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Two Margins of Informality

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*A mi Father,
que dió la primera mitad de su vida a la lucha por los derechos de los trabajadores
y la segunda mitad, a mi mamá y a mí.
(1938-2019)*

Abstract

The ILO (2018) report shows that more than 61 per cent of the world's employed population work informally, most of them in emerging and developing countries. The majority lack social protection, rights at work, and decent working conditions. The ILO emphasizes that a transition to a formal economy is a condition to realize decent working conditions for all. Despite its importance, informality still lacks a universal definition. Throughout this thesis, I consider two margins of informality. The *extensive margin*, where firms do not register their business; and the *intensive margin*, where legally established firms do not pay mandatory contributions such as retirement and health insurance on behalf of their workers.

In the first chapter, I confirm that both informal workers and women receive lower wages than their formal and male counterparts. Most importantly, I find that the informality wage penalty is stronger for extensive-informal workers. Moreover, the gender wage gap is substantially bigger when women are employed in the extensive margin of informality. I also conduct a descriptive study on workers' individual characteristics that motivate them to accept a job in either of the margins of informality. I find that demographic characteristics such as age, civil status, education and geographic location are significantly different for each margin of informality.

In the second chapter, I study the effect of exposure to trade on informality and find that the effect is different on each margin. It goes in opposite directions. On the one hand, stricter import competition triggers a decline in the extensive

margin of informal employment as unregistered firms shrink or exit the market because they are not productive enough to survive. On the other hand, intensive-informal employment rises as registered firms reduce marginal costs by hiring informal workers. Furthermore, results show that the intensive margin drives the overall effect. Thus, exposure to trade increases informality.

In the third chapter, I develop a theoretical framework that models firm's decision. Specifically, firms choose to be informal (or not) in either of the margins. They do so taking into account that there is a risk of detection and that they might also be penalized by the tax collection agency. Adding these features to a Melitz (2003) type model provides a better understanding of the firms' choice on informality found in the second chapter. The least productive firms choose to operate as unregistered firms while the most productive registered firms allocate a substantial proportion of their labour to formal workers. Furthermore, I find that when the economy faces an increase in import competition, registered firms reallocate labour towards informal employment as a mean to reduce costs. At the same time, when the least productive unregistered firms face tougher competition coming from abroad, they exit the market. Thus, the effect of trade on informal labour is ambiguous as informal labour grows in registered firms and shrinks in unregistered ones. In this chapter, I study under what conditions the effect of the intensive margin of informality dominates as the empirical results suggest.

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Introduction

As Kanbur (2009) points out, informality can be described as a “conceptual incoherence” since the literature has not reach consensus regarding its definition. However, in the 17th International Conference of Labour Statistics organized by the International Labour Organization (ILO) informality was defined as the sum of employment in unregistered firms and the portion of employment in registered firms that does not comply with labour legislation. In this way, ILO acknowledges the existence of two types of informal worker. Surprisingly this distinction has been mostly overlooked by the literature. This thesis presents three chapters where I elaborate on these two dimensions of informality. I show that, even though, informality is understudied in this manner, these dimensions are prevalent and sizeable. More importantly, I find that trade liberalisation affects informal labour in different ways contingent on the margin of informality.

Following Ulyssea (2018), I distinguish two margins of informality. The *extensive margin* where firms decide to not register with the tax collection agency and the *intensive margin* where registered firms keep a portion of their workers “off the books”. Chapters 1 and 2 study informal labour in the context of Peru. I focus on the manufacturing sector between 2007 and 2014. I find that the extensive margin of informality fell from 59 to 48 per cent of total employment during the period the period of analysis while the intensive margin raised between 20 and 22 per cent of total employment . In this way, informal manufacturing-employment in Peru accounts for 70-80 per cent of total labour force between 2007 and 2014.

Throughout this thesis I study the informal sector in Peru. While the first two chapters conduct an empirically analysis, the third chapter takes a theoretical approach. Nevertheless, all chapters complement each other. In chapter 1, I study how the gender wage gap is affected by informality and focus on each margin separately. In chapter 2, the focal point shifts to the effect of openness to trade on informal employment. Finally, in chapter 3, via a theoretical model, I study how firms react in each margin of informality to policy changes.

In chapter 1, I analyse the informal worker as an individual and examine the effect of informality on its income. First, I study the demographic characteristics of both types of informal worker. I focus on understanding how different individuals select into each margin. Importantly, I find that gender is key to understand what drives a worker to accept an informal job. Second, I evaluate how the gender wage gap changes is affected by informality. Results suggest that informal workers pay a more substantial wage penalty when employed in the extensive margin of informality. Furthermore, I find that women employed in this margin are specially taxed. Also, from a descriptive analysis, I find that informal workers in registered firms are actually very similar to formal workers. They tend to be educated middle-age individuals while informal workers in unregistered firms are mostly uneducated, young and poor. Furthermore, I speculate that since married women tend to be secondary earners, they are more willing to accept jobs in extensive informal employment. In line with this explanation, I find that married men are more likely to work formally. Moreover, single men do accept intensive-informal employment, possibly because these jobs are an entry-level requirement before becoming formal.

In chapter 2, I study the interplay between globalisation and informality and uncover the implications of looking at these two margins. The theoretical literature provides different predictions on how each margin of informality would react to trade liberalisation. On the one hand, authors that follow Melitz (2003) approach, argue that the least productive unregistered firms would not survive an increase in

import competition. In this way, informality would drop in the extensive margin. On the other hand, authors such as Piggot and Whalley (2001) and Emran and Stiglitz (2005) show that when taxes increase, formal firms are encouraged to become informal. One might argue that another way of inflicting pressure on firms is by increasing competition from abroad. Hence, it may be the case that registered firms' deal with competition by reallocating labour towards informal and cheaper workers. If so, informality would increase in the intensive margin.

In chapter 3, I provide a theoretical discussion of the mechanisms behind the results found in chapter 2. I develop a partial equilibrium model in the spirit of Melitz (2003) to ask a series of complementary questions. To keep the model as close to what the data shows, I add firms' decision on informality as a trade-off between getting caught and paying a fine, and avoiding paying taxes. Specifically, I add to firms' maximization problem a probability of inspection that is increasing in labour. Thus, the model can mirror the stylized fact that larger firms are more likely to face an audit. Even though this feature embeds complexity in the model, it also brings light on the mechanisms that trigger the empirical results found in chapter 2. Namely, I aim to understand under what conditions firms decide to register and if they do so, how they allocate employment between formal and informal workers. Moreover, I explore exporting firms decisions on informality in these two margins. Finally, I am interested in the effect that changes in policy may have in each margin of informality. For instance, I study the impact of an increase in the probability of inspection, a decrease in fines and an increase in import competition. I find that the least productive firms choose to produce for the domestic market only and operate as unregistered firms. The model also shows that firms in the middle of the productivity distribution register and supply only the domestic market. Lastly, the most productive firms choose to register and to export. The model shows that registered firms' optimal employment choice is to increase their share of formal workers with productivity. The key findings in this chapter are that when trade opens up the extensive margin of informality goes down and

the intensive margin increases when the probability of inspection is increasing in firm size and is different for registered and unregistered firms. In this way, the model explains findings in chapter 2. As unregistered firms require a higher level of productivity to operate, the extensive margin of informality diminishes. On the other hand, all registered firms, whether they operate domestically or also supply the foreign market, reallocate employment towards informal-cheaper workers.

Chapter 1

Informalities-Wage Penalty or Gender Wage Gap?

1.1 Introduction

Since Hart (1973) first coined the concept of “informality”, there has been a great deal of discussion of its causes, consequences and on the most appropriate way to measure it (Chacaltana, 2017). Informality refers to jobs carried out without government’s labour regulations, social protection scheme or government’s taxes structures. It is prominent in developing economies. The informal sector accounts for over 30 per cent of non-agricultural employment in Latin America, 50 per cent in Asia, and 60 per cent in Africa (ILO, 2018).

The International Labour Organisation Resolution concerning decent work in June 2002 called for countries to implement policies aiming to reduce the informal economy. With that goal in mind, in the 17th International Conference of Labour Statistics in 2012, the informal economy was defined as the sum of jobs carried out in unregistered firms and jobs carried out in registered firms but in an employment relationship that does not comply with labour law legislation. In line with this distinction and following Ulyssea (2018), this chapter considers that informality in

labour markets can occur along two margins: The *extensive margin*, where firms do not register their business; and the *intensive margin*, where registered firms do not declare some of their workers.

Informality may have profound implications in the economy in the developing world. First, it hinders governments' ability to collect taxes. Second, it may distort firms' decisions in terms of labour force and size. Third, it might translate into lower income for workers. In this chapter, I focus on the latter and study wage penalty across informality margins in the Peruvian manufacturing sector. Peru is a prominent counterexample of the stylized prediction in development economics that informality will disappear with economic growth (Kanbur, 2017). In 2007, almost 20 per cent of employment in manufacturing refers to "off the books" workers in firms registered to pay taxes and nearly 60 per cent to employees working in firms operating without government consent. Even though these numbers drop by 10 percentage points by 2014, informality remains sizeable in Peru. Despite Peru being among the leaders in Latin America in terms of growth, both margins of informality are still significant.

It is well known in the literature that there is a wage penalty associated with informality (Bargain and Kwenda, 2011; Douglas Marcouiller et al., 1995; Gong et al., 2004). This is particularly true in Peru's manufacturing sector. As I document below, Peruvian informal workers earn up to 6 times less than formal workers. In this chapter, I study whether this feature depends on what type of informality I am looking at. Moreover, I focus on the marginal effect that gender has on wages when hired as an informal worker in either margin. The analysis study the manufacturing sector. Hence, I do not tackle the discussion regarding women's household work and its impact in the gender wage gap.

I focus on worker's demographic characteristics as a potential source of self-selection into the informal sector. I find that results are different for each margin of informality. On the one hand, I find that working in the extensive margin

of informality translates into 75 percentage point (pp) decline in wages with respect to employees in registered firms. On the other hand, results show that intensive-informal workers' wages are 45 pp lower than their formal counterparts. Furthermore, I find that women pay a higher penalty for accepting an informal job. Crucially, if they are employed in the extensive margin of informality their income is significantly lower than if they take an intensive-informal job. Women working in unregistered firms see their wages cut by 104 pp while men see theirs reduced by 54 pp with respect to their same gender counterparts in registered firms. Also, women's wages in the intensive margin of informality reduce by 51 pp while men's wages decline by 38 pp with respect to formally hired employees of the same gender. These results suggest that the informality wage penalty affects women disproportionately. Furthermore, women's income reduction is even more extreme in the extensive margin of informality. I am not aware of another paper looking at the effect of the gender wage gap considering these two margins of informality.

I also present a descriptive analysis of informal workers' profile that provides a deeper understanding of individuals' motivation to accept an informal job. I show the individual characteristics that determine self-selection into informal employment change with each margin of informality. I build an informal worker profile while keeping track of their margin of informality and their gender. A well-accepted stylized fact in the literature is that informal workers are on average less educated, less skilled and poorer than formal workers (Gasparini and Tornarolli, 2009; Perry et al., 2007). Even though my study is of descriptive nature, it shows that the stereotypical informal worker is a better description of extensive-informal employees than intensive-informal ones. Informal workers in registered firms are quite educated individuals and are not especially poor. In 2014, over 25 per cent of employees working in the intensive margin of informality in Peru had a technical degree or above. Moreover, workers in the intensive margin of informality are mostly young and live in middle-income regions in Peru.

Hence, this analysis suggests that workers who accept informal employment do so for different reasons in each margin of informality. A potential explanation is that while extensive-informal workers accept these jobs out of necessity, intensive-informal jobs are an entry-level contract into a registered firm that eventually would hire workers as formal employees. I find evidence consistent with this possibility. However, since the dataset does not allow to follow workers through time, it is not possible to confirm the latter.

Another well-known stylized fact in the literature is that even after controlling for worker observable characteristics, there is an important wage gap between formal and informal workers (Perry et al., 2007; Ulyssea, 2010, 2018). Along these lines, I find that the income distribution of extensive informal workers is severely skewed to the left, so much so that it allows for income below the national minimum wage. Intensive-informal workers income distribution is less skewed. Interestingly, I find that the wage distribution of intensive-informal workers is closer to that of the formally employed workers than to extensive-informal employees. Also, I show that women's income distribution is significantly skewed to the left compared to their male's counterparts in the extensive margin of informality. This difference is not as important when looking solely at the intensive margin.

This chapter contributes to two streams of literature. First, it enriches informality literature as it brings attention to the intensive margin of informality. Furthermore, it deepens understanding on informal workers' wage penalty as it considers two margins of informality. Second, it expands the scope of the literature that focuses on gender inequality. I show that in countries like Peru, where the informal sector is substantial, women's income is potentially reduced because of the type of job they accept rather than because of discrimination. Hence, when seeking to reduce the gender wage gap, informality should be a central focus in any policy.

When studying firms' informality there are three leading views (La Porta and Shleifer, 2008, 2014). De Soto (1989, 2000) introduced the first view and argues

that informal firms are full of entrepreneurial energy but, government regulations stop them from reaching their potential. The second view treats informality as a voluntary decision. Levy (2008) and Farrell (2004) stress the cost advantage enjoyed by informal firms when avoiding taxes and regulations. They argue that informal firms can be productive enough to survive in the formal sector but prefer to benefit from lower costs and remain informal. Along the same lines, Yamada (1996) finds that informal self-employed workers in Peru choose to remain unregistered. The third view believes that informality is a survival strategy for firms that are too unproductive to survive in the formal market. Maloney (2004) states that informality is individuals' optimal decision given their preferences, constraints in human capital and productivity level.

Regardless of the view, the existing literature analyses informality as a binary decision to comply or not with labour regulations and taxes. Hence, authors such as Rauch (1991); Fortin et al. (1997); Amaral and Quintin (2006); de Paula and Scheinkman (2010, 2011) and Bosch and Esteban-Pretel (2012) focus on the extensive margin of informality. For the Peruvian economy, the early work of León and Cermeño (1990) and Castells and Porte (1989) analyse the interdependence between the formal and informal sector focusing on the extensive margin. The intensive margin breaks firm informality from worker informality. Ulyssea (2018) introduces the intensive margin and allows for formal firms to hire informal workers in a model that studies government's enforcement technology and size-dependent distortions at the firm level.

The literature on gender inequality traditionally argues that the differences in earnings between men and women are due to discrimination and they apply a version of the Blinder-Oaxaca technique such as Gardeazabal and Ugidos (2005) and López-Nicolás et al. (2001) did for the case of Spain. Other authors focused on policy changes effect on the gender wage gap. For instance, DiNardo et al. (1996) implemented a semiparametric procedure and conclude that changes in minimum wage particularly affects women. Weichselbaumer and Winter-Ebmer (2003) show

that government introduction of equal treatment laws can reduce the gender wage gap. Alternatively, authors such as Goldin (2014) focus on women's choice to work in low wage jobs. She finds that women place higher value to working less and flexible hours and that a significant portion of the wage gap is due to non-linear compensation within occupations flexibility.

Since the informal sector is often described by its flexibility, it is not surprising that it is an important source of employment for women in the developing world (Martha Chen and Heintz, 2006). Moreover, Malta et al. (2019) find a strong association between gender gaps and female informality when doing cross-country comparisons in sub-Saharan Africa. Even though there is a growing literature linking informality with gender inequality, informality is still studied as a binary phenomenon. In this chapter, I show that the gender wage gap is stronger in the extensive margin of informality when analysing the manufacturing sector. Thus, a policy aiming to encourage firms to operate legally would help close the gap. Furthermore, the intensive margin of informality also promotes gender inequality but, since women employed in this manner are young and educated, another type of policy would be needed. As Goldin (2014) points out, the gender wage gap would be considerably reduced if firms were not encouraged to favour individuals willing to work long hours and worked particular hours.

The chapter is organised as follows: Section 1.2 describes the dataset and the definitions used throughout the chapter. Section 1.3 characterizes informal workers' demographic information such as education, age and civil status. Section 1.4 analysis informality wage penalty in each margin of informality. Section 1.5 studies the impact of informality on income while keeping track of gender bias. Finally, Section 1.6 concludes.

1.2 Data and Informality

In this chapter and in chapter 2, the empirical analysis is based on the data provided by the Peruvian Statistics Agency, INEI, comes from its acronym in Spanish *Instituto Nacional de Estadística e Informática*. The INEI yearly publishes its National Household Survey on Living Conditions and Poverty, ENAHO (Encuesta Nacional de Hogares sobre Condiciones de Vida y Pobreza, in Spanish).¹ The ENAHO is a survey that regularly collects data on demographic and living conditions in Peru. The data collection for the survey is continuous, and it focuses on measuring living conditions and poverty status of the Peruvian population. It gathers detailed employment and household expenditure data at the national level in urban and rural areas. In addition to employment, income, and expenditure data, main topics covered by the surveys include agricultural activities, health expenditure, housing and demographics.

The survey provides data on type of employer, occupational status, characteristics of principal and secondary employment, size of employer on number of workers, contract information, method of remuneration, weekly hours worked, monthly income and employer's industry association at the ISIC 4 digit level revision 3, among others.

The ENAHO is the source of information used by Peruvian authorities to quantify variables such as participation in the workforce, income, health and education of the population. Subsequently, sections of the data is also published by the International Labour Organization (ILO). I focus on the module on income and labour that provides information on all individuals in the household older than 14 years old and on the module for the independent worker.

For this chapter and chapter 2, I concentrate on employed individuals in the manufacturing sector. However, the dataset does include information for all members of the population employed in any industry or unemployed. I only include in

¹Microdatos Section in INEI website.

the analysis individuals classified as employed. In this way, I eliminate from the sample everyone that is unemployed, looking for a job or does not declare their situation in terms of having or not a job. During the period of analysis, 2007-2014, unemployment remained stable in Peru and the database reflects it. As stated by de Estadística e Informática (2018), the unemployment annual average growth rate between 2007 and 2017 was 0.1 per cent. In 2007, the unemployment rate was 4.8 per cent, and in 2017, 4.1 per cent. Along these lines, in 2007, 5.5 per cent of the sample was unemployed, and in 2014, 3.1 per cent. Also, between 23 and 26 per cent of the sample is classified as not looking for a job and less than 0.2 per cent of the sample does not declare if they are working or not during the period of study. Then, between 71 and 72 per cent of interviewed people are classified as occupied, meaning that the sample accounts for 413010 workers in all industries for the period 2007-2014.²

These workers take part in various industries. The larger concentration of individuals are employed in agriculture with 36 per cent of the employed population. It follows retail with 17 per cent and manufacturing with 8 per cent of the employed population. For the empirical analysis in this chapter and chapter 2, I only take into account people employed in manufacturing. There are 32792 workers in manufacturing during the period of analysis.³ I eliminate individuals working in manufacturing in industries with very little participation as I consider them outliers. These represent 2.6% of the population in manufacturing. After eliminating those observations the total number of workers in manufacturing is 31953.⁴ Food production is the industry within manufacturing with the larger portion of workers in the sample, 27.5 per cent. Textiles and wearing apparel follows with 15 and 14 per cent of workers in manufacturing, respectively.

In this chapter, I study the effect of informality and gender on wages. The ENAHO

²More detailed information on a yearly basis can be found in Table A.1 in Section A.1 in the Appendix.

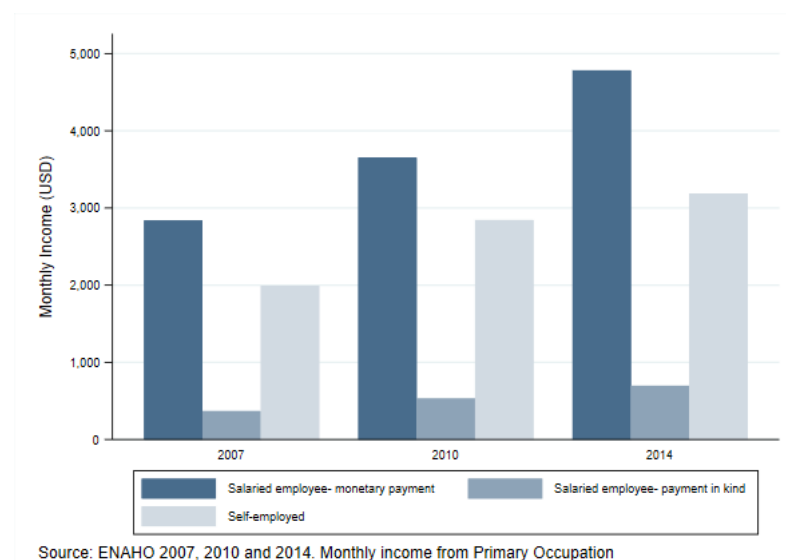
³Table A.2 in the Appendix, presents the amount of individuals in each industry surveyed for each year of analysis.

⁴In Table A.3 in the Appendix I provide more details.

provides information on income both for salaried workers and for self-employed individuals. All salaried workers are asked “*How much was your total income in the last month from your primary occupation, including overtime, bonuses, payment for transport, etc.? (in soles)*” and “*How much have you been paid in kind as a salaried worker in your primary occupation in the last month? (equivalent in soles)*”. Moreover, all self-employed workers are asked “*In your primary occupation, what was your net income last month? (in soles)*”.⁵ The INEI publishes these data deflated and annualised. Throughout this chapter, whenever I report income comes from the answers to these questions reported by the INEI.⁶

Figure 1.1 shows the average values for salaried workers and for self-employed. Salaried workers’ income are paid both monetarily and in kind. In 2007, 11.5 per cent of salaried workers’ income was paid in kind and in 2014 it increased to 12.7 per cent of their income. I also find that self-employed workers’ income is persistently higher than that of workers employed as salaried employees.

Figure 1.1: Income Composition



Notes: Monthly income is calculated based on individuals declaration of wages for their primary occupation. Monetary payment refers to total pay including bonuses, overtime, etc.

⁵ “Soles” is Peruvian National Currency. All values are converted to US dollars using the mean exchange rate for any given year.

⁶ The ENAHO is a very comprehensive household survey in which individuals are asked about their income and about their expenditure. Hence, it would become evident if an individual declares to have no income whatsoever when is in fact employed, for example, informally.

As Kanbur (2009) points out, the literature on informality does not reach agreement on how to define informality. Depending on whether the focus is on employment or firms, the definition of informal employment and the informal sector differs.

When the focus is on the informal enterprise, many paths are taken to distinguish the informal firm from the formal one. Sometimes the stress is on the scale of the operations, and firms with less than a certain amount of workers are characterized as informal. Other times, the emphasis is on the relationship between the firm and the Law. In this case, firms recognized by a government agency or registered to pay social security contributions are considered formal. When using the enterprise-based approach, the informal sector is comprised by all the informal firms in the economy.

The enterprise-based approach is not without limitations. First, the size of a firm might be misleading as it may classify highly skilled services as informal (e.g. lawyer's office). Furthermore, this approach does not allow for unregulated employment in formal firms such as "off the books" workers. The 17th International Conference of Labour Statisticians (ICLS) recommended employment-based definitions to deal with these drawbacks. An employment-based approach when defining informality allows to unite enterprise-based concepts with jobs-based notions (ILO, 2018).

The INEI, advised by the International Labour Organization's agency for the Formalization in Latin America and the Caribbean (FORLAC), followed the ICLS recommendation and constructs a method to identify two types of informality. INEI (2004) outlines a two stages approach to identify informal workers in formal firms and informal workers in informal jobs. I take this approach to identify workers' informality-status both for this chapter and for chapter 2. The ENAHO and this methodology proposed by the INEI to identify the informal sector is widely used and accepted both in the academic literature and in policy bodies

(Chacaltana, 2017; FORLAC, 2014a,b; OECD, 2019; Villagomez and Chafloque, 2019; Chong et al., 2008).

First, I identify the extensive margin of informality with the enterprise-based notion of informality. Formal firms are characterized as the ones that keep the books either manually or electronically complying with the Peruvian Tax agency software. I focus on workers' principal source of employment. If the primary employer does not comply with the Law when keeping books, it is classified as unregistered. I also apply this criterion to self-employed workers.⁷

Second, I classify the intensive margin of informality with the employment-based concept of informality. The intensive margin of informality is twofold. On the one hand, employees in registered firms but hired as non-paid family workers are considered intensive-informal workers. On the other hand, intensive-informal salaried workers are classified using an indicator of labour law compliance. The indicator used before 2012 is different to the one used after 2012 because of a change in the questionnaire. Before 2012, employees whose income was not deducted in any way while working in a registered firm were featured as intensive-informal workers. From 2012 onwards, employees whose employer, contrary to Peruvian legislation, does not pay health insurance on their behalf is identified as in intensive-informal employment.⁸

Throughout this chapter and chapter 2, all workers are classified in 3 groups: i) **Extensive-informal workers:** Workers employed in unregistered firms or self-employed workers who do not pay taxes for their income. ii) **Intensive-informal workers:** Informal employees in a registered firm. iii) **Formal workers:** Formal worker in a registered or self-employed individuals who pay taxes for their income.

