipeline divestitures by the U.S. government, the state-led build-up of China's oil & gas infrastructure through the various waves of the country's post-war evolution to its recently reorganized infrastructure State Owned Entity (SOE). It is shown through the way the U.S. oil and gas companies leveraged the data left through over a century of exploration, building on the American pioneering efforts from the prior cycles. It is shown through the way in which past populist policy

commitments continue to challenge unconventional development in Argentina. It is shown by the connection between the U.K.'s fracking ban and its origins born out of the low interest rate environment and international rush for returns.

As such, I am making the argument throughout this dissertation that historical foundations matter.

As Chapters 4-7 detail, my primary research interviews, spanning 25 industry experts, provide unique insights across the four countries studied and four Independent Variables. These provide first-hand accounts into many of the critical aspects of development. These accounts mostly reinforce or dispute the secondary literature, and in some instances, notably Chapter 4 on Political Opportunity Structure, they provide new and unique narratives from the front-lines of development. In my view, these accounts are unique additions to the literature.

Importantly, as shown in Chapter 7 on Geology & Infrastructure, it is not *if* a country has attractive geology and legacy infrastructure, it is *how* its geology is understood and *how* its infrastructure was developed. As shown in the cases of China and the U.S., this has critical implications for CMEs and LMEs alike. In the cases of Argentina and the U.K., a misunderstanding of these variables can lead to development challenges.

In Chapter 6 on Capital Markets & Markets Structure, my primary research reinforces the arguments of Murtazashvili and Piano (2019), and Wang and Krupnick (2013), in that the U.S. Capital Markets & Market Structure variable was key for development. However, I also show how some of the key subcomponents in Chapter 6 helped unlock the U.S. shale experience, and how some of these same aspects impact MME and CME structures. Notably, I also provide a first-hand account of how the search for returns globally during a period of low interest rates led to the ill-fated U.K. shale experience.

The chapters are meant to be both standalone and interdependent. As such, I reference how a point might relate to one made in another chapter. This is done to show the institutional arrangements between the Independent Variables, which is a product of their market economies. For example, the interconnections between Infrastructure and Capital Markets will vary depending on the type of market economy (as mentioned by the differences in *how* China and the U.S. have developed legacy infrastructure). Further, the connections between Government and Political Opportunity Structure are critical, with the level of

polycentric or unitary governance being a key consideration for opposition groups, as shown in the cases of New York and the U.K. relative to Argentina and China.

Lastly, my interviewees provided unique insights that allowed me to build on the secondary literature while introducing new data to the various cross-sections of energy policy that this dissertation spans. I recommend future researchers utilizing the SRDF also rely on new primary research into each of the Independent Variables and countries they are studying.

Overall, my overarching research design is mixed methods in its approach, utilizing cross-disciplinary primary data and overlaid on secondary data that spans a wide array of published sources. Taken together, I present my new framework for strategic natural resource development.

Chapter 3: Literature Review

3.1.1. Introduction

In this chapter, I present a literature review for the SRDF in two parts, with one part on the relevant energy literature and the second on academic theory. I show how the energy policy literature spans key themes, has followed oil price volatility, and has made a meaningful contribution to the foundation of International Political Economy. As mentioned in the Introduction Chapter, the SRDF is particularly influenced by comparative analysis inquiry into the 1970s energy crises and by Historical Institutionalism.

This chapter also provides process tracing accounts of some of the key elements behind the Independent Variables of the SRDF (such as climate change for Political Opportunity Structure), and the key drivers for strategic rationale for resource development (such as mechanized warfare and for Energy Security). Lastly, the chapter also provides suggestions for additional literature reviews, based on future optimizations for the SRDF.

Chapter 3 - Part 1: Energy Policy Literature Review

3.1.2. Three Key themes: Energy Security, Environment, Economics

While many of the key waves covered in the first section predate shale oil and gas development, various sub-themes and common threads explored in this section extend and connect to the critical components and questions related to unconventional oil and gas resource development and its inquiry through the SRDF.

As mentioned, the dominant themes of the energy literature review are incorporated in the SRDF as rationale for national strategic resource development, which are 1) economics, 2) energy security, and 3) the environment. Notably, this framework could be applied to future strategic resource development across regions, resource types, and technologies, despite the heavy focus on oil and gas in this chapter. The literature review attempts to help frame several questions related to my research, which are:

- Does the existing literature suggest that unconventional oil and gas development is incompatible with certain political or economic structures?

- What key common threads link unconventional oil and gas development to the body of energy policy research?

- What periods and aspects of energy research are most relevant to unconventional oil and gas development?

- Do any prior periods of energy policy research support or discredit my initial hypothesis that the international sample set countries will have trouble developing unconventionals?

Part 1 - Energy Literature Review

3.1.3. - Key Waves of Energy Policy Research Over the Past Century

In Part 1 of this chapter, I focus on the key waves of energy policy research over the past century, spanning several themes which underpin the SRDF. These key themes are energy security (as shown through mechanized warfare in World Wars I and II), economics (as shown by the effect oil and gas crises have had on economies and for governments, as well literature on the Resource Curse), and the environment (as shown by the rise of climate change as part of the energy policy literature).

Academics have argued that energy politics is an understudied field, given the important ramifications energy plays in the various aspects of society. Following a survey of six major political science reviews from 1972 to 2012, Hughes and Lipscy (2013) found "the politics of energy appears to be neglected despite its importance relative to other, more conventional topics". Considering the significant impact unconventional resources have already had on the global economic and political order, a trend likely to persist, I argue that shale as a strategic resource has also received insufficient academic attention.

Evolution of Energy Policy Research - Constant Conflict

3.1.4. Mechanized War, Economic War, and the War on Climate Change

Energy policy research since the early 20th century has centered on various forms of national security, but has evolved alongside changing perceptions of threats to supply, as well as with military, economic, and environmental considerations. Shale oil and gas has created new national security considerations as well, but also relates to the aforementioned historical energy security considerations, including conventional military strategies and economic warfare. More recently, climate change has emerged as a major energy policy theme.

The "rise of mechanized warfare" during the first half of the 20th century made oil a vital commodity for nations and shaped early energy policy research. The formation and rise of the Organization of the Petroleum Exporting Countries (OPEC) in the 1960's and 1970's, coupled with the ensuing oil embargoes and nationalizations of these periods created the foundation for a new wave of energy policy research, which explored variations in national responses to price volatility. Research exploring international organizations and cooperation between states was also an important focus in the aftermath of the price volatility of the 1970s. The "Resource Curse", or the adverse and paradoxical economic and political effects that can stem from resource abundance, was an area of research which mushroomed in the late 1980s. While climate change research predates all of these topics, dating back to the 1830s, it has experienced a renaissance and is one of the most important areas of energy research today. All of these topics have implications for the SRDF and should provide insights into its applicability for future resource development.

3.1.5. Energy Policy and the Rise of Mechanized Warfare

Brown (2003) finds that petroleum's strategic military benefits were being recognized and explored as far back as the post-Civil War United States, as stated in the 1867 Annual Report of the Secretary of the Navy (Welles 1867). The Royal Navy, which dominated the high seas during this time, tested oil in the early 1900s but continued to harness coal for its ships as coal was plentiful domestically and an "economic asset" for Britain (King 1953).

King argues that the strategic military benefits of oil ultimately trumped the economic benefits, leading Churchill in 1912 (then First Lord of the Admiralty), to sanction five “super swift class” ships, laying the foundation for the Royal Navy to switch its fleet to oil (ibid). My research into countries’ strategic reasoning for unconventionals shows King’s argument still stands today. The British Navy’s shift to oil from coal was the first step in coal’s loss of its hegemonic status in the transportation sector (Luft and Korin 2009).

Roughly 100 years later, shale gas would further downgrade coal’s position in the energy mix. Churchill's move came with energy security questions though, as Persian oil would replace coal from Wales. However, in a response to these concerns, Churchill seemed to foreshadow many of the energy policy challenges of the second half of the twentieth century by stating, “safety and certainty in oil lie in diversity and diversity alone” (Yergin 2006). As such, Churchill’s energy transition provides some of the earliest foundations for energy security as a national driver for the SRDF.

The strategic importance of oil in war in the first half of the 20th century was clear with statements from France’s Minister of War during WWI, Georges Clemenceau, that oil was “as necessary as blood”, and by U.S. President Calvin Coolidge, who wrote in 1924, “it is even probable that the supremacy of nations may be determined by the possession of available petroleum and its products” (Frankel 1946).

While the U.S. acknowledged the importance of oil as an economic and military strategic commodity at this time, its foreign policy did not provide the security-of-supply respect that the age of mechanized warfare deserved. By comparison, its foreign policy related to oil was significantly more hands-off in contrast to the British experience. The difference in approaches was influenced by the U.S.’s late entry and limited role in World War I (relative to the British). Stoff (1981) argues that pre-World War II, U.S. foreign policy was indistinct from the country’s general commercial policy, and the private sector played a significant role in shaping its international energy agenda.

In 1941, as the U.S. entered the war following the Japanese attack on Pearl Harbor, fears were growing in the Roosevelt Administration that the U.S. was running out of oil. At the time, the U.S. was supplying the

majority of oil to the allied forces and there had been limited discoveries in recent years. Risk of German attack on U.S. tankers from Texas to the Northeast led to the creation of two major pipelines as an alternative, the Big Inch and the Little Big Inch, approved by the War Production Board in June 1942 with construction "through a private company, War Emergency Pipelines, Incorporated, but the pipelines were owned by the federal government through its Defense Plant Corporation, a subsidiary of the Reconstruction Finance Corporation", at a cost of $146 million (financed entirely by the Reconstruction Finance Corporation), or $2.5 billion adjusted for inflation (Palmer and Johnson 1995).

During this time, the Permian Basin, which spans New Mexico to West Texas and where production dates back to 1921, supplied "much of the oil used during World War II" (Gilmer and Thompson 2012). Both of these wartime infrastructure and production developments have an important impact on the U.S. shale experience, as discussed in Chapter 7.

At this point in the early 1940s, U.S. international oil policy began to take shape. However, with industry playing a large role in policy and governance, there were concerns it would not adequately take national security interests into account. "History does not give us confidence that private interest alone would adequately safeguard the national interest", stated Senator Henry Cabot Lodge (Yergin 1991). However, the government had limited capacity for international oil policy and politics during this time.

As a result, President Roosevelt moved to fuse state and industry in various areas to address the wartime oil challenges, and the associated U.S. institutional deficiencies. This move would meaningfully mold the future of U.S. foreign oil policy. As a result of the dearth of government expertise and capacity related to international oil issues, Roosevelt created the Petroleum Administration for War, a public agency that included a private advisory system of local committees financed by industry. This example of public-private cohesion is one of the earliest examples of state strength in modern strategic resource development and energy policy. Researchers utilizing the SRDF for future strategic resources would benefit from noting the U.S. oil industry's military roots and state involvement, as its LME structure can leave the impression it was not born out of any government involvement. As this section shows, the proliferation of the U.S. oil and gas industry internationally in many ways was the result of this intertwinement between industry and state.

Further, the war "brought oilmen into government in unprecedented numbers", with only industry having a large enough pool of petroleum engineers and administrators to rapidly draw from (Stoff 1981). As a result, most executive departments working with foreign oil created standalone oil divisions or had professionals from oil companies working as advisors. Oilmen also served as attachés in foreign embassies and consulates, providing technical expertise, as well as cultural and business knowledge to U.S. diplomats in oil rich countries. Many of these oilmen were on loan from U.S. oil companies, often with the balance in lost wages picked up by the company.

While private employers sometimes benefitted from the exchange, a Congressional investigation into the practice following the war found that the workers genuinely believed national and commercial interests were identical (ibid). The partnership between industry and state reflected the post-war ethos of the U.S., where "politically motivated support for a liberal international economy ran parallel to and was reinforced by the economic interests of the business community" (Katzenstein 1977).

In the end, oil did ultimately shape the outcome of the war. The German and Japanese militaries both suffered from inadequate supplies, affecting overall strategies and each's ability to carry out tactical missions, as well as gain and hold territory.

After World War II, oil dependence had firmly set in, and it was clear oil would impact U.S. foreign policy for decades to come. Harold Ickes, U.S. Secretary of the Interior and Petroleum Administrator, summarized this post-war oil dependent view by stating, "tell me the sort of agreement the United States will reach with respect to the world's petroleum resources when the war is over, and I will undertake to analyze the durability of the peace that is to come" (Ickes 1944). As a result, oil would play a central role in the post-World War II international order, particularly for the United States, which was the driver of a liberal economic world order during a period in which the "world was now divided into ideological camps" (Kissinger 1994).

However, the U.S. government was not interested in running the oil and gas industry, despite the lure of greater control of this strategic industry for energy security purposes. Reflecting this, after the war, the

Big Inch and Little Big Inch pipelines were sold at auction to Texas Eastern Transmission Corporation and converted to natural gas pipelines, after an initial preference to maintain government ownership of the pipelines for "use as in the war to ensure availability of the lines in a national emergency". The quick divestiture of the pipelines highlights how the U.S. intended on maintaining an LME private sector-led post-war oil and gas strategy. This experience also highlights the importance of legacy oil and gas infrastructure, as discussed in Chapter 7 (Palmer and Johnson 1995).

With the British withdrawing from the world stage and focusing more on economic development and building a welfare state at home, the U.S. took the post-World War II global lead of providing economic and military assistance to nations confronted by the threat or influence of Soviet Union inspired communism, effectively known as the Truman Doctrine (U.S. Department of State 1947). This competitive ideological struggle between the U.S. and Soviet Union during the post-war years has reemerged, but this time between the U.S. and China, which Kissinger argued echoes the post-war period, "Both sides have convinced themselves that the other represents a strategic danger" (The Economist 2023). For the SRDF, competitive ideologies have two relevant elements: 1) it enhances energy security as a driver for strategic resource development, and 2) it creates a race for resources in regions where ideological competition plays out over critical minerals, such as rare earth elements in Africa or critical minerals in South America, for example (Barlett 2023, Lu and Fabbro 2023).

With oil's role in World War II clear, U.S. oil and foreign policy were quickly intertwined in the post-war years. As a result, greater consideration was given to wartime preparedness and security of supply. Rostow (1948) argued for a buildup of domestic supplies by relying on imported oil during times of peace. This call coincided with a period of growing U.S. interest and involvement in the Middle East and the region's resources. The National Security Act of 1947 reorganized the U.S. defense apparatus, creating various bodies for the "the National Military Establishment", including the Secretary of Defense, the Joint Chiefs of Staff, and individual departments for the various branches of the armed forces.

The Act also created three bodies for "Coordination for National Defense", including the National Security Council, the Central Intelligence Agency, and the National Security Resources Board. Included in the mission of the National Security Resources Board was to advise the President in "the coordination of

military, civilian, and industrial mobilization", including "the relationship between potential supplies of, and potential requirements for, manpower, resources, and productive facilities in the time of war", as well as "policies for establishing adequate reserves of strategic and critical material, and for the conservation of these materials" (U.S. Congress 1947).

In 1949, the National Security Resources Board argued that energy dependence on peacetime Middle Eastern oil resources would allow the U.S. to create a domestic petroleum stockpile in the event of wartime (or post wartime) scarcity. It argued that large-scale imports would allow a million barrels of domestic oil to be shut-in (Yergin 1991). This process tracing to the roots of oil as a strategic resource and energy security driver for the SRDF provides an example for future researchers to evaluate the importance of national interests in future resources.

Oil would shape U.S. diplomacy in-concert with its military objectives during this period, with implications that remain today. One of the pillars of the U.S.'s post-war Middle East diplomatic foundations would be its special relationship with Saudi Arabia. The intersection of the Truman Doctrine and the intertwinement of U.S. oil and foreign policy was fully illustrated through the burgeoning relationship between the U.S. and Saudi Arabia, as outlined in a letter to King Abdul Aziz Ibn Saud of Saudi Arabia from President Harry Truman in October 1950:

> "Our countries have been comrades in arms together and we have common cause in opposing the godless forces of Communism which are endeavoring to destroy freedom throughout the world...
>
> ...I wish to renew to Your Majesty the assurances which have been made to you several times in the past, that the United States is interested in the preservation of the independence and territorial integrity of Saudi Arabia. No threat to your Kingdom could occur which would not be a matter of immediate concern to the United States" (Truman 1950).

However, the security alignment between Saudi Arabia and the U.S. at times conflicted with the aforementioned ideological viewpoints, presenting fissures in the relationship and highlighting inherent

energy security risks for LMEs with strategic resource partnerships with CMEs, an energy security dynamic to be considered through the SRDF, as Hall and Soskice point out the "systematic differences in corporate strategy across LMEs and CMEs". More directly, Marcel (2006) states, "NOCs (national oil companies) are instruments of the state and help government achieve a number of policy objectives".

As such, one of the most significant modern energy policy events was born out of ideological differences between the U.S. and Saudi Arabia, negating its post-war alliance. Gendzier (2015) argues that U.S. oil politics was central to the founding of Israel, its foreign policy related to Israel and Palestine, and its involvement in the Middle East for decades to come. This regional involvement would set the stage for the oil embargoes of the 1970s, with major implications for international relations, economics, and future oil policy research.

On October 6, 1973, Egyptian and Syrian forces launched coordinated attacks on Israel during Yom Kippur, setting off the fourth Arab-Israeli Wars, and altering the global oil and geopolitical landscape to this day. On October 17, in response to countries providing military support to Israel, OPEC announced an oil embargo, primarily targeting the U.S., highlighting the aforementioned energy security vulnerabilities to LMEs over ideological differences with CMEs. Over the following two months, world oil supplies fell roughly 9.8% and spot market prices increased more than 180% to over $19/bbl in December, up from $6.71/bbl in October (U.S. Senate 1975).

The embargo saw oil's role in global affairs and conflict shift from a critical strategic commodity for conventional mechanized warfare to a tool for economic warfare. A host of new national security questions were raised as a result. As Hughes and Lipscy (2013) highlight, these events and this period set off a rich era of discourse into international oil politics and economics, spawning many themes, questions, and conversations that remain at the forefront of some of the most pressing international energy issues today.

The literature of this period shows an increasingly hawkish view of securing energy supplies seems to have shifted the military and political establishments' attention away from some of the more symbolic concerns

during the Cold War (including countering Soviet influence abroad), to preparing and being more willing to engage in kinetic military action (Deese and Nye 1981).

As a result of this process tracing, an understanding of the past strategic priorities and objectives of U.S. policymakers informs the present market structure of the U.S. oil industry. Similar assessments and process tracing exercises can inform insights into the strategic priorities of countries to be researched in the future through the SRDF and allow for inferences into how strategic resource development might unfold in various market structures.

"The First Wave" of Energy Policy Research:

3.1.6. The Impact of the 1970s Price Shocks; National Security, State Policy Variations, and International Cooperation; A Rise in International Energy Research

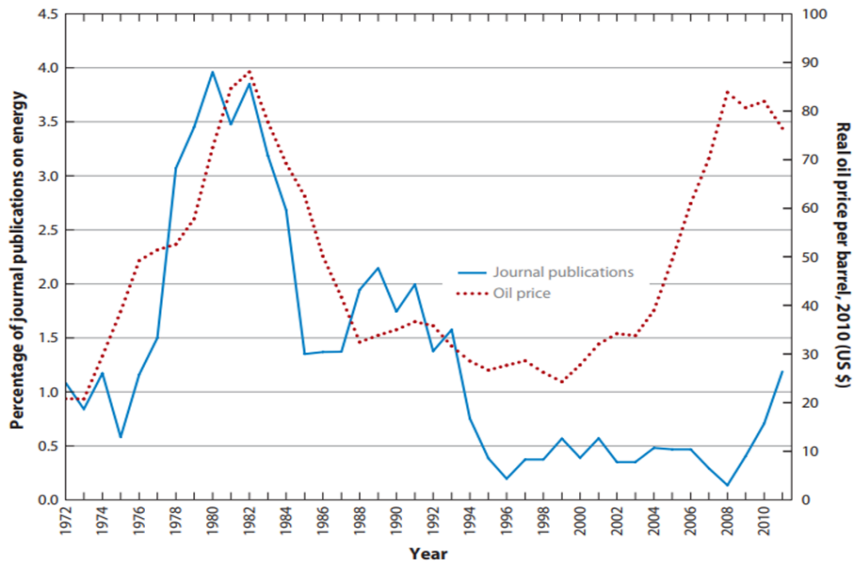
In this section, I show how the literature affirms that different energy and resource-related outcomes can be inferred through analyzing market and state structures. This assertion is central to the SRDF, which provides a tool for assessing the outcome of strategic resource development across countries and economies.

Prior to the oil embargo of 1973, energy security was being raised in relation to national objectives. Notably, James Akins (1973), an energy expert and diplomat, elevated public awareness to the threat of energy insecurity prior to the oil embargo of 1973-1974 by arguing for additional U.S. policies to address rising oil imports. The enhanced energy security scrutiny from this period planted the seeds for the U.S. shale experience over 30 years later. This section shows how energy security concerns during the 1970s led to government support and R&D funding for unconventional gas. This support was one of the "strong state" mechanisms that did not alleviate short-term oil prices, but that quietly set the stage for the radical innovation that the U.S. Independents would commercialize. Independents focus exclusively on the upstream exploration of the development process, while Integrated Oil Companies (IOCs) participate throughout the value chain, spanning exploration, midstream (pipelines and transportation), and refining, as detailed in Chapter 7.

The oil price shocks of the 1970s resulted in a period of relatively high levels of research into energy policy, including various aspects of international petroleum politics.

Hughes and Lipscy (2013) observed a rise in energy policy research in the mid-to-late 1970s, in-concert with the period of high prices and high price volatility. Their work found that publications in top political science and international relations journals devoted to energy issues rose to 4% in the late 1970s, up from 1% during earlier in the decade, as illustrated in Figure 9, highlighting the correlation in energy policy research and oil prices.

Figure 9: Hughes and Lipscy's Research on "Oil prices and political science journal publications on the politics of energy, 1972–2012"



Source: Hughes and Lipscy 2013

State Policy Variations:

3.1.7. The Foundations of International Political Economy and the SRDF

This section of the literature review focuses on State Policy Variations, one of the research themes that is relevant to the SRDF and born out of the 1970s energy crises. In this section, I discuss the importance of the works of scholars analyzing the events of this period, such as Ikenberry (1986, 1988), Keohane (1978, 1984), Tugwell (1988), Hughes (2014), and Katzenstein (1977). The country-level comparative analysis on

the events of this period provides insights into state and market responses to energy challenges and opportunities spanning LMEs, CMEs, and MME.

The period of oil price volatility in the 1970s led to a shift in thinking by policy makers around the "best way to govern economies", providing important foundations for International Political Economy (IPE) and the SRDF (Hughes 2014). Within the literature during this period, new national security questions were asked under the realities of the new international energy order, but still through the lens and objectives grounded in the Truman Doctrine and the LME objectives it aimed to spread.

Ikenberry's (1986) analysis on the policy responses during the oil price shocks by four key oil importing countries, including the U.S., West Germany, France, and Japan, and Katzenstein's (1977) review of the strategies of six industrial states, including the U.S, Britain, West Germany, France, Italy, and Japan provide critical examples of comparative analysis across economies, influencing the SRDF.

National security remained the primary focus through this period; however, the research shifted from fueling conventional warfare, which dominated the first half of the century, to the rise of the "oil weapon" (Rustow 1974, Turner 1974, Licklider 1988). Variation in state responses to the oil crises of the 1970s also constituted an important aspect of the research during this time, and provided much of the foundation for important early work in IPE.

"No one contributed more to the emergence of IPE than Robert Keohane", who explored the International Energy Agency's (IEA) role in state interdependence and cooperation (Moravcsik 2009). Keohane's work during this period, along with the work of his contemporary G. John Ikenberry, provides the strongest connections to the themes my research explores around unconventional oil and gas development, and provides some of the important theoretical foundations for the SRDF, pre-dating Hall and Soskice's VoC framework. Hughes and Lipscy refer to this rich period of focus on IPE and energy, and international cooperation around energy issues as the "first wave of research into energy politics in the advanced industrialized states" (Hughes and Lipscy 2013).

Ikenberry (1986, 1988) focuses on available policy tools in addressing crises, while Katzenstein's (1977) emphasis on values and state evolution seem to act as a precedent for the ultimate policy tools that become available. Both provide relevant insights into how various countries might fare in attempting to develop shale resources or future strategic resources utilizing the SRDF. Ikenberry (1988) sought to explain national responses as a product of "resources and mechanisms" available to "politicians and executive officials, particularly in the United States, to direct the course of energy adjustment". Ikenberry.

For Ikenberry, the American political economy, constituted of previously established institutions and policies, as well as already entrenched political obstacles and precedents, made up the unique state characteristics that allowed the Carter Administration to impose the policy and market solutions to address the oil crises. This provides parallels to Ikenberry's (1988) *Reasons of State*, written the same year, in which he argued "strong states are tied to past policy commitments just as weak states are". Tugwell (1988) presents a much less optimistic picture, suggesting the Carter Administration's final decision to deregulate prices was one born out of despair, resulting from the limits of the U.S. political landscape.

In analyzing how three major oil consumer countries, the U.S., France, and Japan, responded to the 1970s oil crises, Hughes (2014) attempts to explain why some governments "adopted more liberal forms of oil market" and others "continued to protect domestic interests in the name of energy security". He boils the reason down to differences in the characteristics of firms, which "conditioned how they responded to the emergence of a global market for oil".

Hughes's (2014) primary tool for explaining the differences in outcomes are "industrial compacts", which balance the interests of firms and policymakers. The industrial compacts are essentially the bargaining process between firms and governments over how to govern energy markets. As a result, the varied outcomes are reflective of the historical nuances, individual interests and cultural specificities found in each of the three countries' studies. In focusing on the firm and country cultural histories and the associated negotiations, Hughes attempts to "remedy the scarcity of studies which place the evolution of oil governance in the context of broader trends" (Mitchell 2015).

Hughes (2014) sees the industrial compacts that shaped these firms and markets as having two characteristics: 1) market share was regulated between firms through policy instruments including tariff and non-tariff, and 2) these negotiations were "durable, with many established during the interwar years and lasting, with only incremental changes, until the 1980s".

There are several interconnections between Hughes's study and my research. One of my research questions (*if unconventional oil and gas development is incompatible with certain political or economic structures*) has roots in Hughes's focus on how oil industries differ from country to country depending on how governments responded to the oil crises of the 1970s by either liberalizing oil markets or supporting and protecting state champion oil firms.

Ikenberry (1986) argues that these strategies were pursued as the result of the institutional and instrumental capacities at the country's disposal. Further, he argues that a minimalist approach can be as effective as "the juggernaut of extensive and systematic direct intervention", which represents the irony of state strength. This minimalist approach was available through the U.S. LME, which Ikenberry (1988) describes: the "United States exhibits weak features: an organizationally decentralized and heterogenous private sphere as well a fragmented and diffuse policy process".

By contrast, Ikenberry (1988) describes the strong French state, which directed policy through state owned companies for oil and nuclear power in response to oil price volatility during this period, stating "France is the counterpoint, with centralized and coherent bureaucracies, a wide range of policy instruments, and developed links with key industries and sectors", providing France energy-related benefits from its strong state policy from this era.

These lessons should be remembered when market observers are quick to dismiss the potential for strong state policies and CMEs to develop strategic natural resources, and could provide insights for the next era of Chinese shale development, as well as future state-led strategic resource development experiences (Slav 2018; Gagliardi 2015). Despite my argument that the U.S.'s LME structure provided a head-start advantage in the global shale race, in the next section I show how a statist approach in the 1970s unlocked the U.S. shale experience.

3.1.8. Statist Approaches in the Natural Gas Crisis Had Limited Near-Term Effect, but Led to Commercialization of Fracking

This section is more heavily focused on the U.S. shale experience due to the U.S.'s role in commercializing fracking in response to the U.S. domestic natural gas crisis of the 1970s. As I detail, high natural gas prices in the 1970s in the U.S. encouraged various domestic policy responses, including the U.S. DOE's "Unconventional Gas Research Programs", and price controls (NETL 2007). As I detail in section 3.1.15, these institutional responses in the U.S. allowed various individuals to commercialize fracking, providing the unique circumstances which enabled the U.S.'s successful development of unconventional oil and gas. As also described in this section, policy initiatives to encourage unconventional development during the same period spanning of the 1970s-1990s were largely absent in the international sample set countries.

One of the many strong state mechanisms the U.S. introduced during the 1970s was R&D funding for unconventional gas. The natural gas shortage of the 1970s was independent of and overshadowed by the oil crises; however, it compounded the Administration's intervention and ultimately set in motion the foundation for the commercialization of fracking (ibid).

"After World War II, the availability of abundant supplies of natural gas -- most of it found in the search for oil -- and improved quality of pipe for high-pressure, long-distance delivery enabled the gas utility industry to expand rapidly and widely", a special report for President Ford stated. Natural gas production peaked in 1973 with new natural gas discoveries dwindling and demand growth driven by "it's clean-burning properties, low-cost, and until recently, accessibility" (Federal Energy Administration 1975). The decrease in gas reserves, new discoveries, and production which led to the 1970s natural gas shortage is illustrated in Figure 10 below.

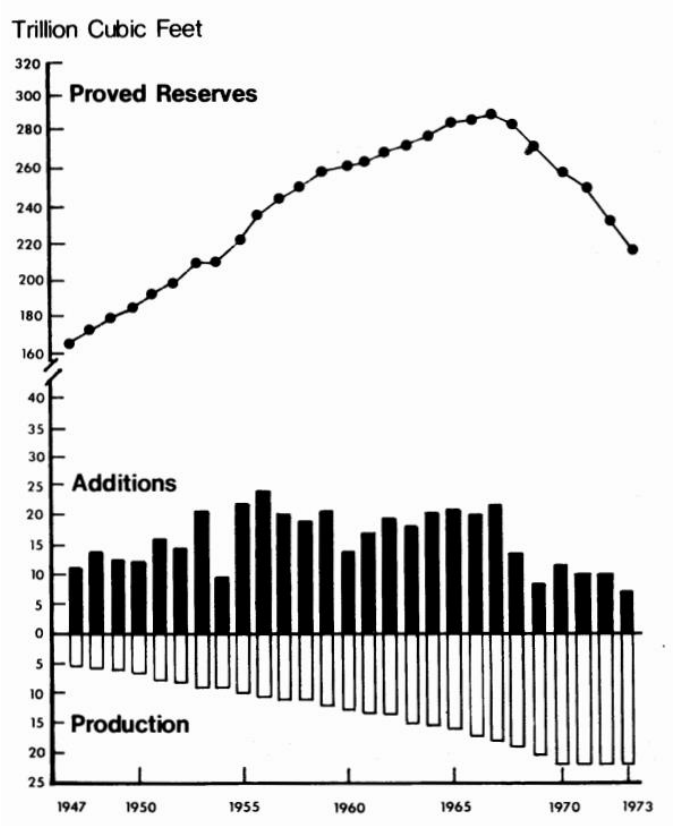
Notably, "In the mid-to-late 1970s, fears that supplies of natural gas would soon run out led to the initiation of U.S. government and private efforts to better understand both the magnitude of the nation's natural gas resource and how best to find and produce it" (U.S. DOE 2007). This led to particular interest in low-permeability gas in the Appalachian Basin, leading to R&D spending for unconventional development. Similar to the French experience as detailed by Ikenberry (1986), while the statist actions by the U.S. government had little ability to affect change in the short-term (with the oil crisis at-hand), they laid the earliest foundations for the commercialization of fracking.

This initiative was launched in 1976 (but with initial research by the Federal Power Commission stemming from 1973). Gold (2014) details how this initiative, through the Congressionally funded DOE Unconventional Gas Research Programs, led to the commercialization of fracking by Mitchell Petroleum in the late 1990s and the start of its wide-spread adoption in the 2000s.

Price controls were set to encourage the adoption of technologies that could unlock unconventional gas, with gas from existing wells receiving the lowest price, new wells a higher price, and the highest prices for gas from unconventional sources (ibid). Notably, in June 1982 Mitchell Petroleum fracked its first well in the Barnett Shale in the Ft. Worth, Texas area, targeting the higher priced unconventional natural gas. Gold points out how Mitchell persistently fracked wells in the region for the following ten years, coinciding with government R&D efforts, a key period in the path towards Mitchell commercializing fracking, which in turn was proliferated by others (ibid).

I include this development in this section to highlight the significance of this experience as it relates to the long-term potential impacts of statist actions, but their inability to affect change in the short-term, as Ikenberry (1986) argues. This is a theme that is also seen in the Chinese shale development experience, as discussed in Chapter 7.

Figure 10: U.S. Natural Gas Reserves (Excluding Alaska); 1975 Preliminary Assessment Report to the U.S. President on the Natural Gas Problem and its Impacts



Source: Federal Energy Administration 1975

Outside the U.S., limited policy initiatives took place to encourage the development of unconventional oil and gas during the 1970s to 1990s. Of the countries studied other than the U.S., the most substantive research on shale and fracking was conducted in the U.K., albeit to a minimal extent until the 2010s.

In the U.K., "The first hydraulic fracturing of onshore conventional UK wells was done in the late 1950s, and it has been a common field operation to increase flow rates since then" (DECC 2015). However, this early hydraulic fracturing differs from the "modern fracks" which Mitchell Petroleum commercialized in the 1990s which enabled the U.S. unconventional development experience (Gold 2014; Zuckerman 2013). Research in the mid-1980s began into the potential for gas production from UK shales, led by Professor Richard Selley at Imperial College. Selley (2012) detailed, "In the early 1980s it was generally believed that shale gas could only be generated by the thermal maturation of kerogen beyond the oil window". This

analysis found that the dual Corporation Tax and Petroleum Revenue Tax made shale gas production not economical. Selley further stated in retrospect, "On 8 January 1985 the conclusions of the Imperial College study were presented to the UK Department of Energy. Polite interest was expressed, but the possibility of shale gas being exempt from the payment of Petroleum Revenue Tax was not countenanced" (ibid).

The repeal of the Petroleum Revenue Act in the U.K. in 2012 exempted shale gas from the Petroleum Revenue Tax (The Royal Society 2012). At this point, the U.S. shale development boom was well underway.

In China, research into unconventional oil and gas development did not commence until the late 2000s. In a retrospective review of fracking in the country shows "2008, Tang et al. published the first academic paper on shale gas development in China and proposed the idea that natural fractures must be communicated via shale gas fracturing" (Zhao et al 2022). Industry work followed the next year. "From 2009 to 2011, Southwest Petroleum University and CNPC Daqing Oilfield jointly launched the first fracture network fracturing research project in China, implemented the fracture-network fracturing field test for the first time, and performed microseismic monitoring" (ibid). Like the U.K., by this point the U.S. shale experience had a significant head-start.

Similar to China, in Argentina, there was little to no research into unconventional oil and gas development prior to the late 2000s. Early shale gas exploration in Argentina was led by Apache in 2008, followed by Repsol YPF SA's discovery of Vaca Muerta in 2010 (Vásquez 2016; Oil & Gas Journal 2008; Orihuela and Walsh 2010). The following year, the EIA's global analysis ranked Argentina third globally in terms of shale gas reserves in place (EIA 2011). In 2012 and 2013, decrees were passed to incentivize "large scale investments, at a time when YPF and Chevron where jointly launching an ambitious unconventional development programme in Vaca Muerta" (Gomes and Brandt 2016).

As a result of the U.K., China, and Argentina's initial policy measures in the late 2000s to early 2010s, the U.S. was able to capitalize on its first mover advantage for unconventional development due to its over three-decade head-start stemming from policy initiatives which commenced in the 1970s.

3.1.9. “When you control things, why can't you control things?”

The relevance of Ikenberry’s (1986, 1988) research on state variance to strategic challenges in the 1970s is echoed by Leading Energy Investor & Expert, who asked me, “When you control things, why can't you control things?”, referring to the head-start awarded the U.S.’s LME in the global shale race versus CME and MMEs. However, Ikenberry’s (1986) analysis of state capacity and the oil crises of the 1970s shows that “irony abounds” in regards to “simple notions” of strong and weak states, which can be “crude and misleading”. However, longer-term, Ikenberry’s research asserts there is not one correct answer, as highlighted by my research, and as illustrated by the positive outcomes from France’s strong-state approach to oil price volatility, including the emergence of France’s dominant nuclear energy, as Ikenberry details (ibid).

Regarding the aforementioned energy adjustment strategies Ikenberry was researching, Ikenberry states that the most powerful adjustment force followed the reimposition of market pricing by the United States, which was the result of the U.S. taking a defensive market response approach (regulatory decontrol and market liberalization) and letting subsidized domestic oil prices return to international levels.

This dynamic is echoed by my primary research in price controls and labor markets, as discussed in Chapter 6 on Capital Markets & Market Structure, which shows the responsiveness of the U.S. shale market to price signals versus the Argentine market which was subject to price controls and employment mandates. Under the U.S. model, oil and gas companies had mechanisms to cut costs through reducing workforces, while the companies operating in Argentina did not. Hall and Soskice (2001) characterize this dynamic as labor market arrangements which allow companies in LMEs to reduce costs during downturns through workforce reductions, as a result of fluid labor markets, and to link company profitability to access to capital.

The characteristics of the countries explored by Ikenberry (1986) have similarities to the countries I reviewed through the SRDF in this dissertation, as it relates to the differing degrees of state versus market led economies. While there are obvious differences between a country’s ability to respond to an energy

crisis and its ability to execute an energy development strategy, there are sufficient similarities to explore the interconnecting issues, and build on this prior inquiry.

From a high-level, Ikenberry's analysis suggests that more market-led economies could have more success in realizing unconventional oil and gas development than state-led ones, due to the "irony of state strength" (Ikenberry 1986). However, as he shows, both strong and weak states have different institutional capacities and benefits to address challenges over the longer-term. This assessment pre-dates some of the work of Hall and Soskice, and shows that one size does not fit all, and that LMEs, CMEs, and MMEs have different institutional capacities for addressing challenges and pursuing strategic resource development.

For Ikenberry, the state as an organization staffed by empowered executive officials, coupled with pluralistic forces found in the country, are driving forces behind institutional capacity. This idea presents another strong relative connection between Ikenberry's work and my research. "State strategy itself, while serving as a powerful explanatory variable, is subject to the political play of groups and social coalitions" (ibid). This is particularly the case in the MME of Argentina, where unions play an important role in industry, as discussed in Chapter 4 on Political Opportunity Structure.

3.1.10. Conclusion: Impact of the 1970s Price Shocks on the SRDF

For the SRDF, the arguments by the various scholars discussed are formative for my new framework. However, the challenges polycentric governance can present to strategic resource development highlight the importance of taking into account some of Tugwell's (1988) less rosy inquiry into the U.S.'s response to the 1970s oil crises, which was more a "cycle of failure". As a result, future inquiry utilizing the SRDF should be aware of pluralistic competing interests and political gridlock, highlighted by Tugwell, and presented by LMEs, as detailed in Chapter 4 on Political Opportunity Structure.

My primary research into unconventional development echoes Ikenberry's (1986, 1988) work on state strength and market structures, as shown by Argentina and China relative to the U.S. experience, whereby the LME approach or the defensive market response (in Ikenberry's example) is not the only answer to

longer-term challenges presented by new resource related opportunities. As a result, Ikenberry's early research as well as other critical comparative economy research into the oil crises of the 1970s helped set the stage for my new framework, presenting opportunities for inference into future strategic resource development challenges.

Hughes and Lipscy (2013) believe the politics of energy would benefit from more attention from IPE scholars today and more attention with respect to the "open economy politics approach", focusing on domestic preferences and building up to international interaction. I agree but would add that Political Opportunity Structure is a major missing inquiry in today's evolving energy landscape, particularly for LMEs.

The challenges and choices facing countries pursuing strategic resource development are a good area to build on the rich body of IPE literature that was developed in the aftermath of the oil price shocks of the 1970s. As a result, my inquiry builds on many of the questions explored by the various thought-leaders of IPE during this period, particularly Keohane (1978, 1984), Katzenstein (1977), Ikenberry (1986, 1988). I also believe the shale development cycle would benefit from more inquiry by contemporary scholars, as it holds similar comparative analysis insights as the 1970s oil crises.

The underappreciated natural gas crisis of the 1970s provided parallels to the oil crises in that a statist approach had limited abilities to impact near-term outcomes, but that these efforts were not wasted and ultimately led to the commercialization of fracking.

Future scholars aiming to utilize the SRDF for critical mineral, renewable energy, and broader strategic resource development challenges should revisit this period of rich energy policy research for more insights and inspiration into comparing state structures and strategies.

3.1.11. The Resource Curse - What it means for the SRDF

In this section, I show how literature on the "Resource Curse" is important for the SRDF. The Resource Curse literature shows how governments in resource-rich countries can be susceptible to adopt strong state policies which ignore the wills of the citizens due to lower public-appeal incentives as a result of the rent-seeking nature of the state. This paradox (also known as the "paradox of plenty") shows how resource-rich countries with strong state characteristics contrast LMEs which have a comparative advantage for radical innovations.

The Resource Curse research builds on the wave of state policy variation research from the 1970s and explores the economic and political outcomes of countries that developed oil and gas resources with a strong state-led approach.

"Since the late 1980's, economists and political scientists have produced "a flood of new research" on the resource curse, as academic interest shifted from the consequences and responses of the supply shocks of the 1970s (Ross 1999). The literature on the Resource Curse describes the tendency by natural resource endowed countries to not only fail to harness resources for development, but to also harm themselves in the process (Shaxson 2007). Several aspects of resource curse literature support my aforementioned hypothesis including, the inefficient nature of companies and the industry in countries plagued by the Resource Curse, the lack of a full market economy in these countries, a limited number of market participants, and friction around rapidly deploying new technologies.

"Dutch Disease" was coined in 1977 by *The Economist* to describe economic challenges the Netherlands faced following large gas discoveries in the North Sea in 1959, including exchange rate strengthening driven by a dominant industry and the corresponding adverse impact on the manufacturing and tradable economies (The Economist 1977; Bjørnland 1998). While Dutch Disease addresses some of the negative economic effects related to extractive industries, the Resource Curse depicts a broader set of social, political, and economic problems. As a result, the literature related to the Resource Curse includes discourse on corruption, civil unrest, and environmental degradation, important themes for strategic resource development, particularly as it relates to Political Opportunity Structure and the SRDF.

Daniel (1986) characterizes discourse into the Resource Curse as “political economy of mineral rent generation and distribution”, and Dutch Disease as “general equilibrium effects of a minerals boom”. The broader political economy focus of the Resource Curse has more relevance for the SRDF than the more narrowly defined Dutch Disease.

Early academic pioneers in Resource Curse research during the late 1980s were Alan Gelb (1988) and Richard Auty (1990). Gelb found that oil export windfalls could generally not be translated into sustained economic development, with some exceptions. The same argument was made by NY Fracking Opposition Leader during my interview with him on the New York experience. In Chapter 4 on Political Opportunity Structure, NY Fracking Opposition Leader highlights the fleeting and overstated economic benefits of fracking for New York’s economy as an underpinning argument against development.

Auty (1990) suggested that even under the most optimistic assumptions of a large developing country with an efficient government, the economic impact of resource-based industrialization is likely to be limited (Chapman 1992). In the mid-1990s, Jeffrey Sachs and Richard Warner (1995) published one of the most influential studies on the topic, showing that countries with high natural resource exports to GDP tended to have low growth rates from 1971-1989. In the late 1990s, Thorvaldur Gyfason and colleagues (1999) began to bridge Daniel’s two aspects of Resource Curse research, leveraging research into the role of human capital in empirical models of economic growth. They argued that abundant natural resources tend to inhibit economic growth as a result of a lack of investment in human capital.

Most of the scholars up to the 2000s focused on the empirical evidence related to the Resource Curse, linking slow growth or sub-optimal economies with natural resource extraction, more in-line with Daniel’s (1986) description of the “general equilibrium effects of a minerals boom”. Ross argues that petroleum revenues have three unique characteristics which lead to economic and political upheaval: 1) the size of oil revenues, 2) the stability of oil revenues, and 3) the secrecy of oil revenues (Ross 2012). This confluence of factors creates company and industry inefficiencies in countries with stronger state institutions. As a result, exploring the Resource Curse through the lens of the SRDF, by taking strong and weak market economies into account, can help infer development outcomes.

3.1.12. Conclusion - The Resource Curse

In this section I explained how the nature of oil (and potentially future resources) revenues discourages movement towards the very LME structure which provides nations the head-start advantage to win the resource race. As a result, the importance of countries pursuing strategic resource development to recognize and avoid the Resource Curse through the establishment of institutions and policies that support full-market economies is critical. For example, future research into the critical mineral-rich regions endeavoring to develop value-added supply chains and full-market economies while capitalizing on the applications for these minerals presents an opportunity to explore the applicability of the SRDF in the context of the Resource Curse.

3.1.13. Climate Change and the Paradoxical Role of Shale Gas

In this section, I trace the literature on climate change, connecting it to: 1) Political Opportunity Structure for unconventional development, and 2) the environmental benefits of shale gas as a result of decarbonization from increased natural gas production at the expense of coal. This section shows the evolution of shale gas' paradoxical role in the Independent Variables for the SRDF, providing a foundation for my primary research on Political Opportunity Structure.

This section shows that the emergence of climate change as a leading research topic and international issue over the past decade or so has played a major impact on the role of unconventional development in the global energy mix. Process tracing to the roots of the climate change literature shows how it affects unconventional development today through the lens of Political Opportunity Structure and the SRDF.

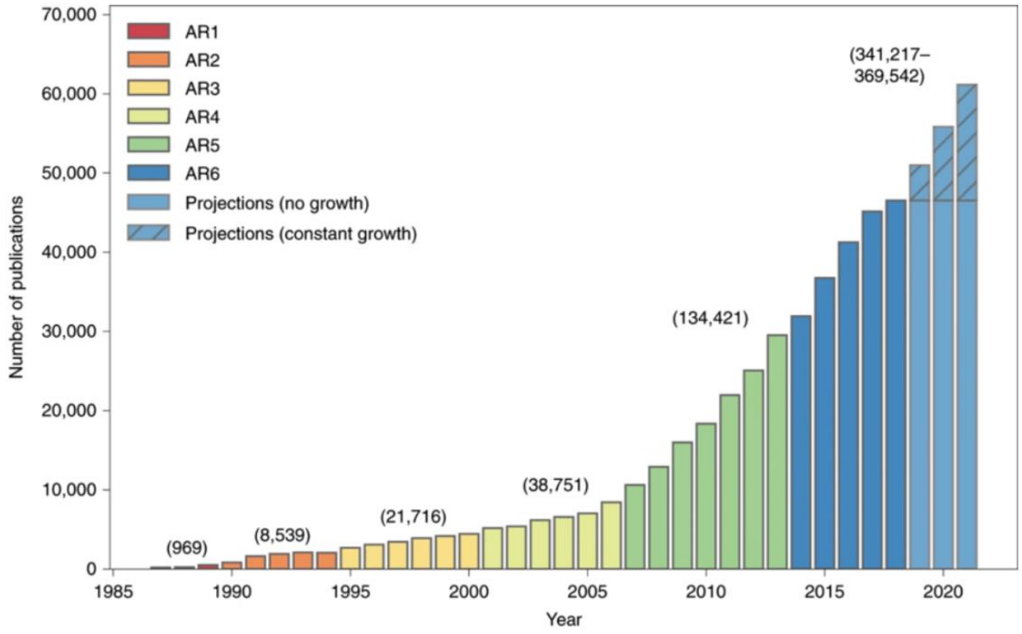
3.1.14. The Duality of Climate Change and Shale Gas, as Viewed through the SRDF

Advocates for unconventional development point to natural gas' low-carbon footprint, relative to coal, while anti-fracking campaigners argue the world needs to move beyond hydrocarbons altogether.

Climate change has been one of the fastest growing areas of energy research over the past few years, as illustrated in Figure 11. Further, the politics and public perception of climate change has changed dramatically in recent years as well, and the topic has evolved from a fringe political interest into a leading domestic and international policy agenda. This increase since the mid-2000s coincides with the start of the U.S. unconventional development cycle.

More recently, the science of climate change has been more widely accepted. In the U.S., the debate over climate change has been divided by political parties. In recent years, the Republican party (which traditionally carries closer ties to the oil and gas industry) has generally downplayed the credibility of the science of climate change and has downplayed the associated risks. However, this has changed as industry increasingly acknowledges the science and risks, and as the issue became more important to the youth vote in the mid-2010s (Page and Signer 2016).

Figure 11: Literature explosion in climate change research (Callaghan, Foster, Minx)



Callaghan, Foster, Minx 2020

The recent admissions and the evolution in public and private posturing are significant, particularly when considering that climate change research predates the oil industry with roots dating back to the 1830s. Louis Agassiz is credited with providing the foundation and origin for climate research, by proving that the earth had experienced different periods of climate. His research was grounded in the belief that the world had experienced an ice age, a period where much of Europe had been covered in vast sheets of ice, "resembling those now in Greenland" (Yergin 2011).

This assertion was bold at the time, as "few geologists anywhere in Europe regarded glaciers, or land ice in general, as anything more than a phenomenon to high altitudes and high latitudes with no role in geological processes" (Hansen 1970). John Tyndall and Svante Arrhenius notably built on Agassiz's research during the remainder of the 19th century. Tyndall experimented with various gasses to understand how the earth's surface was regulated, ultimately laying the foundation for the understanding of the greenhouse gas effect and how global warming works (Tyndall 1860; The Royal Institution n.d.). Arrhenius (1896) endeavored to mathematically show how changes in carbon would result in changes in the earth's temperature, arguing that variations in carbon could greatly influence the heat budget on earth. His extensive calculations showed "temperature of the Arctic regions would rise about 8 degrees or 9 degrees Celsius, if the carbonic acid increased 2.5 to 3 times its present value", generally in-line with some of the sophisticated models of today (Uppenbrink 1996; Graham 2000).

However, Arrhenius's quantitative research on climate change and the associated warning was generally ignored for the first half of the 20th century (Fleming 1998). Over a century later, this overlooked research would provide the foundation for arguments to reshape the global economy at the United Nations from the IEA and would provide arguments that appealed to these groups for fracking from some of the industry's most prominent actors, led by Aubrey McClendon.

Guy Stewart Callendar, a steam engineer that built on Arrhenius's findings in a paper published in 1938, reintroduced the topic, arguing that climate change caused by the burning of fossil fuels was a positive development for mankind. Callendar (1938) argued that the rise in CO2 and the earth's temperature meant that "the return of the deadly glaciers should be delayed indefinitely". This linkage of rising CO2 levels with increasing temperature became known as the Callendar Effect (Fleming 2009). However, while

Callendar brought global warming back into the realm of academic and scientific discourse, his theory was generally dismissed by his contemporaries, as they questioned the accuracy and reliability of his data and doubted that CO2 levels had increased by 10% over the 50 years he measured (Grant 2016). Further, there was an assumption that excess carbon released in the atmosphere could be absorbed by the ocean (Revelle and Suess 1957).

In 1965, Revelle chaired a "Report of the Environmental Pollution Panel" as part of President Lyndon Johnson's Science Advisory Committee titled "Restoring the Quality of our Environment" (President's Science Advisory Committee 1965). In the report, Revelle, Keeling, and colleagues warned of the dangers from rising carbon levels, and the general risk of pollutants. At this time, an environmental movement in the United States was beginning to take form, allowing more than 100 years of climate warnings to finally start gaining public traction (Gordon 2012). This period also laid the foundations for the duality of climate charge for fracking.

A series of environmental disasters in the U.S. in the 1960s and 1970s led to civil concerns over corporate interests coming before environmental considerations. Some of the more high-profile accidents and issues included the pollution of Lake Erie, oil spills offshore California, hydrogen bomb testing on Bikini Atoll (Marshall Islands), and the damaging effects of insecticides on bird populations, particularly the bald eagle. The environmental movement was multi-pronged, with a focus on water and air, and on the local, national, and international level (Gordon 2012).

