GLOBALISATION AND SUPERSTAR FIRMS



CHARIKLEIA VAVOURA

Thesis submitted to the University of Nottingham

for the Degree of Doctor of Philosophy

SCHOOL OF ECONOMICS

UNIVERSITY OF NOTTINGHAM

FEBRUARY 2018

Acknowledgements

I am grateful to Giammario Impullitti and Spiros Bougheas for their suggestions and support. I also want to thank Paolo Epifani, Peter Neary and Holger Breinlich for their comments and suggestions. Finally, I would like to express my special thanks to Ioannis and Athena Vavoura, Stelios and Soulis Korkotsides.

Abstract

Strong empirical evidence points towards an extremely skewed distribution of exporters, corresponding to a few "superstar" firms operating alongside a fringe of small competitors. Superstars are characterised by superior efficiency, increased access to financial capital and, unlike fringe firms, by the ability to internalise the impact of their behaviour on the market. We develop a model in order to examine how productivity differences result in different abilities to invest in cost-reducing innovation which, in turn, allows firms to expand to the extent that they can exploit their market power. We then introduce international trade into this model and calculate the impact of increasing trade openness on aggregate welfare. We show that incorporating productivity heterogeneity jointly with differences in strategic behaviour generates a composition effect that dampens the pro-competitive effect of trade liberalisation. This effect materialises through a market share reallocation from smaller towards larger rivals. We find that, although trade always increases welfare by reducing the average markup and markup heterogeneity, gains from trade are lower when market power distortions are more severe. Consequently, in the presence of such distortions, size-dependent policies could have a welfare-enhancing role to play. We then use an appropriately augmented version of our model to account for the role of credit constraints differences between superstars and smaller enterprises. We examine how an economy's financial development affects the welfare gains from trade and explore the role of large firms. We show that trade benefits less financially developed countries more and that the oligopolistic inefficiency resulting from the presence of large firms crucially alters theoretical predictions of the gains from trade. We go on to investigate the effect of trade with a more financially developed partner and find that it could act as a substitute for financial development by diminishing the impact of domestic credit market and oligopolistic inefficiencies.

Contents

1 General Introduction **6**

1.1 Introduction 6

1.2 Stylised facts 14

2 The Rise of The Superstar Firms **19**

2.1 Introduction 19

2.2 Setup of the model 23

2.2.1 Preferences and demand 23

2.2.2 Production 27

2.2.3 Equilibrium 35

2.2.4 Welfare 39

2.3 Equilibrium analysis 39

2.3.1 Subgame perfection 39

2.3.2 Numerical comparative statics 41

2.4 Conclusion 47

3 Liberalising Trade in The Shadow of Superstar Firms **49**

3.1 Introduction 49

3.2 Setup of the model 52

3.2.1 Preferences and demand 52

3.2.2 Production 55

3.2.3 Equilibrium 60

3.2.4 Welfare 62

3.3 Equilibrium analysis 63

3.3.1 Iceberg trade cost 64

3.3.2 Size-dependent policy analysis 69

3.4 Conclusion 73

4 Trade, Mixed Market Competition and Credit Constraints **75**

4.1 Introduction 75

4.2 Closed economy model 81

4.2.1 Preferences and demand 82

4.2.2 Production 83

4.2.3 Equilibrium 85

4.2.4 Welfare in closed economy 93

4.3 Open economy model 94

4.3.1 Symmetric trade 97

4.3.2 Welfare under symmetric trade 102

4.3.3 Asymmetric trade 105

4.3.4 Welfare under asymmetric trade 109

4.3.5 The role of mixed markets 111

4.4 Conclusion 112

5 Concluding Remarks **118**

6 Appendix **120**

6.1 Appendix for Section 2 120

6.2 Appendix for Section 4 129

References **135**

1 General Introduction

1.1 Introduction

Global markets are extremely concentrated. In the case of the U.S., the largest 1 percent of trading firms -formally defined as the *superstar* firms- are responsible for over 80 percent of the value of total trade (Bernard et al., 2007). The same pattern is being repeated in Europe and most developed and developing countries, with superstars consistently accounting for more than 45 percent of total exports (Freund and Pierola, 2015; Mayer and Ottaviano, 2008). Research on superstar firms dates back to Rosen (1981) but interest in the field has recently intensified due to an emerging new empirical literature highlighting globalisation as, arguably, the most powerful force behind their increasingly dominant presence (Autor et al., 2017; Head and Spencer, 2017). The theoretical literature, on the other hand, by emphasising the increase of competition as a robust effect of globalisation, has not gone far enough in explaining how the growing influence of superstar firms can be reconciled with this pro-competitive effect that international trade is predicted to trigger (Neary, 2010; Bernard et al., 2009; Wooldridge, 2016). So how do superstars emerge? What is their effect on the size of gains from globalisation? And, in the presence of these large companies, how are the gains from trade affected by financial markets?

In this thesis, firstly, we develop a simple model to explain the emergence of superstar firms. We argue that some firms grow large due to a lucky draw from a common productivity distribution and successful cost-reducing innovation. Most of their competitors, however, remain small, constrained by their low productivity draw and their limited access to credit. As a result, a small number of extremely productive firms grow into superstars while they compete with a fringe of small and relatively inefficient counterparts. Secondly, to this model economy we intro-

duce international trade and calculate the welfare gains from trade liberalisation. Thirdly, we explore the idea of small firms' limited access to credit. We use a version of our model augmented appropriately to allow for the introduction of credit constraints that differ between large and small firms. We use this model to examine how firm-level credit constraints and the behaviour of large firms affect the welfare gains from trade. Finally, we look into the link between financial development and globalisation and how it is altered by the presence of superstar firms.

In the first chapter titled "The Rise of The Superstar Firms" our goal is to present a simple mechanism that allows some firms to grow to the extent that they become superstar firms. To answer the question of how such firms could emerge endogenously, our natural starting point is to refer to the empirical literature and examine how superstars differ from small and medium enterprises. Large firms are characterised by superior productive efficiency and the ability to charge a higher markup of price over marginal cost (Mayer and Ottaviano, 2008; De Loecker and Warzynski, 2012). More crucially, they are capable of exploiting their strategic market power (Hottman et al., 2016) and internalise the effect of their decisions on domestic and export market aggregates. As a result, unlike their smaller competitors charging a markup consistent with monopolistic competition, currently the workhorse of international economics, the largest, most efficient suppliers exhibit oligopolistic behaviour and choose their markup in a strategic fashion. This pattern cannot be generated by the standard models of firm heterogeneity where firms only differ in their productivity, regardless of whether they maintain the assumption of monopolistic competition, like Melitz and Ottaviano (2008), or follow the alternative market structure assumption of pure oligopoly, like Atkeson and Burstein (2008).

We propose a two-period model with free entry that highlights the specific

conditions required to generate the market power heterogeneity that we observe in the data. On the consumer side we consider a CES demand system which enables us to abstract from any demand-driven markup heterogeneity. On the producer side, we start off with a newly-created industry (period one) populated by monopolistically competitive firms that incur a sunk entry cost and then draw a productivity that shapes accordingly their marginal cost of producing a variety of a differentiated good. Similarly to Melitz (2003), although under CES and monopolistic competition all firms charge the same constant markup, if at least some firms get luckier in their draw, these firms will have a higher market share and accumulate a higher profit over time. The most successful among firms can then choose to invest part of their accumulated profit in a discrete innovation in order to reduce future costs. Incorporating the micro-level data suggesting that small firms are more financially constrained (Cleary, 2006; Beck and Demirguc-Kunt, 2006; Beck et al., 2005), less profitable firms are unable to invest. Having increased the productivity gap that separates them from their competitors, innovators are now responsible for a disproportionately large market share and, as a result, have a significant influence on market aggregates. We find that when the initial productivity distribution is sufficiently fat-tailed and when the cost of innovation is sufficiently low, it becomes optimal for the most efficient successful innovators to switch from a monopolistically competitive to a Cournot oligopolistic behaviour. We end up with a mature industry (period two) governed by a *mixed market* structure consisting of two subsectors governed by distinct forms of competition, namely monopolistic competition and oligopoly in line with Hottman et al. (2016).

The mixed market structure was initially developed as a closed economy model by Shimomura and Thisse (2012) and has appeared in trade literature in Parenti (2017). However, both of these models are static and operate under the assumption of a fixed number of large firms which are born with the ability to be-

have strategically. By introducing a dynamic perspective and by endogenising, via innovation, the choice of adopting a strategic behaviour, our study extends the mixed market structure to a subgame perfect equilibrium result of firm dynamics. By incorporating a free entry condition we are able to illustrate the relationship between product innovation and competition. We show that as markets become more competitive innovation follows an inverted-U pattern that peaks at relatively low levels of competition, echoing the endogenous growth literature following Aghion et al. (2005).

Having established the existence of behavioural differences between large and small firms and having rationalised how these differences could arise endogenously, we move on to the second chapter titled "Liberalising Trade in The Shadow of Superstar Firms" where we aim to explore the size of welfare gains from trade when these differences are explicitly modelled. We use the mixed market competition framework developed in the first chapter, introduce international trade and calculate the welfare gains from decreasing the trade cost. We show that the behavioural differences between superstars and smaller firms account for their well recorded different abilities to pass-through (Mayer et al., 2016): a decrease in the trade cost will only partly be passed on to the prices of large oligopolists who are able to adjust their markups, as opposed to small monopolistically competitive firms that cannot. We find that bringing together the two established but hitherto unrelated market structures of oligopoly and monopolistic competition in an open economy setup, the result is not a simple combination of the variety gains predicted by the monopolistically competitive Krugman (1980)-type models with the pro-competitive gains predicted by pure oligopoly as in Brander and Krugman (1983). Differences in strategic behaviour give rise to a composition effect of these two traditional sources of gains. This effect materialises through a market share reallocation from smaller towards larger players which

dampens the pro-competitive effect of increasing openness and reduces welfare gains from trade. As a result, trade liberalisation disproportionately benefits large firms whose gains from the decrease in the cost of exports dominates their losses from increased competition in the domestic market. This result is in line with the empirical literature that portrays superstars as the big winners of globalisation (as, for example, in Bernard et al. (2009)). This composition effect could not occur without the presence of small firms since they largely absorb competitive pressures, shielding large firms from increased import penetration.

We show that superstars are the big beneficiary of globalisation because of their increased productivity, as demonstrated by their lower prices generating increased market shares, and due to their oligopolistic nature, as manifested in their unique ability to vary their markups with their market shares. Trade triggers two different types of market share reallocation away from the smaller and towards the larger firms: a reallocation which resembles the Melitz (2003)-type selection and is due to the efficiency advantage of superstar firms and a reallocation that is exclusively attributed to the unique ability of superstars to charge variable markups. Our study is, to our knowledge, the first to analyse these two coexisting mechanisms and their effect on welfare. We find that, as in Mayer et al. (2014) and Edmond et al. (2015), increasing openness to trade decreases the average markup and markup heterogeneity and thus trade always raises aggregate welfare. However, the reallocation generated by differences in market power is inefficient. We show that this inefficiency is more evident in more concentrated industries characterised by more severe initial markup distortions. In these industries, where large firms are more rare and, therefore, more powerful, the welfare boost from trade liberalisation is unlikely to be significant. In fact, the aforementioned inefficient reallocation resulting from asymmetric strategic market power, creates a role for size-dependent trade policies which, in polarised markets, could turn out

to be socially desirable. In comparison to the mixed market literature, our framework is the first to analyse the composition effect of oligopoly and monopolistic competition under trade and derive specific policy implications.

In the first and second chapter of the thesis we work under the assumption that firms only rely on their own past profits for funding. This assumption is crucial because, in the absence of financial institutions, firms with bad initial productivity draws are credit constrained, unable to innovate and end up falling too far behind their lucky counterparts. In the third chapter titled "Trade, Mixed Market Competition and Credit Constraints" we investigate the role of financial markets in polarised economies where few large companies co-exist with numerous smaller rivals.

The extensive literature that lies at the intersection of trade and finance has established that firms are constrained by the stage of financial development of the country where they are located (Bekaert and Harvey, 1995; Bekaert et al., 2011; Henderson et al., 2006) but there is also substantial within-country heterogeneity in firms' access to credit. Most crucially, firm size is a key variable in the analysis of financial restrictions (Beck et al., 2005). Small firms seeking small loans face higher transaction costs and higher risk premia since they have less collateral to offer and their internal information is less transparent compared to their large competitors. As a result, financial institutions are less willing to lend to small firms. In our third chapter, we propose a model of international trade with financial constraints and heterogeneous firms in order to examine how an economy's financial development affects the welfare gains from trade and uncover the role of large firms in shaping these gains. We further investigate whether trade with a more financially developed partner could limit the effects of domestic financial market imperfections, a question of uttermost importance for less financially developed economies, many of which are export-oriented but, at the same time,

suffer from severe credit market inefficiencies.

We build a closed economy model where firms differ in their productivities, their strategic behaviour and the level of credit constraints that they face. In our model economy there is a continuum of closely substitutable varieties and each one of them is produced by both large oligopolistic firms and a fringe of small monopolistic competitors. This framework is similar to the one presented in Melitz and Ottaviano (2008) except that in our model each variety is produced not by a single monopolistically competitive firm subject to free entry but under mixed market competition between massive Cournot oligopolistic producers who make positive profits and massless monopolistic competitors that are subject to free entry. We abstract from the assumption of free entry for the oligopolistic firms to better reconcile our findings with the oligopolistic theoretical literature which commonly assumes that oligopolistic rents are not eroded by entry, as in Neary (2016), but also with the emerging new empirical literature, like for example Barkai (2016), which documents that superstars are making profits that are too large to reconcile with free entry. Comparing this setup to the model used in the first two chapters, both involve mixed market competition but the two of them differ in their timing, their demand structure, the entry technology and the productivity distribution. In addition, in the economy of the third chapter there exist financial market imperfections. All firms use external funding provided by financial institutions to cover up-front costs and are, therefore, credit constrained. However, these constraints are more stringent for small firms. We find that more severe financial constraints induce tougher selection for all firms, large and small, since they increase survival cutoff productivities.

Next, in this framework we introduce international trade. First, we look into the simplest case of opening up to trade with a perfectly symmetric partner (symmetric trade) and then explore the effects of trade with a more financially de-

veloped partner (asymmetric trade). We find that there are pro-competitive and selection gains from both kinds of trade: trade liberalisation generates new entry of monopolistically competitive firms causing markups of all firms to fall and intensifies selection which raises productivity. However, trade benefits more less financially developed countries because, in the presence of severe constraints, trade creates more selection thus increasing survival cutoffs and average productivity. We also show that a less financially developed economy benefits more when credit constraints in the foreign country are lower. As globalisation proceeds, when foreign firms are less constrained they can afford to charge lower export markups inducing a larger decrease in the average markup charged domestically.

Turning to the role of superstars, given that superstars exist, as in our second chapter, welfare gains from trade are lower when large firms are fewer and, therefore, more powerful. An increase in the number of large firms reduces the oligopolistic inefficiency generated by their presence and increases welfare gains from trade. However, the results from increasing the number of oligopolistic firms do not tend asymptotically to the monopolistically competitive outcome of Melitz and Ottaviano (2008). The reason is that, in our setup, oligopolists are not subject to free entry. To compare our model to Melitz and Ottaviano (2008) we assume away the existence of an oligopolistic subsector. We find that, as in Edmond et al. (2015), liberalising trade in an economy with superstar firms creates higher pro-competitive gains than it would in a purely monopolistically competitive framework. In mixed markets, the pre-globalisation inefficiency is higher and trade triggers a larger reduction of this inefficiency. This result is overturned when economies become relatively segmented and the trade cost increases to the extent that trade creates further inefficiencies.

Our model has important implications for economic policy since it is rich enough to allow comparisons of the relative efficiency of promoting trade, com-

petition and access to financial capital. We show that trade policy is the most efficient among the three, especially in the presence of tougher liquidity constraints. It does, however, work best when combined with domestic pro-competitive measures, in the form of discouraging opportunistic behaviour by the few large firms, as well as with financial development. Finally, a key insight of our model is that trade openness could partly substitute for financial development. Trading with a more financially developed partner creates a positive spillover through the increased ability of foreign less constrained exporters to lower their markups, in comparison to domestic firms, boosting domestic welfare partly overcoming local frictions. When trade is not too costly, this result is more evident in the presence of superstar firms.

The remainder of this thesis is organised as follows. In Section 1.2 we present some stylised facts from the empirical literature that motivate our theoretical models. In Section 2 we present our first chapter, in Section 3 our second chapter, Section 4 contains the third chapter, Section 5 concludes and Section 6 contains the Appendix.

1.2 Stylised facts

We start off by documenting the stylised facts that motivate our theoretical models.

Superstars dominate export markets. The distribution of exporters is extremely skewed, corresponding to few large firms driving trade volumes. This skewness has been documented in a number of empirical works, such as Bernard et al. (2007) and Bernard et al. (2009) for the case of the U.S. and Mayer and Ottaviano (2008) for European countries. Their main finding is that, in the exhaustive datasets, the top 1 percent of exporters account for more than 45 percent

of aggregate exports whereas, if we look at the top 10 percent of exporters, they account for more than 80 percent of aggregate exports. In order to highlight the importance of large firms, in Table 1, we present the shares of exports for the top exporters in the U.S. and a number of European countries as they have been reported in the aforementioned papers. Freund and Pierola (2015) use data on 32 mainly developing countries and reach quantitatively similar conclusions.

Table 1: Export concentration across firms: Share of exports for top exporters

Country of origin	Top 1 percent	Top 10 percent
U.S.	80.9	96.3
Germany*	59	90
France	68	94
United Kingdom*	42	80
Italy*	32	72
Hungary*	77	96
Belgium	48	84
Norway	53	91

Source: U.S. data are from Bernard et al. (2009) and remaining data are from Mayer and Ottaviano (2008)

Notes. Datasets on Germany, Hungary, Italy and the UK are from 2003 and the asterisks indicate that they contain only large manufacturing firms; French, Belgian and Norwegian datasets are also from 2003 but contain exhaustive manufacturing data. The U.S. dataset is from 2000 and it contains almost all U.S. firms.

Pass-through drops rapidly with firm performance and market share There is a vast literature (originating from the analysis of exchange rate shocks and surveyed by Mayer et al. (2016)) that better performing firms with higher market shares have higher pass-through rates: they adjust their markups much more in response to a given change in trade cost, in comparison to worse-performing smaller suppliers.

In comparison to their smaller competitors, larger firms charge disproportionately higher markups which are consistent with oligopolistic behaviour. The dominant theoretical framework in international trade, following Melitz (2003), includes monopolistic competition and productivity heterogeneity: among non-

atomic firms the most productive ones grow larger and increasing openness to trade triggers a *selection* of the fittest, enabling the most efficient producers to expand even further. However, when we take it to the data, the monopolistically competitive model breaks down -but only for the largest firms. In Table 2, Hottman et al. (2016) report the distribution of markups across firms assuming that firms compete as Cournot competitors ("Cournot" column) and as monopolistic competitors ("Monopolistic competition" column). They find that markups are higher for larger firms and that, moving on to smaller firms, they decrease sharply. As a result, for most firms, the Melitz (2003)-type monopolistically competitive constant markup is a very good approximation. The top firms, however, depart substantially from the monopolistically competitive benchmark and behave strategically when they select their markups. This is a key reason why controlling for productivity differences across firms, both in monopolistically competitive and oligopolistic models, does not lead to markup equalisation but leaves out a significant *residual* markup inequality (De Loecker and Warzynski, 2012).

Table 2: Distribution of markups

Ranked percentile	Cournot	Monopolistic competition
10	0.57	0.52
25	0.45	0.45
50	0.31	0.31
75	0.24	0.24
90	0.16	0.16

Source: Hottman et al. (2016)

Only the largest firms within a sector are able to exploit their market power. In Table 3, Hottman et al. (2016) investigate the importance of the ability to exploit market power in the determination of firm size. They contrast the cross-sectional analysis of the full sample of firms (second row) with the one that contains only the largest firms, with a market share above 0.5% (third row). In the full sam-

ple, the importance of markup variation in explaining the firm-size distribution is extremely small. But when the largest competitors are isolated, a strong association is revealed, meaning that it is only the largest firms that possess the ability to internalise their impact on market aggregates and vary their markups.

Table 3: Determination of firm size

Decomposition	Markup
All firms	-0.00195 (0.00001)
Largest firms (with market share >0.5%)	-0.04396 (0.00016)

Source: Hottman et al. (2016)

We generate this pattern by blending the standard monopolistically competitive paradigm with the alternative approach of trade under oligopoly reviewed by Neary (2010). By introducing the co-existence of fixed- and variable-markup firms in a heterogeneous productivity framework, we reconcile the previous facts with the one presented above: pass-through rates diminish so quickly that most firms are actually incapable of passing-through. As a result, by moving away from pure monopolistic competition and pure oligopoly, we relax the uniform supply-side market power assumption that is built into both of these modes of competition but appears to have little empirical support (Bernard et al., 2016; De Loecker et al., 2016; De Loecker and Van Biesebroeck, 2016; De Loecker and Warzynski, 2012).

Small firms face more stringent credit constraints Beck et al. (2005) regress firm-level obstacles (firm-level survey responses on summary obstacles which take values 1 - 4, where 1 indicates no obstacle and 4 indicates a major obstacle) on, among others, domestic bank credit to the private sector divided by GDP (Priv) and the interaction between Priv and three size dummies: Small (for firms employing 5–50 employees), Medium (for firms employing 51–500 employees), and Large (for firms employing more than 500 employees). The results are presented in Table 4. At the foot of the table they report whether the coefficients are

significantly different for large and small firms. Table 4 indicates that the firms' perception of the financing obstacles they face relates to firm size, with smaller firms reporting significantly higher obstacles than large firms. Firm size remains an important determinant of the level of financial obstacles even after controlling for the quality of a country's institutions, and corruption obstacles.

Table 4: Financial constraints and firm size

Variable	Financing obstacles
Priv*Small	−0.167 (0.208)
Priv*Medium	−0.746*** (0.205)
Priv*Large	−0.864*** (0.242)
Priv (large-small)	−0.700*** (0.055)

Source: Beck et al. (2005)

These findings are part of an extensive literature on firm size and liquidity reviewed in Segarra and Teruel Carrizosa (2009) which confirms that small firms have to confront greater financial constraints than large firms when they decide to enter, produce or export.

2 The Rise of The Superstar Firms

2.1 Introduction

Superstar firms are pervasive in our daily lives and they appear to be pulling ahead of their smaller rivals in one area after another. In this part of the thesis our goal is to present a simple mechanism of the emergence of superstar firms. To answer the question of how superstars emerge, our natural starting point is to examine how they differ from small and medium enterprises.

What distinguishes large firms from their smaller counterparts is their superior productive efficiency and their ability to charge a higher markup of price over marginal cost (Mayer and Ottaviano, 2008; De Loecker and Warzynski, 2012). More crucially, unlike their competitors, these *happy few* are capable of exploiting their strategic market power (Hottman et al., 2016). In other words, they are the only ones that can internalise the effect of their decisions on domestic and export market aggregates. As a result, whereas most firms operating within a sector charge a markup consistent with monopolistic competition, currently the workhorse of international economics, the largest, most efficient suppliers exhibit oligopolistic behaviour and choose their markup in a strategic fashion. This pattern cannot be generated by the standard models of firm heterogeneity where firms only differ in their productivity, regardless of whether they maintain the assumption of monopolistic competition, like Melitz and Ottaviano (2008), or follow the alternative market structure assumption of pure oligopoly, like Atkeson and Burstein (2008).

In order to illustrate the emergence of superstars, we propose a two-period model that highlights the specific conditions required to generate the market power heterogeneity that we observe in the data. In doing so, our study introduces strategic market power differences and examines them jointly with productivity dif-

ferences in an integrated framework. Following Hottman et al. (2016), on the consumer side we consider a CES demand system which enables us to *shut down* any demand-driven markup heterogeneity. On the producer side, we start off with a newly-created industry (period one) populated by young monopolistically competitive firms that incur a sunk entry cost and then draw a productivity. Productivity draws are from a commonly known distribution and shape accordingly each firm's marginal cost of producing a variety of a heterogeneous good. Similarly to Melitz (2003), although under CES and monopolistic competition all firms charge the same constant markup, if at least some firms get luckier in their draw, these firms will have a higher market share and accumulate a higher profit over time. The most successful firms can then choose to invest part of their accumulated profit in a discrete innovation in order to reduce future costs and further increase the productivity gap that separates them from their competitors. Having increased this productivity gap, innovators are now responsible for a disproportionately large market share and, as a result, have a significant influence on market aggregates.

We find that (1) when the initial productivity distribution is sufficiently fat-tailed and when (2) the cost of innovation is sufficiently low but yet unaffordable for the least efficient firms, it becomes optimal for the most efficient successful innovators to adopt a Cournot oligopolistic behaviour. At the same time, firms that drew a low initial productivity remain small and unable to manipulate market aggregates, treating them parametrically when they form their decisions. We end up with a mature industry (period two) governed by a *mixed market* structure consisting of two subsectors governed by distinct forms of competition, namely monopolistic competition and oligopoly where, in line with Hottman et al. (2016), small companies charge constant markups whereas large firms choose higher and variable markups.

In this simple model, superstars emerge due to luck and successful innovation: firms supplying a big share of the market choose to take action towards exploiting their power on the market. We model this action as a a reduced form representation of a technological adoption cost in line with the endogenous growth literature like, for example, in Impullitti and Licandro (2016). On the other hand, small firms are financially constrained (Cleary, 2006; Beck et al., 2005; Beck and Demirguc-Kunt, 2006) and, therefore, unable to invest and exploit their market power. Differences in productivity are obtained as the necessary condition for differences in strategic behaviour or, in other words, for the mixed market structure to be a subgame perfect equilibrium in pure strategies. This intuition is in line with Peters (2013) and Tamminen and Chang (2013) who argue that, under imperfect competition, high productivity is an indication of market power and that the presence of market power affects markets not only statically but also dynamically, through its influences on firms' innovation decisions.

This chapter is related to the recent industrial organisation literature on mixed markets. The mixed market structure was initially developed as a closed economy model by Shimomura and Thisse (2012) and it has also appeared in trade literature in Parenti (2017). However, both of these models are static and operate under the assumption of a *fixed* number of large firms which are *born* with the ability to behave strategically. Our model contributes to this literature in a variety of ways.

Firstly, by introducing a dynamic perspective and by endogenising, via innovation, the choice of adopting a strategic behaviour, our study rationalises the emergence of polarised markets and the evolution of superstar firms, thus extending the mixed market structure to a general equilibrium result of firm dynamics. In our model superstar firms are not born different. They grow because of luck and active effort that takes the form of process innovation. Besides process innovation, our framework can embed a number of other alternative isomorphic ra-

tionalisations for a cost-reducing investment that generates market power. As in Igami (2015) it can be the cost of offshoring, since offshoring alters market structure along with the cost structure. In line with the lobbying literature like, for example, Bombardini (2008) it can be the cost of making political contributions, a practice only affordable by the top firms that creates a level of protection equivalent to a decrease in costs. As in Eckel and Yeaple (2015) it can be an investment in screening technology that can assess worker's productivity enabling better firms to hire better employees. Finally, Cellini et al. (2015) argue that just *realising* one's impact on the market implies costly information acquisition and processing. Indeed, we find that it could still be optimal to pay the cost to become an oligopolist even if this investment does not create a further boost in productivity and the only benefit is the ability to charge a higher and variable markup.

Secondly, by incorporating a free entry condition, our study is the first to explore a number of interesting properties of the mixed market structure. We use free entry to illustrate the relationship between product innovation and competition. We show that as markets become more competitive (in the sense that they become less heterogeneous), Romer (1990)-type innovation (as it is reflected in the number of differentiated varieties produced in the economy) follows an inverted-U pattern that peaks at relatively low levels of competition. Although our modeling approach is completely different, these findings bear a strong resemblance to the ones of the endogenous growth literature following Aghion et al. (2005).

The structure of this chapter is as follows. In Section 2.2 we present a two-period model where mixed market competition emerges as the subgame perfect equilibrium. In order to illustrate our results, in Section 2.3 we conduct a comparative statics analysis of the equilibrium. We look into the role of superstar firms and, in particular, how they affect the profitability of smaller firms and social welfare through their entry, pricing and innovation decisions. Section 2.4 concludes.

2.2 Setup of the model

In this part, we set up a model that captures the ability of large firms to choose a variable oligopolistic markup as well as the constant-markup behaviour which is characteristic of firms with small market shares.

2.2.1 Preferences and demand

In order to mimic firm dynamics in the simplest possible way we analyse a tractable two-period game, where the first period corresponds to a newly-created industry and the second period represents a mature one. Our aim is not to develop a fully dynamic model but, rather, to show that, even in the most basic dynamic setup, initial efficiency differences à la Melitz (2003) can be endogenously magnified leading to differences in strategic behaviour.

At each point in time ($t = 1, 2$) the economy involves one horizontally differentiated and one homogeneous good the production of which only requires labour, which is perfectly mobile. Following Shimomura and Thisse (2012), the horizontally differentiated good (H) is produced under increasing returns. At time t, H_t can be supplied either by large Cournot oligopolists (CO firms) or by small monopolistically competitive firms (MC firms). We assume that the differentiated good is formed by two CES-composites, X and Y, which at time t are defined as follows:

$$X_t = \left(\sum_{i=1}^{n_{xt}} x_{it}^a \right)^{\frac{1}{a}} \tag{1}$$

$$Y_t = \left(\sum_{i=1}^{n_{yt}} y_{it}^a \right)^{\frac{1}{a}} \tag{2}$$

where x_{it} is the output level of large firm $i = 1, 2, \ldots, n_{xt}$ at time t and y_{it} is the output level of small firm $i = 1, 2, \ldots, n_{yt}$ at time t. The parameter $a \in (0, 1)$, implying that the goods are imperfect substitutes. The elasticity of substitution between any two goods is given by $\sigma \equiv \frac{1}{(1-a)} > 1$. Firms can costlessly differentiate their products and all products enter symmetrically into demand. Hence, in the eyes of the consumers, large and small firms produce equally substitutable goods. Pan and Hanazono (2015) examine how allowing for different substitutabilities would alter the predictions of the mixed market model. To shut down any demand driven heterogeneity we assume that the elasticity of substitution is equal to σ both across and within subsectors. In pure monopolistic competition, consumers' utility only depends on Y, whereas in pure oligopoly it only depends on X. Combining X and Y we obtain H which corresponds to the output index of the entire differentiated sector:

$$H_t = (X_t^a + Y_t^a)^{\frac{1}{a}} \tag{3}$$

The homogeneous good (O) sums up the rest of the economy and serves in placing the analysis in general equilibrium. O is produced under constant returns and supplied by perfectly competitive firms.

Given CES preferences, we can assume that there is a representative consumer who describes the aggregate behaviour of consumers having different tastes (Anderson et al., 1992). This agent is endowed with L units of labour and holds the shares of all firms. Preferences of the representative consumer over the homogeneous and the differentiated good are represented by a logarithmic upper-tier instantaneous utility function. At every period $t = 1, 2$, the representative consumer maximises the utility function:

$$U_t = \ln H_t + \beta \ln O_t \tag{4}$$

subject to the budget constraint:

$$O_t + E_t = I_t \tag{5}$$

In the utility function, the parameter $\beta > 0$ expresses the weight of the homogeneous good. A higher β shifts consumption away from the differentiated and towards the homogeneous industry. In the budget constraint, E represents the expenditure on the differentiated good, which at time t is defined as $E_t = P_t H_t$, and I is the income level (in terms of the numeraire). Since income is given by the wage bill wL plus any uninvested profits and given that profits are determined at the equilibrium, I is endogenous. Without loss of generality, we assume that one unit of labour produces one unit of the homogeneous good. We take O as the numeraire commodity and, therefore, the equilibrium wage will be equal to 1 and $wL = L$. We move on to P_t, which, following Dixit and Stiglitz (1977), can be defined as the aggregate price of the differentiated sector:

$$P_t = \left(\sum_{i=1}^{n_{xt}} p_{xit}^{\frac{-a}{1-a}} + \sum_{i=1}^{n_{yt}} p_{yit}^{\frac{-a}{1-a}} \right)^{-\frac{1-a}{a}}$$

The price index is the appropriate deflator that converts nominal expenditure on differentiated products to the industry output index:

$$P_t = E_t H_t^{-1}$$

The assumption of CES preferences is crucial. Under a CES demand system there is no demand-driven market power and hence no demand-driven markup heterogeneity. The only demand-side market power stems from imperfect substitutability which is equal across varieties. As a result, unlike models like Melitz and Ottaviano (2008), our mechanism creates markup dispersion that is not generated via a demand-side assumption (namely linear demand) but is a corollary

of the underlying process of firm dynamics. This allows us to attribute any markup heterogeneity to supply-side determinants, namely productivity and strategic market power. Controlling for productivity, any residual markup inequality will be driven by differences in strategic market power.

Assuming that there are no means available to the consumer to transfer wealth from one period to the other, we can ignore time discounting and focus on the per-period optimisation problem, which, using the expressions presented above, we can re-write as follows:

$$\max_{\{x_{it}\}_{i=1}^{n_{xt}},\{y_{it}\}_{i=1}^{n_{yt}},O_t} \left\{ U_t = \ln\left[\left(\sum_{i=1}^{n_{xt}} x_{it}^a\right) + \left(\sum_{i=1}^{n_{yt}} y_{it}^a\right)\right]^{\frac{1}{a}} + \beta \ln O_t \right\}$$

$$\text{s.t. } O + \sum_{i=1}^{n_{xt}} p_{xit} x_{it} + \sum_{i=1}^{n_{yt}} p_{yit} y_{it} = I_t$$

The problem can be decomposed in three choices which are presented in the Appendix: between H and O, between X and Y and the allocation of expenditure within X and Y. Utility maximisation leads to the following optimal decisions:

$$O_t = \beta E_t \tag{6}$$

$$p_{xit} = x_{it}^{a-1} H_t^{1-a} P_t \tag{7}$$

$$p_{yit} = y_{it}^{a-1} H_t^{1-a} P_t \tag{8}$$

According to the first equation, the demand for the homogeneous good is β times the total spending on the differentiated good, which is a standard result of log preferences. Equations (7) and (8) give the inverse demand for each differentiated

variety, produced by either a CO or by an MC firm. The aggregate price index of each subsector is defined as follows:

$$P_{\varphi} = \left(\sum_{i=1}^{n_{\varphi t}} p_{\varphi it}^{\frac{-a}{1-a}} \right)^{-\frac{1-a}{a}}$$

where $\varphi = \{x, y\}$. Note that although income I is endogenous the income *share* spent on the differentiated good is constant:

$$E_t = \frac{1}{\beta + 1} I_t \tag{9}$$

2.2.2 Production

We focus on a two-period game.