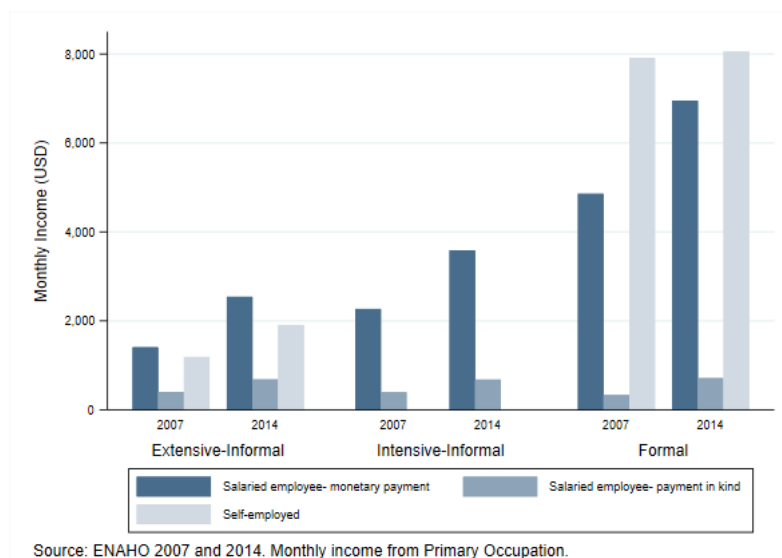
⁷Self employed workers are formal if they are registered as a legal person or as a legal entity with Tax Identity Number: RUC, RUS, RER. "RUC" comes from its acronym in Spanish *registro unico del contribuyente*, it uniquely registers all taxpayers, firms or individuals. "RUS" is a tax system that was created to motivate formalization. It targets small firms and tax them based on their sales. "RER" is a system that targets only people whose annual income does not exceed the USD 61200

⁸The estimations presented in Section 1.5 are also performed for the 2007-2011 period before the survey changed, and results are presented in Appendix A.3. Results are very similar.

As Figure 1.2 shows, extensive-informal income is consistently lower than formal and intensive-informal workers. Moreover, extensive-informal workers receive a larger proportion of their wages in kind. In 2007, 22.3 per cent of extensive-informal workers' income was provided in kind and in 2014, 21.2 per cent of their income was given in kind. As expected, this is lower for intensive-informal workers and even less for formal workers. In 2007, 14.8 per cent of intensive-informal workers' income and 6.4 per cent of formal workers' income was received in kind. Similarly, in 2014, 15.9 per cent of intensive-informal workers' income and only 9.3 per cent of formal workers' income was in kind.

By construction, self-employed workers cannot be classified as intensive-informal workers as they are their own firm. Hence, in Figure 1.2, self-employed are either extensive-informal or formal workers. It is clear that formal self-employed workers received the highest wages in manufacturing.

Figure 1.2: Income composition by Informality Margin



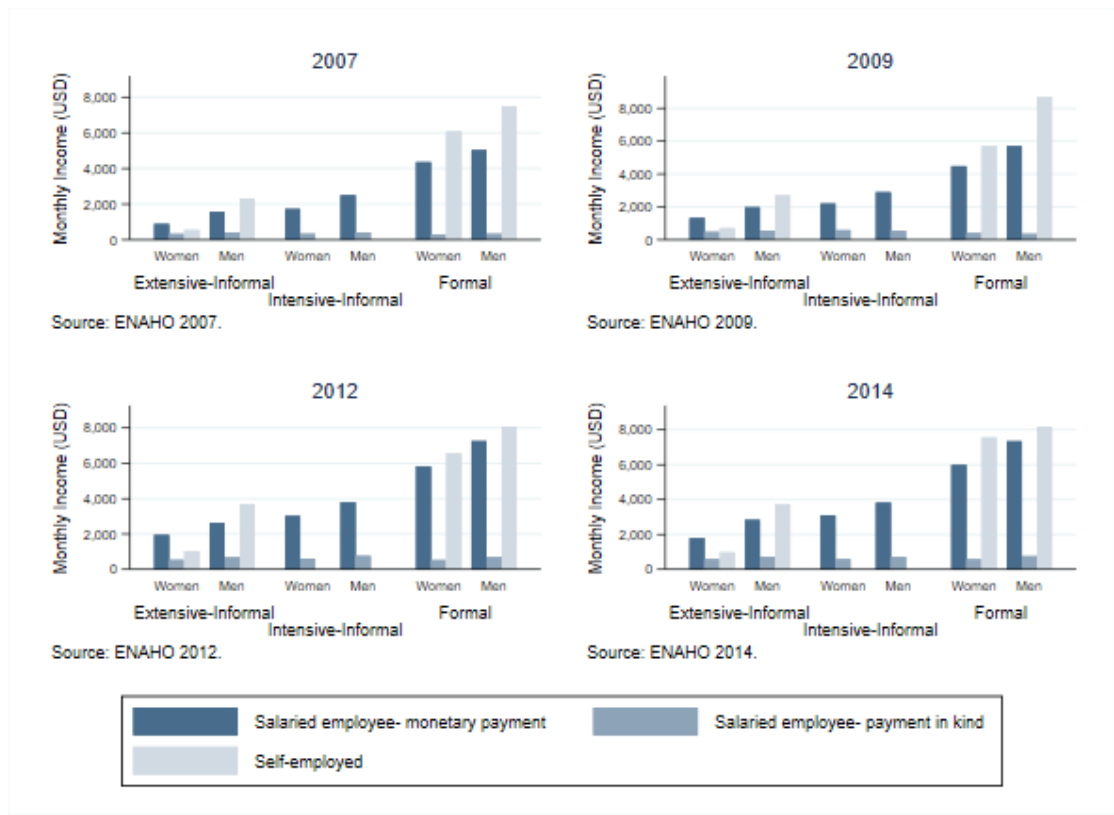
Notes: Monthly income is calculated based on individuals declaration of wages for their primary occupation.

The ENAHO is a national survey that comprises information regarding all households and its occupants. As such, it provides information on the demographic characteristics of all workers in the manufacturing sector. I compare workers' informality status while keeping track of their age, gender, civil status, education

and ethnicity.

In particular, I study the gender wage gap in the context of informality. Figure 1.3 overwhelmingly shows two persistent facts. First, women's income is always lower than men's salary with the same informality status. Second, extensive-informal workers earn less than intensive-informal ones, and these less than formal employees. Another interesting fact is that self-employed-formal workers tend to have higher income than salaried workers.

Figure 1.3: Income composition by Gender and



Notes: Monthly income is calculated based on individuals declaration of wages for their primary occupation.

1.3 Demographic Characteristics

The informal sector is very often described as a reservoir of uneducated, young, poor workers who are not efficient enough to migrate to formal jobs (La Porta and Shleifer, 2008). In this Section, I study informal workers' characteristics and evaluate if the stereotypical description of an informal worker is accurate. I show

that it is close to the profile of an extensive-informal worker but it is quite imprecise when describing intensive-informal workers.

As Table 1.1 shows, informal employment in Peru is quite sizeable. Columns 3, 6 and 9 show the evolution of the share of workers in unregistered firms, informal workers in registered firms and formal workers in registered firms, respectively. In 2007, only 22 per cent of total employment was formal while 59 per cent was located in unregistered firms and 19 per cent was comprised of informal employees in registered firms. Hence, the informal sector accounted for 79 per cent of total employment in 2007. In 2014, informality dropped by over 8 percentage points. Interestingly, while the extensive margin of informality declined over 11 percentage points, the intensive margin of informality in fact increased by almost 3 percentage points. Hence, it is clear that what drives one margin of informality does not necessarily affects the other in the same way. Thus, it seems essential to have a better understanding of what sort of employee falls under the umbrella of an “informal worker”.

Table 1.1: Informality and Gender over the years

	Extensive-informal workers			Intensive-informal workers			Formal workers		
	Men	Women	Total [‡]	Men	Women	Total [‡]	Men	Women	Total [‡]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2007	45.51	54.49	<i>59.05</i>	69.39	30.61	<i>19.46</i>	76.63	23.37	<i>21.49</i>
2008	44.34	55.66	<i>58.57</i>	69.71	30.29	<i>20.32</i>	76.26	23.74	<i>21.11</i>
2009	43.43	56.57	<i>58.65</i>	71.90	28.10	<i>19.03</i>	74.82	25.18	<i>22.32</i>
2010	45.04	54.96	<i>57.92</i>	68.87	31.13	<i>19.67</i>	77.15	22.85	<i>22.41</i>
2011	44.89	55.11	<i>58.22</i>	69.77	30.23	<i>18.52</i>	74.54	25.46	<i>23.26</i>
2012	41.59	58.41	<i>50.23</i>	67.62	32.38	<i>22.32</i>	76.28	23.72	<i>27.45</i>
2013	40.12	59.88	<i>50.37</i>	66.21	33.79	<i>21.79</i>	76.82	23.18	<i>27.84</i>
2014	41.19	58.81	<i>47.82</i>	65.70	34.30	<i>22.34</i>	73.15	26.85	<i>29.84</i>

Source: Own elaboration based on ENAHO 2007-2014.

[‡] Columns 3, 6 and 9 present the share of each type of worker on total employment.

Notes: Columns 1 and 2 show the proportion of women and men working as extensive-informal employees. Columns 4 and 5 show the share of men and women working informally in registered firms and Columns 7 and 8 the same for formally employed workers in registered firms.

Since I am interested in the role of gender in informality, Table 1.1 unfolds employment in each margin by gender. I find that in the extensive margin between

55 and 60 per cent of the employees are women during the period 2007-2014. This is probably due to women being secondary earners in the household and would be willing to forego security that comes with labour law protections. Consistent with this explanation, Columns 7 and 8 in Table 1.1 show that among the employees hired formally by a registered firm, between 73 and 77 per cent are men during the period of analysis. Thus, men primarily take jobs that provide social benefits. Interestingly, men account between 66 and 72 per cent of intensive-informal employment. In other words, as the social benefits and labour protection increase so does the share of men participating in these jobs.

Between 2007 and 2014, women's participation in the labour market remained stable around 43 per cent. However, women's participation in informal employment has increased in both margins during the period of analysis. This is specially worrisome in the extensive margin of informality as total employment in this margin decreased between 2007 and 2014. Also, women's importance in the intensive margin increased by more percentage points than total employment in said margin. In the remaining of this Section, I study workers' characteristics while keeping track of gender's role on informality.

Columns 1-3 in Table 1.2 show the distribution of extensive-informal workers by civil status. Column 3 shows that approximately 70 per cent of people employed in the extensive margin of informality is not single. Since this margin of informality provides the least amount of benefits and stability in the labour market, it makes sense that people willing to take this type of contract are less likely to have dependants. In line with this reasoning, comparing Columns 1 and 2 shows that the share of men working in the extensive margin that are single is almost twice the share of single women that work in the extensive margin. Hence, it is likely that gender plays a vital role in understanding the relationship between civil status and working in the extensive margin of informality. It seems unattached men or married women take these jobs. Probably, women are either secondary

Table 1.2: Informality and Civil Status
(Per cent by row for each informality margin)

	Extensive- informal workers			Intensive- informal workers			Formal workers		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year 2007									
Cohabitant	24.49	26.03	25.33	29.67	24.45	28.07	27.33	19.17	25.42
Married	26.43	33.95	30.53	17.73	14.41	16.71	45.18	28.50	41.28
Div/Sep/Widow	6.29	17.30	12.29	6.36	17.03	9.63	7.27	23.32	11.02
Single	42.79	22.72	31.85	46.24	44.10	45.59	20.22	29.02	22.28
Year 2014									
Cohabitant	27.24	24.36	25.55	22.31	20.91	21.83	28.40	18.84	25.84
Married	27.95	37.90	33.80	14.08	16.97	15.07	40.85	29.57	37.82
Div/Sep/Widow	9.08	18.91	14.86	7.44	19.09	11.43	8.94	25.51	13.39
Single	35.73	18.83	25.79	56.17	43.03	51.66	21.81	26.09	22.96

Source: Own elaboration based on ENAHO 2007 and 2014.

Notes: Columns 1-3 show extensive-informal total employment distribution among civil status categories. Columns 4-9 show employment in registered firms distribution according to workers' civil status. Columns 4-6 provides the information for intensive-informal and Columns 7-9 for formally employed workers.

earners in the household or desperate enough to take any job.

Looking at the intensive margin's composition in terms of civil status, Column 6 in Table 1.2 shows that almost half of the intensive-informal labour force is single. Furthermore, this result remains unchanged when taking a look at Columns 4 and 5, where the analysis is specific to men and women, respectively. Hence, it seems that single people regardless of gender, prefer this type of contract. On the other hand, Column 9 shows that formal workers are mostly married. Indeed, 41 per cent of formally employed workers in 2007 were married and 38 per cent in 2014.

Interestingly, when focusing on formally employed women, it turns out that 29 per cent of women are single and 29 per cent married while 45 per cent of formally employed men are single. Then, civil status operates in a different way for each gender regarding formal jobs. Since men tend to be the primary source of income when married, it makes sense that they seek the most stable and best remunerated jobs.⁹

⁹As Figure 1.2 shows, formal workers' wages are higher than informal wages in either of the margins.

Next, I analyse the distribution of age groups by type of worker. Column 3 in Table 1.3 shows that age does not seem to be a strong determinant for the extensive margin of informality. However, when comparing Columns 1 and 2, it does seem that men tend to be a bit younger than women when employed as extensive-informal workers. Column 6 shows that almost 55 per cent of intensive-informal workers are younger than 30 years old. Moreover, as workers get older, they also seem less likely to accept informal jobs in registered firms. When looking at differences between the age group distribution of men and women employed as informal workers in the intensive margin, no big differences appear. On the other hand, Column 9 shows that formally employed workers are mostly between 30 and 44 years old. Moreover, gender does not seem to make a big difference. Given these descriptive analyses, one could infer that the intensive margin of informality might be an entry-level job for workers employed in registered firms.

Table 1.3: Informality and Age
(Per cent by row for each informality margin)

	Extensive-informal workers			Intensive-informal workers			Formal workers		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year 2007									
Age: 14-29	44.05	30.80	36.83	53.56	56.77	54.55	23.85	32.12	25.79
Age: 30-44	25.65	34.52	30.48	32.56	30.57	31.95	41.71	50.26	43.70
Age: 45-64	22.65	27.32	25.20	13.10	12.66	12.97	31.28	17.62	28.09
Age: >65	7.65	7.36	7.49	0.77		0.53	3.16		2.42
Year 2014									
Age: 14-29	31.25	21.55	25.55	56.17	48.18	53.43	20.43	25.80	21.87
Age: 30-44	26.06	31.63	29.33	23.58	34.55	27.34	37.87	39.13	38.21
Age: 45-64	32.43	36.99	35.11	16.77	15.15	16.22	36.49	32.46	35.41
Age: >65	10.26	9.83	10.00	3.48	2.12	3.01	5.21	2.61	4.51

Source: Own elaboration based on ENAHO 2007 and 2014.

Notes: Columns 3, 6 and 9 present the distribution of each type of employment by age group. Columns 1 and 2 show the proportion of women and men working as extensive-informal employees by age group. Columns 4 and 5 show the share of men and women working informally in registered firms and Columns 7 and 8 the same for formally employed workers in registered firms.

Another critical demographic characteristic when discussing informality is education. Many times, informality is related to individuals whose education level is not

very high, and as a result they are not able to work in registered firms. According to Table 1.4, this is especially true for the extensive margin of informality. As Column 3 shows, in 2007, 31 per cent of extensive-informal employment is performed by individuals that have only finished primary school and 48 per cent by people with a secondary degree. Moreover, employees with higher than secondary education employed in the extensive margin of informality are scarce. Also, despite the decline of informality in the extensive margin, the distribution by education level is pretty similar in 2014. As expected, when comparing men and women in the extensive margin of informality (Column 1 and 2, respectively), men are more educated than women. 58 per cent of men working in the extensive margin of informality have finished secondary school, while less than 40 per cent of extensive-informal women have that level of education.

Workers in the intensive margin of informality have mostly finished secondary education or above. Column 6 in Table 1.4 shows that in 2007 62 per cent of intensive-informal employment was done by secondary educated people and 17 per cent by workers with technical education. Table 1.4 also shows that the distribution did not change significantly between 2007 and 2014 for intensive-informal employment. Interestingly, while in the extensive margin of informality, women are less educated than men, in the intensive margin of informality, the opposite is true. Column 5 shows that in 2007 27 per cent of women in intensive-informal employment had technical, undergraduate or postgraduate education while men with the same level of instruction accounted for 24 per cent. Furthermore, in 2014 women with technical or higher education accounted for 30 per cent of women in the intensive margin of informality while men for 25 per cent.

Column 9 shows that formally hired workers with secondary education were almost as important in 2007 as the intensive margin of informality. On the other hand, it is also clear that workers with university-level education are formal. In 2007, over 42 per cent of formal workers had technical, undergraduate or postgraduate education. Formal workers' distribution by education group does not change much

between 2007 and 2014 looking it as a whole. In 2007, 42 per cent of men formally hired in registered firms had above secondary education, and 44 per cent of women are in that group. Interestingly, by 2014 women's education increased a great deal as 52 per cent of women hired as formal workers in registered firms have either technical or Undergraduate-Postgraduate level.

Thus, these results are consistent with the potential explanation that people working in the extensive margin do it out of necessity, and this is especially true for uneducated women. Also, it seems that workers in the intensive margin of informality expect to be formally hired, and that is why educated employees accept this type of employment. Moreover, educated women are more prone to take informal jobs when hired by registered firms. Findings regarding formal employment are consistent with the interpretation that the intensive margin of informality is an entry-stage in registered firms.

Table 1.4: Informality and Education
(Per cent by row for each informality margin)

	Extensive-informal workers			Intensive-informal workers			Formal workers		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<u>Year 2007</u>									
No Level	2.13	12.69	7.89	0.39	1.75	0.80		0.52	0.12
Primary	23.91	35.81	30.40	10.79	16.59	12.57	8.06	8.81	8.23
Secondary	58.95	38.24	47.67	65.32	55.02	62.17	50.08	47.15	49.39
Technical	9.58	8.89	9.21	15.22	19.65	16.58	22.91	24.87	23.37
UG-PG	5.42	4.37	4.85	8.29	6.99	7.89	18.96	18.65	18.89
<u>Year 2014</u>									
No Level	1.42	11.73	7.48	0.16	0.91	0.42	0.11	0.87	0.31
Primary	25.03	38.56	32.99	13.29	13.64	13.41	8.40	9.28	8.64
Secondary	57.62	36.83	45.38	62.03	55.76	59.88	47.77	37.97	45.14
Technical	10.74	8.34	9.33	15.51	15.15	15.38	24.47	28.99	25.68
UG-PG	5.19	4.54	4.81	9.02	14.55	10.91	19.26	22.90	20.23

Source: Own elaboration based on ENAHO 2007 and 2014.

Notes: Columns 3, 6 and 9 present the distribution of each type of employment by highest education group. Columns 1 and 2 show the proportion of women and men working as extensive-informal employees by education group. Columns 4 and 5 show the share of men and women working informally in registered firms and Columns 7 and 8 the same for formally employed workers in registered firms.

Table 1.5: Informality and Geography

	Low Income Departments			Middle Income Departments			High Income Departments		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year 2007									
Extensive-Informal	74.24	93.75	85.24	54.55	84.76	68.72	36.13	52.52	41.98
Intensive-Informal	19.70	5.08	11.45	23.77	9.91	17.27	24.49	22.82	23.89
Formal	6.06	1.17	3.30	21.69	5.33	14.01	39.39	24.66	34.13
Year 2011									
Extensive-Informal	61.03	89.63	76.97	41.87	66.91	51.83	44.03	61.70	50.75
Intensive-Informal	21.84	6.46	13.27	24.32	18.12	21.85	20.52	10.94	16.88
Formal	17.13	3.91	9.76	33.81	14.98	26.32	35.45	27.36	32.37
Year 2014									
Extensive-Informal	52.41	88.71	71.71	46.94	76.89	61.08	22.79	39.46	29.07
Intensive-Informal	27.27	7.76	16.90	23.15	11.92	17.84	27.56	27.81	27.66
Formal	20.32	3.53	11.39	29.91	11.19	21.07	49.65	32.73	43.27

Source: Own elaboration based on ENAHO 2007, 2011 and 2014. Income classification according to INEI (2018).
Notes: Columns 1-3 provide the share of each type of employment in selected years for low-income departments. Columns 4-6 give similar information for middle-income departments. Columns 7-9 the same for high-income departments.

Since informality is often described as a phenomenon prevalent in poor areas, I group Peruvian regions based on their monetary poverty levels. I name “low income” departments those that, according to INEI (2018) face poverty levels above 20 per cent. The “middle income” group refers to departments with poverty between 20 and 10 per cent. Lima, the capital of Peru, is in the middle-income group. Finally, the “high income” group has poverty levels below 10 per cent. These groups do not necessarily have the same departments for all years as each year their poverty level is evaluated, and the department is categorized.¹⁰

Table 1.5 makes it clear that the extensive margin of informality is mostly found in regions with high poverty levels. Even though the proportion of employment that is extensive-informal decreases as years go by, it is always significant for low-income departments, less in middle-income departments and reaches its minimum in high-income departments.¹¹ Regions where poverty is high, people are more will-

¹⁰See Appendix A.2 for more details on the specific departments included in each category for each year.

¹¹Departments are the first-level administrative subdivisions of Peru.

ing to work without any social benefits and so unregistered firms proliferate and with them, the extensive margin of informality. Conversely, the intensive margin of informality is more important in middle and high-income departments. Interestingly, the share of intensive-informal employment in 2014 reached its highest in high-income departments when informality as a whole was declining. Registered firms turn to the intensive margin of informality as a way to remain competitive as informal workers are cheaper than formal ones. Finally, as expected, formally hired workers are overwhelmingly prevalent in high-income departments.

Since gender has proven to give a more comprehensive understanding of the informal sector Table 1.5 also provides information on informality for women and men in each margin. Column 2 shows that 94 per cent of women working in low-income departments in 2007 are employed as extensive-informal workers. Even though this number slightly decreases during the period of analysis, in 2014, 89 per cent of women in low-income regions of Peru are employed in the extensive margin of informality. Men's situation is always a bit better but, in low-income regions, they are still working predominantly in the extensive margin of informality. However, 20, 22 and 28 per cent work as intensive-informal workers in 2007, 2011 and 2014 respectively. While only 5, 6, and 7 per cent of women in low-income regions in 2007, 2011 and 2014, respectively, work in the intensive-margin of informality.

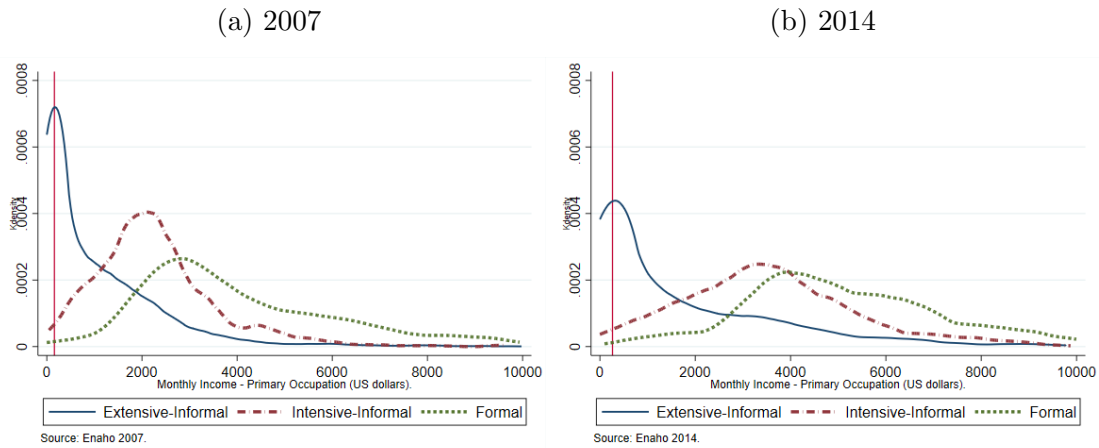
Also, Columns 4 and 5 in Table 1.5 show that in middle-income departments, women are still predominantly extensive-informal employed. However, comparing 2007 with 2014 in Columns 2, 5 and 8, women are shifting from the extensive margin of informality towards either intensive-informal or formal employment. As expected, this migration also took place for men and to a more significant extent. Also, high-income departments are more inclusive to women as 25 per cent of women were formally employed in 2007, and by 2014, 33 per cent were formal. Again, men formally employed are also a lot more important in high income departments than in other regions of Peru.