In 1972, the first UN environmental conference was held, laying out a series of international governing principles and paving the way for the first Intergovernmental Panel on Climate Change (IPCC) established by the United Nations Environmental Program (UNEP) and the World Meteorological Organization (WMO) in 1988 (UNEP 1972). Ever since, the IPCC has been the central platform for international collaboration and communication for climate change mitigation. These meetings are called "Conference of Parties (COP)", and there have been 27 annual meetings since the inaugural meeting in 1995 (UNFCC n.d.).

Little progress was made towards forming international consensus or pursuing solutions during the Bush years; however, early expectations around climate action were elevated under President Barack Obama,

who made addressing climate change a cornerstone of his energy policy platform (Skocpol and Jacobs 2011). During this period, public support and awareness of climate change was also high, as evidenced by a Gallup Poll which surveyed 206,193 residents in 128 countries (Pugliese and Ray 2009).

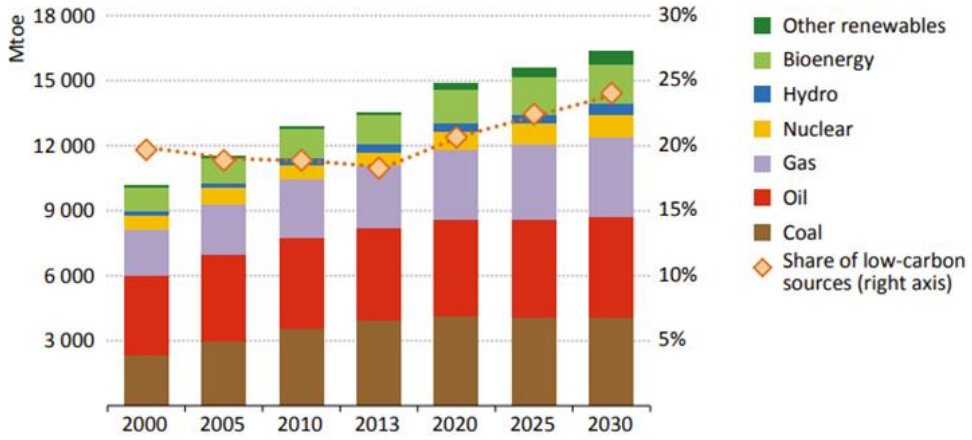
During this period, a clear shift in public sentiment toward more conservation and climate related values is seen, which makes shale gas' paradoxical position as it relates to Political Opportunity Structure clearer. In Chapter 4, NY Fracking Opposition Leader notes in my interview that it is around the 2010 to 2012 timeframe when the opposition to fracking in New York starts to build. Prior to this period, the public was generally supportive. While NY Fracking Opposition Leader points to the negative press coming out of Pennsylvania and the effects of *Gasland*, the anti-shale documentary, this section shows the turning point in local shale development (shortly followed by a similar experience in the U.K.) coincided with the building public support at the intergovernmental level.

As a result, hopes were high for the Copenhagen Climate Change Conference in 2009 (COP 15), which was generally seen as "a near complete failure" (Dubash 2009). The COP21 meeting in Paris in late 2015 was broadly heralded as a "landmark", with representatives of 195 nations signing onto an accord which "commit nearly every country to lowering planet-warming greenhouse gas emissions to help stave off the most drastic effects of climate change" (Davenport 2015). Following COP21, with the political support for addressing climate change now seemingly in place, policymakers, economists, and academics started to look for more concrete policy and monetary mechanisms to facilitate a transition to a lower carbon economy, providing an active role for shale gas (Farid et al. 2016).

Importantly, for shale gas, the pledges from COP21 (known as "Intended Nationally Determined Contributions") set the stage to introduce quantifiable modeling projections by research organizations and international coordination bodies, such as the IEA, to start to manage expectations for meeting global climate change goals, as shown in Figure 12 below. This would provide intergovernmental and institutional support for fracking with natural gas to act as a bridge fuel for decarbonization.

"World natural gas demand increases by around 30% by 2030, helping to suppress growth in emissions when acting as a substitute for other fossil fuels but adding to emissions when acting as a substitute for renewables and nuclear" (IEA 2015).

Figure 12: IEA Global primary energy demand by type in the INDC (Intended Nationally Determined Contributions) Scenario - 2000 to 2030 (forecast)



Note: "Other renewables" includes wind, solar (photovoltaic and concentrating solar power), geothermal, and marine

Source: IEA 2015

For shale gas, COP21 and the events in the few years leading up to it provided a justification for global growth in natural gas under the pretenses of decarbonization. Offsetting this mandate to decarbonize with shale gas, this period also institutionalized growing support for environmentalism, which was undergoing a resurgence not seen since the late 1960s, providing a counterbalance of grassroots opposition to development against the macro decarbonization targets incorporating shale gas. With this duality for shale gas now established, the development risk posed by Political Opportunity Structure in LMEs, due to their polycentric governance structures, is clear.

As the New York and U.K. experiences highlight in Chapter 4, unconventional development carries other environmental and health considerations for local communities and opposition groups that are often grouped in with the broad climate change agenda. This duality presents natural conflict points between national governments and local opposition groups, as national governments pursue quantifiable

decarbonization goals and as local stakeholder groups prioritize community-related environmental and health concerns. As a result, NIMBYism ("not in my backyard") takes hold, with particular risks to block or slow development through polycentric governance. I explore NIMBYism, unconventional development, and the SRDF approach in greater detail in Chapter 4 on POS (Devine-Wright 2009, Coelho 2014, Zanocco, Boudet, Clarke, Stedman, Evensen 2020; Dokshin 2021; Cotton Rattle Van Alstine 2014).

3.1.15. Conclusion - Climate Change, Unconventionals, and the SRDF

In this section, I showed how climate change and resurgent environmentalism created a paradoxical role for shale gas, with insights for POS utilizing the SRDF approach.

Process tracing decarbonization and shale gas as a case study utilizing the SRDF has shown that the Environment driver for shale gas was an intergovernmental and national goal, and not aligned with many local ones, leading opposition groups to seek-out POS access points, as shown in the New York and U.K. experiences. However, the local benefits from switching to natural gas from coal in China, where smog presents health issues, as discussed in Chapter 2, provides an example of how national and local Environmental drives can be aligned.

As a result, in this section I showed how the SRDF can be utilized to assess strategic resource development through analyzing strategic drivers for governments with the potential to infer development outcomes across market structures. Importantly, the SRDF incorporates POS to highlight that polycentric governance presents challenges to development when local opposition groups act in front of industry when a local fit-for-purpose regulatory framework is not yet in place. As such, the SRDF takes into account global, intergovernmental, and national objectives, juxtaposed against local stakeholder interests, incentives, and actions.

3.1.16. Individualism Versus Institutions in the SRDF; the Commercialization and Proliferation of Fracking

There has been significant discourse on shale development by scholars focusing on the U.S., U.K., Argentina, China, and other countries, with research into public opinion, framing of the debate between groups that are for and against development, Political Opportunity Structure, and other topics related to my research (Simonelli 2014; Arnold and Neupane 2016; Dodge 2017; Lee and Lee 2021; Dokshin 2021; Dokshin 2016; Zanocco, Boudet, Clarke, Stedman, Evensen 2020; Wilber 2017; Hedding 2017; Metze, and Dodge 2016; Ashmoore, Evensen, Clarke, Krakower, Simon 2016; Evensen, Clarke, Stedman 2014; Williams, Sovacool 2019; Garland, Saunders, Olcese, Tedesco 2023; Evensen 2018; Williams, Sovacool 2020; Fischer, Ingold, and Ivanova 2017; Cotton, Rattle, and Van Alstine 2014; Evensen, Stedman, O'Hara, Humphrey, and Andersson-Hudson 2017; Whitton, Brasier, Charnley-Parry, and Cotton 2017; Evensen 2018; Bradshaw, Devine-Wright, Evensen, King, Martin, Ryder, and Williams 2022; Devine-Wright, Ryder, Dickie, Evensen, Varley, Whitmarsh, and Bartie 2021; Bradshaw, and Waite 2017; Cairney, Fischer, Ingold 2016; Costie, Holm, Berardo 2018; Tan, Xu, and Wong-Parodi 2019). These works and others are discussed in Chapter 4, while this section focuses on the intersection of individuals and institutions through process tracing the U.S. shale experience from conception to commercialization to proliferation.

In this section, I show how the combination of entrepreneurialism and the unique U.S. LME institutional backdrop led to the successful U.S. shale development experience. I do this by analyzing the works of Gold (2014), Zuckerman (2013), Murtazashvili and Piano (2019), Wang and Krupnick (2013), and Gamper-Rabindran (2018), as well as other authors that explore the modern U.S. unconventional oil and gas experience.

Through the literature, I connect the modern U.S. shale experience with the 1970s oil and natural gas crises and highlight how a combination of the U.S. institutional framework coupled with the individualistic, independent, and incentive-based nature of the U.S. entrepreneurial experience created the shale revolution. As such, I show how LMEs have a comparative advantage for radical innovation based on the U.S. shale development literature, affirming Hall and Soskice's (2001) VoC framework, and providing a case study for the SRDF. I acknowledge that this section is more heavily weighted to the U.S., which is due

to the U.S.'s leading role in the 1970s oil crises as well as the U.S.'s leading role in commercializing fracking in response to the U.S. natural gas crisis during the 1970s.
Further, this section shows how the Independent Variables in the SRDF on Capital Markets & Market Structure and the Government intersect with institutions and individuals for strategic resource development.

While the SRDF is based on institutions and aims to neutralize the impact of individuals, the contribution of the pioneers that shaped the U.S. shale industry is clear from the literature, as notably detailed by Gold (2014) and Zuckerman (2013). As a result, it is recommended to evaluate the intersection of institutions and individualism for researchers utilizing the SRDF for any given country, particularly LMEs.

3.1.17. U.S. Shale Experience - Intersection of Institutions and Individualism

Since the emergence of the U.S. oil and gas industry in the 19th century, recurring themes of individualism, self-determination, and entrepreneurialism have been prevalent. The story of the American oil and gas industry has been one of risk, incentives, and the individuals that have shaped it. Gold (2014) and Zuckerman (2013) show how George Mitchell commercialized fracking allowing individuals leading the Independents to proliferate it.

Hacker (1947) argues that "Americans have always been convinced of the unique qualities of their civilization". He points to the "frontier theory", developed by Hegel, which argues that due to its distance from Europe, the U.S. has focused on its own specific challenges and opportunities. Hacker notes these "have centered in the conquest of a movable frontier of wild lands where the soil has been arable and also rich in timber and mineral resources". Hacker adds that in the "fusing fires of this process there has developed an American civilization".

The proponents of shale development display many elements of the frontier theory and ethos of the American, as described by Hacker, such as independence and the pursuit of opportunity, while the critics highlighted the environmental risks and concerns around corporate intervention in the community. The U.S. shale experience started in the mid-2000s and unfolded as "the country struggles to find new

economic initiatives in a somewhat post-industrial landscape, to attain independence from foreign oil in the aftermath of 9/11, and to navigate the dilemmas involved in extracting previously unrecoverable fossil fuels now that most of the world's more accessible reserves have dwindled" (Bezzina 2013).

Hacker (1947) states, "The American, as a type, became an individualist, a democrat, an equalitarian, and utilitarian". The pioneering oilmen that unlocked the shale revolution have been generally described by their biographers in a similar vein and against this backdrop. Similarly, John D. Rockefeller stated "I have no desire to trace myself back to nobility", Chernow highlights, Rockefeller added "I am satisfied with my good old American stock" (Chernow 1998). Since the origins of the American oil and gas experience at the turn of the 20th century, the industry has been the lifeblood of this conquest of a movable frontier Hacker describes. It has both enabled it and embodied it. Many of the entrepreneurs that unlocked the shale revolution are uniquely American visionaries in this sense and follow in the footsteps of Rockefeller in their individualistic, egalitarian, and determined pursuit of opportunity.

Hacker (1947) further describes the American:

> "He came to look upon government only as an effective device for assuring his happiness and for curbing the oppressive tactics of privilege-hunters. And all because the frontier served as a safety valve. In the wild zones of the West, where land was easily accessible, the American could find both haven and opportunity. Because he conquered the wilderness with his own hands and carved out a freehold for himself and his family, because he erected governments by free association, because he started with his compeers from the same bottom level - for these reasons the attitudes and institutions of his way of life were profoundly conditioned to individualism, democracy, equality, and utilitarianism".

This American ethos is prevalent throughout the U.S. shale revolution, in the stories of those who catalyzed it, shaped it, and continue to build it to this day. Gold and Zuckerman therefore affirm Hacker's description through the lens of the American individuals that refined the U.S. oil and gas industry with the advent and proliferation of shale development.

Regarding the U.S. unconventional oil and gas experience, Murtazashvili and Piano (2019) stated “the institutional framework set the stage but entrepreneurs had a key role in the shale development”. Wang and Krupnick (2013) detail the unique U.S. characteristics that “led to the boom”, while Gold (2014) and Zuckerman (2013) explore the individuals behind the boom.

While the legacy infrastructure and regulatory framework would remain consistent in the U.S., the low interest rate environment, the high oil and gas price environment stemming from emerging market growth in the 2000s, the growing energy security concerns in the 2000, and the growing aforementioned climate concerns of the 2010s were all unique and coincided with these exceptional entrepreneurs' interests and incentives.

Additionally, Murtazashvili and Piano (2019) argue that private property rights were key for U.S. shale success. They state that “private property rights and markets can be a source of innovation in the economy.” “Entrepreneurs are the source of creativity that brings about change in the economy”. This shows that “the institutional framework set the stage” for the potential for U.S. success in unconventional development, but that it was the determination, creativity, and unique intersection of interests of Mitchell that unlocked the opportunity. Gold (2014) shows how Mitchell positioned himself at the intersection of government R&D, energy policy, and industry to recognize the potential from fracking, and also shows how his unique personal experiences led to his interests in this cross-section.

As a result, the individualistic aspect of the U.S. unconventional development experience and the contributions from these specific individuals cannot be overlooked. As such, the question of whether the shale revolution could have unfolded in another LME, without the support of the individuals that catalyzed it, is not possible to answer. However, one can utilize the SRDF to analyze if a country has the Independent Variables, the strategic interests, and if the “stage is set” for future strategic resource development in that respective country at that specific time.

3.1.18. The Advent of Shale Development - Institutions and Individualism

The story of George Mitchell, Founder and CEO of Mitchell Petroleum, and the "father of fracking", is an individualistic one. However, his story, and that of the commercialization of fracking, is also one that highlights the importance of institutions. Gold (2014) connects Mitchell Petroleum's commercialization of fracking in the late 1990s to a little-known research initiative that set-off the U.S. unconventional revolution. Gold shows Mitchell Petroleum commercialized the "modern fracks" (which he traces back to 1998) versus the "hydrafracs" (which oil companies were testing back to World War II), which was an improvement from the first successful tool for fracking wells which was patented in 1865, the Roberts Torpedo.

Gold states that Mitchell was a "born dreamer" who earned a degree in "petroleum engineering but also took as many courses as possible in geology", which he notes was an "odd combination" at the time. Highlighting the influence of the incentive and risk-based U.S. LME system for the SRDF, Gold noted that following university Mitchell "wanted to work for himself, taking the risk and capturing the reward", and that a "liberal streak set him apart from a city of oilmen who embraced ultraconservative causes and candidates". He embraced environmentalism and dreamed of building a "new community that would become a showcase of racial harmony and pioneer the new idea of sustainable development", which led to the creation of the Woodlands in the greater Houston area (ibid).

Mitchell's unique background and interests led to his interest in the intersection of industry, government, and sustainability. This positioned Mitchell to recognize the potential for the commercialization of fracking, which was born out of the natural gas crisis of the 1970s.

As Ikenberry (1986, 1988) points out, it was ultimately the most liberal approach through deregulation that allowed for near-term price alleviation. However, like some of the approaches taken by CMEs during this period, intervention into the natural gas crisis led to attempts to unlock alternative sources of natural gas for longer term energy security.

This statist approach to the natural gas crisis in the 1970s resulted in the creation of the Unconventional Gas Research Program. Gold (2014) states that Mitchell was "one of the few in the industry who paid attention" to the work coming out of this government initiative (ibid). During the 1980s and 1990s, Mitchell Energy leveraged government research efforts and price controls to unlock the potential of fracking. The results were not encouraging from an economic standpoint, and "many people thought the project was a money sink". However, Mitchell, the controlling owner of Mitchell Energy, was persistent in his efforts and in his belief that the Barnett Shale "held an enormous volume of gas" (ibid).

Gold points out how in the early 1990s Mitchell Energy collaborated with researchers at the Energy Technology Center, which was funded through the Unconventional Gas Research Program, as part of Mitchell's role on the Board of Directors of the Gas Research Institute, "a private non-profit funded by a government-sanctioned surcharge on inter-state pipelines" (ibid).

The persistence displayed by Mitchell during the 1980s and 1990s is not unique to Mitchell as part of the American experience, as highlighted by Hacker (1947). However, his individual contribution and his unique personal experience, views, and efforts are worth taking into account as part of the SRDF. In doing so, it is apparent that his combination of determination in the face of opposition of opinions, and his unique position at the intersection of industry and government, underpinned by an interest in sustainability with an unusual educational background for the time, makes his role in unlocking the shale revolution an individualistic one.

This analysis of Mitchell Energy and the events leading up to the commercialization of fracking are only realized by the institutional foundations and LME framework which has a comparative advantage for radical innovation, in combination with the unique timing and individual contributions of George Mitchell. Further, Mitchell's relatively frictionless experience accessing property rights to drill and test his hypothesis in the Barnett Shale affirms Murtazashvili and Piano's (2019) assertion around the importance of institutional property rights as part of the shale revolution. As such, future researchers utilizing the SRDF should recognize that the U.S. unconventional development experience shows the importance of the intersection of individualism and institutions. This affirms Murtazashvili and Piano's aforementioned

argument that “the institutional framework set the stage but entrepreneurs had a key role in the shale development” (ibid).

3.1.19. The Proliferation of Shale Development - Institutions and Individualism

Pre-dating COP21 in 2015, when natural gas became a globally accepted institutional tool for decarbonization, Aubrey McClendon, founder and CEO of Chesapeake Energy, the “fracking king”, was a vocal early campaigner for increased natural gas (Bloomberg 2016). McClendon led an effective call to action to embrace fracking out of a sense of patriotism, and forged unlikely coalitions with environmental leaders to promote shale gas’ role in decarbonization. Gold states McClendon was the “chief apostle of an energy revolution that left America richer, cleaner, and freer to pursue a new course in the world” (Gold 2014).

Just as Mitchell’s unique personal experiences, personality, and efforts catalyzed the commercialization of fracking, the same is the case for McClendon, who proliferated fracking and shale development through Chesapeake Energy. Notably, Gold argues, “Understanding how the energy boom unfolded requires understanding the person whose personality most influenced it” (ibid). Like Mitchell, McClendon had interests at the intersection of fields (history and accounting in his case), intellectual curiosity that drove him to uncover new opportunities, and persistence to pursue his vision for the realization of personal economic incentives.

Like Mitchell, after a short stint with an oil and gas company, McClendon went out on his own, but McClendon was driven by an interest in land. Echoing Hacket and his argument for the American as a type, who stated because “land was easily accessible”, McClendon said “In land, I found my true love in the oil/gas business” (Hacker 1947; Gold 2014).

McClendon co-founded Chesapeake with industry peer Tom Ward, who both were doing small land deals in Oklahoma in the early 1980s, again echoing Hacket’s description of the American, “...because he started with his compeers from the same bottom level”. They focused on buying land, highlighting the importance Murtazashvili and Piano (2019) place on institutional property rights, which they note are “political

constructs that depend for their effectiveness on the extent that the government is willing to enforce those rights" (Hogson 2015).

Another important aspect of the Chesapeake story is one of the key Independent Variables for the SRDF: Capital Markets & Market Structure. In this, McClendon was a pioneer and his role in the U.S. shale experience highlights the importance of capital markets within the SRDF. Gold (2014) argues that McClendon's unique contribution and Chesapeake's place in the shale revolution was that "McClendon figured out how to finance the revolution, tapping into Wall Street's deep reservoir of capital. He sold the revolution to the world's bankers". In Chapter 6, Private Equity Energy Investor argues that it was the Federal Reserve that created the shale revolution, and that the Independents only capitalized on this search for returns amidst a prolonged low-interest rate environment. As such, Gold states "McClendon's signature contribution was attracting capital" (ibid).

However, in addition to McClendon's role in proliferating fracking by leveraging the technology commercialized by Mitchell and the capital available in the low-interest rate environment, his story and that of Chesapeake also embodies the boom-and-bust cycle and associated excesses and concerns of fracking, as warned by NY Fracking Opposition Leader in New York in Chapter 4. Foreshadowing the looming downturn in the mid-2010s, NY Fracking Opposition Leader points to one of the primary opposition points to fracking in New York in the early 2010s as an absence of long-term economic growth.

3.1.20. What the U.S. Shale Experience Says About the Independents and Market Structure for LMEs

Gold (2014) and Zuckerman's (2013) accounts represent constructivist perspectives on the U.S. unconventional experience and likely provide insights into the ability of future influential actors to shape the strategic resource industries of the future. However, institutional themes explored more deeply in Murtazashvili and Piano's (2019) work runs through both *The Boom* and *The Frackers*, such as property rights, capital markets, and entrepreneurialism. All set against the polycentric backdrops of the U.S. oil and gas landscape, spanning Texas, North Dakota, and Pennsylvania, with unique regulatory frameworks. As such, the bold personas enshrined in these books are no less important; however, the institutional foundations on which their success was built could be somewhat underappreciated, unless viewed in

contrast to other national unconventional development experiences. Future industry development cycles, in oil and gas, as well as other strategic resources, should provide room for comparative inquiry.

In “A Retrospective Review of Shale Gas Development in the United States”, Wang and Krupnick (2013) provide a concise overview of the factors that allowed for the successful development of shale in the U.S. The paper provides “the first academic review of the economic, policy, and technology history of shale gas development to answer the question of what led to the shale gas boom in the United States.” The authors argue several factors “led to the boom”, including government policies, high commodity prices, technology, geology, private land rights, a fragmented and open market structure, water availability, legacy infrastructure, and capital markets (ibid). Gold (2014) and Zuckerman (2013), as well as Murtazashvili and Piano (2019) show that more emphasis should be placed on the unique contributions of individuals, but in the context of the institutional foundations in which they operated.

Wang and Krupnick’s (2013) research provided much of the basis for my hypothesis that countries with state-led unconventional development strategies will have difficulties emulating the U.S. shale experience. Their findings suggest that shale was developed in the U.S. because this unique blend of factors made production profitable. As a result, they argue other countries trying to emulate the U.S.’s success should “generate a policy and market environment in which firms have the incentive to make investments and would eventually find it profitable to produce shale gas” (ibid). But how can one think about individuals and their unique contributions within this framework? The U.S. shale experience shows that firms were the agents that carried out the boom. The fact that much of the shale revolution is attributed to the Independents affirms this, as the Independents carried out their founders’ visions and the ethos of these firms were embodiments of their founders’ personal characteristics.

Further, the shale revolution being unlocked and proliferated by the Independent oil and gas companies (versus the larger Majors) builds on the individualistic nature of the American experience that Hacker (1947) details and the entrepreneurial one for shale development that Gold (2014) and Zuckerman (2013) describe.

In retrospect, one of the key questions for the U.S. shale experience is how the discovery and proliferation of unconventional development was done by the Independents, and largely overlooked by the Majors. Zuckerman (2013) highlights this point by noting Exxon's headquarters is positioned "directly above a huge shale formation". Both Gold and Zuckerman's focus on the individual and personal stories speaks to the entrepreneurial, open-market, and competitive nature of the U.S. shale experience, underscored by many of the attributes discussed by Hall and Soskice (2001) on LMEs.

The descriptions of the individuals that unlocked the U.S. shale experience mirrors Hacker's (1947) description of the American as a type, as written in 1947. As Hall and Soskice (2001) point out, incentives play an important role in the difference between LMEs and CMEs, with risk-taking a key consideration as seen in the shale development experience, as affirmed by Gold (2014) and Zuckerman (2013), and described in the description of the American by Hacker. Hall and Soskice (2001) argue that the long-term employment contracts given by CMEs places a premium on consensus building and leads "managers to focus heavily on the maintenance of their reputations". By contrast, the incentive-based economic backdrop LMEs operate in encourages risk and the creation of new enterprises to realize an individual's commercial visions. As such, the Independents were uniquely positioned to be the vehicles for radical innovation as viewed through the SRDF.

The historical significance of the Independents and their contribution to the industry dates back to the promotion of U.S. "energy independence" during the post-war period, through the 1970s, and continues today. Global Oil Service & Clean Energy Analyst articulated the impact this unique market structure has played historically and continues today, in my interview with him. Global Oil Service & Clean Energy Analyst argued, "because it's so dynamic (the U.S. oil & gas market structure), because there's many entrepreneurs, because the oil and gas has a long legacy in the US, there's over four or five thousand E&P (exploration and production) companies at any one time, and so you have a huge amount of market participants. As a result of that, you've created an oil service industry to drill the oil (and) complete the wells that are unrivaled (in) scale and size anywhere else in the world".

3.1.21. Conclusion: Individualism Versus Institutions in the SRDF; the Commercialization and Proliferation of Fracking

In this section, I showed how the intersection of individualism and institutions interacted as part of the U.S. shale development experience. By connecting the U.S. shale experience with the literature on the 1970s oil and natural gas crises, I show how the seeds for the shale revolution were planted out of the long-range statist goals for natural gas diversification, but I also show the irony of state strength at work, as it was the LME based Independents that unlocked and proliferated fracking (Ikenberry 1986). Further, I argue that while the SRDF is based on institutions, individualism cannot be dismissed. However, through the shale development literature, I provide a case study for the SRDF.

Drawing on the works of Hacker (1947), Gold (2014), Zuckerman (2013), Murtazashvili and Piano (2019), and Wang and Krupnick (2013), I argue that the Independents were uniquely positioned to unlock the shale revolution as vehicles of their founders, "Americans as a type", against the LME backdrop of the U.S., which has a comparative advantage for radical innovation. The intersection of individualism and institutions is important for the SRDF as "the institutional framework set the stage but entrepreneurs had a key role in the shale development".

I argue that the U.S. shale experience was influenced by the ethos of Hacker's assessment, and future U.S. resource development should continue to be influenced by the U.S. frontier experience. This case study highlights that utilizing the SRDF should correspondingly take into account a country's unique relationship to the Independent Variables within the SRDF, and its Historical Institutionalism underpinnings, to infer outcomes for strategic resource development.

3.1.22. Additional Shale Development Literature - Weighing Benefits and Geopolitics

Much has been written on the geopolitical implications of the development of unconventionals, with numerous scholars pointing to the emergence of shale as the start of a new era in energy security and diplomacy. These works broadly explore the new energy landscape amidst heightened geopolitical tensions and the U.S.'s new place at the top oil and gas producer globally (Bordoff and O' Sullivan 2022).

While my literature review captures a fair amount on energy security, notably from World War II to the 1970s oil crises, it would be beneficial for researchers studying future strategic resource development to analyze the literature on shale development and geopolitics.

3.1.23. Conclusion - Energy Literature Review

Reviewing the literature on energy over the last century or so reveals the recurring focus on energy security (notably beginning with World War II), economics (emphasized by the 1970s) and the environment (starting with the environmental movements followed by rise of climate change in public discourse). All three of these themes have converged in today's energy complex, with unconventional oil and gas impacting all three.

Similarly to the first-hand accounts which contributed to the energy literature of the 1940s, 1970s, and early parts of the shale revolution, the literature would benefit from new first-hand accounts of some of the critical variables that played a role in unlocking, or stopping, unconventional development, which undoubtedly deserves an important historic place in the energy literature. In addition to my first-hand accounts detailed in Chapters 4-7, I make some suggestions to future researchers for additional first-hand accounts that would be important contributions to the literature.

The energy policy literature, particularly following the 1970s oil crises, has several parallels for how various countries choose different paths when faced with the same challenge. The SRDF aims to institutionalize this process. Hughes' (2014) contribution to the 1970s literature shows how this inquiry-rich period has impacted the oil and gas industry today, representing a critical junction from the post-World War II period. Further, Hughes' work benefits from more complete retrospection (relative to the pioneering discourse in the 1980s that followed the 1970s oil crises, led by Ikenberry (1986, 1988) and Keohane (1978, 1984).

Some of the literature on the Resource Curse suggests oil exporting countries are susceptible to economic development issues as they are not able to develop full-market economies. Since the "U.S. Model" (for developing unconventionals) utilized a full market economy, some of the challenges for state-run, oil

exporting countries to develop unconventionals overlap with elements of the Resource Curse. My primary research into the New York state unconventional development experience highlights these concerns, with NY Fracking Opposition Leader pointing to the fleeting economic benefits of shale development (but lingering environmental effects) as one of the critical issues for the opponents. Evensen (2018) also highlights how questions around the economic benefits of fracking in the U.K. encouraged public pushback.

Through the literature on climate change, I trace how the birth of the literature on this topic over 100 years ago connects to the argument for shale gas as a mechanism for decarbonization. I juxtapose this macro argument for shale gas against the literature on NIMBYism, presenting the duality in the Environment strategic driver for the SRDF as an Independent Variable. Notably, my primary research in chapter 4 on Political Opportunity Structure builds on this duality, with local interests outweighing intergovernmental natural gas and decarbonization goals.

Lastly, the literature on U.S. shale development experience shows several things for the SRDF, particularly at the intersection of institutions and individuals. The first is that the statist policies of the 1970s in response to the oil and natural gas crises achieved the unintended consequences of unlocking shale development. It also shows that Individualism played a meaningful role for U.S. shale development.

As Hacker (1947) argues it is in this "fusing fires of this process there has developed an American civilization", I argue that the U.S. shale experience was also fused in the fires of the American experience. In-turn, and through the SRDF, this experience now provides another chapter in the American story to inform future resource development, once again, in search of "both haven and opportunity", and in a manner "profoundly conditioned to individualism, democracy, equality, and utilitarianism". As such, the literature on energy policy provides an important foundation for the SRDF and can help inform future development outcomes.

Chapter 3 - Part 2: Theory Literature Review

3.2.1. Introduction

In Part 2 of the literature review chapter, I review the theoretical literature and show how it applies to the SRDF. In doing so, I connect the energy literature review, including the strategic drivers behind a country's efforts to develop resources, as well as the key waves of energy policy, with my chosen theoretical lens for the SRDF: Historical Institutionalism.

My theory literature review builds on the preceding energy policy literature section, spanning World War II to the 1970s to the shale revolution, which shows how these periods moved from Realism to Neo-Realism to Neo-Liberalism, respectively. As such, these periods followed the path from a wartime focus on sovereignty, security, and military might in the 1940s, to a focus on balancing power in the 1970s, to economic interdependence and incentives focused on absolute (versus relative) economic outcomes today. Considering I introduce the SRDF with Historical Institutionalism as its theoretical lens, this contemplates: 1) an international system that is open, coordinated, and dynamic, as well as having 2) domestic systems that are also dynamic with actors that are not just the state actors, but spanning corporations, movements, interest groups, and other potential stakeholders.

As such, in this section I discuss why Historical Institutionalism is the appropriate theoretical lens for the SRDF, why some other theories were not appropriate, and why a few theories help inform the SRDF, and should be viewed complementary, but are not suitable for the primary theory. As a result, I show how future researchers can ground inquiry into strategic resource development by process tracing the Independent Variables for various countries. I primarily do this by connecting the afore-discussed U.S. shale experience to this section, utilizing shale development as a case-study, highlighting how institutions matter (as well as their historical contexts) for inferring development outcomes utilizing the SRDF.

In doing so, I build on Hall and Soskice's (2001) VoC framework for analyzing market economies. Utilizing U.S. shale development as a case-study for the SRDF, by building on the VoC framework and using Historical Institutionalism as a theoretical lens, shows the U.S. had a comparative advantage for shale

development. This process shows that strategic resource development can be inferred across countries, technologies, and resource bases in a similar manner.

I also point out two nuances where the literature and my primary research show that Historical Institutionalism would benefit from mixed methods research and should be complemented with additional theories.

The first relates to Individualism, as detailed in the preceding section about experiences of the pioneers of fracking. The importance of these individuals and their experiences, personalities, interests, and efforts argues that *they* do matter. The institutional setting in which they operate enables their efforts to achieve the end-results, but their personal roles cannot be denied. As a result, Historical Institutionalism is not sufficient and should be complemented with Constructivism. The second nuance relates to POS, which represents a key Independent Variable for the SRDF, particularly for LMEs with polycentric governance structures.

As a result, researchers can utilize Historical Institutionalism and VoC as a foundation for the SRDF, but can see how additional theoretical lens' can be applied to complement specific aspects of their research.

3.2.2. State Strength, Institutional Autonomy, and Varieties of Capitalism for Strategic Resource Development

My initial underlying hypothesis in 2014 was that unconventional development success in the "international sample set" would be dictated by the extent that countries have components of the "U.S. Model". Further, I believed some components should be more important, including government policies and market structure. This hypothesis was viewed through an initial lens of a predisposed belief that U.S. neo-liberal market structure was the best foundation for unconventional oil and gas development. Following my literature review and primary research, my hypothesis is reinforced in some areas and dispelled in others.

My research into international unconventional resource (shale) development compares the ability of various countries to follow the U.S.'s success with shale development as a case-study for the SRDF. This cross-national study is underpinned by numerous elements that are critical to comparative politics, notably studying the causes of variance in outcomes between different countries endeavoring to achieve similar outcomes. Central to my research are questions around the role of the state, the strength and autonomy of institutions, the contribution of individuals, and the effect of various political economy models.

The SRDF builds on the field of New Institutionalism, the sub-field of Historical Institutionalism, and the comparative politics research framework VoC by affirming that shale development presents LMEs with a comparative advantage for radical innovation. However, it is clear from the slow and steady production growth and development currently being experienced in Argentina and China that the U.S. model is not the only path forward for unconventional oil and gas development and likely for other strategic resources that require incremental innovation over investment cycles.

Importantly for policy makers, where a first-mover advantage is deemed critical for long-term strategic objectives, replicating the U.S. model for strategic resource development could be advantageous. Where stepping in following the radical innovation first-mover advantage is a national strategy, CMEs are well positioned to build on the initial radical innovation delivered by LMEs and instead focus on incremental improvement. As such, the SRDF shows that economic models are not consistent or inconsistent with a certain type of resource development, but rather that they have a comparative advantage at various points in the investment cycle. Institutions are at the foundation of this inquiry and allow for this inference.

3.2.3. New Institutionalism and Additional IPE Inquiry into Energy Politics

New Institutionalists concern themselves not just with the impact of institutions upon individuals, but with the *interaction* between institutions and individuals (Lowndes 2002). In the previous section, Gold (2014) and Zuckerman (2013) show that Individualism played a meaningful role for U.S. shale

development, and that the U.S. shale experience unfolded at the intersection of institutions and individuals.

As such, New Institutionalism provides an effective lens for the SRDF, based on the literature. For the U.S. shale example, New Institutionalism shows how individuals, including George Mitchell of Mitchell Energy, Aubrey McClendon of Chesapeake Energy, and Harold Hamm of Continental Resources, meaningfully affected U.S. shale development, utilizing various institutions (Zuckerman, 2013; Gold, 2014). These individuals leveraged the institutions surrounding the U.S. oil and gas landscape, such as capital markets, property rights, and public-private research initiatives, to advance their goals and make shale development possible in the U.S. This combination lends credence to the individual contributions of the actors involved, but largely credits the institutions and the institutional makeup of the states these actors operated in, affirming Murtazashvili and Piano's (2019) argument that "the institutional framework set the stage but entrepreneurs had a key role in the shale development".

While reflective of the fundamental problem of political science, in that we can never know the outcome under a different set of variables, as "inference is an imperfect process", it seems that while critical to the success of shale development in the U.S., I argue that these individuals would likely not have been able to achieve similar levels of success with shale in another country given the different institutional factors (King, Keohane, Verba 1994). As such, viewing their contributions in relation to their institutional settings is critical. Conversely, Hall (1986) argues that institutions are not the sole cause of outcomes, rather that they structure the battles in which broad political forces work out their struggle, and influence their outcomes (Steinmo, Thelen, Longstreth 1992).

This acknowledges the individual contributions but prioritizes the institutional makeup of the oil and gas industry in the U.S., prioritizing the interaction between the individuals and the institutions. This provides a compelling approach to examine my research questions, and for the SRDF for future research. This cross-sectional analysis provides future scholars a platform to build on and incorporate other narrower and more actor-centric approaches, against institutional considerations.

The importance of POS for the SRDF provides another argument for New Institutionalism as a theoretical approach, as it provides a sociological lens to analyze the interaction of various institutions, and "socioeconomic and political structures that mold behavior in distinctive ways in different national contexts" (Thelen and Steinmo 1992). This is seen in the New York shale experience, where the anti-fracking movement took on a political identity and ultimately led to the ban on fracking, which could have adversely affected monetary outcomes for individuals, communities, and the state. This is made possible by sociological considerations trumping purely monetary ones, despite the argument by NY Fracking Opposition Leader that economics would be short-lived. Highlighting this, Hay (2002) argues that one of the key considerations for New Institutionalism is that "Actors do not always behave instrumentally in pursuit of material self-interest".

The shift in Institutionalism over the past fifty years to include more sociological considerations was part of an effort to explain how politics "really works" (Eulau and March 1969). The aforementioned case-study on the New York fracking ban (in Chapter 4) aims to achieve this goal by showing the various factors that ultimately led to the ban. This approach has helped illuminate political orders, which March and Olsen (2006) define as "a collection of institutions that fit more or less into a coherent system". As a result, New Institutionalism is a compelling avenue for additional IPE inquiry into energy politics, considering energy's influence on and from various political orders, including the SRDF.

Hall (1986) defines institutions as "the formal rule, compliance procedures, and standard operating practices that structure the relationship between individuals in various units of the polity and economy". More broadly, March and Olsen (1989, 1995) define an institution as a "relatively enduring collection of rules and organized practices, embedded in structures of meaning and resources that are relatively invariant in the face of turnover of individuals and relatively resilient to the idiosyncratic preferences and expectations of individuals and changing external circumstances".

The American experience in which shale development unfolded is grounded in a unique "relatively enduring collection of rules and organized practices", as the literature from the prior section shows. The institutional differences among the countries pursuing unconventionals are substantial (ibid). As such,

these historical institutional considerations are important to consider and should illuminate where shale development challenges could appear, particularly relative to the U.S. model.

More specifically, and building on the previous section, the way the U.S. shale experience unfolded leveraged three unique intersections at institutions and individuals. They were: 1) the ability to access government R&D initiatives for private-sector commercialization, 2) the ability of the Independents to leverage institutional property rights for the rapid build-up and delineation of development, and 3) the ability to leverage the institutional capital markets for the proliferation of fracking. These three specific examples of the intersection of individuals and institutions resulted in the realization of the head-start available to LME countries through a comparative advantage for radical innovation. The juxtaposition to these intersections across countries and Independent Variables is clear in chapters 4-7. They also provide insights and specific examples for inference for future research utilizing the SRDF.

3.2.4. Popular Criticism of New Institutionalism and the SRDF

There are several considerable criticisms and downsides to New Institutionalism, which mostly point to the potential for new institutionalists to be too loose in the labeling of institutions. John (1998) argues that institutionalists “include too many aspects of political life under one category”. Lowndes and Roberts (2013) highlight that for March and Olsen (1989) “there seems to be no clear distinction between institutions and norms in general”. Rothstein sums the general criticism up by saying that if an institution “means everything, then it means nothing” (Rothstein 1996).

Understanding the drawbacks of Historical Institutionalism is critical for continually optimizing the SRDF and complementing it with other theoretical approaches. Immergut (2006) points out two problems with Historical Institutionalism, stating the term “historical” is not well understood, and “institutional change is particularly vexing for this approach”. She adds that historical institutionalism is not unique enough from the other new institutionalist approaches and notes Thelen and Steinmo’s (1999) assertion that the main distinction is explaining how distinct sets of political preferences develop.

These arguments are valid, and as a result, I maintain a relatively conventional assessment of what constitutes an institution in my research. The institutions I explore are well established and understood "rules of the game", as Lowndes (1996) calls what new institutionalists deem institutions. These institutions are the labor market, the capital market, the legal framework, the industrial competitive landscape, and the technical and infrastructure capacity in the countries being explored. However, I note that POS takes on more of an esoteric or questionable understanding as an institution. As such, I look at this key Independent Variable through more of a social or Constructivism lens.

While there are exceptions to these and the other institutions I explore as being too broad, these institutions are well defined and the industry participants (oil and gas companies and other relevant stakeholders) have a good understanding of the standard operating procedures associated with each of them, including POS through local stakeholder engagement (as my primary research shows). As a result, New Institutionalism in my research stands up to some of the criticism related to the approach and provides a strong theoretical lens for the SRDF as a starting point to be optimized by future researchers.

3.2.5. Historical Institutionalism as a Theoretical Lens for the SRDF

Historical Institutionalism is a compelling potential approach for the SRDF, largely due to its emphasis on how state and societal institutions shape how actors define their interests and structure relationships with other groups (Thelen and Steinmo 1992). This is important for my research as Historical Institutionalism can reflect a government's ability to execute a strategic initiative (like shale development), particularly in a regulated and capital-intensive industry like energy and natural resources, and how in doing so creates a playing field or rules of the gam" that either encourage or discourage specific types of innovation. Further, the emphasis on Path Dependency in Historical Institutionalism provides insights into the outcomes of my various research questions and allows for inference into development outcomes based on the SRDF's Independent Variables (Lowndes 1996). This reinforces my hypothesis that countries pursuing unconventional resource development with a state-led approach will have trouble replicating the U.S. level of success.

Ikenberry (1994) argues Historical Institutionalism shows how political struggles are "mediated by the institutional setting in which it take place". Hattam's (1992) case study on the 19th century English and American labor reform movements illustrates Ikenberry's point and shows how legacy political and social struggles and compromises impacted the English court system and led to divergent outcomes in the U.S. and England.

This example is important to my research because it illustrates how institutional differences between two countries led to different points of access for similar groups trying to influence political outcomes, which I mentioned as a critical consideration for fracking in my discussion on Behaviouralism. While both the U.S. and U.K. face opposition to fracking from various domestic actors, the level of success and experiences these groups have had in their respective countries have varied significantly. Opposition in China and Argentina have had widely different experiences in this regard as well; however, institutional differences in these countries have led to different points of access across the political system as well.

Other subfields of New Institutionalism might not offer as strong a theoretical framework for my research as Historical Institutionalism, largely due to their emphasis on individual actors within institutions. Normative Institutionalism and Rational Choice Institutionalism for example, both offer frameworks to analyze individual actors' ability to achieve goals through institutions, with Normative Institutionalism viewing actors as being constrained by institutional norms and path dependent on the characteristics of the institutions in which they operate, and with Rational Choice Institutionalism viewing institutions as mechanisms for individuals to achieve political or strategic goals. Actor-Centered Institutionalism could represent a more interesting framework for future use of the SRDF, considering its focus on institutions' relationships with society and other organizations.

Overall, the focus on individual goals in the other sub-fields of New Institutionalism is too narrow in scope for the type of cross-national research I am conducting in this dissertation and for the SRDF as a tool. Sanders (2006) argues Historical Institutionalism teaches us that "the place to look for answers to big questions about class, power, war, and reform is in institutions, not personalities, and over the longer landscapes of history, not the here and now". As such, Historical Institutionalism allows for the incorporation of personal considerations, like the individual contributions of pioneers for fracking, but

does so in a broader institutional and political economy context, as I show in the prior section by connecting their unique persona and actions to Hacker's (1947) description of the American as a type. Once again, this is reinforced by Murtazashvili and Piano's (2019) argument that "the institutional framework set the stage but entrepreneurs had a key role in the shale development", and not the other way around.

By doing this, Historical Institutionalism acknowledges individual contributions and character, but within a broader political economy context that creates a systematic framework for inference. As a result, Historical Institutionalism places individual contributions within the broader struggle of a state's goals and identity, as defined by the Strategic Drivers for the SRDF, and the ability to affect change by these unique efforts. As a result, Historical Institutionalism provides a framework for systematic inference for the "big questions" over the "longer landscapes", which is a good starting place for strategic natural resource development, which contemplates many institutional and IPE considerations (Sanders 2006).

3.2.6. The Varieties of Capitalism Framework

Varieties of Capitalism (VoC), a "framework for understanding the institutional similarities and differences among the developed economies" provides a useful tool for cross-national research and is the foundational framework for the SRDF (Hall and Soskice 2001).

In highlighting the robustness of the VoC framework, I note that my initial hypothesis at the start of my inquiry has been dispelled. My initial hypothesis (that countries pursuing shale development with a state-led approach will have trouble replicating the U.S. model) offered a strong counter-argument to some of the central aspects of the VoC framework. My initial hypothesis was ultimately shown to be incorrect, as highlighted by the slow and steady development approach by Argentina and China. Further, what my inquiry has shown only reinforces the SRDF, in that LMEs have a comparative advantage for radical innovation and CMEs have a comparative advantage for incremental improvement. As a result, in addition to the contribution to the literature the SRDF makes as a tool for inference, my case-study on unconventional oil and gas utilizing the SRDF also adds to the VoC literature by affirming its ability for inference for strategic natural resource development.

Institutions are at the center of the VoC framework, lending further support to my focus on New Institutionalism and Historical Institutionalism as a theoretical backdrop for the SRDF. The VoC approach places companies at the center of political economies and looks at how companies utilize institutions to address "coordinating problems" that occur as the result of “technological change or international competition”. The VoC framework is particularly suitable for the SRDF research as it views LMEs and CMEs as having “quite different capacities for innovation”, presenting a foundation for future resource development inference (Hall and Soskice 2001).

The VoC approach argues that “differences in the institutional framework of the political economy generate systematic differences in corporate strategy across LMEs and CMEs” (ibid). While the approach does not suggest one strategy is superior to the other in terms of overall output, it ultimately argues that differences in the institutional structure of political economies create “comparative institutional advantages” favoring different types of output and industries. At the core of the institutional differences (between LMEs and CMEs) is LMEs’ harnessing of market relations to resolve coordination problems, and CMEs’ use of “non-market coordination that entail collaboration and strategic interaction” (ibid). Innovation plays a critical role in determining the comparative advantage between LMEs and CMEs, as the U.S. shale experience affirms.

Critically, as Hall and Soskice argue that LMEs are more supportive for industries where radical change is prevalent, such as biotech, software, and software, while CMEs are better suited for “maintaining competitiveness in the production of capital goods”, and “to secure continuous improvements in the production process in order to improve quality control and hold down costs” (ibid).

This is important because the U.S. shale experience has been characterized by gradual improvements in efficiency and productivity as a result of a series of technological enhancements and operational optimizations that has ultimately lowered costs, improved financial returns, and increased oil and gas production, as detailed in Chapter 6.

However, as the energy policy literature review shows, the shale development experience was unlocked and commercialized by Mitchell Energy as the result of radical innovation. As such, the U.S.'s head-start from its LME-based comparative advantage was based on its initial radical innovation, with incremental improvements thereafter. However, the *comparative* advantage for radical innovation is clear as this head-start advantage allowed the U.S. to capitalize on its first-mover role and provide the Independents the opportunity to proliferate the technology with the help of institutional property rights and capital markets.

This case-study provides a precedent for future researchers utilizing the SRDF to study and infer how different technologies, natural resource bases, and political economies might fare in the resource development races of the future.

3.2.7. Criticism of Varieties of Capitalism

Since pioneering the Varieties of Capitalism framework in 2001, criticism has emerged for the framework while the originators and other scholars have addressed, updated, and modified some of the initial points and underlying aspects of the framework.

Hancké (2009) describes how the "liberal convergence theorists" question the "idea of institutional divergence among capitalist economies". Hancké draws Phelps and Eichengreen in with arguments of how "a significant level of non-market coordination in capitalist economies...may have allowed economic and political elites to mobilize the resources associated with the need for fast growth in the post-war era", essentially claiming coordinated actions allowed liberal ones to be effective.

Another criticism is that the aforementioned gradual liberalization of the global economy and increase in trade and interconnectivity since the 1970s has exposed some shortcomings in the framework (Howell 2003). Recent tension between the U.S. and China and questions around economic decoupling from their two economies has negated Howell's assessment (Kucik and Menon 2022). As such, a new era of strategic natural resource competition between economic models could play out in the decades ahead, making the VoC framework highly relevant and reinforcing the need for the SRDF (Byamungu 2022).

Streeck (2010) argues that historical institutionalism plays a role in capitalist countries becoming and remaining different. He sees historical institutionalism as one of four accounts explaining capitalist variety, as inherited institutions have "constraints and opportunities for economic action". Notably, "in historical-institutionalist work, institutions that regulate and accommodate collective interests and collective organization at the intermediate level of society between the market and the state are especially important for capitalist variety" (ibid).

This speaks to the coordinating problem Hall and Soskice (2001) argue economies face and pulls in path dependency as countries with these types of institutions would be more flexible in their ability to solve the problem. As a result, "economic liberalization and the opportunities for mobilization" is the main source of convergence from CMEs to LMEs in the historical institutionalism model (Streeck 2004; Streeck 2010a).

To reinforce this argument, Streeck (2010b) uses Germany, one of the main examples of a CME by Hall and Soskice (2001), as a case for how countries naturally shift towards the more liberal consensus. However, despite the broader post-World War II trend of economic liberalization, the natural resources landscape remains divided between state-led and private approaches. As such, the VoC framework enables the SRDF as a tool for inference for researchers exploring natural resource development across these two models.

The U.S. shale experience builds on the work of other scholars that are critical of the innovation claims in the VoC framework. Notably, Taylor (2009) criticizes the distinction between radical and incremental innovation arguing that sectors are able to deliver both types of innovation. We have seen evidence of this U.S. shale experience; however, the question is over what period the cycle should be viewed, as Kemp (2023) argues the shale revolution is now over. I agree.

Herrigel and Wittke (2004) argue the institutional advantages in LMEs and CMEs could be substantially overstated and states they "reject the strong...argument that societies are endowed with comparative institutional advantages", pointing to the converging strategies and conflicting outcomes with the

framework in OEM sectors in the U.S. and Germany, two supposedly opposite sides of the spectrum. While this may be true for some inquiry, my primary research does not support these criticisms and affirms Hall and Soskice's (2001) framework for resource development. Further, the introduction of Political Opportunity Structure strengthens the VoC framework for the SRDF.

3.2.8. Developmental State Literature Complements Varieties of Capitalism (VoC)

In this section, I discuss the Developmental State literature as it relates to the SRDF. I show why the SRDF should consider institutional capacity, ahead of resource development, for Developmental States with CME and MME political economies, to ensure nations can avoid the pitfalls of the Resource Curse. I also show how this compares to the downside for LMEs in moving ahead with resource development ahead of a fit-for-purpose regulatory being established, due to the development risks presented by Political Opportunity Structure from polycentric governance.

Central to the Developmental State literature is the Weberian ideal of giving a monopoly of force to the state, underpinned by a civil service and political class that is clearly based on merit (Weber 1919; Yoshioka 2016). This creates an "essential foundational element of developmental states" (Evans 2010). More recently, research linking the quality of institutions with economic growth and income is at the core of the developmental state concept (Rodrik 2002).

Central to success for the Developmental State is the absence of political patronage and corruption, which as discussed in the literature on the Resource Curse, can be particularly challenging for state-led and resource dependent economies. For my research and the countries I study in this dissertation, this is not as much of a concern as it could be for future inquiry utilizing the SRDF. For example, despite China and Argentina's rich shale gas resources, both enjoy diversified economies relative to the "Petrostates" Ross (2012) characterizes as being susceptible to the size, secrecy, and economic swings that can be associated with oil revenues. Argentina's historically agriculture-based economy has more resource state characteristics than China's industrial and manufacturing focused one. As a result, it is less of a concern for my dissertation, and the relevance of this section is more important for future inquiry utilizing the SRDF.