Period 1 At the beginning of the first period N firms enter the market. Entry only occurs at the beginning of the game and there are no exogenous shocks that could force a firm to exit before the end of the game. With costless differentiation, each firm will choose to produce a different variety. To enter, firms must make an initial investment in the form of a fixed sunk entry cost $f_e > 0$ (measured in units of the homogeneous good). N is such that the total expected profits from both periods of the game are equal to the entry cost. Prior to entry firms are identical and they are considered symmetrically non-strategic. Once they enter the market, firms draw an initial productivity parameter $z > 0$ from a common distribution, where z is defined as the inverse of a firm's marginal cost and one can think of a high versus a low random productivity draw as a "good", as opposed to a "bad", business idea.

The first period of our model is similar to Melitz (2003) with two key differences. Firstly, instead of a continuum of firms producing a continuum of varieties, we follow the original Dixit and Stiglitz (1977) paper and assume discrete varie-

ties. This is a simplifying assumption, since discrete firms do not have a zero mass and therefore, by definition, they can affect the market (Yang and Heijdra, 1993). However, we argue that this assumption is, in fact, empirically feasible since the firm distribution is found to be discrete and granular but, at the same time, firms, when they are small, appear to be behaving in a fashion best approximated by monopolistic competition (Hottman et al., 2016; Amiti et al., 2016). Secondly, to keep the model tractable, we start off with only two possible levels of productivity. Relaxing this assumption by incorporating a continuous productivity distribution à la Melitz would severely affect the model's tractability without adding to the key insights of the model. We assume that z can only take two discrete values, each with a known probability:

$$z \in \{z_l, z_h\} \text{ where } z_l < z_h \text{ and } P(z = z_h) = \gamma < 1$$

This simplification is in line with the intuition of the empirical literature like, for example, Freund and Pierola (2015) who argue that the well-documented skewness in the firm distribution "could be achieved in a heterogeneous firm framework with firms having a small probability of getting a very high productivity draw".

Production only requires labour which, at each period, is inelastically supplied at the aggregate level L. The technology of each firm is represented by its productivity z. Production also requires a fixed cost $f > 0$ which is the same across all firms. Thus, labour used for the production of output q equals:

$$l(q; z) = \frac{1}{z}q + f \tag{10}$$

Given that the common (across all sectors) wage w is set equal to 1, the above equation is also the cost function of a productivity-z firm.

In the first period all firms operate under monopolistic competition and hence only the Y-subsector is active. This is equivalent to the following notation:

$$n_{x1} = 0 \text{ and } n_{y1} = N$$

A firm with productivity z will face the following profit maximisation subject to the inverse demand function:

$$\max_{y_{i1}} \left\{ \pi_{yi1} = p_{yi1} y_{i1} - \frac{1}{z} y_{i1} - f \right\}$$

$$\text{s.t. } p_{yi1} = y_{i1}^{a-1} H_1^{1-a} P_1$$

Since $a \in (0, 1)$, the above profit function is strictly concave in the level of output. Therefore, the first order condition gives the unique optimal solution:

$$y_{i1}(z) = \left(\frac{1}{az} \right)^{\frac{-1}{1-a}} E_1 P_1^{\frac{a}{1-a}} \tag{11}$$

which is equivalent to the following optimal pricing rule:

$$p_{yi1}(z) = \frac{1}{az} \tag{12}$$

Thus, in the first period, the more productive firms (with productivity equal to $z_h > z_l$) produce a higher output ($y_1(z_h) > y_1(z_l)$), charge a lower price ($p_{y1}(z_h) < p_{y1}(z_l)$) and earn higher profits ($\pi_{y1}(z_h) > \pi_{y1}(z_l)$) compared to the less productive firms. First-period profits are presented below:

$$\pi_{y1}(z_h) = \left(\frac{1}{az_h} \right)^{\frac{a}{a-1}} (1-a) E_1 P_1^{\frac{a}{1-a}} - f \tag{13}$$

$$\pi_{y1}(z_l) = \left(\frac{1}{az_l} \right)^{\frac{a}{a-1}} (1-a) E_1 P_1^{\frac{a}{1-a}} - f \tag{14}$$

However, all firms, regardless of their productivity, will choose the same profit

maximising markup of price over marginal cost (defined as θ_{y1}):

$$\theta_{y1} = \frac{1}{a} \tag{15}$$

Aggregating over the total number of entrants[1] (or, equivalently, the total number of varieties) N and given the distribution of productivities, we get the total period-one production of the differentiated good H_1 and the equilibrium aggregate price level of the first period P_1, both as functions only in terms of N. Using the definition for the period-one income we can also write the expenditure on the differentiated good E_1 as a function of N. Using the following expressions for the first-period market aggregates E_1 and P_1 (both functions only of N) we can express (13) and (14) only in terms of N. We get:

$$P_1 = \left[\gamma N \left(\frac{1}{az_h}\right)^{\frac{a}{a-1}} + (1-\gamma) N \left(\frac{1}{az_l}\right)^{\frac{a}{a-1}}\right]^{\frac{a-1}{a}} \tag{16}$$

$$E_1 = \frac{L - Nf}{\beta + 1 - \left[\frac{(1-\gamma)\left(\frac{1-a}{(az_l)^{\frac{a}{a-1}}}\right) + \gamma\left(\frac{1-a}{(az_h)^{\frac{a}{a-1}}}\right)}{\gamma\left(\frac{1}{az_h}\right)^{\frac{-a}{1-a}} + (1-\gamma)\left(\frac{1}{az_l}\right)^{\frac{-a}{1-a}}}\right]} \tag{17}$$

Period 2 In the beginning of the second period each firm has the option to invest in a discrete efficiency-enhancing innovation. This innovation works as follows. Incurring a fixed sunk cost $f_k \geq 0$ increases a firm's productivity by $k \geq 0$ and, more importantly, it enables the firm to act as a Cournot oligopolist, in other words to exploit its market power. We define the post-innovation level of productivity as follows:

$$z_k \equiv z_h + k$$

To simplify the analysis this innovation is successful with probability 1. A non-deterministic innovation would result in a heterogeneous monopolistically com-

[1] Notice that the total number of entrants N will be pinned down in the equilibrium subsection by the free entry condition.

petitive fringe with two different levels of productivity and fixed costs. Given the extended research on monopolistic competition with heterogeneous firms[2], relaxing the assumption of deterministic innovation would unnecessarily complicate the analysis.

The obvious intuition behind this innovation is that it acts as a reduced form representation of a technological adoption cost in line with the endogenous growth literature as, for example, in Impullitti and Licandro (2016). A high productivity draw in period 1 enables firms to accumulate profit which they may choose to invest to further increase their cost efficiency. Having increased the productivity gap from their competitors, innovators are now responsible for a disproportionately large market share and, as a result, have a significant influence on market aggregates, namely aggregate output H_2. Under general assumptions that will be presented below, it is optimal for these firms to internalise this effect which is equivalent to adopting an oligopolistic behaviour.

Alternatively to process innovation a discrete investment that offers the ability to decrease production costs and exploit market power could manifest itself in a variety of ways. Igami (2015) explains it as the cost of offshoring since this is an option that only the most profitable firms have the means to pay for. By paying the fixed cost of offshoring, these firms not only reduce their future costs but also trigger a radical increase in market concentration. The lobbying literature like, for example, Bombardini (2008) incorporates fixed costs of making political contributions that generate protection equivalent to a cost reduction. This practice is only affordable by the most profitable among firms. Wooldridge (2016) adds that, not only lobbying but also complicated regulation -which is a usual problem in both Europe and the U.S.- works in favour of large firms since it requires a high fixed cost of compliance. In this setup we can interpret f_k as a reduced form re-

[2]For a survey, see Melitz and Redding (2014).

presentation of the policy instruments that could potentially affect the effective cost of being able to exploit market power from a firm's perspective. Moreover, Eckel and Yeaple (2015) demonstrate that, in the presence of labour-market imperfections, large firms, as opposed to smaller ones, will choose to incur a fixed cost of investing in screening technology in the form of hiring human resource staff. This staff can assess worker's productivity enabling better-performing firms to hire better workers. Finally, Cellini et al. (2015) use insight from the managerial literature in order to argue that just "realising" one's impact on the market implies costly information acquisition and processing. Indeed, we show in the Appendix that it can still be optimal to pay the fixed cost f_k even if $k = 0$ as long as the investment generates the ability to charge an oligopolistic markup.

If, in the second period, all z_h-productivity firms choose to incur f_k and compete as oligopolists and all z_l-productivity firms compete monopolistically we get that both the X- and the Y- subsector are now active:

$$n_{x2} = \gamma N \text{ and } n_{y2} = (1-\gamma)N$$

Notice that in the following part of the chapter we derive the conditions under which this is actually an equilibrium result: the decision to become an oligopolist is optimal for a firm if and only if this firm has initial productivity equal to z_h.

Large firms (CO firms) Large firms maximise their period-two profits subject to the inverse demand function:

$$\max_{x_{i2}} \left\{ \pi_{xi2} = p_{xi2}x_{i2} - \frac{1}{z_k}x_{i2} - f - f_k \right\}$$

$$\text{s.t. } p_{xi2} = x_{i2}^{a-1} H_2^{1-a} P_2$$

and taking as given that the MC firms maximise their profits subject to the inverse

demand and that every other CO firm j (where $j = 1, 2, \ldots, n_{x2}$ and $j \neq i$) produces according to their reaction function. Substituting the inverse demand, the profit function of a large firm can be re-written as follows:

$$\pi_{xi2} = x_{i2}^{a} E_2^{1-a} P_2^{a} - \frac{1}{z_k} x_{i2} - f - f_k$$

Notice that every large firm maximises π_{xi2} with respect to x_{i2} where π_{xi2} is a function of the firm's own output x_{i2}, the industry price index P_2 and the total industry output $H_2 = E_2 P_2^{-1}$ (produced by both small and large firms). The intuition behind this is that any large firm understands that:

1. Their input choice affects the industry price index and is therefore involved in a game-theoretic environment.

2. The industry price index is influenced by the *aggregate* behaviour of the MC firms (Shimomura and Thisse, 2012). Therefore, we represent the MC firms by the pseudo-player $i = 0$ producing a total optimal output equal to x_{02}.

3. Since the income share spent on the differentiated product is constant, we get that the income level influences firms' demands and hence their profits. As a result, all firms must correctly anticipate what the total income will be. Because of their market power, large firms could in theory manipulate the income level and hence their demands through their choices. To avoid the non-existence of equilibrium that is a usual result of accounting for these feedback effects, we will take the approach followed by Neary (2016) and empirically tested by Hottman et al. (2016) that each firm that is large within the sector is small in the economy as a whole. This *income-taking* assumption means that no large firm seeks to manipulate its demand through the income level. In our model, this assumption is reasonably approximated by selecting a sufficiently high β.

Let $x_{-i2} = (x_{12}, \ldots, x_{i-12}, x_{i+12}, \ldots, x_{n_x 2})$ be the vector of all outputs of all large firms but that of firm i. Because $\frac{\partial \pi_{xi2}}{\partial x_{i2}}$ is strictly decreasing in x_{i2} we have that:

Lemma 1 (best response of CO firm) *For any CO firm $i = 1, 2, \ldots, n_{x2}$ and for any given output vector of all other CO firms x_{-i2} and any aggregate behaviour of the MC firms x_{02}, the profit function π_{xi2} is strictly concave with respect to own output x_{i2}. Hence, the best response of firm i, defined as $x_{i2}(x_{-i2}, x_{02}; E_2)$, is the unique solution of:*

$$\frac{\partial \pi_{xi2}}{\partial x_{i2}} = \frac{a \sum_{j \neq i} x_{j2}^a}{x_{i2}^{1-a} \left(x_{i2}^a + \sum_{j \neq i} x_{j2}^a \right)^2} E_2 - \frac{1}{z_k} = 0 \tag{18}$$

Small firms (MC firms) Every small firm treats the period-two prices and income as given parameters. Therefore the optimisation problem of a small firm is the following:

$$\max_{y_{i2}} \left\{ \pi_{yi2} = p_{yi2} y_{i2} - \frac{1}{z_l} y_{i2} - f \right\}$$

$$\text{s.t. } p_{yi2} = y_{i2}^{a-1} H_2^{1-a} P_2$$

Exactly as in the period-one case, π_{yi2} is strictly concave in y_{i2}. Applying the f.o.c. gives the equilibrium output of a small firm:

$$y_2(z_l) = \left(\frac{1}{a z_l} \right)^{\frac{-1}{1-a}} E_2 P_2^{\frac{a}{1-a}} \tag{19}$$

which yields the equilibrium price:

$$p_{y2}(z_l) = \frac{1}{a z_l} \tag{20}$$

We have omitted the i-index since, in equilibrium, all MC firms produce the same output, sold at the same price, and, hence, make the same period-two profits. Given that period-one profits are also the same across all productivity-z_l firms, the total profits will also be equal within the MC subsector. Notice that the equili-

brium price for an MC firm is the same as the one under pure monopolistic competition whereas its equilibrium output varies with the quantities chosen by the CO firms through the price index P_2 and the income share E_2.

2.2.3 Equilibrium

We consider a non-cooperative game in which big and small firms choose their output simultaneously. We close the model with the free entry condition[3], which is that the total number of firms N that enter the differentiated sector is adjusted up to the point where the total expected profits (prior to entry) become equal to zero. All the proofs are presented in the Appendix.

We can characterise a mixed market equilibrium using the profit maximisation conditions of the small and large firms as well as the free entry condition. We focus on a *symmetric* equilibrium where, in the second period, all CO firms choose the same output (i.e. $x_{i2} \equiv x_2$ for every $i = 1, 2, \ldots, n_{x2}$) sold at the same price (i.e. $p_{xi2} \equiv p_{x2}$ for every $i = 1, 2, \ldots, n_{x2}$) and, hence, earn the same profits (i.e. $\pi_{xi2} \equiv \pi_{x2}(z_k)$ for every $i = 1, 2, \ldots, n_{x2}$)[4]. Therefore, the second-period profits for CO firms are given by:

$$\pi_{x2}(z_k) = x_2^a E_2^{1-a} P_2^a - \frac{1}{z_k} x_2 - f - f_k \tag{21}$$

whereas the second-period profits of MC firms are equal to:

$$\pi_{y2}(z_l) = \left(\frac{1}{a z_l}\right)^{\frac{a}{a-1}} (1-a) E_2 P_2^{\frac{a}{1-a}} - f \tag{22}$$

The first step is to list the equilibrium conditions for each one of the two periods and express them only in terms of N. Under the symmetry assumption we can

[3]Oligopoly with free entry raises an integer problem. For a discussion see for example Friedman (1977).

[4]In the Appendix we specify the range of parameter values that guarantees the existence of such a symmetric equilibrium.

express the period-two aggregate price index in terms of the output level of an oligopolist:

$$P_2 = E_2(Y_2^a + \gamma N x_2^a)^{\frac{-1}{a}} \tag{23}$$

Substituting the above expression in the f.o.c. for the period-two profit maximisation of a CO firm we get:

$$E_2^{1-a} = \frac{1}{az_k} P_2^{-a} x_2^{1-a} + E_2^{1-2a} P_2^a x_2^a \tag{24}$$

Using (22) and (19), we can express the second-period market aggregates as follows:

$$P_2 = E_2 \left[\left(\left(\frac{1}{az_l} \right)^{\frac{-1}{1-a}} (1-\gamma)^{\frac{1}{a}} N^{\frac{1}{a}} E_2 P_2^{\frac{a}{1-a}} \right)^a + \gamma N x_2^a \right]^{\frac{-1}{a}} \tag{25}$$

$$E_2 = (\beta+1)^{-1} \left(L + \gamma N \pi_{x2}(z_k) + (1-\gamma) N \pi_{y2}(z_l) \right) \tag{26}$$

Our equilibrium conditions (for given N) form a system of nine equations in nine unknowns: the per-period profits from equations (13), (14), (21) and (22), the price indices from (16) and (25), the levels of expenditure on the differentiated good from (17) and (26) and the level of output produced by an oligopolist in period two (x_2) which is given by the optimality condition (24). Once we solve this system of equations for given N we close the system by adding the free entry condition which will pin down N. However, before we add the free-entry condition we can present some interesting results that hold in the short run, or, in other words, for fixed N[5]. We can write the aggregate period-two price index and the pricing rule and markup (defined as θ_{x2}) charged by a large firm in terms of M, where M is a decreasing function of the number of firms N:

$$P_2 = \frac{1}{az_l} \left(\frac{M}{(1-\gamma)N} \right)^{\frac{1-a}{a}} \tag{27}$$

[5]Proofs can be found in the Appendix.

$$p_{x2} = \frac{1}{az_l}\left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{\frac{1-a}{a}} \tag{28}$$

$$\theta_{x2} = \frac{1}{a}\frac{z_k}{z_l}\left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{\frac{1-a}{a}} \tag{29}$$

Using the above expressions we show the following result:

Proposition 1 (pricing of CO firms) *Assume that the size of the market for the differentiated good is exogenous (i.e. N is given). Then, the industry price index as well as the price and markup charged by a CO firm decrease when the total number of firms increases.*

The combination of CES and monopolistic competition imply that the price and the profit-maximising markup for a small firm (defined as θ_{y2}) will be the following:

$$p_{y2} = \frac{1}{az_l} \tag{30}$$

$$\theta_{y2} = \frac{1}{a} \tag{31}$$

We get that large firms will charge a higher markup than small firms:

$$\frac{z_k}{z_l}\left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{\frac{1-a}{a}} > 1 \tag{32}$$

and that, for a sufficiently high productivity gap between large and small firms, large firms will charge a lower price:

$$\left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{\frac{1-a}{a}} < 1 \tag{33}$$

Notice that if all firms have the same marginal cost, large firms will choose a higher markup but also a higher price. However, in the presence of a productivity advantage, oligopolistic firms will select a lower price compared to their non-strategic competitors. From the markup expressions (θ_{x2} and θ_{y2}) we can compute the markup gap between the oligopolistic and the MC firms. We find that

the residual markup inequality documented by De Loecker and Warzynski (2012) would at least partly be due to the difference between the two markups after equalising productivities. This gap is presented below:

$$\theta_{x2} - \theta_{y2} \mid_{z_k = z_l} = \frac{1}{a}\left[\left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{\frac{1-a}{a}} - 1\right] \tag{34}$$

which is the expression for $\theta_{x2} - \theta_{y2}$ in the counterfactual exercise where $z_k = z_l$.

The second, and final, step for computing the equilibrium is, having expressed the system of nine equations only in terms of the number of firms N, we close the system by adding a tenth equation that will determine N, namely the free entry condition. We show that there exists a value of N that solves our system of equations. This N is the solution to the following free entry condition[6]:

$$E\Pi(N) = \gamma\left[\pi_{y1}(z_h) + \pi_{x2}(z_k)\right] + (1-\gamma)\left[\pi_{y1}(z_l) + \pi_{y2}(z_l)\right] - f_e = 0 \tag{35}$$

We show the following result[7]:

Proposition 2 (free entry) *There exists at least one $N > 0$ such that the free entry condition holds. This N will be unique for sufficiently low levels of a and γ.*

This step completes the closed economy equilibrium which is characterised by equations (13) - (17) and (21) - (35) and the following unknowns: the per-period profits $\pi_{y1}(z_h)$, $\pi_{y1}(z_l)$, $\pi_{x2}(z_k)$ and $\pi_{y2}(z_l)$, the per-period aggregate price and aggregate expenditure on the differentiated good E_1, P_1, E_2 and P_2, the second-period optimal output of a large firm x_2, and the total number of firms N.

[6] We ignore the integer constraints in the free entry condition.

[7] As shown in the Appendix, uniqueness holds for the parameter values for which:

$$\frac{z_l}{z_k}\left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{-\frac{1-a}{a}}\left(\frac{1-a}{a}M^{-1}+1\right) > 1$$

2.2.4 Welfare

We can now calculate the indirect utility of the representative consumer and, given that preferences are homothetic, the indirect utility function will describe aggregate welfare. The aggregate welfare function is presented below:

$$V = \ln\left[\gamma N \tilde{y}_1^a(z_h) + (1-\gamma) N \tilde{y}_1^a(z_l)\right]^{\frac{1}{a}} + \ln\left[\gamma N \tilde{x}_2^a + (1-\gamma) N \tilde{y}_2^a(z_l)\right]^{\frac{1}{a}} + \beta \ln(\beta^2 E_1 E_2) \tag{36}$$

where for $t = 1, 2$ we have that:

$$\tilde{x}_t = E_t \left(\frac{p_{xt}}{P_t^a}\right)^{-\frac{1}{1-a}}$$

$$\tilde{y}_t = E_t \left(\frac{p_{yt}}{P_t^a}\right)^{-\frac{1}{1-a}}$$

As a result, aggregate welfare decreases with prices and, therefore, it decreases with the average markup and increases with the average productivity.

2.3 Equilibrium analysis

2.3.1 Subgame perfection

Having computed the mixed market equilibrium, we go on to specify the conditions under which this equilibrium is subgame perfect in pure strategies.

Proposition 3 (subgame perfection) *Investing in acquiring market power is subgame perfect if and only if:*

1. *z_h is sufficiently higher than z_l so that $f_k \in (\pi_{y1}(z_l), \pi_{y1}(z_h))$ is unaffordable for z_l-productivity firms.*

2. *Given f_k, z_k could be higher or even equal to z_h, as long as f_k, γ and a are sufficiently low.*

We present the formal proof in the Appendix. However, the intuition is straightforward: if there is only one possible initial productivity draw and all firms are equally productive, then at the end of period one they will all have accumulated the same profits. As a result, there is no reason why there will be different abilities to innovate in period two. In a perfectly homogeneous setup, mixed markets can only arise as an equilibrium in mixed strategies. The only possible equilibria in pure strategies are pure monopolistic competition and pure oligopoly. Which of the two will emerge depends on the demand elasticity and the equilibrium number of firms. It is also worth noting that, for our results, the assumption of simultaneous choice of output is crucial. In sequential models, if large firms act first, they choose to mimic the behaviour of the fringe (Kokovin et al., 2011).

With (at least) two possible productivity draws, firms accumulate different levels of period-one profits. Therefore productivity heterogeneity that is commonly assumed in trade models emerges as a necessary condition for the existence of mixed markets. This result is in agreement with Parenti (2017) although in that model the exogenous cost differences stem from the ability of some firms to operate as multi-product and benefit from economies of scope. However, in our model, a high initial productivity advantage can be endogenously magnified via the decision of a firm to engage in innovation. Innovation plays a dual role: it could be efficiency-enhancing if $z_h < z_k$ and it always enables successful innovators to exploit their market power (even in the limit where $z_h = z_k$). Deciding whether to innovate, a firm compares the losses (fixed cost f_k) with the productivity gains and the gains from entering an elite subsector with the ability to charge a higher markup. In the data or in a fully dynamic model, we expect that the industry wouldn't jump from "new" to "mature". Different firms would grow at

a different pace and the change in market concentration would be gradual. This could be obtained in a theoretical model with continuous time and convex costs like in Felbermayr et al. (2015). However, in our simple two-period model with constant marginal costs, the case where $z_h < z_k$ mimics a dynamic setup where firms will engage in innovation if we allow enough time for the innovation to pay back. This intuition is in line with Peters (2013) who argues that market power affects markets not only statically but also dynamically, since it influences the innovation decisions of firms.

2.3.2 Numerical comparative statics

Parameter values Our model is too stylised to be fully calibrated. However, we are able to perform numerical comparative statics and draw interesting conclusions. These results are extremely robust to changes in the parameter values. We normalise $L = 1$ and set our key parameters as presented in Table 5.

Table 5: Calibrated parameters

Parameters	Value	Interpretation	Source
a	0.5	Varieties substitutability	Broda and Weinstein, 2006*
β	0.5	Share of homogeneous good	Rauch, 1999
γ	0.01	Percentage of oligopolists	Freund and Pierola, 2015

The asterisk indicates that our elasticity of substitution is hypothetical although it does fall within the acceptable range specified by Broda and Weinstein (2006). Nonetheless, our model is not sensitive to changes in a. The selection of the three productivity levels z_l, z_h and z_k is arbitrary. However, as long as the ranking is preserved, a change in the parameter values only rescales the numerical analysis. Our results are robust to changes in the parameters provided subgame perfection is guaranteed. The fixed cost of production f and the cost of entry f_e are also hypothetical. Given z_l, z_h, z_k, f and f_e, the cost of innovation f_k is selected so that

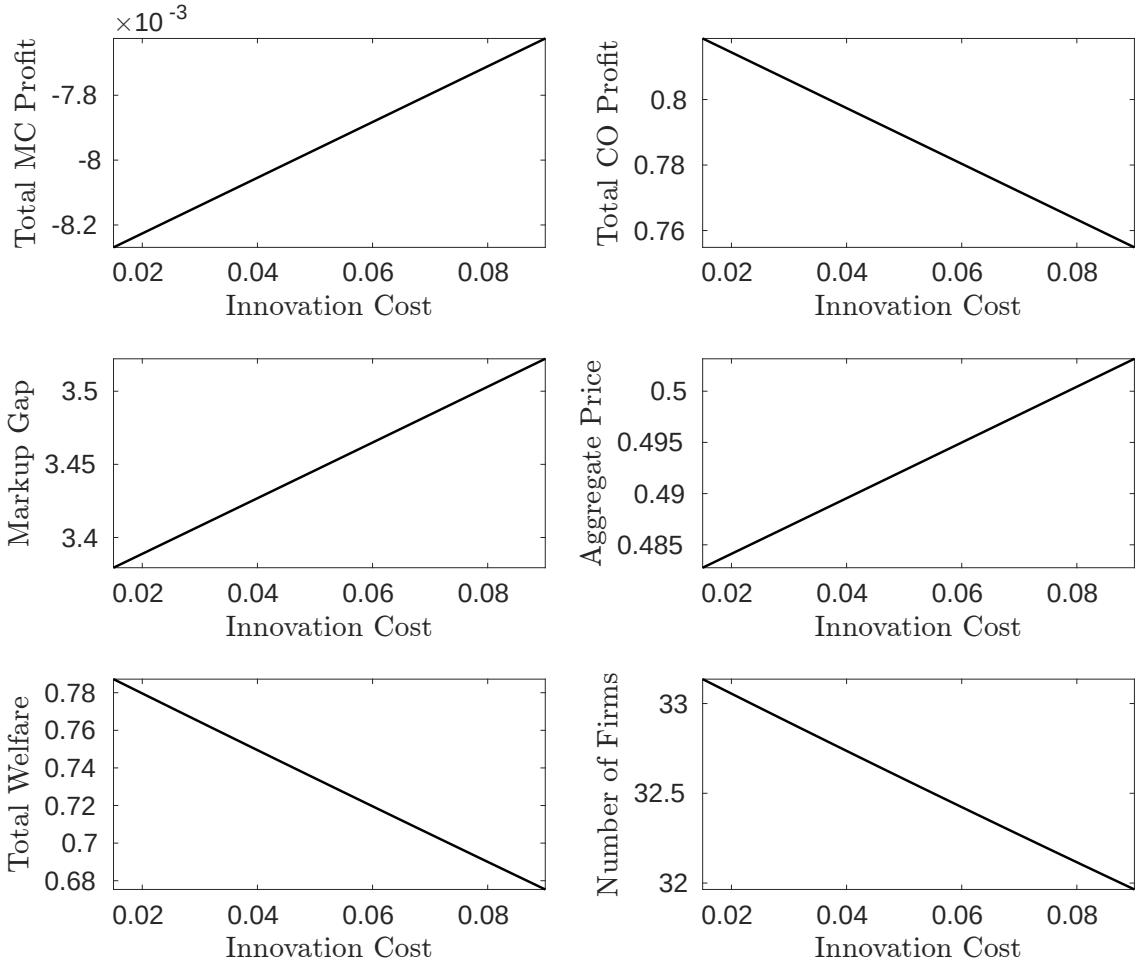
innovation becomes only just unaffordable for a small firm[8].

Fixed cost of innovation In Figure 1 we present the numerical comparative statics with respect to the fixed cost of innovation f_k. We start from a very low level of f_k that, as mentioned above, makes it marginally unaffordable for MC firms to innovate and then we increase it but only up to a point where it is still optimal for large firms to innovate (so as not to violate subgame perfection), given the magnitude of the productivity increase due to innovation. We find that for a fixed boost from the initial high productivity draw z_h to the post-innovation one z_k, as innovation becomes more costly the profitability of large firms decreases and this creates a market share reallocation from large towards small firms, since the latter are not harmed by the increase in f_k. In expectation, the decrease of expected CO profits dominates the increase of expected MC profits driving down the total expected profits prior to entry. As a result, the number of firms in the market decreases. The decrease of the number of firms decreases the competitive pressures within the oligopolistic subsector increasing their markup difference from the small firms. This increase in markups drives an increase in the aggregate price index which, according to equation (36), causes aggregate welfare to decrease. Rationalising f_k as the effective cost of being able to exploit market power from the perspective of the firm, we conclude that markets with more complex regulation, increased offshoring, higher lobbying or innovation costs, severe labour market imperfections and economies where it is more expensive to acquire and process market information, will tend to have higher markup-related inefficiencies.

Post-innovation productivity Fixing the initial high draw z_h and the cost of innovation f_k, an increase in the post-innovation productivity z_k is equivalent to

[8]For the graphs presented here the parameter values are the following: $z_k = 7$ $z_h = 3$, $z_l = 0.1$, $f = 0.001$, $f_k = 0.015$ and $f_e = 0.03$.

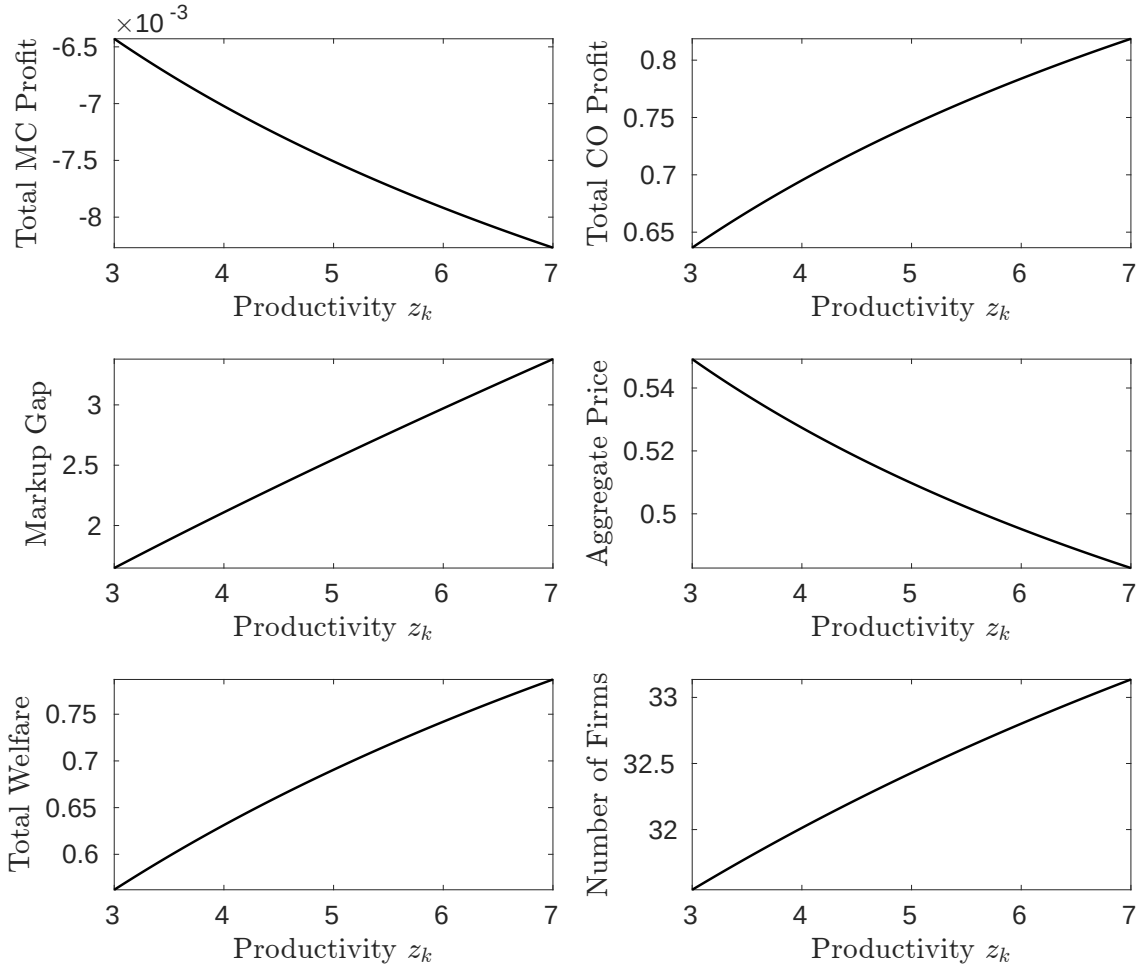
Figure 1: Innovation cost



a more efficiency-enhancing innovation. In Figure 2 we present the impact of a change in z_k. We start from $z_k = z_h$ and increase z_k. When $z_k = z_h$ innovation is not cost-reducing but has the sole purpose of allowing the firm to act as a Cournot oligopolist. This is the approach followed by Cellini et al. (2015) who argue that "realising" one's impact on the market is a costly procedure. We conclude that, as the productivity gap between large and small firms increases, their profitability gap increases accordingly and there is a market share reallocation from the less productive MC firms towards the more productive CO firms. Again the effect on the oligopolistic profits dominates the effect on monopolistically competitive profits causing expected profits prior to entry to rise. This creates entry which in-

creases the equilibrium number of firms. The increase in the number of operating firms N increases competition within the oligopolistic subsector and this is why markups of price over marginal cost do not increase as much as productivity. This decrease in the cost that is only partly incorporated in the markups drives prices down, thus, by (36), increasing social welfare. In our model, innovation plays the dual role of increasing aggregate efficiency and, via attracting entry through an increase in expected profits, increasing competition. Both of these mechanisms are welfare-enhancing.