1.4 Gender and Informalities Wage Penalty

In the previous Section, I study workers' demographic characteristics that encourage individuals to accept jobs in one of the following type of contracts: formal, intensive-informal or extensive-informal. Furthermore, I also showed that, on average, informal workers' income is lower than that of formal ones. In the following Section, I confirm that informal workers receive a lower wage than formal workers even when controlling for observables and that this wage penalty is distinct for each margin of informality and gender. Crucially, I find that the extensive margin is greatly penalised and that women are particularly fined when hired in the extensive margin of informality.

As Figure 1.4 shows, informal employees in the extensive margin have the lowest average income in the market, and their income distribution is skewed to the right. Furthermore, most extensive-informal workers' income is below the minimum wage (vertical line). As expected, intensive-informal workers' income distribution is less skewed to the right, and its mean is larger. Finally, formal workers have the highest average monthly income, and the distribution is flatter.

Figure 1.4: Monthly Income

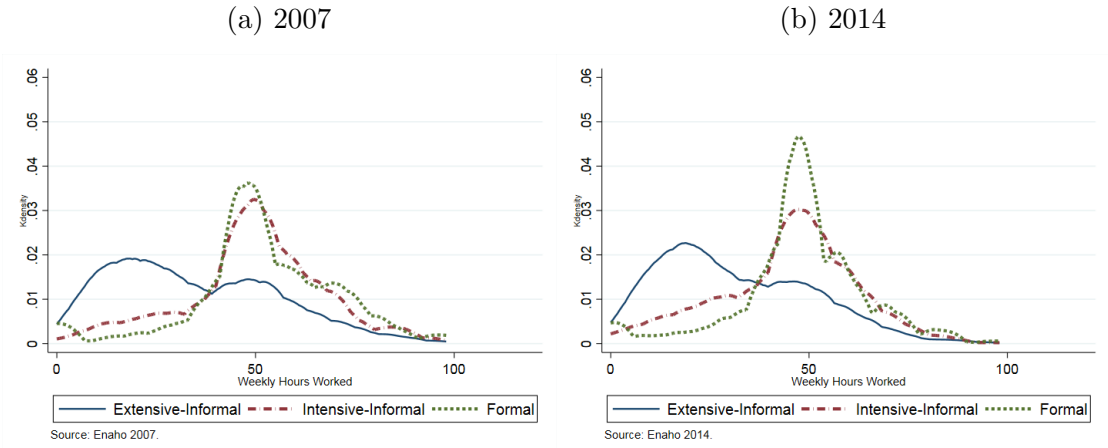


Notes: Graphs are truncated for individuals with more than 10000 US dollars. The vertical line indicates the minimum wage. In 2007, the minimum wage equivalent in US dollars was 160 US dollars, and in 2014, 264 US dollars.

Since many times the extensive margin of informality refers to part-time work, it is worth mentioning that in the case of Peru, this is not true. Coherent with

Yamada (2005) findings, Figure 1.5 shows that Peruvian employees work on average 40 hours per week. Even though it is true that extensive-informal employees work on average less hours than employees in registered firms, it can hardly be said that they are part-time workers. For instance, in 2007, formal and intensive-informal employees worked on average 52 and 50 hours respectively, while extensive-informal employees worked 35 hours per week. By 2014, all type of employees worked a couple of hours less per week but qualitatively the distribution of hours worked remained the same.

Figure 1.5: Weekly Hours Worked

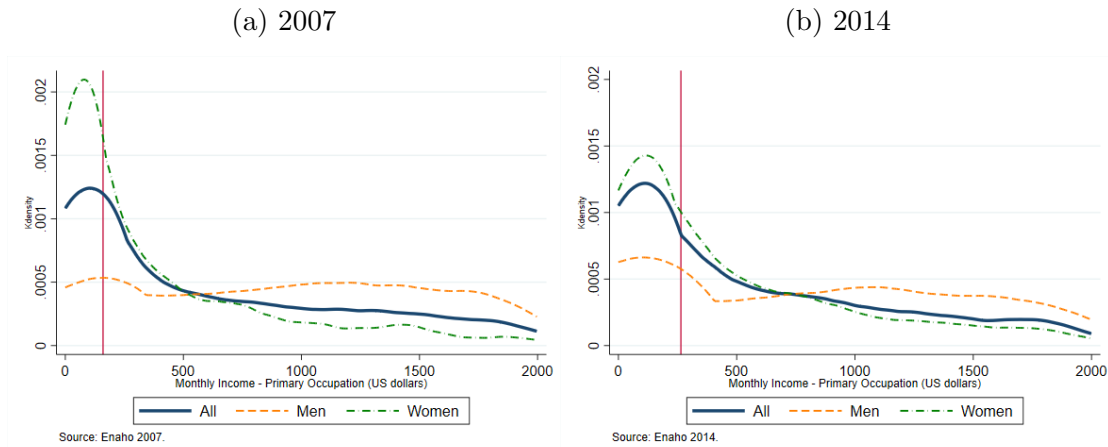


Notes: Hours worked on Primary occupation upon individual's declaration.

Moreover, as Figure 1.6 shows, when women are employed as extensive-informal workers, their income is below average while men's wages are above average within extensive-informal workers. It seems that women in the extensive margin of informality are willing to accept a lower pay either because they do not have bargaining power or they do not mind it, possibly because they are secondary earners. An encouraging finding in terms of gender inequality is that the gender wage gap for extensive-informal workers between 2007 and 2014 has decreased. Moreover, the gap seems to be closing due to women's wages increasing and approaching the mean rather than men's wages going down.

As Figure 1.4 shows, intensive-informal and formal workers are consistently better remunerated than workers in the extensive margin of informality. Figure 1.7 pro-

Figure 1.6: Extensive-Informal Workers' Monthly Income



Notes: Monthly income is calculated based on individuals declaration of income from primary occupation. Graphs are truncated for individuals with more than 2000 US dollars as the average income for extensive-informal employees is 1143 US dollars in 2007 and 1832 US dollars in 2014. The vertical line indicates the minimum wage. In 2007 it was 160 US dollars and in 2014, it was 264 US dollars.

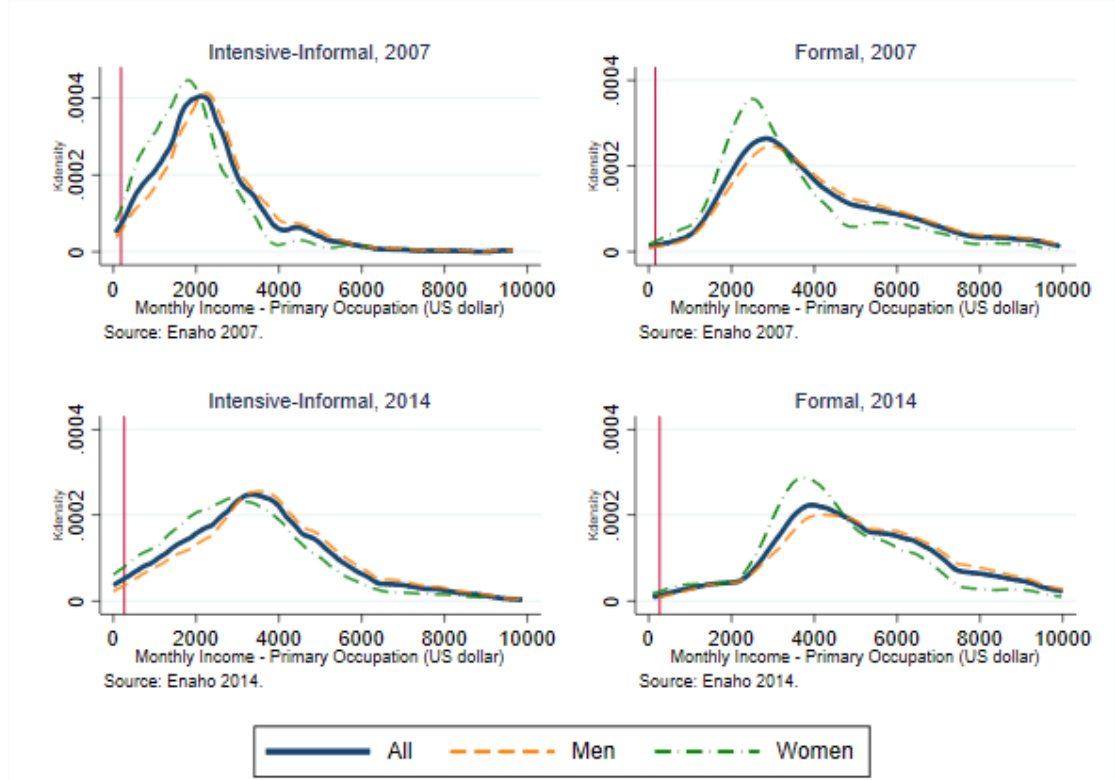
vides a bit further insight as shows income distribution for intensive-informal and formal workers by gender. It seems that the bias against women is lesser when hired in the intensive margin of informality. However, it is still present as women's average income in the intensive margin was 1845 US dollars in 2007, while that of men was 2653 US dollars. Furthermore, in 2014 women's average salary was 3097 US dollars while men's average income was 4044 US dollars.

As expected, the gender pay gap remains a problem among formally hired workers. In 2007, formally hired women's income was 5235 US dollars and men's was 5808 US dollars. Furthermore, in 2014, women's average wage when hired as formal employees was 6535 US dollars and men's 7885.

Thus, from a descriptive analysis, it appears that while there is a significant wage penalty on informality, women pay a substantial portion of it. More precisely, women in the extensive margin of informality are the most adversely affected party. I also find that registered firms' employees see their income increase when they get a formal contract. Even though women's income as formal or intensive-informal workers is closer to that of men, it never completely catches up. Since women in the extensive margin of informality have less bargaining power than

women in registered firms given their level of education and family situation, it is not unexpected that gender bias is stronger among extensive-informal employees.

Figure 1.7: Registered Firm Workers' Monthly Income



Notes: Monthly income is calculated based on individuals declaration of wages for their primary occupation. Graphs are truncated for individuals with 10000 US dollars. The vertical line indicates the minimum wage. In 2007, the minimum monthly salary was the equivalent of 160 US dollars and in 2014 of 264 US dollars.

1.5 Empirical Strategy

As it is well established in the literature, informal workers' income is lower than that of their formal counterparts. Similarly, women's pay is consistently lower than men's income across countries and industries. Both the gender wage gap and the informality penalty, persist even when controlling for observables such as level of education, age and family situation. In this Section, I test whether the gender wage gap importance changes with the margin of informality.

1.5.1 Extensive Margin Estimations

First, I look at the effect of the extensive margin of informality on women's wages. I estimate Equation 1.1 and evaluate the effect on wages for extensive-informal workers in the manufacturing sector.

$$\ln(w_{\ell jt}) = \beta_0 + \beta_1 EXT_{\ell t} + \beta_2 Men_{\ell j} + \beta_3 \mathbf{H}'_{\ell t} + F_j + F_t + \varepsilon_{\ell jt} \quad (1.1)$$

where the dependent variable is the logarithm of monthly income, $w_{\ell t}$, for individual ℓ who is working in industry j in year t . $EXT_{\ell t}$ is a dummy that is = 1 if individual ℓ who is working in industry j in year t is working as an extensive-informal worker. Similarly, $Men_{\ell j}$ is a dummy variable that takes value of 1 if individual ℓ working in industry j is a man and 0 if they are a woman. I also control for all other demographic characteristics discussed in Section 1.3, $\mathbf{H}'_{\ell t}$, namely, the highest level of education attained, age, marital status and department of residence. Furthermore, I control for year fixed effects, F_t , as wages grow with time and industry fixed effects at the 4 digit level of aggregation, F_j , as some industries are known to pay higher salaries than others.

Results for estimating Equation 1.1 with OLS and computing Huber-White robust standard errors clustered by industry at 4 digit level of aggregation are presented in Table 1.6 in Columns 1, 3 and 5. I also estimate Equation 1.1 using Heckman's maximum likelihood estimator (ML). Selection in the labour market might be biased as the OLS estimation only takes into account individuals who join the labour market, i.e., individuals with positive income. On the other hand, since the dataset is a household survey, it includes workers that can be considered as unemployed in other surveys while they are in fact informal workers.¹² Results

¹²According to ILO's estimations, 4.2 per cent of Peruvian total labour force was unemployed in 2007 and in 2014 it went down to 3 per cent. Peru's unemployment rate is below the average for the Latin America and Caribbean, which oscillates between 6 and 7.6 per cent in this period. It is also below average unemployment in middle-income countries which is between 5.5 and 6 per cent. For the manufacturing sector, Peru's unemployment rate was between 4.8 per cent and 4 per cent during 2007-2014.

Table 1.6: Extensive Margin Estimations

	Dependent Variable: $\ln(Income)$					
	All			Men		Women
	OLS (1)	Heckman [†] (2)	OLS (3)	Heckman [†] (4)	OLS (5)	Heckman [†] (6)
Extensive-Informal Indicator	-0.7532*** (0.047)	-0.7486*** (0.046)	-0.5394*** (0.023)	-0.5429*** (0.027)	-1.0527*** (0.086)	-1.0442*** (0.085)
Men	0.7803*** (0.077)	0.7763*** (0.076)				
Married/Cohabitant	0.0312 (0.037)	0.0275 (0.038)	0.2406*** (0.020)	0.1977*** (0.020)	-0.1640*** (0.035)	-0.1715*** (0.036)
Age: 30-44	0.1978*** (0.039)	0.1968*** (0.037)	0.2202*** (0.019)	0.1540*** (0.017)	0.1402* (0.076)	0.1413* (0.078)
Age: 45-64	0.1396*** (0.047)	0.1425*** (0.045)	0.1553*** (0.027)	0.1065*** (0.029)	0.0710 (0.090)	0.0770 (0.091)
Age: > 65	-0.3103*** (0.070)	-0.3146*** (0.070)	-0.5015*** (0.062)	-0.5384*** (0.077)	-0.2233*** (0.081)	-0.2218*** (0.081)
Primary Education	0.4144*** (0.117)	0.4332*** (0.117)	0.4242*** (0.112)	0.4213*** (0.114)	0.2212*** (0.059)	0.2393*** (0.057)
Secondary Education	0.7596*** (0.143)	0.7864*** (0.144)	0.6149*** (0.126)	0.6305*** (0.122)	0.5986*** (0.086)	0.6236*** (0.086)
Technical Education	0.9216*** (0.145)	0.9525*** (0.147)	0.7507*** (0.124)	0.7573*** (0.122)	0.8011*** (0.087)	0.8347*** (0.084)
UG-PG degree	1.0733*** (0.159)	1.1038*** (0.159)	0.9333*** (0.137)	0.9618*** (0.130)	0.8867*** (0.119)	0.9230*** (0.117)
Middle Income Department	0.3028*** (0.032)	0.3052*** (0.032)	0.2072*** (0.027)	0.1873*** (0.025)	0.3278*** (0.028)	0.3345*** (0.027)
High Income Department	0.6060*** (0.059)	0.6160*** (0.059)	0.4289*** (0.034)	0.3985*** (0.028)	0.7142*** (0.068)	0.7344*** (0.067)
Wald test of indep. eqns. ($\rho = 0$)						
$\chi^2(1)$		6.39		248.05		0.58
$Prob > \chi^2$		0.0115		0.0000		0.4473
Observations	29796	31009	17248	17508	12548	13501
R^2	0.57		0.38		0.52	

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include year and industry fixed effects. [†] Results are from a Heckman maximum likelihood estimation.

for the outcome equation from Heckman ML estimations are in Columns 2, 4 and 6 in Table 1.6. The variables for the selection equation are age, education and a dummy for being married or in cohabitation. Column 2 shows results for all individuals; Column 4 presents results from estimating Equation 1.1 only for men and Column 6 only for women.

Columns 1 and 2 show results for all individuals. The Wald Test in Column 2 finds that there is evidence in favour of selection bias. Hence, the OLS estimation in Column 1 is biased. Looking at Heckman estimation results in Column 2, I find that men's income is higher by 78 percentage points (pp) than women's income when hired as extensive-informal workers. Furthermore, the income of extensive informal workers is 75 pp lower than that of workers in registered firms (either intensive-informal or formal employees).

When splitting the sample by gender, I find that there is a crucial selection bias for the case of men, and there is none for the case of women. Hence, when studying the effect of the extensive margin of informality on wages for men I focus on results from the Heckman estimation described by Column 4 in Table 1.6 and for the case of women I look at the OLS estimation in Column 5 in Table 1.6. I find that extensive-informal men's income is 54 pp lower than that of men working in registered firms. Quite a worrisome result is that women working in the extensive margin of informality see their income reduced by 105 pp with respect to women in the intensive margin of informality or formally hired.

Also, Table 1.6 shows that married women have lower income than single women, and the opposite is true for men (Columns 4 and 5). Moreover, in Section 1.3, the descriptive analysis showed that men in the extensive margin of informality are mostly single while women are mostly married. These results, taken together, speak to the claim that women tend to be secondary earners when married and as a result, accept lower wages.

Column 2 in Table 1.6 shows that workers that are more than 30 and less than 64

years old, earn a higher income than workers with less than 30 years old. Also, when a worker lives in a more prosperous region of Peru, their wage increases. Unsurprisingly, education increases wages significantly as individuals with university degrees have wages 110 percentage points higher than workers without education. Moreover, individuals with primary education increase their income by 43 percentage points with respect to workers without education.

Furthermore, comparing Columns 4 and 5 shows that while education increases income for both men and women, the degree to which each additional level of education rises wages is lower for women. On the other hand, the returns of living in a more prosperous department are much more important for women than for men.

All in all, women are disproportionally taxed when working in the extensive margin of informality. Their income is significantly lower to that of men with a similar level of education, age and marital status. Furthermore, their income is also lower to women employed in the intensive margin of informality or hired formally. Hence, it becomes apparent that when discussing the gender wage gap in developing countries such as Peru where the informal sector is significant, it is imperative to also include in the conversation the extensive margin of informality.

1.5.2 Intensive Margin Estimations

In this Section, I study the effect that being hired in the intensive margin of informality instead of formally hired, has on wages. Furthermore, I analyse if this effect is enlarged or reduced for women. I estimate Equation 1.2 where the dependent variable is the logarithm of monthly income, $w_{\ell t}$, for individual ℓ who is working in industry j in year t . $INT_{\ell t}$ is a dummy that is $= 1$ if individual ℓ who is working in industry j in year t is working as an intensive-informal worker and $= 0$ if the individual is formally employed in a registered firm. Note that the regression of Equation 1.2 is conditional on individuals being hired by a registered

firm. As for the extensive margin analysis, I include a dummy variable, $Men_{\ell j}$, that takes value of 1 if the worker is a man and 0 if they are women. I also control for all other demographic characteristics, $\mathbf{H}'_{\ell t}$ and for year, F_t , and industry fixed effects, F_j .

$$\ln(w_{\ell jt}) = \beta_0 + \beta_1 INT_{\ell t} + \beta_2 Men_{\ell j} + \beta_3 \mathbf{H}'_{\ell t} + F_j + F_t + \varepsilon_{\ell jt} \quad (1.2)$$

where individual ℓ has to be employed by a registered firm in industry j in year t .

Results for estimating Equation 1.2 with OLS and computing Huber-White robust standard errors clustered by industry at 4 digit level of aggregation are presented in Table 1.7 in Columns 1, 3 and 5. Column 1 shows results for all individuals working wither as an intensive-informal worker or as a formal employee, Column 3 for all men in either of those formality statuses and Column 5 for all women also in either the intensive margin of informality or formally hired. Since I am concerned about selection bias when joining the labour market and seeking employment, I also conduct a Heckman estimation of Equation 1.2. Due to data constraints, the Heckman maximum likelihood estimation does not converge. Hence, I present results for a two-stage Heckman estimation in Columns 2, 4 and 6 in Table 1.7.

Column 2 shows that selection bias is significant when all individuals (intensive-informal and formal) are considered in the sample as the inverse mills ratio is significant. Thus, I focus on Heckman estimation's results in Column 2. I find that intensive-informal employees' wage is 45 pp lower than formal employees' salaries. Moreover, men working with registered employers earn 25 pp more than their female counterparts.

Even though the gender wage gap within registered employers is lower than the biased experienced by women in the extensive margin of informality, it is still significant. In order to take a closer look at worker employed by registered em-

Table 1.7: Intensive Margin Estimations

	Dependent Variable: $\ln(wages)$					
	All			Men		
	OLS	Heckman [†]	OLS	Heckman [†]	OLS	Heckman [†]
	(1)	(2)	(3)	(4)	(5)	(6)
Intensive-Informal Indicator	-0.4331*** (0.029)	-0.4486*** (0.030)	-0.3835*** (0.031)	-0.3814*** (0.030)	-0.5114*** (0.043)	-0.5110*** (0.043)
Men	0.2699*** (0.026)	0.2506*** (0.026)				
Married/Cohabitant	0.1207*** (0.019)	0.0228 (0.024)	0.1777*** (0.014)	0.1095*** (0.024)	-0.0079 (0.029)	-0.0942 (0.089)
Age: 30-44	0.1773*** (0.011)	-0.0451 (0.070)	0.1981*** (0.010)	0.1427*** (0.022)	0.1327*** (0.023)	0.2035** (0.080)
Age: 45-64	0.1789*** (0.021)	0.0048 (0.063)	0.1915*** (0.026)	0.1660*** (0.028)	0.1430*** (0.041)	0.2312** (0.092)
Age: > 65	-0.1030* (0.056)	0.1589* (0.088)	-0.1057* (0.061)	-0.0708 (0.063)	-0.0702 (0.150)	-0.4421 (0.450)
Primary Education	0.6080*** (0.139)	0.0000 (.)	0.3107** (0.123)	0.0000 (.)	0.7395*** (0.240)	0.0000 (.)
Secondary Education	0.7432*** (0.148)	0.2606*** (0.054)	0.4065*** (0.113)	0.1264*** (0.038)	0.9620*** (0.244)	0.1759** (0.080)
Technical Education	0.8882*** (0.148)	0.4325*** (0.067)	0.5576*** (0.112)	0.2753*** (0.043)	1.1022*** (0.241)	0.2940*** (0.109)
UG-PG degree	1.1431*** (0.155)	0.7367*** (0.091)	0.7853*** (0.108)	0.5141*** (0.059)	1.4095*** (0.266)	0.5918*** (0.126)
Middle Income Department	0.0940*** (0.026)	0.0800** (0.036)	0.0853*** (0.024)	0.0824*** (0.024)	0.1126** (0.055)	0.0848 (0.056)
High Income Department	0.2201*** (0.031)	0.1290*** (0.033)	0.2077*** (0.031)	0.2035*** (0.031)	0.2472*** (0.059)	0.2163*** (0.060)
Inverse Mills Ratio		-18.7562*** (5.337)		-5.4950*** (1.888)		4.2205 (5.207)
Observations	14046	13985	10192	10164	3854	3821
R^2	0.35	0.31	0.34	0.34	0.34	0.34

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include year and industry fixed effects. † Results are from a Heckman two-stage estimation.

employers, I also estimate Equation 1.2 solely for men in Columns 3 and 4 and solely for women in Columns 5 and 6. I find that there is significant selection biased when estimating the model only for men and that there is no selection biased when estimating the model only for women. Thus, I discuss the Heckman estimated model for men and the OLS estimation for women. As Column 4 shows, men's income when hired as intensive-informal workers is 38 pp lower than that of men formally hired. Similarly, women hired in the intensive margin of informality earn 51 pp less than female formally hired (Column 5).

Also, I find that married men have higher wages when hired formally or in the intensive margin of informality. Moreover, women do not see their income altered for being married when employed in any way by a registered employer. Furthermore, I find that age affects wages in a similar way for men and women. Namely, their income is positively affected when they are in the age range 30-64 years old.