Routley (2012) highlights that the term Developmental State was initially used to describe various Asia Pacific countries which have "experienced rapid economic growth through state-led policies or interventions". While Japan is often recognized as the original developmental state, Routley credits Friedrich List as making the first argument for the concept with Germany's economy needing state support and guidance to catch-up to Great Britain's "insular supremacy" (ibid; List 1909). However, in her review on Developmental States, Routley (2012) points out the term has been broadened to include a "wider group of countries..." with ".... the state playing a key role in development". For my purposes, Routley's assertion of how the developmental state model conflicts with the neo-liberal economic model provides an apt lens to compare LMEs and CMEs.

Aside from List's original articulation of the developmental state in the early 20th century, the origins of the developmental state can be traced through various themes, such as colonialism and national security (Routley 2012). For national security, strong institutions often born out of geopolitical necessity have created economic opportunity, such has been the case for Japan, Botswana, South Korea, and Taiwan (Doner, Ritchie and Slater 2005). For China and Argentina, national security has played an important role in developing energy strategies that support state energy institutions and unconventional development, as shown in Chapter 2.

Importantly for the SRDF is Leftwich's (2008) assertion that an effective state must be established before a Developmental State can actually economically develop. This reinforces the Resource Curse risks for strategic resource development as highlighted by Ross (2012). As such, the establishment of a full market economy is critical for the SRDF. Leftwich (2008) identifies various forms of Developmental States as autocratic, democratic, and noting that "some have been run by dominant single parties and others by shifting coalitions". These are largely made up of Asia Pacific and East African economies that have experienced state-led rapid economic growth.

Counter to this model are the Latin American economies which have "powerful landed interests" that are able to counter state strength, which could present a poignant challenge for Argentina's unconventional development goals (ibid).

Routley (2012) breaks down the various developmental states by their key attributes, which does not include Argentina and its Latin American peers (except Chile) and puts China in its own category. Of the various categories she identifies, Argentina seems to have characteristics that could be a blend of "Developmental Patrimonialism" and "Aspirational Developmental States", in-line with its position as an MME under the VoC framework and for the SRDF. This shows that the Developmental State literature complements the Resource Curse literature and builds on the VoC framework. As a result, for future research into strategic resource development, researchers utilizing the SRDF should consider institutional capacity for CME and MME Developmental States ahead of resource development, just as they consider fit-for-purpose regulatory frameworks for resource development for LMEs due to the risk from Political Opportunity Structure through polycentric governance.

"Social Processes" versus "Formal Operation of Politics"

3.2.9. Constructivism and Historical Institutionalism in my case study on U.S. Shale Development and the SRDF

As mentioned, for my unconventional oil & gas case study utilizing the SRDF, I draw from various approaches when analyzing certain countries in a mixed approach. I recommend future researchers do the same to both optimize the SRDF and for country, resource, and technology specific nuances.
Several critical aspects of shale development are underpinned by social considerations, particularly as it relates to the environment and NIMBYism, which has been "extensively critiqued by social scientists as a useful concept for research and practice" (Devine-Wright 2009). Devine-Wright argues NIMBYism arises when "new developments disrupt pre-existing emotional attachments and threaten place-related identity processes" (ibid).

As discussed in my literature review, NIMBYism was a critical challenge for the early development of the Appalachian Basin in the Northeast U.S. As my primary research in chapter 4 shows, it was also one of the central issues in the U.K. The issue has been building in Argentina recently as well, as also discussed in Chapter 4 (Castilla, 2017). This opposition reflects Stoker and Marsh's assertion of social processes

making politics about "more than what governments choose to do or not" (Marsh and Stoker 2010). Place attachment and NIMBYism are key re-emerging themes from my primary research, particularly in New York, New Mexico, and the U.K. My primary research is supported by arguments on place attachment and NIMBYism in Chapter 4 by various scholars (Zanocco, Boudet, Clarke, Stedman, Evensen 2020; Dokshin 2021; Cotton Rattle Van Alstine 2014).

My primary research shows that social movements matter significantly for strategic resource development, particularly where access points for opposition groups are available as a result of development moving ahead of a fit-for-purpose regulatory regime being put in place. As such, constructivism best acknowledges the social considerations related to strategic resource development.

Constructivism concentrates on the "social constructs...through which people perceive the world" (Parsons 2010). In addition to social movements, constructivism provides space for analysis of individual actors, their self-interest, as well as their broader institutional settings. As mentioned, certain individuals played a large role in pioneering fracking in the U.S.

Some of the main mechanisms of constructivism also match well with my research and the SRDF, particularly in relation to the key individuals in the U.S. example. *Socialization* and *Persuasion* are among the more popular mechanisms used by constructivists. Both mechanisms deal with how individuals relate to social constructs, with socialization suggesting a "diffused, decentralized, collective, and consensual process in which a group of people work their way to certain norms or ideas", and persuasion focusing on "entrepreneurial people who invent new ideas and sell them to others (Parsons 2010)".

Socialization is relevant to the competitive yet collaborative nature of the oil and gas industry, where industry participants benefit from the development of new technologies and methods, as well as neighboring exploration successes of competitors.

This dynamic, which leads to the delineation of oil fields, dates back to the early days of the U.S. oil industry. "The major companies...were eager to assist independents", a wildcatter active in Texas during the 1920s recalled of inter-industry socialization and norms at the time. He added that the Majors "were happy to see every wildcat that was drilled", and would offer tips on where to drill and lend equipment if

necessary (Burrough 2009). This dynamic continues in the U.S. today, with co-investment the industry standard and the oil services companies spreading best practices among operators.

This collaborative development is encouraged by small-scale leases that can often only be held by maintaining production, a dynamic somewhat unique to the U.S. shale experience. This fragmentation of land leases led to the Independents' success, and was the starting point of McClendon's focus, as discussed. Murtazashvili and Piano (2019) highlight the importance of the market intermediaries and property entrepreneurs behind this dynamic, which they classify as "a second of entrepreneurs".

By contrast, in Argentina for example, acreage leases provided by the state are much larger and can be held for a longer period, negating the need for concentrated activity and a state of collaborative competition. Argentina Oil & Gas Consultant argued, this practice in Argentina is not efficient or sensible "because it's so capital intensive that you're going to focus from the little corner where you have a sweet spot and you're going to spend $500 million there or more, and then you're going to develop that and you're not going to spend money prospecting the rest and it's going to sit there for 35 years".

This less competitive starting of large blocks with longer leases is exacerbated by an absence of royalties for private landowners in countries outside the U.S., including Argentina. For example, Argentina Oil & Gas Consultant describes how larger players could "farm out" underutilized acreage to smaller players to maximize production on leases in Argentina (as is done in the U.S.), encouraging a collaborative competitive landscape with aligned economic interests among various private companies within a certain geography, similar to the U.S. experience (Wood and Stebbing 2023).

As it relates to the U.S. development story, constructivism, and Parsons' (2010) theory, Persuasion is another important concept as part of process-tracing the U.S. shale experience. Persuasion focuses on "carriers" and individuals that bring new ideas into an arena and sell them to others. As discussed in my energy policy literature review, the experiences of Mitchell and McClendon revolved heavily around this mechanism (Gold 2014, Zuckerman 2013).

Parsons (2010) states that these carriers are able to spread their new ideas through charisma, sheer force of their ideas, or the alignment (or "fit") of the new ideas with existing ideas or norms (Gold 2014). Mitchell, despite his less vocal and public approach, should also be seen for his persuasion, but more through his actions in the pursuit of the commercialization of fracking than words (Zuckerman 2013).

The contributions Mitchell and McClendon have had on the development and proliferation of fracking is significant, and can be better understood using a constructivist approach. However, some of the limitations of constructivism highlight the actor-centric nature of the approach. Weber (1978) argued that while constructivism might shine light into explaining an individual's actions, as well as understanding what the actor thought was the motivation or meaning of these actions, it does not necessarily mean that these two factors always co-exist.

While constructivism can shine light on the shale pioneers' interaction with various social constructs, it is difficult to draw conclusions to their motivations and meaning. Here is where Historical Institutionalism presents a compelling lens for the U.S. shale experience, as well as the SRDF.

In the previous section, I showed how the actions of the Independents were shaped by the founders that managed them, and how this impacted development outcomes, highlighting how organizations and institutions structure the actions of actors (Hall and Soskice 2001, Ikenberry 1994). Further, I showed how these organizations, and their founders, which provided guiding visions for the firms, mirrored the historical institutional foundations of the U.S. experience.

Reinforcing this alternatively are CMEs' comparative advantage for incremental innovation set against a corporate framework that has "structural bias towards consensus decision making" and is usually underpinned by institutional state support that often comes with less autonomy, particularly in regards to relations with trade unions or "representative bodies for employment" (Hall and Soskice 2001).

This compares with LMEs where "Top management usually has unilateral control over the firm", as my case study into the U.S. shale experience shows (ibid). This again highlights the importance of Constructivism in exploring the role of individuals through the SRDF, particularly within LMEs.

3.2.10. Theory Suggestions for Future SRDF Research

In this section, I showed why the SRDF uses Historical Institutionalism as its theoretical approach and discussed why I complemented it with Constructivism for my case study on utilizing the SRDF to examine the U.S. unconventional experience. Future researchers should also aim to complement Historical Institutionalism with other theoretical approaches to optimize the SRDF for country, technology, and natural resource specific cases. Two they might consider (but were not quite right for my case study) are Behaviouralism and Rational Choice Theory.

Behaviouralism asks "why do people behave in the way they do?" (Sanders 1995). From a broader perspective and in relation to my research, I think this fundamental question and approach is too limited for the bigger picture approach to strategic natural resource development, which deals more widely with varying economic systems, institutions, and market forces. However, like Constructivism, I think Behaviouralism can shine light on critical aspects of strategic resource development where human aspects, emotions, and individuals and groups are involved, potentially Political Opportunity Structure.

One of the key considerations around the adoption of fracking has become local opposition to the technology. Sanders (1995) points out that Behaviouralism has been used to explain the origins of participation in more unconventional political activities like demonstrations, strikes and riots (Barnes and Kaase 1979; Parry et al. 1992; Anderson and Mendes 2006).

Despite the success of fracking in the U.S., opposition to the practice in certain areas has been significant (Simonelli 2014; Dodge 2017; Lee and Lee 2021; Dokshin 2016; Evensen, Clarke, and Stedman 2014). In this context, Institutionalism complemented by Behaviouralism can provide interesting insights into some of the most important questions surrounding the impact of local and legal opposition to fracking, and likely for future resource development.

However, beyond including Behaviouralism as a complement to Institutionalism in a mixed method approach in looking at opposition to fracking, I think there are more downsides than benefits in its broader usage in the SRDF as the approach has several substantial shortcomings. From a research design standpoint, Behaviouralism's focus on empirical testing, as well as resistance to research that takes place at a higher level of abstraction does not make it a natural fit for national resource development inquiry. More importantly for the SRDF, Sanders notes that Behavioralists are often criticized for failing to comprehend the "big picture", an important goal of cross-national strategic resource inquiry (Sanders 2006).

Rational Choice Theory could be an effective complementary choice for the SRDF considering its intersection at economics and political economy, as well as its focus on "rationality and self interest" (Hindmoor 2010). As a result, it provides support to individual decisions that take larger national strategies or personal political interests into account at the expense of near-term market forces. In this context rational choice theory can be interlinked with VoC, as it speaks to market conditions, and maximizing benefits while minimizing costs and risks.

Hindmoor highlights that "rent-seeking" has led to government decisions to support particular firms, an important consideration for CMEs (ibid). However, the theory is also relevant in LMEs as more open markets take cues from price signals for ways for management teams to more efficiently allocate capital. In both environments it should be relatively clear that certain decisions would be in the best interest of individuals, by either helping to advance a national strategy or creating economic value for shareholders.

However, there are several shortfalls with rational choice theory that do not make it a good choice for my research. Some of the things that make Rational Choice Theory not the best choice for the SRDF are among the leading criticisms of the approach. These include people not being perfectly rational, individuals harboring hidden agendas, and having prejudices.

Lastly, it would be beneficial to look closer into some of the differentiating institutional elements between LMEs and CMEs with the SRDF, particularly the labor market. The labor market could represent an interesting conduit or hindrance for innovation in strategic resource development, as unions in Argentina

show, while the various labor markets and national employment strategies could provide insights into how firms are able to respond to opportunities presented by new technologies.

Hall and Soskice (2001) argue that the "institutional features of liberal market economies tend to limit firms' capacities for incremental innovation" and that "the institutional frameworks of liberal market economies provide companies with better capacities for radical innovation, while those of coordinated economies provide superior capacities for incremental innovation".

3.2.11. Conclusion: Theory Literature Review

In the section, I showed why I chose Historical Institutionalism as the theoretical approach for the SRDF and why I complemented it with Constructivism for parts of my case study. In doing so, I show how the SRDF builds on Hall and Soskice's (2001) VoC framework and why Political Opportunity Structure is the missing Independent Variable to Wang and Krupnick's (2013) inquiry into the U.S. unconventional oil and gas experience.
In addition to discussing why I chose Historical Institutionalism, I discuss why some of the other theoretical approaches were not appropriate for the SRDF.

As such, I introduce a new theoretical-based tool for strategic natural resource inquiry, grounded in the cross-national comparative analysis VoC framework, utilizing Historical Institutionalism as an approach, and provided an example through a case-study (the U.S. shale development experience) for how future researchers can optimize the SRDF to infer resource development outcomes by complementing Historical Institutionalism with Constructivism. I also make suggestions for how this could be done by future researchers with different theories (instead of Constructivism for example), such as Behaviouralism and Rational Choice Theory.

3.2.12. Conclusion: Chapter 3 - Literature Review; Energy Policy Literature & Theory Literature

Viewed together, the energy policy literature and the theory literature show how strategic resource development takes place with the *interaction* between institutions and individuals, and how political

struggles “are mediated by the institutional setting in which [they] take place” (Lowndes 2002; Ikenberry 1988). In the energy policy literature review, I showed how this was the case with each of the eras discussed, spanning the Realism World War II period, to the Neo-Realism 1970s oil and natural gas crises era, to today’s Neo-Liberalism order in which the shale revolution was set.

One of the critical aspects of the SRDF is based on Hall and Soskice’s (2001) argument that LMEs and CMEs have different advantages as a result of their divergent institutional capacities. One of the more important connections between the energy policy literature review and the theory literature review is how the U.S. achieved a first-mover advantage for shale development as a result of its LME structure, as the Independents had the opportunity to proliferate the technology with the help of institutional property rights and capital markets.

Another important connection between the two parts of this chapter is the downside risk to strategic natural resource development, as presented by the Resource Curse in the case of CMEs and by Political Opportunity Structure in the case of LMEs. As such, I connect the Resource Curse and Climate Change and NIMBYism literature to the Constructivism literature and show how I optimized the SRDF to take the connection of these issues into account.

Lastly, I showed how my primary research into Political Opportunity Structure was utilized in this inquiry. In doing so, I provide a tool for future researchers to utilize through the SRDF, built on the theoretical literature, and an example for how to use and optimize the SRDF for specific countries, technologies, and natural resource bases, through the energy policy literature and primary research.

Chapter 4: Political Opportunity Structure

4.1 Introduction

Building on my secondary research in the energy policy and theory literature reviews in chapter 3, chapters 4-7 rely on my interview-based primary research and focus on the four Independent Variables for the SRDF: 1) Political Opportunity Structure, 2) Government, 3) Capital Markets & Market Structure, and 4) Geology & Infrastructure.

I place Political Opportunity Structure first as this chapter is organized in more of a narrative nature (with subsequent chapters drawing from it), and the SRDF notably includes Political Opportunity Structure as a new and critical variable building on the ones studied by Wang and Krupnick (2013). Further, POS provides an important aspect for the SRDF approach, as my primary research shows that it is the main risk to polycentric governance in LMEs and their comparative advantage for strategic resource development.

POS's role in the SRDF acknowledges that the battle for strategic resource development is about more than technology and economics. Metze and Dodge (2016) argue fracking is more than a technical problem, it is "also an interpretive and communicative problem that consists of interpretive contests, including the framing of facts". The same holds for various forms of strategic resource development utilizing various new technologies across geographies and political economies. Sovacool and Williams (2019) state "Framing and the associated notion of storylines are crucial concepts in the study of environmental politics and climate policy".

This chapter highlights the importance of framing as it relates to strategic resource development. Evensen et al. (2017) state, "The general public's framing of unconventional gas development, portrayed in mass media, social media, and documentary film, has influenced political regulation of development and the industry's social license to operate. My primary research builds on these assertions.

This chapter on Political Opportunity Structure is organized differently than the other Independent Variable chapters. It includes three case studies into Political Opportunity Structure and shale development, which draw from my primary research interviews with actors who were at the front lines of shale development in three areas (Argentina, New York, the U.K.,). Further, while the other

Independent Variable chapters (chapters 5-7) are organized by themes within their respective Independent Variables, this chapter on Political Opportunity Structure is narrative in nature.

4.2. Introduction - View from the Front Lines of the Conflict Over Strategic Resource Development

In this chapter, I provide findings based on first-hand accounts of three opposition movements by individuals that were personally involved in activist campaigns spanning Argentina, the U.K., and the U.S., with two interviews from the standpoints of the company-perspective (in the cases of Argentina and the U.K.) and one from the perspective of opposition groups (in the case of the U.S.). I also discuss the strength of the unions in Argentina, and their influence on development.

My research is complemented by my interview with a cabinet-level secretary for the State of New Mexico, the second largest oil producing state in the U.S. New Mexico aims to thoughtfully balance strategic resource development with the state's unique political and historical identity. As a result, this chapter provides a unique contribution to the literature of strategic resource development due to the first-hand accounts of individuals on the frontlines of strategic resource development.

Notably, the first-hand accounts provide case studies into how opposition groups capitalized on local opposition access points in the cases of the U.K. and U.S., how companies responded to mounting push-back (in Argentina), and also important lessons-learned for future industry groups, non-governmental organizations, local stakeholders, investors and asset owners, as well as policymakers.

The national and local governments analyzed in this chapter all have differing political alignments, which impacts the planning process and resulting "form and frequency of protest" (Kriesi et al. 1995). Utilizing the local-national-state-nexus (LNSN) model, Garland et al. (2023) show how differing national and local political opposition access affects the level of local demonstrations (Kriesi et al. 1995). My primary research shows how the countries analyzed using the SRDF all had differing national and local relationships, levels of political opportunity access points, and unique form and frequency of protests as a result of the level of national and local support for fracking.

In the U.K., UK Oil & Gas Executive, a former executive at Cuadrilla Resources, provided a detailed first-hand description of the ultimately successful political opposition movement to stop fracking in the U.K. The protests over fracking in the U.K. were intense, particularly in Lancashire County, where local

opposition efforts were offset by strong national support. My primary research reinforces the work of Garland et al. (2023) as it relates to national authorities overriding local decision-making, "which creates the potential for the uptake of a greater number of confrontational actions as integrative pathways decline".

One of the most prominent insights gained from the U.K. shale opposition experience was the impact of Cuadrilla moving too fast and developing ahead of having a "fit-for-purpose" regulatory regime in place.

For the SRDF, I establish the use of "fit-for-purpose" from the industry's perspective. While the term could be applied to other stakeholders, for the SRDF it is used to reference an appropriate regulatory regime being in place for a particular geography, technology application, and resource. As such, a fit-for-purpose regulatory regime allows industry participants to operate with a clear understanding of how regulations match operational objectives, limiting the potential effectiveness of opposition groups attempting to access the Political Opportunity Structure.

As detailed, opposition groups were able to add a significant amount of costs and delays to Cuadrilla's development plans by local regulatory and permitting access, despite the substantial national top-down support for fracking. I argue based on my primary research that the opposition groups were successful as a result of a fit-for-purpose regulatory regime not being in place during the time of the opposition campaign.

While I recognize there have been many exceptions, such as where: 1) fit-for-purpose regulations were established and development still did not progress, or 2) where it was not in place at the beginning of development, and it did not impede operations. However, while recognizing that there are exceptions, the intention for this mechanism's inclusion in the SRDF is to show that an absence of a fit-for-purpose regulatory regime being in place creates increased Political Opportunity Structure access points.

Future researchers utilizing the SRDF could evaluate to what extent fit-for-purpose regulatory regimes did or did not limit Political Opportunity Structure across geographies, technologies, and resources.

In the U.S., NY Fracking Opposition Leader, led the successful drive to instill a moratorium on unconventional development in the state of New York. His efforts built on the anti-fracking waves of the early-2010s, leveraged the media attention brought by celebrities, included the courting of non-obvious

stakeholders in towns where development was not expected to take place, and effectively accessed the rule-making, permitting, and public comment process to ultimately influence the outcome and instill a moratorium on fracking in New York state.

The New York experience is significant as "it made New York the first state in the country with known gas reserves to prohibit fracking" (NRDC 2020). By comparison, while Vermont also banned unconventional development in 2012, the move was symbolic as the liberal state has no known unconventional hydrocarbons to develop. New York's ban is significant as it sits atop both large shale oil and gas resources representing a meaningful milestone for opposition groups as a result.

Further, the New York case is an important addition to the literature from a theoretical standpoint as it shows that the institutional property rights and governance in the U.S. cannot predict success for unconventional oil & gas development, as argued by Murtazashvili and Piano (2019), and highlights the importance of incorporating Political Opportunity Structure into the SRDF.

An important lesson-learned from the New York experience was the impact a proactive approach by opposition groups had on affecting the outcome. As detailed, there was little to no counter-campaign by industry, providing a clear path for opposition groups to mount an ultimately successful campaign in New York. This shows how there is a race for either the blocking of development or the establishment of a fit-for-purpose regulatory framework in polycentric governance structures, representing a risk to LMEs for their advantage for radical innovation.

Polycentric governance, developed by Vincent and Elinor Ostrom, was introduced as "a vision of governance that embraced the potentially positive consequences of governmental fragmentation" (McGinnis 2016). For the SRDF, polycentric governance is important as there are various governance institutions at different levels, such as national (federal), central, state, or local, presenting overlapping authority for development and potentially presenting challenges for strategic resource development and opportunities for POS access points. This chapter shows several examples of this. As a result, polycentric governance is particularly relevant in LMEs, which are more market-centric, democratic in nature, and can have more autonomous local regulatory bodies than their CME unitary governance counterparts (Hall and Soskice 2001; Witt 2010).

My primary research shows how polycentric governance was leveraged by opposition groups in New York and the U.K., as local regulatory governance bodies had authority over construction and logistical issues such as zoning, permits, and traffic. Delays, denying permits, or moratoriums related to these actions at the local level proved to be highly effective tactics to slow development and quell support at higher levels of government. As discussed in this chapter, in the U.K., polycentric governance led to the denial of local planning applications and added significant costs and delays, and ultimately impacted industry resolve and national support. As also discussed in this chapter, in New York, local moratoriums and restrictions created a mosaic or a "patch-work" of local opposition which also ultimately influenced an adverse development decision at a higher level of government through the state moratorium.

My conversation with NY Fracking Opposition Leader represents a unique contribution to the understanding of the mechanics of Political Opportunity Structure, and poses new questions and lessons learned for future strategic resource development. I hope that future researchers can utilize the case study for future inquiry into strategic resource development utilizing the SRDF.

As discussed in the Government chapter, the New York experience in many ways mirrored the outcome in the U.K., despite strong national support for fracking in both countries. Water was a key concern for local opposition groups in both cases. Concerns around earthquakes were a driving force in the UK and ultimately provided a critical issue to specifically use for administrative tactics, adding years of development time and adding exponential budgetary burdens for development, as detailed in this chapter. These risks and their impact on public support have been detailed by various scholars.

Cross-national research on U.S. and U.K. public perceptions on fracking show more support and less uncertainty from respondents in the U.S. (Evensen et al. 2017). This analysis, which was conducted utilizing simultaneous surveys that adjusted for national macro conditions, showed:

> "a higher percentage of UK respondents, compared with US respondents, associated the three negative impacts with shale gas (i.e. earthquakes, water contamination, and higher emissions); a higher percentage of US respondents associated the three positive impacts with shale gas (i.e. cheap energy, clean energy, energy security)" (ibid).

Highlighting the U.K.'s public perception problem with fracking, Evensen et al. showed higher support in the U.K. for domestic coal production than shale gas (ibid). In addition to the differences in public

perception between the U.S. and U.K., a less fragmented market in the U.K. placed more political opposition pressure on fewer players.

Whitton et al. (2017) discuss other important distinctions between the U.S. and U.K. shale regulatory and ownership structure, such as a more centralized regulatory approach as well as the government (Crown Estates) owning mineral rights in the U.K.

While unconventional development was led in the U.S. by a fragmented group of independents, the U.K. experience saw Cuadrilla not only leading development, but also essentially solely taking on the significant operational burdens, including costs and delays, associated with fighting opposition groups, as detailed in this chapter. UK Oil & Gas Executive summed up this experience, “you've got all of those stakeholder issues going on around a relatively small, sleepy local authority in Lancashire with frankly, a very small E&P company trying to fight this battle when the [larger energy companies] of the world all kind of sat on the sidelines”.

As such, Cuadrilla’s experience in the U.K provides important insights for future strategic development efforts, for both governments, private sector participants, investors, and local stakeholders. This case study shows that the SRDF relies on Political Opportunity Structure as a key Independent Variable to infer development outcomes. The U.K. shale experience highlights the “duality of polycentric governance”, showing that opposition groups can affect development within LMEs with Political Opportunity access ahead of a fit-for-purpose regulatory regime being established.

In areas that lack a fit-for-purpose regulatory regime, framing by stakeholders and discourse coalitions to shape public opinion and advance arguments and agendas is critical, as shown by research on fracking in the U.S. and U.K. (Cotton et al. 2014; Williams and Sovacool 2019, 2020; Evensen et al. 2014; Ashmoore et al. 2016; Metze and Dodge 2016; Hedding 2017; Zanocco et al. 2020; Dokshin 2021; Dodge 2017).

For example, following elite semi-structured interviews and newspaper analysis, Cotton et al. (2014) reduced the various divergent viewpoints by stakeholders and discourse coalitions in the U.K. to just “three principal emergent storylines”, simplified to: 1) dirt and cleanliness, 2) energy transitions, and 3) geographies of environmental justice. Alternatively, as discussed in this chapter, Williams and Sovacool (2019) present seven key frames found in the academic literature on U.K. fracking spanning pro-shale and anti-shale discourse coalitions. This fight over the storyline for new strategic resource development ahead

of a fit-for-purpose regulatory regime being enacted is a critical exercise in the attempt to influence development outcomes.

In Argentina, I had the opportunity to speak with Argentina Community Engagement Executive, an executive at a large Argentina-based oil and gas company from 2012 to 2015. Argentina Community Engagement Executive detailed the experience working with concerned community groups. Argentina has generally enjoyed the benefits of alignment between the national government, provinces, and communities, an important condition for successful development within polycentric governance. However, there has been conflict with some of the indigenous groups, notably the Mapuche people. The Argentina shale experience and lack of local procedural justice and political opportunity access points reinforces the argument that "the absence of demonstrable social justice within shale gas projects will likely lead to societal resistance and opposition, political critique, and the inability to be deemed as positive or good" (Whitton et al 2017).

Argentina Community Engagement Executive provided me with a first-hand account of the company's experience with the Mapuche people in the early days of unconventional development in Argentina. The conflict between the Mapuche and industry has increased since then, and the insights shared foreshadow some of the challenges the company and other industry leaders face today. Importantly, Argentina Community Engagement Executive's experience provides unique insights for the future of strategic resource development and the SRDF.

My findings on China's political opportunity structure do not include a first-hand account; however, interviews with knowledgeable experts provide insights into the impacts its state-led development approach has on the ability of locals to have a voice in development. Political Opportunity Structure in China should not be dismissed due to the strong state characteristics. There has been significant local opposition to fracking due to earthquakes, and the ruling Chinese Communist Party is keen to maintain social cohesion and ensure operations consider operational procedures that quell these concerns (Radio Free Asia 2019). Water is a significant concern as well. Semi-structured interviews with 25 individuals residing in Weiyuan County, Sichuan Province showed "More than half (52%) of the participants thought shale gas development contaminated groundwater – their primary source of drinking water" (Tan et al. 2019). Further, 16% of participants cited "their own personal observation of impurities in the water as evidence of it being polluted" (ibid).

An opportunity for future research would include in-depth analysis and interviews into Chinese Political Opportunity Structure. I was ultimately unfortunately unable to secure any of these interviews, presenting an opportunity for future research, building on my first-hand Political Opportunity Structure research in Argentina, New Mexico, New York, and the U.K., as well as on Tan et al.'s in-depth interview work in China (ibid).As discussed in the subsequent Government chapter, New Mexico presents a unique case which would benefit from future research, as it is a left-leaning and environmentally conscious resource-rich state that is trying to balance the budgetary opportunity of developing unconventionals with adhering to its underpinning political and environmental principles, including strongly safe-guarding the environment, effectively managing its scarce water resources, and taking its meaningful indigenous population into consideration as part of development efforts.

New Mexico Cabinet Level Secretary highlights how resource development and these principles can often be in conflict and aims to balance local stakeholder inclusion in the development process. The New Mexico experience can be juxtaposed to the New York and U.K. experiences, with New Mexico seen as a potential model for stakeholder inclusion to balance development with local concerns. As this chapter shows, this balance was elusive in the New York and U.K. experiences and remains missing for the Mapuche peoples in Argentina. In the following chapter on Government, I discuss the New Mexico case as it relates to "institutional arrangements", as characterized by Hall and Soskice (2001).

As a result, my conversation with New Mexico Cabinet Level Secretary complements the in-depth first-hand accounts over the struggle for development between industry and opposition in Argentina, the U.K., and New York. The New Mexico experience provides important lessons-learned and a case study for policymakers to evaluate the trade-offs of strategic resource development in a left-leaning state.

The discussion with New Mexico Cabinet Level Secretary also lends insights into the search for thoughtful and balanced state-level energy, environmental, and economic planning. As such, the case of New Mexico provides a contrast to the New York experience for left-leaning policymakers looking to evaluate outcomes for strategic resource development, with New Mexico in many ways showing the potential for how development can be balanced as well as presenting a case that shows the opportunity cost of shutting down development preemptively, with measurable impacts to the economy, energy security, and environment.

4.3. Key Findings - Political Opportunity Structure in Unconventional Oil & Gas and the SRDF

My research suggests opposition groups can have successful outcomes impacting national strategic resource development despite federal support in LMEs with strong local institutions, as shown in the U.K. and New York, due to considerable local Political Opportunity Structure access points made available through polycentric governance. While Ashmoore et al. (2016) argue shale development is "far more localized in the US"; providing particularly strong POS access, other LMEs also present local opportunities to block development. This should be a key consideration for researchers utilizing the SRDF, presenting a risk to LMEs and their inherent comparative advantage for radical innovation.

Dokshin (2016) states, "Prohibiting an industrial siting requires mobilization of a critical mass of local residents, with sufficient resources, who share a common interest in stopping the proposed development". The viability of these opposition efforts is affected by the level of POS access, which is influenced by local policy frameworks.

My research shows that the establishment of local policy frameworks that align with national goals are important to have in-place prior to development. The lack of a "fit-for-purpose" regulatory regime in an area where development is in the early stages of unfolding can provide an ill-fated foundation for eager industry participants seeking to move quickly with development, as the U.K. and New York experiences highlights. Despite successful opposition campaigns in both New York and the U.K., Whitton et al. (2017) argue the "publics' influence on shale gas decisions is perceived to be minimal or not at all", as the U.S. public discourse mechanism are primarily public hearings while in the U.K. "the exploratory stage of activities means that a similar examination of opportunities to participate is not possible". This is in addition to the central government's ability to overturn local restrictions in the U.K., as detailed in this chapter.

In contrast, the cases of Argentina and New Mexico highlight how proactive industry approaches coupled with local and national alignment can outweigh opposition push-back and ultimately result in balanced resource development strategies. Further, as discussed in the Government chapter, Pennsylvania presents another alternative to the New York and U.K. shale experiences, as a fit-for-purposes regulatory framework was established through Act 13, providing a clear path for development which limited local Political Opportunity Structure access points, as highlighted is critical by New Mexico Cabinet Level

Secretary (Pennsylvania General Assembly 2012). While legacy operations likely played a part in providing more public support for fracking in Pennsylvania relative to New York, the enactment of Act 13 in early 2012 reduced POS access points. Legacy operations in Pennsylvania were shown to affect framing of key issues related to fracking, as illustrated by Hedding (2017), and likely led to support for fracking further from development (Zanocco, Boudet, Clarke, Stedman, Evensen 2020).

Hedding (2017) shows how state-level differences in framing "can be attributed to the locally relevant sources used in reporting" as well as unique state-level political ideology. A detailed state-level news comparison showed how legacy operations in Pennsylvania likely led to more industry sources being included in local reporting on fracking relative to New York and North Carolina. Broadly, my primary research shows that local policies providing review around seismicity and water security have been two of the most prominent Political Opportunity access points for opposition groups. These findings are in-line with social discourse research on shale development in the Appalachian Basin, which found water, wastewater, and earthquakes to be the most represented environmental impacts in local newspapers from 2009 to 2012 (Ashmoore et al. 2016). Similarly, research into local newspaper coverage in New York and Pennsylvania spanning 2007 to 2011 and covering 1,037 articles showed "Effects of water quality were by far the most prevalent environmental representation in each newspaper" (Evensen et al. 2014). In the U.K., elite interviews and political document analysis showed water contamination and seismicity to be key concerns as well (Sovacool and Williams 2019).

Future research into how other extractive or energy industries manage seismicity, including geothermal drilling for example, could provide compelling contrasts and insights for national and local development policies. This work could utilize the SRDF and be built on my research and some of the inquiry into "perception spillover", which can examine how public perceptions into new technologies can influence views on other novel technologies (Westlake et al. 2023). For example, inquiry into perception spillover from fracking showed negative perceptions of deep geothermal energy but "more positive perceptions of green hydrogen because they deemed it dissimilar to fracking" (ibid). Similarly, Cuppen et al. (2020) found that technology "controversy spillover" can cause project developers to attempt to dissociate the controversial elements of the new technology, and that this strategy can "backfire", leading to claims that the developer is attempting to evade dialogue. Further, research into stakeholder views of geothermal in the Netherlands showed "a societal dialogue at the national level should precede local joint fact finding

in order to prevent (unintended) power politics between administrative levels, and between governments and a wider group of citizens", providing another example of how a novel energy technology could develop a strategic resource in a polycentric government structure (Metze et al. 2023).

All four countries studied have seen opposition efforts centered around earthquakes and water security, highlighting the importance local stakeholders place on the environment as a key strategic independent variable, often outweighing national interests in energy security and economic development. Dodge (2016) refers to discourse on these and other issues as "frame disputes" by pro and anti-fracking coalition groups aiming to frame the discourse and influence outcomes. Notably, opposition groups' concerns around health and the environment outweigh the substantial contributions to the local economy which can be brought by fracking.

Importantly, my primary research shows that the interplay between national and local government is critical for the SRDF. Related, Garland et al. (2023) argues, "A national-level POS explanation of the protest phases therefore remains insufficient to capture the differences between the case countries' campaign forms and frequencies".

The U.K. and Argentina case studies are similar in that they provide insights into companies dealing with opposition groups, with YPF in Argentina successfully quelling opposition concerns, and Cuadrilla in the U.K. ultimately failing to do so. While the contexts are different between Argentina and the U.K. (with local groups generally more supportive in Argentina versus the U.K.), the first-hand accounts are unique and provide insights for future research.

The similarities between the U.K. and New York experiences are substantial as well, both told from opposite sides (told from an operator in the case of the U.K. and an opposition leader in the case of New York). In both cases, a skeptical public and patch-work of local opposition groups prevailed over industry through organized grassroots efforts, highlighting the duality of polycentric governance, as further discussed in the following chapter on the Government variable for the SRDF.

Overall, my primary research in this chapter reinforces key findings in the literature, such as the importance of procedural justice, the risk of on limited public input on local planning, and how a common theme of the academic discourse argues there is an "inadequacy of policy" on unconventional development (Evensen 2018).

4.4. Argentina in Focus - Importance of Realizing Stakeholder Regulatory Alignment

While development in Argentina has been stalled for several reasons, notably including government policies, capital availability, and insufficient service equipment and infrastructure, my research does not suggest that political opposition is a driving factor. Argentine Oil & Gas Investor, an Argentina-focused investor with in-country oil & gas operating experience, told me, “Even though it's an emerging market, you'd be surprised as to how much emphasis is put on protecting the natural environment”.

While much of the development takes place away from urban centers, there is still scope for meaningful opposition pushback, similar to in New York state (where development would have taken place in rural areas), New Mexico, and parts of the U.K. However, this has largely been avoided with the majority of my interviews detailing aligned national and local views on development.

The notable exception is the case of the Mapuche people, an indigenous group that span the Chile-Argentine border with roots dating back to 100 AD (Warren 2013; Museo Chileno De Arte Precolombino 2023). The Mapuche people have a significant presence in the gas-rich Neuquén Basin, home to the sizeable Vaca Muerta shale, and have consistently pushed for economic consideration and participation as part of unconventional gas development within their area of interest, as well as demands on environmental remediation and responsibilities within the industry.

Importantly, structural alignment achieved through the regulatory system has remained elusive for the Mapuche people. As a result, today the Mapuche people continue to resist unconventional oil and gas development (Williams, N., et al. 2019). This has led to protests, legal action, blocking access to sites, and environmental damage.

My discussion with Argentina Community Engagement Executive, Argentina-based former executive, highlights the importance of realizing regulatory alignment with local stakeholders. Argentina Community Engagement Executive details early engagement around 2012 which led to positive tangible results with the Mapuche people; however, a transactional approach to dealing with the Mapuches has not satisfied both parties’ objectives, and in many ways has made it worse.

Argentina Community Engagement Executive left the company in 2015 and notes a lot of positive work was done with the Mapuches during that time; however, ultimate alignment was never realized as the

Mapuches struggled with Political Opportunity Structure access in Argentina and the Neuquén province. In 2018, the Mapuche Confederation of Neuquén sued YPF and other oil and gas companies for environmental crimes, "alleging mishandling of toxic fracking waste" (Mapuche Confederation of Neuquén v. YPF et al. 2018). The Neuquen Ministry of the Environment has since overseen the remediation of the site in question; however, challenges and conflict remain as a result of alignment and regulatory agency remaining elusive (Subsecretaría de Ambiente - Youtube 2020).

4.5. Mapuche Peoples and the Consequences of Transactional Relationships in Polycentric Governance for Political Opportunity Structure

Costie et al. (2018) stated "The most important cooperative enterprise in Vaca Muerta is the partnership between YPF, GPyN (Neuquén's public energy company), and the American-based Chevron", signed in 2013. The authors see this accord as an example of an "institutional shock" and argue that it "triggered the mobilization of those that had, up to that point, remained mostly disengaged from public discussions regarding the value and threats posed by unconventional oil and gas production".

Despite fundamental challenges facing opposition groups and general broad-based national and local alignment, this institutional shock brought meaningful opposition to fracking by local activist groups, led by Observatorio Petrolero Sur, or the South Petroleum Observatory, which include members of the Mapuche people (Observatorio Petrolero Sur 2019). According to Observatorio Petrolero Sur, in response to the 2013 development agreement between Chevron and YPF not being ratified by Neuquén's parliament, anti-fracking protests including roughly 5,000 individuals representing "unions, Mapuche Confederation, political parties and the Neuquén's Platform Against Fracking, among others", were conducted outside the legislators office in Neuquén (OPSur 2013).

According to their English website:

> "The Southern Petroleum Observatory [OPSur] is an organization that was formed in 2008 and currently has permanent working groups in the Autonomous City of Buenos Aires and the provinces of Neuquén and Río Negro (Argentina). Our main challenge is to ensure that energy production and consumption is done in a fair, democratic, healthy and sustainable way. To this end, we use tools such as communication, training, research and advocacy in public policies based on the articulation and creation of social movement" (Observatorio Petrolero Sur 2023).

These protests were met with tear gas and rubber bullets, and Observatorio Petrolero Sur claims forces associated with the federal government retaliated by burning down houses in the following days (Observatorio Petrolero Sur 2013). This response stands in stark contrast to the New York and U.K. protest experiences. Despite continued efforts in Argentina, local groups including Observatorio Petrolero Sur, have raised awareness but have had trouble accessing the POS due to their lack of political clout, with indigenous communities only winning legal points "in a few instances" (Gamper and Saulino 2018).

In 2012, Argentina Community Engagement Executive joined YPF's senior leadership to the gas-rich Neuquén Basin. An hour ahead of landing, Argentina Community Engagement Executive recalls how they received a call from the governor of Neuquén alerting them that "at the airport there were all the Mapuches waiting for us and we shouldn't talk with them because they are violent and there is no way to negotiate with them". Argentina Community Engagement Executive added that the governor said, "please don't make a meeting with them and avoid them when you arrive with a car which will be waiting for you".

Argentina Community Engagement Executive recalls their response to this request, "I said, no way, we are going to talk with the Mapuches, and we stayed for two hours in the airport in a lunch with the leaders of the Mapuches. And we say that we wanted to align their interests and almost offered them to name one of them to make the control of the environmental damages that we were sure we are not going to do, but we wanted to have their support and control".

Additionally, Argentina Community Engagement Executive highlighted how one of the initial agreements with the Mapuche focused on the sustainable delivery of natural gas to the communities, as the Mapuche paradoxically found themselves sitting atop ample gas reserves, but stable electricity and gas for cooking has eluded the Mapuches. Further, Argentina Community Engagement Executive "negotiated certain improvements in the schools and the houses". This provides insights into the transactional approach industry took to managing local stakeholder conflict in the early days of shale development in Argentina. However, Argentina Community Engagement Executive was quick to note that since leaving the company in 2015, "I don't know exactly what's happened, but I know that they have had many problems with the Mapuches". The transactional approach has continued, and the Mapuche Peoples still struggle to gain access to the POS.

Since that time, according to various oil and gas companies, the Mapuche have demanded cash payments and blocked access to wells in the Neuquén Basin. For example, according to a 2017 Reuters report, YPF "spent 55 million pesos (£2.27 million) on payments to a Kaxipayiñ Mapuche community leader last year, more than double the payments in 2014, a company source said" (Castilla 2017). From the Mapuches' perspective, Kaxipayiñ Mapuche leader Gabriel Cherqui stated, "Imagine you find yourself overnight with 10 drilling towers in the yard of your house and you see them throwing polluted water on either side and breaking everything". Cherqui added "members of his community have cancer and seen the number of abortions rise" (Ibid).

Regarding the Mapuches' ability to access the regulatory or political structure, Argentina Community Engagement Executive stated, "It was still very difficult to them to be in touch with the official authorities, and I think after we left, it was also, for them, difficult to have a good relationship with the authorities of [the company], and they are also difficult". The Mapuches' lack of access contrasts starkly to the U.S. experience, where NY Fracking Opposition Leader stated it was "surprisingly easy to make first contact" with Mayors in towns across New York as part of the grassroots effort to ban fracking across the state. NY Fracking Opposition Leader added that maintaining a working relationship with Mayors and local leaders "wasn't very hard either", as his group, a leading environmental non-profit, lent support in drafting and seeing local anti-fracking resolutions through.

Alternatively, the Mapuches lacked both the access and the organization, relative to the U.S. experience. Argentina Community Engagement Executive stated, "it is not only perhaps the fault of the governors and [the company]", adding that the Mapuches are not well organized and are not specific enough in their stakeholder discussions. Ultimately, Argentina Community Engagement Executive notes, "there were no big advances made in the regulatory framework. So it was a work that had to be started to be made, but it was really difficult".

Argentina Community Engagement Executive discussed the consequences of the short-term and transactional relationship, highlighting "The outcome is that we had our four first years of Vaca Muerta were very good, because we had a very good relationship and they achieved good results for them. They got gas in their houses. They got a lot of improvement in their lives. They got money we offered them also some work to do, but it was not achieved in a regular regulatory form".

However, with little structural change or long-term alignment between the Mapuches and industry, the relationship can be viewed as more of a transactional one characterized by industry providing payments, goods, services, and other concessions, but with the Mapuches not realizing satisfactory alignment for their role as stakeholders in development. As such, Argentina Community Engagement Executive stated "there is a lot of work to do with them to have them in peace and to align their interests in an honorable way". Without an ability to affect development due to a lack of POS access, the Mapuches are beholden to this ever-changing transactional approach to act as a substitute for an agreed upon governance framework that balances their local stakeholder issues with broader national development objectives.

Compared to the U.K. and New York experience, the ongoing conflict between the Mapuches and industry highlights the weaker Political Opportunity Structure in Argentina, particularly for disenfranchised groups, like the Mapuches. As a result and as Argentina Community Engagement Executive highlights, the Mapuches have not enjoyed the kind of the access to the permitting and regulatory mechanisms that affected change in the U.K. and New York, are subject to a transactional approach to govern their stakeholder interests, and are still in search of balance and representation for unconventional development in Argentina. As such, the Mapuche Peoples' shale development experience in Argentina shows how Political Opportunity Structure can be limited in MMEs.

While the story of the Mapuches represents a conventional opposition conflict scenario to strategic resource development, surprisingly, most industry participants I spoke with did not put much weight on the Mapuches' ability to influence activity, highlighting the indigenous group's relatively limited agency within the oil and gas industry. Alternatively, the role of the unions played a prominent role in my interviews, with nearly all industry participants acknowledging the strength of the unions and their outsized influence over development.

4.6. Majority of Political Opportunity Structure in Argentina Driven by Unions

Argentina's federal government and many of the critical provincial governments have supported unconventional development; however, there has been substantial opposition from unions, local communities, NGOs, and indigenous groups (Saulino and Gamper 2018). Organized labor and unions have played a large role in the development and conflict surrounding Argentina's oil and gas sector. This has persisted for unconventionals and has resulted in violent conflicts between the Patagonian oil union and

the oil and gas companies. As a result, “oil companies typically associate the elevated costs of operating in Argentina, relative to other countries, to high labor costs and risk premiums (Vásquez 2016).”

Labor unions are an important part of the Argentine political economy and shale development experience. Argentina E&P Executive stated to me that the country has a “heavily unionized labor force”, which creates an “added layer of expense”. Based on my interviews, it is clear that labor in Argentina is very much a political issue and intertwined with government decision-making processes.

Argentine Oil & Gas Investor stated, “YPF is the largest employer in the industry, which is essentially politically controlled. So once there's a new administration, the entire leadership at YPF gets canned”. Argentine Oil & Gas Investor added that the workforce in Argentina is educated and valuable; however, notes that “Everything in the country is done on an overstaffed basis”.

Retired Argentina Oil Executive told me the political power held by unions in Argentina “unparalleled” in other countries, and on the same level as Congress or the press force, with unions “part of the government”.

Public push-back over price reforms has made it challenging for the federal government to further shift the cost of subsidies to consumers, as price reforms that lowered prices at the wellhead and raised them at the pump in 2016 were met with protests and impacted President Macri’s approval ratings (Turner 2016). However, these opposition efforts and pressures have yet to sway federal support for shale, but the Political Opportunity Structure has contributed to Argentina’s slow development by maintaining high capital and operating costs and keeping smaller independent producers at bay.

Persistent inflation coupled with resistance to adjust to lower oil prices has hardened the unions’ position (Castilla 2016; Raszewski and Castilla 2016). The strength of the unions has limited oil and gas companies’ ability to respond to lower prices through shedding workforce and reducing operating expenses. According to a director of an oil and gas company operating in Argentina that spoke to Reuters on the condition of anonymity, “new technology should allow drilling with a team of 16 workers, but the unions require companies to continue to employ 25 workers” (Castilla 2016).

At the time of my interview with Argentine Oil & Gas Investor in November 2020, he stated, “it is illegal for a private enterprise to fire an employee anywhere in the country through the end of January. That has

been going on for about two years now and it's been rolling. Previously, the rule was that if you wanted to fire someone, you had to give them double severance. That was the first penalty that was employed. Now it's illegal".

Former Development Bank Energy CIO has first-hand experience investing in Argentina's oil and gas sector through providing equity and debt financing to projects of national strategic significance. Former Development Bank Energy CIO highlighted to me that the biggest challenge of the strong unions in Argentina as not allowing the companies to respond to commodity price volatility with headcount reductions. However, Argentine Oil & Gas Investor builds on Former Development Bank Energy CIO's view, saying despite the bloated nature of the workforce, that the people he has met working in the oilfield are "very good at what they do", and extremely vigilant when it comes to environmental protection, including water, plant, and animal life.

Former Development Bank Energy CIO told me that the Neuquén province is "by far the most developed pro-business one", but added "if you go to Salta or other regions, then negotiating with the unions is quasi impossible, which means that if tomorrow oil goes from $50 to $20 and they need to lower my CapEx and my OpEx, I can't because the unions will continue to force me to pay the people at the same level and to employ as many people". This provides a direct contrast to the fluid LME labor markets, as discussed in the following chapter on Government.

A challenge for opponents of shale and a weakness of the POS is the federal government's reluctance to uphold challenges to development, and limits of public access to information. According to Saulino, "Argentina has a number of laws that protect the public's access to information, but in practice, obstacles must be surmounted to actually access information" (Gamper and Saulino 2018). In 2013, President Kirchner issued Decree 1172/03, which established regulatory access to information at the federal Executive Branch (Información Legislativa 2003). However, the decree has been shown to be weak or difficult to uphold. For example, a study showed that 23 of 49 requests for information to government agencies were granted, with much of the data incomplete (Gamper and Saulino 2018).

In another study, questions were sent to 14 public entities, which constituted roughly 85% of public expenditures, with responses only received from nine entities. Further, of the nine entities that responded, four responded with less than 10% of the information requested (Elena, Rivière, Ruival 2014).

As a result, the POS is inhibited by a lack of federal government transparency and willingness to uphold regulations for many opposition groups to meaningfully oppose development through the legal system. Further, the Argentina shale experience shows how labor enjoys better access to the Political Opportunity Structure than local stakeholders as a result of the unique institutional arrangements in Argentina.

4.7. Conclusion and Recommendations for Future Political Opportunity Structure Research in Argentina

The story of the Mapuche people in Neuquén acts as a warning to policymakers and industry participants of the risks of a weak Political Opportunity Structure in MMEs and the inability of indigenous groups and other stakeholders in accessing the regulatory landscape in strategic resource industries. I was unsuccessful in my attempts to speak with the Mapuche Confederation of Neuquén, but am grateful for the opportunity to speak with Argentina Community Engagement Executive, who played a unique role at the front-lines of community relations in the early days of unconventional development in Argentina. Future research would benefit from conversations with the Mapuche People, particularly those with knowledge of the negotiations with YPF or local authorities.

Argentina's strong labor unions stand in stark contrast to the U.S. unconventional experience, which benefited from the ability of U.S. oil and gas companies to match the cyclical and volatile commodity nature of unconventional development with workforce reductions amidst industry downturns. The historical roots of populism and inequality play a meaningful role in the role of labor unions, which based on my interviews and research, has unfortunately inhibited unconventional development and national strategic resource development goals. Future research should be conducted into the alignment of unions' policies with the national long-term interests.

4.8. U.K. in Focus - Moving too Fast on “the Crowded Island”; U.K. Unconventional Development and Political Opportunity Structure

UK Oil & Gas Executive spoke with me about the Cuadrilla experience in the U.K., and broke down the country’s key ill-fated shale obstacle with the term: “the crowded island”. Notably, the conversation highlighted the importance of alignment in national and local views, as well as the challenges associated with industry moving too fast, particularly around local communities with inadequate regulatory regimes. Similar to the New York shale experience, in the U.K., the framing of the fracking debate amongst various discourse groups played a critical role. In the U.K., my primary research builds on Sovacool and Williams’ (2019) “Bad gas governance” anti-shale development coalition frame, which argues the national government attempted to “fast-track fracking, bypass communities” and betrayed local democracy.