Figure 2: Post-innovation productivity z_k

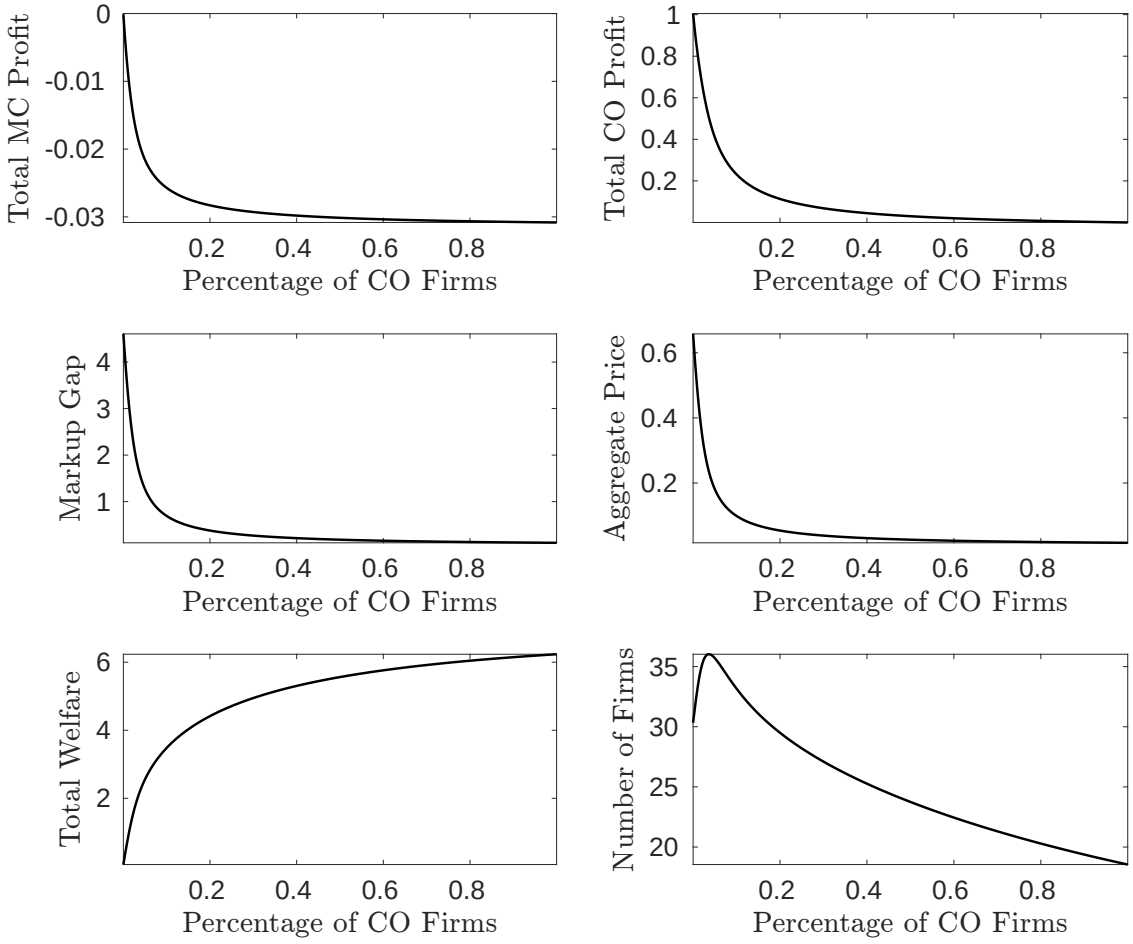


Percentage of CO firms Our standard value for the probability of an initial high draw γ, which is essentially the percentage of large firms, is $\gamma = 0.01$. This is motivated by the empirical literature that emphasises the role of the superstar firms, formally defined as the top 1 percent. However, we can trace the whole spectrum of $\gamma \in (0,1)$. As $\gamma \to 1$ our model tends to pure oligopoly and as $\gamma \to 0$ it tends to pure monopolistic competition. As γ increases, competitive pressures within the oligopolistic subsector increase and the competition among MC firms becomes lower. However, the non-strategic type of the MC firms implies that the competitiveness of the market is driven by the competitiveness of the oligopolistic subsector. Hence, competition increases as γ increases.

In Figure 3 we illustrate how our model behaves as we change γ in the $(0,1)$ interval. As γ increases, markups decrease but at a decreasing rate. This is because, from a level of γ on, the two subsectors are almost of comparable magnitude and behave very similarly. As $\gamma \to 1$ markups in the market tend to be equalised. They never are perfectly equalised, though, because, by construction, oligopolists behave differently than the MC firms. The decrease of markups suppresses prices which has a positive effect on the welfare. In the oligopolistic subsector, as γ increases, competition among large firms increases and CO profits decrease. However, the profits of the MC firms also decrease as γ increases but this result is different. A higher γ by definition means a smaller fringe since the fringe is proportionately equal to $(1-\gamma)$. Therefore, an increase in γ decreases the market share of the fringe by suppressing its magnitude. Since there is no exit this will be equivalent to a decrease in the fringe profits.

Finally, we present the relationship between the number of firms and the level of γ. Given that the equilibrium total number of firms adjusts according to the free entry condition, we need to examine the impact of increasing γ on the expected profits. MC firms make positive total operational profits but, when the entry cost

Figure 3: Percentage of CO firms



is subtracted, their total profits are negative. The reason they do not exit is that they have to repay the sunk fixed entry cost. On the contrary, even after the deduction of the entry cost, oligopolists make positive profits. This means that entry is created from the prospect of the oligopolistic profit. More firms will enter when the oligopolistic profit is higher and when the probability of being an oligopolist and making the high profit is higher. As we increase γ these two effects move in the opposite direction. The high oligopolistic profit decreases but the probability of being the high type increases. We show that for low levels of γ where the competition among large firms is still low, the increase in the probability of being a profitable firm dominates and N increases. However, beyond a level of γ,

the oligopolistic subsector is already very competitive, oligopolistic profits have decreased enough and, hence, any further increase in γ will drive the number of firms down. The result is an inverted-U curve which expresses the relationship between the level of competition (which increases with γ) and the level of Romer (1990)-type innovation, as it is reflected in the number of differentiated varieties produced in the economy (N). This inverted-U pattern that peaks at relatively low levels of competition is in line with the endogenous growth literature following Aghion et al. (2005).

2.4 Conclusion

Based on the assumption that firms grow because of luck and successful innovation, we construct a two-period general equilibrium model with free entry where the most efficient firms choose to take action in order to exploit their market power whereas firms that supply only a small percentage of the market have no choice but to disregard their impact on the aggregates and engage in monopolistic competition. Conditions are derived for this asymmetry to emerge as the subgame perfect equilibrium. We find that productivity heterogeneity that is commonly assumed in trade models is a necessary condition for the formation of mixed markets. Our setup can explain the empirically confirmed differences in markup variability across firms with different market shares as well as the documented residual markup inequality which cannot be attributed to differences in productivity. In particular, in markets with more barriers to enter the oligopolistic subsector, like in the presence of increased innovation costs, this residual markup inequality will tend to increase. Finally, regarding the effect of superstars on welfare, under the assumption that large firms are more productive than their smaller rivals, we find that mixed markets could serve as an alternative interpretation of the inverted-U relationship between innovation and competition.

A key feature of our model is that there are exogenous barriers, unaffordable by most, to becoming a superstar firm. Further research could exploit the possibilities of innovation and competition policy in a fully dynamic setup of endogenous growth where the ability of large firms to exploit their market power could manifest itself as strategic innovation or co-operation. Both of these practices constitute endogenous barriers to enter the superstars subsector.

3 Liberalising Trade in The Shadow of Superstar Firms

3.1 Introduction

Global markets are becoming increasingly concentrated. And, although the recent theoretical international trade literature has highlighted the increase of competition as a fundamental source of gains from trade, the biggest beneficiary from trade liberalisation has, in fact, been this handful of large companies (Neary, 2010; Bernard et al., 2009; Wooldridge, 2016; Head and Spencer, 2017). So why are superstars the big winners of globalisation? And in their dominant presence, as documented in micro-level data, what is the size of gains from trade?

In the previous chapter we established that, as Neary (2010) puts it, "large firms are more than more productive clones of small ones" because they behave differently. In this chapter we argue that this behavioural difference between larger and smaller firms becomes crucial in a globalised economy setup. In a mixed market competition framework where large oligopolistic firms compete with a fringe of monopolistic competitors we introduce bilateral trade and calculate the welfare gains from decreasing the trade cost. Our model allows for general equilibrium considerations and free entry but without losing sight of the behavioural differences among firms. These differences result in the well recorded different abilities to pass-through (Mayer et al., 2016): trade liberalisation in the form of a decrease in the cost to export will only partly be passed on to the prices of large oligopolists since they are able to adjust their markups, as opposed to the fringe firms that cannot. As a result, firms are not symmetrically affected by trade liberalisation.

The main finding of this chapter is that, bringing together the two established but hitherto unrelated market structures of oligopoly and monopolistic competition in an open economy setup, the result is not a simple combination of the

variety gains predicted by the monopolistically competitive Krugman (1980)-type models with the pro-competitive gains which are expected to materialise under pure oligopoly as in Brander and Krugman (1983). The coexistence of firms that differ in their strategic behaviour gives rise to a *composition effect* of these two traditional sources of gains resulting in a market share reallocation from smaller towards larger players which dampens the pro-competitive effect of increasing openness and reduces welfare gains from trade. Trade liberalisation disproportionately benefits large firms whose gains from the decrease in the cost of exports dominates their losses from increased competition in the domestic market. This result could not occur without the presence of small firms who largely absorb competitive pressures, shielding large firms from increased import penetration.

Superstars are the big winners of globalisation (1) because of their increased productivity, as demonstrated by their lower prices generating increased market shares, and (2) due to their oligopolistic nature as manifested in their unique ability to vary their markups with their market shares. As a result of these two key defining characteristics of superstars, trade triggers two different types of market share reallocation away from the smaller and towards the larger firms: a reallocation which resembles the Melitz (2003)-type selection and is due to the efficiency advantage of superstar firms and a reallocation that is solely attributed to the differential abilities of the two types of firms to charge variable markups. Our study is, to our knowledge, the first to explore how these two coexisting mechanisms operate as trade becomes less costly.

We find that, as in Mayer et al. (2014) and Edmond et al. (2015), increasing openness to trade decreases the average markup and markup heterogeneity. Consequently, trade always raises aggregate welfare. However, the form of reallocation that stems from differences in market power is inefficient. We show that, contrary to a purely oligopolistic setup as in Edmond et al. (2015), this inefficiency is

more evident in more concentrated industries characterised by more severe initial markup distortions. In these industries, where large firms are more rare and, therefore, more powerful, the welfare boost from trade liberalisation is unlikely to be significant. In the same spirit as Bertoletti and Epifani (2014) and Arkolakis et al. (2015), pro-competitive gains from trade are systematically miscalculated both in purely monopolistically competitive and in purely oligopolistic models. In fact, the aforementioned inefficiency generated by asymmetric strategic market power, creates a role for size-dependent trade policies which, in polarised markets, could turn out to be socially desirable. Our policy analysis highlights the trade-off between the efficiency gains from innovation undertaken by superstars and the welfare losses due to decreased competition in the presence of few powerful firms. Echoing Epifani and Gancia (2011), we conclude that trade and competition policy are complementary and should be jointly pursued, aiming at increasing competition by lowering entry costs and the cost of innovation.

Besides the aforementioned trade literature, this chapter is also related to the industrial organisation literature on mixed market competition. Mixed market is a structure introduced in Shimomura and Thisse (2012) that has only appeared in trade literature in Parenti (2017). In comparison to Parenti (2017), our model has relaxed his assumptions of no free entry and homogeneous productivity. The combination of these assumptions drive Parenti's result that there are zero pro-competitive gains from trade and that, in fact, lowering trade costs turns out to be harmful for consumers. Being a more general framework, this chapter nests Parenti (2017) as a special case but performs better in replicating the vast majority of empirical works in the field of international trade according to which trade is, on aggregate, welfare-enhancing.

The remainder of this chapter is organised as follows. In Section 3.2 we present a two-period model with mixed markets and international trade. In Section 3.3 we

discuss our findings and explore the impact of trade liberalisation by illustrating the behaviour of our model in response to changes in the trade cost. We use our results to state some interesting policy implications. Finally, we conclude in Section 3.4.

3.2 Setup of the model

We construct a two-period model in which Cournot oligopolistic and monopolistically competitive firms co-exist and introduce bilateral trade between two symmetric countries aiming at analysing the evolution of gains from trade as globalisation proceeds.

3.2.1 Preferences and demand

The consumer side of our model is the same as the closed economy setup of Section 2.2. For completeness purposes we re-state the key equations here.

At each point in time ($t = 1, 2$) the economy involves one horizontally differentiated and one homogeneous good the production of which only requires labour, which is perfectly mobile. The horizontally differentiated good (H) is produced under increasing returns and, at time t, H_t can be supplied either by large Cournot oligopolists (CO firms) or by small monopolistically competitive firms (MC firms). We assume that H is formed by two CES-composites, X and Y, which at time t are defined as follows:

$$X_t = \left(\sum_{i=1}^{n_{xt}} x_{it}^a \right)^{\frac{1}{a}} \tag{1}$$

$$Y_t = \left(\sum_{i=1}^{n_{yt}} y_{it}^a \right)^{\frac{1}{a}} \tag{2}$$

where x_{it} is the output level of large firm $i = 1, 2, \ldots, n_{xt}$ at time t and y_{it} is

the output level of small firm $i = 1, 2, \ldots, n_{yt}$ at time t and $a \in (0,1)$. The elasticity of substitution between any two varieties of H is given by $\sigma \equiv \frac{1}{(1-a)} > 1$. Combining X and Y we obtain H which corresponds to the output index of the entire differentiated sector:

$$H_t = (X_t^a + Y_t^a)^{\frac{1}{a}} \tag{3}$$

The homogeneous good (O) is produced under constant returns, supplied by perfectly competitive firms and serves as the numeraire commodity. In the open economy framework, maintaining the assumption of CES has the additional advantage of making our results straightforwardly comparable to the existing trade literature since CES is the standard preference structure in international trade.

The representative consumer is endowed with L units of labour, holds the shares of all firms and has a logarithmic upper-tier instantaneous utility function over the homogeneous and the differentiated good. At every period $t = 1, 2$, the representative consumer maximises the utility function:

$$U_t = \ln H_t + \beta \ln O_t \tag{4}$$

subject to the budget constraint:

$$O_t + E_t = I_t \tag{5}$$

where E represents the expenditure on the differentiated good, which at at time t is defined as $E_t = P_t H_t$, and I is the endogenous income level in terms of the numeraire. Under the assumption that one unit of labour produces one unit of the homogeneous good, the equilibrium wage will be equal to 1 and $wL = L$. The aggregate price index of the differentiated sector P_t is defined as follows:

$$P_t = \left(\sum_{i=1}^{n_{xt}} p_{xit}^{\frac{-a}{1-a}} + \sum_{i=1}^{n_{yt}} p_{yit}^{\frac{-a}{1-a}} \right)^{-\frac{1-a}{a}}$$

implying:

$$P_t = E_t H_t^{-1}$$

Assuming that there are no means available to the consumer to transfer wealth from one period to the other, we can focus on the per-period optimisation problem:

$$\max_{\{x_{it}\}_{i=1}^{n_{xt}}, \{y_{it}\}_{i=1}^{n_{yt}}, O_t} \left\{ U_t = \ln \left[\left(\sum_{i=1}^{n_{xt}} x_{it}^a \right) + \left(\sum_{i=1}^{n_{yt}} y_{it}^a \right) \right]^{\frac{1}{a}} + \beta \ln O_t \right\}$$

$$\text{s.t. } O + \sum_{i=1}^{n_{xt}} p_{xit} x_{it} + \sum_{i=1}^{n_{yt}} p_{yit} y_{it} = I_t$$

The consumer maximisation problem leads to the following optimal decisions:

$$O_t = \beta E_t \tag{6}$$

$$p_{xit} = x_{it}^{a-1} H_t^{1-a} P_t \tag{7}$$

$$p_{yit} = y_{it}^{a-1} H_t^{1-a} P_t \tag{8}$$

The first equation, which is the demand for the homogeneous good implies that the income share spent on the differentiated good is constant and given by:

$$E_t = \frac{1}{\beta + 1} I_t \tag{9}$$

3.2.2 Production

We use the two-period framework presented in Section 2.2 in order to analyse a global economy consisting of two symmetric countries with the same preference and production structure. In period one we model a newly-created industry that consists only of small non-strategic firms that compete monopolistically. In the second period, according to the mechanism described in Section 2.2, some firms have become superstars and, through luck and successful innovation, have gained the ability of behaving strategically. We assume that the countries open up to trade only in the second period of the game. In other words, we examine trade between two economies that are "mature" enough to have both large and small firms. The reason we introduce trade at the second period only is that we want to focus on trade between countries characterised by the empirically supported market competition with a handful of big players and a myriad of small businesses. Trade in the first period would involve two monopolistically competitive industries as in Melitz (2003) and we have nothing new to say here about the gains from this type of trade.

Period 1 The first period of the model is identical to the first period of the model presented in Section 2.2. We repeat the crucial assumptions and the key equations for the purposes of completeness. At the beginning of the first period N_τ firms enter the market. Entry only occurs at the beginning of the game and there is no exit before the end of the game. To enter, firms pay a fixed sunk entry cost $f_e > 0$. N_τ is such that the total expected profits from both periods of the game are equal to the entry cost. Prior to entry firms are identical and non-strategic.

Once they enter the market, they draw an initial productivity parameter $z > 0$ from a common distribution. We assume that z can only take two discrete values, each with a known probability:

$$z \in \{z_l, z_h\} \text{ where } z_l < z_h \text{ and } P(z = z_h) = \gamma < 1$$

Production only requires labour which, at each period, is inelastically supplied at the aggregate level L. Given that the wage w is set equal to 1, the labour demand function is also the cost function. For a productivity-z firm, production of output q requires labour equal to:

$$l(q; z) = \frac{1}{z}q + f \tag{10}$$

where $f > 0$ is a production fixed cost, same across all firms. In the first period all firms operate under monopolistic competition and hence only the Y-subsector is active:

$$n_{x1} = 0 \text{ and } n_{y1} = N_\tau$$

With costless differentiation, each firm will choose to produce a different variety. In particular, a firm with productivity z will face the following profit maximisation subject to the inverse demand function:

$$\max_{y_{i1}} \left\{ \pi_{yi1} = p_{yi1} y_{i1} - \frac{1}{z} y_{i1} - f \right\}$$

$$\text{s.t. } p_{yi1} = y_{i1}^{a-1} H_1^{1-a} P_1$$

which has a unique optimal solution:

$$y_{i1}(z) = \left(\frac{1}{az} \right)^{\frac{-1}{1-a}} E_1 P_1^{\frac{a}{1-a}} \tag{11}$$

This is equivalent to the following optimal pricing rule:

$$p_{yi1}(z) = \frac{1}{az} \tag{12}$$

Thus, in the first period, the more productive firms produce a higher output, charge a lower price and earn higher profits compared to the less productive firms. First-period profits are presented below:

$$\pi_{y1}(z_h) = \left(\frac{1}{az_h}\right)^{\frac{a}{a-1}} (1-a)E_1 P_1^{\frac{a}{1-a}} - f \tag{13}$$

$$\pi_{y1}(z_l) = \left(\frac{1}{az_l}\right)^{\frac{a}{a-1}} (1-a)E_1 P_1^{\frac{a}{1-a}} - f \tag{14}$$

However, all firms, regardless of their productivity, will choose the same profit maximising markup of price over marginal cost (defined as θ_{y1}):

$$\theta_{y1} = \frac{1}{a} \tag{15}$$

Aggregating over the total number of entrants N_τ and given the distribution of productivities, we get the aggregate price index in the differentiated sector for period one P_1 and the aggregate first-period expenditure:

$$P_1 = \left[\gamma N_\tau \left(\frac{1}{az_h}\right)^{\frac{a}{a-1}} + (1-\gamma)N_\tau \left(\frac{1}{az_l}\right)^{\frac{a}{a-1}}\right]^{\frac{a-1}{a}} \tag{16}$$

$$E_1 = \frac{L - N_\tau f}{\beta + 1 - \left[\frac{(1-\gamma)\left(\frac{1-a}{(az_l)^{\frac{a}{a-1}}}\right) + \gamma\left(\frac{1-a}{(az_h)^{\frac{a}{a-1}}}\right)}{\gamma\left(\frac{1}{az_h}\right)^{\frac{-a}{1-a}} + (1-\gamma)\left(\frac{1}{az_l}\right)^{\frac{-a}{1-a}}}\right]} \tag{17}$$

Period 2 In the beginning of the second period each firm has the option to invest in a discrete efficiency-enhancing innovation. Incurring a fixed sunk cost $f_k \geq 0$ increases a firm's productivity by $k \geq 0$ with probability 1 and enables the firm to act as a Cournot oligopolist, in other words to exploit its market power. The post-innovation level of productivity is defined as follows:

$$z_k \equiv z_h + k$$

Once the innovation decisions have been made firms can export to a foreign, perfectly symmetric economy. In order to analyse polarised markets, we assume that all firms of one country compete with all firms of the other, regardless of their size. However closed-economy oligopolists compete oligopolistically when they trade in the global market and, similarly, closed-economy MC firms compete monopolistically when they open up to trade. Trade costs are of the iceberg type: $\tau > 1$ units of goods must be shipped abroad in order for 1 unit to be consumed. We abstract from the presence of a fixed entry cost in the export market and therefore all firms will choose to export. Since the two countries are perfectly symmetric, we can focus on the home one.

Large firms (CO firms) Large domestic firm i chooses the quantity sold in the domestic and the foreign market, denoted by x_i^d and x_i^f respectively, to maximise its profits subject to the inverse demand function of each country:

$$\max_{x_i^d, x_i^f} \left\{ \pi_{x\tau i} = \left(p_{xi}^d - \frac{1}{z_k} \right) x_i^d + \left(p_{xi}^f - \frac{\tau}{z_k} \right) x_i^f - f - f_k \right\}$$

$$\text{s.t. } p_{xi}^d = (x_i^d)^{a-1} (H^d)^{1-a} P^d$$

$$\text{and } p_{xi}^f = (x_i^f)^{a-1} (H^f)^{1-a} P^f$$

and taking as given that both domestic and foreign MC firms maximise their profits subject to the inverse demands at home and abroad and that every other oligopolist (foreign and domestic) produces according to their reaction functions. Notice that the symmetry assumption implies that the two countries have the same price level ($P^d = P^f = P_\tau$), the same number of oligopolists ($n_x^d = n_x^f = n_{x\tau}$) and

also the same level of industry output:

$$H^d = \left[(x_i^d)^a + \sum_{j \neq i} (x_j^d)^a + \sum_{j=0}^{n_{x\tau}} (x_j^f)^a \right]^{\frac{1}{a}} = H^f = \left[(x_i^f)^a + \sum_{j \neq i} (x_j^f)^a + \sum_{j=0}^{n_{x\tau}} (x_j^d)^a \right]^{\frac{1}{a}} = H_\tau$$

where x_0^d and x_0^f represent the aggregate behaviour of the monopolistically competitive subsector. Because $\frac{\partial \pi_{x\tau i}}{\partial x_i^d}$ is strictly decreasing in x_i^d and $\frac{\partial \pi_{x\tau i}}{\partial x_i^f}$ is strictly decreasing in x_i^f we have that:

Lemma 1 (best responses of CO firm) *For any CO firm $i = 1, 2, \ldots, n_{x2}$ and for any given output vector of all other CO firms x_{-i2} and any aggregate behaviour of the MC firms x_{02}, the profit function $\pi_{x\tau i}$ is strictly concave with respect to own domestic and exported output x_i^d and x_i^f. Hence, the best response functions of domestic oligopolist i are the unique solution of each one of the following first order conditions:*

$$\frac{\partial \pi_{x\tau i}}{\partial x_i^d} = \frac{a \left(\sum_{j \neq i} (x_j^d)^a + \sum_{j=0}^{n_{x\tau}} (x_j^f)^a \right)}{(x_i^d)^{1-a} \left((x_i^d)^a + \sum_{j \neq i} (x_j^d)^a + \sum_{j=0}^{n_{x\tau}} (x_j^f)^a \right)^2} E_\tau - \frac{1}{z_k} = 0 \qquad (18)$$

$$\frac{\partial \pi_{x\tau i}}{\partial x_i^f} = \frac{a \left(\sum_{j \neq i} (x_j^f)^a + \sum_{j=0}^{n_{x\tau}} (x_j^d)^a \right)}{(x_i^f)^{1-a} \left((x_i^f)^a + \sum_{j \neq i} (x_j^f)^a + \sum_{j=0}^{n_{x\tau}} (x_j^d)^a \right)^2} E_\tau - \frac{\tau}{z_k} = 0 \qquad (19)$$

Small firms (MC firms) Small domestic firm i chooses the level of output supplied in the domestic market y_i^d as follows:

$$\max_{y_i^d, y_i^f} \left\{ \pi_{yi\tau} = \left(p_{yi}^d - \frac{1}{z_l} \right) y_i^d + \left(p_{yi}^f - \frac{\tau}{z_l} \right) y_i^f - f \right\}$$

$$\text{s.t. } p_{yi}^d = (y_i^d)^{a-1} (H^d)^{1-a} P^d$$

$$\text{and } p_{yi}^f = (y_i^f)^{a-1} (H^f)^{1-a} P^f$$

where $P^d = P^f = P_\tau$, $n_y^d = n_y^f = n_{y\tau}$ and $H^d = H^f = H_\tau$. Omitting the i-index, since in equilibrium all MC firms make the same optimal decisions, and applying the f.o.c. yields the equilibrium output sold domestically and abroad:

$$y^d(E_\tau, P_\tau; \tau, z_l) = \left(\frac{1}{az_l}\right)^{\frac{-1}{1-a}} E_\tau P_\tau^{\frac{a}{1-a}} \tag{20}$$

$$y^f(E_\tau, P_\tau; \tau, z_l) = \left(\frac{\tau}{az_l}\right)^{\frac{-1}{1-a}} E_\tau P_\tau^{\frac{a}{1-a}} \tag{21}$$

which give the equilibrium prices charged in the domestic and the export market:

$$p_y^d(z_l) = \frac{1}{az_l} \tag{22}$$

$$p_y^f(z_l) = \frac{\tau}{az_l} = \tau p_y^d \tag{23}$$

This implies that each domestic small firm sets a domestic price equal to the one in a closed-economy setup but a higher price is set in the foreign market, reflecting the increased marginal cost of supplying to this market.

3.2.3 Equilibrium

We consider a non-cooperative game in which big and small firms choose their output simultaneously. We characterise a mixed market equilibrium using the profit maximisation conditions of the small and large firms as well as the free entry condition.

We focus on a *symmetric* equilibrium where all large firms choose the same output, foreign and domestic (i.e. $x_i^d \equiv x^d$ and $x_i^f \equiv x^f$ for every $i = 1, 2, \ldots, n_{x\tau}$), sold at the same corresponding price (i.e. $p_{xi}^d \equiv p_x^d$ and $p_{xi}^f \equiv p_x^f$ for every $i = 1, 2, \ldots, n_{x\tau}$) and, hence, earn the same profits (i.e. $\pi_{xi\tau} \equiv \pi_{x\tau}(\tau, z_k)$ for every $i = 1, 2, \ldots, n_{x\tau}$). The equilibrium conditions for the open economy (for given

N_τ) along with the equations for the closed-economy period-one profit functions and aggregate prices) form a system of eleven equations in eleven unknowns. The first-period is summed by equations (13) - (17), exactly as in the closed-economy setup (except that it is in terms of N_τ instead of N), given that in the first period there is no trade. For the second period, where there is costly trade in the varieties of the differentiated good and free trade in the homogeneous good, we consider the open-economy profits:

$$\pi_{x\tau}(z_k) = (x^d)^a E_\tau^{1-a} P_\tau^a - \frac{1}{z_k} x^d + (x^f)^a E_\tau^{1-a} P_\tau^a - \frac{\tau}{z_k} x^f - f - f_k \tag{24}$$

$$\pi_{y\tau}(z_l) = \left(\frac{1}{az_l}\right)^{\frac{a}{a-1}} (1-a) E_\tau P_\tau^{\frac{a}{1-a}} + \left(\frac{\tau}{az_l}\right)^{\frac{a}{a-1}} (1-a) E_\tau P_\tau^{\frac{a}{1-a}} - f \tag{25}$$

From the two optimality conditions for the open-economy profit maximisation of a large firm we get the conditions linking E_τ, P_τ, x^d and x^f:

$$E_\tau^{1-a} = \frac{1}{az_k} P_\tau^{-a} (x^d)^{1-a} + E_\tau^{1-2a} P_\tau^a (x^d)^a \tag{26}$$

$$E_\tau^{1-a} = \frac{\tau}{az_k} P_\tau^{-a} (x^f)^{1-a} + E_\tau^{1-2a} P_\tau^a (x^f)^a \tag{27}$$

Finally, we have the open-economy aggregate expenditure on the differentiated good:

$$E_\tau = (\beta+1)^{-1} \left(L + \gamma N_\tau \pi_{x\tau}(z_k) + (1-\gamma) N_\tau \pi_{y\tau}(z_l)\right) \tag{28}$$

Using the definition of the aggregate price index P_τ we get that:

$$(x^d)^a + (x^f)^a = E_\tau^a \left[\frac{1 - (az_l P_\tau)^{\frac{a}{1-a}} (1-\gamma) N_\tau (1+\tau^{\frac{-\alpha}{1-\alpha}})}{\gamma N_\tau P_\tau^a}\right] \tag{29}$$

Equations (26) - (29) yield the equilibrium values of x^d, x^f, E_τ and P_τ as functions

of N_τ only. Using (17) and the free entry condition:

$$E\Pi(N_\tau) = \gamma \left[\pi_{y1}(z_h) + \pi_{x\tau}(z_k)\right] + (1-\gamma)\left[\pi_{y1}(z_l) + \pi_{y\tau}(z_l)\right] - f_e = 0 \quad (30)$$

we close the system and compute the open-economy equilibrium number of firms N_τ operating in each country.

To sum up, the open economy equilibrium is characterised by equations (13) - (17) and (24) - (30) and by the following unknowns: the per-period profits ($\pi_{y1}(z_h)$, $\pi_{y1}(z_l)$, $\pi_{x\tau}(\tau, z_k)$ and $\pi_{y\tau}(\tau, z_l)$), the price indices (P_1 and P_τ), the levels of expenditure on the differentiated good (E_1 and E_τ) and the levels of output sold by an oligopolist in the domestic (x^d) and the foreign market (x^f) once costly trade is allowed and the number of firms operating in each country N_τ. We find that, as in the closed economy equilibrium, oligopolists charge a higher markup than monopolistic competitors. Furthermore, oligopolists are able to charge a markup that varies with τ, unlike the fringe firms who charge a constant markup of price over marginal cost. These results replicate the empirical findings presented by Hottman et al. (2016).

3.2.4 Welfare

We can now calculate the indirect utility of the representative consumer and, given that preferences are homothetic, the indirect utility function will describe aggregate welfare. The aggregate welfare function is presented below:

$$\begin{gathered} V = \ln\left[\gamma N_\tau \tilde{y}_1^a(z_h) + (1-\gamma) N_\tau \tilde{y}_1^a(z_l)\right]^{\frac{1}{a}} + \\ \ln\left[\gamma N_\tau \left((\tilde{x}^d)^a + (\tilde{x}^f)^a\right) + (1-\gamma) N_\tau \left((\tilde{y}^d)^a + (\tilde{y}^f)^a\right)\right]^{\frac{1}{a}} + \\ \beta \ln(\beta^2 E_1 E_\tau) \end{gathered} \quad (31)$$

where:

$$\tilde{x}_1 = E_1 \left(\frac{p_{x1}}{P_1^a} \right)^{-\frac{1}{1-a}}$$

$$\tilde{y}_1 = E_t \left(\frac{p_{y1}}{P_1^a} \right)^{-\frac{1}{1-a}}$$

and for $\mathcal{C} \in \{d, f\}$ we have that:

$$\tilde{x}^{\mathcal{C}} = E_\tau \left(\frac{p_x^{\mathcal{C}}}{P_\tau^a} \right)^{-\frac{1}{1-a}}$$

$$\tilde{y}^{\mathcal{C}} = E_\tau \left(\frac{p_y^{\mathcal{C}}}{P_\tau^a} \right)^{-\frac{1}{1-a}}$$

For the evaluation of welfare gains from trade we use the compensating variation ω of going from the trade equilibrium Ω_1 to the autarky equilibrium Ω_2. It can be expressed as follows:

$$\ln \omega = V(\Omega_1) - V(\Omega_2) \tag{32}$$

Welfare and welfare gains from trade decrease with prices and the average markup and increases with average productivity. For the evaluation of a trade policy regime we use the exact same approach where Ω_1 is the equilibrium under the policy regime and Ω_2 is the equilibrium without the policy.

3.3 Equilibrium analysis

Our model does not have an analytical solution because we cannot solve for x^d and x^f analytically. However, we are able to perform numerical comparative statics and draw interesting conclusions. We normalise $L = 1$ and set our key parameters as presented in Table 5. Our results are robust to changes in the parameters provided subgame perfection is guaranteed.

3.3.1 Iceberg trade cost

We consider a setup where there are no fixed costs to export. In the presence of fixed costs, under the symmetry assumption, we would get one of two possible cases. Either the fixed cost of exporting would be too high for the small firms, in which case we would have trade only among oligopolists or the fixed costs would be low enough for all firms to export, in which case the no-fixed cost analysis is exactly applicable, only scaled down. The case where only oligopolists trade is found to be an even more extreme version of the results under no fixed costs where the fringe firms are even less flexible to react to trade liberalisation and, hence, even more severely harmed by it.