Similarly to results in Section 1.5.1, education is related to higher income. However, the degree in which an additional level of education affects income is greater for women than it is for men. For example, on the one hand, men with a technical degree see their income increase by 28 pp with respect to men in registered firms with no education. On the other hand, women with a technical degree receive an income 110 pp higher than women with no education in registered firms. Moreover, the department of residence has a more significant impact on women's wages than it does on men's income. Women living in high-income regions see their wages enlarged more than men with similar characteristics.

1.6 Conclusions

This chapter shows that there are two margins of informality and that these are distinct and relevant. Also, I confirm two widely accepted facts in the literature: i) informal workers' income is lower than that of formal ones and ii) women's wages are consistently lesser than their male counterparts. Most importantly, I show

that these wage penalties are significantly larger for women hired in the extensive margin of informality than for women in the intensive margin of informality.

Furthermore, I show that the individual characteristics determinant in self-selecting in one margin of informality are not necessarily the same that drive auto-selection into the other margin. While in the literature, many times informal workers are described as uneducated, young and poor individuals, a simple descriptive analysis shows that this is not true for both margins of informality. Informal workers employed by registered employers are closer to formal workers than to extensive-informal workers in terms of education and income. Extensive-informal workers have indeed the lowest income in the market. Moreover, they are mostly found in the poor regions in Peru and tend to be young single men with secondary education or below. Furthermore, women in the extensive margin of informality earn a significantly lower wage than men. They are extremely vulnerable to this type of employment when living in low-income departments of Peru.

In this way, I find evidence consistent with the hypothesis that while workers resort to the extensive margin of informality out of necessity, they accept jobs in the intensive margin of informality with the hope that it will become a formal contract in time.

To conclude, when governments write policies with the intent to reduce the gender wage gap in countries such as Peru where informal employment is important, it is vital that they take into account that there are at least two margins of informality to consider. As I showed, the informality wage penalty levies women more than men. Crucially, the extensive margin of informality taxes women significantly more than the intensive margin does.

Chapter 2

Unfolding Trade Effect in Two Margins of Informality. The Peruvian Case.

2.1 Introduction

Informality is a prevailing and persistent feature in labour markets in developing countries. Loosely describing informal labour as jobs that do not comply with taxation nor the regulations that ensure protection to workers such as paid holidays, parental leave and retirement. The informal sector accounts for over 50% in Latin America, over 58% in Asia and 76% of total employment in Africa (ILO, 2018; WB, 2018). In this paper I study the effect of trade liberalisation on informal labour by distinguishing two crucial margins of informality. Following Ulyssea (2018), the *extensive margin* refers to workers hired by firms that are not legally registered with the tax collection agency; and the *intensive margin* refers to informal workers employed in registered firms.

The growing literature addressing the effect of trade liberalisation on informality has focused on the extensive margin and treated informality as a binary decision to

comply or not with taxes and regulations (Dix-Carneiro et al., 2018; Dix-Carneiro and Kovak, 2015, 2017; Ulyssea and Ponczek, 2018; Goldberg and Pavcnik, 2003, 2007; McCaig and Pavcnik, 2015, 2018; Bosch et al., 2012; Cruces et al., 2018; Paz, 2014; Filho and Muendler, 2007). The intensive margin allows to detach firm informality from worker informality. Hence, I am able to shed light on the different mechanisms that affect each margin of informality when trade liberalisation takes place.

I build on the informality and trade literature and take a novel approach. I distinguish these two margins of informality when studying a reduction in tariffs. In doing so, I am able to study in isolation two different economic mechanisms. Moreover, each of these mechanisms has distinct policy implications that are of great importance when choosing a public policy that aims at reducing informality. I show that these margins of informality react in opposite directions when tariffs go down. As a result, the question on the effect of trade liberalisation on informality requires an empirical analysis.

Using data from Peru's manufacturing sector, results suggest that a reduction in tariffs triggers two competing and contrasting effects. On the one hand, I find that extensive-informal employment diminishes in all industries as tariffs drop. On the other hand, in industries where firms, on average, have less than 50 employees, intensive-informal employment grows when tariffs decline.

Due to data constraints I can only speculate as to what drives these results. I claim that a reduction in tariffs affects each margin of informality through a different mechanism. On the one hand, trade liberalisation induces reallocation towards more efficient firms through a selection effect identified by Melitz (2003). Since unregistered employers are less productive than registered ones (Perry et al., 2007; Maloney, 2004; Ulyssea, 2018), informal firms that hire only these type of workers are not efficient enough to survive an increase in competition and are forced to exit or shrink. In this way, trade liberalisation reduces extensive-informal employment

in the economy.

On the other hand, when tariffs drop generates a negative shock for domestic firms that would have to compete with new products coming from abroad, firms might look for ways to cut costs. Since informal workers are “cheaper” than formal workers, because of taxes associated with formality, a reduction in tariffs could translate into an increase in the fraction of informal workers as an adjustment mechanism to remain competitive. I argue that before the tariffs cut, firms restrain themselves from hiring informal workers, despite being cheaper, because hiring them comes with a risk of, for example, paying a fine in case of getting caught. This risk is worth taking only after import competition increased as the alternative could be bankruptcy.¹ In this way, intensive-informal employment escalates with trade liberalisation.

The relative strength of each effect when a country becomes more open is difficult to establish as there is no ex-ante theoretical answer. Therefore, the effect of trade liberalisation on informal employment requires an empirical study. Due to data constraints, I am not able to observe firms’ decisions and verify the mechanisms I described. Nevertheless, I can examine firms’ labour outcomes and study the effect on informal employment in both margins when tariffs go down. I find that the overall effect of a tariff cut on informality is dominated by the intensive margin. Thus, a boost in import competition generates an overall increase in informal employment.

Peru provides a very suitable context to study this question as approximately 70% of total employment in manufacturing was informal in 2014, the highest in the region. At the same time, Peru exhibited a practically unprecedented annual growth rate of 6% for more than a decade (except in the crisis period of 2008-

¹In trade literature, firms respond to a reduction in tariffs by reducing wages or firing workers. Assuming that the probability of an inspection is increasing in the size of the firm and that firms fire workers after tariffs are cut, firms’ are more likely to hire informal workers after tariffs go down. Then, another way to rationalize this mechanism is that since the probability of getting caught decreases with their size, firms are less likely to get caught if hiring informal workers. Hence, they are prone to do so.

2009). Moreover, from 2002 to 2013, Peru ranked second for growth in Latin America. Furthermore, since the 2000s Peru is also the most open country in Latin America, as its average applied tariff went down to less than 5% while the norm in the region was 15%.

The empirical strategy is twofold. First, I study the effect at the individual level on the probability to be hired as an informal employee in each margin. Second, I study how employment composition shifts at the industry level when tariffs drop. Results are robust to these two different approaches. I find that when tariffs drop, both the probability to hire informally in the extensive margin and the fraction of workers who are hired as extensive-informal employees at the industry level decrease. Conversely, as competition tightens the probability to be hired in the intensive margin of informality rather than as a formal employee, increases in industries where employers, on average, have less than 50 employees. Similarly, in those same industries, the share of intensive-informal employment on total employment within registered firms increases. Crucially, results suggest that the effect of trade liberalisation on informal labour is driven by the intensive margin of informality. Namely, the effect on informal labour employed by registered employers is stronger than the effect on labour employed by unregistered employers. Hence, informality as a whole increases when there is an increase in import competition.

My findings show that distinguishing between the extensive and intensive margin of informality is central when seeking to understand the underlying mechanisms that the effect of trade liberalisation has on informality. Moreover, from a policy standpoint, it is relevant to know that the prevailing impact on informality is through informal workers hired by firms that do pay taxes. Thus, my results would suggest that to address informality, authorities should focus on monitoring registered firms to ensure that they fully comply with taxes and regulations, instead of aiming for policies that reduce entry costs in the formal sector.

I build on Ulyssea (2018) and Samaniego de la Parra (2016), who study informal-

ity while considering both the intensive and the extensive margin of informality. However, since they set their study in a closed economy framework, their research questions are very different. Ulyssea (2018) uses an estimated model to conduct counter-factual analysis of a reduction in the payroll tax, an increase in law enforcement on hiring off the books, and a change in entry cost for formal and informal firms. He finds that there are winners and losers in all policies and that a reduction on informality does not necessarily mean higher GDP, TFP or welfare. Samaniego de la Parra (2016) studies empirically an increase in the inspections in the Mexican market and finds that spouses of informal workers change their labour market participation decision and reservation wage after an inspection.

These papers belong to a vast informality literature. This literature encompasses three different views on informality (La Porta and Shleifer, 2008, 2014). I contribute to all of them because, as Ulyssea (2018) shows when introducing the distinction between the intensive and the extensive margin of informality, these views are not competing frameworks. They are in fact, echoing the presence of firm heterogeneity when deciding what taxes to pay and which regulations to obey. The first view, describes informality as a reservoir of productive entrepreneurs that due to barriers such as taxes or burdensome regulations are unable to enter the formal economy (De Soto, 1989, 2000). The second one, sees informal firms as parasites that could survive in the formal sector but prefer to enjoy the advantages of not paying taxes and avoid regulations (Farrell, 2004; Levy, 2008). Lastly, the third view considers firms and workers operating outside the formal economy as inherently inefficient (Rauch, 1991; Maloney, 2004; Amaral and Quintin, 2006; Perry et al., 2007; de Paula and Scheinkman, 2011).

This paper most significant contribution is to the growing stream of literature that studies the effect of trade on informality. Notably, there is a recent and expanding literature which takes a local labour market approach to research labour market effects from trade in Brazil (Dix-Carneiro et al., 2018; Dix-Carneiro and Kovak, 2015, 2017; Ulyssea and Ponczek, 2018). They show that informality acts like a

buffer that absorbs displaced workers from trade liberalisation. Hence, exposure to trade leads to an increase in informality.

In the past, the relationship between informality and trade seemed unclear.² However, recent papers taking the industry level approach have found similar results to the papers using the local labour market approach. For instance, McCaig and Pavcnik (2018) study the effect of the United States-Vietnam bilateral trade agreement on labour allocation and find that the share of manufacturing formal employment increased in response to US tariff reductions. Also, Acosta and Montes-Rojas (2014) and Cruces et al. (2018) study the effect that trade liberalisation has on informality in Argentina. They concur that trade increases informality in the industries where trade liberalisation has been more intense. Moreover, Cruces et al. (2018) specifies that the magnitude of the effect depends on the size of the firm and Acosta and Montes-Rojas (2014) brings attention to industries with low investment ratios. Paz (2014) builds a small open economy model in which tariffs impact on firms' payroll tax compliance. Using data from Brazil, he finds that a reduction in import tariffs increases the share of informal labour.

The paper is organised as follows: Section 2.2 describes the dataset and the definitions used throughout the paper. Section 2.3 characterizes the Peruvian economy focusing on the manufacturing sector. Section 2.4 discusses the estimation strategy and presents the empirical results. Section 2.5 concludes.

2.2 Data and Definitions

The empirical analysis in this paper uses two main data sources. The data on informality comes from the Peruvian National Household Survey (ENAHU) provided by the Peruvian Institute of Statistics (INEI) and the information on tariffs

²Bosch et al. (2012) establish that trade liberalisation explains to a very small extent, the increase in the size of the informal sector in Brazilian metropolitan labour markets. Goldberg and Pavcnik (2003) study the effect that an increase in foreign competition has on Brazil and Colombia. They conclude that trade policy is of second order of relevance in the effect on informal employment.

comes from the World Trade Organization’s Tariff Analysis Online (WTO’s TAO) Database. I also construct input tariffs using the 2007 input-output Peruvian table provided by the INEI.

The ENAHO is a continuous survey which began in May 2003. However, since the questions I use to classify workers’ informality status are only present from 2007, the analysis started in 2007. The survey is representative of the Peruvian population. It comprises information regarding all households and its occupants surveyed in all 24 Peruvian departments.³ In this paper, I am only interested in the population that is economically active in the sense that they are either employed or looking for a job. Hence, I mainly use data from the section regarding the independent worker (ENAHO.04) and labour and income (ENAHO.500) which contain information on individuals who are at least fourteen years old.

All individuals in the dataset are classified as either intensive-informal, extensive-informal or formal employees. In order to do so, I follow the methodology proposed by the INEI and the International Labour Organization’s agency for the Formalization in Latin America and the Caribbean (FORLAC). First, I distinguish the extensive margin of informality. Since the Peruvian Tax agency (SUNAT) requires all firms to keep books using either an online platform or with a specific software, when workers declare that their employer does not keep books in a way that agrees with the Tax agency, the employer is classified as an “informal employer”. In case the worker is self-employed, it is considered to have a registered employer if it is registered as a legal person or as a legal entity (with Tax Identity Number: RUC, RUS, RER).⁴ Otherwise, it is considered to have an unregistered employer and is classified as an informal worker in the extensive margin.

Second, I characterize the intensive margin of informality. Intensive-informal work-

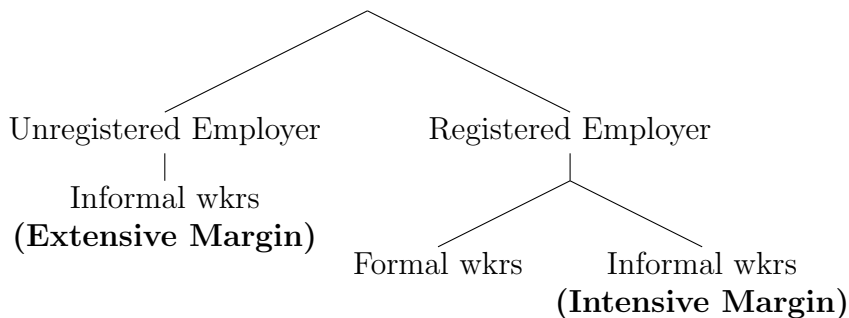
³Departments are the first-level administrative subdivisions of Peru.

⁴RUC comes from its acronym in Spanish *registro unico del contribuyente*, it uniquely registers all taxpayers, firms or individuals. RUS is a tax system that was created to motivate formalization. It targets small firms and tax them based on their sales. RER is a system that targets only people whose annual income does not exceeded the USD 61200.

ers can be employed on a family firm or as a salaried employee. Individuals employed by a registered family firm but as a non-paid family worker are considered intensive-informal. Due to a change in the questionnaire, salaried workers are classified as intensive-informal using different criteria before and after 2011. Salaried workers surveyed between 2007 and 2011 are classified as informal workers if they declare that their income is not deducted by the tax collection agency in any way. Individuals surveyed between 2012 and 2014 are considered informal workers if, contrary to Peruvian legislation, their employer does not pay health insurance on their behalf.⁵ In the empirical analysis, I also study the period 2007-2011 as a robustness check to make sure that the change on the way I classify intensive-informal employment does not tamper results.

As Figure 2.1 illustrates, throughout this paper I define as *extensive-informal workers* those employed by an unregistered employer and all the self-employed individuals who do not pay taxes for their income. Moreover, *intensive-informal workers* are those that are defined as informal workers and are employed by an employer that is registered with the Tax Institution.

Figure 2.1: Informality Status



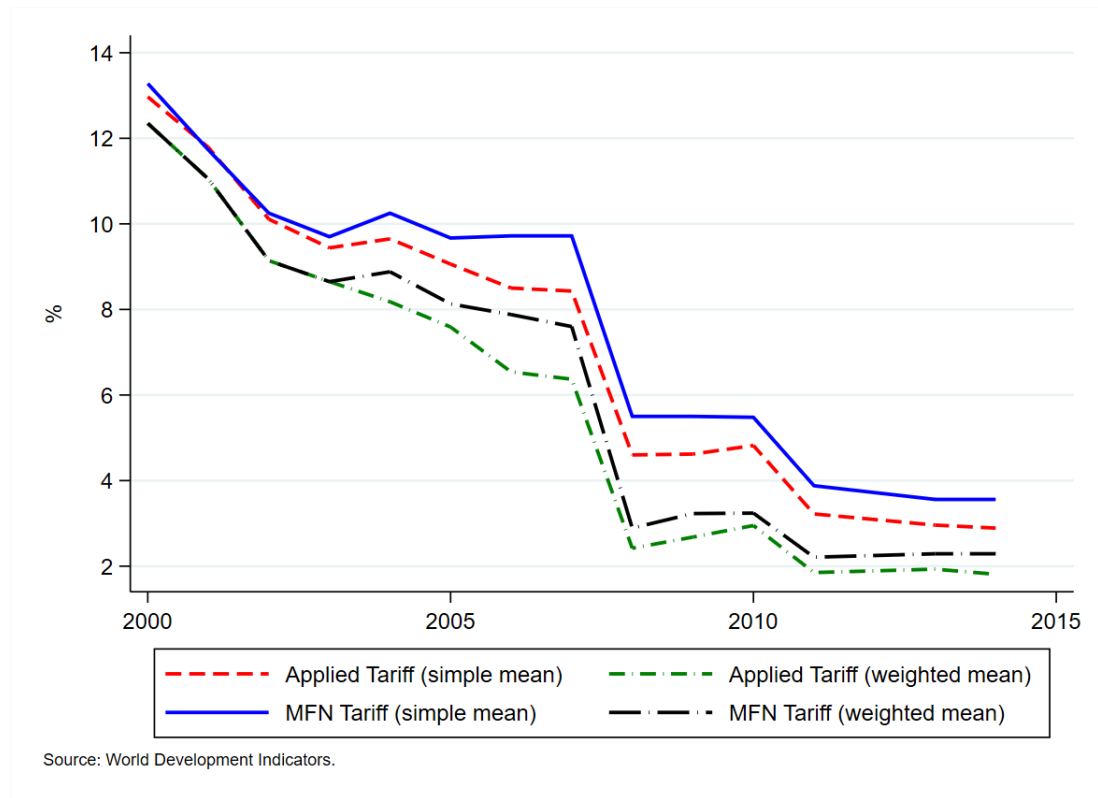
As with all self-reported surveys, individuals' answers reliability is a concern. However, since my interest is mostly in how informality changes across time rather than measuring it in one specific point in time, the measurement error would arguably not alter my results. Moreover, it is worth pointing out that both the data and the way I determine informality status is widely used in academic papers

⁵The question regarding income deductions only exists between 2007 and 2011. The question regarding health insurance only exists from 2012 onwards.

and in policy reports from the ILO and OECD (Chacaltana, 2017; FORLAC, 2014a,b; OECD, 2019; Villagomez and Chaffloque, 2019; Chong et al., 2008).

The survey contains information on individuals' socio-demographic characteristics such as age, gender, civil status, race, education level and department of residence. This information is valuable as it allows me to build a profile of the informal worker in each margin of informality. Crucial to my empirical strategy is that, even though it is a household survey, individuals are also asked specific questions on their employer. They are asked how many people work in their place of work and the employer's industry at ISIC 4 digit level revision 3. This information is fundamental to my analysis as it allows me to link worker's data with trade data through the worker's employer industry affiliation .

Figure 2.2: Tariffs in Manufacturing



I measure trade openness with the average Most Favoured Nation tariff (MFN). The MFN tariffs are what countries promise to impose on imports from other members of the WTO, unless the country is part of a preferential trade agreement (such as a free trade area or customs union). This means that, in practice, MFN

rates are the highest (most restrictive) that WTO members charge one another. As shown in Figure 2.2, the MFN tariff is higher than the applied tariff because it does not take into account trade agreements. Even though the MFN tariff is a conservative measure of the country's openness, to my knowledge, it is the only tariff available for Peru at 6-digit level of disaggregation.⁶

I obtain the MFN tariffs from the WTO's Tariff Analysis Online (TAO) for the period 2007-2014 without information for 2012. For a reason I am not aware of, information for 2012 was not published in the WTO but it was available in the Peruvian Central Bank (BCRP).⁷ The WTO publishes the data using the Harmonized System of commodity classification at a 6-digit level of aggregation in three editions.⁸ I link the informality data to the trade data using several correspondences tables from World Integration Trade Solution (WIITS).

2.3 Peru: Openness and Informality

2.3.1 Trade Liberalisation

Peru underwent a major trade liberalisation in the 1990s that focused on dismantling the import substitution industrialisation policy, a protectionist scheme set in 1970s. An additional opening process happened in the 2000s during one of the fastest economic growth periods recorded in Peru. In this way, Peru concluded its liberalisation process by reducing its average tariffs from 14% to 5%.

While the first wave is more drastic, it was also more homogeneous. The reduction in tariffs on the 2000s shows much more heterogeneous tariff reduction across industries. I study the second wave of liberalisation to take advantage of this

⁶The World Development Indicators database (source of the data in Figure 2.2) only provides the average for the manufacturing sector.

⁷Even though information in the BCRP for other years is consistent with WTO information, as a robustness check I also conduct the analysis in Section 2.4 for the period 2007-2011 and results are reported in the Appendix in Tables B.5 and B.6.

⁸For 2007 and 2008 the information is expressed in the 2007 edition (HS07) and for the following periods it is in the 2012 edition (HS12).

heterogeneity. Moreover, during this period, informality varies across industries both in terms of importance and in terms of the margin of informality.

As shown in Table 2.1, the level of protection varies significantly from one industry to another. All tariffs are falling after 2007 and they do so at different rates in different industries. For example; food, textiles, clothing, wood and furniture experienced a stronger liberalisation than chemicals and machinery. In any case, it is evident by looking at the last row that Peru experienced a continuous liberalisation process in terms of average output tariffs during the period of study.

When countries cut down tariffs across industries, they might also reduce tariffs on intermediate inputs. As a result, the increase in import competition that firms face might be offset by a reduction in the cost of their imported inputs. I construct input tariffs as in Topalova and Khandelwal (2011) to ensure that firms are indeed facing an increase in import competition as a result of a reduction in tariffs. Then, input tariffs are estimated as follows:

$$IT_{jt} = \sum_s \alpha_{js} * OT_{st} \quad (2.1)$$

where IT_{jt} is the input tariff in industry j in year t , α_{js} is the share of input s in the value of output j , and OT_{st} is the output tariff in industry s in year t . The α 's are calculated using the Peruvian Input-Output table for 2007 made available by the Peruvian Institute of Statistics (INEI).

As shown in Figure 2.3, not only output tariffs were dropping during the period of study, input tariffs were also significantly cut.⁹ Then, it could be argued that firms costs might have declined enough to offset the increase in import competition. Hence, I control for input tariffs in all the specifications that I discuss in the next Section.

⁹Figure 2.3 shows a box plot for input tariffs in manufacturing. The box upper limit is the third quartile (Q3), and the lower limit is the first quartile (Q1). The line in the middle of the box is the median. The ends of the whiskers are the most extreme values within $Q3+1.5(Q3-Q1)$ and $Q1-1.5(Q3-Q1)$, respectively. The points on top of the whiskers are outliers.