Also similar to New York state, the U.K. unconventional development experience highlights the risks polycentric governance poses to LMEs for strategic resource development and the potential to negate the head-start advantage awarded to LMEs through their comparative advantage for radical innovation. Further, as UK Oil & Gas Executive highlights, moving ahead of a “fit-for-purpose” regulatory regime being in place created an opportunity for opposition groups to effectively access the permitting process thereby significantly extending project lead times and associated costs. As such, the U.K. illustrates the duality of polycentric governance for the SRDF.

4.9. Importance of the Planning Regime in the SRDF - Lessons Learned from the UK

This first-hand account by UK Oil & Gas Executive is unique as it provides both operational and investor insights from a technical executive from the pioneering efforts to unlock the shale potential presented by the U.K., thereby globalizing the benefits the U.S. was in the midst of enjoying. However, despite their best-efforts, ultimately, UK Oil & Gas Executive said he and his team “underestimated the difficulty with that very localized U.K. planning system”.

Referring to the period of 2010-2012, UK Oil & Gas Executive said, “I would say the mindset around shale gas and fracking at that time was not hostile. In a retrospective study aiming “to explain the U.K. Government’s shale failure” researchers noted there was “little public reaction until April 2011” (Bradshaw et al. 2022). The stories emerging from the U.S. (shale experience) were largely positive”, UK

Oil & Gas Executive said, adding how the U.K. has a positive history in oil and gas offshore and partially onshore.

Sovacool and Williams (2019) characterize this viewpoint as the "Manageable risk" frame, which highlights the "proud history of regulation" in the U.K. oil and gas industry. This positive storyline was one of four pro-shale development coalition frames researchers identified through semi-structured elite interviews and analysis of political documents. The Manageable Risk frame was also found to be used substantially by Conservative party members in Parliamentary debate from 2010 to 2018 (Sovacool and Williams 2020).

Following the 2010 to 2012 period and in the wake of induced seismicity, the rise of a vocal opposition characterized the fracking debate in the U.K. Evensen (2018), who reviewed fifty research articles on fracking in the U.K. spanning 2013 to 2018, argues, "Activists have attacked the issue with fervency seen for few other societal issues", more than offsetting these pro-development frames.

In retrospect, UK Oil & Gas Executive points to the inappropriate planning regime at the local level, despite strong national support, as the foundation for opposition to shale development in the U.K. Referencing the early 2010s, UK Oil & Gas Executive stated, "there was largely a supportive government, political regime, but a planning regime that wasn't fit-for-purpose, for doing onshore oil and gas activity and fracking". UK Oil & Gas Executive added, "So we were going through planning rules that were really around people building supermarkets".

"It was sort of local authorities who had to give approvals", UK Oil & Gas Executive stated, adding, "and much of the rest of the questions that were raised were around road transport, level of traffic, how many cars, how many truck journeys will there be to build the site when it's operating, local issues". The national and central government level support remained during this period, with support from a coalition that Cairney et al. (2016) stated supported fracking on the belief that "if it is regulated well, drilling for shale gas is a low risk, potentially high return industry". This was juxtaposed against an anti-fracking advocacy coalition that saw "unclear risks and potentially catastrophic environmental consequences".

It was against this backdrop that development took place, with public support waning along the way (Bradshaw et al. 2022). As part of the process, a lot of trust was put on the local E&P company. Beyond the planning phase, UK Oil & Gas Executive stated the local regulatory authorities had high-level

development questions, including “if you find gas, will it be safe? How will you manage? What will the transportation be?”.

Evensen (2018) detailed broad criticism of the planning and regulation process as part of his review, stating “over half of the articles offered notable critiques of the planning process. Various scholars pointed to a regulatory landscape that heavily favored development, was “piecemeal”, and had deficiencies spanning “water, environment broadly, and human health” (ibid).

With this inadequate regulatory framework in place, Cuadrilla moved to frack its first well in Preston Road around 2010-2011. According to UK Oil & Gas Executive, Cuadrilla aimed to deliver the most attractive well results possible in efforts to highlight the potential of the opportunity to the marketplace. According to UK Oil & Gas Executive, the Cuadrilla management team opted for an aggressive initial approach versus “one step at a time”.

As a result, with the first well, Cuadrilla management took the approach, “let's see if we can get the biggest flair possible to attract the most attention possible”, UK Oil & Gas Executive said, despite not having a fit-for-purpose regulatory regime in place.

“So this is seen as the equivalent of a gusher”, UK Oil & Gas Executive noted. He added, “and then totally unexpectedly, (as) they started fracking, (as) they were flowing gas, they were trying to just go as fast as they could, and they triggered seismic activity, which was very unexpected and which was ultimately found that the metal casing in the well, it actually kind of distorted or twisted that was found later, it was never clear whether that was caused by the seismic activity or that was something else or whatever, but something happened that was very unexpected”.

Four days later, Cuadrilla released a statement stating it had halted operations as a result of the seismicity. “The company decided on this action whilst it interprets seismic information received from monitoring information located around the site, following a small seismic event in the Blackpool area recorded at approximately 0.48 am on Friday, May 27th 2011”, the release stated (Cuadrilla 2011). Following the announcement, DECC suspended fracking operations pending formal review.

At Cuadrilla, the company was now at the center of a national debate on energy policy and earthquakes. UK Oil & Gas Executive stated, “So we found ourselves at the forefront of the newspaper headlines.

Fracking triggers earthquakes in Preston sort of thing. And so, not surprisingly, that event caused a sort of hiatus in activity".

Notably, "there was a period of a few years when we and everyone else in the UK sort of went on hold because we couldn't get planning approval to carry on with the activity" UK Oil & Gas Executive stated referring to the years following the earthquake in 2011. He added, "a whole new regulatory regime had to be figured out around fracking". At this point, regulations needed to catch-up with Cuadrilla's early and aggressive moves, highlighting the risk polycentric governance presents to development through Political Opportunity Structure access points at the local level.

While the U.S. experience might have had some small earthquakes that were largely going unnoticed at this point, the U.K. had little policy precedence to draw on from the U.S. In the UK, the disconnect between national and local views and policies diverged during this time, according to UK Oil & Gas Executive, crippling potential development. With the introduction of a new energy technology, research into the U.K. shale development experience conducted from 2007 to 2012 shows how policy makers share information with each other at substantially higher rates when political beliefs are aligned (Fischer et al. 2017). This combination of technical uncertainty with a new technology or application, local apprehension, and a national-level political feedback loop created gridlock at the national local nexus.

UK Oil & Gas Executive described the challenge facing Cuadrilla and the industry more broadly during the period following 2011 when everything went on hold. He stated, "we had to figure out how to deal with this technical geological issue, but in relying on a framework of a small, crowded island with people who weren't expecting to have all the gas wells drilled underneath their background and who were nervous and suspicious about what that might do and planning authorities who were, you know, who frankly weren't expecting to have to deal with this, but with the central government regime that was supportive but didn't have the legal framework to be able to support activity like this as a national priority".

Importantly, regarding the disconnect at the national and local level as well as the process for getting a policy framework in place, UK Oil & Gas Executive stated, "everything had to be done through the central government providing guidance to local authorities, but the planning approvals to actually do the activity needing to be approved by local authorities. And that meant things went very, very slowly".

According to UK Oil & Gas Executive, this led to a period characterized by technical studies, figuring out the science, what had happened, peer reviews with the U.S., data collection, and ultimately working with the government and regulators to try to understand a path forward.

In December 2012, a year and a half after the earthquake at Cuadrilla's site, Edward Davey, Secretary of State for Energy & Climate Change, announced the end to the first UK fracking moratorium (Davey 2012). "Having carefully reviewed the evidence with the aid of independent experts, and with the aid of an authoritative review of the scientific and engineering evidence on shale gas extraction conducted by the Royal Academy of Engineering and the Royal Society, I have concluded that appropriate controls are available to mitigate the risks of undesirable seismic activity", Davey detailed to Parliament.

Davey detailed the "traffic light system" with companies monitoring for seismic activity "so that operations can be quickly paused, and data reviewed if unusual levels of seismic activity is observed", he added to Parliament (ibid). UK Oil & Gas Executive described the traffic light system from industry's perspective. He described it as a system whereby "certain triggers where if you were drilling or fracking and you detected some level of seismic activity, if there was nothing detected or below a certain level, you carried on green light. If you started to detect seismic activity, orange light, you pull certain activities. You gave it periods of time. You see it sort of escalated. And then if you reach the threshold levels, you have a red light". Evensen (2018) pointed to the traffic light system as an example of a gap in knowledge about how the public thinks or feels about specific fracking policies.

Cotton, Rattle, and Van Alstine (2014) argue "The rapid policy response to shale gas within central government following the "all clear" from the BGS on seismic risks and from the Royal Academy of Engineering on environmental pollution shows that Government prioritises the economic development potential of shale gas over the potential climate change impacts raised by national NGOs, and the localised disruptions, adverse health, air and water quality, place identity and place attachment effects raised by local activists, community members and academic scientists operating within that discourse coalition". This discourse analysis by Cotton et al. led to the conclusion that the absence of an acknowledgement by the national government of the anti-fracking coalition's stakeholder storyline "will likely exacerbate protest actions across multiple governance and geographic scales" (ibid).

This proved correct as Davey's assurance to Parliament or Cuadrilla's statements did not calm the British public. In the ensuing period of Cuadrilla's earthquake, political opposition mounted in the UK against fracking, led by a growing number of opposition groups that became increasingly vocal and organized.

Cuadrilla's positive well results in Lancashire were enough to attract Centrica, the UK based power and utility company which also had E&P operations, despite the seismicity concerns. On June 13, 2013, following the end of the Moratorium, Cuadrilla announced "Centrica plc has today become a 25 per cent investment partner in the Cuadrilla Resources operated Lancashire Bowland shale gas exploration license area" (Cuadrilla 2013).

However, growing local opposition contributed to Centrica maintaining a distance, according to UK Oil & Gas Executive. The transaction was structured as a milestone-based investment option, whereby "in return for providing funding they had the right to take stakes in the company". UK Oil & Gas Executive described the "slightly at arms length and unusual" relationship and transaction. "Centrica never became an owner of Cuadrilla. They funded a lot of the activity and had and still have rights to step in and take equity. But they've never fully exercised those rights", he said.

4.10. Political Opportunity Structure Access Points Available During Down Period

During the period following 2012, the anti-fracking movement in the U.K. became organized and public opposition continued to grow. As such, the opposition groups had clear political opportunity access points made possible by polycentric governance, with time to coordinate and impact the regulatory and permitting system. Evensen (2018) argues a mix of factors led to growing public opposition of fracking in the U.K., such as procedural concerns, unequal exposure to risks among populations, a lack of trust in industry, government, and publicly available data, as well as "questioning of the purported benefits", drawing from extensive literature.

The leading anti-fracking group in the aftermath of the earthquake was Frack Off, which was started by Dr Lloyd Davies, an astrophysicist turned community organizer and protester (Rayner 2013). Notably, Frack Off organized a three-day protest in mid-August, 2013 that energized the anti-fracking movement (Taylor and Harvey 2013).

International Oil Service Analyst described to me being from the Blackpool area, where drilling by Cuadrilla Resources at New Preston Road in Lancashire when “site construction began in early 2017 and drilling began in mid-2017” (Cuadrilla 2023). International Oil Service Analyst remembers roads being blockaded by local protesters. International Oil Service Analyst described how local opposition groups appeared to be organized in a grassroots manner. However, International Oil Service Analyst noted that “all the local towns have an anti-fracking campaign”, which are “like local town name against fracking, and then you look at the background and basically it's a coordinated effort where you can buy an action group pack that feels like from a Friends of the Earth or Greenpeace”.

This description mirrors the one NY Fracking Opposition Leader gives later in this chapter about how the non-profit helped communities across New York state institute “no-fracking resolutions”. Both the New York and U.K. grassroots organizational efforts stand in stark contrast to those of the Mapuches.

A notable difference between the New York and U.K. shale experience was how companies in the U.K. could receive exploration permits prior to undergoing Environmental Impact Assessments, which were not required until pursuing permits for commercial purposes. Not conducting an Environmental Impact Assessment ahead of exploration work provided procedural justice concerns and failed to generate a local license to operate, further emboldening the opposition (Whitton et al. 2017; Hays et al. 2015).

While it is difficult to determine the impact the anti-fracking movement had on public sentiment, an examination by University of Nottingham researchers showed support for unconventional development fell substantially from 2013 to 2015 (Andersson-Hudson, Knight, Humphrey, O’Hara 2016). Again, this is in-line with the public sentiment experienced during this period in New York, as NY Fracking Opposition Leader highlights later in this chapter. However, Evensen (2018) points to how this survey relied on different participants each time, which “limits the ability to reliably conjecture about trends in support”.

From Cuadrilla’s perspective, UK Oil & Gas Executive stated, some of the local opposition groups were “actually reasonable and rational, and some of them were at the extreme end of the spectrum, but what those local opposition groups really did was put pressure on the local planning approval process and they in some cases reasonably, had concerns and raised those concerns with the locals and got the attention of the local authority, and often those local and planning groups, you could say, got a disproportionate amount of concern”.UK Oil & Gas Executive detailed the relationship and activities between Cuadrilla and

Centrica during 2012 to 2018, a period of limited industrial progress. He stated, Centrica "committed capital to Cuadrilla to fund the company and carry it through a work program in the order of hundreds of millions of dollars with certain milestones at which if they were completed, they funded more money. If they didn't hit the milestone, they could exit. But because of the sort of controversy that had arisen around fracking in the UK, they didn't want to be a named owner of Cuadrilla. So they essentially negotiated an option, a call option. In return for providing the funding, they had the right to take stakes in the company at certain milestones, contingent on funding certain amounts of activity. But what that did was it funded essentially overhead costs from 2012 through to around about 2017, 2018".UK Oil & Gas Executive added, "Originally that was envisaged of funding more wells and fracking in practice. It took so long to get the regulatory regime in place and took so long to get planning approval. Centrica capital basically funded the overhead of the company and all the studies to put the regulatory regime in place and all the work to get planning approval and their carry funded some of the drilling and fracking of the next two wells, but kind of expired before that was finished".

The collapse in industrial progress due to cost overruns and delays emboldened the anti-fracking groups and reduced national support. This period was characterized by limited industrial activity, growing opposition, and waning support at the national level. Evensen (2018) argued the national government's "capacity to brush away opposition may be fading".

4.11. Critical Juncture in the U.K. Shale Experience - Shifting in Permitting Process

Following the unveiling of the traffic light system in the U.K., companies like Cuadrilla now had clarity on moving forward with development, which led to the permitting process. Regarding the planning approvals, UK Oil & Gas Executive stated, "it took us a couple of years to go from, OK, we now have a planning approval to get the local authority to go back and drill again in the Bowlin shale in the same broad area that we have done it previously." However, this period represented a critical juncture for shale development in the U.K., providing opposition groups with enhanced access to the permitting process.

In 2015, three years after the lifting of the moratorium, Cuadrilla was ready to move forward with new permits. Notably, as a result of the seismicity, the permitting process underwent a significant shift that resulted in more slowdowns, challenges, and fueled more local opposition and strengthened opposition access points. UK Oil & Gas Executive detailed how the Preston City Council shifted its permitting and

development focus from the regeneration of old industrial sites to open countryside. The original strategy was an industry regeneration strategy, UK Oil & Gas Executive noted; however, that changed when the government required significant seismic monitoring as part of the development process.

During this time, measures were taken at the national level to help facilitate development, such as appeal recovery powers, and it was “widely anticipated that these reforms would limit the scope for local input in decision-making on shale development” (Williams and Sovacool 2020). Attempts to remove local decision-making authority had the unintended consequences of galvanizing the opposition and resulted in an intensification of protests (Garland et al. 2023).

UK Oil & Gas Executive told me, “Our original focus had all been on sort of brownfield industrial sites that we would convert a former British aerospace factory to a site where we could drill multiple wells from, and we'd recreate jobs and all those things. When we had seismicity issues, we worked through all the regulations with the government. The government's answer was basically to do masses of seismic data gathering. You put in all sorts of listening devices and you develop a tremendous amount of data, and it's what we've come to call micro seismicity. So this isn't the sort of seismic monitoring that is typically done. This is much more detailed”.

The shift in the permitting process from industrial sites to farmland was significant for the Political Opportunity Structure. In addition to galvanizing the local opposition groups, it provided a new suite of issues to refute with the local government. As a result, Cuadrilla had to manage the increased regulatory considerations. This represented a critical juncture in the U.K. shale development experience, providing local opposition groups expanded Political Opportunity Structure access, which they utilized to significantly slow the development process and add additional costs.

UK Oil & Gas Executive continued, “And the issue around all of that is you can't do micro seismicity monitoring through feet of concrete. You can't set yourself up in industrial areas, and for the factories, you've actually got to go to a kind of farmland or green fields in areas where you could gather all this seismic data without noise pollution and without working in brownfield areas. So the whole strategy changed”.

He added, “All of a sudden, we have to go get planning approvals to drill in things that look like farmers’ fields, and that took a long time, it opened up a very different set of Environmental Impact Assessments,

all the stuff we've done previously as it was in largely industrial land, we were now having to do Environmental Impact Assessments on what impact will this have on the wildlife and so on".

As a result, there was a "long, slow approval process to reassure the council that we had a regulatory framework that they understood, did all the monitoring, went through the local approvals, identified a handful of sites, and that was literally years of work, of getting approvals", UK Oil & Gas Executive stated. Doing the baseline environmental impact statements and studying the potential effects on wildlife slowed the process significantly and added a few years to the permitting process.

The additional assessments and considerations also added additional points for opposition groups to refute in local hearings. "We were initially refused planning approval" UK Oil & Gas Executive stated, "and ultimately had to go to appeal and ultimately had to go to central government to get final appeals that we were entitled to get the planning approval and the judicial reviews of the process and so on".

As Cuadrilla experienced, one of the key characteristics of polycentric governance is the ability to revert to centralized conflict resolution mechanisms (V. Ostrom 1961; Carlisle and Gruby 2017). However, the project delays and associated increase in costs as a result of the local rejection and central government appeal had already negated the benefits Hall and Soskice detail for LMEs in having a comparative advantage for rapid innovation. Further, Garland et al. (2023) highlights how the overturning of the local decision-making led to a change in the POS configurations and corresponding opposition strategy, leading to more frequent and non-conventional protests. They argue that locally open but closed nationally POS was replaced by a closed local and national context which led to confrontational opposition approaches, similar to other anti-development campaigns. As such, the U.K. shale experience clearly shows the duality of polycentric governance for the SRDF.

4.12. “All Downside, No Upside” for Local Regulators in the U.K.; The Paradox of Polycentric Governance and Varieties of Capitalism for Strategic Resource Development

In June 2015, the Lancashire County Council rejected a drilling planning application by Cuadrilla, by a vote of nine out of 14, due to “the cumulative effect of the proposal would lead to the industrialisation of the countryside and adversely affect the landscape character”. New reports stated rejection was driven by “visual impact and unacceptable noise, and also rejected a related application for an array to monitor seismic activity” (Vaughan 2015). This decision was the result of the move to the farmland focused regulatory framework, from the industrial revitalization one previously.

Regarding the decision, UK Oil & Gas Executive stated, “I have personally some level of sympathy for these guys, it was very difficult for them, even if they thought that this was the right thing and there were lots of strong arguments about this was right for the UK, (such as) we shouldn't be burning coal, climate change, gas as a transition fuel much cheaper. The UK needed a bridge to go from coal and gas to renewables. Gas had a great role. The central government strategy made it very clear the UK needed this and this was the right place to do it. For local authorities, it was all downside, no upside”. This point reinforces the duality of climate change and local environmental issues discussed in Chapter 3.

Roughly 500 protesters were on hand for the decision at town hall, setting off a massive celebration, according to press reports. Liz Hutchins, a senior campaigner at Friends of the Earth, spoke from outside the town hall where she said the atmosphere was a “massive celebration.” She told the press, “This is a bigger win than anyone was expecting, it shows the huge strength of feeling here. There was no way councillors could go against the feelings of local people. This is a real blow for Cuadrilla and the government” (Vaughan 2015). Protest Event Analysis (PEA) research spanning 2011 to 2019 showed protests peaking in 2016 to 2017 in the U.K. (Garland et al. 2023).

The rejection raised the visibility of the opposition and slowed Cuadrilla’s progress significantly. The company moved forward with appeals, but it was a major setback, loss of momentum, and invigorated local opposition. While the Lancashire County Council planning permit rejection caused delays, UK Oil & Gas Executive detailed it did not stop Cuadrilla. He noted, “it ended up being effectively forced through by the company, supported by the central government, through appeals and other processes. So, there was a lot of hostility locally”. This hostility highlights the argument by Garland et al. (2023) that a national

government overriding local decision-making “creates the potential for the uptake of a greater number of confrontational actions”.

4.13. Polycentric Governance and New Local Regulatory Framework Slowed Process and Led to Cost and Time Overruns

However, despite Cuadrilla winning the appeal, operational concessions as part of the new regulatory framework reverberated through Cuadrilla’s operations and further slowed the development process, adding additional cost and project timeline overruns. For example, UK Oil & Gas Executive highlighted, “we ended up drilling the wells with a very underpowered small rig, because to stop it being noisy, to meet the planning hurdles, you couldn't use a bigger, taller, more powerful rig because it would be more visible and noisy”.

The misalignment in interests between the national and local governments coupled with a layered regulatory framework added years and significant additional costs for Cuadrilla. . UK Oil & Gas Executive stated, “in the period through 2010 through to 2016, 2017, 2018, there was no mechanism for providing central government support to drive national priorities”. He added, “the government started to bring in legislation about national infrastructure and national priorities, which could essentially override local planning approval. But only once you've attempted to get local planning”.

However, this strong-arm tactic by the national and central governments could not offset the local realities, challenges, and associated cost overruns. It was too late. At this point, the opposition groups had successfully accessed the Political Opportunity Structure at the local level and made development unviable and uneconomical.

“It was really layering on top a series of national priorities which local authorities had to take account of and was supposed to incent them to approve projects like this if it was a national priority”, UK Oil & Gas Executive stated. “But what it really did was it gave them a set of incentives, but which conflicted with the local incentives” He added, (the central government) eventually forced (the local government) to either force them to have to go down a process which led to appeal to the central government, and then the central government ultimately said yes”. This top-down approach to forcing permits through had limits. The local authorities could still lengthen the process with the introduction of new questions and requirements, including hearings and studies.

UK Oil & Gas Executive highlighted that while it worked to have the permits “forced through locally”, it took years for the planning approvals. He noted, “I'm talking about literally tens of millions of pounds in, you know, studies, lawyers, processes, the sort of sums we thought we would spend on drilling appraising”. He added, “We literally spent on just going through development of regulation, going through planning approval and so on, things that we thought would take a year took five years, things that we thought would cost a million [pounds], cost twenty million”. Ultimately, forcing the appeals at the central government level, which is how polycentric governance aims to solve disputes between governance levels, was too impractical and costly.

Despite the added costs and time, Cuadrilla received its permits and planning approval. The company drilled and fracked two wells in the period of 2017 to 2019. Both wells caused seismicity, leading to “amber lights and some red lights” in the traffic light system.

The first well experienced light seismicity, but the second one touched 2.8 on the Richter scale, UK Oil & Gas Executive recalls, which is the “sort of level you feel if trucks drive past your house”. He added, “But it was enough to cause some minor damage, cracking of plaster, some broken windows”. The seismicity from the first two wells led Cuadrilla to go “back to the drawing board”, he said.

UK Oil & Gas Executive noted the company found itself in a Catch-22, “On the one hand, the government regulation had been set so finely that it made drilling and fracking these wells commercially very difficult. But on the other hand, even trying to follow those rules, we had an event that honestly we didn't expect and didn't think was acceptable”. As a result of the seismicity at Preston Road on August 26, 2019, operations were halted and the Oil and Gas Authority of the UK announced, “Fracking will not be allowed to proceed in England” (Gov.UK 2019). Public awareness and support for the moratorium were both high in its aftermath (Devine-Wright et al. 2021). In early 2020, in the wake of the moratorium, Cuadrilla shareholder Riverstone Holdings, sold its stake in the company (Cuadrilla 2020).

The sudden about-face by the U.K. government was a surprise, despite the strong public opposition. Evensen (2018) notes that as late as 2018 researchers believed the pro-fracking national government would prevail over local governments (Rattle et al. 2018). In 2022, during the energy crisis in the wake of the Russia-Ukraine war, the moratorium was briefly overturned (Sandle et al. 2022).

While one of the core aspects of polycentric governance proved successful and provided Cuadrilla recourse to a central authority body through the appeal process following its blocked local permit, the delays caused by this process (and the corresponding cost overruns) were sufficient to more than offset the benefits awarded to the U.K.'s LME in its strategic endeavors to develop unconventional gas.

Echoing Ikenberry's (1986) argument around the irony of state strength, Garland et al. (2023) highlight how the U.K.'s strong state POS approach ultimately had unintended consequences and "it simultaneously appeared relatively weak".

Looking back, UK Oil & Gas Executive seemed supportive of the regulatory approach in light of the pioneering and unprecedented nature of the company's work. He stated, "speaking bluntly, it turned out that that traffic light system was actually probably right, because there was much more seismic activity than was expected not only in the first well, but the second and third wells".

4.14. Conclusion and Recommendations for Future Research – Political Opportunity Structure Lessons Learned and Questions from the U.K. Shale Experience

With this case study, I show how the SRDF recognizes the risks LMEs face through polycentric governance in strategic resource development at the local level prior to a fit-for-purpose regulatory regime being enacted. Through my primary research, I showed how the U.K. shale experience was subject to this risk by industry moving ahead of the regulatory regime. Specifically, pursuing development without a fit-for-purpose regulatory framework presented an opportunity to the local opposition groups who were able to slow the exploration process considerably, notably by pushing for the enactment of a permitting process that was more onerous and relevant to farmland, which added significant costs and delays for industry.

This experience highlights the duality of polycentric governance in achieving a rapid response to strategic resource development through LMEs' comparative advantage for radical innovation, as discussed in the theory literature review section in Chapter 3. The U.K. political economy has all the benefits of an LME that provide the foundation for a head-start for a new technically driven industry, as was experienced by the U.S. in case unconventional gas development; however, overlapping governance in the polycentric structure is part of the U.K.'s political economy, presenting a risk to this rapid development. This outcome in many ways mirrors the New York experience, showing that the absence of private institutional property rights (which are available in New York) was not the cause of the ban. Rather, the race to either block

development or institute a fit-for-purpose regulatory regime (as enjoyed in Pennsylvania and New Mexico) was won by the opposition groups in New York and the U.K.

The national government's support without local coordination provided mixed messages to industry and seems to have impacted its credibility with investors and potential industry participants. Bradshaw and Waites (2017) state, "The real problem with shale gas is that the supposed benefits are at the national scale—energy security, balance of payments etc.—while the costs are both local and global", with local communities suffering the negative impacts and development contributing to climate change on the global level. UK Oil & Gas Executive details how despite strong national support and encouragement, it took time for this to translate into tangible support mechanisms. Of the various lessons that could be learned from the U.K. shale experience, with relevance for other countries and energy sources, Bradshaw et al. (2022) states "the first is the power of frames and public discourse".

Future research could benefit from studying political economies that have the fit-for-purpose regulatory framework in place prior to pursuing development, as well as having the aligned policy guardrails between the national, central, and local governments, particularly when ample local opposition is present.

Further, future research could also look at parallels between the U.K. unconventional shale experience and the unfolding geothermal and lithium development experience, which also utilizes drilling, processing, and substantial logistical operations, but enjoys local support, building on "perception spillover" and "controversy spillover" work already explored for novel energy technologies (Westlake et al. 2023; Cuppen et al. 2020). Juxtaposing the differences in industry participants' response to approaching the regulatory framework ahead of meaningful activity would draw out important aspects of what made the U.K. shale experience unique and why it fell short of achieving the strategic advantages that should have been awarded to its LME.

4.15. The New York Shale Development Experience as Seen Through the SRDF

In this section, I provide a case study on the New York shale development experience, which ultimately led to a moratorium on fracking, followed by a legal ban. This New York shale experience mirrors the U.K. experience in some ways, notably including showing how polycentric governance provided local POS access points. However, it differs in various ways, including showing how a patchwork of opposition led

the state to ban fracking (versus the U.K. experience where the opposition effectively stopped industry and then a moratorium followed).

From a structuring standpoint, my case study on New York is built on my primary research with an opposition movement leader, versus the U.K. case study, which is built on primary research with a leading industry participant. The two perspectives provide unique insights into differing sides of a similar challenge: an LME endeavoring to develop strategic natural resources utilizing a new technology within a polycentric governance framework. While the outcomes are similar, there are unique nuances in the two experiences.

Like the U.K. experience, the New York opposition movement also benefited from a critical junction which expanded Political Opportunity Structure access (in the form of an expanded review to include health impacts), compared to the critical juncture in the U.K., which expanded opposition political opportunity access through the shifting of the regulatory framework (to farmland from industrial revitalization), as discussed in the previous section.

Both case studies can be viewed independently and together, and like the U.K., I also complement my primary research on the New York shale experience with my primary research on New Mexico, which has achieved balance between development and stakeholder concerns.

4.16. First Hydrocarbon-Rich State to Ban Unconventional Oil & Gas Development

As shown in the map below, New York state is home to both the oil-rich Utica shale and the gas-rich Marcellus shale, within the broader Appalachian Basin, providing ample potential for unconventional resources to be developed, similar to Pennsylvania and Ohio.

I spoke with NY Fracking Opposition Leader, who led the successful and high-profile opposition campaign to implement a moratorium on fracking in the state of New York. NY Fracking Opposition Leader began the campaign in 2008 with a small non-profit team, ahead of a critical time that saw a wave of anti-fracking media coverage and a number of academic reports published questioning the health implications associated with fracking (Goldstein 2012; Rabinowitz 2015).

The 2010 documentary, *Gasland*, which focused on the adverse effects of unconventional development, primarily in the gas-rich Pennsylvania portion of the Appalachian Basin, had an important impact on the

New York unconventional development experience, allowing NY Fracking Opposition Leader to capitalize on public concerns stemming from the popular documentary (McVeigh 2011). Researchers at the University of Iowa illustrated the film's impact through a "systematic analysis of Internet search data, social media postings, and newspaper articles…to identify how the documentary *Gasland* reshaped public discourse" (Vasi, et. Al 2015).

The film provided a catalyst for the opposition movement, as NY Fracking Opposition Leader noted that the media was on industry's side in 2010. As he details, the momentum of the anti-fracking movement increased from 2010 until fracking was ultimately banned in 2014. Important events following *Gasland* that contributed to the movement included critical investigative journalism and an "aggressive grassroots movement" which saw intense mobilizations of multiple coalitions, which Dodge characterizes as crowded advocacy (Urbina 2011; Dodge 2016).

While acknowledging its influence, NY Fracking Opposition Leader is also quick to add his voice to the broad criticism over some of the film's tactics and scientific shortcomings, saying, "I think *Gasland* the movie played a big role, whether it's good science or not, I don't think it is", in-line with some of the broader criticism of the film (Walsh 2011).

Dodge (2017) notes that the "Environmental Threat Discourse Coalition" often used *Gasland* in framing debates, as well as geospatial data mapping spills and toxic sites made available in 2010 by Toxic Targeting, Inc. Further, Dodge argues "This coalition introduced an important shift in the conversation: no longer was developing the Marcellus Shale viewed as inevitable, but citizens were asked to consider whether it was worth the risks", representing a critical juncture for the anti-fracking movement (ibid).

Dokshin (2016) also argues "Popular films, like the documentary *Gasland* and the fictional Hollywood production *Promised Land*, contributed to the emerging environmentalist opposition to fracking", and highlights how only 22 articles about fracking appeared in the *New York Times* prior to 2010, versus close to 40 articles per month in 2012.

Dokshin (2016) argues the New York "local ban movement" of 2010 to 2013 followed a substantial shift in the public debate which showed a "vast partisan divide" with liberals opposed to fracking and conservatives supporting it (Boudet et al. 2014; Davis and Fisk 2014). Through surveys spanning 2009 to 2012, Willits, Luloff, and Theodori (2013) illustrate this "partisan divide" formed from over this short

period as Pennsylvania "respondents in 2012 who offered an opinion were significantly more likely than those in 2009 to express concerns about environmental issues".

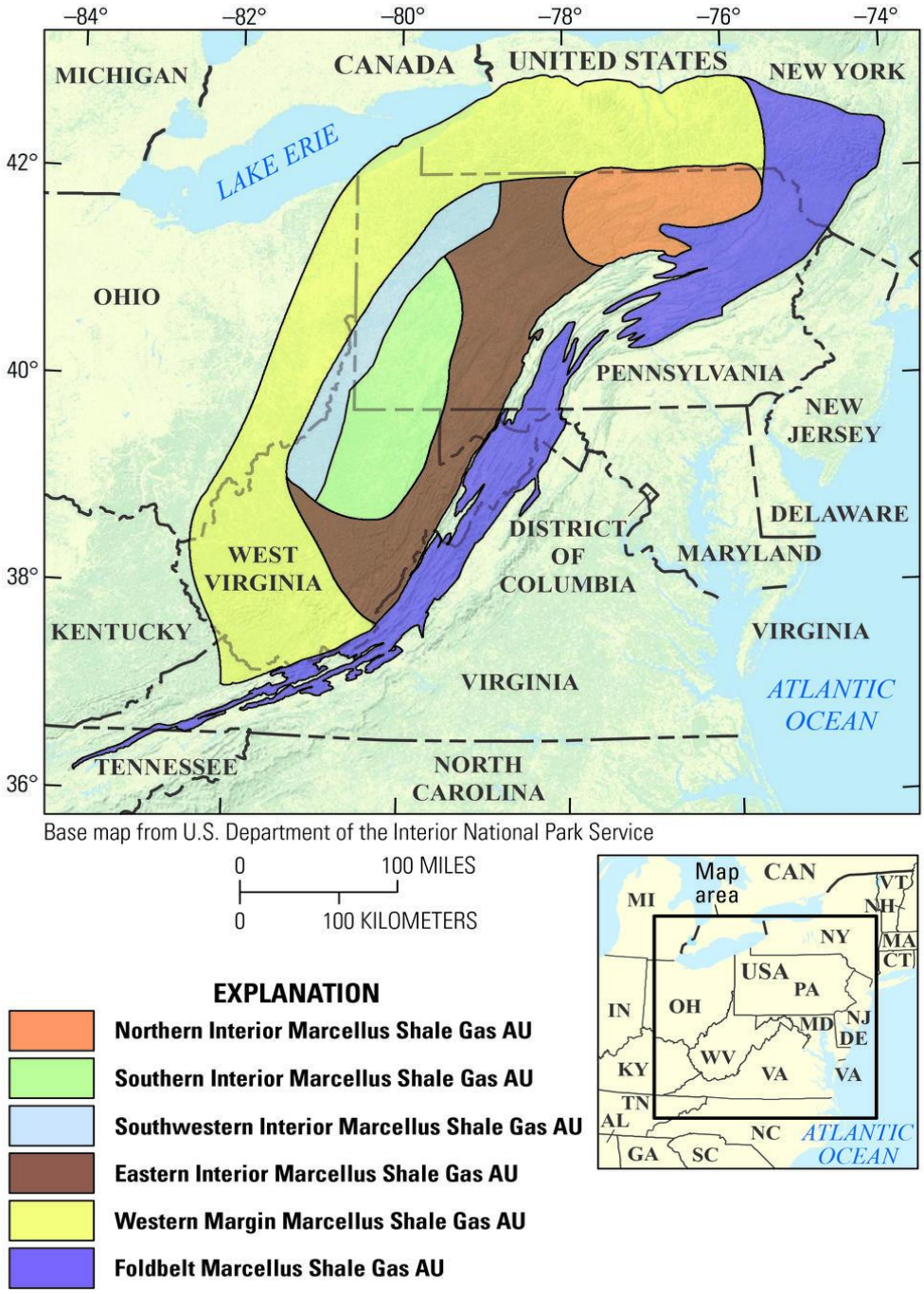
However, in Pennsylvania, a fit-for-purpose regulatory policy was put into place in early 2012 through Act 13, providing "local ordinances relating to oil and gas operations" and stifling the opposition's opportunity to capitalize on the unfolding anti-fracking movement (Pennsylvania General Assembly 2012; Dodge 2016). Act 13 further narrowed local regulatory involvement and political opposition access points from the Pennsylvania Oil and Gas Act, enacted in 1985, which "pre-empts the ability of local communities to regulate oil and gas activity" (Whitton et al. 2017).

While environmental concerns around fracking increased substantially in Pennsylvania over this three-year period, surveys showed Pennsylvania residents remained generally supportive of fracking in 2012 (Willits, Luloff, Theodori 2013). Research indicates residents in areas with legacy industries have generally more supportive views of that industry (Dokshin 2016; Molotch, Freudenburg and Paulsen 2000; Wright and Boudet 2012). Dokshin (2016) notes New York has a "rich history of oil and gas development" dating back to the 19th century. However, the state's modern oil and gas activity is nascent. From 1987 to 2005, New York state only had an annual average of two active drilling rigs, compared to 12 in Pennsylvania over the same period (Baker Hughes 2024).

Around the time Act 13 was enacted in Pennsylvania in February 2012, the New York local ban movement was accelerating, and the Sierra Club announced it publicly opposed fracking following years of support (Sheppard 2012; Sierra Club 2012; Dokshin 2016). The tide had officially turned but the opposition movement had missed the window of opportunity in Pennsylvania with the enactment of Act 13, which significantly limited local POS access points.

As a result, the Pennsylvania and New York fracking experiences highlight how there is a race between pro and anti-development groups to either enact a fit-for-purpose policy framework that limits POS access points or enlarge and exploit POS vulnerabilities. This is a key consideration for the SRDF.

Figure 13: Overview of the Appalachian Basin



Source: USGS 2019

NY Fracking Opposition Leader's work culminated in 2014 with the ban on hydraulic fracturing in the State of New York in December, following a seven-year review (NYS Department of Environmental Conservation, High-Volume Hydraulic Fracturing in NYS 2023). The details of the multi-year campaign provide the most organized and effective opposition to unconventional development I was able to find. His story is unique and from what I understand, has remained untold as it relates to the specific Political Opportunity Structure regulatory access points and campaign milestones which influenced the ultimate unconventional development ban in the state of New York. As a result, my interview with NY Fracking Opposition Leader represents an important contribution to the literature on Political Opportunity Structure and strategic resource development.

4.17. Leveraging the Environmental Impact Statement as a "Structuring Device" in New York to Ban Unconventional Development

In discussing the genesis of his work, NY Fracking Opposition Leader noted, "We were engaged in a very formal role as far as intervening in the Environmental Impact Statement (EIS) that the Department of Environmental Conservation in New York (DEC) was doing under state law to look at places around New York where there could be some fracking", representing the specific POS access point for the opposition groups.

Legally implemented on November 1st, 1978, "New York's State Environmental Quality Review Act (SEQR) requires all state and local government agencies to consider environmental impacts equally with social and economic factors during discretionary decision-making" (NYS Department of Environmental Conservation 2023). Notably creating a strong Political Opportunity Structure in New York State, as part of the SEQR, "If an action is determined to have potentially significant adverse environmental impacts, an "Environmental Impact Statement" is required" (Ibid).

In the early days of the campaign, NY Fracking Opposition Leader recognized that the EIS represented a "structuring device for both a legal as well as a kind of political opportunity". Looking into the initial research, he and his team also recognized correlations between environmental incidents and health outcomes could formulate his team's opposition strategy. NY Fracking Opposition Leader told me, "A number of things were uncovered during that investigation and research, especially in terms of problems that were happening in Pennsylvania, just across the border, the New York border in Dimock

(Pennsylvania), and a few other towns where there have been very substantial and very negative impacts on the water supply".

4.18. Three Key Opposition Campaign Developments

According to NY Fracking Opposition Leader, the three developments that contributed to the successful campaign were: 1) his team's effective role in the EIS process, 2) the broadening of the EIS to include an overall cumulative health impact study, and 3) the perceived overstatement of the economic benefits to the state by supporters of unconventional development. As the opposition efforts unfolded, "the EIS was an important organizing structure for us", NY Fracking Opposition Leader told me.

Public comments as part of the EIS showed broad opposition for fracking throughout New York state, but with opposition spanning a broader range of local issues for respondents closer to development and more associated with mass media's perceptions of the risks for respondents residing further away from potential drilling sites (Dokshin 2021). However, Dokshin (2016) also showed how local support in towns that stood to benefit was strong, noting, "Primary data on public participation in one town suggest that local support for fracking was significant and concentrated among large landowners".

First, NY Fracking Opposition Leader and his team were able to utilize the public EIS process for visibility and to mobilize resources. He stated, "we were able to raise some money and brought in some expert witnesses", to provide accounts on the potential impacts to various key local stakeholders and constituent groups, including potential implications for air, water, for children, and for first responders. NY Fracking Opposition Leader also highlighted how media attention from neighboring states, notably Pennsylvania, provided early support for their campaign. Beyond providing public support for the campaign, these data points in Pennsylvania lent critical evidence for the EIS.

Additionally, NY Fracking Opposition Leader noted, "Cabot Oil and Gas had just been indicted, criminally indicted by the attorney general of Pennsylvania just the last month or so around those incidents as well." Dimock, Pennsylvania has been seen as "ground zero in the fight over fracking", has been widely detailed in the media, and was the subject of the *Gasland* documentary (StateImpact Pennsylvania 2023). As a result, the media attention and public health questions being asked just across the state border created an opportune time to mount NY Fracking Opposition Leader's campaign.

Second, in the long-run, the opposition actually benefited from Governor David Patterson's veto in 2010 of a five-year moratorium on fracking which passed each House in 2009 and 2010. NY Fracking Opposition Leader detailed the importance of this development. He stated, "Governor Paterson vetoed it (the five-year moratorium), but in his veto…he put into the veto another assignment that would add to the Environmental Impact Statement that included the Department of Health to do an overall cumulative health impact so it would incorporate the studies that have been done up to that point in other jurisdictions, as well as studies that are being done in Pennsylvania, which is very close geographically." Dodge (2016) argues that the "Environmental Discourse Coalition" aimed to expand regulatory reach through involvement in the regulatory and assessment process by multiple agencies. Alternatively, industry and pro-fracking coalitions "sought to limit the range of agencies involved in regulating fracking". In this regard, Dodge notes Pralle (2006) stating, "those who favor the status quo legitimize existing institutions, while those who seek change challenge the legitimacy of institutions and patterns of governance".

Importantly, this additional consideration in the EIS represented a critical juncture in the opposition campaign by providing NY Fracking Opposition Leader and his team increased access under the already robust Political Opportunity Structure. With the EIS now broadened, the opposition was able to expand its campaign stakeholders to include stakeholders focused on health and broaden the pool of experts under its expanded POS access.

Regarding the expanded EIS scope to include broader health considerations, NY Fracking Opposition Leader noted, "We brought in a pediatrician who did a terrific job testifying, and we also brought in someone who talked about the overall impact it would have on first responders, that there were a number of different accidents increasing that happened in other states, particularly Texas, Louisiana, Oklahoma and North Dakota".

NY Fracking Opposition Leader emphasized the significance, "So that was an important turning point because the campaign then became even more than just about clean water or clean air impacts. It became about public health impacts and a number of health practitioners, doctors, nurses, organizations like Concerned Physicians in New York, Physicians for Social Responsibility, the New York State Medical Society, a conservative institutional stakeholder, they all became very engaged and were part of our ongoing lobbying of both the Executive as well as the Legislature."

As a result of the expanded EIS, the campaign can be viewed in two phases, according to NY Fracking Opposition Leader, with 2009 to 2010 focused on the environment and targeting more of the counties in the southern portion of the state around New York City, and phase two in 2011 to 2014, which focused on health and included more of a patchwork of counties throughout the state.

By comparison, in New Mexico, which shows how a left-leaning state can find balance for resource development within polycentric governance, New Mexico Cabinet Level Secretary stated, “that’s where we get into a lot of permit challenges and problems that people feel as if they were left out of key decisions that affect their public health or their environment.” As such, the New Mexico case shows how addressing local stakeholder considerations, particularly related to essential stakeholder issues that outweigh monetary incentives, is essential for development, particularly with strong Political Opportunity Structure access.

Third, the perceived economic benefits of unconventional development appeared to be overstated from an economic perspective, NY Fracking Opposition Leader articulated the EIS showed. “There weren’t as many jobs created as they said there were, and the ones that were, were short term”, NY Fracking Opposition Leader stated. As part of the EIS, the opposition “had economists come in and we had professional testimony through the EIS to look at the economic impacts, which did have a positive impact, but only for about two, maybe three years”. The uneven economic benefits throughout the state impacted local support, depending on proximity to resource and drilling locations, according to Dokshin (2016). Dokshin’s research showed how anti-fracking measures were more prevalent where “perceptions of threat existed but promises of economic benefits were not credible”, with data showing support for fracking in municipalities where drilling was expected to take place and anti-fracking measures on the outskirts of development (ibid). More broadly, NY Fracking Opposition Leader added, “and then there was a very steep decline as far as job creation, and what happens is you are just exhausting the site and the site gets exhausted relatively quickly”.

Reinforcing the resource curse literature, Arnold and Neupane (2016) argue “Areas that experience booms are often ill-prepared for the resulting socioeconomic and demographic changes”. In highlighting the economic risks to New York ‘s Southern Tier, Arnold and Neupane (2016) point to the Jacquet’s (2009) economic analysis of the Marcellus. Jacquet argues “Local governments are often caught unprepared by the waves of new growth and are at a disadvantage to mitigate potential growth problems” (ibid).

Arnold and Neupane (2016) argue local governments "often struggle to cope with busts wherein resources are exhausted, the job market contracts, population shrinks, and unemployment returns to pre-boom levels or higher.

Highlighting NY Fracking Opposition Leader's point, New Mexico Cabinet Level Secretary told me (in relation to New Mexico), "Often the economic benefits through tax and royalties stemming from resource development is not enough if it is not met with employment benefits as well. In an area trying to balance economic and environmental considerations, this can often be a tipping point for local opposition". This point is echoed by the U.K. experience as well.

The divide between economic expectations industry presented and the economic picture the EIS review painted was a key consideration. NY Fracking Opposition Leader stated, "that was of real importance too as far as the difference of what was being claimed and what was in a sense, being a major piece of the argument for fracking, which was job creation, but it was more limited than what the numbers were in terms of what the industry was giving us".

This followed a number of bankruptcies of the middle-sized fracking companies in the 2011 to 2013 period. NY Fracking Opposition Leader pointed to Norse Energy, which was targeting unconventional development in New York and stated financial problems "related to the continued delay of permits to develop the company's assets" led to its filing for bankruptcy in 2014 (Norse Energy Corp. ASA, 2014).

4.19. Aggressive Grassroots and Coordination with the Media

In 2011, as Governor Andrew Cuomo replaced Governor Paterson, NY Fracking Opposition Leader and his team spoke with Gov. Cuomo "multiple times" and "to his credit, had an open discussion", he noted. The Cuomo Administration "had to abide by the Paterson executive order", which included the Paterson era health component. As a result, Cuomo had to look at two agencies (NYS Department of Environmental Conservation and NYS Department of Health), with the health department "very concerned".

Two additional factors were also important leading up to Gov. Cuomo's re-election in 2014. The first was "a grassroots movement that was very vibrant and very aggressive". The second was coordination with the media, which had initially been "hostile" to the opposition and supportive of unconventional development, but switched around 2012, as an "awful lot of information (had) been coming out about

the contamination of groundwater, but also the impacts that were happening as far as the air impacts, which are just as negative, which I don't think people had expected it to be that deleterious".

Importantly, these two factors coincided at a critical time in the political cycle, as "Cuomo had a 2014 primary and a general election, and in the primary," NY Fracking Opposition Leader added, "his candidate running against him was very anti-fracking and he could see that there was a strong anti-fracking kind of effort in the Democratic Party, and then polling started to show that Democrats and independent voters in New York were increasingly anti-fracking. I mean, with big numbers, too, like 75-80%".

The grassroots movement was centered around five or six groups, according to NY Fracking Opposition Leader, and Frack Action, "was really the leadership group", he stated, while Dodge tracked eight opposition groups split between two anti-fracking discourse coalitions (Dodge 2016). Metze and Dodge (2016) describe a discourse coalition as a "a loose network of actors who develop a shared way of interpreting a policy issue".

According to the nonprofit's website, "Frack Action started in 2010 as an emergency response to prevent fracking from coming to New York State and was founded in order to create a full-time organizing team dedicated to mobilizing citizens to stop fracking statewide" (Frack Action 2023). NY Fracking Opposition Leader highlighted the significance of these groups for the grassroots movement, "They could frankly put together three, four thousand people at a main event, which is a lot of people to organize, something a big union would do", he stated. Dodge (2016) analyzed Frack Action as part of a discourse group that framed fracking as an environmental threat, an escalation from an earlier opposition discourse group that focused on environmental regulations.

Simonelli (2014) discusses the importance of the "virtual movement" during this period. She attended local government and opposition meetings in Otsego Country, NY in 2012-2013 but notes the importance of listservs and coordination among opposition groups and stakeholders. Simonelli argues "the frack battle is the first virtual civil rights movement" (ibid). While many of these groups had alternative visions for why they might be opposed to fracking (spanning land use, environmental reasons, water stewardship), this loosely connected opposition played into NY Fracking Opposition Leader's broader strategy, despite the challenges associated with crowded advocacy such as groups expending resources on the framing of issues (Dodge 2016). This type of framing can also impact trust within coalitions or

sustainability networks (Lee and Lee 2017; Rein and Schön 1993). The coordination between the environmental non-profit, which was focused on leveraging the Political Opportunity Structure provided by the EIS, and the grassroots groups was also important. NY Fracking Opposition Leader stated, “We were engaged in discussions with them and at some points we overlapped”.

He added, “Where it overlapped is they helped work on the legislative campaign to get the moratorium bill passed. I would help strategize, to do local organizing with some of the grassroots campaigners who’d go door to door in people’s districts where they were on the fence, and we would try to provide support locally for the five-year moratorium bill”.

Additionally, NY Fracking Opposition Leader highlighted the importance of media coordination and the combination of investing in media as well as attracting media attention as a result of the grassroots efforts. He stated, “We were doing a lot of press on it, releasing reports. We did a lot of press about the Environmental Impact Statement process and how we’re engaged in that”.

Additionally, NY Fracking Opposition Leader noted the importance of attracting celebrities to the campaign for further visibility. He stated, “And we had some celebrities like Mark Ruffalo, who got a lot of press wherever he went. On this he was very engaged, very active, more than any celebrity I’d ever seen before in an issue like this”.

4.20. Reinforcing Media and Legislative Cycle

Legislative hearings in Albany during 2012 to 2013 created a self-reinforcing cycle of more media, awareness, and in-turn research by journalists, academics, and advocacy groups. NY Fracking Opposition Leader noted he and his team were active and would testify at every one of these hearings. He told me, “That would generate more media and a sense that this is a potential crisis if you allow it to go forward. So that was very important”.

The hearings and campaign benefited from the in-state coverage of the *New York Times*, coupled with the growing national interest in the topic, as well as the spotlight that celebrities like Mark Ruffalo brought. NY Fracking Opposition Leader noted that the campaign benefited from significant coverage by the *New York Times* starting in 2011, including a mix of opinion pieces as well as an investigative series by Pulitzer Prize winning journalist Ian Urbina titled *Drilling Down* (New York Times 2023). Hedding (2017) argues

much of the discourse and debate around fracking has focused on the framing of the practice "over its environmental effects and economic benefits". The *New York Times'* coverage provided high-profile nationwide framing of fracking as an environmental threat.