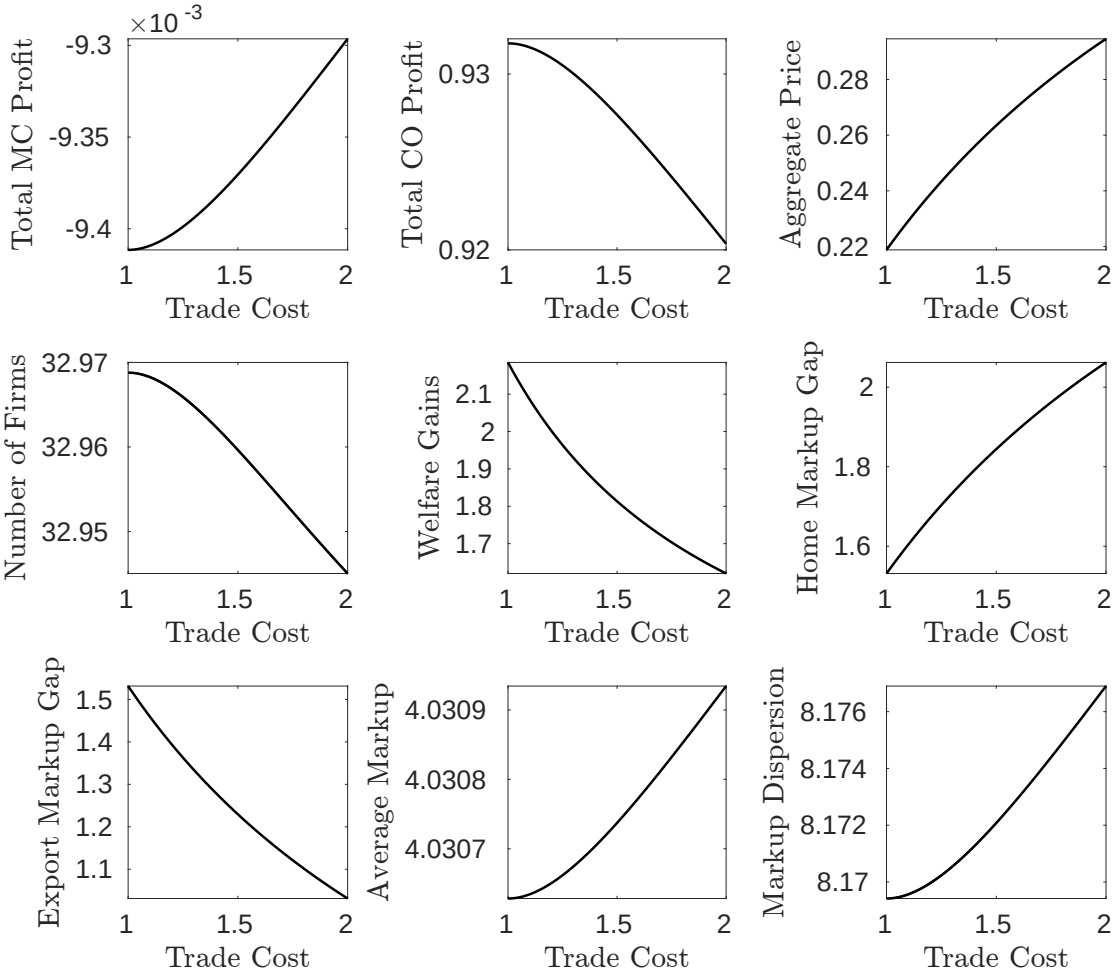
In Figures 1 and 2 we illustrate the effects of trade liberalisation[1]. We start with free trade where $\tau = 1$ and increase τ. Trade liberalisation is captured as a decrease of the iceberg cost τ and so our figures should be read from the right to the left. As τ decreases and trade liberalisation proceeds, the export penetration from both small and large foreign firms increases (Figure 1). This decreases the market shares of all types of domestic firms in the home market and increases the shares of all types of foreign firms. With CES, MC firms cannot adjust their markups, as opposed to the oligopolists who can (Hottman et al., 2016). As in the standard oligopolistic models, oligopolists engage in reciprocal dumping by charging a lower markup abroad than at home (Figure 1). More importantly, as τ decreases, large firms lower their markups in the domestic market because of increased competition and increase them in the foreign because of decreased export costs. Differential abilities to adjust markups give rise to a composition effect of the two traditional sources of gains, namely the variety gains predicted by monopolistically competitive models and the pro-competitive gains which are

[1]We set our parameters as follows: $a = 0.5$, $\beta = 0.5$, $\gamma = 0.01$, $z_k = 7$ $z_h = 3$, $z_l = 0.1$, $f = 0.001$, $f_k = 0.015$ and $f_e = 0.03$.

expected to materialise under oligopoly. Our predictions from the mixed-markets model differ from the predictions of both the Krugman (1980)- and the Brander and Krugman (1983)-type models. In the presence of market power heterogeneity, there is a new channel through which trade liberalisation affects welfare. This channel works through the differential abilities of firms to price-to-market and materialises a market share reallocation from small towards large firms.

In the remainder of Figure 1 we focus on the markup adjustment that takes place as trade openness increases. Notice that variable markups imply that the change in trade costs is only partly being passed on to the prices. Prices decrease but less than the decrease in trade costs. The decrease in prices creates an increase in aggregate welfare, in comparison to the autarky equilibrium. Finally average markups decrease but only marginally. The increase in foreign markups is slightly lower than the decrease in domestic markups. Average markup and markup dispersion both decrease as τ decreases. This implies that some pro-competitive gains from trade survive but they are crucially diminished due to market power asymmetries. Overall, as τ decreases, MC firms become less profitable whereas oligopolistic firms increase their profits. The pro-competitive effect of trade liberalisation is dampened. This is because, in the presence of a competitive fringe, the fringe largely absorbs the competitive pressures. As a result, leaving out strategic asymmetries leads to a systematic error in the estimation of trade-induced competition. Reconciling these findings with the part of Section 2.3 that refers to the comparative statics with respect to f_k, we conclude that, similarly to Peters (2013), the welfare gains associated with markup heterogeneity will be higher from reducing fixed cost barriers (whether they are innovation, offshoring, lobbying or regulation costs or even costs that relate to labour market imperfections and imperfect information on a firm's own impact on the market) allowing more firms to exploit their market power, than from reducing marginal trade cost.

Figure 1: Trade liberalisation



Finally, the increase in the oligopolistic profits dominates the decrease in the monopolistically competitive profits causing expected profits prior to entry to increase and so a higher number of firms enters the market. Even though the number of firms increases, intensifying competition among large firms, this is not sufficient to overturn the increase in oligopolistic profits due to trade liberalisation. Comparing the number of available varieties (N versus $2N_\tau$), variety gains from trade survive, although the adjustment of N_τ as τ changes is a result of new entry which is due to the existence of market power (Krugman, 1980).

The idea of incomplete pass-through has been explored in a number of theoretical and empirical works. The pattern is generated with a variety of assumptions

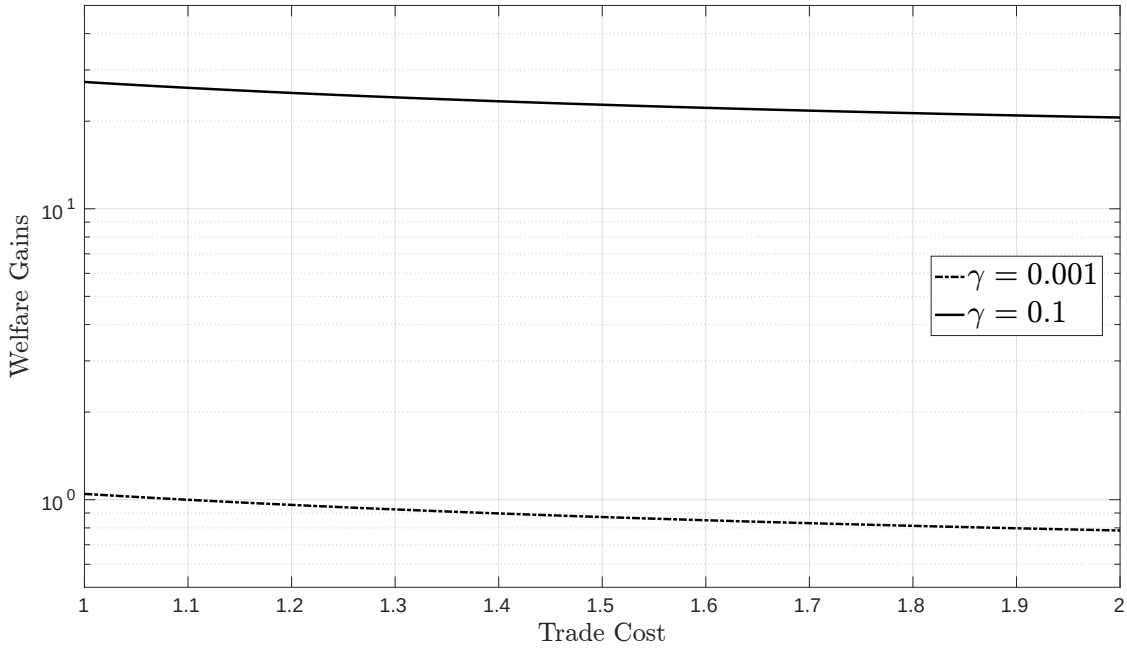
on the demand and market structure. For example, Atkeson and Burstein (2008) assume CES preferences and Cournot oligopoly, Melitz and Ottaviano (2008) assume linear demand and monopolistic competition, Goldberg and Verboven (2005) use nested logit and Bertrand oligopoly and Goldberg and Hellerstein (2013) use Bertrand with random coefficients[2]. In all the aforementioned papers all firms have the ability to charge variable markups and any differences in markups across firms are a result of productivity heterogeneity. In our case, the existence of a productivity gap alone leads to zero markup dispersion. Our model contributes to this literature by introducing the co-existence of fixed- and variable-markup firms in a heterogeneous productivity framework.

The importance of market power becomes obvious when we compare the levels of welfare for different levels of γ (Figure 2). We compare welfare gains for different values of γ ($\gamma = 0.1$ and $\gamma = 0.001$ as opposed to the baseline $\gamma = 0.01$) and use a logarithmic representation of our y-axis for illustration purposes. We conclude that as concentration increases (γ decreases) and large firms are more protected from competition, welfare gains from trade decrease, although trade liberalisation always increases welfare. These results are in line with Mayer et al. (2014) and Edmond et al. (2015) who find that markups decrease due to pro-competitive gains from trade. However, contrary to the findings of Edmond et al. (2015), pro-competitive gains are lower in the presence of extensive misallocation which is due to large inefficiencies associated with markups. The crucial difference between our model and Edmond et al. (2015) is that we abstract from the pure oligopoly assumption by incorporating the inability of most firms to change their pricing behaviour in response to changes in trade costs. In fact, in the presence of extreme markup heterogeneity, which would be captured by a very low γ, welfare gains from trade are so low that we could even speculate that in a richer

[2]For a survey see De Loecker and Goldberg (2014). Other papers include Feenstra and Weinstein (2010), Mayer et al. (2014) and Arkolakis et al. (2015).

setup that would allow for the analysis of inputs as well as outputs markets, trade liberalisation could even lead to markup increase. De Loecker et al. (2016) find that markups actually increase as a result of less costly trade because trade liberalisation not only reduces a firm's cost of exporting its output but it also reduces the cost of imported inputs. Given that superstars tend to make more intensive use of imported inputs (Bernard et al., 2016), allowing for input considerations, would suppress the already limited pro-competitive gains even further possibly to the point of even overturning the effect on markups in line with De Loecker et al. (2016). However, a rigorous input market analysis lies beyond the scope of this chapter.

Figure 2: Gains from trade and market concentration



In terms of the mixed market literature, our model shares the same intuition as Parenti (2017). However, this model operates under the assumptions of homogeneous productivity across firms and an exogenously given number of oligopolists. From the assumption of no free entry, trade liberalisation only works through the adjustment of the competitive fringe. In this case there are no pro-competitive

effects. Furthermore, in the absence of productivity heterogeneity oligopolists charge not only a higher markup but also a higher price compared to the monopolistically competitive fringe. A combination of the two results implies that, in Parenti (2017), lowering trade costs is expected to drive consumer surplus down. This chapter captures this result as an extreme case when productivities across firms are set equal and the number of firms operating in the market is kept fixed[3]. However, in the subgame-perfect case, welfare increases with trade liberalisation but the pro-competitive gains are significantly reduced due to a new channel of market share reallocation which becomes active only when we explicitly allow for differences in market power.

3.3.2 Size-dependent policy analysis

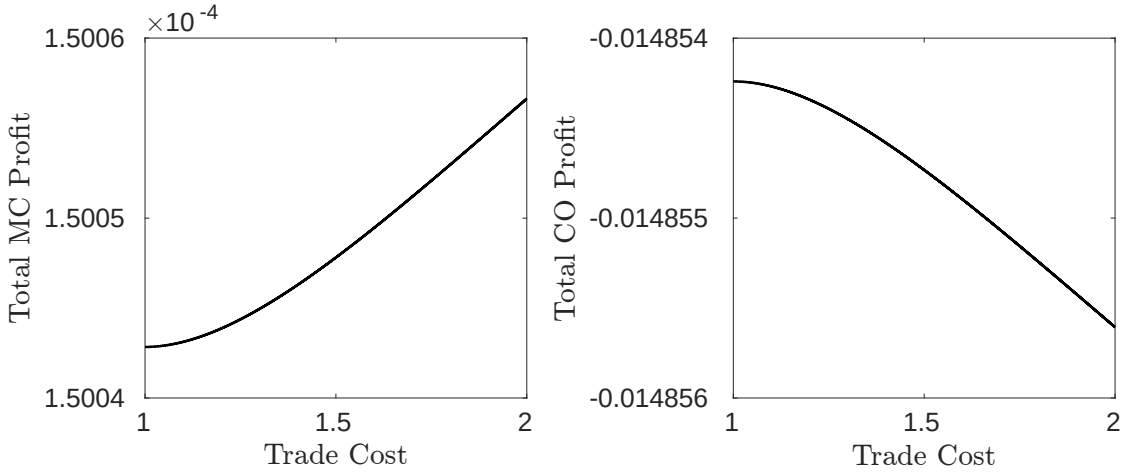
We can now use our model to show how differential market power rationalises the widespread use of size-dependent policies. Going back to the markup analysis under trade liberalisation, the occurring market share reallocation is partly due to an exit-less Melitz (2003)-type selection. Oligopolistic firms are more efficient and therefore they can expand more as trade becomes less costly. Selection-related reallocation is welfare-enhancing and any policy intervention raising obstacles to this mechanism is, without doubt, a harmful practice. However, selection is not the whole story. In Figure 3 we present a counterfactual exercise in which all firms in the market are equally productive: $z_l = z_h = z_k$[4]. In this scenario (which is not subgame perfect since oligopolistic firms are not behaving optimally when they choose to incur f_k despite their lack of productivity advantage) market share reallocation still occurs. This is an inefficiency triggered by trade liberalisation: even without a cost advantage, strategic firms will always set a higher markup

[3]There is also a number of oligopolistic models arguing that, in the presence of firm heterogeneity, trade liberalisation could decrease welfare. See for example Bekkers and Francois (2013).

[4]For this example we set $z_l = z_h = z_k = 3$.

and will benefit from pricing-to-market. Echoing Eckel and Yeaple (2015), our model emphasises "the need to know why firms "excel" before drawing welfare conclusions regarding the cross-firm reallocation of resources".

Figure 3: Inefficiency

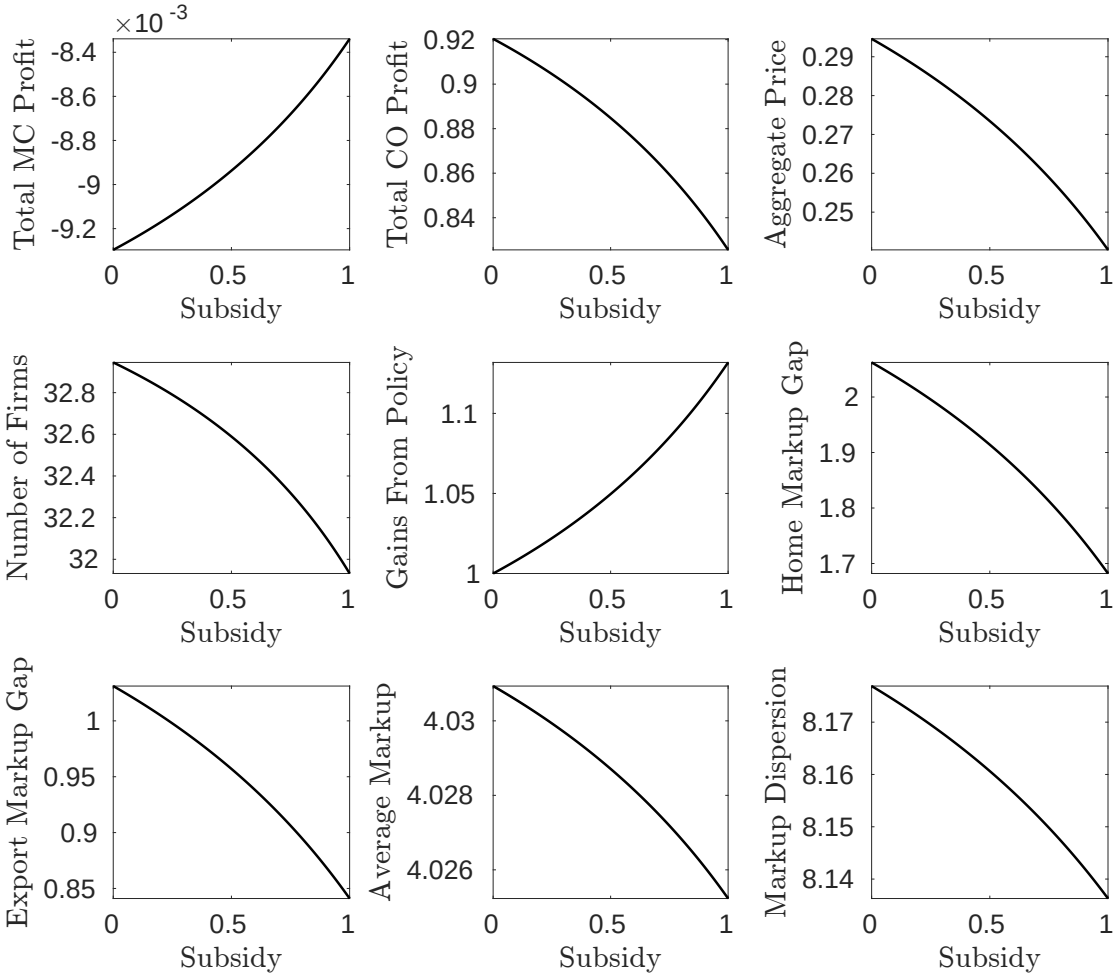


Our market structure highlights the complementarities between trade and competition policy[5] that are yet to be exploited. In the presence of the inefficiency presented above, we go on to investigate whether size-dependent trade policies could magnify the welfare gains from trade. This type of government policies that restrict large establishments and/or promote small ones are widespread across countries. They take different forms, including trade restrictions and subsidies, and there is a large literature like, for example, Restuccia and Rogerson (2008) and Guner et al. (2008) aiming at evaluating costs and benefits from such policies as well as their impact on the size distribution of firms. Following the neoclassical growth model with heterogeneous productivities, the findings from these works tend to agree that size-dependent policies suppress both aggregate output and average productivity. We show that, in the presence of strategic market power heterogeneity, size-dependent policies might actually increase social welfare.

Our size-dependent policy is simple and abstract taking the form of an export

[5]In our model, competition policy refers to measures like price controls and anti-trust policy designed to suppress markup-related inefficiencies.

Figure 4: Size-dependent export subsidy



subsidy. The level of the subsidy is revealed once each firm has drawn an initial productivity. Government budget balances through a lump-sum tax T to the consumers, whose lifetime income drops by T. We compare the results from a subsidy to the low-productivity firms to the situation where all firms face the same trade cost, for example $\tau = 2$. In Figure 4 we present the effect of an export subsidy to the monopolistically competitive firms where the subsidy takes the form of a decreased trade cost faced by these firms. In other words, oligopolistic firms face the real trade cost $\tau = 2$ whereas the MC firms face a trade cost $\tilde{\tau} \in [1, 2]$. The difference between the two costs $\tau - \tilde{\tau}$ is equal to the subsidy per unit of exported output. The lump sum tax imposed on consumers is equal to:

$$T = (1-\gamma)N_\tau \left(\frac{\tilde{\tau}}{az_l}\right)^{\frac{-1}{1-a}} E_\tau P_\tau(\tau - \tilde{\tau})$$

We find that contrary to the homogeneous market power case, a size-depend policy, like the one described above, leads to an increase in output which drives aggregate prices down. Reading Figure 4 reveals that substituting small firms lowers the average markup and the markup dispersion by decreasing both the home and the foreign markup gap between small and large firms. As a result, a market share reallocation of the opposite direction from the one that takes place during trade liberalisation increases the monopolistically competitive profit in the expense of the oligopolistic subsector. As a result, aggregate welfare increases and the welfare gains from the policy increase with the magnitude of the subsidy. Finally, subsidising MC firms leads to a decrease in the expected profits prior to entry which are, again, driven by the decrease in oligopolistic profits. Hence, although they are found to be socially beneficial, size-dependent policies, in our setup, discourage entry. These findings are different from Edmond et al. (2015) who find trade to be an alternative for pro-competitive reforms in the presence of widespread markup heterogeneity. They are, however, aligned with Epifani and Gancia (2011) who argue that global market integration should be accompanied by competition policies.

To conclude, we should note that, although in our simple setup it is beneficial to promote size-dependent policies supporting SMEs, we should be very careful in our evaluation of such practices. On the one hand lower concentration decreases welfare but, on the other, in a dynamic setup, size-dependent policies could affect innovation incentives. There is an important, although nuanced, trade-off between efficiency gains from superstar's innovation and welfare losses because of decreased competition and markup-related misallocation. This concern emphasises the need to design and pursue trade reforms jointly with compe-

tition and innovation policy.

3.4 Conclusion

We build a two-period general equilibrium model with free entry where the subgame perfect equilibrium is that the most efficient firms choose to acknowledge their effect on market aggregates and act oligopolistically whereas their less productive rivals act as monopolistic competitors. We show that increasing the openness of a polarised market with a monopolistically competitive and an oligopolistic subsector is not a simple combination of the variety gains predicted by monopolistically competitive models with the pro-competitive gains predicted by pure oligopoly. In fact, the presence of firms with heterogeneous abilities to adjust their markups opens up a new channel of market share reallocation from the monopolistic competitors to the oligopolists that tends to significantly suppress the pro-competitive welfare gains from trade. As trade becomes less costly, oligopolists benefit more from exporting to the foreign market than they are harmed by the increase in domestic competition because most of the competitive pressures are absorbed by the monopolistically competitive fringe. Therefore, when trade takes place between countries with a similar degree of concentration, superstars are not threatened enough by the competitive pressures driven by trade liberalisation. We find that using monopolistically competitive or oligopolistic models to theoretically predict the welfare gains from trade leads to a systematically miscalculated estimation of trade-induced competition. As De Loecker and Van Biesebroeck (2016) observe, the net effect of trade on welfare crucially depends on which firms see the largest increase in perceived competition due to increased import penetration. In our model, large firms face a lower degree of perceived competition than they would under pure oligopoly. Our results go in the direction of Stiglitz and Greenwald (2014) in that trade liberalisation alone would not ensure a welfare boost. In that

sense, we show that competition policy, innovation policy and size-dependent trade policies could be welfare-enhancing if they succeed in decreasing markup dispersion without altering the incentives to innovate.

Further research could extend the model by adding an input market. Considering the increased use of imported inputs by large firms and our newly established composition effect from the co-existence of large and small firms, the trade outcome could potentially even turn into welfare losses as documented in De Loecker and Goldberg (2014).

4 Trade, Mixed Market Competition and Credit Constraints

4.1 Introduction

Production often requires large up-front expenses that cannot be funded internally. These expenses include everything from capital equipment and advertising to market research and investment in research and development. Engaging in international trade is subject to additional fixed costs including assessing market profitability, setting up a foreign distribution network, product customisation and regulatory compliance. Consequently, the ability to access financial capital has a profound impact on firm entry, production and export behaviour and influences the welfare gains from international trade.

Firms are constrained by the stage of financial development of the country where they are located but there is also substantial within-country heterogeneity in firms' access to credit. In particular, firm size appears to be a key variable in the analysis of financial restrictions (Beck et al., 2005). Small firms seeking small loans face higher transaction costs and higher risk premia since they have less collateral to offer and their internal information is less transparent compared to their large competitors. As a result, financial institutions are less willing to lend to small companies which therefore operate under stringent credit constraints.

In this chapter, we propose a model of international trade with financial constraints and heterogeneous firms in order to examine how an economy's financial development affects the welfare gains from trade and uncover the role of large firms in shaping these gains. We further investigate whether trade with a more financially developed partner could limit the effects of domestic financial market imperfections, a question of uttermost importance for less financially developed economies, many of which are export-oriented but, at the same time, suffer from

severe credit market inefficiencies.

We start off by building a closed economy model where firms differ not only in their productivities but also in their strategic behaviour. In our model economy there is a continuum of closely substitutable product lines and each one of them is produced by both large oligopolistic firms and a fringe of small monopolistic competitors. This mixed market competition setup has the advantage of combining massive with massless producers as well as not assuming away the ability of large superstar firms to behave strategically when they form their decisions. The economy is characterised by the existence of credit constraints and we assume that financial market conditions are such that small firms are more severely affected by them. We find that more financial constraints induce a tougher selection effect for all firms, large and small, since they increase survival cutoff productivities.

In this framework we introduce international trade. First we look into the simplest case of opening up to trade with a perfectly symmetric partner, a scenario which is referred to as *symmetric trade*, and then explore the effects of trade with a more financially developed partner (*asymmetric trade*). We find that there are pro-competitive gains from both kinds of trade: trade liberalisation generates new entry of monopolistically competitive firms causing markups of all firms to fall. However, trade benefits more less financially developed countries because, in the presence of severe constraints trade creates more selection thus increasing survival cutoffs and average productivity. We also show that a less financially developed economy benefits more when credit constraints in the foreign country are lower. As globalisation proceeds, when foreign firms are less constrained they can afford to charge lower markups inducing a larger decrease in the average markup charged domestically. Turning to the role of superstars, welfare gains from trade are lower when large firms are fewer and, therefore, more powerful. Similarly to the model presented in Section 3 (Figure 2), given that there exist large firms op-

erating in the market, an increase in the number of these large firms reduces the oligopolistic inefficiency generated by their presence and increases welfare gains from trade.

But for the existence of credit constraints, our model economy is similar to the one presented in Melitz and Ottaviano (2008) except that, in our model, each variety is produced not by a single monopolistically competitive firm subject to free entry, but under mixed market competition between Cournot oligopolistic producers who make positive profits and monopolistic competitors that are subject to free entry. In this chapter, we abstract from the assumption of free entry for the oligopolistic firms explored in the previous two chapters in order to keep our model tractable and focus on the role of differential credit constraints.

To compare our model to Melitz and Ottaviano (2008) we assume away the existence of an oligopolistic subsector. We find that, as in Edmond et al. (2015), liberalising trade in an economy with superstar firms creates higher pro-competitive gains than it would in a purely monopolistically competitive framework. In mixed markets, the pre-globalisation inefficiency is higher and trade triggers a larger reduction of this inefficiency. This result is overturned when economies become relatively segmented and the trade cost increases to the extent that trade creates further inefficiencies. As a result, the inclusion of mixed markets does not alter the prediction that gains from trade could exist but is key in determining under which trade cost conditions they occur and in shaping the magnitude of these gains.

Our model has important implications for economic policy since it is rich enough to allow comparisons of the relative efficiency of promoting trade, competition and access to financial capital. We show that trade policy is the most efficient among the three, especially in the presence of tougher liquidity constraints. It does, however, work best when combined with domestic pro-competitive meas-

ures, in the form of discouraging opportunistic behaviour by the few large firms, as well as with financial development. Finally, a key insight of our model is that trade openness could partly substitute for financial development. Trading with a more financially developed partner creates a positive spillover through the increased ability of foreign less constrained exporters to lower their markups, in comparison to domestic firms. Trading with a less constrained partner lowers markups more than trading with an equally constrained one which boosts domestic welfare to the extent of partly overcoming local frictions. Excluding the presence of oligopolistic firms results in significantly different predictions for the magnitude of the gains from trade.

In the remaining part of this Introduction we offer a review of the literature related to this chapter. First, we consider the recent resurgence of interest involving oligopoly and international trade, both theoretically and empirically as a result of the extreme concentration of international trade as well as the increasing role of superstar firms in the global economy. Second, there is an extensive new literature on trade and financial constraints.

Recent developments in international economics under firm heterogeneity have allowed the introduction of financial economics considerations by shifting focus to the various costs of the operations of individual firms and how access to credit to finance these costs could affect trade. Finally, a growing part of this literature focuses on firm-level differences in liquidity. In the various analyses of the effects of financial constraints on firm choices there is a general consensus that large firms are less liquidity constrained than their smaller counterparts.

In the case of the U.S., the largest 1 percent of trading firms are responsible for over 80 percent of the value of total trade (Bernard et al., 2007). The numbers are similar in Europe and most developed and developing countries, with superstars consistently accounting for more than 45 percent of total exports (Freund

and Pierola, 2015; Mayer and Ottaviano, 2008). These few powerful firms are capable of exploiting their strategic market power and behave oligopolistically unlike small and medium enterprises whose conduct is best approximated by monopolistic competition (Hottman et al., 2016). Those facts have generated a renewed interest in oligopoly and trade, reviewed by Head and Spencer (2017), and have motivated the mixed market competition model in which a small number of large firms operates alongside a fringe of infinitesimally small competitors. Mixed market competition was initially developed by Shimomura and Thisse (2012) and has appeared in trade literature in Parenti (2017). Our model contributes to this literature by introducing productivity heterogeneity across a continuum of closely substitutable products as well as by incorporating credit constraints that are heterogeneous across firms. The aforementioned extensions allow us to introduce insights from corporate finance into the model and account for the impact of financial conditions on trade.

By introducing credit constraints into a trade model we add to the prominent field that lies at the intersection of trade and finance. The importance of financial constraints has been investigated in a number of works reviewed in Foley and Manova (2015). The financial economics literature like in Bekaert and Harvey (1995), Bekaert et al. (2011) and Henderson et al. (2006) has established that local financial institutions affect firms' decisions to enter, produce and export. As a result, the introduction of financial capital in international economics frameworks has produced a number of interesting results. Most notably, Manova (2013) considers a model with heterogeneous firms and credit constraints where the quality of domestic financial institutions pins down the probability that loan contracts are enforced. More productive firms earn a higher revenue and can therefore receive more funding. As a result credit constraints increase the productivity cutoff for exporting above the first best. Abstracting from the assumption that productiv-

ity and access to capital are perfectly positively correlated, Chaney (2016) shows that this correlation may become imperfect in the presence of exogenous credit misallocation in a setup where firms randomly draw both productivities and liquidity endowments. Bonfiglioli et al. (2016) propose a model where the ex post distribution of firms' productivities is endogenously shaped by financing frictions through their effect on innovation decisions.

Departing from the monopolistically competitive paradigm, our model is most closely linked to Baccini et al. (2017) who introduce financial frictions in an oligopolistic trade model which, besides being positively correlated with productivity, are also affected by firm ownership (state or privately owned). They conclude that trade liberalisation has a smaller pro-competitive effect for state owned enterprises enjoying weaker credit constraints. Compared to our model, Baccini et al. (2017) do not examine mixed markets or asymmetric trade and their focus is on productivity rather than welfare gains. However, their paper is similar to this chapter in that, besides productivity, they also introduce other dimensions of heterogeneity that determine the level of credit constraints. In our model, for a given level of productivity, frictions vary with firms' strategic behaviour and entry technology. On the one hand, large oligopolistic firms whose profits are not dictated by free entry are less impeded by financial institutions. On the other hand, a Melitz and Ottaviano (2008)-type monopolistically competitive fringe of small firms faces harsher borrowing conditions. Thus, our model reveals the mechanism through which financial imperfections affect the welfare gains from trade and how assumptions regarding entry and the competition mode drive our results.

Finally, our model incorporates findings from research on firm size and liquidity reviewed in Segarra and Teruel Carrizosa (2009). Among others, Beck et al. (2005), Beck and Demirguc-Kunt (2006) and Cleary (2006) confirm that small firms

have to confront greater financial constraints than large firms. By differentiating between the financial constraints of large and small firms, this chapter is the first to provide a framework for policy comparisons. Are trade liberalisation and financial development complements or substitutes? How do large firms' practices impact on welfare and why should competition policy be pursued together with lowering trade barriers?

The remainder of the chapter is organised as follows. In Section 4.2 we build the closed economy model in which differences in financial market conditions between large and small firms pinpoint the survival cutoff productivities. Section 4.3 introduces bilateral trade first between symmetric countries and then between countries that differ in their credit market imperfections. We derive a number of results regarding how survival cutoffs change with the trade cost, production costs and the level of financial frictions and calculate the welfare gains from trade. We compare different policies in terms of their effect on the welfare gains and state our policy implications. Section 4.4 concludes.

4.2 Closed economy model

The model economy involves one homogeneous and one horizontally differentiated sector and one production factor, labour. The homogeneous sector operates under constant returns and perfect competition and its output is used as a numeraire. The differentiated sector exhibits increasing returns and is an aggregate of Ω goods (also referred to as product lines) $\omega \in [0, \Omega]$ each produced by N_ω Cournot oligopolistic (CO) firms $n = 1 \ldots N_\omega$ and M_ω monopolistically competitive (MC) firms $m \in [0, M_\omega]$. Each firm $j = m, n$ produces a differentiated variety of ω and therefore, given that MC firms are of infinitesimal mass and setting the mass of each CO firm equal to one[1], the total mass of varieties of ω provided is

[1]Endogenising the mass of CO firms as in Parenti (2017) would generalise the model but without affecting its qualitative results.

equal to:

$$K_\omega = N_\omega + M_\omega \tag{1}$$

4.2.1 Preferences and demand

The economy is populated by a continuum of identical consumers of measure one who supply one unit of labour inelastically. Labour can be transformed one-to-one into the homogeneous good. Hence, without loss of generality, the total size of the population as well as the equilibrium wage are both set equal to one.