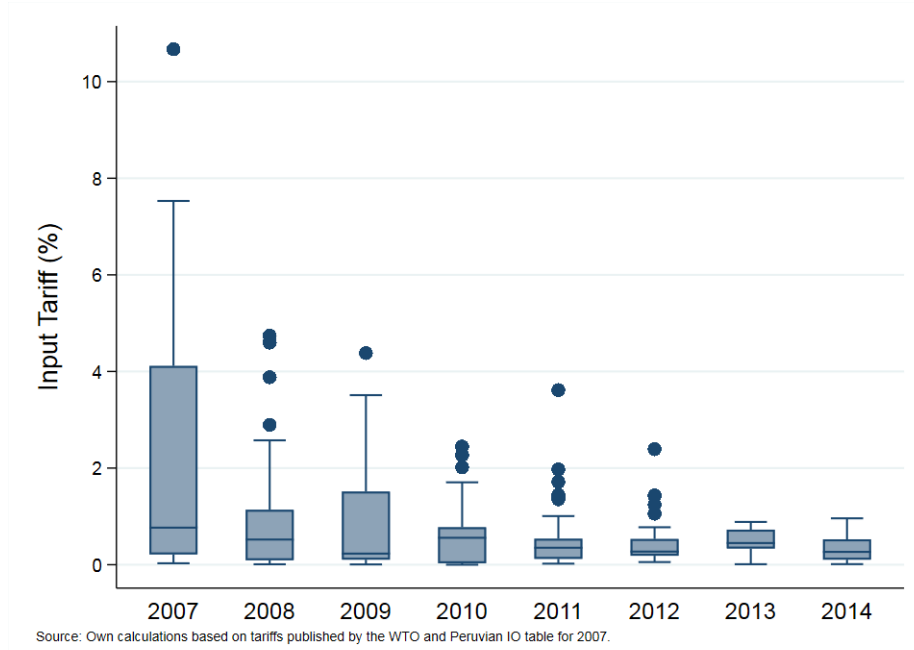
Table 2.1: Tariffs in Manufacturing (%)

	2007	2008	2009	2010	2011	2012	2013	2014
Food products and beverages	17.01	10.38	4.17	3.99	2.35	2.09	2.28	2.23
Textiles	18.19	15.32	15.15	14.43	10.94	9.18	9.45	9.35
Wearing apparel; dressing and dyeing of fur	19.55	16.53	16.52	16.53	12.61	10.71	10.72	10.73
Tanning and dressing of leather	17.38	15.60	15.27	14.20	10.68	9.75	9.29	9.53
Wood products, except furniture	11.42	6.56	5.71	5.36	3.69	3.81	3.86	3.65
Publishing, printing and reproduction of recorded media	11.07	7.38	6.38	5.44	4.87	4.83	4.70	4.40
Chemicals and chemical products	6.76	5.18	4.75	4.69	2.95	3.37	2.66	2.82
Rubber and plastics products	8.47	4.27	4.96	5.23	3.41	3.44	3.38	3.61
Other non-metallic mineral products	3.90	2.26	1.24	2.49	1.77	2.23	1.33	1.19
Basic metals	9.36	5.60	4.95	5.55	2.93	3.33	3.12	2.08
Fabricated metal products, except machinery and equipment	11.46	2.91	1.96	2.33	0.94	1.09	1.08	1.07
Machinery and equipment	2.41	0.60	1.42	0.86	0.75	0.84	0.47	0.70
Other transport equipment	1.12	0.22	0.65	0.16	0.09	0.01	0.16	0.04
Furniture	11.27	8.03	7.97	8.05	5.36	5.36	5.37	5.33
Average in Manufacturing	14.68	10.53	8.30	8.07	5.52	5.12	5.13	5.08

Source: Own elaboration based on WTO.

Notes: Average MFN tariff at the 2 digit ISIC level within the Manufacturing sector.

Figure 2.3: Input Tariffs in Manufacturing



Source: Own elaboration based on tariffs published by WTO and Peruvian IO table for 2007.

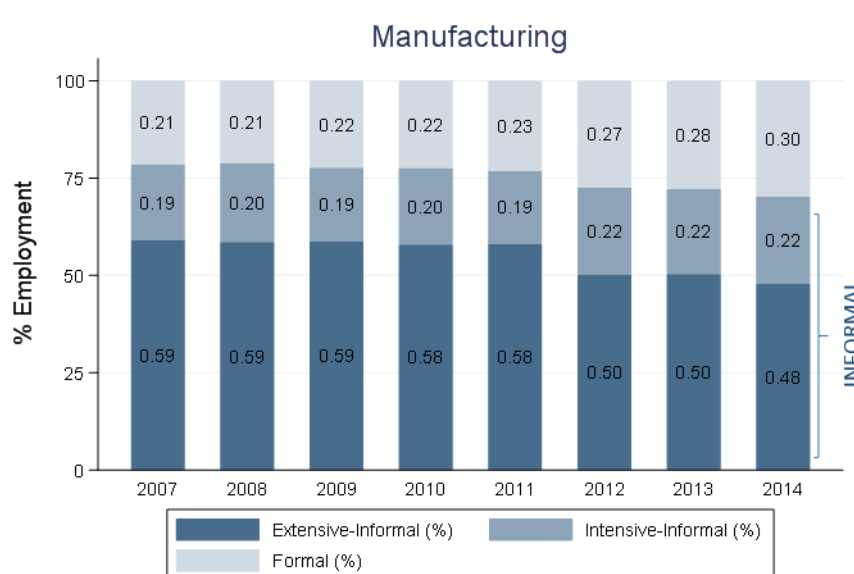
Notes: Outliers from the following industries are not included in the Figure: Manufacture of food products and beverages, Manufacture of textiles, Manufacture of wearing apparel, Tanning and dressing of leather and Manufacture of wood products and cork.

2.3.2 Informal Labour

In this paper, I study informal labour in the manufacturing sector. I take advantage of a rich dataset and divide total employment into three types of labour: i) informal labour in the *extensive margin* (jobs carried out in unregistered firms), ii) informal labour in the *intensive margin* (workers hired by registered firms but in an employment relationship that does not comply with labour legislation) and iii) formal labour in registered firms. As Figure 2.4 shows, informal employment accounted for almost 80% of total employment in 2007 and even though it decreased in importance, by 2014, it still accounted for 70%.

It is more likely to understand the underlying mechanisms through which trade affects informal labour when opening up the informal sector in these two margins of informality. The analysis in Section 2.4 recognizes that informal employment's reaction to an increase in import competition might be different for each margin of

Figure 2.4: Total Employment



Source: Peruvian National Household Survey (ENAHU) 2007-2014

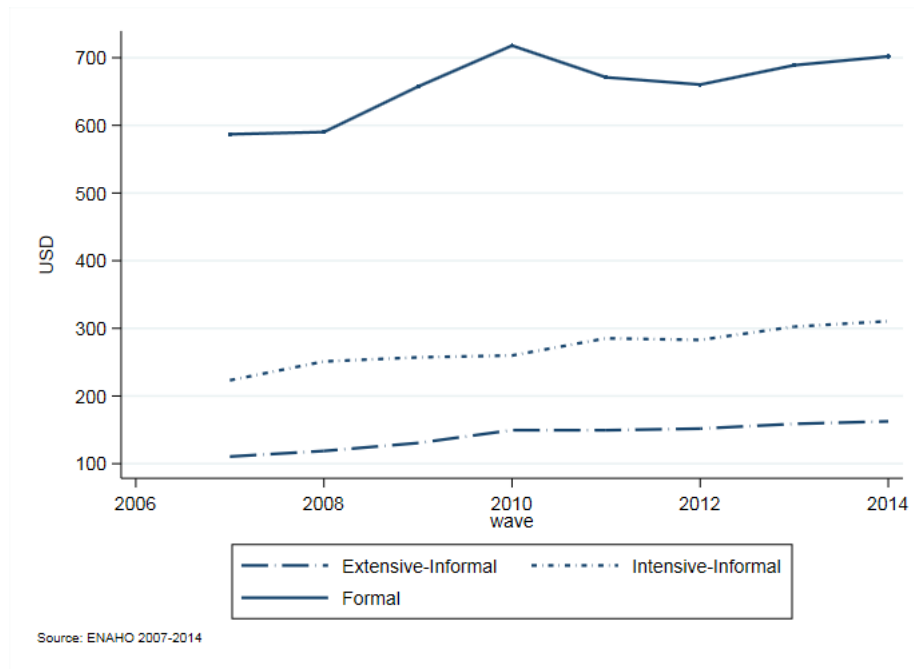
informality. On the one hand, extensive-informal workers might struggle to retain their job as they tend to be least efficient workers in the economy (Ulyssea, 2018; Maloney, 2004). On the other hand, intensive-informal workers might benefit from being cheaper than formal workers and manage to preserve their position.

As Figure 2.5 shows, extensive-informal workers consistently earn a lower income than all other workers. Moreover, extensive-informal employees' average income is lower than the minimum wage.¹⁰ Also, from Figure 2.5 its evident that there is a big difference between wages for workers in the intensive margin of informality and formal employees. Intensive-informal employees earn on average half of formal workers' monthly wage.

Informal workers' employers are different when they are registered and when they are not. It is widely documented in the literature that extensive-informal workers' employers are smaller than the ones hiring intensive-informal workers (Maloney, 2004; Paz, 2014; Perry et al., 2007). This is often driven by Tax and Labour legislation that favours smaller firms. In the Peruvian case, in order to access

¹⁰The minimum wage in Peru has evolved as follows: In 2007 it was PEN 530, in 2008 and 2009 it was PEN 550, in 2010 it was PEN 580, in 2011 it was PEN 675 and 2012-2015 it was PEN 750.

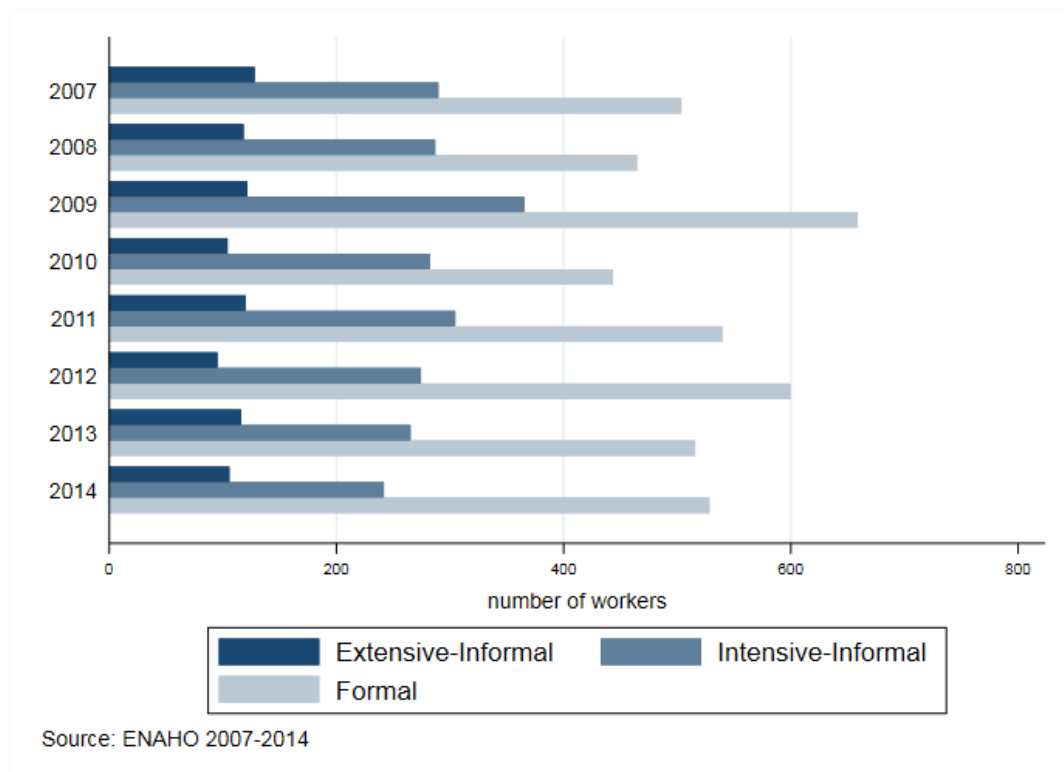
Figure 2.5: Average Monthly Income by Informality Status



those benefits firms had to have less than 10 employees up to 2008 when the law changed and small enterprises were defined as those with less than 100 workers. I find that throughout the period 2007-2014, approximately 60% of individuals in Peru are hired by employers with less than 100 workers while only 10% are hired by employers with more than 500 workers. Moreover, firms size distribution is skewed to the right. Figure 2.6 shows that extensive-informal workers are employed in industries where employers tend to have less than 100 workers. In the same way, intensive-informal workers are more likely to be in industries where employers, on average have between 200 and 300 workers. Finally, formal workers are on average, hired in industries where employers tend to have more than 400 workers.

In the identification strategy discussed in Section 2.4, I also take into account that the literature often describes informal workers as single women with low education. I find that description is somewhat accurate when equating the extensive margin of informality with the totality of informal employment. However, the intensive margin of informality is not necessarily composed by that demographic. In Table 2.2, I present the results of two linear probabilities models (LPM) with the sole intent of providing a descriptive analysis of informal workers' demographic charac-

Figure 2.6: Average Industry Size by Informality Status



Notes: All surveyed individuals are asked how many workers are employed in their workplace. With this information I calculate an industry-year average at the 4 digit level. This Figure presents the average industry size per informality status in each year of the sample.

teristics in either margin. In Column 1, the dependent variable takes value of 1 if the individual is hired as an extensive-informal worker and 0 otherwise. In Column 2, the dependent variable takes value of 1 if the individual is an intensive-informal worker and 0 if the individual is a formal employee.

Column 1 shows that it is less likely to be hired in the extensive margin of informality for married men with above secondary education. Moreover, individuals above 45 years old are more likely to be hired as extensive-informal workers. Also, individuals identified with the quechua ethnicity are more likely to be in the extensive margin of informality. As expected, extensive-informal workers tend to be the most vulnerable in the workforce as they are also the ones with very little bargaining power and simply take the job that is offered.

Results in Column 2 show that single women with less than 30 years and education below secondary school are more likely to work in the intensive margin of informality than as a formal employee. Moreover, older workers employed by registered employers are less likely to be informally hired. In this case, ethnicity does not seem to play a role. As I do not have more information I can only speculate. However, it appears that informal workers are entry-level posts with registered employers. Since they are probably healthy and do not think about retirement yet, they are willing to renounce to the benefits that come with a formal job such as a pension, health insurance and parental pay.

2.3.3 Manufacturing Sector

The literature finds that the proportion of informal workers in a firm's labour force diminishes with the size of the firm as larger firms are more likely to face an inspection (Kleven et al., 2016). Moreover, unregistered firms tend to be smaller than registered firms (Levy, 2008). Even though I do not have firm level data, the household survey asks individuals the number of workers employed in their workplace. It is quite unlikely for an individual to know the exact amount of

Table 2.2: Individual Characteristics

	Extensive-Informal Indicator	Intensive-Informal Indicator
	(1)	(2)
Married	-0.0165* (0.008)	-0.1244*** (0.012)
Male	-0.1870*** (0.022)	-0.0649*** (0.010)
Primary Education	-0.0530 (0.045)	-0.0717 (0.078)
Secondary Education	-0.2110*** (0.057)	-0.1478* (0.078)
Technical Education	-0.3070*** (0.059)	-0.2733*** (0.076)
UG-PG degree	-0.3380*** (0.060)	-0.3038*** (0.082)
Quechua ethnicity	0.0368*** (0.009)	-0.0184 (0.016)
Age: 30-44	-0.0140 (0.011)	-0.2486*** (0.017)
Age: 45-64	0.0436* (0.024)	-0.3424*** (0.025)
Age: > 65	0.1201*** (0.027)	-0.3347*** (0.037)
Observations [†]	31009	14126
R^2	0.34	0.23

[†] In Column 1, the LPM is estimated on total employment. In Column 2, the LPM is estimated conditional on workers with a registered employer.

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

workers employed. However, most workers do have a rough idea of how many people work with them. Intending to correct for this measurement error, I calculate the average size of each 4 digit industry in every given year.¹¹ In this way, I have an average employer size per industry and year that hopefully allows for any inaccuracies on workers' knowledge on the size of their employer to cancel out.

Since industry size is an important variable in the study I conduct in the following Section, Table 2.3 sheds some light on which are the industries with the smallest and the largest employers. Table 2.3 groups manufacturing industries at the 2 digit level. It shows that most employers in food products and beverages tend to have over 50 employees. In contrast, in textiles, firms tend to have between 16 and 50 workers. Also, while in industries such as Basic Metals and Furniture, average industry size does not vary much over time, in industries such as Food products and Other transport equipment, there is quite a change on employers' size between 2007 and 2014.

As some industries seem to consistently have smaller firms, it is also possible to see that some industries tend to be characterized by one of the informality margins. As Table 2.4 shows, manufacturing of furniture, textiles and wearing apparel are the 2 digit industries where most workers are hired as extensive-informal employees. Conversely, workers employed in the manufacturing of basic metals are mostly formally employed.

It could be argued that some industries might have a stronger lobby power and would be able to advocate for a lower reduction in tariffs to protect their sector. Since these industries would also be more visible to the government, one could infer that these are also the industries with less informal workers. By comparing Tables 2.1 and 2.4 it is possible to see that there is no relationship between industries' informality and industries' openness. For example, the industry of *food products and beverages* experienced a drop in tariffs of 14% between 2007 and 2014, the

¹¹In all waves between 2007 and 2014 of the household survey ENAHO employees are asked how many workers are employed in their workplace.

Table 2.3: Employer Size in Manufacturing (%)

	2007			2014		
	Average Employer Size ≤15	Average Employer Size 16-50	Average Employer Size >50	Average Employer Size ≤15	Average Employer Size 16-50	Average Employer Size >50
	(1)	(2)	(3)	(4)	(5)	(6)
Food products and beverages	7.6	4.76	87.64	8.31	35.9	55.78
Textiles	27.42	53.52	19.06	28.16	58.18	13.66
Wearing apparel; dressing and dyeing of fur			100			100
Tanning and dressing of leather	29.84	70.16		25.95	74.05	
Wood products, except furniture	36.36		63.64	35.61	59.47	4.92
Publishing, printing and media		7.69	92.31	4.27	0.85	94.87
Chemicals and chemical products			100		2.3	97.7
Rubber and plastics products	11.11		88.89			100
Other non-metallic mineral products	64.47	19.08	16.45	6.63	50.51	42.86
Basic metals			100			100
Fabricated metal products		20.4	79.6		13.44	86.56
Machinery and equipment	15.22	20.65	64.13		13.04	86.96
Other transport equipment	48.65	2.7	48.65	1.89		98.11
Furniture	0.82	94.29	4.9	6.21	93.79	
Total	13.35	27.81	58.84	10.59	39.15	50.26

Source: Own elaboration based on ENAHO 2007 and 2014.

Notes: Columns 1-3 show how total employment in a given industry was distributed in 2007. Similarly, Columns 4-6 show total employment distribution in 2014. From employees declaration on their workplace size in terms of the number of workers, I calculate the average industry size at the 4 digit level for every year in the sample. This Table shows the distribution within industries at the 2 digit level.

Table 2.4: Two Margins of Informality in Manufacturing (%)

	2007			2014		
	Extensive Informal	Intensive Informal	Formal worker	Extensive Informal	Intensive Informal	Formal worker
	(1)	(2)	(3)	(4)	(5)	(6)
Food products and beverages	47.82	23.81	28.37	39.76	25.19	35.05
Textiles	82.4	6.45	11.14	82.12	7.42	10.46
Wearing apparel	60.21	19.9	19.9	51.45	22.99	25.56
Tanning and dressing of leather	54.03	29.03	16.94	46.49	36.76	16.76
Wood products, except furniture	52.63	33.49	13.88	50	26.52	23.48
Publishing and printing	19.23	44.23	36.54	14.53	40.17	45.3
Chemicals and its products	27.16	27.16	45.68	6.9	17.24	75.86
Rubber and plastics products	13.89	30.56	55.56	12.5	22.5	65
Other non-metallic mineral products	76.97	7.89	15.13	57.65	11.73	30.61
Basic metals	7.41	18.52	74.07	10.42	18.75	70.83
Fabricated metal products	58.8	20.8	20.4	34.06	25.94	40
Machinery and equipment	21.74	33.7	44.57	15.65	26.96	57.39
Other transport equipment	51.35	16.22	32.43	41.51	28.3	30.19
Furniture	73.88	13.06	13.06	55.11	22.24	22.65
TOTAL	59.05	19.46	21.49	47.82	22.34	29.84

Source: Own elaboration based on ENAHO 2007 and 2014.

Notes: Columns 1-3 show the labour composition in a given industry in 2007 and Columns 4-6 in 2014. This Table shows how total employment is composed of intensive-informal, extensive-informal and formal workers within industries at the 2 digit level.

largest within manufacturing, while 35% of its employment is formal. Given that the average share of formal employment in 2007 in manufacturing was a bit less than 30%, *food products and beverages* industry does not have a particularly low share of informal labour. Also, *chemicals and its products* industry experienced a drop of less than 4% on its tariffs in the same period while having over 76% of its employment formal in 2007.

2.4 Identification Strategy and Results

In this Section, I estimate the impact of an increase in import competition on informal employment. First, I study informal labour as a binary phenomenon as I do not discriminate between type of informal worker. These baseline estimations are presented in Section 2.4.1. Second, I study the intensive margin of informality in Section 2.4.2. Third, I focus on the extensive margin in Section 2.4.3.

In Sections 2.4.1, 2.4.2 and 2.4.3, the analysis is twofold. On the one hand, I study the effect of a reduction in tariffs on the probability to be hired as an informal worker. In this way, the analysis is conducted at the individual level and I control for individual characteristics that might influence workers' probability to be informal. On the other hand, I calculate the impact of an increase in import competition at the industry level by estimating the effect on the importance of informal employment on total employment.

2.4.1 Baseline estimations

Even though the data allows to distinguish between informal workers in the intensive and in the extensive margin of informality, in this Section, I do not make this distinction. In this way, the results are comparable to those obtained in the literature (Acosta and Montes-Rojas, 2014; Ulyssea and Ponczek, 2018; Goldberg and Pavcnik, 2003; Cruces et al., 2018). I estimate the linear probability model described by Equation 2.2:

$$INF_{\ell jt} = \alpha_0 + \alpha_\tau OT_{jt} + \alpha_g S_{gjt} * OT_{jt} + \alpha_s S_{gjt} + \alpha_i IT_{jt} + \alpha_H \mathbf{H}'_{\ell t} + F_j + F_t + \varepsilon_{\ell jt} \quad (2.2)$$

where $INF_{\ell jt} = 1$ if individual ℓ working in industry j in year t is informal either in the extensive margin or in the intensive margin, and 0 otherwise. OT_{jt} is the output tariff in industry j in year t and, its coefficient provides the effect of import competition on informal employment.

Since I identify the increase in import competition as a reduction in tariffs, I have to make a distinction between input and output tariffs. Input tariffs are the tariffs that a domestic firm pays for all imported inputs while output tariffs are the entry cost paid by foreigner competitors when selling at home. Then, a cut in input tariffs is a reduction in domestic firms' costs. As such, it could compensate for an increase in competition coming from abroad, i.e., a decrease in output tariffs. For example, a domestic firm might import leather for the manufacture of shoes. If the tariffs for leather go down, the firm's costs also go down. On the other hand, if tariffs for shoes produced abroad are also cut, firm's import competition increases. While the reduction in input tariffs is a positive effect for the domestic firm, the cut on output tariffs is a negative effect. Hence, in Equation 2.2 I also control for input tariffs with IT_{jt} which is the input tariff in industry j in year t . In this way, I can make sure that the effects do not cancel each other out when all tariffs diminish.

Equation 2.2 also includes an industry-size indicator calculated each year (S_{gjt}) and interaction terms with output tariffs ($S_{gjt} * OT_{jt}$). Since the average industry-size is constructed each year based on workers' answer regarding the size of their employer, it changes with time for a given industry. Then, it is possible to control for size variation within industries over time. I do so by indexing size with the variable S_{gjt} where $g = s, m, l$. When $g = s$, employers in industry j in time t have on average less than 15 employees, when $g = m$ they have between 15 and

50 and when $g = l$ they have more than 50 workers. Since S_{gjt} is an industry size indicator variable, each of the coefficients of the interaction term, α_g , is the differential effect of output tariffs on informality on industries with different average size. Henceforth, I classify small, medium and large industries according to the definition given by S_{gjt} .

It can be argued that informality is the result of a bargaining process between the worker and the employer. Hence, the individual's attributes are critical in determining the outcome of the bargain. For example, it is expected that more educated individuals are less likely to be hired as informal workers (Table 2.2). I control for these characteristics by including the vector for each individual $H_{\ell t}$ that contains observable attributes of worker ℓ in year t such as age, education, gender, civil status, ethnic background and department of residency.¹² Finally, I control for industry time-invariant characteristics and aggregate shocks by adding industry fixed effects, F_j and year fixed effects, F_t .

I use a linear probability model to estimate Equation 2.2. I account for heteroskedasticity and serial correlation in the error term by using robust (Huber-White) standard errors clustered by industry at 4 digit level. Results are in Table 2.5 in Columns 1-4. Column 1 suggests that there is no significant relationship between the reduction of tariffs and the probability to be hired as an informal worker. In Column 2, I also control for average industry size and the output tariffs remain statistically insignificant. In Column 3, when I add industry size interacted with output tariffs, I find that a reduction in output tariffs increases the probability to be hired as an informal worker in industries where on average employers have less than 15 employees. In particular, a 1-percentage point (pp) decrease in output tariffs generates a 0.55-pp increase in the probability to be hired as an informal worker in such an industry. To a lesser extent, this is also true for medium size industries as a 1-pp reduction in output tariffs translates in a 0.23-pp boost in the probability to be hired as an informal worker. Moreover,

¹²Peru's first level administrative subdivision are "departments".

these results are robust to controlling for input tariffs in Column 4. However, in this case, I also find that there is a positive significant relation between output tariffs and informality. Then, when controlling for input tariffs, the effect in small and medium industries is counteracted eliminating the effect on medium industries and reducing significantly the effect on small firms. Furthermore, the impact on large industries goes in the opposite direction, and when output tariffs are cut, informal employment in these industries is also reduced.