Robert F. Kennedy, Jr., former Senior Attorney and Advisor at the Natural Resources Defense Council (NRDC) during the time of the campaign as well as member of Gov. Cuomo's High Volume Hydraulic Fracturing Advisory Panel, said about the *New York Times*, "The paper's ongoing series on natural gas drilling is one of the strongest pieces of investigative journalism this year from any news venue" (Kennedy 2011).

Further powering the cycle between media, legislation, and celebrity involvement in the New York fracking issue, Urbina's series inspired *Promised Land*, the 2012 movie with Matt Damon and John Krasinski as a small-town landman facing a natural gas boom (Karpel 2013). Dokshin (2016) highlighted how these films contributed to people learning more about fracking through an "increasingly politically polarized information environment", further highlighting the importance of framing for fracking and other new technologies for the SRDF.

Notably, NY Fracking Opposition Leader highlighted how *Drilling Down* "was looking mostly at Pennsylvania, but he (Urbina) was looking at a combination of what had happened as far as Dimock and Cabot's illegal dumping of fracking wastewater in Pennsylvania and West Virginia'', including "documentation that was fraudulent by the companies". NY Fracking Opposition Leader added, "those were important stories, and we elevated those stories too", highlighting the reinforcing cycle.

However, NY Fracking Opposition Leader added the campaign's efforts did not go untested and that the campaign was met with significant industry counter-support, with pro-industry groups also benefiting from the New York state legislature being an "open political site".

He recalls, "there was just an enormous amount of money spent by the oil and gas industry on politics and also on propaganda, TV and radio ads, print ads", adding I think it could be as much as four or five million bucks was spent over a three-year period by a combination of 10 or 12 oil and gas companies, combination of also of advertising and lobbying". For example, lobbying in New York by Chesapeake Energy alone during 2008 to 2011 surpassed $1.6 million, up from around $40,000 the three years prior. Overall, the *New York Times* stated in November 2011, "The money those companies have spent in New

York since the beginning of last year is more than four times the roughly $800,000 that the state's most prominent environmental groups have spent on their lobbying efforts" (Kaplan 2011).

NY Fracking Opposition Leader highlighted the effectiveness of the inquiry into health issues coupled with the opposition groups' focus on "Drinking water, public health, and kids". He noted that "The industry didn't respond very well. Even though they spent a lot of money, they were not organized, and no one believed it."

Reinforcing this, despite industry counterclaims during this period, Urbina stated in late 2011 "So far, we have no corrections", in describing the methodical nature of fact-finding and reviewing the original documents that went into *Drilling Down,* which Urbina highlighted to me was nominated by the *New York Times* for a Pulitzer Prize (Rosen 2011).

Urbina was unable to speak with me due to constraints on time as a result of his current investigation, but his team pointed me to a number of references reinforcing NY Fracking Opposition Leader's statements via email, and stated "the series was investigated by fact checkers internally at the paper and found that there were zero errors".

Ultimately, Urbina's investigative journalism, the ongoing legislative hearings, the celebrity involvement, the growing grassroots participation, and the institutional weight brought by the health professionals as part of the EIS all coincided and reinforced the growing opposition within the Democratic party during the 2011 to 2014 period, leading up to Gov. Cuomo's reelection and the decision to ban fracking in 2014.

4.21. County by County Campaign – Rise of the "No Fracking Resolutions"

The importance of the polycentric nature of governance for NY Fracking Opposition Leader is apparent through the patch-work opposition campaign. As NY Fracking Opposition Leader built his legislative strategy, he targeted counties where either the waste would be disposed of, or ones that had more general concerns about fracking. He noted, during the first phase of the campaign, "my target area in terms of the legislative effort was Ulster County, Albany, Westchester, New York City, Long Island, that was the area I was looking at, Long Island was less engaged because the waste wasn't going there as far away from where the frack is going to take place, but New York City cared and was concerned about its water supply up in Sullivan and Delaware County".

In discussing a jurisdiction's capacity and how it relates to fracking policies, Arnold and Neupane (2016) note Sapat's (2004) research that finds "citizen income significantly predicts state adoption of hazardous waste regulations". However, Chung and Kim (2009) have shown how local perception of economic gains can be a leading indicator of local support for a hazardous waste facility (Chung and Kim 2009).

While the more Republican and pro-fossil fuel western New York counties were not a focus for NY Fracking Opposition Leader, he was surprised to find a higher percentage opposition in these areas than expected, "around 50/50". Research shows that citizens who voted for Obama in 2008 and 2012 were more likely to support anti-fracking measures (Barnes 2013; Arnold and Neupane 2016). However, a more nuanced state-level analysis showed that support from conservative voters in New York decreased with distance from the nearest well, versus support increasing by conservatives with distance from wells in Pennsylvania, showing legacy operations and state-level politics present exceptions (Zanocco, Boudet, Clarke, Stedman, Evensen 2020). This suggests, "political ideology can play a larger role in shaping opinions toward [fracking] at greater distances from development, but ideology's influence on proximity-support relationships may vary depending on context and analytic scale" (ibid).

This coordination and organization stands in clear contrast to the organizational short-comings Argentina Community Engagement Executive referenced regarding the Mapuches in Argentina. As my primary research makes clear, at this point in the opposition campaign NY Fracking Opposition Leader and his peers have instituted and are executing on a systematic coordinated effort to draw in a patchwork of stakeholders to affect the EIS (the coordinating Political Opportunity Structure mechanism) and ultimately influence a legislative outcome.

During the second phase of the campaign, NY Fracking Opposition Leader focused on small wins throughout the state, as opposed to a large one at the state capital. He noted, "the legislative wins were not in Albany", rather the opposition was "able to organize a lot of local villages, towns and municipalities to do no fracking resolutions".

Through a geospatial analysis of local bans, Dokshin (2016) showed "fracking bans rarely passed in regions most likely to see intense development, but they proliferated in a geographic sweet spot on the periphery of potential development regions".

NY Fracking Opposition Leader estimates 60-70 towns and villages passed no fracking resolutions, providing important local advocates, including mayors and town council members, to bring to Albany for marches, meetings with key legislators, and press events. Dokshin (2016) shows "164 towns and cities passed land use ordinances prohibiting fracking within their borders" between March 2010 and July 2013.

Importantly, while only the state has the authority to ban fracking, vested through the DEC, the resolutions provided powerful messaging to the state, and also signaled the willingness to institute local ordinances that could have caused broader industry challenges, like a town council passing an ordinance that stops "fossil fuels in any way distributed through or transported through the town, which would have created a lot of chaos for the industry", as NY Fracking Opposition Leader highlighted.

Simonelli (2014) argues, "Taking advantage of New York's moratorium, individual townships in the shale gas regions of the state have used home rule in an attempt to chart their own development course, by passing bans and moratoriums on fracking and the industrial development associated with it".

Home rule government gives a local government a level of autonomy in the allocation of state and local government powers (Cornell Law School 2022). Simonelli highlights how New York has broader home rule powers than many other states.

Further, Simonelli (2014) notes "Although it is not always clear, the New York Constitution does grant local governments fairly broad home rule powers to adopt local laws". However, Simonelli noted "While bans and moratoriums that have been passed by receptive town boards utilizing home rule and zoning are heartening for the anti-drilling portion of the community, these results are not permanent", as "Changes in town board make-up can result in changes in town policy, without much involvement by community members" (ibid). This provides support to NY Fracking Opposition Leader's strategy of using local bans as a patchwork to create political support for a ban at the state level, which is more stringent and binding.

As noted by Murtazashvili and Piano (2019), in their inquiry into regulating unconventional gas development in the U.S., "the states – not local governments – have always been the foundation of self-governance". However, while local government might not be able to institute bans (as in the U.K. as well) as the power is vested in the states, stemming back to the Constitution and made mechanically clear in the DEC in the case of New York, they could still drive significant cost overruns and delays, as UK Oil & Gas Executive details regarding Cuadrilla's experience in the U.K.

NY Fracking Opposition Leader and his team had a formula for recruiting local governments in New York state to their cause. He stated, “What we wanted to do then was just get resolutions of as many of these localities as we could get, and we would help. We’d go in with a formal language for a resolution, and then we would talk to council members of those towns or villages, and we would bring in people who would testify for them. We’d get them materials that made sense, we would speak to the local media with the local elected officials”.

Arnold and Neupane (2016) argue there were resolutions passed in local municipalities in questionable oppositional nature. They point to The Town of Wayne, which explained its local moratorium as neither pro nor anti-fracking, but rather to allow time to review the land use agreement and “make sure we’re protected” (Penham 2012). NY Fracking Opposition Leader noted a success rate of around 80% to get a resolution in towns they were engaged with, highlighting the breadth of opposition and effectiveness of their strategy.

Further, NY Fracking Opposition Leader stated that a number of towns passed resolutions that they did not even speak with, and that a town representative would ask the non-profit to speak at a vote or hearing event, for example, with the expectation that the resolution would pass unanimously. This created a powerful patchwork of local opposition to begin to take to the state level.

In a geospatial retrospective analysis of the local resolutions, Walsh, Bird, and Heintzelman (2014) found three factors contributed to local support for no-fracking resolutions. They stated, “Factors which increase the probability of local restrictions on fracking include a community’s presence in the Utica shale region, the relative leaning of the community to the Democratic Party, and the education level of the local population”. Notably, the researchers state “We do find that communities with lower levels of educational attainment, as represented by the % of people over 25 with only a high school diploma, are less likely to pass bans or moratoria”.

Alternatively, a retrospective review by Arnold and Keupane (2016) argued, “We cautiously expect that greater education will increase adoption likelihood, though municipalities with more educated citizens could be less likely to adopt pro-HVHF (fracking) measures if education fosters more environmental concern; extant research on HVHF policy making in New York supports the latter argument”. Their

quantitative findings ultimately showed lower income and right-leaning political alignment to be among the key determinants in determining pro-fracking positions on local resolutions.

As noted in the case of Town of Wayne, some of the municipalities passed resolutions to provide time to evaluate land and road considerations and were not necessarily meant to be pro or anti-fracking resolutions. Regardless of the local government's intentions, these resolutions and local moratoriums were capitalized on by NY Fracking Opposition Leader as part of the patchwork opposition strategy that ultimately led to the state-level ban.

NY Fracking Opposition Leader told me, "Each one of those resolutions in those towns and villages, those were local victories. Those were local political victories that all led to a broader sense that nobody wanted this, or only a few really wanted this to happen there". This message was the foundation of his highly structured and coordinated campaign, made possible through the duality of polycentric governance.

Importantly, in addition to the broader messaging to the state and industry from the local resolutions, NY Fracking Opposition Leader pointed out the significance on the state senatorial political level. For example, the resolutions are "going to create some hesitation and a little bit more of a political counterweight to what the state Senate or Assembly member might want to do", NY Fracking Opposition Leader stated, referring to a Republican state senator that might be pro-development but is representing various towns and villages that had passed resolutions supporting a ban on fracking.

4.22. Louder Drum Beat Leading Up to the Gubernatorial Election

At the high-profile New York City level, Mayor Michael Bloomberg, who was in office from 2002 to 2013, took a "middle of the road" view, according to NY Fracking Opposition Leader, generally supporting unconventional development but focused on the protection of New York City's water supply (Navarro 2012). In 2014, Mayor Bill DeBlasio was elected supporting a fracking ban (Waldman 2014).

At this point, NY Fracking Opposition Leader highlighted that opposition groups were riding on the growing anti-fracking movement and were now pushing for an outright ban, versus a five-year moratorium previously. In a unitary governance structure, like China, local leaders are elected by national government party officials, making NY Fracking Opposition Leader's strategy not possible in CMEs. In an

MME, institutional arrangements with other powerful stakeholders, like labor groups, could outweigh local stakeholder concerns for political purposes, also negating the effectiveness of this strategy.

The final year and half leading up to the ban in December 2014 was the strongest for the campaign. Nearly two thirds of the local resolutions were signed during this period, according to NY Fracking Opposition Leader, who said, the "drumbeat got louder and louder". More public health officials were leading the charge (highlighting the critical juncture of the expansion of the EIS to include health considerations), particularly children's health, not just general health. With children's health now becoming a leading issue, NY Fracking Opposition Leader highlighted how mothers groups were increasingly lobbying in the halls in Albany.

As part of the public engagement process made available by the EIS process spanning 2009 to 2014, the DEC received hundreds of thousands of public comments and provided a legislative forum for the grassroots campaign. Importantly, in the months prior to the ban, polls showed strong opposition to fracking in New York, paving the way for an easy political decision to ban the practice in the state (NRDC 2014).

As a result, in December 2014, in the month following Gov. Cuomo's re-election, "Acting DOH Commissioner Dr. Howard Zucker recommended that high-volume hydraulic fracturing should not move forward in New York State" (NYS Department of Health 2023). In-concert with Dr. Zucker's report, the Department of Health issued a notice stating, "As a result of Dr. Zucker's report, Commissioner Martens (Department of Environmental Conservation Commissioner) stated at the Cabinet Meeting today that he will issue a legally binding findings statement that will prohibit HVHF in New York State at this time" (ibid).

The timing of the political cycle with the review was important, as NY Fracking Opposition Leader highlighted. The decision "was immediately hailed by environmental and liberal groups — seemed likely to help repair his (Governor Cuomo's) ties to his party's left wing. It came after a surprisingly contentious re-election campaign in which Zephyr Teachout, a primary challenger who opposed fracking, won about a third of the vote" (Kaplan 2014).

In the aftermath of the ban (which was effectively an order to not issue permits), a permanent ban was codified into state law in April 2020 (NYS Division of the Budget 2020), requiring state House, Senate, and Governor approval to overturn the law.

4.23. Conclusion – The New York Fracking Ban as a Case Study for the SRDF

In this section, I provided primary research on the New York fracking ban building on a first-hand account from an opposition leader to shale development. Key to the case study was the opposition movement's success in accessing the state's Political Opportunity Structure as a result of utilizing the EIS as a coordinating mechanism and as a result of the duality of New York state's polycentric governance structure.

Building on the secondary research, I show how NY Fracking Opposition Leader led a coordinated and systematic campaign to build a patchwork of local "no-fracking resolutions" in a way to enhance the access to the EIS and to provide political counterweight at the more important state level. This counters Murtazashvili and Piano (2019), which focuses on local bans as a strategy to stop development, and shows NY Fracking Opposition Leader acted at a higher level of abstraction in garnering the local bans as part of a systematic way to access the POS and successfully affect development.

It is my hope that future researchers will utilize this case as a juxtaposition to future strategic resource development opposition campaigns in LMEs, optimizing the SRDF in the process.

4.24. Chapter Conclusion – Political Opportunity Structure and the SRDF

In this chapter, I presented three unique case studies leveraging interview-based primary research utilizing the SRDF as a framework to analyze Political Opportunity Structure. The case studies can be viewed independently or together. Together, they show how the duality of polycentric governance creates access to opposition groups in LMEs, with or without private property rights. My primary research into New Mexico complements the New York and U.K. case studies, showing that balance can be achieved in left-leaning LMEs between local stakeholder environmental and health considerations and state-level economic objectives.

The Argentina case study shows how MMEs can have less access to the Political Opportunity Structure, as institutional arrangements with other stakeholders and increased alignment in viewpoints amongst different levels of government limit opposition access points. Further, the Argentina case study shows how a transactional approach in response to this outcome has limited and short-term effects, and as Garland et al. (2023) highlight, can lead to confrontational and non-conventional protest outcomes.

The literature shows that CMEs have low POS access; however, Tan et al.'s (2019) research highlights that state-led development can instill a sense of community pride for supporting projects of national importance, as interview participants in the Sichuan Basin articulated. In contrast, local communities in LMEs (U.S. and U.K.) where development was driven by private companies, were more focused on the economic benefits and environmental risks, with national pride notably absent from the discourse (Dokshin 2016; Evensen et al. 2014; Ashmoore et al. 2016; Cotton and Van Alstine 2014).

Notably for the SRDF, critical junctures in both the U.S. and U.K. experiences, through expanded opposition access to the Political Opportunity Structure, shows the specific times and mechanisms the opposition groups leveraged to affect change in their campaigns. As a result, these case studies show that ahead of strategic resource development, there is a race between local stakeholders and industry to enact a regulatory framework to achieve their respective goals.

As part of the chapter's narrative structure, this chapter provides important foundational primary research for my overall dissertation. These case studies provide the data for the basis of my argument that through the SRDF, researchers can infer that LMEs have a comparative advantage for radical innovation for resource development *except* when a fit-for-purpose regulatory regime is not in place. As such, it builds on Hall and Soskice's (2001) VoC framework, and Wang and Krupnick's (2013) work on the U.S. shale development experience.

Collectively, it is my hope that future researchers add additional Political Opportunity Structure case studies spanning counties, natural resource bases, and technologies, to optimize the SRDF and infer valuable insights for strategic natural resource development.

Chapter 5: Government

5.1. Introduction

In this chapter, I show how the Independent Variable for Government is embedded in the SRDF, and how I analyze it for my case study on shale development. In doing so, I combine my primary and secondary research, building on the literature and drawing from expert interviews.

Further, I highlight how the divergence between LMEs and CMEs on cooperation between firms and government results in varying expectations and outcomes for aspects of strategic resource development, building on Hall and Sockice's (2001) VoC framework as well as the unconventional oil and gas work by Murtazashvili and Piano (2019), and Wang and Krupnick (2013). My interviews with various industry experts and participants show how the unique situations and developments discussed with these individuals as part of the unconventional development efforts of the counties I study reinforce and build on the literature.

Specifically, this chapter shows that the Government Independent Variable in the SRDF reinforces the argument that LMEs have a comparative advantage for radical innovation and CMEs for incremental improvement. This is due to liberal market policies that rely on market signals over price controls, fluid markets over structured ones, and policies that incentivize investments in "switchable assets" over "specific" or "co-specific ones", and vice-versa. In doing so, I show how the "institutional arrangements of a nation's political economy tend to push its firms towards particular kinds of corporate strategies" (Hall and Soskice 2001).

For strategic natural resource development, these institutional arrangements carry considerable ramifications, with outcomes affecting the nation's underlying strategic drivers for developing its resources (economics, energy security, and the environment).

In addition to the understood aspects of the VoC framework, I argue that the Government Independent Variable in the SRDF is particularly important as it relates to POS. This is due to the level of access LMEs (through polycentric governance) present to opposition groups to strategic resource development, as part of the Political Opportunity Structure Independent Variable. CMEs and MMEs, by contrast, particularly with more unitary governance structures, have more narrow Political Opportunity Structure access points,

creating less scope for variance in development outcomes versus the national strategies. As such, this chapter should be viewed in-concert with chapter 4 on Political Opportunity Structure, which is more narrative in structure.

Importantly, one of the key take-aways from my primary research shows the risk of not having a fit-for-purpose regulatory regime in place, which can lead to: 1) LMEs having development risk from Political Opportunity Structure access points made available through polycentric governance, 2) less developed CMEs at risk of the Resource Curse, and 3) more developed CMEs and MMEs at risk of resource-related social unrest, missed opportunities to develop specific or co-specific assets, and less effective comparative advantage for incremental improvement.

The Government Independent Variable is a critical component for strategic natural resource development, as this is the overarching political system that governs the institutional arrangement between state, markets, and firms, either encouraging or encumbering the comparative advantages embedded in the SRDF, underpinned by the VoC framework. As detailed in Chapter 2 (Part 2), I explore the Government variable through Historical Institutionalism, connecting my primary research to the historical foundations of each country's relevant institutions, as understood through my secondary research. This exercise can be replicated across other countries, technologies, and resource-bases.

This chapter includes inquiry into some of the key aspects of the governance for strategic natural resource development. Notably, I discuss property rights, regulatory governance, the historical foundations of regulatory regimes, and how the Government Independent Variable affects the other three Independent Variables within the SRDF. I structure this chapter by market economy type, discussing the SRDF and LMEs, CME, and MMEs, with particular inquiry into important governance-related aspects of strategic resource development, including regulations, national and local interplay, and critical institutional variations, such as property rights.

As illustrated in Figure 14 below, the high-level similarities in Government between the U.S. and the U.K. are substantial, with the exception of institutional property rights. The similarities between Argentina and China are less alike. This chapter aims to show how these variables create institutional arrangements that either encourage or discourage types of comparative advantage, and either invite or dissuade opposition

advances. This inquiry should help inference into strategic resource development using the SRDF based on national government and market economy characteristics.

Figure 14: High-Level Government Attributes by Country for Resource Development

Country	Government Type	Mineral Rights	Resource Development Approach	VoC Market Economy
Argentina	Presidential Republic	Provinces	Mixed	Mixed-Market Economy (MME)
China	Communist party-led state	State (National Government)	State-led	Coordinated Market Economy (CME)
U.K.	Parliamentary constitutional monarchy; Commonwealth realm	Crown Estate	Market-led	Liberal Market Economy (LME)
U.S.	Constitutional federal republic	Private, State, Federal, Indian and Tribal	Market-led	Liberal Market Economy (LME)

Source: Researcher's findings, Hall and Soskice 2001, Thomson Reuters Practical Law, Vinson & Elkins, CIA World Factbook

5.2. LMEs and the Duality of Polycentric Governance for the SRDF

This section shows how the SRDF incorporates the Government variable and its relation to Political Opportunity Structure as a local counterweight to national or state-level support for strategic resource development. While the literature suggests polycentric governance creates an opportunity to stop development at the local level, I argue that the more important duality of polycentric governance is the incorporation of Political Opportunity Structure in the SRDF brings inquiry up a level of abstraction and makes the local tactics part of broader campaigns, and not an end in themselves. This dynamic, which is a mosaic or patch-work of local opposition, is observed in New York and the U.K. in my case study in Chapter 4.

Murtazashvila and Piano (2019) argue that the U.S. bottoms-up approach to regulating unconventional development was "appropriate for the challenges arising from shale gas development". This included a

strong separation between national and state regulations as well as local permitting process. This government backdrop, which they classify as polycentric, embodies that of a constitutional federal republic with strong legal and property rights institutions, unlocked the U.S. shale experience, in their view. However, I argue, as a result of my primary research, that this bottoms-up polycentric governance model also presents significant development risks from opposition groups.

The authors highlight private property rights and the importance of institutions in probing why some economies, particularly the U.S. and Alberta, quickly responded to the opportunity presented by unconventional gas (they omit oil in their inquiry). As discussed in the theory literature review section of Chapter 3, radical innovation was achieved in the U.S. shale experience as a result of this LME structure.

The national level argument in support of polycentric governance by Murtazashvila and Piano (2019) as a preferred foundation for unconventional development builds on the Bloomington school of institutional analysis, drawing on governance work from Elinor Ostrom (E. Ostrom 1990, 2005).

However, while this governance structure creates a desirable environment for shale development in areas with regulatory regimes in place, it creates risks for ones where a fit-for-purpose regulatory regime is not in place yet. Further, local restrictions are not a clear end for Political Opportunity Structure goals, across LMEs, as evidenced in both the New York and U.K. shale experiences, as detailed by NY Fracking Opposition Leader and UK Oil & Gas Executive.

Regarding Political Opportunity Structure access points created at the state and community levels, in "The Federalism of Fracking: How the Locus of Policy Making Authority Affects Civic Engagement", Arnold and Holahan (2014) draw from Ostrom to explore why "residents of the Southern Tier of New York evidenced different levels of civic engagement than residents of the abutting Pennsylvania border region" in their response to fracking". My conversation with NY Fracking Opposition Leader in Chapter 4 reinforces this statement in his narrative on the New York fracking ban, relative to the Pennsylvania experience.

In Pennsylvania, Act 13, which was signed into law in February 2012, provided regulatory clarity for unconventional development, including permitting, zoning, fees, and other critical regulatory particulars (Pennsylvania General Assembly 2012). Murtazashvila and Piano (2019) argue Act 13 was an "effective response, and arguably efficient".

The New York experience in this manner (as juxtaposed to the Pennsylvania one), is similar to the U.K. experience, in that a fit-for-purpose regulatory regime was not put in place in time and ahead of meaningful opposition pressure. “Citizens in New York, where meaningful fracking policy-making authority rests with small local jurisdictions, evidence more civic engagement than citizens in Pennsylvania, where the locus for fracking policy-making authority is a large, commonwealth-wide jurisdiction” (Arnold and Holahan 2014). However, contrary to my primary research, Murtazashvila and Piano (2019), as well as Arnold and Holahan (2014), put a significant amount of weight on the ability of local communities to impose fracking bans. Murtazashvila and Piano point to the initial shale gas development ban by the town of Dryden, New York, with a population of around 13,500, and the decision being upheld by the state’s court of appeals in 2014, that “communities are within their rights to ban fracking”.

It is unclear as to how this can be interpreted and upheld more broadly with power residing with the state. There can be exceptions by resource, technology, type, state, and local community, making systematic inference challenging, if not possible at all. Further, the literature and my primary research shows Murtazashvila and Piano (2019), as well as Arnold and Holahan (2014) could have overstated the strategic importance of local bans as it relates to broader opposition efforts.

As such, the SRDF considers local actions as part of a mosaic for broader strategic resource development, and my primary research shows what they were actually intended for: as a tactic. As such, on an individual basis, these pre-emptive individual bans are not all that important from a broader strategic perspective. However, when taken together, they create an effective mosaic that can be part of an opposition campaign made available by polycentric governance.

The first-hand account on the New York experience in its entirety, from the perspective of the opposition organizer, NY Fracking Opposition Leader shows how local bans were a matter of legal tact, presenting a development delay, and may in-fact actually be counter to the state’s commitment to its grassroots home-rule government ethos (Harvard Law Review 2014).

Primary research into the U.K. shale experience reinforces this and shows the transferability of this dynamic across LMEs within the SRDF.

In the U.K, UK Oil & Gas Executive details and traces back the fracking ban to industry moving ahead with development before a fit-for-purpose regulatory regime was put in place in the country. UK Oil & Gas Executive shows how Cuadrilla appealed local bans to the regional authority, which were overturned, also highlighting the limited local effectiveness of bans within LMEs for the SRDF.

NY Fracking Opposition Leader's practitioner viewpoint of the local fracking bans his organization helped proliferate in New York was more about creating a mosaic across communities throughout the state to provide a "political counterweight" at the more meaningful state senatorial and Gubernatorial level.

In effect, these local resolutions presented warnings to industry from the front-line communities of potential logistical issues (as NY Fracking Opposition Leader notes localities could provide through-traffic and transportation challenges) and re-election warnings to pro-development state senators representing anti-fracking towns and villages.

Further, NY Fracking Opposition Leader clearly articulates that the bottoms-up collection of local no-fracking resolutions across New York state was part of the means to achieving a more robust and long-lasting outcome. As such, Murtazashvila and Piano's focus on New York state as having a "home rule that allows local governments to regulate economic activities, provided that the state does not decide to regulate those issues" (Murtazashvila and Piano 2019)

Simonelli's (2014) research reinforces this argument. Regarding the local New York fracking bans, Simonelli stated, "Resolutions did not carry the risk of retaliatory lawsuits, could be adopted more quickly than actual moratoria or bans, and served as a vehicle for public education and political momentum building".

This experience shows how local governments in New York utilized home rule for broader policy objectives and reinforces NY Fracking Opposition Leader's objective of creating a patch-work of work of local bans to ultimately drive a stronger, more meaningful, and binding ban at the state level.

As a result, this focus on the some of the institutional differences between New York state and Pennsylvania by Murtazashvila and Piano (2019), and Arnold and Holahan (2014) are not impactful in viewing the New York unconventional development experience in its entirety and deviates from NY Fracking Opposition Leader's practitioner viewpoint which was centered around the Environmental

Impact Statement as a legislative, grassroots, and media the "organizing structure". The enactment of Pennsylvania's Act 13 in early 2012 (only shortly after momentum built in the New York anti-fracking movement in 2011) provided only a small window of opportunity for an effective anti-fracking response in Pennsylvania prior to this fit-for-purpose policy mechanism being put in place. Hedding (2017) shows how "Similar to New York, fracking was also covered sporadically in Pennsylvania prior to 2010, with a marked uptick in coverage in 2010".

In countries that have more linear power structures, typically CMEs and MMEs, unitary governance does not provide ample POS access as the result of alignment in national and local governance views and mandates, leading to potential local conflict but with limited scope for affecting change, in-turn providing more local frustration, but increasing development surety in unitary governance structures for the SRDF.

Alternatively, with national and local alignment, polycentric governance, an enabling aspect of the VoC framework within the SRDF are present, as shown by various U.S. states realizing the comparative advantage for radical innovation available to LMEs at the national level, including New Mexico, Texas, Oklahoma, North Dakota, and Pennsylvania.

In all of these cases, fit-for-purpose regulations were enacted from legacy oil and gas operations and governed by state agencies, in-line with national strategic objectives and federal environmental oversight. New Mexico, which I explore more closely, presents a unique case for balancing local and national objectives in an LME and capitalizing on its first-mover advantage, albeit in a measured way.

5.3. CMEs, MMEs, and the SRDF – "When you can control things, why can't you control things?"

In 1998, prior to the U.S. shale boom, U.S. Vice President Dick Cheney, then CEO of Halliburton told a conference, "The good Lord didn't see fit to put oil and gas only where there are democratically elected regimes friendly to the United States" (Cheney 1998).

While the statement nods to conventionally security challenged regions, like the Middle East and Africa, it also underscores the broad range of governance and policy backdrops where exploration and production takes place. However, Cheney's comment, which pre-dates the U.S. shale boom, underappreciated the unique mix of independent variables that unlocked unconventionals in the U.S.,

with the Government variable as one of the key drivers for the country, and also a key inhibitor in countries like Argentina.

Argentina Oil & Gas Consultant, seasoned Argentine oil and gas executive turned investment banker, had a spin on this for Argentina's resource rich unconventional basins, notably the attractive geology of Vaca Muerta, telling me, "The Lord has a sense of humor, and he puts (shale oil and gas) in Argentina like he put a lot of oil in Venezuela". While meant in jest, Argentina Oil & Gas Consultant's comment highlights that democratic governments, like Argentina, can also create unintended challenges for resource development that outweigh attractive geology.

Echoing some of Ikenberry's (1986, 1988) core views around the irony of state strength, Leading Energy Investor & Expert told me, "When you control things, why can't you control things?". His question, in regards to China being the only country in his view to be able to potentially replicate the U.S. success in unconventionals, highlights some of the unquantifiable benefits around the core aspects of the U.S. experience. Leading Energy Investor & Expert added, "The combination of ingenuity and free market stuff is pretty unique."

Argentina, arguably the most attractive country for development from a resource and geology standpoint, has been hampered due to government policies that have underpinned currency concerns, and institutional instability. Labor and union challenges have exacerbated this trend. China has met development with continual technical challenges, with its institutional arrangement between state and industry not solving the country's unique geological and technical challenges.

As such, the institutional arrangement between state and industry in Argentina is left with inadequate Capital Market & Market Structure options, while in China the unitary governance approach has limited foreign market participation and amplified the Geology & Infrastructure challenges. As a result, in both Argentina and China, the institutional arrangements have pushed its firm's towards corporate strategies that are more suited for the development of specific and co-specific assets.

As seen by the U.S. experience, this lacks the dynamic and innovation-based switchable assets the U.S. shale experience has benefited from, as well as the market-based carriers of this technology and secondary property entrepreneurs. As such, these CME and MME markets have lower Political

Opportunity Structure access points, as well as lower scope for radical innovation. However, the slow and steady shale production growth in these countries affirms their potential for incremental innovation.

5.4. Institutional Arrangements in CMEs and MMEs as Viewed through the SRDF – Argentina and China as Examples

In this section, I discuss some of the challenges related to Argentina and China's shale development experiences, as explored through my primary research and the Governance variable as part of the SRDF.

According to Roberto Carnicer and Ieda Gomes (2021), as detailed in a paper published by the Oxford Institute for Energy Studies, Argentina's modern natural gas backdrop can be broken down in four phases (starting with the liberalization and privatization of the industry in 1992). These are:

1) "From the restructuring and privatization of state-owned energy companies, kickstarted in 1989 through the economic and financial crisis of December 2001. During this period, Argentina was a net gas exporter
2) From the Public Emergency Law No 25,561 in January 2002 through the institutional normalization of the energy market starting in December 2015. From 2002 to 2009, government intervention in setting prices boosted demand, which outpaced supply, and the country became a net gas importer
3) From January 2016 up to August 2019, new regulations aiming at promoting investment in the development of unconventional oil and gas reserves in Vaca Muerta (Neuquén basin). During this period, domestic production increased, leading to a decrease in imports.
4) From August 2019 up to the present, marked by another macroeconomic crisis, election cycle, and recent policies implemented by the government inaugurated in December 2019".

Notably, the authors highlight, "Tight gas began to develop more actively from 2013, reaching its peak in March 2018; while shale gas growth began in 2017, reaching its peak in June 2019. However, this boom was short-lived, as domestic production, which peaked in 2019, was affected by the pandemic, lack of investor confidence and discontinued price incentives".

My first-hand accounts with industry participants, including company representatives, financiers, consultants and a community relations executive at YPF reinforce the post 2019 period of macro-driven

industry frustrations and tell the story of a resource rich country too riddled with political and economic challenges to properly capitalize on its unconventional natural gas riches.

UK Oil & Gas Executive played a leading role in his firm's expansion into international shale markets in 2008-2010 and discussed the firm's decision to forego opportunities in Argentina due political risk as part of the firm's global shale diligence process. UK Oil & Gas Executive told me, "We really liked the geology and lots of things around the Neuquén Basin, it's a mature oil and gas basin, you've got infrastructure, but we just couldn't live with the political risk in Argentina in that period".

This point is reinforced by Argentina E&P Executive, with a specialization in distressed debt, and significant operating experience in Argentina shale as he was controlling shareholder and Board Member in an independent Argentine E&P. Others echoed this sentiment.

As such, several interviews include similar comments and concerns that much of Argentina's natural gas resources would not be developed ahead of the global transition to renewable energy resources, resulting in much of the country's unconventional asset-base becoming stranded resources. The vast majority of these frustrations were expressed highlighting anecdotes related to currency controls, unions and labor challenges, and the inability to access meaningful development capital due to foreign investor concerns in Argentina's political economy.

5.5. Labor and Institutional Arrangements

Regarding labor, my interviews showed the prominent role of unions, as well as other forces in play at the province level, has led the national government to install price controls that provide downside price protection for producers while capping upside and protecting consumers. Hall and Sockice (2021) argue that "Since many firms in CMEs make extensive use of long-term labor contracts, they cannot rely as heavily on the movement of scientific or engineering personnel across companies, to effect technology transfer, as LMEs do".

This is certainly the case in Argentina, where unions hold outsized power, particularly relative to the U.S. example. Multiple interviewees discussed how challenging labor unions made operating in Argentina, particularly during industry downturns, where companies "can't fire", and "you have to keep on paying their salaries for them to stay home", as Argentina Oil & Gas Consultant states. This is in contrast to all

U.S. states (except Montana), which are “employment at-will”. At-will generally means “an employer can terminate an employee at any time for any reason, except an illegal one, or for no reason without incurring legal liability. Likewise, an employee is free to leave a job at any time for any or no reason with no adverse legal consequences” (NCSL 2008).

The institutional arrangement between labor and firms impacts corporate strategy and inter-company relations for LMEs and CMEs. The fluid labor markets for LMEs leads to technology transfer taking place “In large measure…through the movement of scientists and engineers from one company to another (or from research institutions to the private sector)”, Hall and Soskice (2001) argue.

As such, intellectual property rights take on increased importance against this fluid labor market backdrop, with firms in LMEs aiming to protect the outcome (IP) of the investments (labor) within this fluid market context. According to the International Property Rights Index, “The USA is leading the world in terms of protection of Intellectual Property Rights” (Property Rights Alliance N.D.). Alternatively, CMEs leverage collaborative research arrangements coordinated by state institutions, which state companies can leverage. In the U.S., Hall and Soskice point to collaborative research amongst firms being an antitrust risk, leading to low collaborative research investments and efforts.

Inter-industry competition coupled with a fluid labor market has been a defining characteristic of the U.S. shale experience. Affirming Hall and Soskice (2001), Leading Energy Investor & Expert highlights how this has played out in practice over the U.S. shale development cycle. Leading Energy Investor & Expert told me, “you’ve seen people stolen away from the big companies, so the transfer of technology via the people, and then you saw a dramatic expansion in capacity, I got to get there first instinct on that”.

As such, the institutional arrangement between labor and firms is highly relevant for the impact on the type of comparative advantage LMEs, CMEs, and MMEs are pre-dispositioned to. For LMEs, the highly fluid labor market coupled with strong IP rights encourages radical innovation. For CMEs, the long-term social contract between labor, firms, and the state, is a form of patient capital that can lead to specialization and carries a comparative advantage for incremental improvement. This dynamic also supports LMEs’ advantage for switchable assets and CMEs’ advantage for specific or co-specific assets.

In the highly cyclical and volatile oil and gas markets, the impacts from labor markets are amplified, as companies in CMEs and MMEs are not as able to respond to market signals by reducing workforce. In

discussing NOCs, which dominate the Chinese oil and gas industry, Marcel (2006) argues, “NOCs are by statute, organization, and often affinity more responsive to the needs of society and the interests of the state”. As such, NOCs rely on state institutional capacity for support and to uphold the firm’s social license objective as it relates to labor, with meaningful impacts on company strategy, structure, objectives, and capabilities.

Global Oil Service & Clean Energy Analyst told me that the impact of market structure on labor in the U.S. plays a negative role in overall stability and long-term industry health in some ways, but also supports in others. The volatility and associated relative job insecurity in the U.S. oil industry as a result of a highly fragmented and cyclical industry has adversely impacted the labor force and has dissuaded new talent from entering the industry, in Global Oil Service & Clean Energy Analyst’s view. Global Oil Service & Clean Energy Analyst told me, “if we can remove some of that volatility from the industry to a better market structure, then we would have a better, I think overall labor force, a better productive, competitive environment and better profitability for stakeholders.”

In Argentina, strong unions make it highly challenging for companies to react to commodity price volatility with employee headcount reductions. Argentina Oil & Gas Consultant told me, “if you hire an employee, you’re adopting a son”, adding “you can’t fire them”.

Further, this patient capital, state support, and social license enables NOCs to view risk and return differently than LME counterparts, which are bearing the costs of labor as part of ongoing operations and through private invested capital. For example, Marcel argues that the two largest Chinese NOCs, Sinopec and CNPC, are “willing to take bigger political risks and lower returns” (ibid).

For the SRDF, this institutional arrangement between labor and firms is apparent in the literature and my primary research, and affirms Hall and Soskice’s argument around comparative advantages. For future inquiry, this shows how researchers can infer outcomes for strategic resource development utilizing the SRDF and how the specific Government variable influences outcomes.

5.6. Market intervention & Institutional Arrangements

Regarding market intervention and price controls, the institutional arrangements between Government and markets plays a meaningful role on resource development, as seen through the SRDF. Of the countries studied, this is most apparent in Argentina, as shown by my primary research.

For MMEs, like Argentina, there is a risk of being caught in the middle as it relates to the institutional arrangement between Government and capital markets, with less institutional support than firms operating in CMEs and less dynamic and fluid capital markets relative to LMEs.

Hall and Soskice argue "the principal problem facing policy-makers is…inducing economic actors to cooperate more effectively with each other". In CMEs, this is not much of a challenge, due to a small group of state-owned companies (as is the case in the Chinese oil and gas industry), and "patient capital" that is aligned with state objectives (ibid). However, in MMEs, where quasi-state owned companies operate in-concert with a more fragmented private industry landscape, the SRDF shows that there are risks to realizing the drawbacks of both CMEs and LMEs, as is the case in Argentina.

Argentina E&P Executive detailed the first-hand unintended consequences of government intervention in currency and capital markets in the Argentine oil and gas sector to me. However, while welcoming the price controls in Argentina, Argentina E&P Executive highlighted the operating challenges related to government and macro considerations and conditions, including regime change, high inflation, its effect on the peso, getting capital in and out of the country, as well as investor concerns over defaults.

Oil prices being pegged to the dollar provides support to oil producers, as drops in the peso allow for cost savings while still being paid in dollars. However, this price pressure for service companies during peso devaluation periods could adversely impact service sector stability. Negotiating contracts for equipment and services requires additional consideration as to currency and payment particulars in the event of peso volatility or commodity price swings.

Former Development Bank Energy CIO argued to me that Argentina's domestic oil and gas industry troubles are built on the various issues born out of Cristina Kirchner's administration, which spanned 2007 and 2015, and was charged with corruption and found to have "worked with others to skim nearly $1

billion from fake contracts and bogus construction of 51 public works projects when she was president" (Kahn 2022).

As detailed in the Resource Curse section of the literature review (Chapter 3), in countries where development moves ahead of fit-for-purpose regulatory regimes being put in place and with weaker institutional capacities, the risk that "full market economies" are not properly developed and resource revenues overwhelm the economy and political system is high, potentially leading to the Resource Curse and systemic corruption.

In Argentina, my primary research shows these issues still linger today. Former Development Bank Energy CIO described the industry and government interconnection and history to me, "It's a pretty bleak picture, unfortunately, but it's been ever since the previous Cristina administration. The extent that really put a massive spanner (wrench) in everything, like when Christina Kirschner arrived and nationalized YPF and all the corruption attached to it and the sector kind of survived and the debt capital markets survived, but propped by the oil price. When the oil price crashed even into a new Marcri government, which was much more pro-business, essentially, that had stripped so much that it was really, really hard to recover".

Argentina's Hydrocarbon Reform Law, promoted by President Kirchner and passed in October 2014, shifted regulatory authority for oil and gas development to the federal government, increased concession durations, and reduced government take. These moves were welcomed by the oil and gas industry and helped attract foreign investment during the time (Gyras and Maqueda 2014). The amendment essentially overturned a 1992 ruling that split hydrocarbon governance between the federal and provincial levels, removing provinces' control of overseeing and granting permits on their territory (Borderes, Parravicini, Varela 2014).

Following this, today ownership and regulatory oversight is split between the provinces and federal government, respectively, in Argentina (Vinson & Elkins 2018). Importantly for shale development in Argentina, the 2002 national water law requires oil and gas companies to obtain a permit from local authorities for source water use (for fracking wells) and to discharge wastewater into water bodies, giving local communities an important point of access in the political process.

While macro-economic issues are the main challenge to development in Argentina, there have been some welcome improvements by the government in recent years that have provided clarity to developers and

investors. Argentina E&P Executive points to the standardization of a number of key aspects of the sector, including concessions and royalties, both of which have been largely standardized across provinces, versus previously managed on an "on-off" basis.

Argentine national environmental regulations were dropped to garner Provincial support (Gamper & Saulina 2018). As a result, provincial governments maintain substantial power over environmental and water issues. However, both the federal and Provincial governments have been criticized for not upholding regulations and giving local and indigenous communities a voice in the political process (Gamper & Saulina 2018). I make this apparent in Chapter 4 on Political Opportunity Structure through my primary research.

Further, in the Neuquén Province, home to the prolific Vaca Muerta formation, a 2012 rule established the procedures for oil and gas companies to receive environmental license necessary for operations, and established the requirements for source water and wastewater management (Saulino 2018 and Martinez, De Hoz, & Reuda N.D.). Retired Argentina Oil Executive highlighted to me an encouraging mix of supportive local and province-level governments towards development in Argentina with industry having strong environmental goals and track records.

Regarding state strength, Leading Energy Investor & Expert noted, "In theory, China has all the money it wants. It can grab whatever it wants, it can take the resource, and it ought to be able to pay for everything that it doesn't have, so it ought to be able to import technology and people, it ought to be able to grab the resources and have the money to do it".

To encourage development, the Chinese government has set a series of production targets as part of its national strategic planning. According to the Ministry of Land and Resources, "failures to fulfill some targets in 12th Five-Year Plan", introduced in March 2021, "were primarily attributed to the slowdown of oil and gas consumption growth, sharp drop of oil price, downgrading of resources, and changes of statistic basis under the new normal" (Jiping, Yu, Luxin 2016).

Despite lowered expectations from the 12th Five-Year Plan, the Central Government continued its broad support to promote gas use and development with the 13th Five-Year plan. As a result, the Government set a goal of producing 30 billion cubic meters of shale gas by 2020 (Xiaochun M, Yinan G 2015). While China's production targets have been missed, the country's continued progress and production growth

represents its slow and steady march towards shale development, somewhat similar to Argentina's measured path forward.

Leading Energy Investor & Expert continues, "So countries that fall into that category ought to be able to do it. But the problem is the system, the mindset of the system doesn't work that way, and so I think if you look at the resources, there's a number of places that ought to be able to do it if they wanted to." However, the SRDF shows that it takes time for CMEs to develop strategic resources, particularly when the Geology & Infrastructure variable is challenged. Wei et al. (2022) highlight how China's complex shale resources have led to longer-than-expected resource development. They state:

> "At present, China has basically mastered the key technologies of geophysics, drilling, well completion and fracturing for shale gas development shallower than 3500 m. However, the technology and equipment for shale gas development deeper than 3500 m has not yet broken through. About 65% of China's shale gas resources are more than 3500 m deep, and long-term technological innovation and practice are still needed".

This shows how the institutional arrangement for China's Government variable can conflict with its Geology & Infrastructure variable within the SRDF, and provides it with a comparative disadvantage of radical innovation. However, the country's production results show that while development is taking longer than expected, it is still moving forward. China missed its 2020 shale gas goal of 30 bcm by roughly one-third, but slow-and-steady production increases represent a "credible performance", (Thompson 2021).

Leading Energy Investor & Expert's argument echoes Ikenberry's irony of state strength theory again by pointing out that China has not been able to successfully develop its unconventional gas resources (Ikenberry 1986). Ultimately, Leading Energy Investor & Expert says he "blame(s) the bureaucracy, not the assets." However, the SRDF shows that Thompson's assertion of China's "credible performance amidst the challenges shown by Wei et al. (2022) show that China's Government institutional arrangement for shale development provides a comparative advantage incremental improvement.

Argentina shares with China the will and state-led strategy to develop unconventionals; however, inequality in Argentina has created a polarizing political landscape, according to Argentine Oil & Gas

Investor, which has created a political pendulum and challenged financing and development conditions. This has led to protectionist policies by the Argentine government as it relates to the oil and gas sector.

As such, Argentina as an MME exposes itself to a downside of CMEs (by having an institutional arrangement with labor that provides a long-term contract, which presents challenges during commodity market volatility) and a downside of the LME model (absence of state-led institutional support and patient capital). As a result, this political pendulum in MMEs presents a major market challenge, as seen in the case of Argentina when viewed with the SRDF.

For capital intensive and technically challenging shale development, Argentine Oil & Gas Investor highlights the impact of these socialist underpinnings on development. He stated, "the challenges when you get very protectionist, when you get very socialist, what happens is you pivot away from allowing others to come into your country and you essentially say we can do this on our own and it's going to be for the full benefit of our people".

Retired Argentina Oil Executive attributes Argentina's tight control on its domestic energy industry, including the inclusion of commodity price controls, to its reliance on natural gas for domestic energy consumption, which stood at around 55% in 2020 (versus 8% in China in 2020, and 40% in the U.K. and 34% in the U.S. in 2021), as illustrated in Chapter 2. As a result of Argentina's high domestic natural gas consumption, Retired Argentina Oil Executive told me that the price of natural gas is felt in every aspect of economic activity throughout the country.

Argentine Oil & Gas Investor notes that "the governing of the country has oscillated between socialist powers and more capitalist powers, over time". He added, "Problem is, you've got a country where 50 percent of the country lives in Buenos Aires and its environs and is generally much more well-to-do than the people that live in the other 50% of the landmass, which is gigantic, and so when the government says we're going to go it alone, they have very little beyond their own balance sheet to go ahead and succeed". As such, Argentine Oil & Gas Investor highlights that Argentina's Government variable makes the country's oil and gas industry subject to the drawbacks of the CME model, but without the corresponding patient capital and without the benefits of the LME model (dynamic capital markets and fluid labor markets).

Argentine Oil & Gas Investor adds, "And at some point, that balance sheet runs out and it's run out many times…in terms of defaults by the country". As discussed in the Geology & Infrastructure and the Capital

Markets chapters, this government backdrop has discouraged capital from entering Argentina and inhibited shale infrastructure development.

Government transparency, stability, and support are important considerations for infrastructure investors, Argentine Oil & Gas Investor highlights and stated, “infrastructure is usually a pretty safe, low yielding type of investment”. He added, “And you usually need big dollars that can safely bet on the fact that they are going to be able to get their money back. And what I mean by that is that there’s not going to be a government that’s going to overturn, export of dollars or earnings, [or] that there’s going to be all sorts of capital controls that come into place that don’t let profits leave the country, and Argentina has been very bad at that over the years”.

As such, Argentine Oil & Gas Investor highlights that in order to “go it alone”, intentionally or unintentionally, countries need the financial wherewithal to do so. In contrast to MMEs, as shown by Argentina, well-backed state sponsored companies in CMEs, like China, including PetroChina (CNPC) and Sinopec, are well positioned to drive development on their own balance sheets. Patient capital and coordinated research efforts provide strong foundations for NOCs in China with a comparative advantage for incremental innovation.

As noted in Chapter 2, the Chinese government has supported unconventional gas development as a means of reducing pollution and switching baseload power from coal to natural gas, and as a means to “increase the proportion of natural gas users in cities” (Central Committee of the Communist Party of China 2015). This government support has been unwavering, and the “credible performance” results, made possible by its CME government arrangement, are being realized today.

Despite all of this, similarly to China’s slower than expected start and missing production goals, as well as various periods of false starts, Argentina has steadily grown shale oil production since 2019 and shale gas production since 2021. As such, Argentina’s MME government institutional arrangements have hampered development, but provide a backdrop that allows for continual development, but does not provide the level of patient capital institutional support as China’s CME government institutional arrangement provides. This can be seen with the SRDF and can be used for future strategic resource inference for CMEs and MMEs.

5.7. Collaboration and Conflict between state, local, and federal governments:

The extent to which governments and governance are structured as polycentric or unitary is important for the SRDF. This can be most seen through collaboration and conflict at the national, state, and local levels. Importantly, the more divergence in national and local viewpoints amidst polycentric governance, the more scope for Political Opportunity Structure access points to impact development. All four of the countries studied show different aspects of this concept, as viewed through the SRDF.

In Argentina, there is a strong local support and government capacity for development, according to Retired Argentina Oil Executive. However, the national government is more of a concern for development, largely due to negative unintended consequences from populist policies, including currency and commodity price controls. Notably, the benefits of government support are offset on the national level with price caps that protect consumers and union support that make it highly challenging for companies to lay off employees.

The NOCs that operate in China's oil and gas industry enjoy the benefits of unitary government and alignment in governance views as it relates to strategic resource development, the literature and my primary research shows. As such, the SRDF shows that strategic resource development within CMEs with unitary governance are at low risks of development delays and bans, as can be a high risk within LMEs with unitary governance when a fit-for-purpose regulatory regime is not in place.

In China, Environmental oversight is conducted by the Ministry of Protection (MEP), which is the country's main environmental protection agency. The MEP oversees the regulatory and environmental assessment process, known as the environmental impact assessment reports (EIA), which have been criticized as a "relatively weak regulatory tool and may not in its current practice meet its stated goal to identify potential environmental and social impacts (Lin and Gamper 2018). This compares to the U.S., U.K., and Argentina examples, all of which have the key regulatory oversight at the state or regional levels. By specific contrast, the New York state organizing mechanism for the opposition movement was the state-level Environmental Impact Assessment. The comparable mechanism being at the national level in China highlights the narrower POS access points.

5.8. New Mexico – Balancing Local and State Considerations; Climate, Economics, and the SRDF in a Left-Leaning State

Many similarities and differences are present in the New Mexico and New York experiences. In my interview, New Mexico Cabinet Level Secretary highlights some of the key considerations facing policy-makers, industry, environmentalists, Indigenous People, and local communities in New Mexico.