The aggregate consumption of each good ω is given by:

$$X_\omega = \sum_{n=1}^{N_\omega} x_{\omega n} + \int_0^{M_\omega} x_{\omega m} dm \tag{2}$$

where $x_{\omega n}$ is the consumption of variety n of good ω produced by the CO firm n and $x_{\omega m}$ is the consumption of variety m of good ω produced by the MC firm m. The utility of the representative consumer of consuming good ω is quadratic to facilitate comparisons with Melitz and Ottaviano (2008). Following a notation similar to Parenti (2017):

$$u(X_\omega) = \int_0^{K_\omega} \left(\alpha x_{\omega j} - \frac{\beta}{2} x_{\omega j}^2 \right) dj - \frac{\gamma}{2} \left(\int_0^{K_\omega} x_{\omega j} dj \right)^2 \tag{3}$$

where the consumption profile X_ω of good ω consists of varieties and $j = m$, $n \in [0, K_\omega]$. The parameters α, β, γ are positive. The parameters α and γ control the substitutability between the differentiated and the homogeneous sector with higher α and lower γ leading to increased demand for the former versus the latter. The parameter β captures the degree of product differentiation between the differentiated goods. As β tends to zero consumers tend to care only about their aggregate consumption of all differentiated varieties. The upper-tier utility func-

tion is quasi-linear:

$$U = A + \int_0^{\Omega} u(X_\omega) d\omega \tag{4}$$

where A is the consumption from the homogeneous sector. Finally, we define X to be the total consumption of the differentiated sector which is equal to:

$$X = \int_0^{\Omega} X_\omega d\omega \tag{5}$$

The representative consumer faces the following budget constraint:

$$A + \int_0^{\Omega} \int_0^{K_\omega} p_{\omega j} x_{\omega j} dj d\omega \leq I \tag{6}$$

where I is the consumer income which is equal to the wage income plus any firm profit[2]. Under the assumption of positive consumption of the numeraire $A > 0$, the inverse demand function for variety $j = m, n$ of good ω is $p_{\omega j} = \alpha - \beta x_{\omega j} - \gamma X_\omega$.

4.2.2 Production

All firms use only labour to cover their costs. We assume that firms are heterogeneous in productivities across product lines $\omega \in [0, \Omega]$ but homogeneous within each ω. A firm $j \in [0, K_\omega]$ producing good ω has productivity z_ω and uses the following production function:

$$z_\omega^{-1} x_{\omega j} + \lambda = l_j \tag{7}$$

where l_j is the labour input of firm j, $x_{\omega j}$ is the quantity produced by firm j and $\lambda > 0$ is the fixed production cost. Each firm producing the same good ω be-

[2]In equilibrium, MC firms make zero profit and hence I is equal to the wage income plus the profits of the CO firms. How these profits are distributed among consumers is irrelevant in models with quasi-linear preferences.

haves non-cooperatively and maximises its operating profit subject to the inverse demand. At this point, it is useful to notice that our setup should be read as one of heterogeneous firms rather than heterogeneous industries given that any empirically relevant definition of a good is composed of a large number of different goods produced by many different firms. We avoid introducing productivity heterogeneity among the producers of each ω since this would complicate the model without adding any new intuition.

We go on to incorporate credit constraints into the model following Manova (2013). We assume that variable costs are funded internally but, to pay their fixed production cost λ, firms must bear a fraction $d \in (0, 1)$ of λ upfront. This up-front cost is covered via borrowing from financial institutions by pledging a fraction $t \in (0, 1)$ of λ as collateral. Higher d and lower t indicate stronger financial vulnerability of the firm or product line. We assume that all firms in all product lines face the exact same d and t. Due to imperfect financial contractability, credit institutions expect to be repaid by firms with probabilities δ_m, $\delta_n \in (0, 1)$ which represent the willingness of these institutions to enforce credit constraints. The δ's of a given country capture its financial development.

The objective function of firm $j = m, n$ indicates that a fraction $(1 - d)$ of the fixed cost λ and the full variable cost are financed internally and that, if the contract is enforced (with probability $\delta_j \in \{\delta_m, \delta_n\}$), firms must pay $\mathcal{F}(z_\omega)$ to the financial institution. In case of default firms lose the collateral. The general

maximisation problem follows:

$$\begin{aligned}
&\max_{x_{\omega j},\mathcal{F}} \quad \pi_{\omega j} = \left(p_{\omega j} - \tfrac{1}{z_\omega}\right) x_{\omega j} - (1-d)\,\lambda - \delta_j \mathcal{F}\left(z_\omega\right) - \left(1-\delta_j\right) t\lambda \\
&\quad \text{s.t.} \\
&\quad p_{\omega j} = \alpha - \beta x_{\omega j} - \gamma X_\omega \qquad \text{(inverse demand)} \\
&\quad A_{\omega j} \equiv \left(p_{\omega j} - \tfrac{1}{z_\omega}\right) x_{\omega j} - (1-d)\,\lambda \geq \mathcal{F}\left(z_\omega\right) \text{ (liquidity constraint)} \\
&\quad B_{\omega j} \equiv -d\lambda + \delta_j \mathcal{F}\left(z_\omega\right) + \left(1-\delta_j\right) t\lambda \geq 0 \text{ (participation constraint)}
\end{aligned} \tag{8}$$

The liquidity constraint implies that in case of repayment firms can pay up to their net revenue $A_{\omega j}$. The participation constraint implies that the financial institution is willing to enter the contract only if their net return $B_{\omega j}$ exceeds the outside option, normalised to zero.

In their maximisation, CO firms face the additional constraint:

$$X_\omega = x_{\omega n} + \widehat{x}_{\omega n} + \int_0^{M_\omega} x_{\omega m} dm \tag{9}$$

where $\widehat{x}_{\omega n}$ represents the quantity sold by the other $(N_\omega - 1)$ CO firms. The reason behind (9) is that, contrary to MC firms, CO firms do not treat the aggregate X_ω parametrically but take, when they form their decisions, into account their ability to manipulate it.

4.2.3 Equilibrium

Each MC firm maximises its operating profit subject to the inverse demand, the liquidity and the participation constraint (8). Each CO firm maximises its operating profit subject to the inverse demand, the liquidity, the participation constraint (8) as well as the additional constraint (9). Our structure follows the "small in the large and large in the small" approach to model oligopoly in general equilibrium as in Neary (2003). Under our assumption that there exists a continuum of ω, CO

firms can manipulate the market of their product line but are unable to affect the aggregate economy.

Moving on to the role of credit constraints, since net revenues $A_{\omega j}$ increase with productivity z_ω, the liquidity constraint is binding for firms below a cutoff $z^*_{\omega j}$, where index j indicates that this cutoff is different between CO and MC firms. The optimal decision of firms is to adjust their payment $\mathcal{F}$ to take investors to their participation constraint which, in equilibrium, holds with equality, $B_{\omega j} = 0$. The optimal price and quantity for MC firms are:

$$p_{\omega m} = \frac{1}{2}\left(\alpha + \frac{1}{z_\omega} - \gamma X_\omega\right) \tag{10}$$

$$x_{\omega m} = \frac{1}{2\beta}\left(\alpha - \frac{1}{z_\omega} - \gamma X_\omega\right) \tag{11}$$

(10) yields the following expression for the markup charged by MC firms:

$$\mu_{\omega m} = p_{\omega m} - \frac{1}{z_\omega} = \frac{1}{2}\left(\alpha - \frac{1}{z_\omega} - \gamma X_\omega\right) \tag{12}$$

The optimal price and quantity for CO firms are:

$$p_{\omega n} = \frac{\beta+\gamma}{2\beta+\gamma}\left[\alpha + \left(\frac{\beta}{\beta+\gamma}\right)\frac{1}{z_\omega} - \gamma X_\omega\right] \tag{13}$$

$$x_{\omega n} = \frac{1}{2\beta+\gamma}\left(\alpha - \frac{1}{z_\omega} - \gamma X_\omega\right) \tag{14}$$

(13) implies that the markup charged by CO firms is:

$$\mu_{\omega n} = p_{\omega n} - \frac{1}{z_\omega} = \frac{\beta+\gamma}{2\beta+\gamma}\left(\alpha - \frac{1}{z_\omega} - \gamma X_\omega\right) \tag{15}$$

Since $\frac{\beta+\gamma}{2\beta+\gamma} > \frac{1}{2}$, using (12) and (15) we can compare the pricing behaviour of CO firms to the one of the MC firms operating within the same product line.

Proposition 1 (market power) *CO firms charge a higher markup than MC firms.*

Plugging $B_{\omega j} = 0$ into the liquidity constraint for each type of firm and using the expressions for optimal pricing, (10) and (13), and optimal quantity, (11) and (14), yields the following cutoff conditions for MC and CO firms respectively:

$$z^*_{\omega m} = \left(\alpha - \gamma X_\omega - 2\sqrt{\beta \widehat{\lambda}_m}\right)^{-1} \tag{16}$$

$$z^*_{\omega n} = \left(\alpha - \gamma X_\omega - (2\beta + \gamma)\sqrt{\frac{\widehat{\lambda}_n}{\beta + \gamma}}\right)^{-1} \tag{17}$$

where the term $\widehat{\lambda}_j \equiv \left[1 + \frac{1-\delta_j}{\delta_j}(d - t)\right]\lambda$ includes the additional cost of financing firms' fixed cost due to the presence of credit constraints[3]. If credit constraints are stronger for MC firms, then fixed operating costs are also higher for MC firms, $\widehat{\lambda}_m > \widehat{\lambda}_n$. From (16) and (17) we get that the relationship between the two cutoff productivities, $z^*_{\omega m}$ and $z^*_{\omega n}$, is in principal ambiguous. However, we can derive the conditions under which the empirically-relevant scenario $z^*_{\omega n} < z^*_{\omega m}$ occurs. In what follows we assume that $z^*_{\omega n} < z^*_{\omega m}$.

Assumption 1 (credit constraints) *MC firms are more financially constrained than CO firms.*

By comparing (16) to (17) we can specify the parameter values for which Assumption 1 holds.

Proposition 2 (cutoff productivities) *CO firms face a lower cutoff productivity than MC firms when financial vulnerability is sufficiently high $d > t$ and credit constraints are sufficiently stronger for MC firms compared to CO firms: $\delta_m \ll \delta_n$.*

In fact, the cutoff relationship is preserved and Assumption 1 holds as long as the

[3]As a result, credit constraints differences across firms are isomorphic to any differences in fixed operational costs regardless of whether they originate from credit market imperfections or not.

ratio of probabilities $\frac{\delta_n}{\delta_m}$ is higher than $\frac{\gamma^2}{4\beta(\beta+\gamma)}\left[1+\delta_n\left(\frac{1}{d-t}-1\right)\right]+1$.

Entry Normalising Ω to be equal to one, there is a unit mass of potential product lines. We assume that a product line is created by the M_ω MC firms and the N_ω CO firms associated with ω which enter together by paying a sunk entry cost f_E. Within each product line ω, all firms jointly draw the same productivity z_ω from a distribution $G(z_\omega)$ common to both CO and MC firms. Next, all CO and MC firms choose their output simultaneously. Due to the presence of fixed operating costs there exist two cutoff productivities $z^*_{\omega j}$ where $j = m,\ n$ given by equations (16) and (17) below which, type-j firms do not enter and therefore exit. Exit also takes place simultaneously for all type-j firms producing the same ω. For every firm with productivity higher than the corresponding cutoff productivity optimal behaviour is given by (10) - (11) for MC firms and (13) - (14) for CO firms. Under Assumption 1, $z^*_{\omega n} < z^*_{\omega m}$ and so we can simplify our notation as follows:

$$M_\omega = M \quad \forall z_\omega \geq z^*_{\omega m} \quad \text{and} \quad M_\omega = 0 \quad \forall z_\omega < z^*_{\omega m}$$

where the mass of MC firms per product line M is pinned down by free entry and:

$$N_\omega = N \quad \forall z_\omega \geq z^*_{\omega n} \quad \text{and} \quad N_\omega = 0 \quad \forall z_\omega < z^*_{\omega n}$$

where the number of CO firms N is exogenous. In other words, oligopoly rents are not eroded by entry[4]. Rewriting (1), our economy is similar to the one presented in Melitz and Ottaviano (2008) except that in our setup each variety is produced

[4]This is a common assumption in oligopolistic trade (see for example Neary (2016)). It can be reconciled with the emerging new empirical literature documenting large and rising profits of superstar firms, like for example Barkai (2016) and Head and Spencer (2017). Notice, however, that CO firms can still choose to produce zero output in equilibrium, effectively exiting the market when they cannot make positive profits. Adding free entry for the CO firms is an interesting generalisation as discussed in the previous chapters but will significantly affect the tractability of the model.

not by a single MC firm but by a total mass of $K_\omega = N + M$ firms of which N are CO and M are MC firms, if it corresponds to $z_\omega \in [z^*_{\omega m}, \infty)$, or just by $K_\omega = N$ firms, where all N are CO firms, if it corresponds to $z_\omega \in [z^*_{\omega n}, z^*_{\omega m}]$. Finally, $K_\omega = 0$ for product lines corresponding to $z_\omega \in (0, z^*_{\omega n})$.

Using (16) and (17) we can rewrite the MC and the CO firm profit function as follows:

$$\pi_{\omega m} = \frac{1}{4\beta}\left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega}\right)^2 - \widehat{\lambda}_m \tag{18}$$

$$\pi_{\omega n} = \frac{\beta+\gamma}{(2\beta+\gamma)^2}\left((2\beta+\gamma)\sqrt{\frac{\widehat{\lambda}_n}{\beta+\gamma}} + \frac{1}{z^*_{\omega n}} - \frac{1}{z_\omega}\right)^2 - \widehat{\lambda}_n \tag{19}$$

According to the free entry condition that applies to MC firms, the expected MC firm profit prior to entry is equal to the entry cost $f_E > 0$. Using (18) free entry of MC firms is equivalent to:

$$\int_{z^*_{\omega m}}^{\infty}\left[\frac{1}{4\beta}\left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega}\right)^2 - \widehat{\lambda}_m\right] dG\left(z_\omega\right) - f_E = 0 \tag{20}$$

We go on to specify a productivity distribution.

Assumption 2 (productivity distribution) *The productivity distribution, common to both CO and MC firms, is Pareto with scale $z_{\omega min}$ and shape k.*

As a result of Assumption 2:

$$dG\left(z_\omega\right) = k z_{\omega min}\left(\frac{z_{\omega min}}{z_\omega}\right)^{k-1}$$

where $z_{\omega min}$ can be normalised to one. The free entry condition with Pareto distribution implies that:

$$\Phi = \phi_1\left(\frac{1}{z^*_{\omega m}}\right)^{k+2} + \phi_2\sqrt{\widehat{\lambda}_m}\left(\frac{1}{z^*_{\omega m}}\right)^{k+1} - f_E = 0 \tag{21}$$

where $\phi_1 = \frac{1}{2\beta(k+1)(k+2)}$ and $\phi_2 = \frac{1}{\sqrt{\beta}(k+1)}$. From (21) using the implicit function theorem we get that the cutoff productivity of MC firms increases with the fixed production cost $\frac{\partial z^*_{\omega m}}{\partial \widehat{\lambda}_m} > 0$. Regarding the fixed entry cost $\frac{\partial z^*_{\omega m}}{\partial f_E} < 0$ meaning that higher entry costs imply less selection. These results suggest that selection increases when there is more competition. Moreover, $\frac{\partial z^*_{\omega m}}{\partial \beta} < 0$ and, as a result, when the different product lines z_ω are closer substitutes the economy is more selective regarding the MC firms.

Proposition 3 (MC selection) *Higher fixed operating and lower entry costs induce tougher competition and, hence, tougher selection for MC firms.*

We can also rewrite the free entry condition (20) as a function of the equilibrium number of MC firms per product line M and the cutoff $z^*_{\omega m}$ which, using (16) and the definition of the aggregate output X_ω from (2), gives M:

$$M = \frac{2\beta}{\gamma}\left[\frac{\alpha\sqrt{2\left(k+1\right)\left(k+2\right)\beta f_E + 2\left(k+2\right)^2\beta\widehat{\lambda}_m} + k\alpha\sqrt{\beta\widehat{\lambda}_m}}{2\left(k+1\right)\left(k+2\right)\beta f_E + 2(k+2)\beta\widehat{\lambda}_m} - 1\right] - \frac{2\beta N}{2\beta+\gamma} \tag{22}$$

From (22) we get that $\frac{\partial M}{\partial N} < 0$, $\frac{\partial M}{\partial f_E} < 0$ and $\frac{\partial M}{\partial \widehat{\lambda}_m} < 0$. At this point it is useful to note that $\frac{\partial z^*_{\omega m}}{\partial \alpha} = \frac{\partial z^*_{\omega m}}{\partial \gamma} = 0$ implying that the parameters α and γ which shape the demand for the differentiated relatively to the homogeneous sector do not matter for the selection of MC firms but only for their equilibrium number. In particular, a decrease in γ as well as an increase in α, shifting demand away from the homogeneous A and towards the differentiated X, increase the mass of the MC fringe: $\frac{\partial M}{\partial \alpha} > 0$ and $\frac{\partial M}{\partial \gamma} < 0$.

Proposition 4 (MC fringe) *The equilibrium mass of MC firms is decreasing in the number of their CO competitors, the fixed entry cost and the fixed operating cost.*

Moving on to the derivation of the CO firm cutoff, by (16) and (17) we can write

$z^*_{\omega n}$ as follows:

$$z^*_{\omega n} = \left(\frac{1}{z^*_{\omega m}} + 2\sqrt{\beta \widehat{\lambda}_m} - (2\beta + \gamma) \sqrt{\frac{\widehat{\lambda}_n}{\beta + \gamma}} \right)^{-1} \tag{23}$$

From (23) we also get that the economy is more selective with respect to the CO firms as substitutability increases ($\frac{\partial z^*_{\omega n}}{\partial \beta} < 0$) but only for high levels of β[5]. Furthermore, we showed that the MC cutoff is unaffected by α and γ. This result, however, is not true for CO firms whose behaviour incorporates the own effect on market aggregates. More specifically, $\frac{\partial z^*_{\omega n}}{\partial \gamma} > 0$ and, if we express $z^*_{\omega n}$ as follows using Assumption 1 for a given N:

$$z^*_{\omega n} = \left(\alpha - [2\beta + \gamma (1 + N)] \sqrt{\frac{\widehat{\lambda}_n}{\beta + \gamma}} \right)^{-1}$$

From the above expression we get that $\frac{\partial z^*_{\omega n}}{\partial \alpha} < 0$. Hence, when the number of CO firms is not subject to a free entry condition stronger preferences for X decrease the CO cutoff. Next, we examine the effect of N. $\frac{\partial z^*_{\omega n}}{\partial N} > 0$ since higher N is equivalent to a more competitive CO subsector within each ω which creates more selection among CO firms. Finally, from (23), the effect of the cost parameters on $z^*_{\omega n}$ are $\frac{\partial z^*_{\omega n}}{\partial \widehat{\lambda}_n} > 0$ and $\frac{\partial z^*_{\omega n}}{\partial f_E} = 0$.

Proposition 5 (CO selection) *Higher fixed operating costs induce tougher selection for CO firms but changes in the costs of entry have zero effect.*

From (21) and (23) we also get that $\frac{\partial z^*_{\omega n}}{\partial \widehat{\lambda}_m} < 0$ and $\frac{\partial z^*_{\omega m}}{\partial \widehat{\lambda}_n} < 0$.

Proposition 6 (Selection and credit constraints) *The economy is less selective for one type of firms in the presence of weaker own credit constraints and stronger credit constraints for the competing type.*

[5]In fact, $\frac{\partial z^*_{\omega n}}{\partial \beta} < 0$ when β is sufficiently high for $\frac{\partial \Phi / \partial \beta}{\partial \Phi / \partial z^*_{\omega m}} + 2\sqrt{\frac{\widehat{\lambda}_n}{\beta + \gamma}} > \frac{(2\beta + \gamma)\sqrt{\widehat{\lambda}_n}}{2\sqrt{(\beta + \gamma)^3}} + \sqrt{\frac{\widehat{\lambda}_m}{\beta}}$ to hold.

We go on to analyse the effect of the different parameters on markups. Optimal prices can be written in terns of the cutoff productivities and hence markups are calculated as follows:

$$\mu_{\omega m} = \frac{1}{2}\left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega}\right) \tag{24}$$

$$\mu_{\omega n} = \frac{\beta+\gamma}{2\beta+\gamma}\left[(2\beta+\gamma)\sqrt{\frac{\widehat{\lambda}_n}{\beta+\gamma}} + \frac{1}{z^*_{\omega n}} - \frac{1}{z_\omega}\right] \tag{25}$$

As a result, selection and pro-competitive effects move together. From (21) and (23) - (25) we get that the CO markup decreases with the fixed operating cost $\widehat{\lambda}_n$ ($\frac{\partial \mu_{\omega n}}{\partial \widehat{\lambda}_n} < 0$) but how the MC markup changes with $\widehat{\lambda}_m$ depends on the parameters of the model. In fact, $\frac{\partial \mu_{\omega m}}{\partial \widehat{\lambda}_m} < 0$ when $\frac{\partial z^*_{\omega m}}{\partial \widehat{\lambda}_m} > \left(z^*_{\omega m}\right)^2 \sqrt{\frac{\beta}{\widehat{\lambda}_m}}$. This is because a change in $\widehat{\lambda}_m$ has the additional effect of changing (in the opposite direction) the total mass of MC competitors whereas an increase in $\widehat{\lambda}_n$ does not alter the number of CO firms.

Labour market clearing To close the model, we need to add the labour market clearing condition:

$$\begin{gathered}\Omega_n N \int_{z^*_{\omega n}}^{\infty}\left[\frac{1}{(2\beta+\gamma)z_\omega}\left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega}\right) + \widehat{\lambda}_n + f_E\right] dG\left(z_\omega\right) + \\ \Omega_m M \int_{z^*_{\omega m}}^{\infty}\left[\frac{1}{2\beta z_\omega}\left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega}\right) + \widehat{\lambda}_m + f_E\right] dG\left(z_\omega\right) + A = 1\end{gathered}$$

The above condition specifies that, in equilibrium, the total labour supply, normalised to one, should be equal to the labour demand which is either transformed into the numeraire or used to cover the fixed and variable production cost of the firms operating in the differentiated sector, according to (7), as well as their entry cost. Notice that although there is no free entry for the CO firms they still have

to pay an entry cost because each product line is create by the entry of MC firms. After a product line is created a fixed number N of CO firms enter and due to the lower credit constraints they can survive even when the MC firms cannot. From the labour market clearing condition we get the optimal consumption of the homogeneous A which must be positive[6].

4.2.4 Welfare in closed economy

Welfare can be calculated using the indirect utility function that corresponds to (4):

$$U = I + \frac{1}{2}\left(\gamma + \frac{\beta}{\Omega_n N + \Omega_m M}\right)^{-1}(\alpha - \bar{p})^2 + \frac{1}{2}\frac{\Omega_n N + \Omega_m M}{\beta}\sigma_p^2 \qquad (26)$$

where $\Omega_j = 1 - F(z^*_{\omega j})$ is the mass of varieties produced by type-j firms with F being the cumulative distribution function of z_ω. Thus $\Omega_j \in [0,\, 1]$ is an inverse function of the cutoff $z^*_{\omega j}$. In (26), $\bar{p}$ represents the average price and σ_p^2 stands for the variance of prices:

$$\bar{p} = \frac{\Omega_n N \int_{z^*_{\omega n}}^{\infty} p_{\omega n} dG\left(z_\omega\right) + \Omega_m M \int_{z^*_{\omega m}}^{\infty} p_{\omega m} dG\left(z_\omega\right)}{\Omega_n N + \Omega_m M}$$

$$\sigma_p^2 = \frac{\Omega_n N \int_{z^*_{\omega n}}^{\infty} \left(p_{\omega n} - \bar{p}\right)^2 dG\left(z_\omega\right) + \Omega_m M \int_{z^*_{\omega m}}^{\infty} \left(p_{\omega m} - \bar{p}\right)^2 dG\left(z_\omega\right)}{\Omega_n N + \Omega_m M}$$

Income I is equal to the labour income (normalised to one) plus the total CO firm profit:

$$I = 1 + \Omega_n N \int_{z^*_{\omega n}}^{\infty} \left[\frac{\beta + \gamma}{(2\beta + \gamma)^2}\left(2\sqrt{\beta \widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega}\right)^2 - \widehat{\lambda}_n - f_E\right] dG\left(z_\omega\right)$$

[6]Guaranteed when $\Omega_n^* N \int_{z^*_{\omega n}}^{\infty} \left[\frac{1}{(2\beta+\gamma) z_\omega}\left((2\beta + \gamma)\sqrt{\frac{\widehat{\lambda}_n}{\beta+\gamma}} + \frac{1}{z^*_{\omega n}} - \frac{1}{z_\omega}\right) + \widehat{\lambda}_n + f_E\right] dG\left(z_\omega\right) + \Omega_m^* M \int_{z^*_{\omega m}}^{\infty} \left[\frac{1}{2\beta z_\omega}\left(2\sqrt{\beta \widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega}\right) + \widehat{\lambda}_m + f_E\right] dG\left(z_\omega\right) < 1.$

4.3 Open economy model

We analyse bilateral trade between countries Home H and Foreign F. H and F share the same population size, preferences, market structure and technology and could only differ in their financial development. In particular, financial institutions expect to be repaid by firms with probability δ_m^H, $\delta_n^H \in (0, 1)$ in H and with probability δ_m^F, $\delta_n^F \in (0, 1)$ in F. We assume that, in order to export, there is an iceberg-type trade cost $\tau \geq 1$, where $\tau = 1$ corresponds to free trade, and there is also a fixed cost to export λ_X on which firms face credit constraints with a structure similar to the closed economy case. Trade liberalisation is captured by a decrease in the trade cost τ. We can focus on country H since country F is the mirror image. Incorporating bilateral trade, the maximisation problem for the domestic firm j is rewritten as follows:

$$\max_{x_{\omega j,}^{HH} x_{\omega j,}^{HF} \mathcal{F}, \mathcal{F}_X} \quad \pi_{\omega j}^{H} = \pi_{\omega j}^{HH} + \pi_{\omega j}^{HF}$$

s.t.

$$\pi_{\omega j}^{HH} = \left(p_{\omega j}^{HH} - \tfrac{1}{z_\omega}\right) x_{\omega j}^{HH} - (1-d)\,\lambda - \delta_j^H \mathcal{F}\left(z_\omega\right) - \left(1 - \delta_j^H\right) t\lambda$$
$$\pi_{\omega j}^{HF} = \left(p_{\omega j}^{HF} - \tfrac{\tau}{z_\omega}\right) x_{\omega j}^{HF} - (1-d)\,\lambda_X - \delta_j^H \mathcal{F}_X\left(z_\omega\right) - \left(1 - \delta_j^H\right) t\lambda_X$$

$$p_{\omega j}^{HH} = \alpha - \beta x_{\omega j}^{HH} - \gamma X_\omega^H$$
$$p_{\omega j}^{HF} = \alpha - \beta x_{\omega j}^{HF} - \gamma X_\omega^F$$

$$A_{\omega j}^{HH} \equiv \left(p_{\omega j}^{HH} - \tfrac{1}{z_\omega}\right) x_{\omega j}^{HH} - (1-d)\,\lambda \geq \mathcal{F}\left(z_\omega\right)$$
$$A_{\omega j}^{HF} \equiv \left(p_{\omega j}^{HF} - \tfrac{\tau}{z_\omega}\right) x_{\omega j}^{HF} - (1-d)\,\lambda_X \geq \mathcal{F}_X\left(z_\omega\right)$$

$$B_{\omega j}^{HH} \equiv -d\lambda + \delta_j^H \mathcal{F}\left(z_\omega\right) + \left(1 - \delta_j^H\right) t\lambda \geq 0$$
$$B_{\omega j}^{HF} \equiv -d\lambda_X + \delta_j^H \mathcal{F}_X\left(z_\omega\right) + \left(1 - \delta_j^H\right) t\lambda_X \geq 0$$

Domestic firm j sells $x_{\omega j}^{HH}$ in H at price $p_{\omega j}^{HH}$ and exports $x_{\omega j}^{HF}$ (from H) to F to be

sold at price $p_{\omega j}^{HF}$. In their maximisation, CO firms face the additional constraints:

$$X_\omega^H = x_{\omega n}^{HH} + \widehat{x}_{\omega n}^{HH} + \int_0^{M_\omega^H} x_{\omega m}^{HH} dm + \int_0^{K_\omega^F} x_{\omega j}^{FH} dj$$
$$X_\omega^F = \; x_{\omega n}^{HF} + \widehat{x}_{\omega n}^{HF} + \int_0^{M_\omega^H} x_{\omega m}^{HF} dm + \int_0^{K_\omega^F} x_{\omega j}^{FF} dj$$

where $\widehat{x}_{\omega n}^{HH}$ ($\widehat{x}_{\omega n}^{HF}$) represents the quantity sold by the other $(N_\omega^H - 1)$ domestic CO firms in the H (F) market and $\int_0^{K_\omega^F} x_{\omega j}^{FH} dj$ ($\int_0^{K_\omega^F} x_{\omega j}^{FF} dj$) is the total quantity sold by both the foreign MC and the foreign CO firms in the H (F) market. Following the exact same steps as in the closed economy, the optimal behaviour of the H-country firms in the H market is given by the same equations as in the closed economy whereas their behaviour in the F market incorporates the additional trade cost.

$$\begin{aligned}
p_{\omega m}^{HH} &= \tfrac{1}{2}\left(\alpha + \tfrac{1}{z_\omega} - \gamma X_\omega^H\right) & x_{\omega m}^{HH} &= \tfrac{1}{2\beta}\left(\alpha - \tfrac{1}{z_\omega} - \gamma X_\omega^H\right) \\
p_{\omega m}^{HF} &= \tfrac{1}{2}\left(\alpha + \tfrac{\tau}{z_\omega} - \gamma X_\omega^F\right) & x_{\omega m}^{HF} &= \tfrac{1}{2\beta}\left(\alpha - \tfrac{\tau}{z_\omega} - \gamma X_\omega^F\right) \\
p_{\omega n}^{HH} &= \tfrac{\beta+\gamma}{2\beta+\gamma}\left[\alpha + \left(\tfrac{\beta}{\beta+\gamma}\right)\tfrac{1}{z_\omega} - \gamma X_\omega^H\right] & x_{\omega n}^{HH} &= \tfrac{1}{2\beta+\gamma}\left(\alpha - \tfrac{1}{z_\omega} - \gamma X_\omega^H\right) \\
p_{\omega n}^{HF} &= \tfrac{\beta+\gamma}{2\beta+\gamma}\left[\alpha + \left(\tfrac{\beta}{\beta+\gamma}\right)\tfrac{\tau}{z_\omega} - \gamma X_\omega^F\right] & x_{\omega n}^{HF} &= \tfrac{1}{2\beta+\gamma}\left(\alpha - \tfrac{\tau}{z_\omega} - \gamma X_\omega^F\right)
\end{aligned}$$

$$\begin{aligned}
\mu_{\omega m}^{HH} &= \tfrac{1}{2}\left(\alpha - \tfrac{1}{z_\omega} - \gamma X_\omega^H\right) \\
\mu_{\omega m}^{HF} &= \tfrac{1}{2}\left(\alpha - \tfrac{\tau}{z_\omega} - \gamma X_\omega^F\right) \\
\mu_{\omega n}^{HH} &= \tfrac{\beta+\gamma}{2\beta+\gamma}\left(\alpha - \tfrac{1}{z_\omega} - \gamma X_\omega^H\right) \\
\mu_{\omega n}^{HF} &= \tfrac{\beta+\gamma}{2\beta+\gamma}\left(\alpha - \tfrac{\tau}{z_\omega} - \gamma X_\omega^F\right)
\end{aligned}$$

Exactly as in the closed economy case, we can compare the markups[7] charged by CO firms to the ones set by MC firms.

Proposition 7 (market power and trade) *CO firms charge a higher markup than MC firms. This is true both in the domestic and in the export market.*

Moving on to the role of credit constraints, we use $B_{\omega j}^{HH} = 0$ and $B_{\omega j}^{HF} = 0$ and the liquidity constraint for each firm type in order to get the cutoff conditions

[7] We compare the absolute markups defined as $\mu_{\omega j}^{HH} = p_{\omega j}^{HH} - \frac{1}{z_\omega}$ and $\mu_{\omega j}^{HF} = p_{\omega j}^{HF} - \frac{\tau}{z_\omega}$.

for the MC and the CO firms in terms of the aggregate outputs X_ω^H and X_ω^F. The domestic profits in country H are given by the following equations:

$$\frac{1}{4\beta}\left(2\sqrt{\beta\widehat{\lambda}_m^H}+\frac{1}{\left(z_{\omega m}^*\right)^H}-\frac{1}{z_\omega}\right)^2-\widehat{\lambda}_m^H=0 \tag{27}$$

$$\frac{\beta+\gamma}{(2\beta+\gamma)^2}\left((2\beta+\gamma)\sqrt{\frac{\widehat{\lambda}_n^H}{\beta+\gamma}}+\frac{1}{\left(z_{\omega n}^*\right)^H}-\frac{1}{z_\omega}\right)^2-\widehat{\lambda}_n^H=0 \tag{28}$$

where $\left(z_{\omega m}^*\right)^H$ and $\left(z_{\omega n}^*\right)^H$ are the domestic cutoffs. Export profits in H are equal to:

$$\frac{1}{4\beta}\left(2\sqrt{\beta\widehat{\lambda}_{Xm}^H}+\frac{\tau}{\left(z_{\omega m}^*\right)_X^H}-\frac{\tau}{z_\omega}\right)^2-\widehat{\lambda}_{Xm}^H=0 \tag{29}$$

$$\frac{\beta+\gamma}{(2\beta+\gamma)^2}\left((2\beta+\gamma)\sqrt{\frac{\widehat{\lambda}_{Xn}^H}{\beta+\gamma}}+\frac{\tau}{\left(z_{\omega n}^*\right)_X^H}-\frac{\tau}{z_\omega}\right)^2-\widehat{\lambda}_{Xn}^H=0 \tag{30}$$

where $\left(z_{\omega m}^*\right)_X^H$ and $\left(z_{\omega n}^*\right)_X^H$ are the export cutoffs. $\widehat{\lambda}_{Xj}^H \equiv \left[1+\frac{1-\delta_j^H}{\delta_j^H}(d-t)\right]\lambda_X$ incorporates the increased fixed cost to export due to the existence of credit constraints. Under Assumption 1 we have that CO firms are less financially constrained than MC firms both in the domestic and in the export market. As a result for country H it holds that $\left(z_{\omega n}^*\right)^H < \left(z_{\omega m}^*\right)^H$ and $\left(z_{\omega n}^*\right)_X^H < \left(z_{\omega m}^*\right)_X^H$. Similarly, for F $\left(z_{\omega n}^*\right)^F < \left(z_{\omega m}^*\right)^F$ and $\left(z_{\omega n}^*\right)_X^F < \left(z_{\omega m}^*\right)_X^F$.