These results are consistent with the hypothesis that an increase in import competition would motivate small employers to hire more informal workers in the extensive margin of informality as they are less likely to be detected transgressing the law. On the other hand, the probability to be informally hired in industries where employers have more than 15 employees goes down as they are more notorious, and it is more likely to be audited.

The reduction in output tariffs not only has an impact on the decision to hire an informal worker but also on the proportion of informal workers hired in a given industry and year. Thus, after estimating the effect on the probability to hire informal workers, I estimate Equation 2.3.

$$ShareINF_{jt} = \psi_0 + \psi_\tau OT_{jt} + \psi_g S_{gjt} * OT_{jt} + \psi_s S_{gjt} + \psi_i IT_{jt} + F_j + F_t + \eta_{\ell jt} \quad (2.3)$$

where

$$ShareINF_{jt} = \frac{\text{Total Informal Employment}}{\text{Total Employment}} \text{ in industry } j \text{ in year } t$$

This identification strategy is somewhat comparable with the two-stage approach used by Goldberg and Pavcnik (2003) and Acosta and Montes-Rojas (2014). Instead of estimating the propensity to be informal, I directly calculate the share of

informal labour in total employment. I report the OLS estimation of Equation 2.3 in Columns 5-8 in Table 2.5. The regressors are the same as the ones described in Equation 2.2, but in this case, the dependent variable is the proportion of informal labour in total employment. Table 2.5 presents results in Columns 5-8.

In Columns 5 and 6 I find that there is no significant effect on the importance of informal employment when output tariffs are cut. However, when including the average industry-year size indicators interacted with output tariffs in Column 7 I find a statistically significant relationship between the share of informal employment on total employment and output tariffs. Namely, I find that a 1-pp decrease in output tariffs cuts the share of informal employment by 0.77-pp. However, this is only true for industries where employers on average are large as in industries with mostly small and medium firms this effect is counteracted. The results suggest that when import competition increases because tariffs are cut by 1-pp, industries that on average have small firms, increase their share of informal employment by 1.30-pp and by 1.09-pp in industries with mostly medium firms. This result remains almost unchanged when controlling for input tariffs in Column 8.

From the results presented in Table 2.5, it is possible to infer that there are two mechanisms that go in opposite direction when studying the impact of an increase in import competition on informal labour. On the one hand, informal employment increases in industries with employers that on average have less than 50 workers. On the other hand, it diminishes for industries that on average, have larger employers. Furthermore, these effects are true in terms of the probability to be hired as an informal worker and in terms of the importance of informal employment on total employment. In the following Sections, I show that when unfolding informality in two margins, these mechanisms are revealed in more detail.

Table 2.5: Informal Employment without distinguishing margins

	Informality Indicator				Share of Informal Employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output Tariff	0.0014 (0.001)	0.0015 (0.001)	0.0023 (0.001)	0.0027* (0.001)	0.0044 (0.003)	0.0043 (0.003)	0.0077** (0.003)	0.0075** (0.003)
Input Tariff				-0.0017 (0.002)				0.0011 (0.007)
S*Output Tariff			-0.0055*** (0.001)	-0.0055*** (0.001)			-0.0130* (0.007)	-0.0130* (0.007)
M*Output Tariff			-0.0023* (0.001)	-0.0025* (0.001)			-0.0109* (0.006)	-0.0109* (0.006)
Small Industry (S)		0.0201 (0.013)	0.0593*** (0.017)	0.0588*** (0.017)		0.2143*** (0.043)	0.2685*** (0.061)	0.2686*** (0.061)
Medium Industry (M)		0.0232** (0.011)	0.0333** (0.014)	0.0337** (0.014)		0.1235*** (0.039)	0.1691*** (0.056)	0.1688*** (0.056)
Married	-0.0686*** (0.010)	-0.0686*** (0.010)	-0.0687*** (0.010)	-0.0688*** (0.010)				
Male	-0.1307*** (0.010)	-0.1307*** (0.010)	-0.1306*** (0.010)	-0.1306*** (0.010)				
Primary Education	-0.0424 (0.028)	-0.0425 (0.028)	-0.0426 (0.028)	-0.0426 (0.028)				
Secondary Education	-0.1191*** (0.035)	-0.1191*** (0.035)	-0.1193*** (0.035)	-0.1193*** (0.035)				
Technical Education	-0.2358*** (0.038)	-0.2357*** (0.038)	-0.2358*** (0.038)	-0.2358*** (0.038)				
UG-PG degree	-0.2861*** (0.038)	-0.2862*** (0.038)	-0.2863*** (0.038)	-0.2862*** (0.038)				
Quechua ethnicity	-0.0026 (0.007)	-0.0024 (0.007)	-0.0036 (0.007)	-0.0036 (0.007)				
Age: 30-44	-0.1259*** (0.013)	-0.1259*** (0.013)	-0.1258*** (0.013)	-0.1259*** (0.013)				
Age: 45-64	-0.1253*** (0.019)	-0.1253*** (0.019)	-0.1254*** (0.019)	-0.1254*** (0.019)				
Age: > 65	-0.0557*** (0.016)	-0.0559*** (0.016)	-0.0560*** (0.016)	-0.0560*** (0.016)				
Observations	31009	31009	31009	31009	695	695	695	695
R ²	0.31	0.31	0.31	0.31	0.61	0.65	0.65	0.65

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Specifications in Columns 1-4 include department of residence fixed effects. All specification include industry and year fixed effects. Average industry-year size is classified as S: <15 workers, M: 16-50 workers, L: >50 workers.

2.4.2 Intensive Margin

To gain some insight into what is driving the effect of the reduction in tariffs on informality suggested in Table 2.5, I take advantage of the detailed individual Peruvian data and distinguish informal employees between informal in the intensive and in the extensive margin. First, I estimate Equation 2.4 where the dependent variable, $INT_{\ell jt}$, takes the value of 1 if the individual ℓ is informal in the intensive margin in industry j in year t and 0 if the individual is a formal worker. Note that the regression of Equation 2.4 is conditional on individuals being hired by a registered firm.¹³

$$INT_{\ell jt} = \beta_0 + \beta_\tau OT_{jt} + \beta_g S_{gjt} * OT_{jt} + \beta_s S_{gjt} + \beta_i IT_{jt} + \beta_H \mathbf{H}'_{\ell t} + F_j + F_t + \varepsilon_{\ell jt} \quad (2.4)$$

I use a linear probability model to estimate Equation 2.4, and I account for heteroskedasticity and serial correlation in the error term by computing Huber-White standard errors clustered by industry at 4 digit level of aggregation. Results are in Columns 1-4 in Table 2.6. All specifications in Columns 1-4 in Table 2.6 control for individual characteristics and include industry, year and department of residence fixed effects. Results show that married men with above technical education and older than 30 years old are less likely to be hired as intensive-informal workers instead of formal ones.

In Column 1, I only control for individual characteristics. In Column 2, I also control for average firm size in each industry-year. In both specifications, I find that the reduction in output tariffs does not have a statistically significant impact on the probability to be hired as an intensive-informal worker. However, when I

¹³In the Appendix, I report the results for a multinomial logit model where the dependent variable has three categories: extensive-informal, intensive-informal and formal. I find that when testing for the violation of the IIA assumption, results are ambiguous hinting that being hired by a registered employer (as a formal or as an intensive-informal worker) and being intensive-informal are not independent. Hence, I estimate Equation 2.4 conditional on being hired by a registered firm.

also control for industry-year size in Column 3, I find that in industries that on average have employers with less than 50 employees, a reduction in output tariffs translates into an increase in the probability to hire informal-intensive workers.

Interestingly, this result remains the same when controlling for input tariffs in Column 4. I find that a 1-percentage point (pp) reduction in output tariffs generates an increment of 1.3-pp in the probability to be hired as an intensive-informal worker in an industry where, on average, firms are small. The effect is quantitatively lesser in industries that have mostly medium size firms as in these industries a 1-pp decrease in tariffs increases the likelihood to be hired as an intensive-informal worker by 0.59-pp. This result is consistent with the hypothesis that smaller registered employers tend to hire informal workers as a mean to reduce costs and remain competitive when there is an increase in import competition. I find that this is the case in industries where firms mostly have less than 50 employees. These firms are less likely to get caught when avoiding the payroll taxes that come with hiring formal workers.

In order to get a more detailed picture at the industry level, I study the effect that a reduction on output tariffs has on the importance of informal labour within registered firms. I estimate Equation 2.5, where the dependent variable is the proportion of informal employment in registered employers.

$$ShareINT_{jt} = \delta_0 + \delta_\tau OT_{jt} + \delta_g S_{gjt} * OT_{jt} + \delta_s S_{gjt} + \delta_i IT_{jt} + F_j + F_t + \eta_{jt} \quad (2.5)$$

where

$$ShareINT_{jt} = \frac{\text{Total Intensive-Informal Employment}}{\text{Total Employment in Registered Firms}} \text{ in industry } j \text{ in year } t$$

I present the results from the OLS estimation of Equation 2.5 in Columns 5-8 in

Table 2.6: Intensive Margin of Informality

	Informality Indicator				Share of Informal Employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output Tariff	0.0005 (0.002)	0.0006 (0.002)	0.0014 (0.002)	0.0018 (0.002)	-0.0013 (0.003)	-0.0013 (0.003)	0.0030 (0.003)	0.0027 (0.003)
Input Tariff				-0.0025 (0.003)				0.0021 (0.007)
S*Output Tariff			-0.0129*** (0.004)	-0.0130*** (0.004)			-0.0196** (0.009)	-0.0196** (0.009)
M*Output Tariff			-0.0057** (0.002)	-0.0059** (0.002)			-0.0133** (0.006)	-0.0132** (0.007)
Small Industry (S)		0.0184 (0.021)	0.0991*** (0.037)	0.0988*** (0.037)		0.0893* (0.049)	0.1755** (0.074)	0.1757** (0.074)
Medium Industry (M)		0.0112 (0.017)	0.0367** (0.018)	0.0369** (0.018)		0.1040** (0.043)	0.1583** (0.060)	0.1577** (0.060)
Married	-0.1166*** (0.014)	-0.1166*** (0.014)	-0.1165*** (0.014)	-0.1166*** (0.014)				
Male	-0.0682*** (0.010)	-0.0681*** (0.010)	-0.0679*** (0.010)	-0.0678*** (0.010)				
Primary Education	-0.0628 (0.077)	-0.0633 (0.077)	-0.0616 (0.077)	-0.0616 (0.077)				
Secondary Education	-0.1262 (0.078)	-0.1267 (0.078)	-0.1252 (0.078)	-0.1252 (0.078)				
Technical Education	-0.2460*** (0.077)	-0.2463*** (0.077)	-0.2448*** (0.077)	-0.2448*** (0.077)				
UG-PG degree	-0.2794*** (0.081)	-0.2799*** (0.081)	-0.2784*** (0.081)	-0.2784*** (0.081)				
Quechua ethnicity	-0.0274* (0.014)	-0.0274* (0.014)	-0.0275* (0.014)	-0.0276* (0.014)				
Age: 30-44	-0.2399*** (0.017)	-0.2399*** (0.017)	-0.2401*** (0.017)	-0.2400*** (0.017)				
Age: 45-64	-0.3337*** (0.024)	-0.3339*** (0.024)	-0.3342*** (0.024)	-0.3341*** (0.024)				
Age: > 65	-0.3182*** (0.037)	-0.3186*** (0.037)	-0.3201*** (0.037)	-0.3202*** (0.037)				
Observations [‡]	14126	14126	14126	14126	660	660	660	660
R ²	0.25	0.25	0.25	0.25	0.37	0.39	0.40	0.40

[‡] All specifications are conditional on individuals being hired by a registered firm.

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Specifications in Columns 1-4 include department fixed effects. All specifications include industry and year fixed effects. Average industry-year size is classified as S: <15 workers, M: 16-50 workers, L: >50 workers.

Table 2.6.¹⁴ I compute Huber-White standard errors clustered by industry at 4 digit level of aggregation. All specifications also control for industry and year fixed effects. In Columns 5 and 6, I find no statistically significant relation between the share of informal employment on total employment in registered employers and output tariffs. However, when controlling for average industry-year size in Column 7, I find that a reduction in output tariffs changes the labour composition towards intensive-informal employment in industries where employers have less than 50 workers.

Moreover, this effect is not offset by the reduction of input tariffs for which I control in Column 8. The coefficients remain almost the same. I find that a 1-pp reduction of output tariffs increases the share of intensive-informal workers in 1.9-pp in industries that, on average, have firms with less than 15 employees. Similarly, the same reduction in output tariffs translates in a 1.3-pp increase in the share of intensive-informal employment in registered employers in medium-size industries.

Results are consistent with the hypothesis that when tariffs drop, registered employers might be motivated to increase their share of informal employment. Since intensive-informal workers are cheaper than formal ones and they might be facing a substantial reduction in profits, employers would be willing to risk getting caught when hiring informal workers only after import competition increases. Moreover, I find that this is true for industries where employers are, on average, small or medium size. Assuming that smaller firms are less likely to be audited, this result is not surprising.

2.4.3 Extensive Margin

In this Section, I study the impact of an increase in import competition on the extensive margin of informality. First, I study the effect on the probability to be

¹⁴Since the dependent variable is a proportion, I also estimate a fractional logit model. The results are very similar and are in the Appendix in Table B.3.

hired as an extensive-informal worker when output tariffs drop. Second, I analyse the effect on the employment composition between labour in the extensive margin of informality and formal or extensive-informal employment.

I estimate Equation 2.6:

$$EXT_{\ell jt} = \gamma_0 + \gamma_\tau OT_{jt} + \gamma_g S_{gjt} * OT_{jt} + \gamma_s S_{gjt} + \gamma_i IT_{jt} + \gamma_H \mathbf{H}'_{\ell t} + F_j + F_t + \varepsilon_{\ell jt} \quad (2.6)$$

where the dependent variable is $EXT_{\ell jt} = 1$ if individual ℓ is informal in the extensive margin and 0 otherwise. In other words, $EXT_{\ell jt} = 0$ if the individual is an intensive-informal worker or a formal worker. As in the previously estimated linear probability models, I measure import competition with output tariffs, OT_{jt} , while controlling for input tariffs, IT_{jt} , and individuals' demographic characteristics, $\mathbf{H}'_{\ell t}$. Furthermore, I control for the average size in industry j in time t in which the individual ℓ is employed by indexing size with variable S_{gjt} where $g = s, m, l$. When $g = s$, firms in the industry have on average less than 15 employees, when $g = m$ they have between 15 and 50 and when $g = l$ they have more than 50 workers.

Unlike when studying the intensive margin of informality, the sample of analysis is not constrained, and I take into account all individuals as I did when I estimated Equation 2.2. However, the dependent variable in this case takes the value of 1 only for extensive-informal individuals rather than informal in any margin. I estimate Equation 2.6 with a linear probability model and compute Huber-White robust standard errors clustered by industry at 4 digit level of aggregation. I include industry, year and department fixed effects in all specifications.

Results for Equation 2.6 are in Columns 1-4 in Table 2.7.¹⁵ In Column 1, I only control for individual characteristics. I find that young married men with above

¹⁵The results are also similar when estimating logit models and are in the Appendix in Table B.2.

primary education are less likely to be hired as extensive-informal workers. These results are consistent in all specifications. Furthermore, I find that when output tariffs are cut, the probability to be hired as an extensive-informal worker also drops. This result is robust to the inclusion of industry-year size indicator in Column 2. In the same way, results are not altered by the addition of interaction terms between industry-year size indicator and output tariffs in Column 3. From Columns 2 and 3 is evident that average industry size does not impact on the probability to be hired as an extensive-informal worker when import competition increases. More interestingly, the result remains unchanged when including input tariffs in Column 4.

The result in Column 4 suggests that a 1-percentage point (pp) reduction in output tariffs decreases the probability to be hired as an extensive-informal worker by 0.35-pp. In other words, a 50-pp decline in tariffs would diminish the probability to be hired in the intensive margin of informality by 17.5-pp. Even though the magnitude of the effect is lesser than that of the intensive margin, the impact on the extensive margin is on all industries, not only on those with mostly small and medium size firms. This result is consistent with the hypothesis that unregistered employer are not efficient enough to compete with imported goods because they are not productive enough. Consequently, the probability to be hired in the extensive margin of informality drops when import competition increases.

Next, I estimate Equation 2.7 to gain insight on the effect that a reduction in output tariffs has on the proportion of employment in unregistered employers in the manufacturing sector. In Columns 5-8 in Table 2.7, I report the results from the OLS estimation. I compute Huber-White robust standard errors clustered by industry at 4 digit level of aggregation. I include industry and year fixed effects in all specifications. I also estimate Equation 2.7 as a fractional logit response model. The results are very similar and are reported in the Appendix in Table B.4.

$$ShareEXT_{jt} = \phi_0 + \phi_\tau OT_{jt} + \phi_g S_{gjt} * OT_{jt} + \phi_s S_{gjt} + \phi_i IT_{jt} + F_j + F_t + \eta_{\ell jt} \quad (2.7)$$

where

$$ShareEXT_{jt} = \frac{\text{Total Extensive-Informal employment}}{\text{Total Employment}} \text{ in industry } j \text{ in year } t$$

Columns 5-8 in Table 2.6 show that a reduction in output tariffs diminishes the share of extensive-informal employment on total employment. This result holds when adding industry-year size indicator and when including interaction terms between these size indicators and output tariffs. Moreover, the relationship between import competition and the relative importance of extensive-informal employment remains unchanged both quantitatively and qualitatively when controlling for input tariffs in Column 8. From Column 8, the results suggest that a 1-percentage point (pp) decrease in output tariffs translates on 0.55-pp reduction in the share of extensive-informal employment in the manufacturing sector. Additionally, Columns 6-8 show that industries with average firm size below 15 employees are more likely to show an increase in the proportion of extensive-informal employment.

Results from Table 2.6 are consistent with Melitz (2003)'s results that the least productive firms are the first ones to leave the market when a trade liberalisation process takes place. Since the literature tends to describe unregistered firms as unproductive (Ulyssea, 2018; La Porta and Shleifer, 2014), it makes sense that when import competition increases the probability to be hired in the extensive margin of informality decreases and the share of extensive-informal employment on total employment also drops.

Table 2.7: Extensive Margin of Informality

	Informality Indicator				Share of Informal Employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output Tariff	0.0034** (0.002)	0.0035** (0.002)	0.0035* (0.002)	0.0035* (0.002)	0.0054** (0.003)	0.0054** (0.003)	0.0058** (0.003)	0.0055* (0.003)
Input Tariff				-0.0002 (0.003)				0.0021 (0.007)
S*Output Tariff			-0.0035 (0.003)	-0.0035 (0.003)			-0.0042 (0.008)	-0.0042 (0.008)
M*Output Tariff			0.0017 (0.003)	0.0017 (0.003)			0.0008 (0.005)	0.0009 (0.005)
Small Industry (S)		0.0171 (0.021)	0.0503** (0.021)	0.0503** (0.022)		0.2475*** (0.039)	0.2667*** (0.053)	0.2669*** (0.053)
Medium Industry (M)		0.0166 (0.015)	0.0052 (0.017)	0.0052 (0.017)		0.0316 (0.027)	0.0254 (0.032)	0.0248 (0.032)
Married	-0.0184** (0.009)	-0.0184** (0.009)	-0.0186** (0.009)	-0.0186** (0.009)				
Male	-0.1726*** (0.019)	-0.1726*** (0.019)	-0.1727*** (0.019)	-0.1727*** (0.019)				
Primary Education	-0.0235 (0.030)	-0.0236 (0.030)	-0.0232 (0.030)	-0.0232 (0.030)				
Secondary Education	-0.1337*** (0.037)	-0.1338*** (0.037)	-0.1332*** (0.037)	-0.1332*** (0.037)				
Technical Education	-0.2226*** (0.040)	-0.2226*** (0.040)	-0.2220*** (0.040)	-0.2220*** (0.040)				
UG-PG degree	-0.2559*** (0.041)	-0.2560*** (0.041)	-0.2552*** (0.041)	-0.2552*** (0.041)				
Quechua ethnicity	0.0105 (0.010)	0.0107 (0.010)	0.0101 (0.010)	0.0101 (0.010)				
Age: 30-44	0.0070 (0.012)	0.0071 (0.012)	0.0072 (0.012)	0.0072 (0.012)				
Age: 45-64	0.0679*** (0.022)	0.0678*** (0.022)	0.0679*** (0.021)	0.0679*** (0.022)				
Age: > 65	0.1504*** (0.025)	0.1503*** (0.025)	0.1505*** (0.025)	0.1505*** (0.025)				
Observations	31009	31009	31009	31009	695	695	695	695
R ²	0.38	0.38	0.38	0.38	0.71	0.76	0.76	0.76

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Specifications in Columns 1-4 include department fixed effects. All specifications include industry and year fixed effects. Average industry-year size is classified as S: <15 workers, M: 16-50 workers, L: >50 workers.

2.5 Conclusions

In this paper, I highlight the importance of distinguishing two margins of informality when studying the effect of import competition on informal labour. First, I present a descriptive analysis of employees in the Peruvian manufacturing sector and show that the demographic characteristics of informal workers in the intensive margin differ from those in the extensive margin of informality. Hence, it is essential to control for individual features when relating trade to informal employment.

I also show that several features that tend to describe the informal sector in the literature such as low wages and small firm size are present in the Peruvian informal sector. Moreover, I provide a descriptive analysis that highlights how some industries within the manufacturing sector are more prone to one margin of informality than the other. Hence, when studying informality at the industry level it is also important to distinguish these two margins of informality.

Furthermore, the empirical analysis demonstrates that an increase in import competition impacts the two margins of informality through completely different channels. A reduction in tariffs triggers a reduction of extensive-informal employment and an enlargement of intensive-informal employment.

On the one hand, registered employers respond to the increase in import competition by hiring cheaper workers. Since intensive-informal workers receive lower wages, employers increase their share of intensive-informal employment rather than the proportion of formal workers as a way to reduce costs and be able to compete with imports. Moreover, since larger firms are more likely to be audited by the Tax Agency, it is easier for small and medium-size firms to hire informal workers. Hence, I find that the share of intensive-informal employment expands in industries that, on average, have small and medium-size employer. In this way, informal employment in the intensive margin increases.

On the other hand, extensive-informal workers are characterized by very low pro-

ductivity. As a result, their employers are not able to cope with stronger competition and are less likely to survive when tariffs drop. Hence, when I study the effect of an increase in import competition on the probability to be hired in the extensive margin of informality and on the share of extensive-informal employment on total employment, I find that it goes down in both settings. Importantly, these results do not depend on the average size of employers in any given industry. These results are true for all industries.

Finally, comparing results obtained separately for each margin of informality, it becomes evident that the effect of the increase in import competition on informality is driven by the intensive margin of informality. On other words, informal labour increases because the effect on “off the books workers” hired by employers that do pay taxes is stronger than the effect on informal workers hired by unregistered employers.

Chapter 3

Inspecting Firms Decisions on Informality: Unregistered Firms and Informal Workers

3.1 Introduction

In Latin American countries, informality has risen significantly in the aftermath of major trade reforms that opened markets to foreign competition (Ulyssea and Ponczek, 2018). Indeed, one crucial concern is that trade opening could lead to a labour reallocation towards informal employment (Goldberg and Pavcnik, 2007). On the one hand, informality is a form of tax evasion and as such it hinders public good provision. Also, informality distorts firms decisions as it allows less productive (informal) firms to take advantage of lower costs and compete with more productive (formal) firms. On the other hand, informality acts as a cushion for firms that would otherwise exit the market due to demanding and costly regulations. In this way, informality may be a buffer that protects jobs (Dix-Carneiro et al., 2019). Therefore, understanding the effect that globalisation has on informality is central.

Motivated by the results found in Chapter 2, this chapter aims to provide a more in-depth understanding on the mechanisms that drive firms' decisions on informality when there is an increase in import competition. Specifically I focus on firms' decision on two margins of informality: firms' choice to register and work as a legally established firm (the extensive margin), and firms' decision to hire some informal workers (the intensive margin). In Chapter 2, I demonstrate empirically the importance of distinguishing between these two margins of informality when studying the impact of trade. In this chapter, I focus on questions that were empirically overlooked.