New Mexico Cabinet Level Secretary highlighted to me his department's mandate of fulfilling the Governor's executive order of focusing on climate change and reducing carbon emissions, despite the unfolding boom in oil production growth within the state (as the northwestern portion of the oil-rich Permian Basin dips into southeast New Mexico).

As a result, his department is working on "setting aggressive carbon limits for emissions, working on ensuring that we have the right building codes in place, looking at the contribution of motor vehicles to our environmental goals and sort of setting the policies and rules in place that would incent and move us in that direction."

This highlights how New Mexico represents a unique oil-rich case study for this analysis in that it differs in political makeup from the other oil-rich U.S. states (notably right-leaning Texas, North Dakota, and Oklahoma which are three of the four leading oil-producing states in the U.S., with New Mexico second behind Texas).

Further, several key elements of the New Mexico unconventional development story are also important to highlight, including environmental and institutional mistrust related to Indigenous people and other marginalized and underrepresented groups, rural poverty, and a very arid environment.

In regards to the amount of oversight and regulations, New Mexico Cabinet Level Secretary noted, "it's somewhat of a David and Goliath story that the states and the Feds will never have enough resources given the breadth of the oil and gas industry". He continues, "we will never be able to check on every dollar, flange and connecter will never be able to check on every barrel of produced water. We'll never be able to check on every leak that's alleged to us or every whistling valve that a neighbor or farmer hears. We just won't be able to do it, and I think we have to have smarter, more efficient regulations and incent the right objective."

New Mexico Cabinet Level Secretary highlighted that “New Mexico has some historic problems with education, early childhood education and health.” New Mexico Cabinet Level Secretary added, “we’ve been traditionally a poorer state, and we need to fix a lot of that, and when 40% of your revenue comes from the oil and gas industry, diversifying the economy is really important to us.”

However, New Mexico has been able to escape the oscillating political pendulum Argentina has experienced. New Mexico Cabinet Level Secretary highlights that “it doesn’t mean that we do that overnight” (meaning transition its economy and move away from fossil fuels overnight), but rather that the state builds “in a way that is just and fair to not only New Mexicans, but our indigenous populations and our sovereign nations, like our tribes and Pueblos”. This is a delicate balance with high-stakes for the state considering the portion of the state budget generated from oil and gas.

Building on this, New Mexico Cabinet Level Secretary noted the interesting balance that the state aims to strike between its left-leaning environmental values and its economic dependency on hydrocarbon production. “40% of our economy is driven by the oil and gas sector”, he stated. “So we don’t see that as being mutually exclusive, and moving into a direction that incents greener production of oil and gas, a move towards renewables”.

New Mexico Cabinet Level Secretary’s unique role of actualizing progressive energy policy in an oil and gas rich state is clear and match New Mexico Cabinet Level Secretary’s personal view of the importance of a just energy transition as well as the states policy actions through passing the Energy Transition Act, which establishes a number of aggressive state climate goals, including a statewide renewable energy standard of 50% by 2030 and zero carbon resource standard by 2050.

He added, “We need to be looking holistically at our policies and regulations, talking to our neighbors and working on the common airshed New Mexico, New Mexicans and Texans breathe, but when you expand that philosophically out, we also need a very strong federal government who is supportive of states. Maybe setting a baseline and then allows states to have the innovation and ability to work hand in hand with other states to solve problems.”

New Mexico Cabinet Level Secretary said, “My values drew me to this role is that I don’t believe that you can sort of move in an energy direction absent protecting public health in the environment.” New Mexico

Cabinet Level Secretary added, “How do we protect our natural resources as we use our natural resources to our benefit?”

New Mexico’s energy policy stance and New Mexico Cabinet Level Secretary’s central question about the energy transition and state’s policies are reflective of New Mexico’s unique place and position as an oil-rich left-leaning state, as well as the state’s experience balancing its environmental political ideology with its budget realities.

As a result, New Mexico could represent a roadmap for future governments trying to balance environmental and economic policy in resource development with left-leaning constituent bases. As such, New Mexico’s Energy Transition Act can be seen as an example of establishing a regulatory framework to balance state goals with its fragmented polycentric stakeholder base.

New Mexico offers insights for future research as it relates to countries and states aiming to balance resource extraction or energy development with strong or polarizing local environmental and economic stakeholder views and considerations. As such, it acts as a unique case for inferring strategic resource development outcomes in LMEs with polycentric governance.

5.9. Royalties and Mineral Ownership Considerations for the SRDF

In the U.S., mineral rights span private, state, federal, and Indian and Tribal ownership. Murtazashvili and Piano (2019) argue that institutional property rights were a leading cause of the U.S. shale gas development experience. They state, “In the idealized world of economics, people contract for property rights when there are opportunities for Pareto improvements”.

However, they note that “Government rarely has the information to decide on the best property institutions”. This provides an opportunity for actors (individuals or firms, as shown in Chapter 3). Further, Murtazashvili and Piano argue that “polycentric governance is more likely to result in a more efficient system of property institutions” (ibid).

The U.S. shale experience affirms this argument, as shown in the literature review. Murtazashvili and Piano add, “These fundamental perspectives suggest that entrepreneurs are the fundamental force behind innovation, but that incentives of entrepreneurs depend on the institutional context, especially private property rights and market institutions, and that politics can and does influence these incentives”

(ibid). As such, the U.S. case shows that polycentric governance provides a compelling Government backdrop to support strategic resource development through institutional property rights. As such, the SRDF provides researchers a tool to infer how resource development in LMEs might be impacted by institutional property right considerations.

In China, all minerals and natural resources exploited are property of the state, despite any transfer of ownership or rights to land from which the resources are attached (PRC 1986). This right "is exercised by the State Council" (PRC 1986). A challenge for oversight and a regulatory gap is "the lack of an overarching sole regulator over the industry" (Deemer, P, Song, N 2014).

The main governing bodies, which often have overlapping authority and responsibility, are the National Development and Reform Commission (the NDRC), the Ministry of Land and resources (MLR), the National Energy Administration (the NEA) and the Ministry of Commerce (MOC) (Deemer, P, Song, N 2014). This is in addition to the National Energy Commission (NEC), which was established in 2010, and which I discuss in greater detail in Chapter 6 in relation to China's oil and gas Market Structure.

On December 3, 2011, the MLR deemed shale gas an independent mineral and outlined regulations for its development, ending a power-struggle between the MLR, which typically governs mining, and the NDRC, which oversees conventional production. Less than a month after the announcement of shale as an independent mineral, the NDRC and the MOC announced a new directive which classifies industries in three foreign investment categories labeled "encouraged", "restricted" or "prohibited", with shale development conducted with a domestic partner "encouraged" (Ministry of Commerce, People's Republic of China 2012).

Both bodies govern resource development similarly with a local commercial partner necessary for foreign partners, but with the MLR leaning towards joint ventures and the MLR favoring production sharing agreements (PSAs)[1], which are more prevalent in mining and oil and gas, respectively (Lin and Gamper 2018). However, there still remains uncertainty from international stakeholders related to overlapping

[1] PSAs allow a foreign operating partner to receive a set share of production, typically above a certain target, as compensation for investment and operating risk. They differ from joint ventures which typically create a shared ownership vehicle for all production.

regulatory mandates as “China now has at least seven ministerial level agencies involved, without a clear division of responsibilities” (ibid).

Criticism of the regulatory architecture includes concerns that oversight has overemphasized financial incentives relative to environmental oversight (Sandalow et al 2014; Lin and Gamper 2018). Subsidies were established for shale gas in November 2012 by the Ministry of Finance and National Energy Administration.

In Argentina, attractive royalties at the regional level have left oil and gas producing regional governments supportive of industry, and often at odds of national monetary policies, including currency controls and price caps, which dissuade development and adversely affect production, as discussed in the Capital Markets & Market Structure chapter.

For example, in November 2022, Fitch Ratings stated “LRGs (local and regional governments) in Argentina operate in a context of a weak institutional revenue framework, high expenditure structures, tight liquidity and FX risks”, in explaining the Province of Neuquén’s credit risk profile as “vulnerable” (Fitch Ratings 2022).

Further, Argentina Oil & Gas Lawyer highlighted to me the balanced support for development between the national and the ten regional governments in hydrocarbon producing provinces. He noted that the two sides endeavor to achieve balance between national export taxes and regional production taxes, to provide ample economic incentives to both sides. Alignment between national and local government and stakeholders generally was a recurring theme of my primary research, despite the polycentric governance structure of Argentina’s LME.

In the U.K., as a constitutional monarchy with strong local government institutions, the U.K.’s Government Independent Variable presents two meaningful challenges for shale development: 1) the majority of royalty proceeds from shale development are directed to the Crown Estate, and 2) local government institutions aim to strongly represent constituents.

As Integrated Oil Energy Analyst told me, the private landowner and community compensation profile in the U.K. does not provide landowners and local stakeholders as much of an incentive to support fracking as in the U.S., despite some efforts to try to ameliorate and align incentives.

Following lackluster local enthusiasm, the U.K. government introduced a new compensation package in 2013 which would compensate communities £100,000 per site and a 1% production royalty (UKOOG 2013). As a result, local landowners are compensated collectively but cannot expect to participate in the financial upside personally of any windfall profits associated with unconventional development in or around their private land or in the community. As highlighted in Chapter 3, property entrepreneurs were key market participants for the U.S. shale experience.

However, as Integrated Oil Energy Analyst pointed out, "in the UK, anything below the ground is owned by the government and by the Crown." She adds this "makes it very difficult to be able to access those resources." The need for alignment of interests between national government and local stakeholders, notably local landowners and community members where the development is taking place, is most notable through the UK experience.

This misalignment is important as governance has been posited as the "most critical domain to bring about changes that improve the management of underlying risks" of shale development (Lozano-Maya, 2016). However, ultimately though, it is believed that "financial compensation, on its own, is incapable of tackling these issues comprehensively and effectively", with NIMBYism playing an important role in the areas where development has been proposed (Coelho 2014).

The New York shale development experience reinforces this view; however, the New Mexico experience shows the impact of incentives. The difference in these cases, considering similar property rights, could be a matter of having a fit-for-purpose regulatory regime in place prior to meaningful development commencing, which New Mexico enjoyed but New York did not. More research on the juxtaposition between the New York and New Mexico shale experiences is recommended for future research.

5.10. LMEs and Polycentric Governance as Viewed Through the SRDF; How Polycentric Governance Impacted the U.K. Shale Experience

Of the countries studied, the U.K. has the most similar polycentric political economy to the U.S. Further, the strong national government support seemingly positioned the U.K. for unconventional development. However, some critical shortcomings relative to the U.S. example impeded development and presented challenges to the country's potential ability to develop unconventional resources.

The U.K. has a long history with resource development, including in a vibrant coal industry leading up to World War II, and more recently a robust offshore oil and gas industry in the North Sea. As a result, the country has strong institutions and regulatory experience for shale development. This mirrors the U.S. experience. The U.K.'s energy regulatory landscape is between national and local governing bodies, with national regulations ensuring uniformed safety and environmental standards, and local governing bodies ensuring operations are compatible with respective community nuances and norms.

Substantial national regulatory measures were put in place as part of the U.K.'s shale development efforts; however, these were ultimately fruitless without a corresponding local fit-for-purpose regulatory regime put into place, as Chapter 4 highlights. The U.K. shale experience in many ways was characterized by regulatory responses to local development, positioning it to continuously play catch-up instead of establishing a "fit-for-purpose" regulatory regime and then provide corresponding oversight.

In May 2011, the Energy and Climate Committee published a report that concluded shale gas extraction did not pose a significant risk to water supplies if operations are conducted properly, and that any risks to underground aquifers stem from well construction and integrity issues (House of Commons 2011).

However, one month before the report's publication, a 2.3 tremor occurred in Blackpool in the aftermath of fracking operations by Cuadrilla, with another following one month later; both of which the British Geological Survey deemed were in relation to the fracked well (DECC 2013).

This event led to an 18-month moratorium on fracking, which was overturned in December, 2012 (Twidale 2017). The lifting of the moratorium following what was viewed by some as a short review process was criticized at the local level and cited as an example of the national government's bias for development, as detailed in Chapter 4 (Vucmanovic 2012).

As part of the Energy Security Act 2016, the Oil and Gas Authority (OGA) was transformed from an executive agency to an independent agency charged with governing the oil and gas industry (Dann and Hadrill, 2017). While this move had more to do with maximizing economic efficiencies from production in the UK's continental shelf, it had supportive implications for the still nascent unconventional oil and gas industry.

The Office of Unconventional Gas and Oil was formed in-concert with the lifting of the moratorium, and was charged with "encouraging and overseeing energy development in the UK" (OUGO 2018). As part of the Energy Security Act 2016, the Oil and Gas Authority (OGA) was transformed from an executive agency to an independent agency charged with governing the oil and gas industry (Dann and Hadrill 2017).

However, any supportive national measures were overshadowed by the local realities in Preston. Notably, Integrated Oil Energy Analyst stated, "one of the things that the Energy Department did at the time that was effectively block, they put in place a limit about the earthquakes, that seismic activity that could be measured", as detailed in the Political Opportunity Structure chapter. In addition to slowing operations, as discussed in Chapter 4, it quelled any addition investor or industry interest.

Integrated Oil Energy Analyst noted the impact to investor sentiment that this policy decision (limiting seismic activity had), stating, "as soon as that went in and the investor was looking at, well, can you realistically get development with that limited seismic activity, it's unlikely, and therefore, the attractiveness of it by itself fell."

Local opposition at every turn outweighed national support, and ultimately led to divestment and new moratorium, and fracking being banned in 2019 (but briefly overturned in 2022 as a result of high natural gas prices).

One of the key lessons learned from the U.K. shale development experience were the risks of moving too fast in developing resources of national strategic importance without a fit-for-purpose local policy framework, as detailed in the Political Opportunity Structure chapter, a key argument of the SRDF for polycentric governance in LMEs. This provides a critical case to draw from for future inference into strategic resource development in LMEs.

5.11. Chapter Conclusion – Government in Focus for the SRDF

In this chapter I showed how the Government Independent Variable within the SRDF creates "institutional arrangements" with the other Independent Variables, ultimately impacting resource development outcomes across different market structures, building on Hall and Soskice (2001). I showed this by drawing from my primary and secondary research on shale development as a case study for the SRDF.

A few of the notable ways the Government variable impacts the other SRDF variables through institutional arrangements are: 1) through labor arrangements, 2) through institutional support (ie., patient capital), or a lack of it and support for dynamic and fluid capital markets, 3) through governance structure (polycentric or unitary), and 4) through property rights.

I discussed the institutional arrangements with each of these sub-components of the Independent Variables and showed how they impact the Government variable and ultimately various market economies comparative advantage for strategic resource development.

As such, my primary research shows that the U.S. shale revolution unfolded with highly fluid labor arrangements, dynamic capital markets, polycentric governance, and with strong property rights. However, my research also shows that the "duality of polycentric governance" for the SRDF risks resource development when local and state (or regional) views are not aligned, due to Political Opportunity Structure access points ahead of a fit-for-for-purpose regulatory regime being enacted.

The Government Independent Variable is a critical component of the SRDF, providing the underpinning mechanism for institutional arrangements (to draw from Hall and Soskice), for some of the most critical ways various market economies approach strategic resource development, and with impacts for their comparative advantage to develop resources. As a result, future researchers should consider how the Government variable sets the stage through institutional arrangements when utilizing the SRDF across countries, technologies, and resource bases.

Chapter 6: Capital Markets & Market Structure

6.1. Introduction

In this chapter, I show how various market economies have different institutional arrangements between the state, capital markets, and industry. For strategic resource development, these institutional arrangements provide actors the ability to organize capital in support of national objectives and individual interests. My primary research includes interviews with industry participants spanning the energy and natural resource investment community. This data builds on the secondary research on the Capital Markets & Market Structure variable that shows how the U.S. capital market system was critical to the country's shale development success, and how Capital Markets & Market Structure have impacted the International Sample Set.

As a result, in this chapter, I argue that the dynamic nature of LME capital markets was a key contributor to U.S. shale development, and underpins LMEs' comparative advantage for radical innovation, presenting countries with fluid capital markets and fragmented market structures a potential head-start advantage in the commercialization of new technologies for strategic resource development, as shown in Chapter 3 through the commercialization and proliferation of fracking throughout the U.S.

This chapter is organized by some of the key factors for the Capital Markets & Market Structure variable across market economies as it relates to shale. These factors are explored through a combination of my primary and secondary research. The chapter builds on the energy policy literature review chapter, particularly as it relates to the work of Gold (2014) and Zuckerman (2013) into the U.S. shale development experience and the impact of the capital markets on the overall market and as utilized by some of the leading Independents, as well as industry data. As such, this chapter shows how the U.S. Capital Markets & Market Structure contributed to the U.S. shale head-start as a result of its LME structure and comparative advantage for radical innovation.

This chapter also complements the narrative-based Chapter 4 on Political Opportunity Structure, as UK Oil & Gas Executive provides a first-hand account into the genesis of the U.K. shale experience, highlighting how the low interest rate environment contributed to a search to deploy excess capital in new markets. This is supported by secondary research on interest rates, capital flows, and exploration activity indicators from various financial sources in the U.S. As this chapter and Chapter 4 on POS show, the search for yield

and investment in the U.K. shale market ahead of a fit-for-purpose regulatory regime being established led to the opposition accessing the regulatory and permitting regime and ultimately blocking development (Federal Reserve Bank of St. Louis 2023; Azir 2017).

This chapter also shows some of the shortcomings as it relates to MMEs and Capital Markets & Market Structure, due to MMEs' place between LMEs (which enjoy the benefits of fluid capital markets) and CMEs (which enjoy institutional patient capital support due to their strategic role in the broader economy). As discussed in the Government chapter, CMEs provide institutional support to actors in industries which represent strategic priorities, known as State Owned Entities (SOEs) or NOCs in the case of oil and gas. Hall and Soskice (2001) argue that institutional arrangements in CMEs provide SOEs with "patient capital" in part of these companies' alignment with national strategies. By contrast, in LMEs, Hall and Soskice argue that firms rely on fluid capital markets (Hall and Soskice 2001).

As this chapter shows, the Argentina oil and gas industry, and its quasi-NOC structure, with a semi-state-owned national champion and a somewhat fragmented private market nature, has struggled due to capital availability and a lack of investor interest in the country's private oil and gas sector. As such, as this chapter discussed, this has skewed the playing field towards the larger international Major oil and gas companies, and limited participation from the Independents, in direct contrast to the U.S. experience.

In addition to the deep and dynamic nature of the U.S. capital markets, this chapter shows how other institutional factors played key roles in development. The prolonged low-interest environment was pointed to by numerous experts as *the* (or a) driving factor for the U.S. shale experience. The fragmented market structure and the ability to quickly start companies and scale operations through fluid labor markets is another consideration. Lastly, the institutional bankruptcy rules and regulations in the U.S. played a meaningful role in both promoting risk and healthily reorganizing overleveraged companies while maintaining operations at a key point in the shale development cycle (Haynes Boone 2022; Azir 2017).

The continued progress of China's shale development shows there is not something unique about shale that limits its development to LMEs. While experts I spoke with argued the U.S.'s success would be hard to replicate without a similar set of Independent Variables, it is clear that the patient capital benefits of the CME structure can achieve successful outcomes (without replicating the extent of the U.S. success and head-start). As a result, the global shale development experience affirms Hall and Soskice's argument

that CMEs have a comparative advantage for incremental innovation, while LMEs have it for radical innovation, with potential for future inference with the SRDF spanning technologies and resources (Hall and Soskice 2001).

For example, the shale development experience and the insights gained are critical for future researchers utilizing the SRDF to infer future strategic resource development outcomes. As such, the institutional arrangements between Government and the Capital Markets & Market Structure Independent Variables has particular relevance as NOCs aim to diversify across resource-bases, energy types, and regions, as part of the energy transition (Cahill 2022). As a result, in the future races to develop strategic natural resources, the institutional characteristics of the underpinning aspects of this chapter's Independent Variable can suggest development outcomes for various market economies, highlighting the importance of Capital Markets & Market Structure across LMEs, MMEs, and CMEs for the SRDF.

6.2. State Strength Versus Market Might

At the core of this chapter, are many of the themes that were central to the energy policy section of my literature review, particularly the literature on the 1970s oil crises. This could be reduced to questions and policy-maker preference of state strength or market might. However, as Ikenberry (1986, 1988) argues, these institutional arrangements are not always questions a state can just respond to during a crisis or when presented with a new opportunity (like strategic resource development). Ikenberry (1988) states, "Strong states are tied to past policy commitments just as weak states are".

Said differently and in relation to my research, it is not easy for strong states to readily adjust to the U.S. LME model just because the U.S. shale development experience was successful and infers similar outcomes could be possible for future resource development. Similarly, LMEs do not enjoy the same kind of patient capital commitments enjoyed by strong states. It is not easy (or feasible) to readily adopt these underpinning characteristics, due to historical institutional characteristics, as shown in Chapter 3. This is clear as it relates to countries' Capital Markets & Markets Structure variables as well.

6.3. LMEs, Capital Markets, and the SRDF – What the U.S. Shale Experience Shows

My primary and secondary research shows the U.S. shale experience affirms Hall and Soskice's argument that LMEs have a comparative advantage for radical innovation. As Gold (2014) argued in Chapter 3, the

Independents were able to proliferate fracking following Mitchell's commercialization in large part due to the fluid U.S. capital market system, in addition to the U.S. institutional private property rights, as also argued by Murtazashvili and Piano (2019). My primary research with various capital market participants reinforces these arguments and provides additional insights to future researchers as part of the overall case study into the shale development experience, to infer future strategic resource outcomes utilizing the SRDF approach.

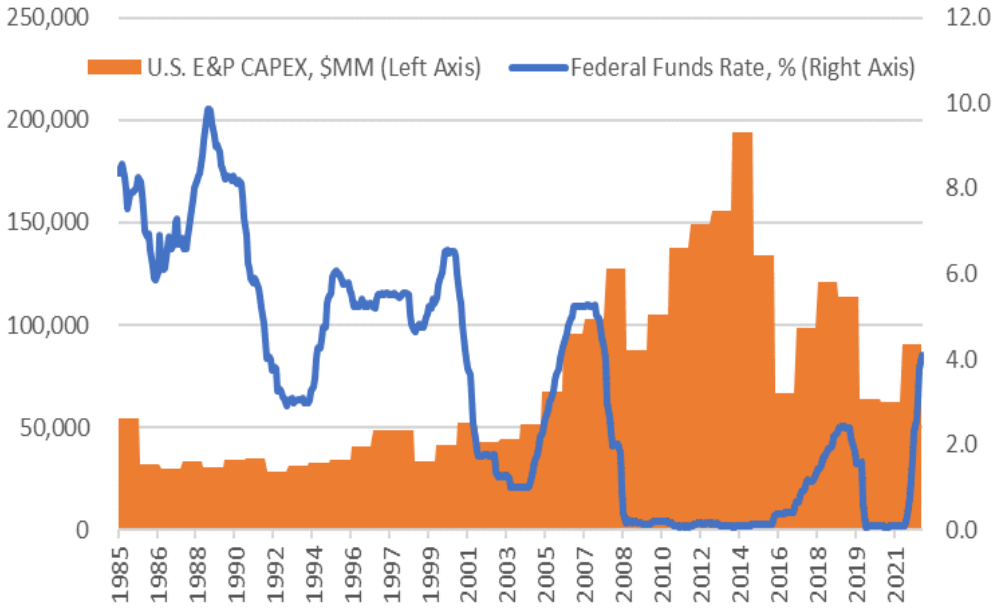
The combination of ample capital availability, a fragmented market, entrepreneurial spirit, and the market structure's impact on technology development and adoption, all seems to have created a unique blend to support unconventional development, according to my research and interviews. As a result, of all the unique historical institutional benefits underpinning the U.S. oil & gas industry, it appears the Market Structure & Capital Market makeup could have had the largest impact for the successful development of unconventionals as part of the SRDF, and could provide significant insights for governments aiming to successfully develop strategic resources.

"The Federal Reserve created U.S. shale", Private Equity Energy Investor told me, crediting a prolonged period of low interest rates in the U.S. as forcing institutional investors to seek returns in the U.S. oil & gas industry. Leading Energy Investor & Expert echoed Private Equity Energy Investor's statement, "cheap money clearly helped", and also referenced the Federal Reserve. "You've been in an environment where interest rates are falling and the desire to invest in something that can generate returns has gone up," stated Leading Energy Investor & Expert. However, more than just "cheap money" (as a result of the prolonged low interest rate environment), it appears several factors underpinned by the LME market structure culminated to create the unique unconventional development experience in the U.S.

Supporting Private Equity Energy Investor's view regarding the Federal Reserve and U.S. shale, Figure 15 illustrates the federal funds rate, which is "the central interest rate in the U.S. financial market", coupled with historical U.S. E&P capital expenditures (West 2022, Federal Reserve Bank of St. Louis 2023). The data affirms the deployment of new capital towards U.S. shale in response to the prolonged low interest rate environment and corresponding increase in high-yield debt (Azir 2017; Federal Reserve Bank of St. Louis 2023).

Global Oil Service & Clean Energy Analyst argues the U.S.'s success in unconventionals would be challenging to replicate without a similar market structure & capital market system in place. He told me, "The fact that we had the biggest capital market in the world, we have the ability of anybody that wants to start a business as long as they can find access to capital, which is more free flowing now and a lightly regulated industry, that's really hard to replicate in other areas."

Figure 15: U.S. E&P Capital Expenditures Versus the U.S. Federal Funds Rate



Source: West 2022, Federal Reserve Bank of St. Louis 2023

As discussed in this chapter, the ability for the U.S. E&P sector to access debt capital on increasingly lenient terms as the unconventional development cycle unfolded was a unique experience in the U.S., with various important backdrops, including low historical interest rates, a supportive bankruptcy system, lenient lending standards relative to traditional reserve-based lending standards, and equity investor interest in production growth over profitability.

In a study on reserve-based lending and the impacts of the debt capital markets on the U.S. shale development experience, Azar (2017) argues, "The real catalyst of the shale revolution was thus the 2008

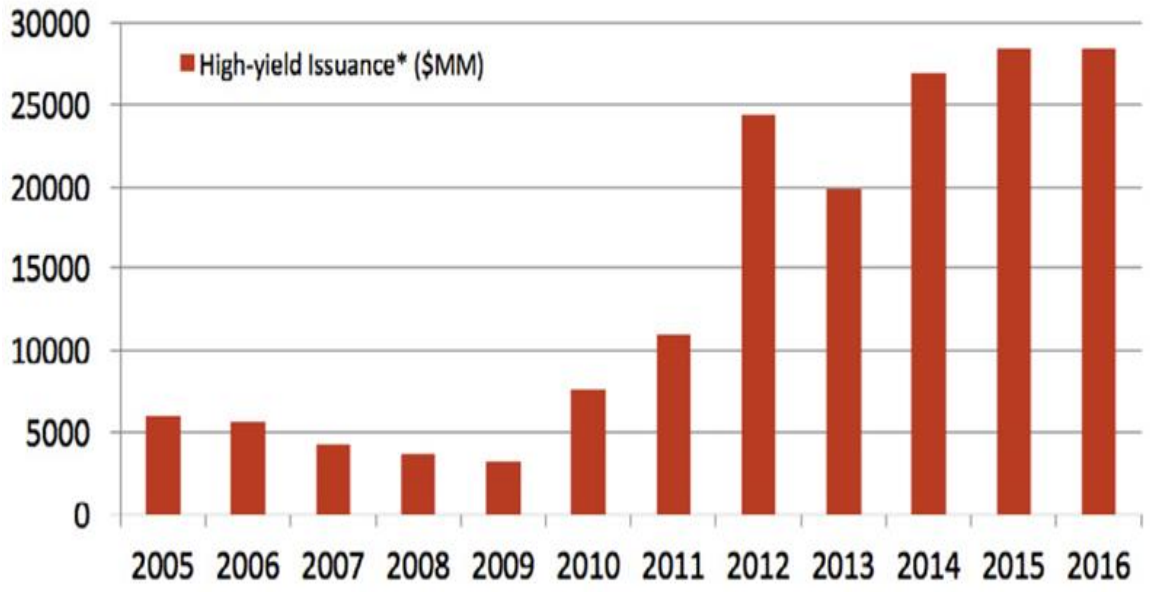
financial crisis and the era of unprecedentedly low interest rates it ushered in, driven by the US Federal Reserve Bank's monetary policy". He added, "American entrepreneurship, coupled with low-cost debt, created the conditions for a surge in production that ranks among the biggest oil booms in history".

Private Equity Energy Investor reinforced this, stating to me, "when there's a massive capital need and perceived high returns, it marries up pretty well. So, we had record bond issuance at one point, 2014, 2015, 2016, high yield energy across upstream, midstream downstream services was like 18% of the high yield index. Today, it's more like 10% percent (in May 2020). But high yield issuance in 2014 2013, energy was number one in issuance. I mean, this was a massive way to take up a lot of that excess capital that was sucking around in the system."

Going back to my energy policy literature review in Chapter 3, Gold argues that McClendon specifically "figured out how to finance the revolution, tapping into Wall Street's deep reservoir of capital", building on Parsons' (2010) argument on the constructivist concept of the importance of carriers in markets (Gold 2014). As such, this chapter shows that the institutional factors were present for the U.S. shale experience, but that this chapter should be viewed in concert with Chapter 3, as it relates to my incorporation of Constructivism as a complement to Historical Institutionalism for the theoretical lens for the Capital Markets & Market Structure variable for the SRDF.

As shown in Figure 16 below, the increase in high-yield debt issuance by the U.S. E&Ps started in 2010 and ran through the mid-2010s, in-line with the run-up in U.S. shale production, followed by overproduction and the eventual price decline, as Gold (2014) details. With this data, Azir (2017) argues "Low-cost debt allowed small and midsize oil companies to access high-yield bond markets in an unprecedented way". This data also should be viewed in concert with Figure 15, as it shows how falling interest rates preceded the growth in high-yield issuances. However, as I argue in Chapter 3, it is not enough to only look at the institutional factors that led to the U.S. shale success.

Figure 16: High-Yield Issuances by North American E&Ps



Source: S&P Capital IQ, Azir 2017

6.4. Impact of Reserve-Based Lending

A critical aspect of the U.S. shale Capital Markets experience is reserve-based lending (RBL), which Azir (2017) describes as "a bank-syndicated revolver credit facility" and argues it is "the most important source of debt financing and growth for these stakeholders", in discussing the U.S. shale experience. The RBL system is used throughout the oil & gas industry (not just shale) and utilizes the various resource classifications for hydrocarbon development, as depicted in Figure 17 below.

As part of the RBL system, debt is available against the discounted value of commercial reserves, not possible or contingent resources (Szczetnikowicz and Dewar 2018). Former Development Bank Energy CIO told me the RBL system is used for Argentine shale development, but that it is a more conservative and limited leverage-based approach, restricting leverage and capital availability in Argentina relative to the U.S. market.

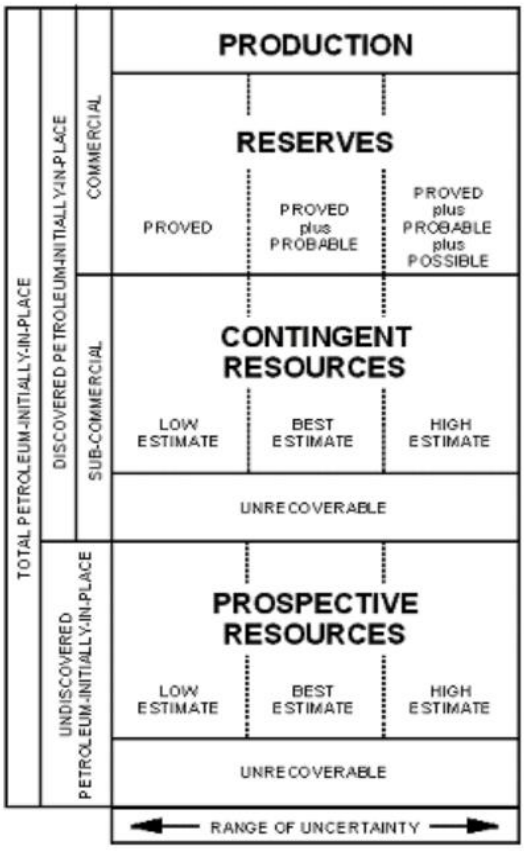
The RBL system classifies oil and gas reserves as either proved, probable (contingent), or possible (prospective). In practice, Azir (2017) details:

> "Bank lenders only extend credit against a company's proved reserves. As the collateral is oil and gas reserves of the company, RBL financing requires engagement of an independent reserve and production engineer to support the bank's calculations in determining the borrowing base, which is the maximum credit that could be made available to the borrower by a lender, calculated based on the company's reserves".

The significance of the RBL in the U.S. shale experience is that it provided the ability to finance shale operations with prospective resources, despite at a discount, and despite shale's more risky nature relative to conventional assets (due to the technical differences, higher economic breakevens, and steeper decline curves).

Azir (ibid) details the formula banks utilize to determine the borrowing base, which is the maximum credit provided to a company through RBL, based on its unique mix of resources. Borrowing bases are determined by a formula that considers future commodity prices (the "price deck") to determine the value of reserves at different discount rates, as illustrated in Figure 18 below (Society of Petroleum Engineers 2000).

Figure 17: Resources Classification System Graphical Representation



Source: Society of Petroleum Engineers 2000

Figure 18: Borrowing Base by Reserve Type

Reserve Type	Advance Rate (%)	Borrowing Base ($)
Proved		
PDP	AR1: 95%-99%	PDB (BB) = AR1 * PDP (PV9)
PDNP	AR2: 65%-75%	PDNB (BB) =AR2* PDNP (PV9)
PUD	AR3: 50%-60%	PUD (BB) =AR3* PUD (PV9)
Total Proved		PDB (BB) + PDNB (BB) + PUD (BB)
Probable	N/A	No borrowing base credit extended
Possible	N/A	No borrowing base credit extended

Source: Azir 2017

6.5. LMEs, Bankruptcy, and Capital Reorganization

Another critical aspect of the U.S. oil and gas experience is the country's bankruptcy laws. The capital intensive, cyclical, and volatile nature of oil and gas presents challenges and opportunities in utilizing financial leverage, as discussed by Private Equity Energy Investor, Global Oil Service & Clean Energy Analyst, and Leading Energy Investor & Expert. In the U.S., bankruptcy protection not only promotes initial entrepreneurial activity, but also enables the reorganization of capital and aims to support continued industrial and economic activity.

The U.S. bankruptcy laws, while similar to other LMEs, including the U.K., are particularly advantageous from an industry perspective in regards to maintaining operations and ensuring operations are continued as part of the reorganization process. This is done by placing the power in the company Board during the process "to continue running the business while a reorganization plan is being constructed", Franks and Torous (1992) point out.

They add that in the U.K. the company "comes under the control of an insolvency practitioner", with a concern that this practice encourages early liquidation (ibid). In the U.S. mode, by maintaining operations, overall market structure is relatively maintained and the ongoing development cycle continues to unfold. This is a unique advantage of the U.S. bankruptcy system for the Capital Markets & Market Structure variable under the SRDF.

In Argentina, the narrow capital markets limit the potential for a broad-based bankruptcy cycle similar to the one recently experienced by E&Ps in the U.S. Former Development Bank Energy CIO told me the capital markets have had a marginal impact on development in Argentina, as "if it's not economical by itself, you just don't have access to capital markets". He adds, "in the US, we have seen the way capital markets have worked, where they have enabled, let's say, IRR negative shale production get to the market, and taken a risk, and taken a view which was a purely financial view, which wasn't derived from the asset themselves".

In China, the concentration of the oil and gas industry in SOEs negates the need for a dynamic bankruptcy system. However, the emergence of a U.S. style bankruptcy system approach, as increasingly adopted in the property development and real estate sector, could influence future market structure (Wei and NG

2019). This dynamic provides a blend between the U.S. and Argentine experience, with less scope for "zombie companies" (ibid, Goldman Sachs 2022).

Regarding the U.S. bankruptcy dynamics, Former Development Bank Energy CIO stated to me, "in the U.S. it is pretty easy for a shale producer to go into bankruptcy, wipe his debt and start again. You cannot do that in Argentina". He adds, "in Argentina, you don't have a mechanism that clears the financial health of a company and allows you to move on with the asset".

Former Development Bank Energy CIO told me this leads to "zombie companies" as owners will use the courts "to stay away from bankruptcy and then from cleaning the system", in an effort to stop the state from stepping in and taking over the asset during the bankruptcy process. Goldman Sachs notes, "Zombie companies are typically defined as firms that haven't produced enough profit to service their debts (also known as an interest coverage ratio below one) for three straight years" (Goldman Sachs 2022).

From 2010 to mid-2014, U.S. oil prices (WTI) were above $75/barrel, providing a healthy backdrop for the shale producers and fueling production growth. The Economist noted, "IHS, a research firm, reckons the cost of a typical project has fallen from $70 per barrel produced to $57 in the past year, as oilmen have learned how to drill wells faster and to extract more oil from each one" (The Economist 2014). I discuss this "break-even" dynamic in Chapter 7.

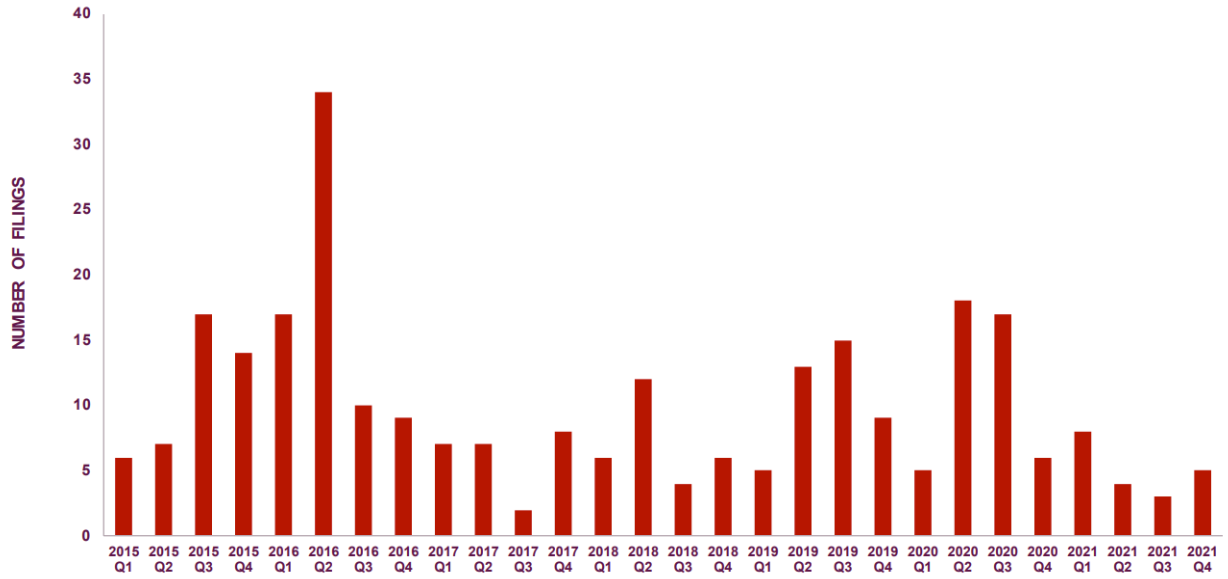
U.S. oil production growth led to a price war with OPEC de-facto leader Saudi Arabia, as U.S. oil production market share grew to 3.7% in late 2014 from 0.5% in late 2014, resulting in oil prices more than halving from June 2014 to January 2015. The price war culminated in Saudi Arabia declining to implement production cuts at an OPEC meeting over Thanksgiving weekend despite ongoing price weakness, "marking a major shift away from its long-standing policy of defending prices" (Lawler et al. 2014).

The 2014 price crash led to a wave of bankruptcies by the U.S. E&Ps in the following years, which Hayes Boone, the U.S. law firm, detailed in its "Oil Patch Bankruptcy Monitor", as shown in Figure 19. In January 2022, Hayes Boone (2022) stated in its final report of the series, "Over the past seven years, there have been 274 oil and gas producer bankruptcies".

In the same period, 330 oilfield services and midstream companies have filed for bankruptcy, bringing the combined North American industry total to more than 600 industry bankruptcies involving over $321

billion in secured and unsecured debt". It added, "While there will continue to be bankruptcies in the oil patch, the tidal wave triggered by the price correction that began in late 2014 is over" (ibid).

Figure 19: 2015-2021 NORTH AMERICAN E&P BANKRUPTCY FILINGS BY QUARTER



Source: Haynes Boone 2022

6.6. Shale Goes Global - the International Search for Returns

In this section, I provide a narrative on the genesis of the U.K. shale experience, which was born out of the aforementioned low interest rate environment and international search for returns (Federal Reserve Bank of St. Louis 2023). This section complements the case study on U.K. shale in Chapter 4, and tells the story of how the Capital Markets Independent Variable catalyzed the U.K. shale experience, while the Political Opportunity Structure variable shows how it was ended.

As a result, in this section, I argue that the search for financial returns and a dearth of corresponding opportunities drove capital providers to international shale basins. A key player in the global search for unconventional oil & gas was U.S. based energy, power, and infrastructure private equity specialist, Riverstone Holdings, as detailed in Chapter 4 (SEC 2008; Sutton 2012; Riverstone Energy 2014).

The firm was a pioneer in the U.S. conventional oil & gas landscape, as well as the shale revolution, presenting the opportunity for a leading U.S. energy and infrastructure investor to take the benefits unlocked by unconventional resources globally.

UK Oil & Gas Executive provided me with the rationale behind the Riverstone's investment in Cuadrilla. As Riverstone looked for international shale opportunities for its Fund IV (building on its success in the U.S.), UK Oil & Gas Executive was key in implementing this strategy.

In 2008, Riverstone raised $6 billion with early funding secured from British Universities Superannuation Scheme Limited, the largest private pension scheme in the UK (SEC 2008). "The mindset was, we can't possibly invest all of that in North America", UK Oil & Gas Executive told me regarding the use of proceeds for Fund IV. UK Oil & Gas Executive described how the fund had more capital to invest than opportunities at the time, leading to its search for similar energy opportunities internationally. As a result, in 2010, Fund IV invested $58 million in Cuadrilla in 2010, setting off the ill-fated U.K. shale experience (AJ Lucas Group Limited 2016).

"In hindsight, that was absolutely wrong", UK Oil & Gas Executive told me, "Because the shale gas business and the unconventional oil and gas business happened on our doorstep". Riverstone found itself well positioned for the unconventional oil and gas boom due to its origins in the conventional U.S. onshore oil & gas market, from which the unconventional market emerged.

UK Oil & Gas Executive detailed the path that led the firm to lead the unconventional buildout in the U.S. and ultimately push out internationally. "The unfashionable E&P (business) had been originally onshore lower 48 conventional oil and gas fields…nodding donkeys in Texas, that are now no longer strategic for not only oil Majors, but also the Independents. You can buy these things cheap. They've been starved of capital". This approach contributed to Riverstone's early success, UK Oil & Gas Executive added.

The firm found success in U.S. unconventionals due to its legacy strategy as a market leader in financing U.S. conventional opportunities. "Because Riverstone was doing that unfashionable onshore, they saw that business emerge around them and got onto it early. And Riverstone had a series of very successful, small, independent investments, in originally shale gas and then unconventional liquids through the 2000s", UK Oil & Gas Executive said.

Despite this early success, the search for more opportunities led to the push into new markets. "But the view then (was) with six billion dollars of new money that we're going to run out of opportunity", UK Oil & Gas Executive stated. This led to leveraging "Riverstone's bread and butter" for international shale development. "We had a particular strategy which was: unconventionals have worked in North America" he added, adding "Where else might it work around the world?".

Riverstone then went through a diligence period assessing various international shale opportunities, which included studying these markets and speaking with various people in the industry. At this point, "we came up with a short list, which was Argentina, China and the UK, and fairly quickly, we said political risk is probably a bit lower in the U.K. and we're probably more comfortable in that business environment. So, let's have a proactive strategy to go out and figure out how to see if we can do in the U.K. what Riverstone had done successfully onshore (in the) U.S.", UK Oil & Gas Executive said.

Riverstone and Cuadrilla's pioneering but ill-fated U.K. shale development experience is detailed in Chapter 4 on Political Opportunity Structure. Importantly, UK Oil & Gas Executive discusses how moving ahead of having a fit-for-purpose regulatory regime in place negated 1) the benefits awarded to the U.K.'s LME, 2) Riverstone's deep expertise and experience, and 3) the economic, environmental, and energy security benefits which should have springboarded the U.K. to a successful shale development experience (similar to the U.S. experience).

However, from a process tracing perspective and looking at the benefits the U.S. financial system brought for shale, it is worth noting the unintended consequences of the origins of the U.K. shale development experience and how excess capital stemming from the U.S. market, and industry experience, led to a race to unlock similar opportunities in new markets ahead of regulatory regimes being put in place.

As a result, the interplay between Political Opportunity Structure, Government (as it relates to regulation), and Capital Markets is clear through the U.K. unconventional development experience. The U.K. shale experience and its genesis provides future researchers utilizing the SRDF with an example of how excess capital chasing returns ahead of a regulatory framework being enacted can lead to POS related development risk in LMEs.

6.7. Institutional Arrangements and Market Structure

This section focuses on institutional arrangements between the Government and Market Structure variables, and explores the competitive landscape among CMEs and MMEs through the SRDF. In doing so, I build on my primary research into the market structure for shale development in Argentina and China, comparing these market economies to the U.S. LME market economy, which successfully developed both shale oil and gas.

As such, this section discusses the three different market structures for the SRDF, with broad differences between the market make-up of LMEs, CMEs, and MMEs, as seen through the oil and gas industries in the U.S., China, and Argentina. This section explores some of the critical issues behind the market structures of China and Argentina, as it relates to the SRDF, and provides a historical analysis of the Chinese market structure (the U.S. oil and gas market structure history is provided throughout Chapter 3, the Argentina market structure and regulatory evolution is provided in Chapter 5. I do not provide one for the U.K. as development was blocked before market structure became relevant; however, my research suggests it would have likely followed the U.S. LME market structure to an extent).

As such, this section also details the Capital Market & Market Structure challenges for the Argentina oil and gas industry. As such, this section provides some specific examples of how underpinning aspects of Capital Market & Market Structure can affect resource development outcomes through the SRDF.

The large competitive nature of the U.S. market structure was a driver behind the creation of the oil services industry, which played a critical role in the U.S. shale experience, Global Oil Service & Clean Energy Analyst argues. Global Oil Service & Clean Energy Analyst told me, “Because there’s so many participants, as E&P companies were formed to attack shale, therefore service companies were formed to support those E&P companies.” Global Oil Service & Clean Energy Analyst added, “therefore, you had lots of competition.” He points to the Herfindahl–Hirschman Index, which is a market measure of fragmentation versus monopoly, as being “somewhat fragmented to fragmented” for the majority of product lines sold by U.S. oil service companies.

The market structure between the countries examined varies considerably, ranging from a small handful of state-owned companies in China, to a mix of quasi-state owned and select international companies in Argentina, to a small group of independent companies in the U.K. attempting to follow the U.S.

experience. By contrast, U.S. shale development took place within a highly fragmented and competitive market structure, as Global Oil Service & Clean Energy Analyst highlights. According to the Independent Petroleum Association of America (IPAA), “There are about 9,000 independent oil and natural gas producers in the United States. These companies operate in 33 states and the offshore and employ an average of just 12 people” (IPAA 2023).

6.8. Chinese NOCs, Historical Institutional, and the SRDF

In this section, I provide an overview of the Chinese oil and gas market structure, and show how its evolution has been impacted by the state and China’s CME. Through this brief historical institutional analysis of China’s oil and gas market structure, it is clear how it has evolved into an overarching institution with a comparative advantage for incremental innovation, as seen through its continued shale production growth, despite substantial challenges (which deterred many international Majors), and most recently with some of latest technical breakthroughs and continued production growth.

In stark contrast to the U.S. oil and gas market structure, China’s shale efforts are dominated by three large NOCs, 1) China National Petroleum Corporation (CNPC), also known by its publicly listed subsidiary PetroChina, 2) China National Offshore Oil Corporation (CNOOC), and 3) China Petrochemical Corporation, known as Sinopec. These three NOCs form an oligopoly for oil and gas in the CME, and have received the majority of shale licenses (Kemp 2013).

The Chinese oil and gas Market Structure strongly supports Hall and Soskice’s argument that CMEs have a comparative advantage for incremental innovation. The evolution of the Market Structure and the three main firms within it should be viewed through a Historical Institutional lens, evolving in-line with a value-system at the various phases of China’s economic growth and social, political, and geopolitical evolution. Following this period, today China’s oligopoly oil and gas industry is firmly aligned with the overarching Chinese state.

Provincial NOCs can also play a meaningful role in development, including Yangchang Petroleum, the fourth largest NOC in China, which is focused on the Ordos Basin. These firms bring deep local expertise and also help introduce specific technical incremental improvements which could be uniquely situated for the local geological challenges, as highlighted by recent incremental improvements for “Low permeability tight oil and gas in Yanchang area” (Xiangzeng 2023).

The market is open to international oil companies but challenging conditions, poor well results, and opportunities elsewhere, particularly U.S. shale, has led to various companies leaving China. In April 2019, market reports stated BP intended to pull out of China, the last of several international companies remaining, including Shell, Exxon, Eni, and ConocoPhillips (Meng and Aizhu 2019). Then BP CEO Bob Dudley said Chinese shale faced "great challenges" due to complex shale discouraged, which coincided with the British major drilling eight to 10 wells with disappointing results in the Sichuan Basin (Meng and Aizhu 2019).

Industry observers argued that with development continually below expectations, some of the foundations of Chinese resource governance are shifting with potential new favorable measures that include "drill it or lose it rules", and extension of subsidies, that could encourage new entrants and weaken the NOCs' stronghold by "creating a new sector of independent upstream producers like those that have transformed the U.S. energy industry over the past decade" (Fickling 2018).

However, without amendments to the aforementioned underlying rules that require a domestic partner (typically an SOE) or rapid domestic technological uptake, this prospect seems challenging. At this time, these forecasts have not come to fruition and the Chinese oil and gas market structure is tightly concentrated among the NOCs and controlled by NEC, headed by top cabinet officials.

6.9. Chinese Market Structure Evolution

Broadly, there have been five waves in the evolution of China's oil and gas industry, characterized by "Self-Reliance", the "First Reform", the "Second Reform", a potential move to recentralization, as Francisco (2013) shows, and the fifth and current wave which I characterize by increased competition among the three largest players as a result of the recent midstream reorganization and establishment of China Oil and Gas Pipeline Network Corporation, known as PipeChina, which I discuss in greater detail in the Chapter 7.

The period of Self-Reliance, spanning from 1950-1977, stems from the fallout from Sino-Soviet relations and a move away from Soviet support. This period was characterized by Maoist "massive mobilization of physical and human resources".

The ensuing First Reform from 1978-1991 was characterized by the re-establishment of the Ministry of Petroleum Industry and the introduction of the "Big Contract" system which enabled the export and international monetization of 5.5% of oil produced, with proceeds able to reinvest in equipment and expansion. This period saw the establishment of CNPC, CNOOC, and Sinopec and the somewhat opening up of the industry, Francisco argues (ibid).

The Second Reform spanned 1992-2003 and followed the country's "socialist market economy" reforms, and saw the restructuring of the Chinese NOCs in-line with China's admission into the World Trade Organization in 2001. As such, the NOCs moved from siloed operations to vertical ones, with increased administrative autonomy as well as part of the abolishment of the Ministry of Petroleum Industry and transfer of its duties to the NOCs (ibid). As a result, the Second Reform period significantly contributed to the establishment of today's oil and gas industry in China.