Proposition 8 (cutoff productivities and trade) *CO firms face a lower domestic and export cutoff productivity than MC firms when financial vulnerability is sufficiently high $d > t$ and credit constraints are sufficiently stronger for MC firms compared to CO firms: $\delta_m^H \ll \delta_n^H$ and $\delta_m^F \ll \delta_n^F$.*

This is true under the conditions we specified in Proposition 2.

4.3.1 Symmetric trade

First we explore the case where H and F are characterised by the same δ's:

$$\delta_m^H = \delta_m^F = \delta_m \quad \text{and} \quad \delta_n^H = \delta_n^F = \delta_n$$

and therefore $\widehat{\lambda}_n^H = \widehat{\lambda}_n^F = \widehat{\lambda}_n$, $\widehat{\lambda}_m^H = \widehat{\lambda}_m^F = \widehat{\lambda}_m$, $\widehat{\lambda}_{Xn}^H = \widehat{\lambda}_{Xn}^F = \widehat{\lambda}_{Xn}$, $\widehat{\lambda}_{Xm}^H = \widehat{\lambda}_{Xm}^F = \widehat{\lambda}_{Xm}$. As a result, the aggregate output and the equilibrium number of MC firms are also symmetric: $X_\omega^H = X_\omega^F = X_\omega$ and $M_\omega^H = M_\omega^F = M_\omega$ and hence we can focus on country H since F is exactly the same. When trade takes place there are four cutoff productivities per trading country. In H there will be two domestic cutoffs $(z_{\omega n}^*)$ and $(z_{\omega m}^*)$ and two export cutoffs $(z_{\omega n}^*)_X$ and $(z_{\omega m}^*)_X$ and by Assumption 1, $(z_{\omega n}^*) < (z_{\omega m}^*)$ and $(z_{\omega n}^*)_X < (z_{\omega m}^*)_X$. Domestic cutoffs are the same as in the closed economy scenario given by (16) and (17) and export cutoffs take into consideration the fixed and variable trade costs:

$$(z_{\omega m}^*)_X = \tau \left(\alpha - \gamma X_\omega - 2\sqrt{\beta \widehat{\lambda}_{Xm}} \right)^{-1} \tag{31}$$

$$(z_{\omega n}^*)_X = \tau \left(\alpha - \gamma X_\omega - (2\beta + \gamma) \sqrt{\frac{\widehat{\lambda}_{Xn}}{\beta + \gamma}} \right)^{-1} \tag{32}$$

Using (16) and (31) we can express $(z_{\omega m}^*)_X$ and $(z_{\omega n}^*)_X$ in terms of $(z_{\omega m}^*)$:

$$\frac{1}{(z_{\omega m}^*)_X} = \frac{1}{\tau} \left[\frac{1}{(z_{\omega m}^*)} + 2\sqrt{\beta} \left(\sqrt{\widehat{\lambda}_m} - \sqrt{\widehat{\lambda}_{Xm}} \right) \right] = \frac{1}{\tau} \zeta_{\omega m} \tag{33}$$

$$\frac{1}{(z_{\omega n}^*)_X} = \frac{1}{\tau} \left[\frac{1}{z_{\omega m}^*} + 2\sqrt{\beta \widehat{\lambda}_m} - (2\beta + \gamma) \sqrt{\frac{\widehat{\lambda}_{Xn}}{\beta + \gamma}} \right] \tag{34}$$

where $\zeta_{\omega m} \equiv \frac{1}{(z_{\omega m}^*)} + 2\sqrt{\beta} \left(\sqrt{\widehat{\lambda}_m} - \sqrt{\widehat{\lambda}_{Xm}} \right)$. From (33), higher fixed costs to export increase selection for MC firms $\frac{\partial (z_{\omega m}^*)_X}{\partial \widehat{\lambda}_{Xm}} > 0$ and, since $\frac{\partial z_{\omega m}^*}{\partial \widehat{\lambda}_m} > 0$, higher do-

mestic fixed costs cause MC firms to shift their activity towards the export market and, consequently, reduce the export cutoff $\frac{\partial (z^*_{\omega m})_X}{\partial \widehat{\lambda}_m} < 0$. Similarly, using (34), $\frac{\partial (z^*_{\omega n})_X}{\partial \widehat{\lambda}_{Xn}} > 0$ and if we rewrite (34) using (23) we get that:

$$\frac{1}{(z^*_{\omega n})_X} = \frac{1}{\tau}\left[\frac{1}{z^*_{\omega n}} + (2\beta+\gamma)\left(\sqrt{\frac{\widehat{\lambda}_n}{\beta+\gamma}} - \sqrt{\frac{\widehat{\lambda}_{Xn}}{\beta+\gamma}}\right)\right]$$

and therefore $\frac{\partial (z^*_{\omega m})_X}{\partial \widehat{\lambda}_m} < 0$.

Proposition 9 (fixed costs and selection) *Selection in the export market of both CO and MC firms increases with the fixed costs to export and decreases with the domestic fixed operating costs.*

We now turn to the specification of the entry technology. Using the profit functions (27) and (29), having set $(z^*_{\omega m})^H = (z^*_{\omega m})$, $(z^*_{\omega m})^H_X = (z^*_{\omega m})_X$, $\widehat{\lambda}^H_m = \widehat{\lambda}_m$ and $\widehat{\lambda}^H_{Xm} = \widehat{\lambda}_{Xm}$, we can state the free entry condition in country H in the case of symmetric trade:

$$\begin{gathered}\int_{z^*_{\omega m}}^{\infty}\left[\frac{1}{4\beta}\left(2\sqrt{\beta\widehat{\lambda}_m}+\frac{1}{z^*_{\omega m}}-\frac{1}{z_\omega}\right)^2-\widehat{\lambda}_m\right]dG(z_\omega)+ \\ \int_{(z^*_{\omega m})_X}^{\infty}\left[\frac{1}{4\beta}\left(2\sqrt{\beta\widehat{\lambda}_{Xm}}+\frac{\tau}{(z^*_{\omega m})_X}-\frac{\tau}{z_\omega}\right)^2-\widehat{\lambda}_{Xm}\right]dG(z_\omega)-f_E=0\end{gathered} \tag{35}$$

where f_E is the sunk entry cost. Substituting $(z^*_{\omega m})_X$ using (33), (35) becomes a function of $(z^*_{\omega m})$ only. Under Pareto distribution by Assumption 2 we get that when there is symmetric trade:

$$\begin{gathered}\Phi_{ST} = \phi_1\left(\frac{1}{z^*_{\omega m}}\right)^{k+2}+\phi_2\sqrt{\widehat{\lambda}_m}\left(\frac{1}{z^*_{\omega m}}\right)^{k+1}+ \\ \tau^{-k}\phi_1(\zeta_{\omega m})^{k+2}+\tau^{-k}\phi_2\sqrt{\widehat{\lambda}_{Xm}}(\zeta_{\omega m})^{k+1}-f_E=0\end{gathered} \tag{36}$$

where $\phi_1 = \frac{1}{2\beta(k+1)(k+2)}$, $\phi_2 = \frac{1}{\sqrt{\beta}(k+1)}$. To close the model, we need to add the labour market clearing condition which specifies the optimal consumption of the homogeneous A which is traded freely and whose consumption must be positive.

The condition is similar to its closed economy version and is presented in the Appendix.

We go on to investigate the effect of trade liberalisation on domestic cutoffs $z^*_{\omega m}$ and $z^*_{\omega n}$ in the presence of credit constraints. Firstly, our model confirms the standard result of trade models with heterogeneous firms, namely trade liberalisation (captured by a reduction of τ) increases selection. This is true both for MC and for CO firms. By applying the implicit function theorem to (35) we get that $\frac{\partial z^*_{\omega m}}{\partial \tau} < 0$ (the full proof can be found in the Appendix) and then from (23) it is easy to see that $\frac{\partial z^*_{\omega n}}{\partial \tau} = \frac{\partial z^*_{\omega m}}{\partial \tau} < 0$.

Proposition 10 (trade and selection) *Trade liberalisation increases selection both for CO and for MC firms.*

The intuition behind this result is that a decrease in the trade cost τ generates entry of MC firms which creates additional competition and drives markups down. By (24) and (25) lower markups mean more selection for both MC and CO firms which corresponds to higher cutoffs. This selection effect of trade is of the same magnitude for the two types of firms exactly because it operates through the increase of the MC fringe, given that the number of oligopolists is exogenously given.

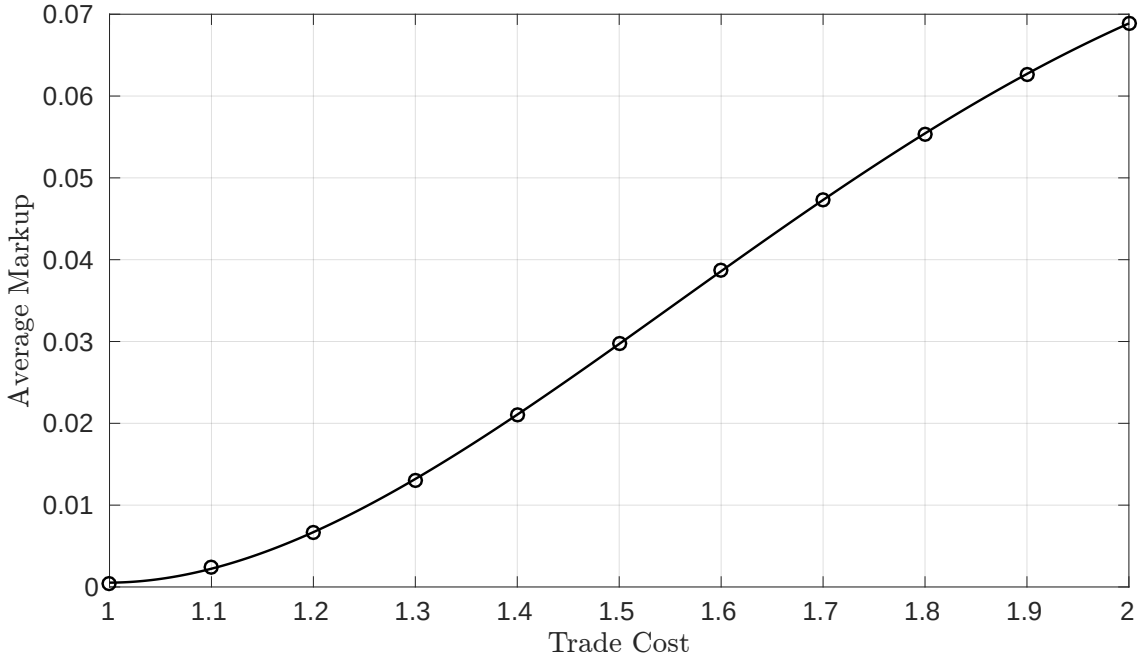
We can dig deeper into the effect of trade on markups. From (24) a decrease in τ drives domestic markups down and export markups up for all domestic firms. However the decrease of the former exceeds the increase of the latter. Since the number of (MC) firms that operate domestically exceeds the number of (MC) exporters and because entry increases the total mass of MC firms (charging a relatively lower markup) relatively to the one of CO firms (charging a relatively higher markup) the average markup in the H market goes down. We define the average

markup below:

$$\bar{\mu} = \frac{1}{(\Omega_n+\Omega_{Xn})N+(\Omega_m+\Omega_{Xm})M}[\Omega_{Xn}N\int_{(z^*_{\omega n})_X}^{\infty}(\mu_{\omega n})_X\, dG(z_\omega) + \Omega_{Xm}M\int_{(z^*_{\omega m})_X}^{\infty}(\mu_{\omega m})_X\, dG(z_\omega) + \Omega_n N\int_{z^*_{\omega n}}^{\infty}\mu_{\omega n} dG(z_\omega) + \Omega_m M\int_{z^*_{\omega m}}^{\infty}\mu_{\omega m} dG(z_\omega)]$$

where $\Omega_{Xj} = 1 - F(z^*_{\omega j})_X$ is the mass of varieties exported by type-j firms. The equilibrium mass of MC firms M is calculated in the Appendix. Our model is too stylised to be fully calibrated and so we use a numerical exploration of our model[8] in order to illustrate the pro-competitive effect of trade in Figure 1. Through the decrease in markups, trade liberalisation drives average MC and CO profits down.

Figure 1: Average markup and trade cost



The model also allows us to examine how the selection effect of trade liberalisation changes with the severity of financial frictions and the magnitude of fixed

[8]Our parameters are as follows: $\alpha = 0.5$, $\beta = 0.1$, $\gamma = 8.2$, $k = 3$, $f_E = 6$, $d = 0.12$, $t = 0.1$, $\delta_m = 0.5$, $\delta_n = 0.8$, $\lambda = 0.3$, $\lambda_X = 0.01$, $N = 2$. As we show below, our results are not sensitive to changes in our key variables N and the δ's.

costs. The proofs can be found in the Appendix. With respect to f_E we get that $\frac{\partial^2 z^*_{\omega m}}{\partial \tau \partial f_E} = \frac{\partial^2 z^*_{\omega n}}{\partial \tau \partial f_E} < 0$. Moving on to the effect of financial frictions we get the following results: $\frac{\partial^2 z^*_{\omega m}}{\partial \tau \partial \widehat{\lambda}_m} < 0$, $\frac{\partial^2 z^*_{\omega n}}{\partial \tau \partial \widehat{\lambda}_m} < 0$, $\frac{\partial^2 z^*_{\omega n}}{\partial \tau \partial \widehat{\lambda}_n} = 0$ and $\frac{\partial^2 z^*_{\omega m}}{\partial \tau \partial \widehat{\lambda}_n} = 0$. Higher credit constraints on the operating cost imply higher selection and thus lower markups and higher competition. As a result, the gains from trade-induced competition will be low when domestic competition is tougher. Similarly, higher entry costs imply less selection, high markups and low competition. In this case, trade hits the market more severely because the scope for a trade-induced increase in competition is larger. Fewer financial frictions in the domestic market for MC firms, in the form of a decrease in $\widehat{\lambda}_m$, translate into more entry of MC firms and hence more competition and stronger selection both for type-m and type-n competitors and, therefore, lower selection gains from trade. However, a decrease in the financial frictions for CO firms (decrease in $\widehat{\lambda}_n$) does not produce more entry and, thus, leaves the selection effect totally unaffected.

Proposition 11 (selection and fixed costs) *The selection gains from trade are decreasing in the financial frictions faced by the MC firms and increasing in the entry cost. They are, however, unaffected by the financial frictions faced by CO firms.*

Regarding the export cutoffs $(z^*_{\omega m})_X$ and $(z^*_{\omega n})_X$, we can observe that $\frac{\partial (z^*_{\omega m})_X}{\partial \tau} > 0$ given that $2\sqrt{\beta}\left(\sqrt{\widehat{\lambda}_m} - \sqrt{\widehat{\lambda}_{Xm}}\right) > 0$. Similarly, $\frac{\partial (z^*_{\omega n})_X}{\partial \tau} > 0$ since $2\sqrt{\beta \widehat{\lambda}_m} - (2\beta + \gamma)\sqrt{\frac{\widehat{\lambda}_{Xn}}{\beta+\gamma}} > 0$. The intuition behind this result is that trade liberalisation makes exporting easier both for MC firms and CO firms as long as the export cutoff is higher than the domestic cutoff, which is true for both types of firms. In this case, à la Melitz (2003), certain goods ω are traded domestically but are not being exported. For firms that are already domestic producers, trade liberalisation means easier exporting and hence weaker selection among exporters.

Regarding the relative cutoff $Z = \frac{z^*_{\omega m}}{z^*_{\omega n}}$, using (23) we get that, under Assump-

tion 1[9], $\frac{\partial Z}{\partial \tau} > 0$ and therefore the increase in $z^*_{\omega n}$ is larger than the increase in $z^*_{\omega m}$ with a given decrease of τ.

Proposition 12 (trade and relative selection) *Trade liberalisation generates weaker selection for MC firms than for CO firms.*

This result is a corollary of the differential entry technology between MC and CO firms. In general, the selection effect occurs through entry of new firms per product line and through the decrease of markups resulting in the increase of the surviving cutoff productivity. If both subsectors were subject to a free entry condition or if neither of them was, as in Baccini et al. (2017), a decrease in τ would affect both subsectors symmetrically by decreasing markups and increasing the number of competitors. Given the lower constraints of CO firms as well as their ability to charge a higher markup, $z^*_{\omega n}$ would decrease less than $z^*_{\omega m}$ causing Z to increase with a decrease in τ. In our setup however where N is fixed, this result is reversed: with a decrease in τ both types of firms adjust their markups but although M increases N remains constant. Hence selection appears to be stronger for CO firms whose number per product line cannot be affected by globalisation leaving the number of surviving product lines the only dimension in which the CO subsector can adjust to the post-globalisation conditions.

4.3.2 Welfare under symmetric trade

As in the closed economy case, welfare under symmetric trade can be calculated using the indirect utility function that corresponds to (4):

$$U_{ST} = I_{ST} + \frac{1}{2}\left(\gamma + \frac{\beta}{(\Omega_n+\Omega_{Xn})N+(\Omega_m+\Omega_{Xm})M}\right)^{-1}(\alpha-\bar{p})^2 + \frac{1}{2}\frac{(\Omega_n+\Omega_{Xn})N+(\Omega_m+\Omega_{Xm})M}{\beta}\sigma_p^2 \tag{37}$$

[9] $Z = \frac{z^*_{\omega m}}{z^*_{\omega n}} = \frac{1/z^*_{\omega n}}{1/z^*_{\omega m}} = \frac{1/z^*_{\omega m}+2\sqrt{\beta\widehat{\lambda}_m}-(2\beta+\gamma)\sqrt{\widehat{\lambda}_n/\beta+\gamma}}{1/z^*_{\omega m}}$ and hence $\frac{\partial Z}{\partial \tau} = -\frac{\frac{\partial(1/z^*_{\omega m})}{\partial \tau}\left(2\sqrt{\beta\widehat{\lambda}_m}-(2\beta+\gamma)\sqrt{\widehat{\lambda}_n/\beta+\gamma}\right)}{(1/z^*_{\omega m})^2} > 0$ since $2\sqrt{\beta\widehat{\lambda}_m} - (2\beta+\gamma)\sqrt{\widehat{\lambda}_n/\beta+\gamma} < 0$ under Assumption 1.

where income I is equal to the labour income (normalised to one) plus the total CO firm profit:

$$I_{ST} = 1 + \Omega_n N \int_{z^*_{\omega n}}^{\infty} \left[\frac{\beta+\gamma}{(2\beta+\gamma)^2} \left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega} \right)^2 - \widehat{\lambda}_n - f_E \right] dG\left(z_\omega\right) +$$
$$\Omega_{Xn} N \int_{(z^*_{\omega n})_X}^{\infty} \left[\frac{\beta+\gamma}{(2\beta+\gamma)^2} \left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega} \right)^2 - \widehat{\lambda}_{Xn} \right] dG\left(z_\omega\right)$$

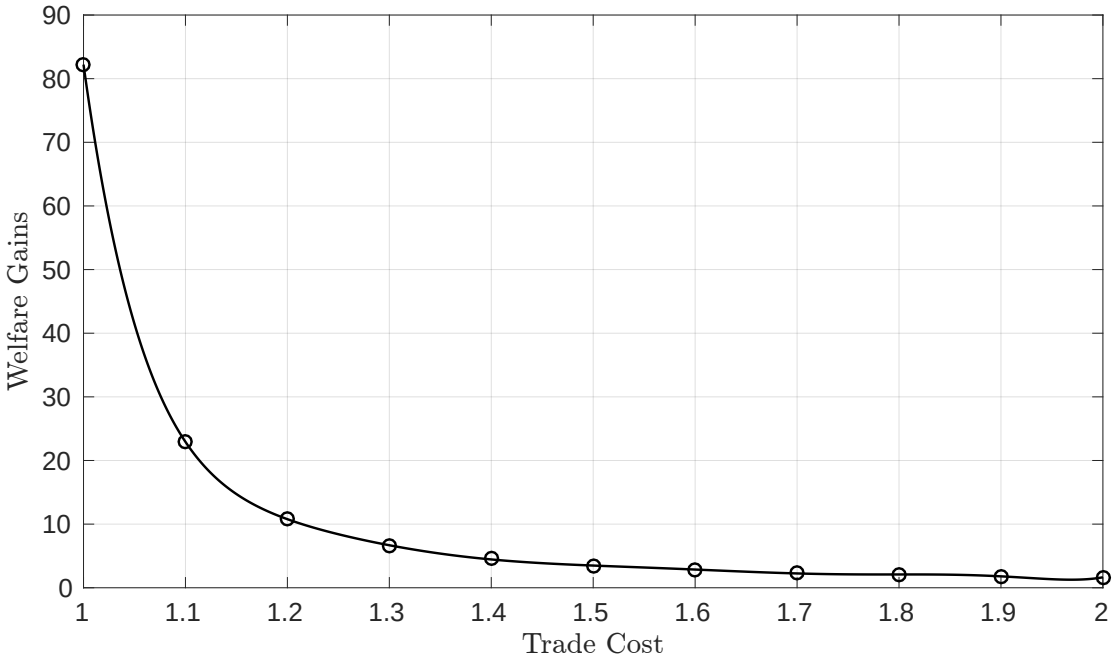
The welfare gains from (symmetric) trade W_{ST} can be calculated by comparing (37) to its autarky analogue (26):

$$W_{ST} = \frac{U_{ST}}{U}$$

Given that the trade cost is below its prohibitive level, the transition from autarky to international trade creates welfare gains through the competition effect that tends to suppress markups and generate new entry. These gains increase as trade becomes cheaper with incremental trade liberalisation. We use the numerical version of our model to illustrate the welfare gains from trade in Figure 2. In Figure 2, welfare gains are always positive even when the trade cost τ is as high as 2. Incremental trade liberalisation generates further gains and welfare is maximised when trade is free at $\tau = 1$.

Welfare and the oligopolistic inefficiency One of the key assumptions of our model is the constant number of CO firms which is equal to N. In this part of the chapter we compare the welfare gains from trade as we increase the number of oligopolists, intensifying competition within the CO subsectors. In our numerical example in Figure 3 we start from $N = 1$ and move up to $N = 10$. We observe that welfare gains from trade slightly increase and this increase is monotonic with the number of CO firms. This result is intuitive and it is similar to Figure 2 in Section 3: given that $N > 0$, lower N implies a more severe oligopolistic inefficiency in

Figure 2: Welfare gains from symmetric trade

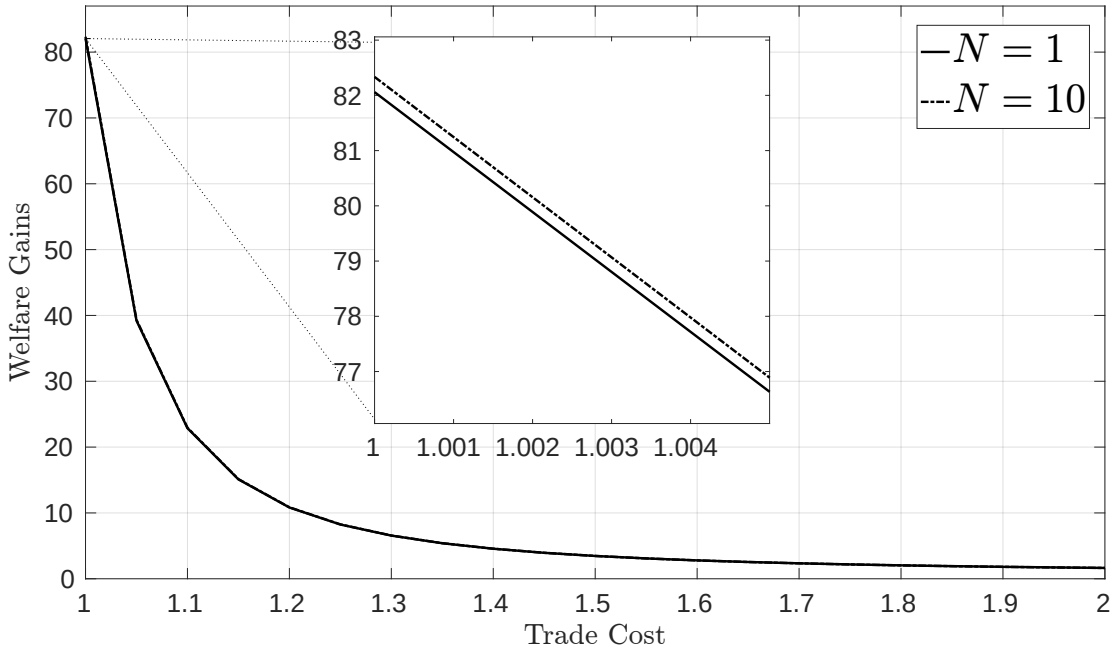


the presence of which the pro-competitive effect of trade is weakened. Notice that, given the existence of oligopolistic firms ($N > 0$), trade policy in the form of a reduction in the variable trade cost is a relatively more welfare-promoting measure compared to competition policy[10]. However, the benefits from trade are magnified when combined with domestic pro-competitive measures.

Welfare and credit constraints We now move on to the importance of financial development in shaping the gains from trade. When credit constraints are weaker (higher δ's), cutoff productivities decrease, more unproductive firms operate and inefficient product lines are being produced. This lowers welfare and the welfare gains. In other words, trade benefits more the less financially developed countries. In Figure 4 we compare the welfare effect of a 25 percent decrease in both δ_m and δ_n to that of a 25 percent increase in the trade cost τ. We get that decreasing both δ's by 25 percent generates an increase in welfare gains that is lower than the

[10]In our model, competition policy refers to measures like price controls and anti-trust policy designed to suppress markup-related inefficiencies.

Figure 3: Welfare gains and the oligopolistic inefficiency: Symmetric case



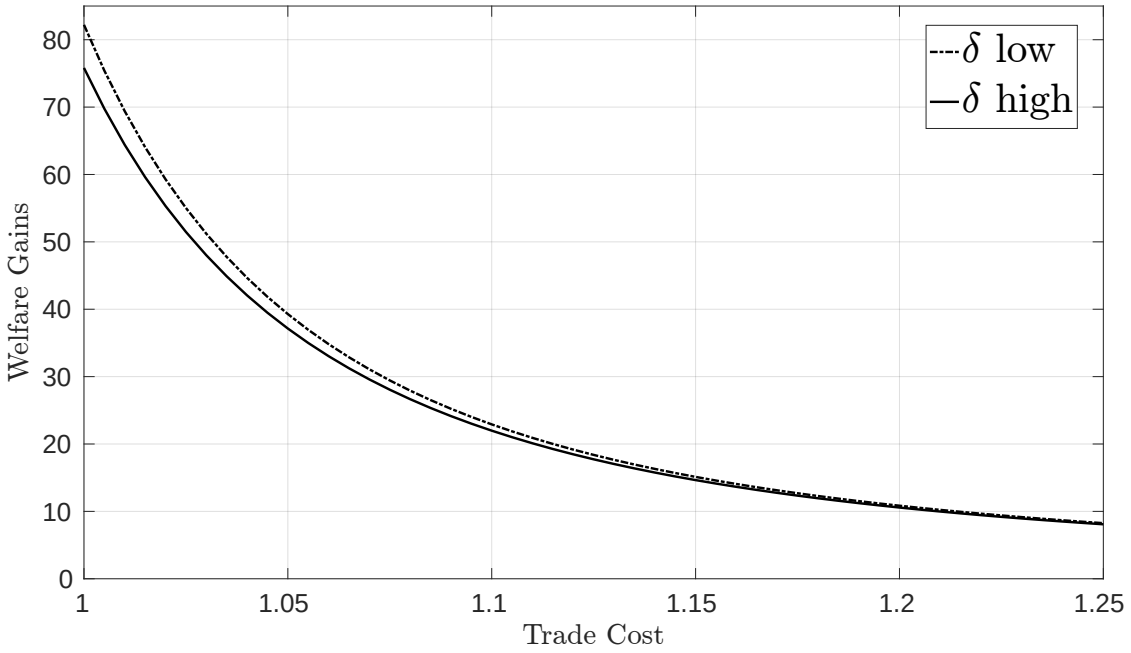
gains from a decrease in τ by 25 percent. Gains from decreasing δ are higher when trade is relatively cheap, since in that case fewer resources are wasted during exports. Hence, in our framework, trade liberalisation is relatively more efficient in the presence of tougher credit constraints although globalisation appears to be a more important determinant of welfare compared to financial development.

4.3.3 Asymmetric trade

In the final part of our open economy analysis we look into the case where countries differ in their financial development. We start with the specification of the eight cutoff productivities (two per type of firm, a domestic and an export one, per country). From (27) - (30) and their country F analogues we get:

$$(z^*_{\omega m})^H = \left(\alpha - \gamma X^H_\omega - 2\sqrt{\beta \widehat{\lambda}^H_m}\right)^{-1} \tag{38}$$

Figure 4: Welfare gains and credit constraints: Symmetric case



$$(z^*_{\omega n})^H = \left(\frac{1}{(z^*_{\omega m})^H} + 2\sqrt{\beta \widehat{\lambda}^H_m} - (2\beta+\gamma)\sqrt{\frac{\widehat{\lambda}^H_n}{\beta+\gamma}} \right)^{-1} \tag{39}$$

$$(z^*_{\omega m})^H_X = \tau \left(\alpha - \gamma X^F_\omega - 2\sqrt{\beta \widehat{\lambda}^H_{Xm}} \right)^{-1} \tag{40}$$

$$(z^*_{\omega n})^H_X = \left[\frac{1}{(z^*_{\omega m})^H_X} + \frac{1}{\tau} \left(+2\sqrt{\beta \widehat{\lambda}^H_m} - (2\beta+\gamma)\sqrt{\frac{\widehat{\lambda}^H_{Xn}}{\beta+\gamma}} \right) \right]^{-1} \tag{41}$$

$$(z^*_{\omega m})^F = \left(\frac{\tau}{(z^*_{\omega m})^H_X} + 2\sqrt{\beta} \left(\sqrt{\widehat{\lambda}^H_{Xm}} - \sqrt{\widehat{\lambda}^F_m} \right) \right)^{-1} \tag{42}$$

$$(z^*_{\omega n})^F = \left[\frac{\tau}{(z^*_{\omega m})^H_X} + 2\sqrt{\beta \widehat{\lambda}^H_{Xm}} - (2\beta+\gamma)\sqrt{\frac{\widehat{\lambda}^F_n}{\beta+\gamma}} \right]^{-1} \tag{43}$$

$$(z^*_{\omega m})^F_X = \tau \left(\frac{1}{(z^*_{\omega m})^H} + 2\sqrt{\beta} \left(\sqrt{\widehat{\lambda}^H_m} - \sqrt{\widehat{\lambda}^F_{Xm}} \right) \right)^{-1} \tag{44}$$

$$(z^*_{\omega n})^F_X = \tau \left(\frac{1}{(z^*_{\omega m})^H} + 2\sqrt{\beta \widehat{\lambda}^H_m} - (2\beta + \gamma) \sqrt{\frac{\widehat{\lambda}^F_{Xn}}{\beta + \gamma}} \right)^{-1} \tag{45}$$

Equations (38) and (39) are the domestic cutoffs for country H which are the same as in the closed economy case (16) and (23) with the appropriate adjustment of notation. Equations (40) and (41) are the export cutoffs for country H. They differ from the symmetric trade case (31) and (34) because X^F_ω is no longer equal to X^H_ω due to differential financial development between the two economies. Equations (42) and (43) are the domestic cutoffs in country F expressed in terms of $(z^*_{\omega m})^H_X$. Finally, (44) and (45) are the export cutoffs of country F expressed in terms of $(z^*_{\omega m})^H$.

Having expressed all cutoff productivities as functions of $(z^*_{\omega m})^H$ and $(z^*_{\omega m})^H_X$, a system of two equations suffices to find all eight cutoffs. These equations are provided by the free entry conditions for the MC firms in each country. The free entry condition in H is the following:

$$\begin{gathered} \int_{(z^*_{\omega m})^H}^{\infty} \left[\frac{1}{4\beta} \left(2\sqrt{\beta \widehat{\lambda}^H_m} + \frac{1}{(z^*_{\omega m})^H} - \frac{1}{z_\omega} \right)^2 - \widehat{\lambda}^H_m \right] dG(z_\omega) + \\ \int_{(z^*_{\omega m})^H_X}^{\infty} \left[\frac{1}{4\beta} \left(2\sqrt{\beta \widehat{\lambda}^H_{Xm}} + \frac{\tau}{(z^*_{\omega m})^H_X} - \frac{\tau}{z_\omega} \right)^2 - \widehat{\lambda}^H_{Xm} \right] dG(z_\omega) - f_E = 0 \end{gathered} \tag{46}$$

and the free entry condition in F is:

$$\begin{gathered} \int_{(z^*_{\omega m})^F}^{\infty} \left[\frac{1}{4\beta} \left(2\sqrt{\beta \widehat{\lambda}^F_m} + \frac{1}{(z^*_{\omega m})^F} - \frac{1}{z_\omega} \right)^2 - \widehat{\lambda}^F_m \right] dG(z_\omega) + \\ \int_{(z^*_{\omega m})^F_X}^{\infty} \left[\frac{1}{4\beta} \left(2\sqrt{\beta \widehat{\lambda}^F_{Xm}} + \frac{\tau}{(z^*_{\omega m})^F_X} - \frac{\tau}{z_\omega} \right)^2 - \widehat{\lambda}^F_{Xm} \right] dG(z_\omega) - f_E = 0 \end{gathered} \tag{47}$$

Equations (46) and (47) form a system of two equations in two unknowns $(z^*_{\omega m})^H$ and $(z^*_{\omega m})^H_X$ if we express $(z^*_{\omega m})^F$ and $(z^*_{\omega m})^F_X$ in terms of $(z^*_{\omega m})^H$ and $(z^*_{\omega m})^H_X$

using (43) and (44). This generalised version of the model is not tractable enough to provide results analytically. However, we can use the numerical exploration of our model[11] to illustrate our main findings. We are interested in the effect of trade with a more financially developed country. In our calibration we maintain the exact same characteristics for H as in the closed economy and the symmetric trade version and observe what happens to H when it trades with a country F characterised by higher δ's for both MC and CO firms.