I address these questions with a partial equilibrium model where firms are heterogeneous in productivity *à la* Melitz (2003). The model allows studying the mechanisms embedded in firms' decisions when opting to engage in informal employment relationships. With that objective in mind, firms decide to register or not and, to export or not. Hence, there are potentially 4 types of firms: registered and unregistered firms operating in the domestic market and, registered and unregistered firms that also export. Firms that hire informal workers have to pay a fine if they are caught. In order to mimic that larger firms are also more likely to be audited, the probability of inspection is increasing in size (Meghir et al., 2015). Moreover, since registered firms are already on the government's radar, they are already inspected in a regular basis. Thus, I allow for the probability of inspection for registered firms to be higher than that of unregistered firms. Building the probability of inspection in this way adds complexity to the model and prevents the firms' profit maximization problem to be solved analytically. Even though imposing a probability of inspection in this manner forces me to solve the model numerically and to give descriptive results, it brings the theoretical framework closer to the empirical findings.

I assume that workers are homogeneous and can move across firms regardless of firm type. Therefore, all workers are paid the same disregarding the type employment they are engaged in, formal, intensive-informal or extensive-informal.

Even though for the worker, the wage is the same for all types of employment, for the firms is more expensive to hire formal workers because they have to pay payroll tax in their behalf. As a result, registered firms might risk getting caught by the tax collection agency and hire intensive-informal workers.

The main takeaways from the model are: i) The least productive firms decide to operate as unregistered firms. ii) Registered firms are always more productive than unregistered firms. iii) Firms that choose to export are always registered and are the most productive firms in the economy. iv) The share of formal workers employed by registered firms, exporting and otherwise, increases with productivity.

When conducting comparative statics, I find that raising the probability of inspection for the registered firms leads to firms reallocating labour towards formal workers. However, it does not have an impact on firms decision to operate as a registered firm. Moreover, when the probability of inspection for unregistered firms drops, unregistered firms would become, on average, more productive as firms that used to operate as registered firms now find it profitable to not pay taxes and risk an inspection.

When modelling a tightening competition effect I find consistent results with the empirical results. I model opening up to trade as a reduction in domestic demand in tandem with an increase in the demand for imports. On the one hand, I find that a reduction in the domestic demand puts pressure on firms to be more productive. In particular, unregistered firms require to be more efficient to enter the market. In this way, the extensive margin of informality decreases. On the other hand, registered firms shift their demand for labour towards informal employment. Thus, the intensive margin of informality increases. Furthermore, I show that higher demand for imports leads to exporting firms also reallocating labour towards informal employment. Hence, the intensive margin increases both in exporting and non-exporting firms.

Hence, trade has two opposite effects on informality. First, unregistered firms are

unable to cope with the competition and exit the market, reducing the extensive-informal labour in the economy. Second, registered firms increase their intake of informal workers boosting intensive-informal employment in the economy.

This chapter's results complement the evolving literature discussed in previous chapters. It contributes to the expanding literature on trade and informality by building a trade model where both the intensive and the extensive margin of informality are included. The only paper that to my knowledge considers two margins of informality is Ulyssea (2018), and he does it in a closed economy setting. The empirical literature that studies the effect of trade on informal labour is expanding (Goldberg and Pavcnik, 2003; Filho and Muendler, 2007; McCaig and Pavcnik, 2018; Paz, 2014; Dix-Carneiro et al., 2019; Alemán-Castilla, 2006). For instance, McCaig and Pavcnik (2018) study the US-Vietnam bilateral trade agreement and find that the informal sector declines in response to a reduction in US tariffs. There is also increasing interest in examining local labour markets effects on informality when there is a decline in tariffs (Dix-Carneiro and Kovak, 2019; Ulyssea and Ponczek, 2018). Also using data from Brazil, Dix-Carneiro et al. (2019) build a heterogeneous firm model where firms choose to operate formally or informally. They disregard the intensive margin of informality and perform counterfactual analysis. They find that the informal sector acts as a buffer when there is a negative shock. Moreover, they show that there are significant welfare gains from eradicating informality.

This chapter also relates to the literature on informality as an adjustment mechanism in rigid labour markets with costly regulations (Meghir et al., 2015; Bosch and Esteban-Pretel, 2012; Goldberg and Pavcnik, 2007; Davies and Paz, 2011; Rocha et al., 2018). Similar to the results I find, Meghir et al. (2015) show that increasing the costs of informality encourages workers to find jobs in more productive firms. Davies and Paz (2011) discuss a change in tax policy while studying trade effects. They find that a reduction in tariffs can reduce informality and they also show that shifting from tariffs to value-added taxes could lead to a decrease

in the output of the informal sector. Their result is consistent with my findings on the effect of trade on the extensive margin of informality.

The chapter is structured as follows. Section 3.2 lays out the theoretical framework. Section 3.3 briefly describes the parameters used when numerically solving firms' maximization problems. Section 3.4 presents firm's decision on firm type and labour allocation. Section 3.5 shows results from comparative statics analysis. Section 3.6 concludes.

3.2 Theoretical Framework

I specifically design a model that relates types of firms - registered and unregistered- with types of informality -extensive and intensive margin. The model's main objectives are i) Identify how these firms order themselves in terms of productivity, ii) Explain how registered firms choose between formal and informal workers given their level of productivity and iii) Understand how each type of firm reacts when there is an increase in import competition or a change of policy such as an increase in fines or probability of inspection.

In chapters 1 and 2, I showed that the informal labour in Peru is substantial. As such, it is clear that wages are not the result of equalising labour demand and labour supply. Hence, a model constructed to understand firms' response to trade in Peru would not need to be a full-employment trade model. Endogenizing wages does not provide meaningful insights for the questions I address. Thus, I set wages to one for both formal and informal workers. However, since formal ones pay payroll tax, s , they are more expensive from the point of view of the firm.

Consider an industry operating under monopolistic competition. Firms are heterogeneous in terms of their productivity, and each produces a unique differentiated product. Labour is the sole input of production and firms produce using a linear technology on labour and productivity. Firms draw their initial productivity, φ , from a common distribution $g(\varphi)$ with positive support over $(0, \infty)$. It has a cu-

mulative distribution $G(\varphi)$. I assume that productivity is Pareto distributed with parameters described in Table 3.1. Firms are in a continuum ordered by their productivity level. Therefore, I index firms solely in terms of their productivity, φ .

In this Section, I present firms' maximization problem for both domestic and exporting firms. Firms with productivity level φ that only supply the domestic market face the following demand function:

$$q_h(\varphi) = p_h(\varphi)^{-\sigma} A_h, \text{ with } A_h \equiv \frac{R_h}{P_h^{1-\sigma}} \quad (3.1)$$

where $\sigma > 1$ is the elasticity of substitution and $p_h(\varphi)$ is the price charged by the firm. A_h is the demand shifter and it denotes total revenue, R_h , over the price index:

$$P_h = \left[\int_0^\infty p_h(\varphi)^{1-\sigma} g(\varphi) d\varphi \right]^{\frac{1}{1-\sigma}} \quad (3.2)$$

Then, firms revenue is:

$$r_h(\varphi) = q_h(\varphi)^{\frac{\sigma-1}{\sigma}} A_h^{\frac{1}{\sigma}}. \quad (3.3)$$

Firms' costs depend on their behaviour towards tax compliance. Since formal firms have to comply with burdensome and sometimes costly regulations, they have to incur in administrative costs before starting operations. On the other hand, informal firms avoid paying these costs as they operate without government consent. In the model, fixed costs capture this disparity. Thus, I assume that firms that choose to register with the tax collection agency pay higher fixed costs, F_r , than unregistered firms, F_u . In Section 3.3, I provide more details regarding costs of formality in Peru such as the payroll tax and the values I set for the fixed costs.

In this framework, both registered and unregistered firms could potentially export. Since exporting entails a great deal of additional administrative costs as well as know-how of international trade, I assume that exporting firms pay the highest fixed cost in the economy, $F_x > F_r$ units of labour. Firms engaging selling abroad also pay an import tariff to supply the Foreign market. I model this tariff as an iceberg transportation cost such that when the exporting firm ships $\tau > 1$ units, the Foreign consumer receives 1 unit.

I assume that consumers in the Foreign country face the same problem as consumers at Home. Hence, exporting firms face the following demand from the Foreign market:

$$q_f(\varphi) = p_f(\varphi)^{-\sigma} A_f, \text{ with } A_f \equiv \frac{R_f}{P_f^{1-\sigma}} \quad (3.4)$$

where the demand shifter, A_f , the national income, R_f , and the price index, P_f in the foreign country are fixed and equal to 1. I assume that Home is a small open economy and as such, changes in Home do not affect Foreign.

3.2.1 Unregistered Firm

The extensive margin of informality refers to firms decision to register with the tax collection agency. If the firm decides against it and remains unregistered, it does not pay taxes whatsoever. Hence, unregistered firms technology is $q_u(\varphi) = \varphi n_u$ where n_u refers to informal workers in the extensive margin.

Since unregistered firms do not pay payroll tax on behalf of their employees, they are effectively transgressing labour laws. For instance, in Peru, when the authorities audit a firm that is not fully complying with regulations, they impose a fine. Details regarding the possible transgressions and amounts of the fine are provided in Section 3.3. Keeping the Peruvian case in mind, I add this feature to the model. Thus, if an unregistered firm is audited, it will have to pay a fine over

the amount evaded, m_u . Unregistered firms face a probability of inspection, θ_u . I define the probability of inspection as an increasing function on firm's size. In this way, I capture the motion that larger firms are also more visible and are also more likely to be inspected by the relevant government agency. If an unregistered firm is not audited, it's only cost is workers' wage, w_h . In this way, unregistered firms profit maximization problem is:

$$\max_{n_u \geq 0} \pi_u = r_u(\varphi) - w_h n_u [1 + m_u \theta_u] - w_h F_u \quad (3.5)$$

where unregistered firms revenue is $r_u = (\varphi n_u)^{\frac{\sigma-1}{\sigma}} A_h^{\frac{1}{\sigma}}$ and their probability of inspection is:

$$\theta_u = 1 - \left(\frac{1}{n_u} \right)^\beta, \text{ with } \beta < 1 \quad (3.6)$$

3.2.2 Registered Firm

The intensive margin of informality refers to registered firms decision on labour composition as they decide on a bundle of formal, l_r , and informal workers, n_r . In the same way as unregistered firms, registered firms technology is linear in labour and productivity, $q_r(\varphi) = \varphi(n_r + l_r)$.

Registered firms face a trade-off between formal and informal workers. On the one hand, when hiring formal workers, marginal costs are larger as they have to pay a payroll tax s . On the other hand, if hiring informal workers, firms pay a fine, m_r , over the amount evaded with probability θ_r . Then, the registered firms problem is:

$$\max_{n_r \geq 0, l_r \geq 0} \pi_r = r_r(\varphi) - w_h(1+s)l_r - w_h n_r [1 + m_r \theta_r] - w_h F_r \quad (3.7)$$

where $r_r(\varphi) = \{\varphi(n_r + l_r)\}^{\frac{\sigma-1}{\sigma}} A_h^{\frac{1}{\sigma}}$ and θ_r is the probability of inspection when hiring both formal and informal workers.

$$\theta_r = 1 - \underbrace{\left(\frac{1}{n_r + l_r}\right)^\alpha}_{\text{Size Effect}} \underbrace{\left(\frac{l_r}{n_r + l_r}\right)^{1-\alpha}}_{\text{Composition Effect}}, \text{ with } \alpha < 1 \quad (3.8)$$

The probability of inspection encompasses a *size effect*, larger firms are more likely to be inspected, and a *composition effect*, a firm with a larger share of formal workers is less likely to be inspected. Hence, two firms with the same percentage of informal workers but one larger than the other will not have the same probability of inspection as the larger one is more notorious than the other. If $\alpha < 0.5$ the size effect is more important than the composition effect. In Section 3.5.1 I show that results are very similar for $\alpha \in (0, 1)$.

3.2.3 Registered-Exporting Firm

Registered-exporting firms face a demand from the domestic market, $r_{rh}(\varphi)$, and from the foreign market, $r_{rf}(\varphi)$. Hence, for simplicity, I model the firm's problem as if the firm chooses separately formal workers that produce for exports, l_{rf} , and formal workers that produce for the domestic market, l_{rh} . In the same way, informal workers can produce for the domestic market, n_{rh} , or for exporting, n_{rf} .

These firms problem is very similar to the one described in Section 3.2.2. If a firm decides to hire informal workers, it faces a probability of inspection, θ_r , and in case of getting caught, it has to pay a fine, m_r , over the amount evaded. Otherwise, firms can hire only formal workers and pay payroll taxes on behalf of these workers, s . Then, registered exporting firms problem is as follows:

$$\begin{aligned} \max_{\substack{l_{rh} \geq 0, l_{rf} \geq 0, \\ n_{rh} \geq 0, n_{rf} \geq 0}} \pi_{rx} = & r_{rh}(\varphi) + r_{rf}(\varphi) - w_h(1 + s)(l_{rh} + \tau l_{rf}) - \\ & - w_h(n_{rh} + \tau n_{rf})[1 + m_r \theta_r] - w_h F_x \end{aligned} \quad (3.9)$$

where the probability of inspection is the same as the one described for the regis-

tered firm and the revenue functions are:¹

$$r_{rh}(\varphi) = A_h^{\frac{1}{\sigma}} \{\varphi(l_{rh} + n_{rh})\}^{\frac{\sigma-1}{\sigma}} \quad \text{and} \quad r_{rf}(\varphi) = A_f^{\frac{1}{\sigma}} \{\varphi(l_{rf} + n_{rf})\}^{\frac{\sigma-1}{\sigma}}$$

3.2.4 Unregistered-Exporting Firm

Even though it is unlikely to find an exporting firm that is not registered or pays taxes, for completeness, I model such a firm. I show that unregistered firms do not find profitable to sell abroad.

As with the intensive margin, an exporting firm sells both to the domestic and to the foreign market. Then, it obtains revenue both from exporting, $r_{uf}(\varphi)$, and from selling domestically, $r_{uh}(\varphi)$. Similar to the registered exporting firm problem, I model unregistered exporting firms problem as if they choose labour to work on the production for the domestic market, n_{uh} , and for the exporting market, n_{uf} , as two types of worker. It goes without saying that both n_{uh} and n_{uf} refers to informal employment in the extensive margin. Then, the unregistered-exporting firms' problem is as follows:

$$\max_{n_{uh} \geq 0, n_{uf} \geq 0} \pi_{ux} = r_{uh}(\varphi) + r_{uf}(\varphi) - [1 + m_u \theta_u] w_h (n_{uh} + \tau n_{uf}) - w_h F_x \quad (3.10)$$

where the probability of inspection is increasing in size and the same as described for the unregistered firm that only supplies the domestic market.² The revenue functions are:

$$r_{uh}(\varphi) = A_h^{\frac{1}{\sigma}} \{\varphi(n_{uh})\}^{\frac{\sigma-1}{\sigma}} \quad \text{and} \quad r_{uf}(\varphi) = A_f^{\frac{1}{\sigma}} \{\varphi(n_{uf})\}^{\frac{\sigma-1}{\sigma}}$$

¹ $\theta_r = 1 - \left(\frac{1}{l_{rx} + n_{rx}}\right)^\alpha \left(\frac{l_{rx}}{l_{rx} + n_{rx}}\right)^{1-\alpha}$ with $l_{rx} = l_{rh} + l_{rf}$ total formal employment and $n_{rx} = n_{rh} + n_{rf}$ total informal employment hired by a registered exporting firm.
² $\theta_u = 1 - \left(\frac{1}{n_{uf} + n_{uh}}\right)^\beta$.

3.3 Parameters

The firms' problems described in Section 3.2 are solved assuming that parameters take the values specified in Table 3.1. The values of the parameters are consistent with Peruvian data. Payroll tax in Peru is progressive. It levies 8% when annual income is up to 600 US dollars, approximately and 14% when it is between 600 and 25,000 US dollars approximately. Even though the average yearly income in Peru is the equivalent of 500 US dollars, its standard deviation is huge. Hence, I set the payroll tax in the model to 10% to account for the individuals with a higher income than 600 US dollars.³

Table 3.1: Parameters

Elasticity of substitution	$\sigma = 3$	
Wages	$w_h = 1$	
<i>Pareto Distribution</i>		
a	2.76	
φ_{min}	1	
<i>Informality/Formality Costs</i>		
	<u>Unregistered Firm</u>	<u>Registered Firm</u>
Payroll Tax		$s = 0.1$
Fine	$m_u = 0.9$	$m_r = 0.2$
Parameter in Probability of inspection	$\beta = 0.25$	$\alpha = 0.3$
Fixed costs	$F_u = 0.8$	$F_r = 1$
Fixed cost of exporting	$F_x = 4$	
Iceberg cost of exporting	$\tau = 1.3$	

Peru's secretary in charge of supervising labour laws, SUNAFIL (*Superintendencia nacional de fiscalizacion laboral*), imposes fines based on how serious firms transgressions are and how many workers are affected by such transgression. Fines can range from 60,000 to 350,000 US dollars approximately. Penalties are higher when the offence is more severe. SUNAFIL classifies offences in three categories. "Mild offences" refer to not complying with statutory regulation. "Serious offences" are

³Peruvian Tax Agency (SUNAT) website. Information on how to calculate payroll tax.

acts against labour rights that go beyond statutory regulation. “Very Serious offences” refer to not complying with workers’ fundamental rights.⁴ Since statutory law refers to the process of checking by a government that a business is following official rules, unregistered firms would be fine for a mild offence. Additionally, all employees hired by an unregistered firm are informal, and for that, the firm would have to pay a fine for a “serious offence”. Registered firms would pay a fine for a “serious offence” for every worker hired informally. Hence, it makes sense to set fines for unregistered firms higher than that for registered firms. Moreover, since the fine’s amount depends on the number of workers affected, in the model the fine is paid over the amount evaded.

The Doing Business indicator on *Starting a Business* ranks Peru 3 points above the Latin America & Caribbean average. Most of the required procedures to set up a firm need less than one day, and only the technical inspection requires 9 days. Also, the costs of the processes are minimum, except for signing the deed of incorporation before a notary public which is between 200 and 300 US dollars. Hence, the fix cost of operating as a registered firm is set just a bit larger than that of an unregistered firm.

Also, the Doing Business indicator for *Trading across Borders* shows that while the documents required to export do not take more than 2 days, the border compliance cost is 13,300 US dollars. Hence, I set a fixed export cost 4 times higher than the one set for firms that only operate in the domestic market.

Finally, I am agnostic about the values of α and β . I set the values described in Table 3.1 for concreteness and show in Section 3.5 that results are not dependent on their value.

⁴Translated from document *Procedimiento Sancionador: Infracciones y Multas* in SUNAFIL’s website.

3.4 Firms' Decisions on Informality

I solve numerically firms' maximization problems presented in Section 3.2 using the parameters described in Section 3.3. I solve each problem in isolation and find optimal labour choices and profits for each level of productivity. As with all Melitz (2003)-type models, profits and labour are increasing in productivity. Even though it is not new in this type of models that the least productive firms exit the market because their profits are negative, it is innovative to show that these firms are in fact unregistered. Moreover, I confirm that firms in the middle of the productivity distribution are registered and operating solely in the domestic market and that the most productive firms are registered-exporting firms.

Since every endogenous variable in the model depends on productivity, firms' decision to register and to export (or not) depends on their level of productivity. Figure 3.1 shows profits for each level of productivity for each type of firm. The vertical lines denote productivity thresholds.⁵

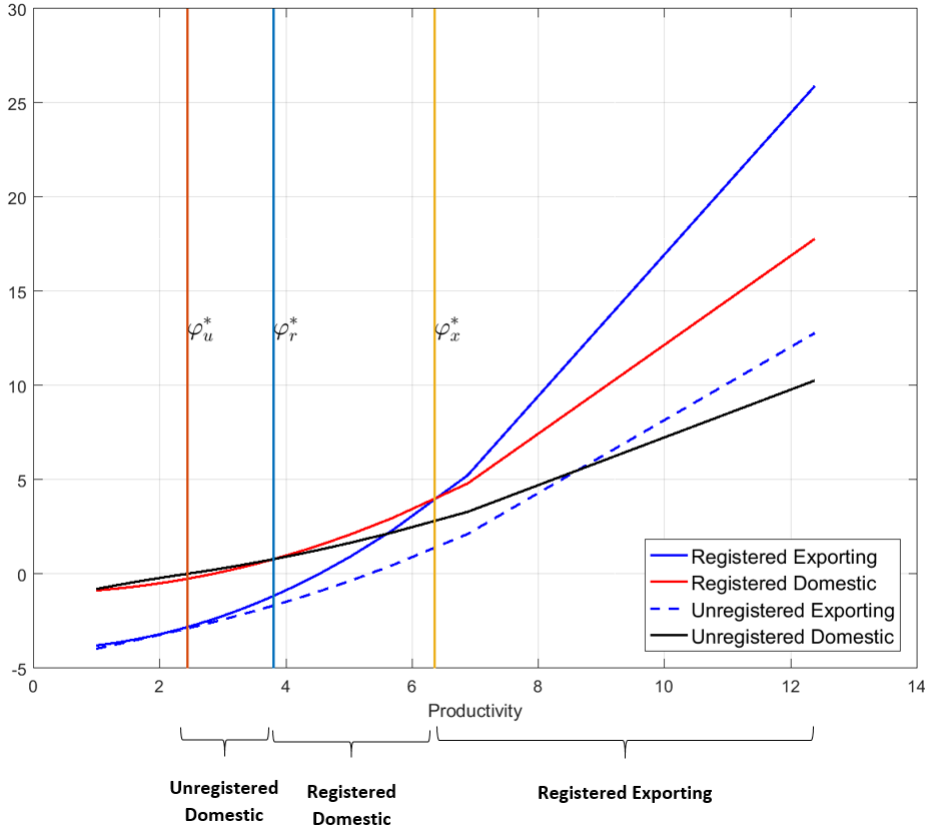
The threshold for unregistered-domestic firms, φ_u^* , is such that unregistered firms' will only operate in the market if their productivity level is above this threshold as below that level profits are negative for unregistered firms:

$$\pi_u(\varphi) > 0 \Leftrightarrow \varphi \geq \varphi_u^* \quad (3.11)$$

Firms choose to operate as registered firms supplying the domestic market solely if their productivity level is between φ_u^* and φ_r^* . As Equation 3.12 states, firms find profitable to operate as registered when their productivity is within the range $(\varphi_u^*, \varphi_r^*]$.

⁵Given the parameters and the fact that productivity follows a Pareto distribution, Figure 3.1 may show a few kinks. Productivity does not grow at a gradual rate. Especially at the end of the distribution where it takes higher values, there are jumps between one value and the next. Since graphs show lines connecting points rather than points, the kinks are because these points are not equidistant while points in the X-axis are.

Figure 3.1: Firms' Profits



$$\pi_r(\varphi) > \pi_u(\varphi) \Leftrightarrow \varphi_u^* < \varphi \leq \varphi_r^* \quad (3.12)$$

Also, registered-exporting firms' profits are increasing in productivity, but the rate at which profits grow as productivity raises is greater than for registered firms that only supply the domestic market. This shows that very productive firms, benefit a great deal from exporting. Hence, registered-exporting firms are also the most productive firms in the economy. As Equation 3.13 states, firms only find profitable to both register and export if their productivity level is above the threshold φ_x^* .

$$\pi_x(\varphi) > \begin{cases} \pi_r(\varphi) \\ \pi_u(\varphi) \end{cases} \Leftrightarrow \varphi \geq \varphi_x^* \quad (3.13)$$

As Figure 3.1 shows, unregistered-exporting firms' profits (the dotted line) is below all other profits for all types of firms at all levels of productivity. Meaning firms do not choose to operate as unregistered-exporting firms no matter how efficient they are. This result makes sense as the fixed costs of exporting are too high to face for firms that have a lot to lose if they get caught infringing the law.

Figure 3.2a shows the probability of inspection for all types of firms by level of productivity. Trivially, the probability of inspection for unregistered firms that only operate in the domestic market remains zero until firms start to produce, i.e., until firms' productivity is above the threshold φ_u^* . For $\varphi > \varphi_u^*$, their probability of inspection increases quickly as the firm decides to hire more extensive-informal workers.

Since labour is increasing in productivity, by construction, the probability of inspection for all firms is also increasing in productivity. Moreover, since exporting firms are larger than firms producing solely for the domestic market, their probability of inspection is also higher for all levels of productivity.