The fourth wave is seen as a potential move to recentralization. This period during the 2000s includes a few ineffective steps to reign in the NOCs, including the establishment of the National Energy Administration. As a result the "super-ministry" National Energy Commission (NEC) was established to govern the oil and gas industry in 2010. Zhiyue (2010) argued at the time that "The establishment of such a super-ministry at this time reflects Chinese leaders' concern for energy efficiency, energy security, and environmental protection". Today, the NEC remains the governing body of China's oil and gas industry and the three dominant NOCs maintain their oligopoly status.

Most recently, the infrastructure and pipeline assets of these three NOCs were consolidated within the newly established Oil and Gas Pipeline Network Corporation (PipeChina), increasing competition and efficiencies between the oligopoly by opening new markets for their commodities that were previously limited to each respective infrastructure owners. This statist approach is the latest indication of the continued centralized development approach and comes at a time when it appears China has been overcoming some of the geological challenges of shale development.

Despite China's continued underperformance relative to its self-set shale development goals, the country continues to grow production and introduce new practices for development optimizations. China's NOCs can be viewed in-line with Marcel's (2006) assertion that NOCs are "instruments of the state and help government achieve a number of policy objectives.

As “The National Energy Commission is tasked to produce China’s energy development strategy, review issues of energy security and development, and coordinate domestic energy exploration and international energy cooperation”, the country’s three leading NOCs are tasked with carrying out these policy objectives.

As a result, China’s highly concentrated and strategically aligned oil and gas Market Structure can be viewed as an ideal institutional arrangement for incremental innovation, under Hall and Soskice (2001) VoC theory, with highly patient capital, and no scope for hostile takeovers. As such, China’s NOCs have reduced “their sensitivity to current profits (and) encourage long employment tenures and employee tenures and the development of the inter-firm and employee relations that foster incremental innovation” (ibid).

I argue that the current fifth wave of development of China’s oil and gas market structure (characterized by the reorganization of the NOCs midstream assets) potentially coincides with the start of China’s period of realizing its comparative advantage for incremental innovation through its CME structure, which has been visible through several initiatives, building on Francisco and affirming Hall and Soskice’s VoC framework.

As such, China’s oil and gas Market Structure creates a strong comparative advantage for incremental innovation. This can be viewed through a number of examples, but mostly in its unrelenting continued drive to develop shale and the associated slow-and-steady production results.

For example, all recently, 1) the Chinese NOCs have established new shale pilot programs, 2) CNOOC recently announced an offshore shale oil discovery in the South China Sea, representing a potential industry breakthrough, and 3) Sinopec announced a deep well discovery representing “another breakthrough in the state oil major's hunt for hard-to-extract hydrocarbon resources” (Yihe 2023; Offshore Technology 2022; Aizhu 2023).

While the commerciality and state of development has been questioned, the discovery was made “using self-developed technology”, affirming that while LMEs have a comparative advantage for radical innovation, CMEs have a comparative advantage for incremental innovation. As such, the SRDF shows that China’s slow and steady approach to shale development affirms Hall and Soskice’s VoC framework and the SRDF.

6.10. Argentina's Market Structure - MME Structure an Advantage for the Majors

As the Argentina shale development experience shows, MMEs can be at risk of having the downsides of LMEs and CMEs without the corresponding benefits.

Many experts I spoke with highlighted the promise of Argentina shale from a geological perspective, but highlighted policy and monetary concerns outweighed the country's attractive geology. For example, Global Oil Service & Clean Energy Analyst stated, "Argentina is held up as an example, but you can see the government interference, the overregulation, the instability of the country and their debt burdens, as well as hampering the overall shale development for their country."

Following missing out on the early stages of the U.S. unconventional experience, and having to buy in at later less attractive levels, the Majors were keen to enter the resource-rich Argentina unconventional market when it opened in the mid-to-late 2010s, noted Argentina Oil & Gas Consultant.

A few of the top-tier U.S. Independents entertained or initially entered Argentina, but have left or idled activity. For example, EOG Resources' CEO, Mark Papa, shared his view on Argentina at a conference in 2011, "We think it could be bigger than the Eagle Ford" (Reuters 2011). Papa's comment followed encouraging pilot test results at EOG's position in Argentina, which spanned around 100,000 acres. Despite the encouraging results and ample resource footprint, EOG sold its Argentina operations in 2016 (SEC 2018).

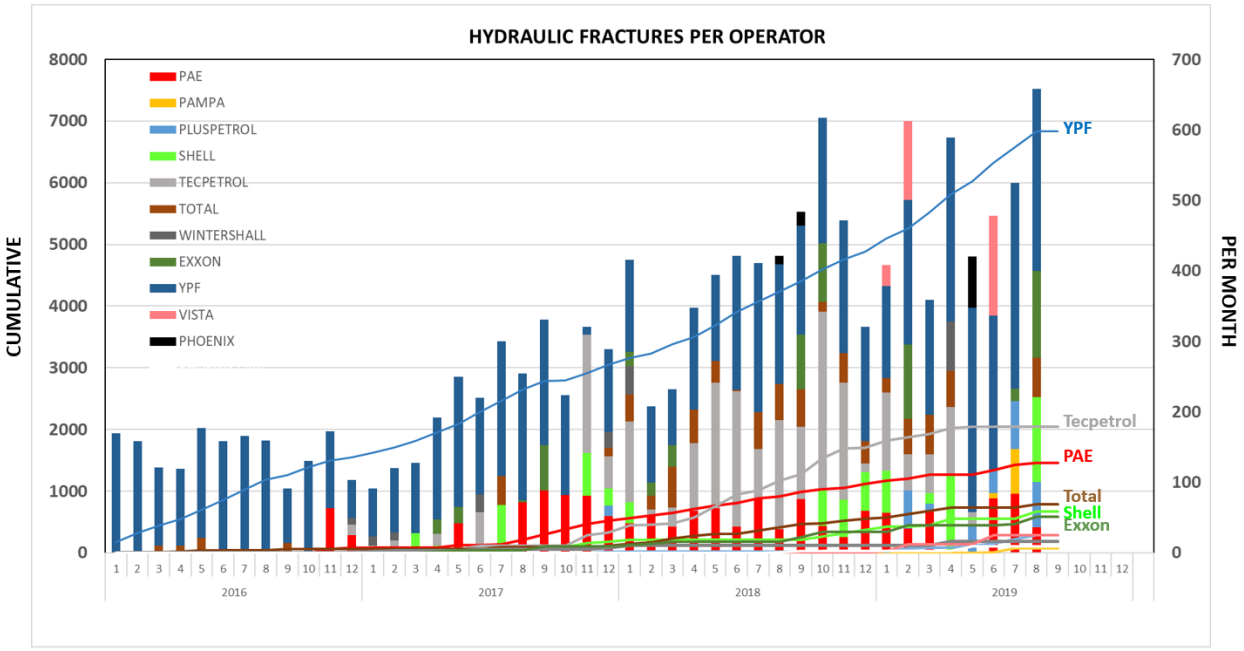
Due to the unique MME market structure in Argentina, the playing field is tilted towards larger multinationals and the integrated Majors as well NOCs, like YPF. This is in contrast to the vibrant and fragmented market structure of Independent companies that drove U.S. development. It is also in contrast to the highly concentrated and NOC dominated Chinese CME market structure. As such, Argentina and its MME can be characterized as a hybrid "quasi-NOC" market, which does not benefit from either of the benefits that the institutional arrangements of LMEs and CMEs have.

The notable exceptions to the Argentina market structure providing an advantage to the Majors are Pan American Energy (PAE) and TecPetrol, as illustrated in Figure 20 below illustrating wells fracked by companies. However, both PAE and TecPetrol benefit from large and well financed strategic owners,

including BP and Sinopec in the case of PAE, and Techint, an Italy and South America focused diversified conglomerate with interests spanning engineering, healthcare, steel, and logistics in the case of TecPetrol.

The illustration below highlights how Argentina's shale Market Structure, with roughly a dozen industry participants, sits between the U.S. highly fragmented LME and China's highly concentrated CME Market Structures.

Figure 20: Wells Hydraulically Fractured by Company in Argentina



Source: Pan American Energy

6.11. Capital Market Challenges and Particulars for the Argentine Oil & Gas Market

In addition to the Majors muscling into Argentina early, access to capital is a particular challenge for the Independents in Argentina. These companies are more dependent on outside capital to fund drilling campaigns. Paradoxically, Former Development Bank Energy CIO argued to me that the local capital markets in Argentina are actually quite developed, with several active leading commercial and investment banks and a local bond market.

Loans are available; however, he notes the currency volatility and controls make navigating the banking situation a challenge. This in-turn favors larger players. As a result, unconventionals in Argentina have

largely been financed from the cash flow from conventionals as well as “from equity injections from the corporate balance sheets” from the incumbents, according to Former Development Bank Energy CIO.

Financing new operations from cash flow or on their domestic balance sheets is not something the U.S. Independents could have easily done in the 2010s when these companies generated limited, if any, free cash flow, as Private Equity Energy Investor highlights. The ensuing shareholder focus on return on capital for the Independents also makes it hard to venture into new regions in search of new resources, continually discouraging the U.S. Independents from entering Argentina.

Argentina’s currency controls and the challenges associated with getting capital in and out of the country has been a major challenge for development and has limited access to capital for smaller companies. The commodity price controls coupled with the capital controls discourages the trading houses from participating in Argentina. As a result, producers are not able to hedge production as easily, often an important instrument for raising capital for U.S. producers.

Currency controls and sovereign debt defaults in Argentina have been the leading challenge to the country’s unconventional development, in Argentina E&P Executive’s view. These issues have quelled foreign capital interest in Argentina’s shale sector. Former Development Bank Energy CIO stated to me, “you have to play a little bit with currency issues. But all that to say that if you needed to get say $50 million dollars equivalent, you can actually get bonds on the Argentine market, that is possible if you have hard assets behind and you also have a fair amount of wealth in Argentina”. For those that do not, it is not possible, providing a clear contrast to the dynamic and deep capital markets that catalyzed the U.S. shale experience.

Further, Former Development Bank Energy CIO added that while possible (to raise debt), this is not always practical, saying, “Now, the problem comes when you look at dollar denominated issues where…the issue of currency control is a real one and it affects the oil and gas sector more because essentially, if I am producing oil and gas and I expect to get paid in dollars, if I get paid in Argentina and I'm in the middle of an FX crunch, my money is stuck”.

Building on Former Development Bank Energy CIO’s comments regarding raising funds in the local market, Argentina Oil & Gas Investment Banker (focused on bridging European capital with South American opportunities), told me, “You don’t raise equity in Argentina, you raise debt, and it’s dollar-linked”.

Argentina Big Four Accountant detailed this to me, “when you don't have a way out for pesos, for example, buying U.S. dollars or other hard currency, you have a lot of money available in the domestic market”, which in-turn creates a currency surplus and further propels inflationary pressures. He added that while these funds are available and effective for small to mid-sized companies for some projects and working capital, they are not of the scale to finance large infrastructure projects or a solution for long-term capital for companies.

Argentina Oil & Gas Investment Banker added, “Some companies have been able to raise a standard loan by some banks, but it's very few. So, it's basically dollar-linked bonds that they’re raising”. Argentina Oil & Gas Investment Banker described how dollar-linked bonds work in practice, “So let's say that you raise $100 million, but you receive in pesos. You receive at the equivalent exchange rate of the date that you raise it, and when you need to repay it, again it’s linked to the exchange rate of the day of the repayment, and you repay in pesos. That's how the markets are basically hedging themselves versus devaluation”. The dollar-linked bonds are supplied in Argentina by domestic investors and market participants, including insurance companies, pension funds, banks, basically (the) institutional market”, Argentina Oil & Gas Investment Banker added.

In March, 2023, however, the Argentine government “ordered public sector bodies” to sell or exchange dollar-linked bonds. A Reuters report said, “The government said its aim was to reduce exchange rate volatility, which has seen a huge gap open between the official peso-dollar exchange rate and parallel foreign exchange markets, and to absorb a surplus of pesos that worsens inflation” (Raszewski 2023).

Notably, from an operating company perspective, Argentine Oil & Gas Investor highlights how strict capital controls make participating in Argentina not only challenging, but impossible for some, particularly as it relates to debt and interest. In 2020, “there was even a decree that was made that you couldn’t pay debt that was located out of the country. Immediately, there was an outcry from oil and gas companies because they have issued bonds outside of the country and technically, if they can't get the money out in order to be able to make interest payments, they would default”. While the measure was reversed, the spirit of the restriction seems clear, and the potential for similar restrictions rattled markets.

The challenges for smaller independent oil and gas companies to access capital naturally tilts the playing field towards the larger international Majors, in contrast to the highly fragmented U.S. market that

developed through the well-capitalized Independent E&Ps, driven by access to cheap capital as a result of an extended period of low interest rates, as Private Equity Energy Investor highlighted, and due to the fluid equity capital markets. Former Development Bank Energy CIO discussed how the Majors are able to use Argentina's capital challenges to their advantage.

Former Development Bank Energy CIO told me, "by default you have seen other companies like Chevron and Total who would be using the international balance sheet and spend money in Argentina and do basically intercompany loans between HQ and the Argentinian sub and then work out the cooking internally so that they could essentially offset the FX issues or local bonds, local capital markets, and in some cases, some companies have had access to international lending, but the history on those has been pretty poor in general".

As a result, a move from dollar-linked bonds could have a significant impact on the oil and gas Market Structure in Argentina, with potentially meaningful ramifications for smaller companies in particular, further altering the market structure and competitive landscape, including exacerbating the Majors' competitive advantage over the Independents.

It is a topic worthy of additional and future research. In summarizing Argentina and capital controls, Argentine Oil & Gas Investor echoes Ikenberry (1986) and the irony of state strength, "They don't realize that they need to give up a little bit on their lock-tight control in order to enable growth".

The lack of capital for independents in Argentina gives the larger players another advantage. It "makes it easy for them to be able to step in and gobble up assets and develop these assets in Argentina", according to Argentina E&P Executive. However, as detailed for the U.S. experience, the smaller Independents were able to explore and develop faster than the larger players. As a result, while the consolidation cycles in Argentina have concentrated assets into hands of larger players, they have not correspondingly increased the pace of development.

6.12. Chapter Conclusion: Capital Markets & Market Structure

In this chapter I showed how Capital Markets & Market Structure can impact development outcomes for resource development across LMEs, CMEs, and MMEs through the experiences of the U.S., China, and Argentina.

For the U.K., development was blocked too early to tell how the market structure might have impacted the country's shale experience; however, I show how Capital Markets catalyzed the U.K. shale experience as a result of the deep and fluid LME capital market system coupled with the international search for returns as part of the low interest rate environment which unlocked the U.S. shale revolution.

Further, in this chapter, I showed how some critical aspects of the U.S. Capital Markets variable played leading roles in the country's success in shale development, including capital availability (through equity and high-yield loans), a fragmented market, entrepreneurial spirit, drawing back to the description of the American, as detailed by Hacker (1947), the reserve-based lending system, the unique U.S. bankruptcy system, and the market structure's impact on technology development and adoption, as detailed by Gold (2014) in Chapter 3 (Hacker 1947).

More specifically, the prolonged low interest rate environment, the unique U.S. bankruptcy system, and the deep and fluid debt and capital market systems are all underpinning aspects of the U.S. shale development success, and should be seen as parts of a case study for analyzing future resource development utilizing the SRDF.

I showed how some of the more critical aspects of the Argentina MME oil and gas market include the absence of the benefits that are brought by the fluid LME markets or the state-supported CME structure. As an MME, I highlighted how Argentina's challenged capital market system tilts the playing field towards larger companies that do not need the same level of capital market access that the Independents relied on for the U.S. shale development experience.

As a result, I showed how this has resulted in neither a highly concentrated and controlled market structure (like China) or a fragmented and competitive one (like the U.S.), but an in-between and generally inefficient one.

Neither the Chinese nor the Argentine market structures have supported rapid development, as both have been slow to develop shale and have arguably missed out on the significant benefits enjoyed by the U.S. However, both countries continue to progress development, showing that the institutional arrangements their governments have taken as it relates to Capital Markets & Market Structure for shale development is in-line with their broader goals.

Regarding China, this chapter shows how CME's can develop a highly effective and tightly controlled market structure with nationally owned companies that are aligned with broader state goals and initiatives. This chapter makes clear that the Chinese oil and gas Market Structure has provided the country with a comparative advantage for incremental innovation, in-line with Hall and Soskice's argument that this is achieved through patient capital, little risk of hostile takeovers, and long-term employment arrangements that encourage long-term thinking and inter-organization collaboration.

As a result, this chapter provides insights for future researchers to infer how LMEs, CMEs, and MMEs, might approach strategic resource development through their Capital Markets & Market Structures, and what the outcome of development might be. Further, this chapter provides insights into some of the more critical underpinnings for Capital Markets & Market Structures for countries endeavoring to develop strategic natural resources, and lessons learned from the challenges and advantages realized by the countries I have studied.

Chapter 7: Geology & Infrastructure

7.1. Introduction

In this chapter, I show the importance of Geology & Infrastructure on strategic resource development, as seen through the SRDF. In addition to simply having attractive geology, this chapter shows that *how* geology has been developed, and to what extent actors in a country understand the geology, can be just as important as the attractiveness of the geology itself.

Note that there are many deep technical reviews of countries' geology, and that I do not attempt to replicate them. My focus is on analyzing the historical institutional characteristics of some of the key considerations for Geology & Infrastructure for the countries I have studied. This includes showing the relevance of the historical ways the various countries being reviewed have developed their oil and gas resources, as dictated by their respective Government's institutional arrangements with their market economies. These historical institutional experiences have all impacted these countries' shale development experiences differently, either providing them an advantage or disadvantage for types of innovation and development.

For example, I show how the U.S. unconventional development experience had the benefit of building on decades of legacy infrastructure, and how its government resisted a state development model even in the immediate aftermath of World War II, and what impact this had on the foundation of shale development.

Through primary and secondary research, I show the impact of the U.S.'s infrastructure being upgraded periodically in-line with various boom-bust cycles, and how the continual re-establishment of old oil and gas fields over and over again played a role in shale development. Institutional knowledge of the underlying geology was a critical component of the U.S. shale experience, my primary research showed. Old vertical well logs provided treasure maps of sorts for the Independents that studied these historical records (as legacy producers overlooked shale resources at the time), to understand the potential of horizontal drilling, and where to specifically target along the wellbore.

Notably critical for unconventional development from a Geology & Infrastructure standpoint is of course that the resource is economically attractive. However, this is not the only factor as my primary research has shown, and many other factors can outweigh geological attributes for a country aiming to develop

unconventionals. The U.S. experience shows how legacy infrastructure, geological data, and new infrastructure and technological enhancements made the geology even more economical, resulting in lower break-even prices.

As also discussed in this chapter, some developers mischaracterized or overestimated the benefits or compatibility of legacy infrastructure, while some countries and areas held legacy infrastructure that posed unexpected benefits. The same overestimation of infrastructure was true for the U.K. experience, contributing to the country's development challenges, and was also referenced in my interviews for Argentina. As such, a notable takeaway from the Infrastructure variable of the expert interviews includes the importance of a sufficient understanding of legacy assets in place prior to development, and the potential pitfalls of over-estimating the relevance and quality of the infrastructure in place.

This chapter highlights how Geology & Infrastructure helped unlock the U.S. comparative advantage for radical innovation, affirming Hall and Soskice's VoC framework and providing a case study for future researchers utilizing the SRDF to infer strategic resource development by looking at these variables for future countries in consideration. However, by exploring China's historical institutional approach to oil and gas infrastructure development, I argue China is on the cusp of realizing its comparative advantage for incremental innovation. This assertion will of course need to be reviewed and affirmed by future researchers.

China's top-down CME-based infrastructure development approach has been completely counter to the U.S.'s LME-based build-up. Years of infrastructure development by the three leading Chinese NOCs has come to an end, with the assets now transferred to a newly formed infrastructure SEO charged with providing efficiencies across the industry and promoting competition among these three NOCs. The strategy coincides with the country's continued progress in developing unconventionals, including various technical breakthroughs and steady production growth (despite below internal expectations). Further, the transaction and strategy highlights how the NOCs are vehicles of broader state priorities, and if successful, provides a case affirming how CMEs have a comparative advantage for incremental innovation as part of the SRDF.

This chapter is structured as a mix of themes, overviews, and juxtapositions of the countries studied and their underlying Geology & Infrastructure Independent Variables. I draw on my primary research providing

insights from industry participants where relevant, and utilize a mix of technical, historical, and industry secondary research.

7.2. Attractiveness of Geology is critical; however, this chapter argues that a legacy understanding of it is crucial

The underlying geological characteristics of shale varies significantly by basin and country. The two most important attributes are porosity, which estimates the pore space in a material, or "the volume within sedimentary rock that can contain fluids", and permeability, which is "the property of a porous material that determines how easily fluid flows through that material" (EIA 2023c; SLB 2015).

Other important considerations are the prevalence of multiple "stacked" independent formations, an attractive aspect of some key basins in the U.S. (notably the Permian Basin), and in Argentina (notably the Neuquén Basin), as shown in Figure 34 in the Permian Basin (U.S. EIA 2018).

The EIA's 2013 updated shale inventory, as detailed in Figure 21, which was expanded to include shale oil, was published as the U.S. unconventional revolution was unfolding. This inventory provided a thorough look at the geological potential of unconventional oil and gas resources globally (considering resources in-place and what was technically recoverable at the time) at the start of the international race to recover shale oil and gas (U.S. EIA 2013).

Figure 21: Top 10 Countries with Technically Recovery Shale Oil and Gas (2013)

Rank	Country	Shale oil (billion barrels)	
1	Russia	75	
2	U.S.[1]	58	(48)
3	China	32	
4	Argentina	27	
5	Libya	26	
6	Venezuela	13	
7	Mexico	13	
8	Pakistan	9	
9	Canada	9	
10	Indonesia	8	
	World Total	345	(335)

Rank	Country	Shale gas (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S.[1]	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
	World Total	7,299	(7,795)

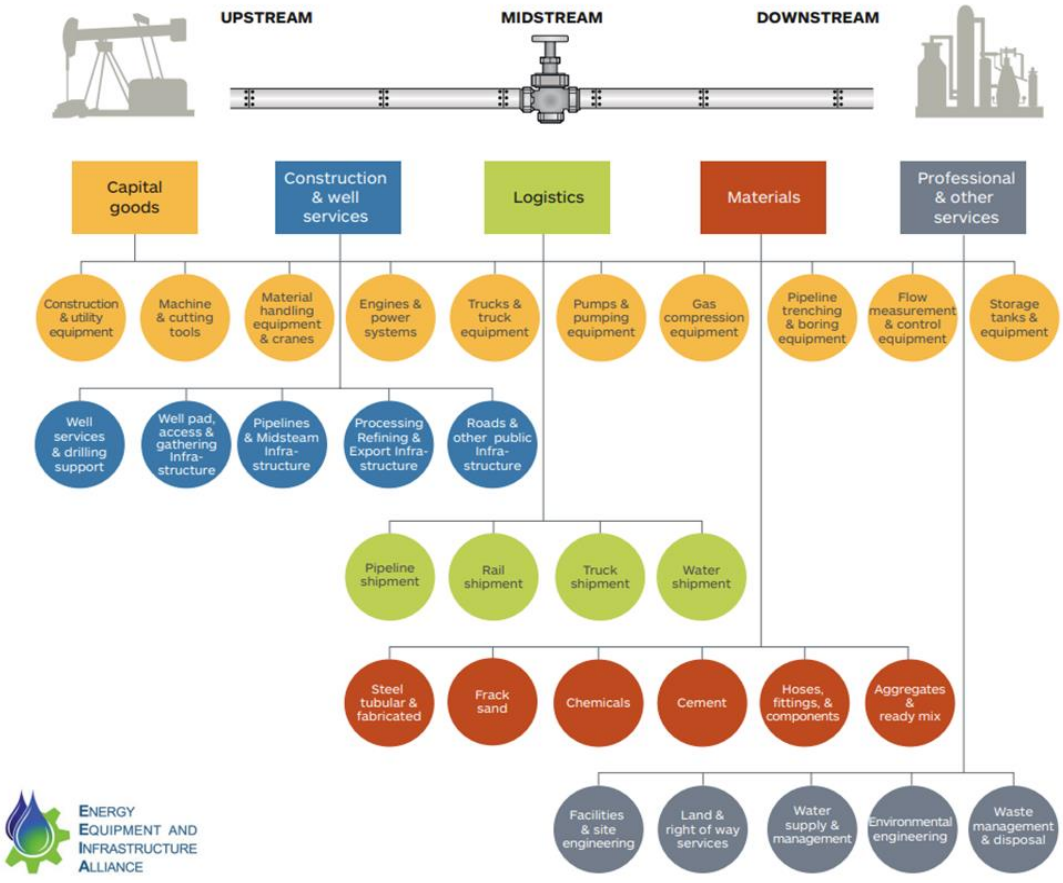
[1] EIA estimates used for ranking order. ARI estimates in parentheses.

Source: U.S. EIA 2013

7.3. Importance of Infrastructure for the SRDF

In addition to geology, having existing infrastructure in place (legacy infrastructure), as well as broader and underpinning industries to supply the core infrastructure components for unconventional development can be a key determinant. As illustrated in Figure 22, infrastructure spans upstream (exploration and production), midstream (moving hydrocarbons), and downstream (refining and storage). Multiple sub-components are part of these three buckets in the gas supply chain, as shown below. Notably, the IOCs participate in all aspects of the supply chain shown below, while the Independents, which commercialized fracking in the U.S., participate in only the upstream exploration aspect of development.

Figure 22: The Unconventional Energy Supply Chain



Source: IHS 2014

7.4. MME Market Structure Inhibiting Infrastructure Development and Limiting Rich-Resource Development

This section highlights the abundance and attractiveness of Argentina's unconventional oil and gas resources, reinforced by market participants in my primary research.

Argentina has the second largest unconventional natural gas reserves standing at 801.5 Tcf (Trillion cubic feet) and the Vaca Muerta holds the largest basin-level shale gas resources in the world, as detailed by the U.S. EIA in its seminal 2013 shale study (U.S. EIA 2013).

The country also has substantial tight oil reserves at 27.0 billion barrels (EIA 2015). According to the EIA, "Argentina has world-class shale gas and shale oil potential – possibly the most prospective outside of North America – primarily within the Neuquén Basin" (ibid).

Figure 23: Prospective Shale Basins of Argentina

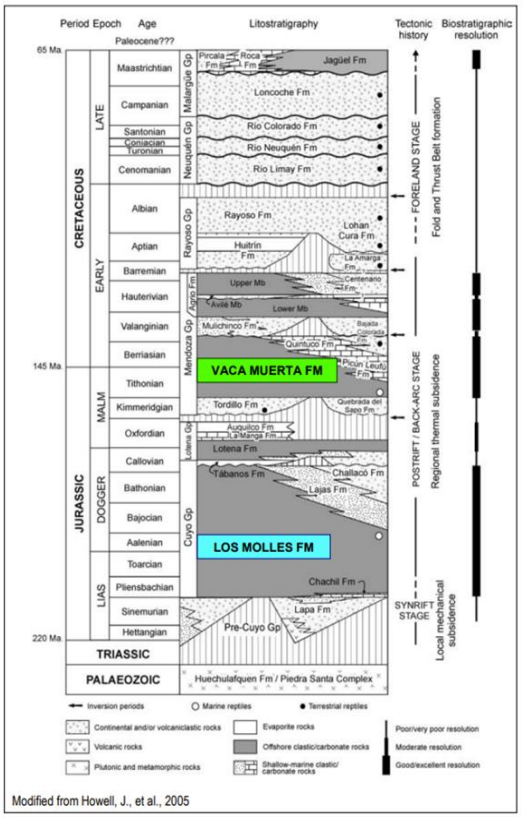


Source: U.S. EIA 2013

The country has four major unconventional basins; however, the most prospective is the Neuquén Basin located central-west on the Chilean border, where the Vaca Muerta shale is located. The basin is characterized by thick and multiple hydrocarbon-rich layers. This led spokesperson Chevron's Robertson to say Argentina "won the geological lottery" (Bronstein 2014). Retired Argentina Oil Executive notes thousands of conventional wells have been drilled through Vaca Muerta, as conventional wells were drilled targeting resources at deeper depths. The rich understanding of the resource due to the abundance of conventional wells drilled enhances the basin's attractiveness.

Argentine Oil & Gas Investor highlights, "As far as I know, I don't think there's anyone that disputes that the geology is exceptional", referring to Argentina. He added that it is the other unknowns, challenges, and difficulties that are important for development. The two primary exploration targets are the Middle Jurassic Los Molles and Late Jurassic-Early Cretaceous Vaca Muerta formations, which are "two thick deepwater marine sequences (EIA 2015)".

Figure 24: Neuquen Basin Stratigraphy



Source: EIA 2011

7.5. Argentina Infrastructure Challenged by Monetary Issues

As the U.S. LME shale infrastructure has been built out by independent players and as China's CME infrastructure has been built by the NOCs, Argentina has struggled to find an obvious sponsor for its much-needed oil and gas infrastructure to support additional shale oil and gas volumes. There is limited domestic demand for Argentina's sizable oil and gas resources, meaning additional infrastructure, including pipelines, storage, and LNG facilities, are needed to continue to grow production for Argentina to achieve the potential presented by its rich resources. With Argentina's Government and Capital Markets variables key inhibitors for the development of its unconventional oil and gas infrastructure, it is clear how its MME market structure is challenged as it relates to Argentina successfully developing its shale resources.

Central to improving the country's currently challenged economic position is shale development, as the government has made "Vaca Muerta a key focus to raise export dollars to erase a $5 billion energy deficit and replenish depleted foreign currency reserves", through the export of LNG. However, the country's economic challenges have limited investment into its infrastructure, as market participants throughout my primary research have made clear. As such, "The government has ambitions to attract some $10 billion investment in liquefaction plants to convert its gas to LNG with the aim of reaching gas exports of some $15 billion by 2027" (Raszewski April 2022; Raszewski December 2022). An illustration of key natural gas infrastructure in Argentina, including proposed assets, is shown in Figure 25.

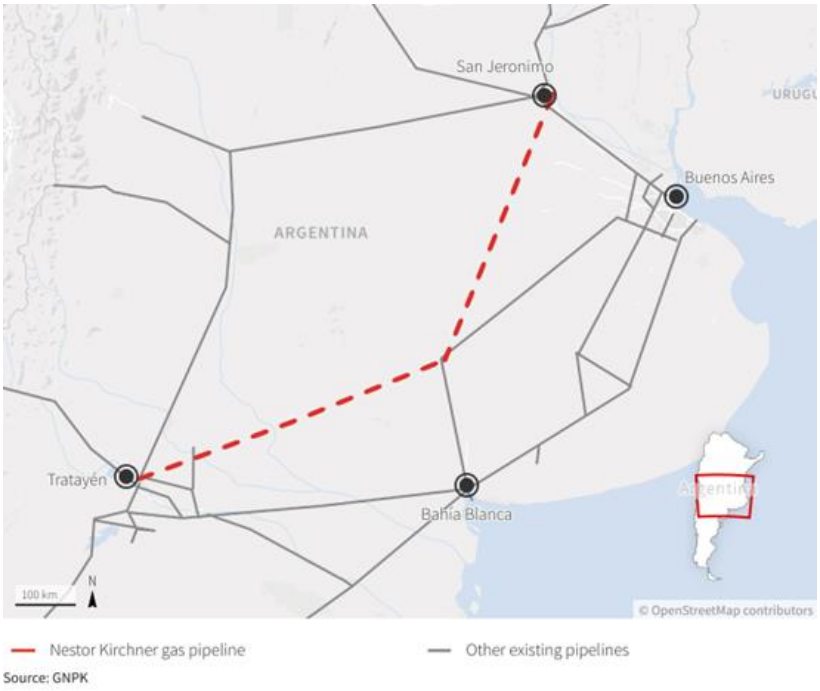
As such, the government has been aiming to improve investor confidence through establishing a regulatory framework for LNG to increase transparency, stability, and the prospects for investment (ibid). Some of the attributes of the bill intended to promote investor confidence are the ability to transact in foreign currencies, a long-term ability to export gas, and various tax benefits (bnamericas 2023).

An Argentine investor and market participant I spoke to highlighted that "Argentina was trying hard to get a U.S. infrastructure player to build that LNG terminal or at least help there" and added "there aren't a lot of usual suspects for this type of project", highlighting the lack of institutional investor confidence in Argentina's MME. The interviewee also highlighted "the Chinese government has approached Argentina to build some infrastructure", but the interviewee thinks the Argentine government "want to explore all alternatives that wouldn't necessarily be offensive to the United States", highlighting: 1) how Argentina's

MME market structure can be more aligned with the interests of CMEs than that of LME focused institutional investors and 2) affirming Marcel's (2006) argument that Chinese NOCs are "willing to take bigger political risks and lower returns".

Future research would benefit from continuing to analyze Argentina's Infrastructure variable as part of the SRDF following the outcome of the LNG bill, regardless of the outcome. Market participants I spoke with stressed the importance of clarity around LNG governance and additional infrastructure's importance on underlying development.

Figure 25: Argentina Natural Gas Pipelines (Existing and Proposed)



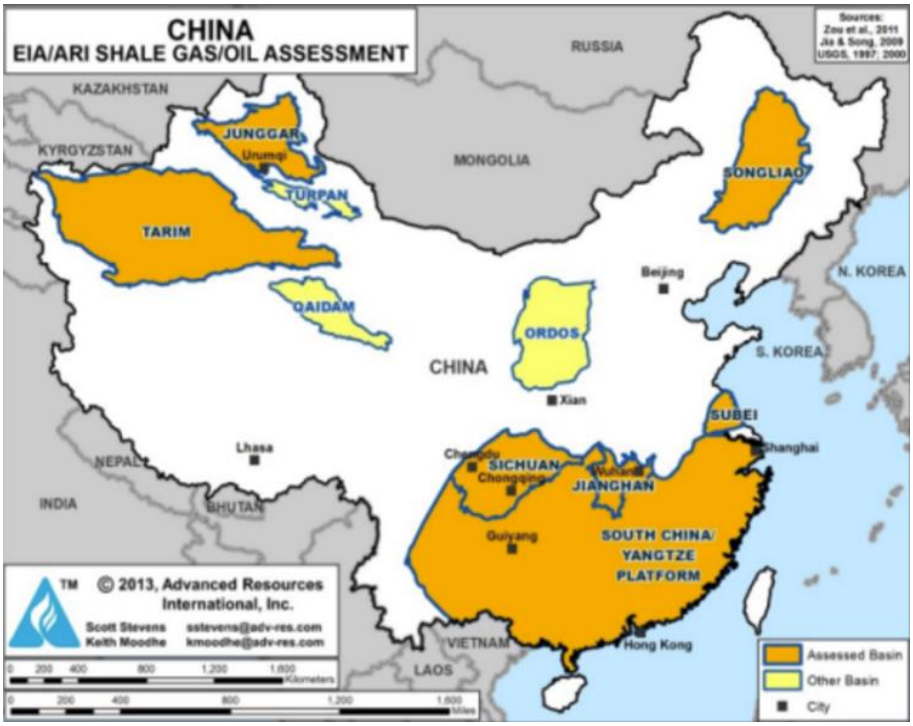
Source: Raszewski 2022; Reuters n.d.

7.6. China Geology & Infrastructure - Overcoming Complex Geology with CME Infrastructure Approach

Aside from its state–led approach, geology has been the most important factor for the Chinese development story. While the country has significant shale resources available spanning its vast landmass and across several basins, most of it is trapped in challenging geological formations. An illustration of the key unconventional basins in China is shown in Figure 26.

China's understanding of its shale resources and potential was born out of "reviews on old data and outcrop studies based on their understandings of the geology theory and technology of shale gas development in United States" (Yongsheng, Xunyu, Peirong 2018). As shown in Figure 21 above, the IEA's landmark 2013 shale study showed China to have the largest technically recoverable shale gas resources in the world and the third largest shale oil resources (U.S. EIA 2013).

Figure 26: Prospective Shale Basins of China

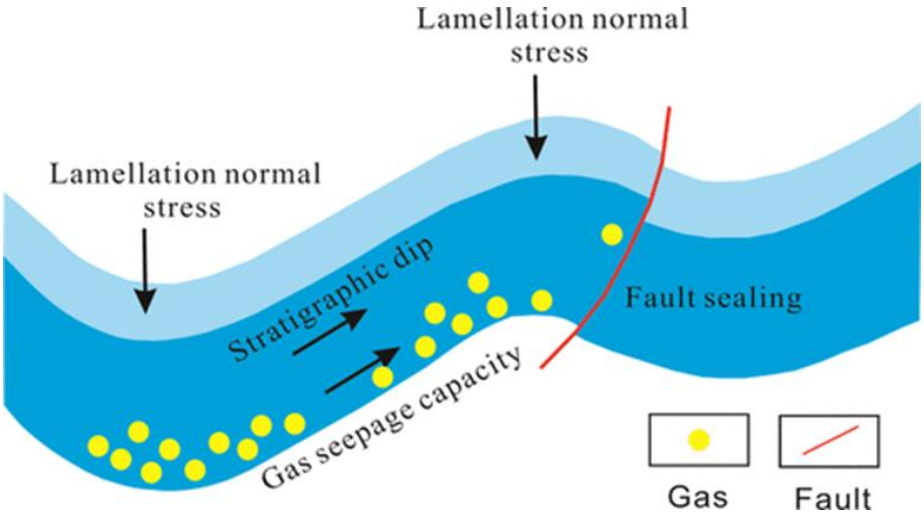


Source: U.S. EIA and Advanced Resources International 2013

China's geological challenges as it relates to shale development are primarily due to a "complex tectonic" makeup as the result of faults running through its shale formation, including the angles and the "complex combination of the fault systems", as illustrated in Figure 27 (Tang et al 2022; Shi et al 2022). This compares with the thick, relatively homogeneous, and stacked formations found in the Neuquén Basin in Argentina and the Permian Basin in Texas and New Mexico, as shown in Figures 24 and 34, respectively (EIA 2011; U.S. EIA 2018).

As mentioned in the previous chapter, the Chinese NOCs are making breakthroughs in drilling deeper wells (that rival some of the deepest ever drilled in the U.S.), and are making incremental improvements to overall development, despite the challenging geology (Aizhu 2023, Dyman et al 1990).

Figure 27: Sichuan Basin Shale Reservoir Fault Interpretation



Source: Shi et al 2022

As a result, and despite challenging geology and terrain, China has increased shale gas production fairly steadily, as discussed below, regardless of overly optimistic production targets. Like the U.S., China leverages legacy infrastructure to connect its unconventional oil and gas resources. However, in contrast, infrastructure build-out has been mostly led by the three leading NOCs.

Despite rural settings in China's northwestern Tarim Basin and the Ordos Basin in Inner Mongolia, the country has built up a substantial oil and gas infrastructure network, as illustrated in Figure 28 below, which shows China's oil and gas infrastructure map created on the interactive Baker Institute China Energy Map on June 16, 2023.

Production has been hampered by various geological and terrain related issues, limiting production and deterring international investment and expertise. As such, numerous national production targets have been curtailed, including the country's initial 2012 shale production goals of 80 bcm by 2015, and its 13th Five-Year Plan, released in March 2015, which aims to "accelerate the exploration and exploitation of shale gas", significantly reigned in expectations and set a goal of producing 30 bcm of shale gas by 2020 (Xiaochun M, Yinan G, 2015; Reuters 2012).

China's 2020 production estimate of 30 bcm by 2020 still proved overly aggressive with production around 20 bcm, but the margin for error improved and production increases are continuing, suggesting incremental improvement for addressing the country's challenging geology is taking hold (Aizhu 2021).

In the mid-2010s, robust drilling activity levels from the NOCs were not translating into production growth as expected. A survey from various market observers placed the issue on geology, arguing "China's geology is fundamentally more difficult than that of North America. Many prospective fields are buried deep below the surface. To make matters worse, they're often riven with seismic faults from the slow collision of continental plates that have built the Himalayas and the Japanese and Philippine island chains" (Fickling 2018).

Despite these substantial geological challenges and lower-than-expected production over the last decade, China has made significant progress and continues to incorporate the latest generation of technology and increase production. As detailed by researchers at Southwest Petroleum University in Chengdu (Zhang, et al 2022).

China's unconventional efforts have largely focused on shale gas; however, a shale oil discovery by Petrochina in early 2019 in the northwestern Jimsar field in Xinjiang province "could trigger a surge in shale drilling" (Murtaugh and Guo 2019). Separately and subsequent to the Petrochina discovery, Shell has signed an agreement with Sinopec to study the "Dongying trough of Shengli in China's eastern province of Shandong" (Aizhu 2019).

The region's modern day shale roots were largely established in 2010 through the joint assessment agreement between Hess and PetroChina; however, this ultimately "faced problems because of different reservoir characteristics between China and the US" (Ling 2012).

Despite Petrochina's discovery in the northeast, "most of China's shale oil is trapped in eastern regions such as the Songliao and Bohai Rim basins" (Aizhu 2019). However, poor geology could hinder China's shale oil development as it is for gas, reflected by an unnamed Ministry of Natural Resources statement that "China's shale oil has very low permeability, which means very low per well output that makes the economics hard to work" (Aizhu 2019). Based on China's continued progress with shale gas, market observers should not be as quick to count out its shale oil potential.

7.7. China's Infrastructure Consolidation and the Fifth Wave of its Oil and Gas Market Structure

As mentioned in the previous chapter, the oil and gas infrastructure assets, including pipelines, storage, and import export facilities, of the three leading Chinese NOCs were assumed by the China Oil & Gas Network Corp., (PipeChina) in September 2020. The majority of the assets were assumed from CNPC (PetroChina), in return for a 30% stake in the new infrastructure entity, with assets to a lesser extent coming from Sinopec (for a 4.6% stake) and CNOOC (2.9%), plus any cash for the balance of the fair value amount (SEC 2020).

At the time of the announcement of the intention of the transaction, West (2019) argued it is "one of the most significant changes to China's NOC landscape" in over 20 years. The transaction represents a statist approach to encouraging collaboration and competition among firms for the broader benefits of China's strategic energy security goals, affirming Marcel's (2006) argument that NOCs are more responsive to the "interests of the state".

The transaction is meant to "make the system more efficient and to open the door for competition between the three giants and potentially other future players by giving everyone access to the same national network", with particular benefits for Sinopec and CNOOC through expanded market access (Gouping et al 2021).

Further, I argue the transaction coincides with the commencement of China's comparative advantage for incremental innovation, which is currently being realized, coinciding with the end of the U.S.'s comparative advantage for radical innovation, in-line with the maturity of U.S. shale (Kemp 2023).

Morse (2012) argued in his North American shale outlook, that in China "development is likely to be slow in the medium term, hinging on the build-out of a still-nascent country-wide pipeline network, as well as being at an earlier point on the curve for technological and geological learning-by-doing". I argue that this "medium term" is now over and that the two challenges for China as Morse saw them in 2012 (infrastructure and experience) have been largely solved and are ready to be built on.

As such, the current fifth wave of China's oil and gas market structure, as discussed in the previous chapter, should realize the benefits from the NOCs' shared infrastructure resources, similar to how the U.S. shale experience benefited from shared legacy infrastructure, as my primary and secondary research shows. This should position China for a new era characterized by a comparative advantage for incremental innovation for shale development.

Figure 28: China's Oil and Gas Infrastructure Assets; The Baker Institute China Energy Map (v.2023)



Source: Baker Institute China Energy Map (v.2023), Created June 16, 2023, Available from: https://www.bakerinstitute.org/chinas-energy-infrastructure

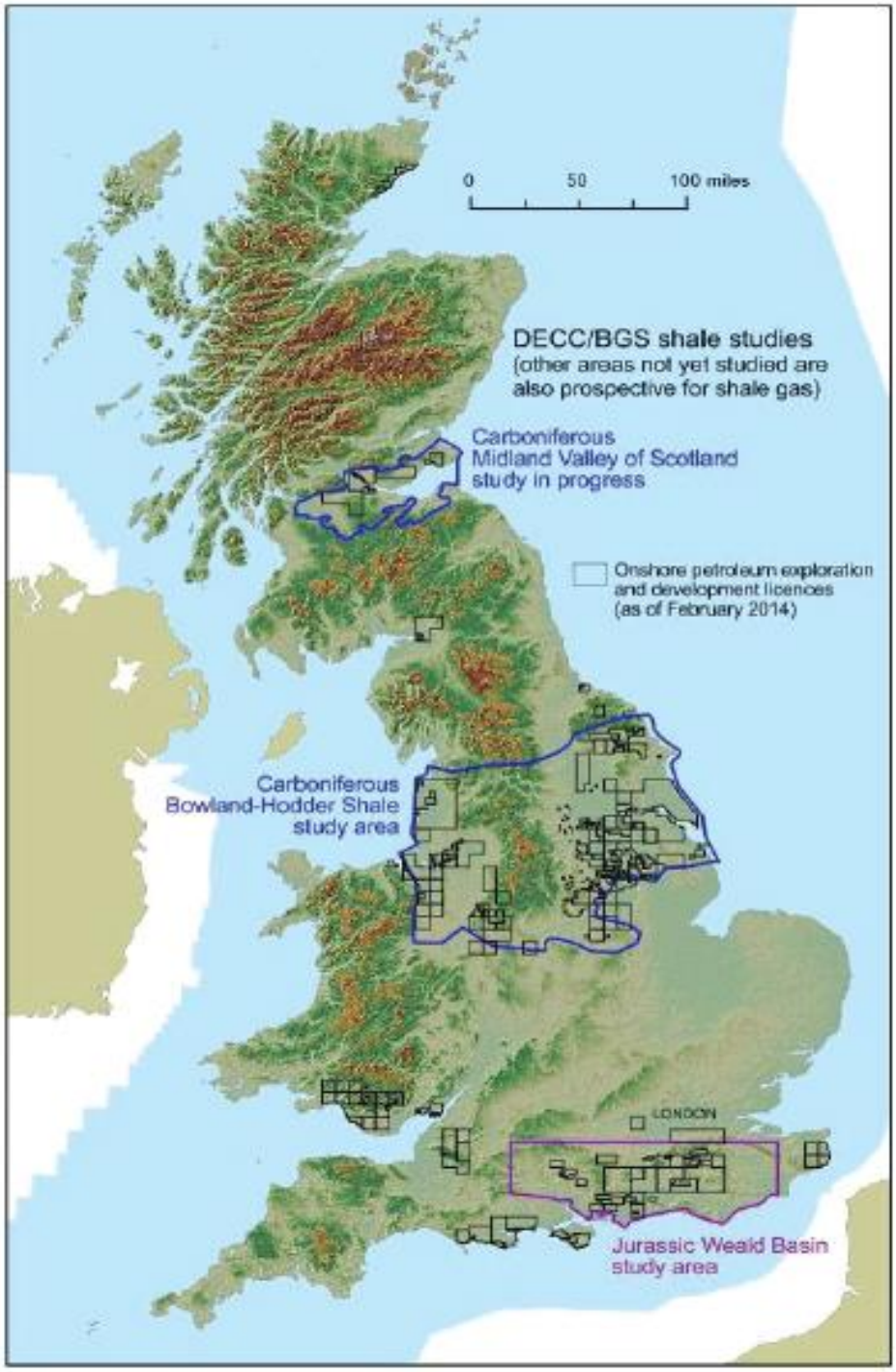
7.8. The U.K. and the Challenges of Inadequate Data and Infrastructure

The U.K. has 25.8 Tcf of wet shale gas and roughly 700 million barrels of oil (both are unproved technically recoverable), according to the U.S. EIA. This compares to the EIA's U.S. estimates of 622.5 Tcf and 78.2 billion barrels in the U.S, respectively (EIA 2015). However, DECC notes that since U.K. shale is in its "infancy", it is difficult to access the actual underlying reserves and production potential.

It estimates that "by analogy with similar producing shale gas plays in America, the U.K. shale gas reserve potential could be as large as 150 bcm, compared to 2 to 6 bcm for estimated undiscovered conventional onshore gas in the U.K. (DECC 2013). Despite the relatively small resource size versus the U.S. (under both the aforementioned EIA and DECC estimates), it is worth noting that the U.K. consumes roughly 10% of the natural gas as in the U.S., highlighting the potential relative strategic importance for shale gas in the U.K. compared to the U.S (BP 2017).

The British Geological Survey highlighted significant potential resources in "northern England, including Widmerpool Gulf near Nottingham and a large area centred on the Elswick Gasfield, near Blackpool", as part of its geological study in 2010, but published in 2012 (BGS 2018). The U.K. Oil and Gas Authority cites "tight-gas reservoirs" as a rock having 10% porosity or less (OGA, 2016). The "best shale gas potential thus includes the Upper Bowland Shale of the Pennine Basin" (DECC 2013). However, while substantial conventional wells have been drilled in the UK, DECC highlights that the quality of U.K. shale resources will only be understood following drilling and appraisal work (DECC 2013).

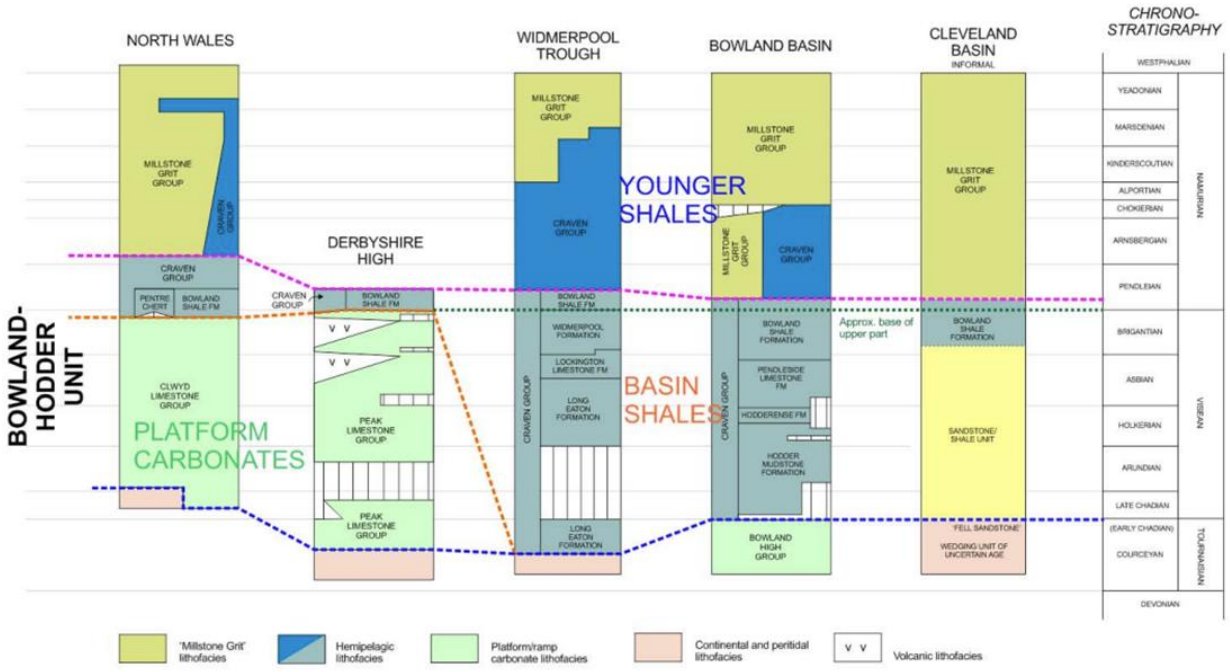
Figure 29: The UK's Principal Shale Bearing Areas:



Source: Parliament 2014

As detailed in Chapter 4, the U.K. shale experience went through several stop-start phases as a result of unexpected seismicity, which ultimately led to fracking being banned. Despite substantial research mapping into the U.K.'s geology, the DECC noted, "Few wells have penetrated the full Bowland-Hodder succession within the deep basins, but several have drilled sections of more than 5000 ft", and into the Bowland-Hodder Unit, where Cuadrilla targeted, as shown in Figure 30 (Andrews 2013). This counters the U.S. and Argentine shale experience, as discussed, where the geological formations are well understood due to significant legacy vertical oil and gas drilling activity.