Assumption 3 (asymmetric trade) *The Foreign country F is more financially developed than the Home country H.*

This assumption implies that $(z^*_{\omega n})^F < (z^*_{\omega n})^H$ and $(z^*_{\omega m})^F < (z^*_{\omega m})^H$. We focus on the case where cross country differences in financial constraints are more severe than cross firm differences ($\delta^H_m \ll \delta^H_n \ll \delta^F_m \ll \delta^F_n$) since this scenario is empirically relevant and facilitates comparisons. In this case the full ranking of the cutoffs is the following:

$$(z^*_{\omega n})^F < (z^*_{\omega m})^F < (z^*_{\omega n})^H < (z^*_{\omega m})^H$$

The specific conditions when this holds as well as the computation of equilibrium M^H and M^F are shown in the Appendix.

We move on to explore the impact of globalisation. As trade cost decreases, exactly as in the symmetric case, markups decrease due to a trade-induced increase in competition. The selection effect of trade occurs in both H and F as cutoff productivities increase with incremental trade liberalisation. In Figure 5, we show the increase in $(z^*_{\omega m})^F$ and $(z^*_{\omega m})^H$ as τ decreases from $\tau = 2$ to free trade. All other cutoffs move as we proved in the symmetric case since they can be expressed in terms of $(z^*_{\omega m})^F$ and $(z^*_{\omega m})^H$.

[11]Our parameters are as follows: $\alpha = 0.5$, $\beta = 0.1$, $\gamma = 8.2$, $k = 3$, $f_E = 6$, $d = 0.12$, $t = 0.1$, $\delta^H_m = 0.5$, $\delta^H_n = 0.8$, $\delta^F_m = 0.9$, $\delta^F_n = 0.95$, $\lambda = 0.3$, $\lambda_X = 0.01$, $N = 2$. As shown below, our results

Focusing on H, in Figure 6 we can observe the decrease in markups charged by firms originating from country H as a result of trading with a more financially developed partner whose firms can afford to charge lower markups. Comparing Figure 6 to Figure 1 we get that markups are lower when trade is with a less constrained economy. Opening up to trade with a country with a higher number of MC firms, due to lower credit constraints, implies a stronger pro-competitive effect for country H.

4.3.4 Welfare under asymmetric trade

We calculate the welfare gains from trade in the same way as in symmetric trade. Focusing on the H economy, under asymmetric trade:

$$\begin{aligned} U_{AT} = I_{AT} + \frac{1}{2}\left(\gamma + \frac{\beta}{\left(\Omega_n^H+\Omega_{Xn}^H\right)N+\Omega_m^H M^H+\Omega_{Xm}^H M^H}\right)^{-1}\left(\alpha-\bar{p}^H\right)^2 \\ +\frac{1}{2}\frac{\left(\Omega_n^H+\Omega_{Xn}^H\right)N+\Omega_m^H M^H+\Omega_{Xm}^H M^H}{\beta}\left(\sigma_p^2\right)^H \end{aligned} \tag{48}$$

where income I_{AT} is equal to:

$$\begin{aligned} I_{AT} = 1 + \Omega_n^H N \int_{\left(z_{\omega n}^*\right)^H}^{\infty}\left[\frac{\beta+\gamma}{(2\beta+\gamma)^2}\left(\sqrt{\frac{\widehat{\lambda}_n^H}{\beta+\gamma}}+\frac{1}{\left(z_{\omega n}^*\right)^H}-\frac{1}{z_\omega}\right)^2-\widehat{\lambda}_n^H-f_E\right]dG\left(z_\omega\right) \\ +\Omega_{Xn}^H N \int_{\left(z_{\omega n}^*\right)_X^H}^{\infty}\left[\frac{\beta+\gamma}{(2\beta+\gamma)^2}\left(\sqrt{\frac{\widehat{\lambda}_{Xn}^H}{\beta+\gamma}}+\frac{1}{\left(z_{\omega n}^*\right)_X^H}-\frac{1}{z_\omega}\right)^2-\widehat{\lambda}_{Xn}^H\right]dG\left(z_\omega\right) \end{aligned}$$

The welfare gains from asymmetric trade W_{AT} can be calculated by comparing (48) to its autarky analogue (26):

$$W_{AT} = \frac{U_{AT}}{U}$$

Again, both a transition from autarky to international trade and incremental trade liberalisation generate welfare gains. The channel is through the competition ef-

are not sensitive to changes in N and the δ's.

fect that occurs through entry of MC firms and a decrease in markups. We use our numerical example to illustrate the welfare gains from trade in Figure 7: welfare gains are always positive even at a trade cost $\tau = 2$. A decrease in τ generates further gains and welfare is maximised when trade is free. Compared to the symmetric case (Figure 2), gains are higher when trade is with a more rather than an equally financially developed partner. The reason is that F's financial conditions create a positive spillover effect: markups in country H drop more in the asymmetric case causing an increase in welfare. This result is driven by the lower markups charged by less financially constrained country-F firms, compared to the markups of their competitors based in H.

Welfare and the oligopolistic inefficiency Moving on to the role of CO competitors, we perform the same exercise of increasing N from $N = 1$ to $N = 10$. Our results are presented in Figure 8. We get that welfare gains are always higher compared to the symmetric case and that they increase monotonically with the number of CO firms. Thus, given that $N > 0$, as N increases the oligopolistic inefficiency becomes a relatively less important obstacle to the pro-competitive effect. As in Figure 3 and similarly to Figure 2 from our Section 3 model, trade policy enhances welfare more than competition policy in relative terms. However, competition policy in the form of discouraging oligopolistic behaviour from the few superstar firms could complement globalisation-promoting practices.

Welfare and credit constraints Regarding the importance of financial constraints, when a country opens up to trade with a less constrained economy, own credit constraints become relatively less important in shaping the gains from trade. As in the symmetric case, weaker constraints (higher δ's) cause a drop in cutoff productivities allowing less efficient firms and product lines to survive inducing a decrease in welfare and welfare gains. In Figure 9 we compare the welfare effect

of a 25 percent decrease in δ_m^H, δ_n^H, δ_m^F and δ_n^F to that of a 25 percent increase in the trade cost τ. We get that decreasing δ's by 25 percent generates an increase in welfare gains that is lower than the gains induced by a decrease in τ by 25 percent. We conclude, that trade liberalisation is always more beneficial for less developed economies and that the importance of local credit frictions is reduced more when the asymmetries with their trading partners are larger. We conclude that trade openness could partly substitute for financial development in the sense that, when opening up to trade, less developed economies benefit from a positive spillover from their more developed partners, namely the increased ability of foreign less constrained firms to lower their markups.

4.3.5 The role of mixed markets

Our structure allows a straightforward comparison with the Melitz and Ottaviano (2008) model. However there is a key difference between the two setups: in our model each variety is produced not by a single monopolistically competitive firm which is subject to free entry but under mixed market competition between Cournot oligopolistic producers who make positive profits and monopolistic competitors that are subject to free entry. As a result, increasing the number of oligopolistic firms as in Figure 8 does not tend asymptotically to the monopolistically competitive outcome of Melitz and Ottaviano (2008). The reason is our assumption that oligopolists are not subject to free entry. As a result, the trend in Figure 8 holds only as long as $N > 0$. To compare our model to Melitz and Ottaviano (2008) we assume away the existence of an oligopolistic subsector and set $N = 0$. We find that, as in Edmond et al. (2015), liberalising trade in an economy with mixed market competition dominated by superstar firms creates higher pro-competitive gains than it would in a purely monopolistically competitive framework. In mixed markets, the pre-globalisation inefficiency is higher

and trade triggers a larger reduction of this inefficiency. This result is overturned when economies become relatively segmented and the trade cost increases to the extent that trade creates further inefficiencies. As a result, the inclusion of mixed markets does not alter the prediction that gains from trade could exist but crucially alters our predictions for the magnitude of these gains and the trade cost conditions under which they occur. In Figure 10 we illustrate the welfare gains from trade with a more developed partner in our model for our standard value of N, which is $N = 2$, and compare them with the $N = 0$ case. We observe that gains from trade are not monotonically linked to the level of domestic markup-related inefficiencies. Although given the existence of an inefficiency more inefficiency implies lower gains from trade, in the binary comparison of zero versus positive inefficiency trade creates more gains when domestic markets are inefficient.

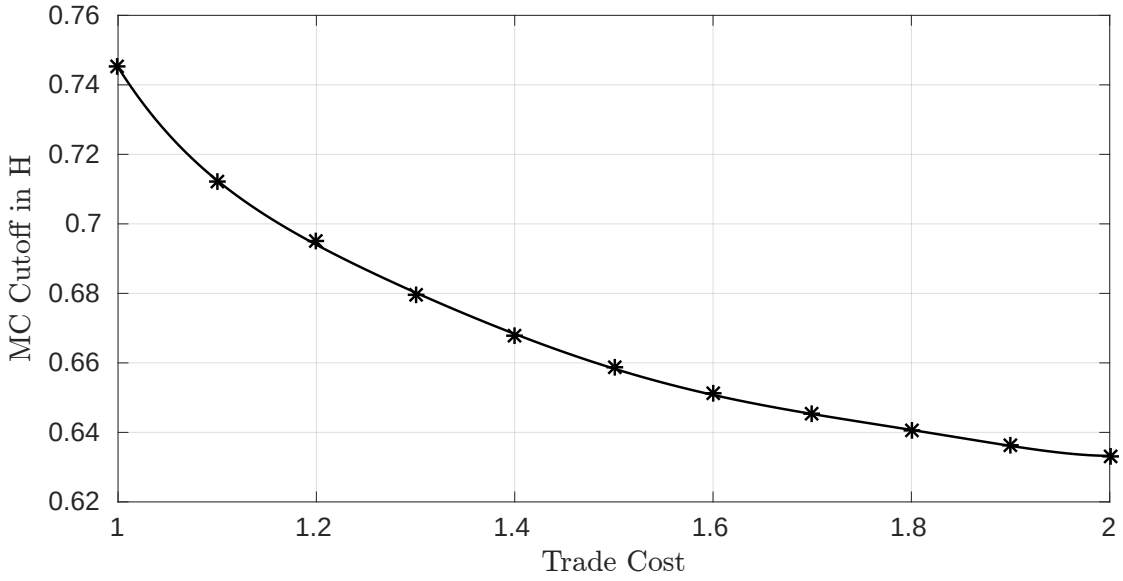
4.4 Conclusion

In a model with heterogeneous large and small firms we introduce credit constraints and investigate how an economy's financial development affects the welfare gains from trade and explore the role of large firms. We show that trade benefits less financially developed countries more because more severe financial constraints create tougher selection as a result of trade liberalisation. Next, we compare the effectiveness of trade liberalisation to that of pro-competitive measures that aim at limiting the behaviour of large firms. We find that the oligopolistic inefficiency resulting from the presence of large firms limits gains from trade and, as a result, discouraging oligopolistic behaviour should be jointly pursued with globalisation-promoting measures. We go on to investigate the effect of trade with a more financially developed partner and find that it could partly act as a substitute for financial development by diminishing the impact of domestic financial market imperfections. We conclude that the incorporation of mixed markets is

key when we aim to derive testable predictions on the magnitude and sign of the gains from trade.

Further research could endogenise the ex post productivity distribution in line with Bonfiglioli et al. (2016) in a mixed market setup where financial frictions would also affect the dispersion of productivities since in a constrained environment firms would not be willing to undertake large productivity-enhancing investments. Another interesting addition would be to allow large oligopolistic firms to become multinationals. In this setup oligopolists would face a trade-off between locating in a more developed, and thus less costly, economy and having to face tougher competition from other large firms. Depending on the timing of the game different interesting equilibria could occur. Finally, our findings indicate that there are complicated links between different trade, competition and financial policies and hence a structural version of this model based on empirical evidence could serve better as a guide for policy-making.

Figure 5: Selection effect of trade



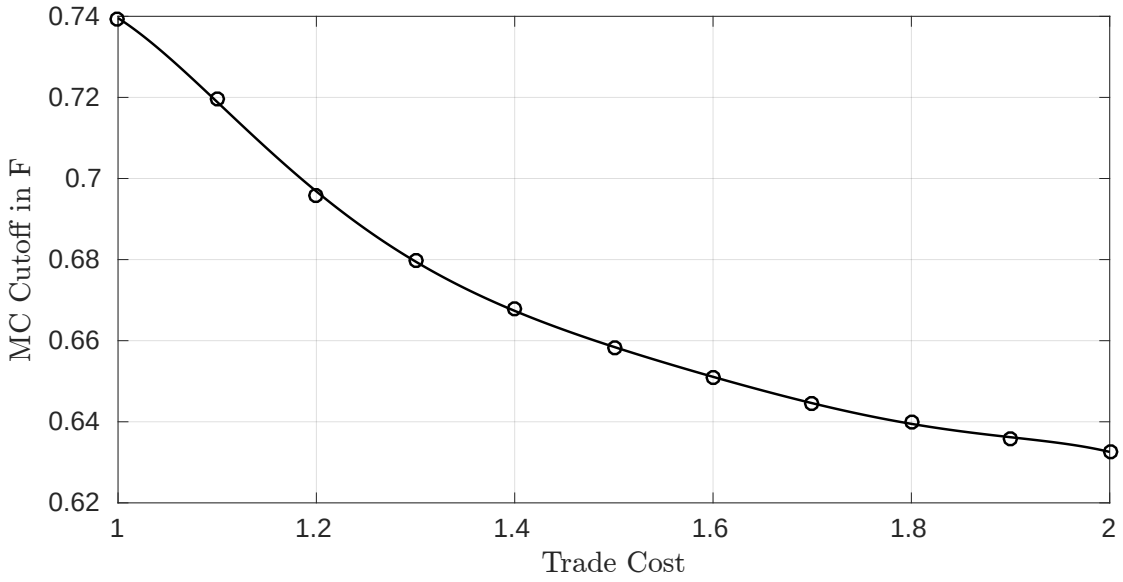


Figure 6: Averaged markup charged by Home firms and trade cost

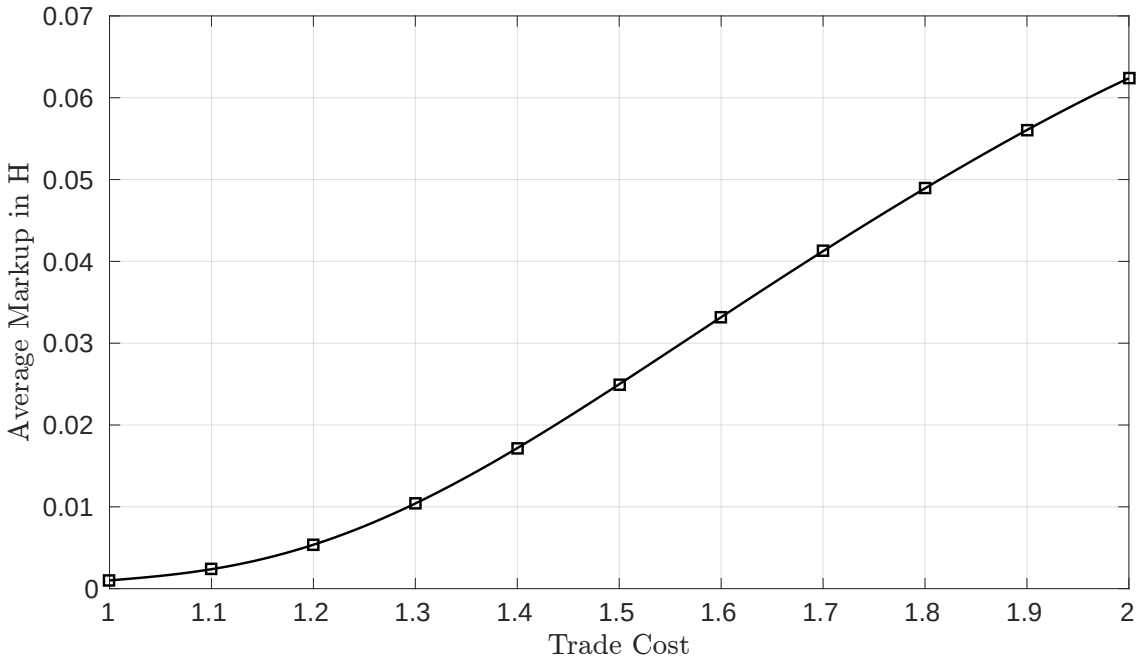


Figure 7: Welfare gains from trade with a more financially developed partner

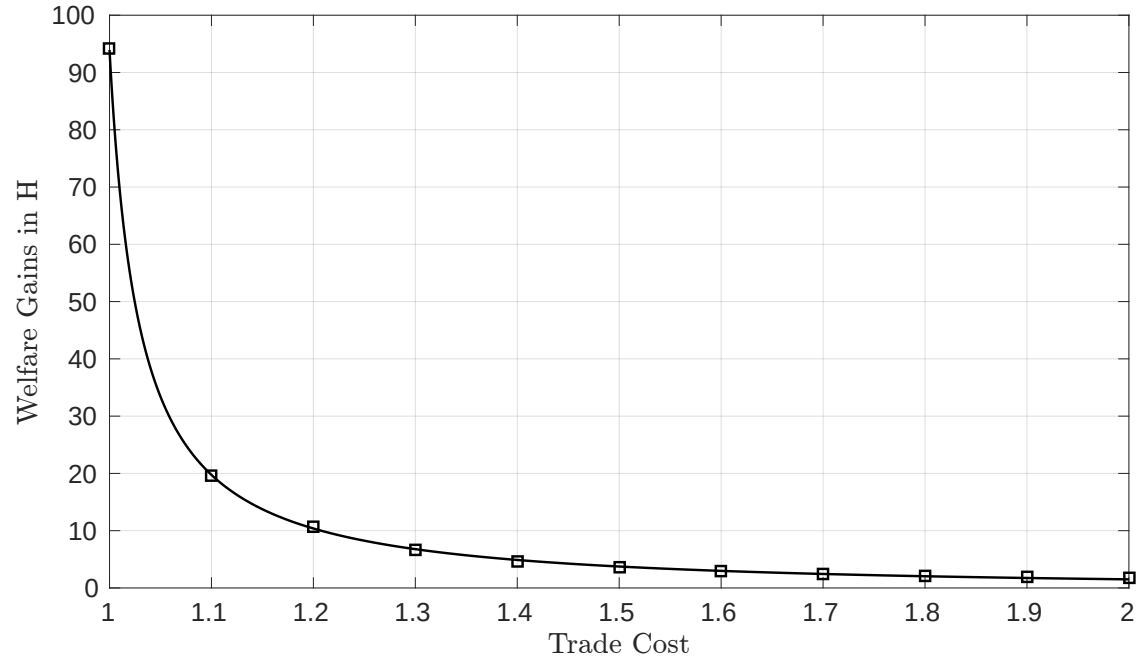


Figure 8: Welfare gains and the oligopolistic inefficiency: Asymmetric case

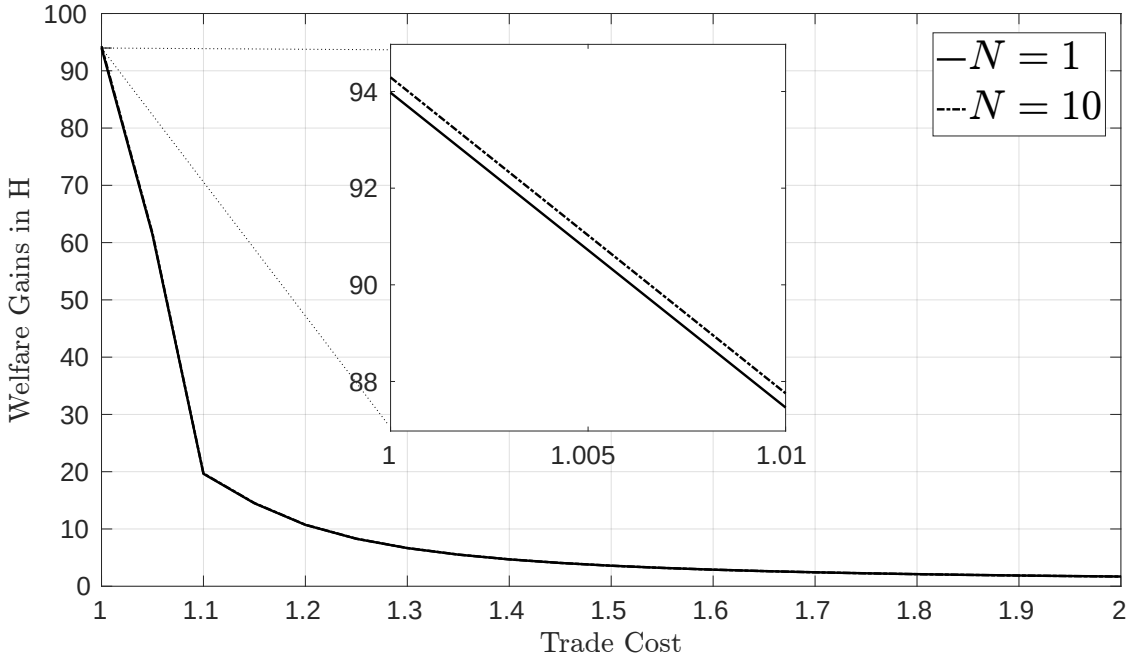


Figure 9: Welfare gains and credit constraints: Asymmetric case

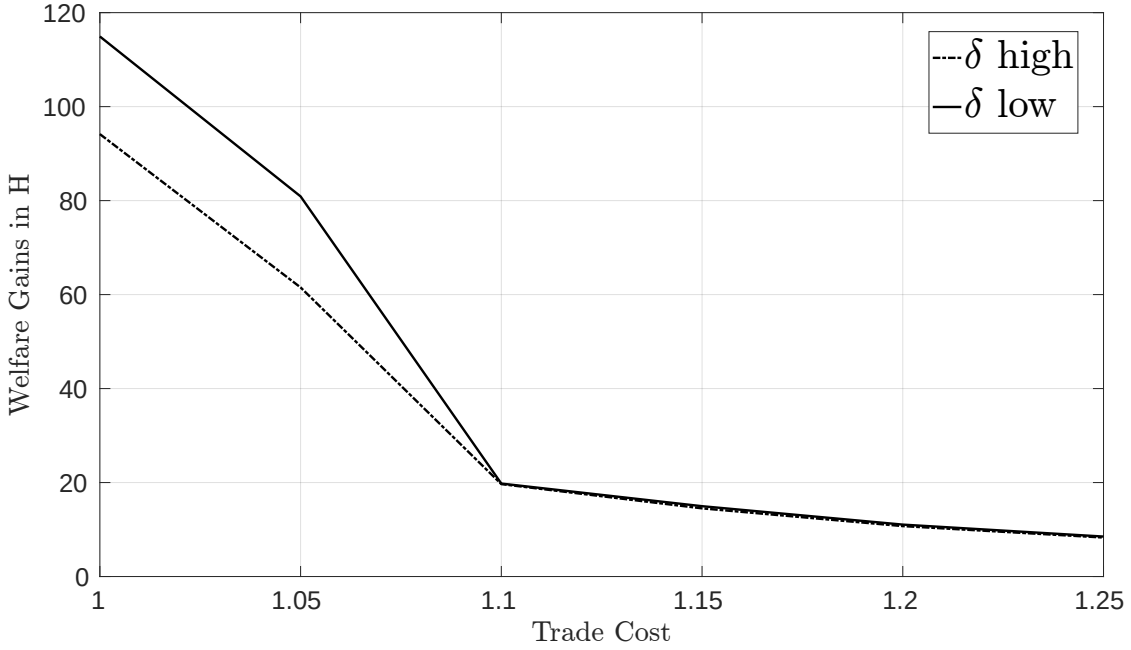
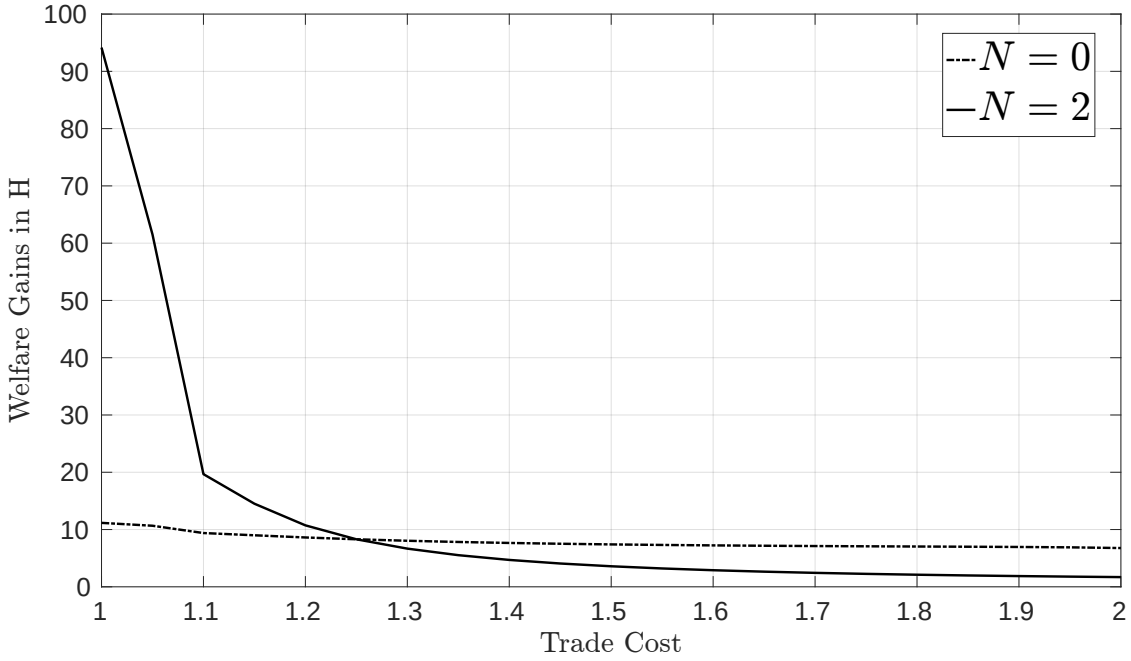


Figure 10: The role of mixed markets



5 Concluding Remarks

Strong empirical evidence points towards an extremely skewed distribution of exporters, corresponding to a few superstar firms co-existing with a fringe of small competitors. Superstars are characterised by superior efficiency, increased access to financial capital and, unlike fringe firms, by the ability to internalise the impact of their behaviour on the market.

In our first chapter, we develop a model in order to examine how productivity differences could endogenously lead to differences in strategic behaviour resulting in polarised markets populated by strategic large firms and non-atomic small ones. Some firms grow large due to a lucky draw from a common productivity distribution and successful cost-reducing innovation whereas most of their competitors remain small, constrained by their low productivity draw and their limited access to credit. As a result, a small number of extremely productive firms grow into superstars while they compete with a fringe of small and relatively inefficient counterparts and polarised markets emerge endogenously as the subgame perfect equilibrium.

In our second chapter, we introduce international trade to this model economy and calculate the welfare gains from trade liberalisation. We show that incorporating productivity heterogeneity jointly with differences in strategic behaviour generates a composition effect that dampens the pro-competitive effect of trade liberalisation. This effect materialises through a market share reallocation from smaller towards larger rivals. We find that, although trade always increases welfare by reducing the average markup and markup heterogeneity, gains from trade are lower when market power distortions are more severe. Consequently, in the presence of such distortions, size-dependent policies could have a welfare-enhancing role to play.

In our third chapter, we explore the idea of small firms' limited access to credit.

We use a version of our model augmented appropriately to allow for the introduction of credit constraints that differ between large and small firms. We use this model to examine how firm-level credit constraints and the behaviour of large firms affect the welfare gains from trade. Finally, we look into the link between financial development and globalisation and how it is altered by the presence of superstar firms. We show that trade benefits less financially developed countries more because their tougher financial constraints imply a stronger selection effect of trade. We go on to investigate the effect of trade with a more financially developed partner and find that it could act as a substitute for financial development by diminishing the impact of domestic credit market and oligopolistic inefficiencies. We conclude that the role of superstar firms is key in shaping the pro-competitive and the selection gains from trade.

The key insight of this thesis is that superstars differ from small firms along many dimensions and most importantly they differ in their strategic behaviour. Consequently, there are barriers to becoming a superstar firm and the existence of these barriers is empirically verified. We argue that we can derive better testable predictions by explicitly modelling key differences between large and small firms. Finally, one of the most prominent directions for future research is the exploration of how some of these barriers could arise endogenously, as a result of superstars' strategic behaviour, and how they are reshaped as a result of the almost limitless opportunities that the globalised economy has to offer.

6 Appendix

6.1 Appendix for Section 2

Existence (Propositions 1 and 2) Using P_2 we get that:

$$x_2 = E_2 \left[\frac{1 - (az_l P_2)^{\frac{a}{1-a}} (1-\gamma)N}{\gamma N P_2^a} \right]^{\frac{1}{a}}$$

To simplify notation we define:

$$M \equiv (az_l P_2)^{\frac{a}{1-a}} (1-\gamma)N$$

Therefore we can re-write x_2 as follows:

$$x_2 = E_2 P_2^{-1} \left[\frac{1-M}{\gamma N} \right]^{\frac{1}{a}}$$

Substituting the above in:

$$E_2^{1-a} = \frac{1}{az_k} P_2^{-a} x_2^{1-a} + E_2^{1-2a} P_2^a x_2^a$$

we get:

$$1 = \frac{1}{az_k} P_2^{-1} \left(\frac{1-M}{\gamma N} \right)^{\frac{1-a}{a}} + \frac{1-M}{\gamma N}$$

Solving the definition of M with respect to P_2:

$$P_2 = \frac{1}{az_l} \left(\frac{M}{(1-\gamma)N} \right)^{\frac{1-a}{a}}$$

Substituting P_2 in the above expression yields:

$$\frac{1 - \frac{z_l}{z_k} \left(\frac{1-\gamma}{\gamma} \frac{1-M}{M} \right)^{\frac{1-a}{a}}}{1-M} = \frac{1}{\gamma N}$$

Define:

$$G(M) \equiv \frac{1 - \frac{z_l}{z_k} \left(\frac{1-\gamma}{\gamma} \frac{1-M}{M} \right)^{\frac{1-a}{a}}}{1-M}$$

The function G increases with M and is such that $\lim_{M \to 0^+} G(M) = -\infty$ and

$\lim_{M\to 1^-} G(M) = \infty$. Therefore, for any given N the equation:

$$G(M) = \frac{1}{\gamma N}$$

has a unique solution $M(N) \in (0,1)$ which decreases with N. It then follows from the definition of M that $P_2(N)$ decreases with N. The inverse demand function faced by an oligopolist is the following:

$$p_{x2} = x_2^{a-1} E_2^{1-a} P_2^a$$

Substituting x_2 and using the definition of M, we get that the equilibrium price $p_{x2}(N)$ set by a large firm is also a decreasing function of N since it can be written as:

$$p_{x2} = \frac{1}{az_l}\left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{\frac{1-a}{a}}$$

We go on to express the second-period profits of each type of firms as a function of N only. Equation:

$$\pi_{x2}(z_k) = x_2^a E_2^{1-a} P_2^a - \frac{1}{z_k} x_2 - f - f_k$$

gives the profit of a large firm, which can be writes as:

$$\pi_{x2}(z_k) = E_2\left(\frac{1-M}{\gamma N}\right) - \frac{1}{z_k} E_2 P_2^{-1}\left(\frac{1-M}{\gamma N}\right)^{\frac{1}{a}} - f - f_k$$

Substituting the above and:

$$\pi_{y2}(z_l) = \left(\frac{1}{az_l}\right)^{\frac{a}{a-1}} (1-a) E_2 P_2^{\frac{a}{1-a}} - f$$

into:

$$E_2 = (\beta+1)^{-1}\left(L + \gamma N \pi_{x2}(z_k) + (1-\gamma) N \pi_{y2}(z_l)\right)$$

gives the equilibrium income spent on the differentiated good:

$$E_2(N) = \frac{L - \gamma N f_k - N f}{\beta + R(N)}$$

where:

$$R(N) \equiv a\frac{z_l}{z_k}\left(\frac{\gamma}{1-\gamma}\right)^{\frac{a-1}{a}}(1-M(N))^{\frac{1}{a}}M(N)^{\frac{a-1}{a}} + aM(N)$$

Having expressed P_2 and E_2 in terms of N, we can obtain $\pi_{y2}(z_l)$ and $\pi_{x2}(z_k)$ as a function of N only:

$$\pi_{y2}(N; z_l) = \frac{(1-a)M(N)}{(1-\gamma)N}E_2(N) - f$$

$$\pi_{x2}(N; z_k) = \left[\frac{1-M(N)}{\gamma N} - \frac{1}{z_k}P_2(N)^{-1}\left(\frac{1-M(N)}{\gamma N}\right)^{\frac{1}{a}}\right]E_2(N) - f - f_k$$

Using the above results we can write the total expected profits, prior to entry, as a function of N:

$$E\Pi(N) = \tfrac{1}{N}[(1-\gamma)N\left[\pi_{y1}(N; z_l) + \pi_{y2}(N; z_l)\right] + \gamma N\left[\pi_{x1}(N; z_h) + \pi_{x2}(N; z_k)\right] - N f_e]$$

which can be written as:

$$E\Pi(N) = \frac{1}{N}\left[(\beta+1)\left[E_1(N) + E_2(N)\right] - 2L - N f_e\right]$$

which is equivalent to:

$$E\Pi(N) = \tfrac{1}{N}\left[-2L - N f_e\right] + \tfrac{(\beta+1)}{N}\left[\frac{L - Nf}{\beta+1-\left[\gamma\left(\frac{1}{az_h}\right)^{\frac{-a}{1-a}} + (1-\gamma)\left(\frac{1}{az_l}\right)^{\frac{-a}{1-a}}\right]^{-1}\left[(1-\gamma)\left(\frac{1-a}{(az_l)^{\frac{a}{a-1}}}\right) + \gamma\left(\frac{1-a}{(az_h)^{\frac{a}{a-1}}}\right)\right]} + \frac{L - \gamma N f_k - N f}{\beta + R(N)}\right]$$

Now we have to show that there exists a value of N, denoted by N^*, that solves our system of equations. This N^* is the solution of the free entry condition:

$$E\Pi(N^*) = 0$$

Given that for any given N we have that $M(N) \in (0,1)$, we get that $\lim_{N\to\infty} E\Pi(N) = -\infty$ and since $E\Pi(0) > 0$ we have that there exists at least one $N^* > 0$ such that the free entry condition holds.

Uniqueness (Proposition 2) For N^* to be unique it suffices that $R(N)$ increases with N. If $R(N)$ is indeed strictly increasing in N or, equivalently, strictly decreasing in M then the expected profits prior to entry $E\Pi(N)$ will be decreasing in N and therefore N^* will be the unique general equilibrium number of firms. We have that for a sufficiently high productivity gap between large and small firms, large firms charge a lower price which implies that:

$$\left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{\frac{1-a}{a}} < 1$$

We define:

$$F(M) \equiv \left(\frac{\gamma M}{(1-\gamma)(1-M)}\right)^{-\frac{1-a}{a}} > 1$$

$F(M)$ will also be decreasing in M (increasing in N). Using $F(M)$ we re-write $R(N)$ as a function of M,$R(M)$ and show that it is in fact decreasing in M. We have that:

$$R(M) = a\frac{z_l}{z_k}\left(\frac{\gamma}{1-\gamma}\right)^{\frac{a-1}{a}}(1-M)^{\frac{1}{a}}M^{\frac{a-1}{a}} + aM$$

To show that $R(M)$ decreases with M we need to show that the term:

$$\frac{z_l}{z_k}\left(\frac{\gamma}{1-\gamma}\right)^{\frac{a-1}{a}}(1-M)^{\frac{1}{a}}M^{\frac{a-1}{a}}$$

is decreasing in M and at a rate which is higher than 1. We show that the first term is indeed decreasing since:

$$\frac{\partial \bar{R}(M)}{\partial M} = -\frac{z_l}{z_k}F(M)\left(\frac{1-a}{a}M^{-1}+1\right) < 0$$

From the comparison of the large and the small firm markup we have that $\frac{z_l}{z_k}F(M) < 1$. Therefore, we can guarantee uniqueness for the parameter values for which the term inside the brackets is above 1 so that:

$$\frac{z_l}{z_k}F(M)\left(\frac{1-a}{a}M^{-1}+1\right) > 1$$

This is true for sufficiently low levels of a and γ.

Subgame perfection (Proposition 3) By construction we select the cost of innovation so that $f_k \in (\pi_{y1}(z_l), \pi_{y1}(z_h))$. Since the innovation decision must be made before the second period production and given that there is no borrowing in the model, the low-productivity firms will be credit constrained and therefore unable to invest. As a result all z_l-productivity firms will compete monopolistically in the second period and their efficiency will be pinned down by their initial productivity z_l. Having constrained the behaviour of inefficient firms, we go on to show under which conditions all z_h-productivity firms will choose to innovate and behave as Cournot oligopolists, resulting in the endogenous emergence of mixed market competition. The game we are considering is the following: in the first stage high-productivity firms choose whether to innovate and become Cournot oligopolists or not innovate and compete monopolistically. Given their decision, in the second stage firms choose their output simultaneously. Solving backwards, we start with the second stage and consider a generic partition of the high-productivity firms in which a percentage $g \in [0,1]$ of these firms act as Cournot oligopolists considering the effect of their choice on the market aggregates whereas a percentage $(1-g)$ of these firms choose to neglect their impact. We define ε, ϱ and η to be the expenditure, aggregate price index and total production of the differentiated good under this partition. We show that there is no

SPNE where $g \in (0,1)$. Under this partition, we have that the total production of the differentiated industry equals to:

$$\eta = (Ng\gamma x^{\alpha} + N(1-g)\gamma y_h^a + N(1-\gamma)y_l^a)^{\frac{1}{a}}$$

where x is the production of z_k-productivity Cournot oligopolists, y_h is the production of z_h-productivity monopolistic competitors and y_l is the production of z_l-productivity monopolistic competitors. As a result, the inverse demand function faced by each firm can be expressed as:

$$p = q^{a-1}\eta^{1-a}\varrho$$

We assume symmetry across the $g\gamma N$ high-productivity firms that act as Cournot oligopolists and across the $(1-g)\gamma N$ high-productivity firms that act as monopolistic competitors and fixed N. The optimal decisions for each type of firms are presented below.

High-productivity MC firms The maximisation problem of z_h-productivity monopolistic competitors is the following:

$$\max_{y_h} \left\{ \pi_{yh} = p_{yh}y_h - \frac{1}{z_h}y_h - f \right\}$$
$$\text{s.t. } p_{yh} = y_h^{a-1}\eta^{1-a}\varrho$$

where p_{yh} is the price of high-productivity monopolistic competitors and π_{yh} is their profit. The f.o.c. yields:

$$y_h = \left(\frac{1}{az_h}\right)^{\frac{-1}{1-a}} \varepsilon\varrho^{\frac{a}{1-a}}$$

which implies the following maximised profit for this type of firms:

$$\pi_{yh}(g\gamma N, N) = \left(\frac{1}{az_h}\right)^{\frac{a}{a-1}} (1-a)\varepsilon\varrho^{\frac{a}{1-a}} - f \tag{1}$$

Low-productivity MC firms The maximisation problem of z_l-productivity monopolistic competitors is the following:

$$\max_{y_l} \left\{ \pi_{yl} = p_{yl} y_l - \frac{1}{z_l} y_l - f \right\}$$

$$\text{s.t. } p_{yl} = y_l^{a-1} \eta^{1-a} \varrho$$

where p_{yl} and π_{yl} is, respectively, the price and the profit of a low-productivity monopolistic competitor. The f.o.c. yields:

$$y_l = \left(\frac{1}{a z_l} \right)^{\frac{-1}{1-a}} \varepsilon \varrho^{\frac{a}{1-a}}$$

which implies the following maximised profit for this type of firms:

$$\pi_{yl}(g\gamma N, N) = \left(\frac{1}{a z_l} \right)^{\frac{a}{a-1}} (1-a) \varepsilon \varrho^{\frac{a}{1-a}} - f$$

CO firms The maximisation problem of z_k-productivity Cournot oligopolists is the following:

$$\max_{x} \left\{ \pi_x = p_x x - \frac{1}{z_k} x - f - f_k \right\}$$

$$\text{s.t. } p_x = x^{a-1} \eta^{1-a} \varrho$$

where p_x is the oligopolistic price and π_x is the oligopolistic profit. The f.o.c. yields:

$$\frac{\partial \pi_x}{\partial x} = \frac{a \sum_{j \neq i} x_j^a}{x^{1-a} \left(x^a + \sum_{j \neq i} x_j^a \right)^2} \varepsilon - \frac{1}{z_k} = 0$$

where the sum $\sum_{j \neq i} x_j^a$ contains the output of all other oligopolists and all monopolistic competitors, regardless of their productivity. Given the symmetry assumption we can substitute $\sum_{j \neq i} x_j^a = \eta^a - x^a$ and using $\eta = \varepsilon \varrho^{-1}$ we get:

$$\varepsilon^{1-a} = \frac{1}{a z_k} \varrho^{-a} (x)^{1-a} + \varepsilon^{1-2a} \varrho^a x^a$$

From the definition of the aggregate price index we get that:

$$x = \varepsilon \varrho^{-1} \left[\frac{1-S}{g\gamma N} \right]^{\frac{1}{a}}$$

where:

$$S \equiv (az_h\varrho)^{\frac{a}{1-a}} N\gamma(1-g) - (az_l\varrho)^{\frac{a}{1-a}} N(1-\gamma)$$

Using the above expression for x we can express the oligopolistic profit as follows:

$$\pi_x(g\gamma N, N) = \left[\frac{1-S}{g\gamma N} - \frac{1}{z_k} \varrho^{-1} \left(\frac{1-S}{g\gamma N} \right)^{\frac{1}{a}} \right] \varepsilon - f - f_k \tag{2}$$

Conditions for mixed market equilibrium Having computed the second-stage profit we move to the first stage where high-productivity firms simultaneously decide to innovate or not. Given a total number N of firms and $(1-\gamma)N$ of these firms having low productivity and behaving as monopolistic competitors there exists a SPNE partition $\{g\gamma N, (1-g)\gamma N\}$ in which $g\gamma N$ high-productivity Cournot oligopolists co-exist with $(1-g)\gamma N$ high-productivity monopolistic competitors iff:

1. No high-productivity monopolistic competitor has a unilateral incentive to deviate and become a Cournot oligopolist because:

$$\pi_x(g\gamma N + 1, N) - \pi_{yh}(g\gamma N, N) < 0 \tag{3}$$

2. And no Cournot oligopolist has a unilateral incentive to deviate and become a high-productivity monopolistic competitor because

$$\pi_{yh}(g\gamma N - 1, N) - \pi_x(g\gamma N, N) < 0 \tag{4}$$

There is no SPNE in pure strategies in which some high-productivity firms incorporate the aggregate impact of their behaviour while others do not ($g \in (0,1)$). The proof follows Cellini et al. (2015) under the generalisation for non-linear functions as long as $\partial p_i(q_i, Q)/\partial q_i < 0$ and $\partial p_i(q_i, Q)/\partial Q < 0$ where Q is the total production, under Aggarwal and Samwick (1999). Consider any given partition $\{g\gamma N, (1-g)\gamma N\}$ with $g \in (0,1)$. Given the expressions for maximised profits (20) and (21), assuming that conditions (22) and (23) are simultaneously satisfied leads to a contradiction and, hence, either a high-productivity monopolistic competitor or a Cournot oligopolist has a unilateral incentive to deviate from $\{g\gamma N, (1-g)\gamma N\}$. Now consider the partition $\{g\gamma N, (1-g)\gamma N\} = \{\gamma N, 0\}$ in which all high productivity firms compete as Cournot oligopolists. We refer to this as the mixed market competition outcome, as opposed to $\{g\gamma N, (1-g)\gamma N\} = \{0, \gamma N\}$ which is the pure monopolistically competitive outcome. Unilateral deviation from mixed market competition is not profitable iff the profit of a single z_h-productivity monopolistic competitor is lower than any z_k-productivity firm's profit when all high productivity firms have chosen to act as oligopolists with productivity z_k. Formally:

$$\pi_{yh} - \pi_x < 0$$

which is equivalent to:

$$E\left[\frac{1-M(N)}{\gamma N} - \frac{1}{z_k}P^{-1}\left(\frac{1-M(N)}{\gamma N}\right)^{\frac{1}{a}} - (az_hP)^{\frac{a}{1-a}}(1-a)\right] > f_k \qquad (5)$$

where P is the aggregate price index and E is the expenditure on the differentiated good. This is more likely to happen when the cost of innovation f_k is higher and the productivity increase due to the innovation (from z_h to z_k) is larger. Notice, however that (5) can hold even when $z_h = z_k$ as long as f_k, γ and a are sufficiently

low.

6.2 Appendix for Section 4

Selection effect of trade To show: $\frac{\partial z^*_{\omega m}}{\partial \tau} < 0$

We get that, by the implicit function theorem and setting $\rho = \tau^{-k}$:

$$\frac{\partial \left(\frac{1}{z^*_{\omega m}}\right)}{\partial \rho} = -\frac{\frac{\partial \Phi_{ST}}{\partial \rho}}{\frac{\partial \Phi_{ST}}{\partial \left(\frac{1}{z^*_{\omega m}}\right)}} < 0$$

because:

$$\frac{\partial \Phi_{ST}}{\partial \rho} = (\zeta_{\omega m})^{k+1} \left(\phi_1 \zeta_{\omega m} + \phi_2 \sqrt{\widehat{\lambda}_{Xm}}\right) > 0$$

and:

$$\frac{\partial \Phi_{ST}}{\partial \left(\frac{1}{z^*_{\omega m}}\right)} = \left(\frac{1}{z^*_{\omega m}}\right)^k \left[\phi_1 (k+2) \left(\frac{1}{z^*_{\omega m}}\right) + \phi_2 (k+1) \sqrt{\widehat{\lambda}_m}\right] + \rho (\zeta_{\omega m})^k \left[\phi_1 (k+2) \zeta_{\omega m} + \phi_2 (k+1) \sqrt{\widehat{\lambda}_{Xm}}\right] > 0$$

Thus $\frac{\partial z^*_{\omega m}}{\partial \tau} < 0$.

Financial frictions and the selection effect of trade To show: $\frac{\partial^2 z^*_{\omega m}}{\partial \tau \partial \widehat{\lambda}_m} < 0$

We get that, by the implicit function theorem and setting $\rho = \tau^{-k}$:

$$\frac{\partial^2 \left(\frac{1}{z^*_{\omega m}}\right)}{\partial \rho \partial \widehat{\lambda}_m} = -\left(\frac{\frac{\partial^2 \Phi_{ST}}{\partial \rho \partial \widehat{\lambda}_m} \frac{\partial \Phi_{ST}}{\partial \left(\frac{1}{z^*_{\omega m}}\right)} - \frac{\partial^2 \Phi_{ST}}{\partial \left(\frac{1}{z^*_{\omega m}}\right) \partial \widehat{\lambda}_m} \frac{\partial \Phi_{ST}}{\partial \rho}}{\left(\frac{\partial \Phi_{ST}}{\partial \left(\frac{1}{z^*_{\omega m}}\right)}\right)^2}\right) < 0$$

because:

$$\frac{\partial^2\Phi_{ST}}{\partial\rho\partial\widehat{\lambda}_m}\frac{\partial\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)} = 2\sqrt{\beta}\left(\zeta_{\omega m}\right)^k\left[\phi_1\left(k+2\right)\zeta_{\omega m}+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_{Xm}}\right]$$
$$\left\{\left(\frac{1}{z^*_{\omega m}}\right)^k\left[\phi_1\left(k+2\right)\left(\frac{1}{z^*_{\omega m}}\right)+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_m}\right]\right.$$
$$\left.+\rho\left(\zeta_{\omega m}\right)^k\left[\phi_1\left(k+2\right)\zeta_{\omega m}+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_{Xm}}\right]\right\}$$

$$\frac{\partial^2\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)\partial\widehat{\lambda}_m}\frac{\partial\Phi_{ST}}{\partial\rho} = \left(k+1\right)+$$
$$\left\{\phi_2\left(\frac{1}{z^*_{\omega m}}\right)^k+2\sqrt{\beta}\rho\left(\zeta_{\omega m}\right)^{k-1}\left[\phi_1\left(k+2\right)\zeta_{\omega m}+\phi_2 k\sqrt{\widehat{\lambda}_{Xm}}\right]\right\}$$
$$\left(\zeta_{\omega m}\right)^{k+1}\left(\phi_1\zeta_{\omega m}+\phi_2\sqrt{\widehat{\lambda}_{Xm}}\right)$$

We rewrite as follows:

$$\frac{\partial^2\Phi_{ST}}{\partial\rho\partial\widehat{\lambda}_m}\frac{\partial\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)}-\frac{\partial^2\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)\partial\widehat{\lambda}_m}\frac{\partial\Phi_{ST}}{\partial\rho} = \Gamma+\Delta>0$$

because:

$$\Gamma = 2\sqrt{\beta}\rho\left(\zeta_{\omega m}\right)^k\left\{\begin{array}{c}\left[\phi_1\left(k+2\right)\zeta_{\omega m}+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_{Xm}}\right]^2\\-\left[\phi_1\left(k+2\right)\zeta_{\omega m}+\phi_2 k\sqrt{\widehat{\lambda}_{Xm}}\right]\\\left[\phi_1\left(k+1\right)\zeta_{\omega m}+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_{Xm}}\right]\end{array}\right\}>0$$

and:

$$\Delta = \left(\frac{1}{z^*_{\omega m}}\zeta_{\omega m}\right)^k\left\{\begin{array}{c}2\sqrt{\beta}\left[\phi_1\left(k+2\right)\zeta_{\omega m}+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_{Xm}}\right]\\\left[\phi_1\left(k+2\right)\left(\frac{1}{z^*_{\omega m}}\right)+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_m}\right]\\-\phi_2\zeta_{\omega m}\left[\phi_1\left(k+1\right)\zeta_{\omega m}+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_{Xm}}\right]\end{array}\right\}$$

and since:

$$\phi_1\left(k+2\right)\zeta_{\omega m}+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_{Xm}}>\phi_1\left(k+1\right)\zeta_{\omega m}+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_{Xm}}$$

we get that:

$$\Delta > 0$$

if it holds that:

$$2\sqrt{\beta}\left[\phi_1\left(k+2\right)\left(\frac{1}{z^*_{\omega m}}\right)+\phi_2\left(k+1\right)\sqrt{\widehat{\lambda}_m}\right] > \phi_2\zeta_{\omega m}$$

which is true by the definitions of ϕ_1 and ϕ_2. Thus $\frac{\partial^2 z^*_{\omega m}}{\partial\tau\partial\widehat{\lambda}_m} < 0$.

Entry cost and the selection effect of trade To show that: $\frac{\partial^2 z^*_{\omega m}}{\partial\tau\partial f_E} < 0$

We can express $\frac{\partial\left(\frac{1}{z^*_{\omega m}}\right)}{\partial\rho}$ as follows, using the free entry condition:

$$\frac{\partial\left(\frac{1}{z^*_{\omega m}}\right)}{\partial\rho} = -\frac{\frac{\partial\Phi_{ST}}{\partial\rho}}{\frac{\partial\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)}} = -\frac{f_E-\left(\phi_1\left(\frac{1}{z^*_{\omega m}}\right)^{k+2}+\phi_2\sqrt{\widehat{\lambda}_m}\left(\frac{1}{z^*_{\omega m}}\right)^{k+1}\right)}{\left(\frac{1}{z^*_{\omega m}}\right)^{k}\left[\phi_1(k+2)\left(\frac{1}{z^*_{\omega m}}\right)+\phi_2(k+1)\sqrt{\widehat{\lambda}_m}\right]+\rho(\zeta_{\omega m})^{k}\left[\phi_1(k+2)\zeta_{\omega m}+\phi_2(k+1)\sqrt{\widehat{\lambda}_{Xm}}\right]}$$

and:

$$\frac{\partial^2\left(\frac{1}{z^*_{\omega m}}\right)}{\partial\rho\partial f_E} = -\left(\frac{\frac{\partial^2\Phi_{ST}}{\partial\rho\partial f_E}\frac{\partial\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)}-\frac{\partial^2\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)\partial f_E}\frac{\partial\Phi_{ST}}{\partial\rho}}{\left(\frac{\partial\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)}\right)^2}\right) < 0$$

where:

$$\frac{\partial^2\Phi_{ST}}{\partial\rho\partial f_E} = 1$$

$$\frac{\partial^2\Phi_{ST}}{\partial\left(\frac{1}{z^*_{\omega m}}\right)\partial f_E} = 0$$

Thus $\frac{\partial^2 z^*_{\omega m}}{\partial\tau\partial f_E} < 0$.

Equilibrium mass of MC firms We specify the equilibrium conditions that give the mass of MC firms operating per product line.

Symmetric trade The equilibrium mass of MC firms solves the following version of the free entry condition:

$$\int_{(z^*_{\omega m})^H}^{\infty} \left[\frac{1}{4\beta\left(1+2\widetilde{M}\right)^2} \left(\alpha - \left(1 + \widetilde{M}\left(1-\tau\right)\right) \frac{1}{z_\omega} \right)^2 - \widehat{\lambda}_m \right] dG\left(z_\omega\right) + \int_{(z^*_{\omega m})^H_X}^{\infty} \left[\frac{1}{4\beta\left(1+2\widetilde{M}\right)^2} \left(\alpha - \left(\tau + \widetilde{M}\left(1-\tau\right)\right) \frac{1}{z_\omega} \right)^2 - \widehat{\lambda}_{Xm} \right] dG\left(z_\omega\right) - f_E = 0$$

where $\widetilde{M} = \gamma\left(\frac{M}{2\beta} + \frac{N}{2\beta+\gamma}\right)$. This is the free entry condition (35) using (16), (31) and the definition of the aggregate output in open economy $X_\omega = \sum_{n=1}^{N_\omega} x_{\omega n} + \int_0^{M_\omega} x_{\omega m} dm + \int_0^{M_\omega} \left(x_{\omega m}\right)_X dm + \int_0^{N_\omega} \left(x_n\right)_X dn$ where $\left(x_{\omega j}\right)_X$ represents the exported output from type-j firms.

Asymmetric trade The equilibrium mass of MC firms in countries H and F solve the following system of the two free entry conditions. The free entry condition (46) in H can be rewritten as:

$$\int_{(z^*_{\omega m})^H}^{\infty} \left[\frac{1}{4\beta\left(1+\widetilde{M}^H+\widetilde{M}^F\right)^2} \left(\alpha - \left(1 + \widetilde{M}^F\left(1-\tau\right)\right) \frac{1}{z_\omega} \right)^2 - \widehat{\lambda}^H_m \right] dG\left(z_\omega\right) + \int_{(z^*_{\omega m})^H_X}^{\infty} \left[\frac{1}{4\beta\left(1+\widetilde{M}^H+\widetilde{M}^F\right)^2} \left(\alpha - \left(\tau + \widetilde{M}^F\left(\tau-1\right)\right) \frac{1}{z_\omega} \right)^2 - \widehat{\lambda}^H_{Xm} \right] dG\left(z_\omega\right) - f_E = 0$$

Under Assumption 3 there are only two possible scenaria for calculating the free entry condition (47) in F. Either the cross country differences in financial constraints are more severe than cross firm differences in which case $\left(z^*_{\omega m}\right)^F < \left(z^*_{\omega n}\right)^H$ or the opposite. We focus only on the first case which is the empirically relevant one. $\left(z^*_{\omega m}\right)^F < \left(z^*_{\omega n}\right)^H$ is equivalent to:

$$\frac{\tau}{\left(z^*_{\omega m}\right)^H_X} + 2\sqrt{\beta}\left(\sqrt{\widehat{\lambda}^H_{Xm}} - \sqrt{\widehat{\lambda}^F_m}\right) > \frac{1}{\left(z^*_{\omega m}\right)^H} + 2\sqrt{\beta\widehat{\lambda}^H_m} - \left(2\beta+\gamma\right)\sqrt{\frac{\widehat{\lambda}^H_n}{\beta+\gamma}}$$

We have that, using the Assumption 1, for fixed N it holds that:

$$(z^*_{\omega n})^F = \left(\alpha - [2\beta + \gamma(1+N)]\sqrt{\frac{\widehat{\lambda}^F_n}{\beta+\gamma}}\right)^{-1}$$

and hence, using (43) we get that when cutoff productivities are in the following interval:

$$\left[1, \left(\alpha - \gamma N\sqrt{\frac{\widehat{\lambda}^F_n}{\beta+\gamma}} - 2\sqrt{\beta}\left(\widehat{\lambda}^F_m + \widehat{\lambda}^H_m\right) + (2\beta+\gamma)\sqrt{\frac{\widehat{\lambda}^H_n}{\beta+\gamma}}\right)^{-1}\right]$$

the free entry condition (47) in F can be rewritten as:

$$\int_{(z^*_{\omega m})^F}^{\infty}\left[\frac{1}{4\beta\left(1+2\widetilde{M}^F\right)^2}\left(\alpha - \left(1+\widetilde{M}^F(1-\tau)\right)\frac{1}{z_\omega}\right)^2 - \widehat{\lambda}^F_m\right]dG(z_\omega) +$$
$$\int_{(z^*_{\omega m})^F_X}^{\infty}\left[\frac{1}{4\beta\left(1+2\widetilde{M}^F\right)^2}\left(\alpha - \left(\tau+\widetilde{M}^F(1-\tau)\right)\frac{1}{z_\omega}\right)^2 - \widehat{\lambda}^H_{Xm}\right]dG(z_\omega) - f_E = 0$$

where $\widetilde{M}^H = \gamma\left(\frac{M^H}{2\beta} + \frac{N}{2\beta+\gamma}\right)$ and $\widetilde{M}^F = \gamma\left(\frac{M^F}{2\beta} + \frac{N}{2\beta+\gamma}\right)$ and using (38), (40) the definitions:

$$(z^*_{\omega m})^F = \left(\alpha - \gamma X^F_\omega - 2\sqrt{\beta\widehat{\lambda}^F_m}\right)^{-1}$$

and:

$$(z^*_{\omega m})^F_X = \tau\left(\alpha - \gamma X^H_\omega - 2\sqrt{\beta\widehat{\lambda}^F_{Xm}}\right)^{-1}$$

as well as the definition of the aggregate output in each country.

Labour market clearing To close the model, we need to add the labour market clearing condition which pins down the optimal consumption of the homogeneous good in each country which must be positive. We present the symmetric case and the asymmetric case is defined accordingly.

$$\Omega_n N \int_{z^*_{\omega n}}^{\infty} \left[\frac{1}{(2\beta+\gamma)z_\omega} \left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega} \right) + \widehat{\lambda}_n + f_E \right] dG\left(z_\omega\right) +$$
$$\Omega_{Xn} N \int_{(z^*_{\omega n})_X}^{\infty} \left[\frac{1}{(2\beta+\gamma)z_\omega} \left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{\tau}{z_\omega} \right) + \widehat{\lambda}_{Xn} \right] dG\left(z_\omega\right)$$
$$\Omega_m M \int_{z^*_{\omega m}}^{\infty} \left[\frac{1}{2\beta z_\omega} \left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{1}{z_\omega} \right) + \widehat{\lambda}_m + f_E \right] dG\left(z_\omega\right)$$
$$\Omega_{Xm} M \int_{(z^*_{\omega m})_X}^{\infty} \left[\frac{1}{2\beta z_\omega} \left(2\sqrt{\beta\widehat{\lambda}_m} + \frac{1}{z^*_{\omega m}} - \frac{\tau}{z_\omega} \right) + \widehat{\lambda}_{Xm} \right] dG\left(z_\omega\right) + A = 1$$

References

Aggarwal, R. K. and A. A. Samwick (1999). Executive compensation, strategic competition, and relative performance evaluation: Theory and evidence. *The Journal of Finance 54*(6).

Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt (2005). Competition and innovation: An inverted-u relationship. *The Quarterly Journal of Economics 120*(2), 701–728.

Amiti, M., O. Itskhoki, and J. Konings (2016). International shocks and domestic prices: how large are strategic complementarities? Technical report, National Bureau of Economic Research.

Anderson, S. P., A. De Palma, and J. F. Thisse (1992). *Discrete choice theory of product differentiation*. MIT press.

Arkolakis, C., A. Costinot, D. Donaldson, and A. Rodríguez-Clare (2015). The elusive pro-competitive effects of trade. Technical report, National Bureau of Economic Research.

Atkeson, A. and A. Burstein (2008). Pricing-to-market, trade costs, and international relative prices. *The American Economic Review 98*(5), 1998–2031.

Autor, D., D. Dorn, L. F. Katz, C. Patterson, J. Van Reenen, et al. (2017). The fall of the labor share and the rise of superstar firms. Technical report, National Bureau of Economic Research, Inc.

Baccini, L., G. Impullitti, and E. J. Malesky (2017). Globalization and state capitalism: Assessing vietnam's accession to the wto.

Barkai, S. (2016). Declining labor and capital shares. *Stigler Center for the Study of the Economy and the State New Working Paper Series* (2).

Beck, T. and A. Demirguc-Kunt (2006). Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance 30*(11), 2931–2943.

Beck, T., A. Demirguc-Kunt, V. Maksimovic, et al. (2005). Financial and legal constraints to growth: Does firm size matter? *Journal of Finance 60*(1), 137–177.

Bekaert, G. and C. R. Harvey (1995). Time-varying world market integration. *The Journal of Finance 50*(2), 403–444.

Bekaert, G., C. R. Harvey, C. T. Lundblad, and S. Siegel (2011). What segments equity markets? *The Review of Financial Studies 24*(12), 3841–3890.

Bekkers, E. and J. Francois (2013). Trade and industrial structure with large firms and heterogeneity. *European Economic Review 60*, 69–90.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2007). Firms in international trade. *The Journal of Economic Perspectives 21*(3), 105–130.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2016). Global firms.

Bernard, A. B., J. B. Jensen, and P. K. Schott (2009). Importers, exporters and multinationals: a portrait of firms in the us that trade goods. In *Producer dynamics: New evidence from micro data*, pp. 513–552. University of Chicago Press.

Bertoletti, P. and P. Epifani (2014). Monopolistic competition: Ces redux? *Journal of International Economics 93*(2), 227–238.

Bombardini, M. (2008). Firm heterogeneity and lobby participation. *Journal of International Economics 75*(2), 329–348.

Bonfiglioli, A., R. Crinò, and G. Gancia (2016). Trade, finance and endogenous firm heterogeneity. Technical report, CEPR Discussion Papers.

Brander, J. and P. Krugman (1983). A reciprocal dumping model of international trade. *Journal of international economics 15*(3), 313–321.

Broda, C. and D. E. Weinstein (2006). Globalization and the gains from variety. *The Quarterly journal of economics 121*(2), 541–585.

Cellini, R., L. Lambertini, and G. I. Ottaviano (2015). To know or not to know: Endogenous market structure when information can be strategically neglected.

Chaney, T. (2016). Liquidity constrained exporters. *Journal of Economic Dynamics and Control 72*, 141–154.

Cleary, S. (2006). International corporate investment and the relationships between financial constraint measures. *Journal of Banking & Finance 30*(5), 1559–1580.

De Loecker, J. and P. K. Goldberg (2014). Firm performance in a global market. *Annu. Rev. Econ. 6*(1), 201–227.

De Loecker, J., P. K. Goldberg, A. K. Khandelwal, and N. Pavcnik (2016). Prices, markups, and trade reform. *Econometrica 84*(2), 445–510.

De Loecker, J. and J. Van Biesebroeck (2016). Effect of international competition on firm productivity and market power. Technical report, National Bureau of Economic Research.

De Loecker, J. and F. Warzynski (2012). Markups and firm-level export status. *The American Economic Review 102*(6), 2437–2471.

Dixit, A. K. and J. E. Stiglitz (1977). Monopolistic competition and optimum product diversity. *The American Economic Review 67*(3), 297–308.

Eckel, C. and S. R. Yeaple (2015). Is bigger better? multi-product firms, labor market imperfections, and international trade.

Edmond, C., V. Midrigan, and D. Y. Xu (2015). Competition, markups, and the gains from international trade. *The American Economic Review 105*(10), 3183–3221.

Epifani, P. and G. Gancia (2011). Trade, markup heterogeneity and misallocations. *Journal of International Economics 83*(1), 1–13.

Feenstra, R. C. and D. E. Weinstein (2010). *Globalization, markups, and the US price level*. Number w15749. National Bureau of Economic Research.

Felbermayr, G., G. Impullitti, and J. Prat (2015). Firm dynamics and residual inequality in open economies.

Foley, C. F. and K. Manova (2015). International trade, multinational activity, and corporate finance. *Annual Review of Economics 7*(1), 119–146.

Freund, C. and M. D. Pierola (2015). Export superstars. *Review of Economics and Statistics 97*(5), 1023–1032.

Friedman, J. W. (1977). *Oligopoly and the Theory of Games*, Volume 8. North-Holland.

Goldberg, P. K. and R. Hellerstein (2013). A structural approach to identifying the sources of local currency price stability. *The Review of Economic Studies 80*(1), 175–210.

Goldberg, P. K. and F. Verboven (2005). Market integration and convergence to the law of one price: evidence from the european car market. *Journal of international Economics 65*(1), 49–73.

Guner, N., G. Ventura, and Y. Xu (2008). Macroeconomic implications of size-dependent policies. *Review of Economic Dynamics 11*(4), 721–744.

Head, K. and B. J. Spencer (2017). Oligopoly in international trade: Rise, fall and resurgence. Technical report, National Bureau of Economic Research.

Henderson, B. J., N. Jegadeesh, and M. S. Weisbach (2006). World markets for raising new capital. *Journal of Financial Economics 82*(1), 63–101.

Hottman, C., S. J. Redding, and D. E. Weinstein (2016). Quantifying the sources of firm heterogeneity. *The Quarterly Journal of Economics*.

Igami, M. (2015). Industry dynamics of offshoring: The case of hard disk drives. *Available at SSRN 1726910*.

Impullitti, G. and O. Licandro (2016). Trade, firm selection, and innovation: the competition channel. *Economic Journal*.

Kokovin, S., M. Parenti, J.-F. Thisse, and E. Zhelobodko (2011). Monopolistic competition with big firms. Technical report, mimeo.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review 70*(5), 950–959.

Manova, K. (2013). Credit constraints, heterogeneous firms, and international trade. *Review of Economic Studies 80*(2), 711–744.

Mayer, T., M. J. Melitz, and G. Ottaviano (2016). Product mix and firm productivity responses to trade competition.

Mayer, T., M. J. Melitz, and G. I. Ottaviano (2014). Market size, competition, and the product mix of exporters. *The American Economic Review 104*(2), 495–536.

Mayer, T. and G. I. Ottaviano (2008). The happy few: the internationalisation of european firms. *Intereconomics 43*(3), 135–148.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica 71*(6), 1695–1725.

Melitz, M. J. and G. I. Ottaviano (2008). Market size, trade, and productivity. *The review of economic studies 75*(1), 295–316.

Melitz, M. J. and S. J. Redding (2014). Heterogeneous firms and trade. *Handbook of International Economics 4*, 1–54.

Neary, J. P. (2003). Globalization and market structure. *Journal of the European Economic Association 1*(2-3), 245–271.

Neary, J. P. (2010). Two and a half theories of trade. *The World Economy 33*(1), 1–19.

Neary, J. P. (2016). International trade in general oligopolistic equilibrium. *Review of International Economics 24*(4), 669–698.

Pan, L. and M. Hanazono (2015). Competition among the big and the small with different product substitution.

Parenti, M. (2017). Large and small firms in a global market: David vs. goliath. *Journal of International Economics*.

Peters, M. (2013). Heterogeneous mark-ups, growth and endogenous misallocation.

Rauch, J. E. (1999). Networks versus markets in international trade. *Journal of international Economics 48*(1), 7–35.

Restuccia, D. and R. Rogerson (2008). Policy distortions and aggregate productivity with heterogeneous establishments. *Review of Economic dynamics 11*(4), 707–720.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy 98*(5 pt 2).

Rosen, S. (1981). The economics of superstars. *The American economic review 71*(5), 845–858.

Segarra, A. and M. Teruel Carrizosa (2009). Small firms, growth and financial constraints. Technical report, Xarxa de Referència en Economia Aplicada (XREAP).

Shimomura, K.-I. and J.-F. Thisse (2012). Competition among the big and the small. *The Rand Journal of Economics 43*(2), 329–347.

Stiglitz, J. E. and B. C. Greenwald (2014). *Creating a learning society: A new approach to growth, development, and social progress*. Columbia University Press.

Tamminen, S. and H.-H. Chang (2013). Firm and sectoral heterogeneity in markup variability. *The Journal of International Trade & Economic Development 22*(1), 157–178.

Wooldridge, A. (2016). In the shadow of giants. a special report on the world's most powpower companies. *The Economist September 17th*.

Yang, X. and B. J. Heijdra (1993). Monopolistic competition and optimum product diversity: Comment. *The American Economic Review 83*(1), 295–301.