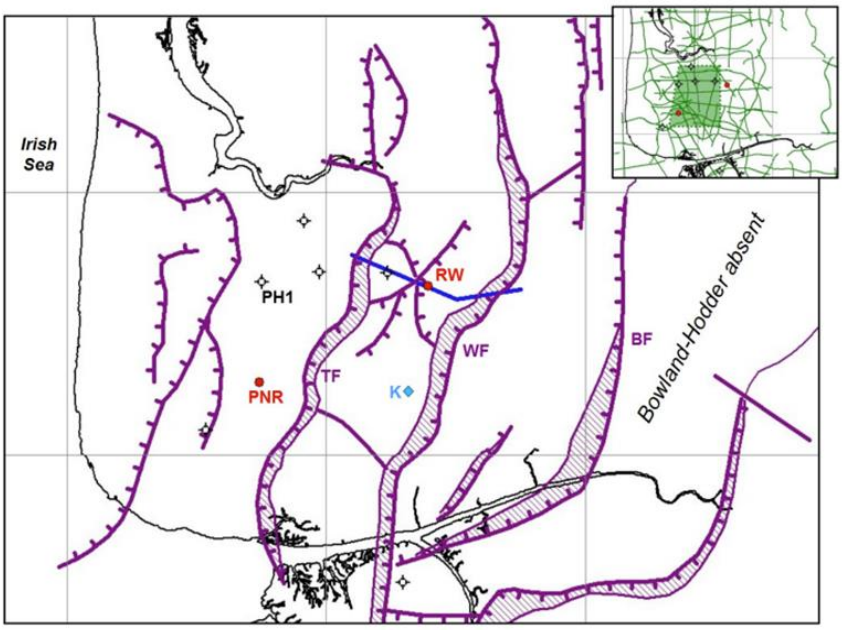
Figure 30: Lithostratigraphic Model of the Bowland-Hodder Basin (where Cuadrilla targeted shale)



Source: Andrews 2013

As UK Oil & Gas Executive noted in Chapter 4, the seismicity they encountered at every phase of development was unexpected. Highlighting why this might have been, in a retrospect geological review in 2016, Smyte (2016) argues, "Identification of faults within a thick shale sequence such as the Bowland-Hodder Unit is evidently very difficult, even with the aid of combined 3D reflection imaging and earthquake hypocentral location". An illustration of Bowland-Hodder highlighting fault lines in proximity to the Cuadrilla wells is shown in Figure 31 (ibid).

Figure 31: Aerial View of Bowland-Hodder with Faults and Cuadrilla Well Positions



Source: Smythe 2016

> "Faulting at top Bowland-Hodder (purple lines, comb on downthrown side), from BGS mapping (Andrews, 2013). Coastline in black. Major faults are: TF – Thistleford-Larbreck; WF – Woodsfold; BF – Bilsborrow. Well locations shown by dry hole' symbol (PH1 – Preese Hall-1). Cuadrilla proposed wells shown as red circles (RW – Roseacre Wood; PNR – Preston New Road). K – Kirkham geothermal borehole. Blue line – location of cross-section of Fig. 3. Inset map shows 2D seismic line coverage (green lines) and subsurface coverage of Cuadrilla 2012 3D survey (green-shaded quadilateral–. Grid - UK national grid at 10 km interval" (Smythe 2016).

The U.K. boasts meaningful legacy infrastructure, a capable workforce, but had ample concerns at the start of development around water, rural countryside, and then ultimately the effects from earthquakes, which as detailed in Chapter 4, was the main POS blocking point.

At the start of development in the late 2000s and early 2010s, it seemed as though the U.K. had sufficient legacy infrastructure to provide the country with an advantage for shale development, similar to the U.S.'s LME that had built-up private legacy infrastructure over the decades. Over 2,000 conventional wells have been drilled in the U.K. (DECC 2013). The country's industry body argues, "The UK has a long, safe and successful history of conventional oil and gas production, both onshore and offshore, with the first

commercial onshore production in 1851" (UKOOG 2018). As a result, the country seemed to have a strong oil and gas legacy and foundation to build on. The U.K. has substantial institutional capacity for regulating oil and gas operations, despite recent organizational changes. It also has a deep labor pool and industry advocacy groups to draw from.

However, all of these factors only led to the overestimation of the country's resource challenges, infrastructure, and Political Opportunity Structure access points. I discuss this in greater detail below, drawing from my primary research, and in-concert with how market participants have also overestimated Argentina's legacy infrastructure and ability to develop its resources.

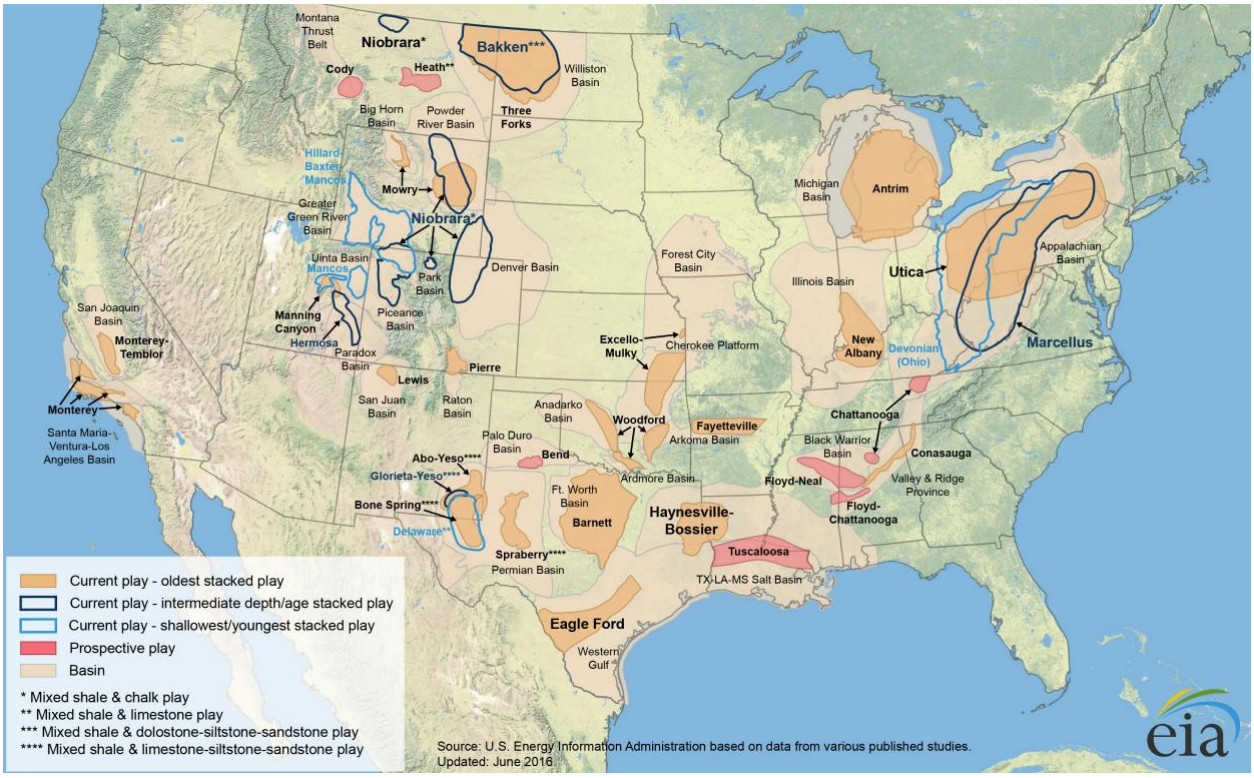
7.9. U.S. Geology and Infrastructure as a Baseline - Leveraging Decades of Data and Infrastructure

Due to the maturity and breadth of each oil and gas basin in the U.S., I do not attempt to explore the U.S. oil and Geology and Infrastructure Independent Variable in detail. However, to provide a sense of scale and comparison as the baseline for my study for my use in the SRDF, I present a few high-level aspects, such as the breadth of basins, the attractiveness of the geology, and the country's extensive infrastructure, which has been built over decades of private ownership and investment, but which also is born out of government investment, an important and underappreciated historical fact with significance for reviewing future strategic resource development with the SRDF.

The U.S. has well over a century of robust oil and gas development, with its initial oil well drilled in 1859 and continual decades of boom-bust development ever since. With each of these booms and busts, valuable data and infrastructure have paved the way for future development (McNally 2017).

The breadth of the U.S. oil and gas industry is sprawling, with multiple basins spanning the country, as illustrated below, with activity from over 9,000 independently owned producers, as discussed in Chapter 6.

Figure 32: Lower 48 States Shale Plays



Source: U.S. EIA 2016

7.10. Attractive Geology and the Benefits of a Deep Understanding of it

Geological formations and attributes vary across the multiple U.S. basins. Instead of discussing all of them, I highlight the oil-rich Permian Basin, which spans Southeastern New Mexico and West Texas, as when viewed collectively (over 7,000 individual fields), it is the most prolific field in the world representing roughly 6% of global production (U.S. EIA 2018; IEA 2023; TRRC 2023).

In my primary research, market participants repeatedly pointed to the attractiveness of the Permian, as well as the Neuquén Basin in Argentina, due to their "stacked pay" and thick homogeneous layers of reservoir shale targets, as shown in Figure 34 below. As with the Neuquén Basin, the Permian's general geology contrasts with China's and the U.K., which as shown, is more jagged, inconsistent, and heterogeneous, making for generally more challenging development, as my primary and secondary research shows.

The U.S. shale experience shows that, while seemingly obvious, for the SRDF, attractive geology is an important consideration. However, the Resource Curse research in Chapter 3 affirms that production is not always higher where geology is more attractive, pointing to a number of resource-rich countries that struggle with resource development due to an absence of a full market economy.

For the U.S., Leading Energy Investor & Expert told me the "confluence of geology that was opening up because of the technology", showing that the geology was suitable to allow for Mitchell to catalyze fracking (in that case in the gas-rich Barnett Shale), and the resource was expansive enough for the proliferation of development by the Independents.

In addition to the attractive nature of the geology for unconventional development, my primary research shows that the legacy knowledge and data associated with the U.S. shale resource-base, from insights gained through wells drilled over previous boom and bust cycles, was a contributing factor for the U.S.'s head-start advantage in developing unconventionals.

I spoke with Seasoned Permian Basin Entrepreneur, who has over 40 years of experience leading oil and gas companies as well as acquiring mineral rights and assets in the Permian Basin. His experience also spans running oil service and equipment companies that service the upstream operators as well as Permian-based infrastructure and waste treatment businesses.

From his experience spanning multiple development cycles and across various parts of the value chain in the Permian Basin, Seasoned Permian Basin Entrepreneur argues that "the most important element" of legacy infrastructure in the U.S. is actually the geological data. Seasoned Permian Basin Entrepreneur told me, "The legacy reserves out here (in the Permian Basin) give you geological control". He added that geological data is available in the form of historical well logs from vertical wells that have been drilled throughout the decades.

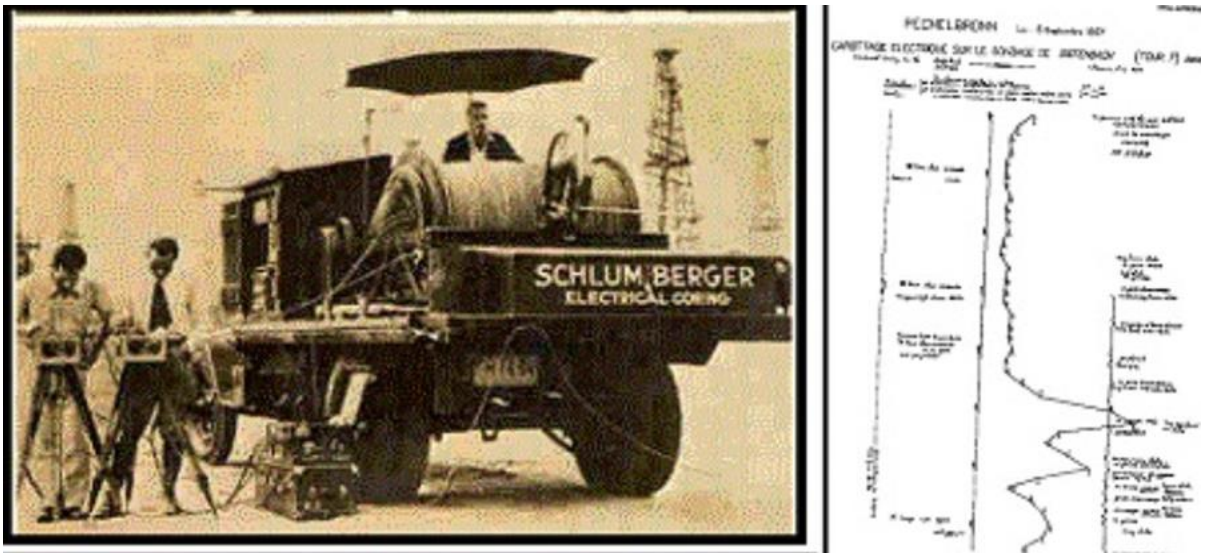
As detailed in Chapter 3, the first well drilled in the Permian Basin was in 1921 and the region has been highly prolific ever since, making up at least 10% of U.S. oil production since World War II, and consisting

of nearly 50% of production today, providing a rich database of well logs for Seasoned Permian Basin Entrepreneur and others to interpret (Federal Reserve Bank of Dallas 2023; U.S. EIA June 2023).

Prior to advances in fracking, as catalyzed by Mitchell, and horizontal drilling, as proliferated by the Independents, oil companies largely drilled vertical wells targeting conventional production from formations that had greater porosity. However, the commercialization and proliferation of fracking made reentering previously drilled vertical wells (and the zones that were previously viewed as uneconomical) now possible to economically extract hydrocarbons that were previously left behind.

Seasoned Permian Basin Entrepreneur pointed out that decades of well logs were like treasure maps for the Independents, providing maps for the resource-rich areas of the Permian Basin that were long overlooked. Coincidentally, the Permian Basin production history coincides with the introduction of electric logging by Conrad and Marcel Schlumberger in the 1920s, providing a geological historical record to the Permian over the life of its development, as illustrated in Figured 33 (American Oil & Gas Historical Society 2022).

Figure 33: Conrad and Marcel Schlumberger tested their electronic logging tool in 1927



Source: American Oil & Gas Historical Society 2022

Seasoned Permian Basin Entrepreneur told me, “Legacy well bores provide you a ton of information through the existing zones that are now being drilled horizontally, so you have well logs in all of those. So now that you know what to look for in terms of porosity and permeability, which in the old days, much of what is productive now (in a vertical well) you wouldn’t even perforate it to try to produce it because it was too tight, meaning it didn’t have enough porosity or pore space”. He added, “At least now with all the legacy information you can see what should be productive and where you want to drill your horizontal and what you want to try to complete, which zones that is, at a specific depth”.

Conversely, as discussed in the U.K. Geology section in this chapter, the limited drilling activity around the Bowland-Hodder Basin left operators guessing as to what they might confront. While in Argentina and China, legacy wells have informed their shale experiences somewhat, but to a much lesser extent relative to the data produced from the highly prolific Permian Basin, providing the U.S. shale experience a unique advantage through not just its attractive geology alone, but through a deep understanding of its geology. As such, Seasoned Permian Basin Entrepreneur shows U.S. operators had the unique advantage of knowing where to look.

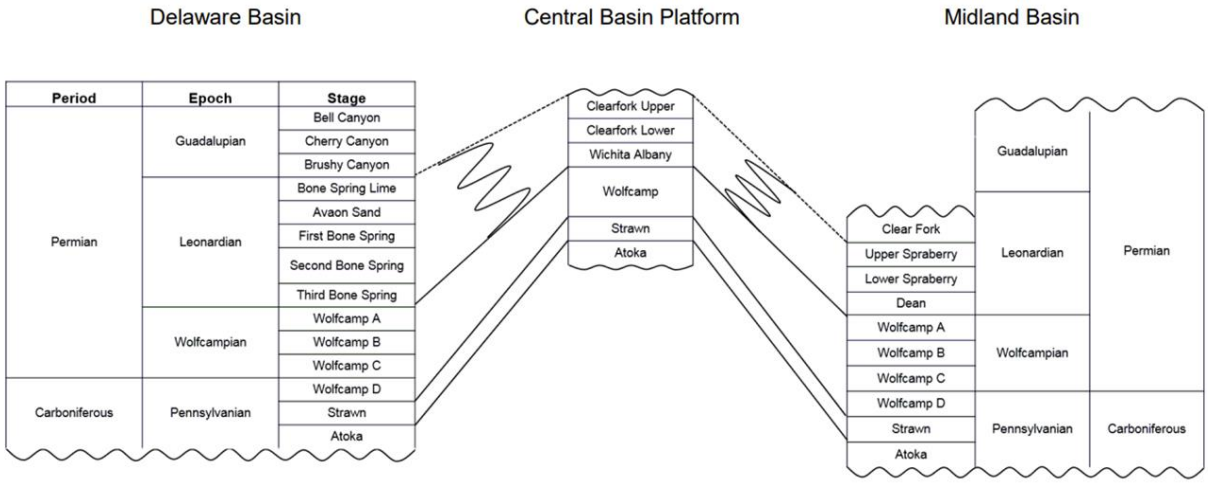
Reinforcing this and pointing to the specific reservoir (as illustrated in Figure 34), Seasoned Permian Basin Entrepreneur points to the “Wolfberry play (the Wolfcamp and Spraberry) has been drilled through forever and ever” and he highlights how old vertically drilled well logs paint a picture of where to drill horizontally (U.S. EIA 2018).

While seemingly obvious, but worth stating, both the attractiveness and the scale of the U.S.’s unconventional resources are key considerations for the SRDF due to the advantage that attractive geology has on the applicability of a new technology to catalyze development, and the importance of the scale from a market structure standpoint, particularly for LMEs. However, my primary research shows the legacy data is an underappreciated aspect of the U.S. shale experience and shows how the Independents built on and leveraged this historical data to unlock the shale revolution.

The scale of the U.S. unconventional resource base provided the incentives and rich mix of players that through competition and collaboration resulted in delineation and successful development, as discussed in energy policy literature review in Chapter 3, and argued in the Market Structure section of Chapter 5.

As such, the unique characteristics of the attractiveness of the U.S. geology coupled with the long-held institutional practice of characterizing a well while mapping out the broader reservoir in a mosaic manner for the greater benefit of future basin development, cannot be understated, my primary research shows. As a result, the U.S. shale experience (particularly when juxtaposed against the U.K. one) shows the significant benefit that historical institutional knowledge, practices, and data have when it comes to an understanding of geology for a country endeavoring to develop strategic resources.

Figure 34: Lithostratigraphic Model of the Permian Basin



Source: U.S. EIA 2018; U.S. Energy Information Administration based on DrillingInfo Inc., U.S. Geological Survey

7.11. Infrastructure, Geology, and Break-even Oil Prices

As an understanding of the geology increased, precision drilling proliferated, and shared infrastructure was leveraged, driving synergies among the Independents resulting in operating expenditure efficiencies, my primary research shows. As such, a critical aspect of the U.S. shale experience is how the proliferation of fracking during the 2010s led to a steady decline in the price to economically bring the commodity to

the market, expressed as the “break-even” price, which is “the price of oil needed to profitably drill a new well”, according to the Federal Reserve Bank of Dallas (Plante and Patel 2019).

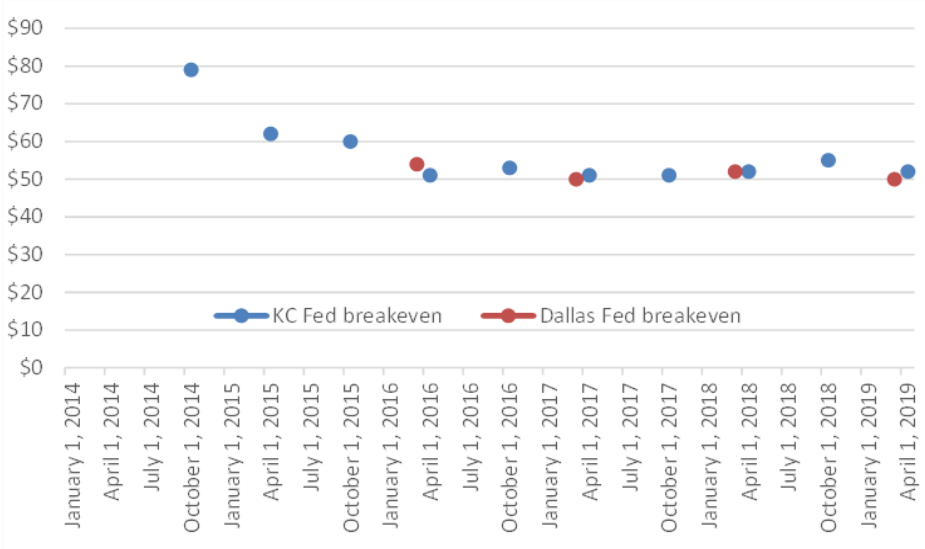
Infrastructure played a key role in this. The drop in break-even shale prices, as illustrated in Figure 35 below utilizing Federal Reserves of Dallas and Kansas City data, was driven by technological innovations, additional infrastructure, greater understanding of geological formations, and economies of scale through resource delineation, as detailed in the literature and my primary research. Figure 35 shows the average break-even dropping to around $50 per barrel (from $80), and the authors note low-end of the range break-evens at $23 per barrel (ibid).

While breakeven prices clearly trended down as the cycle unfolded, my primary research indicates market participants believe the extent of the efficiency gains were overstated and enhanced by financial engineering and a highly competitive infrastructure buildout. Private Equity Energy Investor stated, “when you take out all the financial engineering, the best shale break-evens were probably in the $50s, $40s on average (per barrel), and the average shale break-evens were in the $50s or $60 dollar oil realm (per barrel)”.

Private Equity Energy Investor added, “So probably $20 higher than was advertised”, as Figure 35 shows (Plante and Patel 2019). As it relates to financing infrastructure, Leading Energy Investor & Expert noted that competition for projects led infrastructure builders to become more aggressive with infrastructure project economics and project credit quality in the U.S.

Regardless of an overestimation, it is clear that the technical advances and infrastructure additions drove production increases and lower break-evens, highlighting the U.S.’s LME comparative advantage for radical innovation which gave the U.S. a head-start advantage for unconventional development, as shown by the SRDF.

Figure 35: Break-evens for U.S.-Based Operators, US$/bbl (WTI)



Source: Plante and Patel 2019

7.12. Legacy Infrastructure Played a Key Role for the U.S. Shale Experience; Preventing the Chicken-and-Egg Development Delays Being Experienced in Argentina

In contrast to the CME Chinese oil and gas infrastructure development experience, which has seen the state and NOCs lead infrastructure development (as discussed in this chapter), the U.S.'s energy infrastructure has been largely privately financed, stemming back to the emergence of the Integrated Oil Companies (IOCs), which participated in all aspects of development, and their predecessor, Standard Oil, through the integration of the Majors in the 1980s, and with the emergence of the "growth oriented" stand-alone midstream infrastructure companies that tapped into investor appetite for yield and the Independents' needs to bring their commodities to market, my primary research shows.

As discussed in Chapter 3 with the development of the Big Inch and Little Big Inch pipelines, these pipelines carried oil during World War II from Texas to the Northeastern U.S. and were government financed and owned, but then quickly divested, acquired by a private company, and converted to natural gas pipelines. This experience provides historical institutional insights into the ethos of the U.S. oil and gas industry and its LME market structure.

Even following World War II, when the U.S. government feared the military consequences of running out of oil, the quick divestiture of the pipelines highlights the intent on maintaining an industry-led market structure. This experience highlights that while the U.S. oil and gas infrastructure has been supported periodically through various development cycles, even in the most concerning periods of domestic energy security, the U.S. has maintained its LME approach and market structure (which was reinforced again in the 1970s energy crises, as shown in Chapter 3 as well).

Today, the U.S.'s gas pipeline network and infrastructure asset-base is vast, spanning around "3 million miles of mainline and other pipelines that link natural gas production areas and storage facilities with consumers" (NETL 2023). For the U.S. unconventional oil experience, the legacy infrastructure in the Permian in particular played a pivotal role in allowing the U.S. to capitalize on the commercialization of fracking and realize its head-start advantage awarded through its LME structure. The expansive U.S. oil infrastructure connects the major basins to central storage (in Cushing, Oklahoma), decentralized storage facilities, and refineries via pipeline and train, with support from trucking operations, that have been built throughout the cycles.

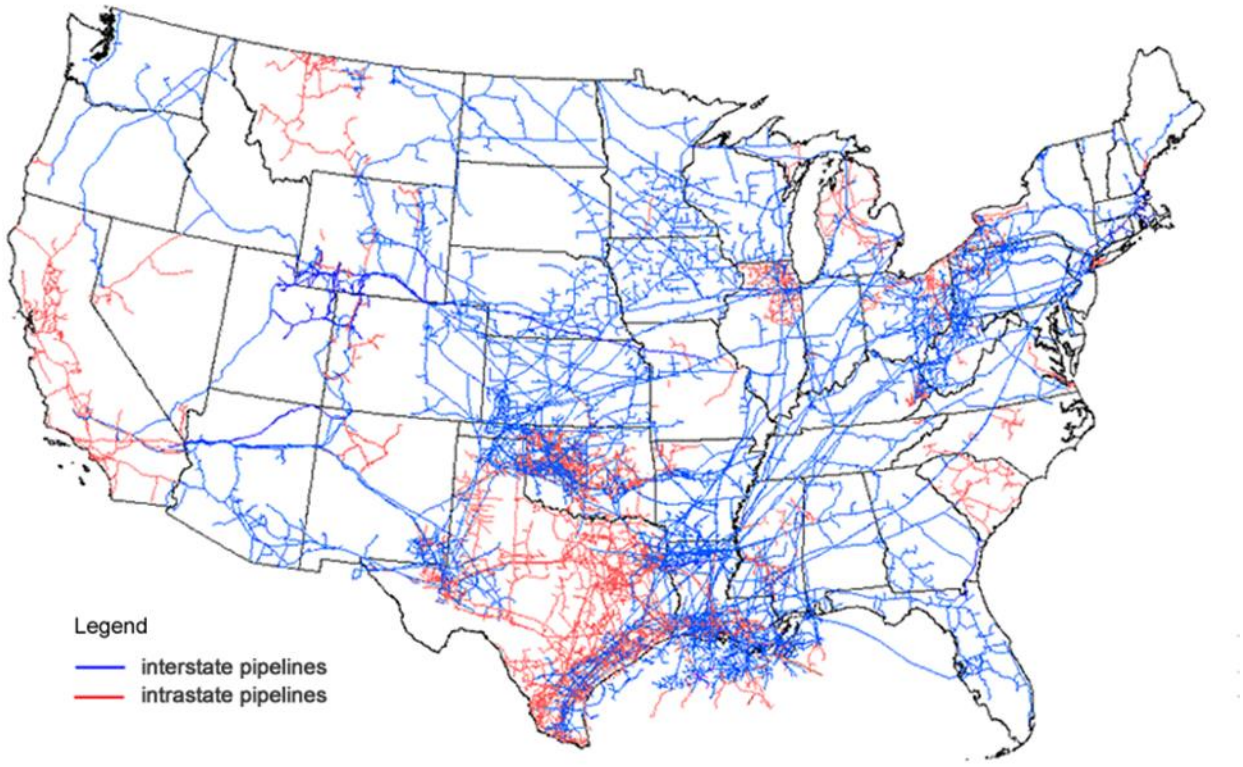
Seasoned Permian Basin Entrepreneur argues, "the whole shale play in (the) Midland part of the Permian Basin would have been very much delayed if you did not have the pipe, the infrastructure to take away natural gas or oil. So these legacy pipelines, for which there are a tremendous number of…without them you could not have had the play". Seasoned Permian Basin Entrepreneur adds, "People would have built them ultimately, but then you're in the chicken and egg situation, because no one's going to drill a lot of wells unless you can take the product away". Figure 36 highlights the vast scale of U.S. natural gas pipeline infrastructure (U.S. EIA 2022).

Seasoned Permian Basin Entrepreneur's chicken-and-egg point speaks to the aforementioned challenges discussed related to Argentina's natural gas infrastructure, which needs to be further built-out to support the Neuquén Basin continued production growth, as highlighted by the considerably less expansive, relative to the U.S., existing and proposed natural gas infrastructure in Argentina, as shown in Figure 25 (Raszewski 2022; Reuters n.d.).

As such, the broader multi-cycle U.S. infrastructure development experience evolved in-line with the fragmented and privately owned LME U.S. oil and gas industry experience, with one foundation built on the next, paving the way for the U.S.'s comparative advantage for radical innovation and its first-mover advantage for shale development.

Seasoned Permian Basin Entrepreneur's first-hand account of how legacy infrastructure catalyzed unconventional development in the Permian Basin provides an example for future researchers of how the Geology & Infrastructure Independent Variable within the SRDF can impact strategic resource development, particularly when compared to the U.K. and Argentina experiences, as this chapter shows.

Figure 36: Map of U.S. Interstate and Intrastate Natural Gas Pipelines



Source: U.S. EIA 2022

7.13. Troubles in Overestimating Legacy Infrastructure - Lessons from Argentina and the U.K.

I end this chapter drawing from my primary research and discussing an infrastructure theme that could be important for future researchers utilizing the SRDF and attempting to identify the significance of a country's legacy infrastructure to infer development outcomes. Rosy views of legacy oil and gas infrastructure enhanced both Argentina and the U.K.'s early attractiveness for unconventional development potential. My primary research suggests this is an easy mistake to make, particularly as so many seasoned experts and market participants I spoke with and studied were susceptible to this.

Robertson, Chevron spokesman, stated in 2014, "one of the unique things about Vaca Muerta from an international perspective is that it is in an area where you've already got oil industry activity...there is already an established oil industry in the region where the shale is. You've got service companies, you've got pipelines and infrastructure. You've got existing assets that do not need to be recreated (Bronstein 2014)." However, based on my various interviews, in retrospect, one of the key disadvantages of Argentina's shale sector is its lack of infrastructure. The challenges facing Argentina's shale infrastructure build-out discussed in this chapter reinforce that.

Regarding the U.K., its oil and gas industry does have meaningful legacy infrastructure, a capable workforce, and it has substantial institutional capacity for regulating oil and gas operations, despite organizational changes. It also has a deep labor pool and industry groups to draw from, as discussed in the U.K. infrastructure section in this chapter.

However, in retrospect, the U.K. experience included an overestimation of infrastructure capacity and service expertise, as well as little-to-no legacy relevant geological data for the Bowland-Hodder shale (the importance of this was clear from the U.S. experience). Further, the sheer lack of new equipment was more of a gating factor for development versus an absence of top service teams. Argentina's lack of service talent is more a resource allocation and risk-reward factor for the diversified oil service companies, including considerations on the country's industry market health and a view on the underlying companies' outlook, my primary research showed. As the U.K. does not have the same monetary and currency challenges as Argentina, it is not clear that the U.K. would have also lacked the service company presence as development unfolded.

As mentioned, Riverstone conducted an assessment of various shale basins globally prior to its investment in Cuadrilla in February 2010. In addition to Riverstone's comfort around the Government variable and political economy in the U.K., the country's legacy infrastructure also played an important role in honing in on the U.K. UK Oil & Gas Executive explained Riverstone's U.K. infrastructure misconception, "in the early stage of Riverstone (in their global shale prospecting efforts around 2008-2010), people really started looking at this and ranking shale opportunities around the world". Riverstone saw the U.K.'s onshore gas infrastructure, established oil service industry, and onshore assets such as drilling rigs as evidence of an attractive starting point for U.K. shale. However, in hindsight, UK Oil & Gas Executive told me, "As we and others got into it, we probably realized that we should have scored the U.K. much lower on infrastructure".

While one Argentine oil & gas expert I spoke with, noted that the conventional development established ample midstream and pipeline capacity which is being leveraged today, these views were refuted by another one I spoke with. The positive view highlighted the country's rich natural gas development history, which dates back to the 1880s, provides a deep intellectual workforce foundation for development, similar to the U.S. oil experience, which dates back to the 1800s as well.

Further, this positive view from the Argentine expert highlighted how significant legacy infrastructure was built during the 1980s and 1990s in the Neuquén Basin as the area was home to around 35% of domestic natural gas production, which came from conventional sources. This legacy infrastructure included gathering and export pipelines that are leveraged today, which are capable of moving today's gas to various neighboring countries, including Chile and Brazil.

The expert expressing this positive view also noted the ample land and water availability in the Neuquén Basin as an advantageous foundation for development, highlighting the ample river water and lack of competing agricultural efforts. While true for the early stages of development, the country's current challenges discussed in this chapter related to financing and building oil and gas infrastructure to keep up with the Neuquén Basin's growth present are counter to this expert's positive view on the state of Argentina's oil and gas infrastructure, and also reflect the opposite of the U.S. shale infrastructure

experience, as noted by Seasoned Permian Basin Entrepreneur, Leading Energy Investor & Expert, and Private Equity Energy Investor, who highlighted how infrastructure was ultimately overbuilt in U.S. (to the benefit of the producers).

The Argentine expert expressing the negative view of Argentina's infrastructure stated, "Argentina is woefully behind when it comes to infrastructure", on a relative basis to other countries that are producing as much oil. Further, this expert highlighted that while there are a lot of international operators in Argentina pursuing unconventionals, the "sophisticated machinery" is not there. Regarding Argentina's midstream infrastructure, "There's certainly a lack of pipe", highlighting production in areas where there are no pipelines, forcing it to be trucked at higher costs.

"There's no financing for midstream assets", I was told. This forces independent E&Ps in Argentina to truck barrels to refineries, as their ability to finance pipelines is limited. As highlighted in Chapter 6, the ability for the Majors, NOCs, and large integrated players to finance midstream assets on their balance sheets is another strategic benefit over the independent E&Ps. Without the development of capital markets for these important sub-sectors, overall shale activity in Argentina is likely to be held back.

On the positive side, several market participants acknowledged that Argentina's long hydrocarbon history has contributed to the country's general sector knowledge and expertise, including Retired Argentina Oil Executive and Argentine Oil & Gas Investor; however, Former Development Bank Energy CIO told me that the market challenges hinder top talent. Former Development Bank Energy CIO told me, "We have a number of service companies as well, but there are a lot of questions today because a few of them have left or are leaving Argentina, and so we have seen less competition".

Cuadrilla came to realize that the U.K. onshore service sector was "pretty out of date", according to UK Oil & Gas Executive, particularly considering the ongoing advances of the U.S. unconventional sector, which was "moving at lightning speed". Most of the U.K.'s expertise was related to the offshore oil and gas industry, from the aging North Sea, with ineffective onshore equipment such as drilling rigs and support assets. Lastly, the U.K's established onshore gas infrastructure 'really isn't set up for new onshore oil gas being produced", UK Oil & Gas Executive said, and added, "it was incredibly slow and expensive and difficult and wasn't much of an advantage on actually putting in new infrastructure ourselves".

Like the U.K., the relevance of Argentina's legacy oil & gas infrastructure for unconventional development appears to have been overestimated by first movers. The legacy infrastructure in place is for conventional oil and gas, which does not include transportation and storage infrastructure for the large volumes of water needed for injection and as a byproduct.

Notably, "the development of Vaca Muerta poses significant infrastructure and logistical requirements", which can be seen today (Gomes and Brandt 2016). Initial hopes that promising geology would attract a lot of independent E&P companies and in-turn result in a meaningful infrastructure expansion has not come to fruition. Conversely, as development has unfolded, the higher start-up costs associated with the lack of broader infrastructure has discouraged these companies from entering the basin, echoing Seasoned Permian Basin Entrepreneur's "chicken-and-egg" comment mentioned in the U.S. infrastructure section of this chapter (Castilla 2018).

Downstream infrastructure development has not meaningfully progressed either in Argentina. One of the Argentine experts I spoke with noted, "Refineries are not well kept. They are pretty much abused to the point where they really need to shut down for an extended period of time in order to be updated". Regarding the service industry and available equipment in Argentina, the expert stated, "They need sophisticated machinery, which is not there". The expert added, "not to say that they're in the Stone Age in Argentina", but continued that the country would benefit from even more basic infrastructure, like roads and trucks". The expert notes that the equipment in the country is simply old and not sophisticated, including pump jacks and other drilling apparatus, for example.

Argentina VP of Exploration told me it costs roughly $10 million USD to drill a vertical shale well in Argentina, largely due to a lack of drilling and service capacity, compared to as low as $2 million in the U.S. shale plays (Somasekhar 2021). Inferior drilling equipment as well as less efficient service crews are likely driving factors. Robertson's 2014 statement about legacy oil & gas infrastructure in Argentina seems to highlight the potential for overestimating relevant assets in place for unconventional development (Bronstein 2014).

In many ways, the insufficient infrastructure in Argentina is a result of the institutional arrangements between the Government and Capital Markets, adversely impacting infrastructure development. Specifically, the lack of oil & gas infrastructure in Argentina, particularly midstream and downstream, is largely due to government policies around capital controls and uncertainty around policies, according to one expert I spoke with, who explained investors want to know "there's not going to be a government that's going to overturn, export of dollars or earnings".

7.14. Chapter Conclusion and Suggestions for Future Research

In this chapter, I showed how the Geology & Infrastructure variables are critical for the SRDF. Further, I showed that it is not just the absolute amount of the resource, or the attractiveness of the underlying geology, but that it is the historical institutional aspects of these variables, notably including a country's understanding of its resources (as shown by the U.S. experience), and the way in which a country's market economy impacted its institutional arrangements with infrastructure development (as shown through the Chinese and American cases). As a result, the manner in which the U.S. legacy infrastructure was built-out through its LME approach and then rapidly built upon for the shale development cycle shows the importance legacy infrastructure can have on strategic resource development, as Seasoned Permian Basin Entrepreneur argues.

Juxtaposing the Argentina and U.K. experiences only enhances the realization of the benefits of the U.S.'s approach and the comparative advantage LMEs have for radical innovation in strategic resource development. As such, this chapter provides insights for future researchers endeavoring to infer strategic resource development through the analysis of various countries' Geology & Infrastructure variables.

Further, the current fifth wave of Chinese oil and gas market structure and the recent reorganization of China's midstream sector presents a completely contrasting model to the decentralized U.S. infrastructure buildout. In the future, a retrospective review of the efficiency gains this approach might yield will provide critical empirical evidence for the SRDF and future strategic resource development inquiry. As mentioned, future researchers will need to affirm my hypothesis that this transaction coincides with the start of China's comparative advantage for incremental innovation, as made possible by their CME, and as seen through the SRDF.

As such, this chapter provides valuable insights for future researchers exploring the potential of strategic resource development across various countries and utilizing new technologies. While the chapter's title might suggest the Geology & Infrastructure Independent Variables for the SRDF are one dimensional and focused solely on the attractiveness of the underlying resource or the presence of the overarching infrastructure, it is not.

The significance of this chapter highlights that the institutional arrangements of market economies will present clues for how market participants will either struggle to develop strategic resources or successfully leverage past institutional resource development experiences for the build-out of the strategic resources of the future.

Chapter 8: Conclusion and Recommendations for Future Research

This dissertation has developed a new framework, the Strategic Resource Development Framework (SRDF). This framework has been developed for the analysis of strategic resource development, and in this dissertation, I have shown how it can be utilized for a particular resource across specific countries.

My dissertation focuses on utilizing the SRDF for analysis into unconventional oil and gas development; however, the SRDF can be applied to other strategic resources found in other countries. For example, it could present important questions, insights, and inference into the future of critical minerals or new strategic natural resources, as these and future inputs of the global economy are dispersed across different countries, and political economies, with development underpinned by the various SRDF Independent Variables.

The culmination of my primary and secondary research is detailed in Figure 37 below by country and Independent Variable. The findings shown in Figure 37 are my interpretations and summaries of the consensus and status of each of the attributes of the Independent Variables analyzed across the countries studied.

While some interviewees might deviate somewhat from my interpretation of the consensus findings as detailed below, I believe the consensus views by country and Independent Variable well represent the status of the strengths, weaknesses, and country-specific nuances of the global unconventional oil and gas experience as viewed through the SRDF.

Figure 37: Overview of Independent Variables of Sample Set for Unconventional Oil & Gas Development

Country & Market Economy Type	Government	Capital Markets & Market Structure	Geology & Infrastructure	Political Opportunity Structure
Argentina Mixed Market Economy (MME)	Polycentric governace with strong federal and provincial influence, limiting local Political Opportunity Structure access.	Weak capital markets challenged by in-country credit and monetary concerns. Somewhat developed in-country credit system. Market structure includes quasi-NOC, Majors, and some Independents. Market participants limited by liquidity challenges.	Highly attractive geology from permeability and porosity perspective characterized by multiple layers of economically extractable resourses. Decent understanding of resource through legacy conventional oil and gas operations. Some legacy infrastructure, but inadequate to maintain production growth.	Strong labor support outweighs local opposition access to Political Opportunity Structure (POS). Indigenous groups struggle to gain POS access. Opposition group demonstrations have failed to achieve more than "transactional" relationship with industry and government over development.
China Coordinated Market Economy (CME)	Unitary governance with strong alignment at national, regional, and local levels.	Strong state financial support. Market led by small group of State Owned Entities (SOEs).	Significant resource but highly challenged geology from permeability and porosity perspective characterized by jagged and inconsistent layers of resource. Challenging geology has limited development; however, there are indications these challenges are being overcome. SOE owned infrastructure (developed by NOCs but recently reorganized for broader industry efficiencies).	Unitary governance structure coupled with limited national-led regulatory structure provides low levels of local Political Opportunity Structure access. Limited local POS access has led to demonstratoins focused on water and earthquakes.
U.K. Liberal Market Economy (LME)	Polycentric governance with strong local representation.	Established capital markets most similar to U.S., and potential for fragemented market structure as well (also like U.S.).	Challenged geology characterized by inconsistent formation and prevelance of fault lines. Limited understanding of geology due to little legacy onshore development in shale areas. Overestimation of relevance of onshore oil & gas infrastructure.	Polycentric governanace and strong local representation led to opposition groups stopping development by influencing the regulatory framework. POS access of regulatory regime ahead of "fit-for-purpose" local and regional regulatory framework being enacted led to fracking ban.
U.S. Liberal Market Economy (LME)	Polycentric governance with strong local representation.	Deep and dynamic capital market systems, with significant equity, debt, and reserve-based lending. Highly fragmented market structure characterized by over 9,000 independent oil and gas companies.	Vast resource spanning multiple basins with attractive geological characteristics coupled with significant understanding of resource base due to prolific legacy production. Substantial legacy infrastructure built over multiple decades of industry-led development.	Polycentric governanace and strong local representation led to New York fracking ban as the result of a coordinated and systematic opposition effort. Scope for high levels of POS access ahead of "fit-for-purpose" state level regulatory regimes enacted.

Source: Zachary F. Sadow, Researcher's findings

In many ways, the shale development cycle has been a strategic resource race, with the U.S. capturing outsized market share of global oil and gas production as a result of the shale revolution. As such, my dissertation shows that the U.S. leveraged its LME comparative advantage for radical innovation to achieve a head-start for this strategic natural resource race. There will be more races. My hope is that this dissertation can inform future researchers on how they can utilize the SRDF, as I have, to infer future strategic resource development outcomes.

As detailed in Chapter 3, the U.S.'s policy response to the natural gas crisis in the 1970s prompted various government initiatives which led to the commercialization of fracking in the 2000s (NETL 2007). Policy initiatives to encourage unconventional development in the 1970s to 1990s were largely absent in the other countries studied. A cross-country comparative analysis showed little-to-no government-led research and development or financial support for fracking in Argentina, China, or the U.K. during this period, providing the U.S. shale experience a significant head-start advantage due to the institutional responses to the 1970s gas crisis. Another important takeaway from my dissertation is that the race is long. While the U.S. has realized its comparative advantage for radical innovation and achieved a head-start, it is not over. By focusing on a *comparative* advantage versus an absolute one, Hall and Soskice (2001) highlight the relative gains and what incremental investment should target. This suggests LMEs should be focusing on breakthroughs that can revolutionize strategic resource industries, similar to how fracking revolutionized the global oil and gas industry.

Kemp (2022) asks, "Is the U.S. Shale Revolution Over?". I argue it is. This does not mean that the oil and gas industry is going away. I also argue the opposite for this point, reinforcing the need for continual evolution of processes, technologies, and regulations. The data shows that despite the unfolding energy transition, oil and gas demand will remain sizable for a long time, even as it eventually enters structural decline (IEA 2023).

However, the revolution which took place, as catalyzed by Mitchell Energy and proliferated by independent oil companies (Independents) in a unique American foundational nature, as discussed in Chapter 3, is over.

The unconventional oil and gas industry in the U.S. has reached maturity and there are now diminishing returns in shale development relative to new energy transition opportunities, which the U.S. and other LMEs are positioned to unlock. As such, there are new strategic resource races for LMEs to run, with the benefits of revolutionizing new technologies for the sustainable development of the resources of the future waiting to be realized. This dissertation shows that the race was won, and it is now time to pass the baton and start again.

Where does this leave the broader shale cycle? I have argued that it is now time for the MMEs and CMEs to further proliferate the shale revolution through incremental improvement, while LMEs (including the

U.S.) use their comparative advantages to unlock new radical innovations for the development of the strategic resources of the future.

There are clear exceptions, where new forms of radical innovation are waiting to be unlocked within the mature oil and gas market, despite its eventual structural decline, setting off new cycles of growth within the broader oil and gas market. For example, I believe critical mineral recovery within the oil and gas industry is one of these fields.

There are clear signs that CME-based China could be well positioned to carry on in unconventional oil & gas, particularly having seemingly overcome previously thought insurmountable technical challenges (Slav 2018; Gagliardi 2015). Conversely for Argentina, unfortunately, despite its attractive geology, there are signs that the MME country could face challenges to pick-up where the U.S. left-off, missing an opportunity to drive incremental innovation and rather just muddling through the shale opportunity.

Specifically, in Chapter 6, I argue that Argentina's MME leaves it vulnerable to its shale experience disappointing as a result of inadequate state support and its inability to attract sufficient capital for the infrastructure needed to support further production growth. Building on the VoC framework, my primary research shows that institutional arrangements between the state and labor organizations prioritizes a market structure that makes it highly challenging for firms to reduce workforce during commodity market downturns, a key aspect of the U.S. shale experience (Hall and Soskice 2001).

As such, this leaves Argentina and its quasi-NOC development approach ill-funded from a state-support standpoint and also inadequately equipped to attract the institutional investors which expect a focus on returns over national priorities and past policy commitments (Ikenberry 1986, 1988). As such, reforms should be considered, beyond the ones currently contemplated as part of the LNG bill, to either garner additional state support or attract international investment.

In Chapter 7, I argue that China's recent shale technological advancements, continued production growth (albeit below internal targets), and recent reorganization of infrastructure assets into a newly formed SOE mark the early stages of the commencement of the country's comparative advantage for incremental innovation as it relates to shale development.

As such, I show how the previous waves of China's oil and gas industry evolution have brought the country to this position. This is due to its strongly state-supported NOC-led infrastructure development initiative, followed by its recent repositioning of these assets to enhance competition among its three leading NOCs for the broader benefit of the state's energy security goals.

One of the key themes of the Chinese Geology & Infrastructure section in Chapter 7 is that a reinforcing cycle of state-support, reforms, and continual learning, underpinned by a relentless drive to unlock the potential of the country's vast unconventional resources, is showing promise following over a decade of outside observer doubt. As such, I believe the current Fifth Wave of China's oil and gas Market Structure, as outlined in Chapter 7, could defy critics and unlock a comparative advantage for incremental innovation.

The ramifications for China's unconventional development potential are profound, not only for the country's energy security and the broader global energy markets, but also as a potential model for strategic resource development for various MMEs, including in Southeast Asia and South America that could be torn between LME and CME development approaches for critical minerals and the resources of the future. Proving over a decade of doubters wrong could provide credibility in a new era of international energy and strategic resource development.

The U.K. shale experience is a cautionary tale in many ways. It should not be overlooked or reduced to the British people simply just not wanting fracking, as it can be overly simplified in retrospect (Excell 2022). As detailed in Chapter 4, the U.K.'s LME structure provided POS access points ahead of a fit-for-purpose regulatory regime being put in place, providing local opposition groups a window to substantially affect the development outcome. Other actors in LMEs embarking on similar strategic resource development initiatives would benefit from studying the U.K. shale experience and utilizing the SRDF in their policymaking and resource development approach.

My research also shows how in racing to replicate the U.S.'s experience, steps were not taken in the U.K. to consider the advantages of the legacy infrastructure enjoyed by the U.S., including the rich data that the historical U.S. oil industry provided the shale-focused Independents.

Instead, the U.K. experience shows how development was attempted to be ushered through against a belief that the country's limited conventional onshore hydrocarbon experience coupled with its well-

established offshore gas industry would be enough to follow in the U.S.'s footsteps, or that a similar regulatory and capital market system was sufficient. It was not.

As such, the U.K. experience should provide valuable insights into any LME endeavoring to develop strategic natural resources, due to the risks that polycentric governance provides to development as a result of Political Opportunity Structure access points.

The U.K. experience should also be viewed in relation to the New York experience. Like the U.K., the ban on fracking in New York should not be viewed through an isolated lens. It would be easy to dismiss the unique New York anti-fracking movement, which coincided with the release of the documentary *Gasland*, and included celebrity involvement, as a one-off or unique case, as detailed in Chapter 4. It was not. My primary research shows that a highly coordinated, organized, well-funded, and systematic opposition campaign can exploit Political Opportunity Structure access points in polycentric governance prior to a fit-for-purpose regulatory regime being enacted.

As such, the U.K. and New York shale experiences should be viewed in parallel, providing unique insights for researchers aiming to infer resource development outcomes in LMEs ahead of regulatory regimes being implemented. Juxtaposing the New York experience are other left-leaning states with more limited Political Opportunity Structure access points due to fit-for-purpose regulatory regimes being in place ahead of development, including New Mexico, as my primary research shows, and Colorado. These states aim to balance economic development objectives with local stakeholder and environmental considerations.

Murtazashvili and Piano (2019) argue that why the "shale boom was even possible" started with economic institutions, pointing to institutional property rights and "spontaneous, market-driven solutions to contracting problems", and that the "American regulatory response" was "appropriate for the challenges arising from shale gas extraction". I agree with these assessments and build on them by showing how the shale revolution was catalyzed and proliferated as a result of these institutional underpinnings through my primary research.

However, my research also builds on Wang and Krupnick's (2013) early retrospective review of what "led to the boom", adding how polycentric governance, which Murtazashvili and Piano (2019) argue was an

enabling factor, has duality within LMEs that present development risks through Political Opportunity Structure access points, as seen in the New York and U.K. experiences.

Political Opportunity Structure is also important within unitary governance structures where governments aim to avoid volatile and transactional relationships with local stakeholder groups that feel left out of the development process. My primary research into Argentina, as it relates to the Mapuches and their lack of Political Opportunity Structure access points for shale development, represents a warning for this risk.

As such, I introduce my new framework for strategic natural resource development (the SRDF) with the hope that researchers will consider development risks, local stakeholder considerations, and various types of governance as part of broader strategic thinking, as they help inform policy and infer development outcomes. I believe this will lead to more thoughtful and sustainable resource development, further aligning local interests with national strategic objectives.

Further, the SRDF presents opportunities for a broad range of actors to incorporate into their outlooks and decision-making processes. As such, I hope those that utilize the SRDF for future strategic resource development will optimize and build on it for the unique characteristics of countries, technologies, and strategic resources for the future.

With this new framework, I hope future generations will benefit from the opportunities that our abundance of resources, when developed thoughtfully, may bring.

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