To understand the intensive margin of informality, one should study registered firms' allocation of employment between formal and informal. Both formal and informal labour are increasing in productivity. However, the rate at which informal employment grows is lesser than formal employment. Hence, as Figure shows 3.2b, the share of formal labour is increasing in productivity. This is a natural consequence of featuring a probability of inspection increasing in firm size.⁶

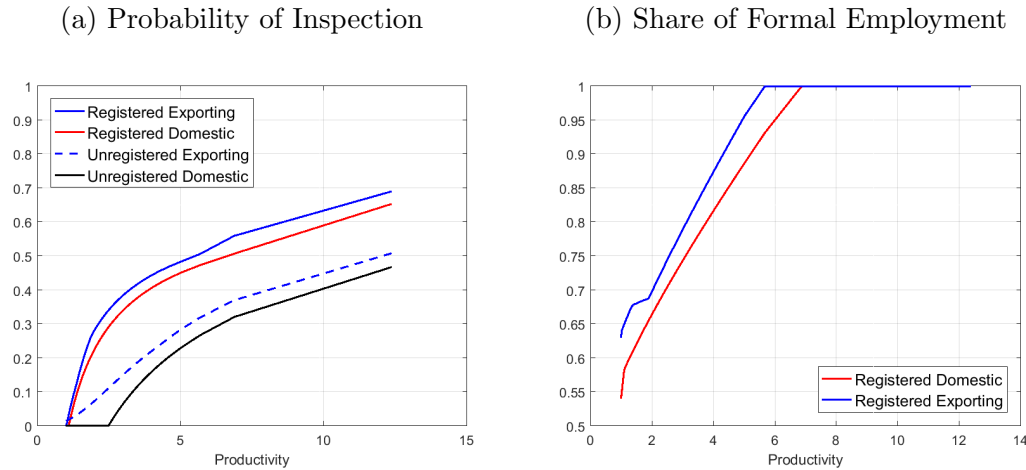
Therefore, exporting firms have tremendous incentives to hire a larger proportion of formal workers than non-exporting registered firms at all levels of productivity. For the most productive firms, it is too risky to face an audit and pay a fine, hence, as Figure 3.2b shows, firms with the highest productivity level hire mostly formal workers.⁷ In this way, the results are consistent with the empirical finding

⁶Figure 3.2b presents a kink when productivity is a bit below 2 because of granularity. More specifically, there is a jump in the productivity values because it follows a Pareto distribution.

⁷Note that in Figure 3.2b it seems that the share of formal workers is equal to 1. This is not exactly true as for very high productivity levels the model predicts informal workers to

that firms that are already in the government's radar are more likely to face an inspection (Levy, 2008).

Figure 3.2: Firms' Optimal Choices



To sum up, a result of the model is that unregistered firms are less productive than registered firms. Hence, extensive-informal workers are found in firms operating in the bottom of the productivity distribution. Furthermore, the model also shows that registered firms prefer to reallocate labour towards formal employment as they become more efficient. Finally, exporting firms choose not to hire informal workers.

3.5 Comparative Statics

In this Section, I study the effects of changing parameters such as α and β from the probabilities of inspection for registered and unregistered firms, respectively. Second, I analyse the impact of changing the policy on fines and payroll tax. Third, I study the effect of deepening the openness to trade by allowing an increase in foreign demand and a reduction in domestic demand. In this Section, I use the subscript “0” to indicate the baseline value for parameters. From now on, baseline results are in solid lines in all figures.

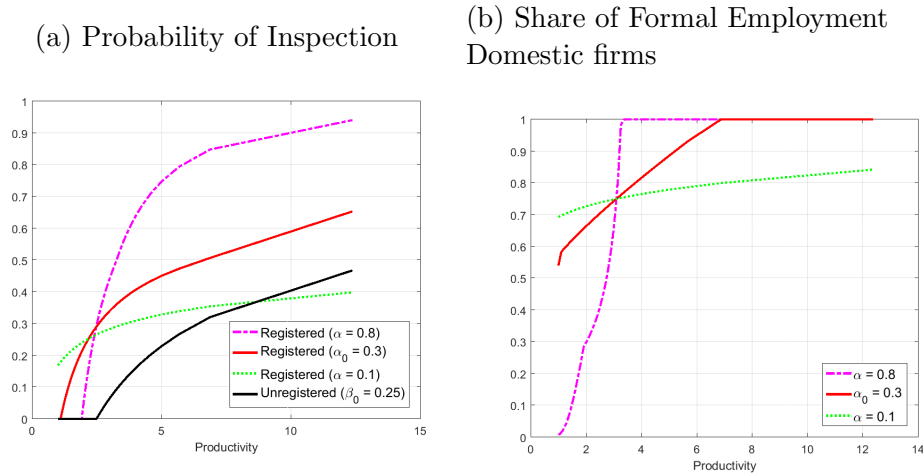
approximate zero but they do not really reach zero.

3.5.1 Changes in the Probability of Inspection

The baseline simulation presented in Section 3.4 assumes that $\alpha > \beta$. In this Section, I show that relaxing this assumption and allowing for $\alpha < \beta$ or even $\alpha = \beta$ does not change results significantly. As described by Table 3.1, the model is numerically solved setting $\alpha_0 = 0.3$ and $\beta_0 = 0.25$.

Since registered firms behave similarly, whether they export or solely supply the domestic market, I focus on the effect on domestic firms only. Increasing α translates into the probability of inspection becoming more steeper. Meaning that the likelihood of an audit would increase considerably more for the most productive firms than for the least productive ones. As Figure 3.3a shows, when $\alpha = 0.1$ the probability of inspection is almost flat. Bigger and more productive firms face almost the same likelihood of an audit as small and less productive firms. However, when $\alpha = 0.8$ the probability of inspection is as low as zero when firms are very small (and inefficient) and is above 90 per cent for the biggest (most productive) firms.

Figure 3.3: Changing registered firms' probability of inspection

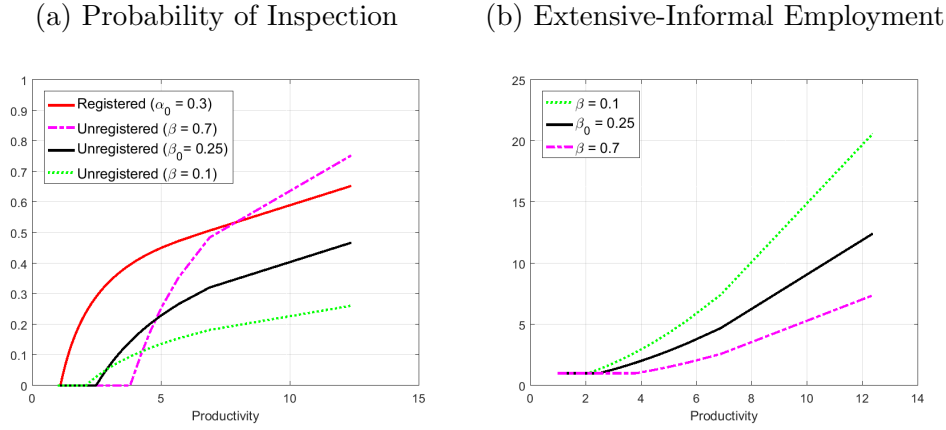


A direct consequence of registered firms' probability of inspection sensibility to a change in its parameter, α , is labour reallocation. When it is more likely to be audited, firms migrate their labour towards formal employment. Hence, it is understandable that as α rises, the productivity level at which registered firms

decide to shift employment towards only formal labour decreases. Figure 3.3b shows that when $\alpha = 0.8$, fairly unproductive firms hire only formal workers. Conversely, when $\alpha = 0.1$ regardless of their productivity level, firms employ between 65 and 85 per cent of formal employment.

Since changes in α affect registered firms' probability of inspection, it could also have an impact on their profits, however, I find that registered firms adjust by reallocating labour from informal to formal as α increases. Thus, registered firms' profits do not change with α . Hence, productivity thresholds remain unchanged, and so does the extensive margin of informality.

Figure 3.4: Changing unregistered firms' probability of inspection



As Figure 3.4a shows, as β increases, the probability of inspection for unregistered firms becomes steeper. When $\beta = 0.1$, the least productive among unregistered firms face approximately 25 per cent probability of an audit. However, when $\beta = 0.7$ these same firms face a probability of an inspection above 75 per cent. Since unregistered firms cannot change their labour composition to diminish the risk of paying a fine, their only answer is to reduce their size. Hence, Figure 3.4b shows how unregistered firms' size goes down as β increases. Labour is still increasing in productivity but the rate at which it increases declines as β goes up. As a result, I find that as β increases, registered firms' productivity threshold, φ_r^* , moves to the right. Unregistered firms' profits reduce for all levels of productivity and more so for the most productive firms. Thus, firms that were not productive

enough to register, find profitable to operate as registered firms after β increased.

Finally, I study the effect of setting $\alpha = \beta$ and find that the effect is inconsequential for the analysis. Since the probabilities of inspection depend mostly on the size of the firm and registered firms are bigger, they also face a higher probability of inspection even when $\alpha = \beta$.

To summarize, first I find that when the probability of inspection for registered firms becomes steeper, registered firms devote a larger share of their labour force to formal employment. In this way, the extensive margin of informality remains unchanged, and the intensive margin goes down. Second, I show unregistered firms' probability function becomes steeper, informal labour in the extensive margin goes down for all levels of productivity. Moreover, the most productive unregistered firms become registered. They can face the costs of formality by devoting a sizeable portion of their labour force to intensive-informal workers. Then, increasing unregistered firms' likelihood of an audit increases the intensive margin and reduces the extensive margin of informality.

Furthermore, I show that registered firms are always more likely to be audited than unregistered firms regardless of the parameter choice due to registered firms always choosing to be bigger than unregistered firms.

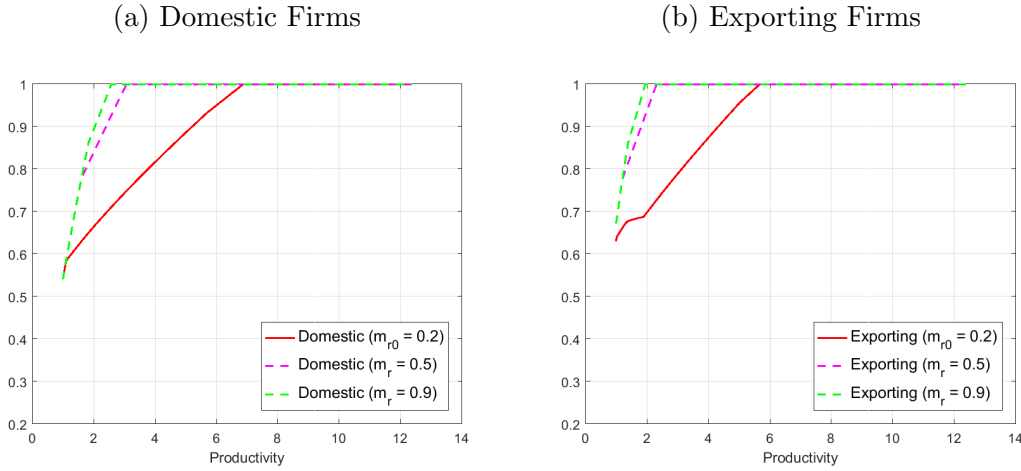
3.5.2 Changes in Fines

Results presented in Section 3.4, assume $m_r < m_u$. Since unregistered firms transgress labour law twice, I assume that they face a higher fine. Unregistered firms operate without the tax collection agency consent and they do not pay payroll tax on behalf of their informal employees. In this Section, I study the effect of results' sensibility to a variation in fines.

First, I analyse the effect of increasing registered firms' fine up until it becomes equal to unregistered firms' fine, $m_{u0} = 0.9$. As Figure 3.5a shows, the share of formal employment increases with m_r for all levels of productivity. Moreover,

the higher m_r becomes, lower the productivity level at which firms shift labour towards 100 per cent formal. When the risk of hiring cheaper-informal workers bares larger punishment, unproductive firms prefer to avoid the risk too. As Figure 3.5b shows, this effect is more abrupt for exporting firms that are already paying higher fixed costs.

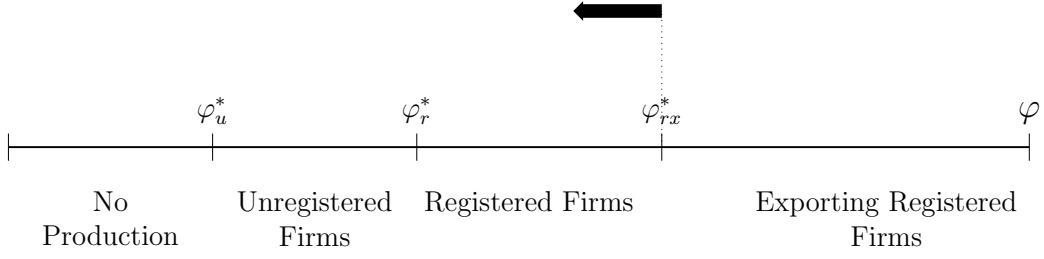
Figure 3.5: Share of Formal Employment
when registered firms' fine increases



Since registered firms operating solely in the domestic market reallocate employment when m_r increases, their profits remain unaltered for all productivity level. A surprising result is that since exporting-registered firms migrate their labour force to 100 per cent formal workers, their profits slightly increase for mid to high productive firms. This means that firms that avoid the risk that comes with informality, increase their profits if they are productive enough to pay the costs of formality. Moreover, as Figure 3.6 shows, when m_r rises, exporting firms' minimum level of productivity required to operate goes down (φ_{rx}^* shifts to the left). This is due to exporting firms hiring solely formal workers even before the fine went up. Hence, when it increased, exporting firms became more productive compared to firms that were hiring some informal workers.

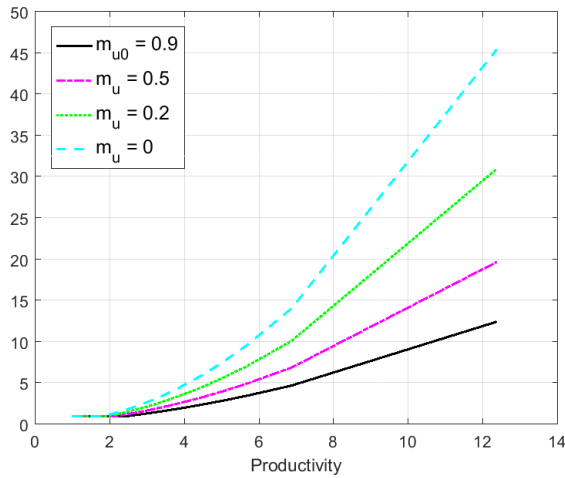
Next, I study the effect of reducing the fine faced by unregistered firms. When it declines, unregistered firms rapidly start to grow in terms of labour force size. As Figure 3.7 shows, the highest the fine, the faster employment grows by pro-

Figure 3.6: Registered Firms' Fine increases



ductivity level. Thus, unregistered firms' profits increase in the same way. Since more productive firms are more capable of taking advantage of a decline in costs, they are the ones that benefit the most. Since the fine's fall affects mostly more productive firms, the productivity threshold to enter the market, φ_u^* , does not change. However, as the unregistered firms' profits increase and registered firms profits remain the same, the productivity threshold to operate as the latter, φ_r^* , shifts to the right. Meaning, firms that used to hire formal workers and operate as registered firms would become unregistered and contribute to the extensive margin of informality. This result means that a registered firm can simply stop paying taxes and become unregistered, Diaz et al. (2018) using a panel data of micro-enterprises in Peru show that this phenomenon does take place and it is not rare during the period 2005-2014.

Figure 3.7: Extensive-Informal Employment when unregistered firms fine declines



Furthermore, since unregistered firms' profits increase as m_u drops, if the fine de-

cline is significant, firms would no longer find profitable to operate in the domestic market as registered firms. They will only choose to register if they are productive enough to export.

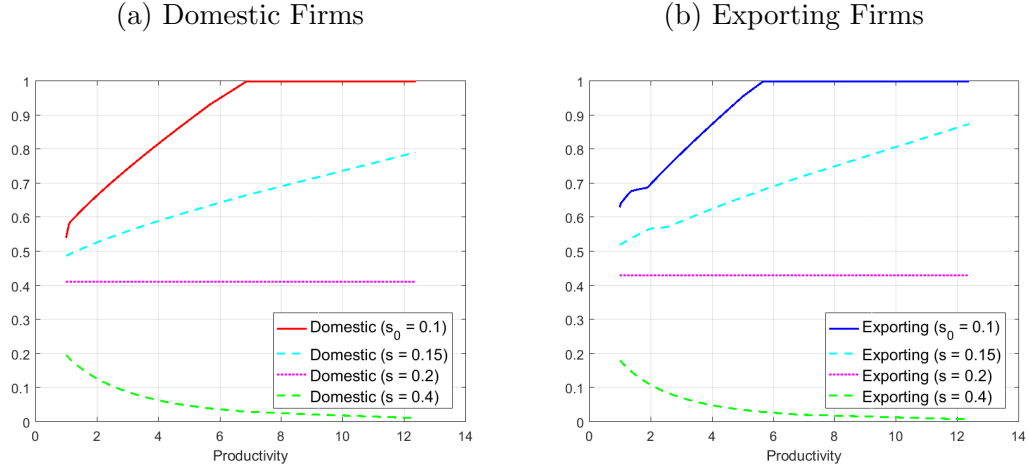
Taking the case of a reduction in fines for unregistered firms to the extreme, I study what would happen if the government implements a policy in which unregistered firms are exonerated from paying a fine altogether. Sometimes policies that aim at formalizing the economy grant amnesty to informal firms. As expected, I find that when this is the case unregistered firms' profits are too high for registered firms to compete with and in the same way as when fines equalize across registered and unregistered firms, it only makes sense to register when exporting.

3.5.3 Changes in Payroll Tax

In this Section, I study the effect of increasing the payroll tax. Since the only firms paying payroll tax are the registered ones, this policy change would only affect their decisions. I find that as the payroll tax increases, both domestic-registered firms' threshold, φ_r^* , and registered-exporting firms' threshold, φ_{rx}^* , shift to the left. Thus, less registered firms choose to solely sell in the domestic market. Furthermore, when the payroll tax is as high as 40 per cent, firms selling domestically are always unregistered and only register if they are efficient enough to cope with the costs of exporting.

Findings in the intensive margin of informality are quite impressive. See Figure 3.8. Not surprisingly, when the payroll tax increases, registered firms reallocate labour towards informal workers as hiring formal workers becomes more expensive. Moreover, results show that firms increase formal employment at the same rate as intensive-informal labour as productivity increase when payroll tax is 20 per cent.

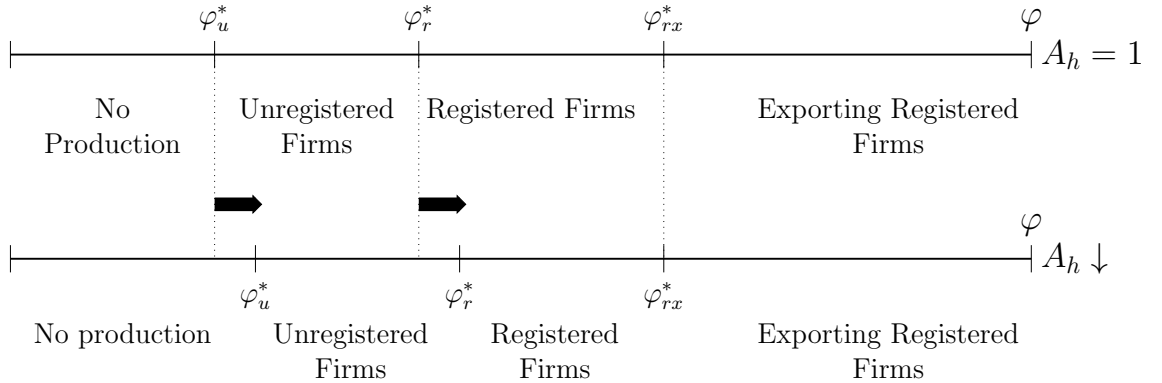
Figure 3.8: Share of Formal Employment
when payroll tax increases



3.5.4 Deepening openness to trade

In this Section, I evaluate the impact on firms choice on both margins of informality when the economy becomes more open. On the one hand, I aim to study the effect of a reduction from domestic consumers on domestic goods due to a larger intake of foreign products. In this way, I consider an increase in import competition. On the other hand, opening the economy also means that exporting firms have a bigger market towards which their goods can be sent. Thus, I also study the effect of an increase in foreign demand.

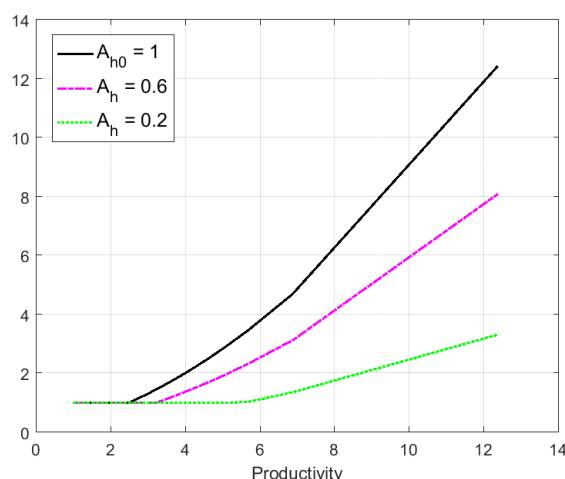
Figure 3.9: Reduction in Domestic Demand



Firms decision described in Section 3.4 assumes that the demand shifter both in Foreign and at Home is equal to one, $A_h = A_f = 1$. First, I study the effect of a reduction in domestic demand, namely A_h goes down. I consider the case of a 40

and 80 percentage points decrease. As Figure 3.9 shows, productivity thresholds for unregistered and registered firms shift to the right. This result is similar to (Melitz, 2003) as it refers to reallocation towards more efficient firms when there is an increase in competition. Moreover, the magnitude of the shift is proportional to the reduction in demand.

Figure 3.10: Extensive-Informal Employment
when domestic demand declines

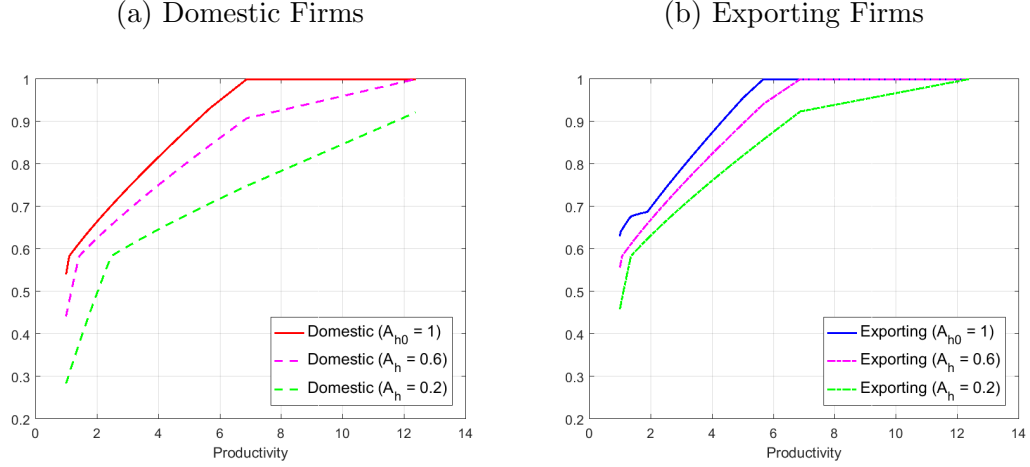


From Figure 3.9, one could infer that firms operating as unregistered firms simply become, on average, more productive and that there is no impact on the extensive margin. However, as shown by Figure 3.10, as the domestic demand drops, so does the size of unregistered firms. Hence, the extensive margin of informal labour diminishes with domestic demand for all productivity levels. For instance, comparing the baseline simulation with the case when domestic demand drops by 80 per cent, extensive-informal employment remains equal to 1 almost until the middle of the productivity distribution when in the baseline case was 3 times that amount. Thus, a drop in domestic demand translates into a reduction in the extensive margin of informality.

Similarly, Figure 3.9 shows that registered firms become more productive on average when domestic demand diminishes. However, as Figure 3.11a shows, the share of formal employment drops significantly with domestic demand. Hence, registered domestic firms that used to hire mostly formal workers, after competition increases

in the domestic market, they migrate towards cheaper (informal) employment. In this way, the intensive margin of informality increases when domestic demand decreases.

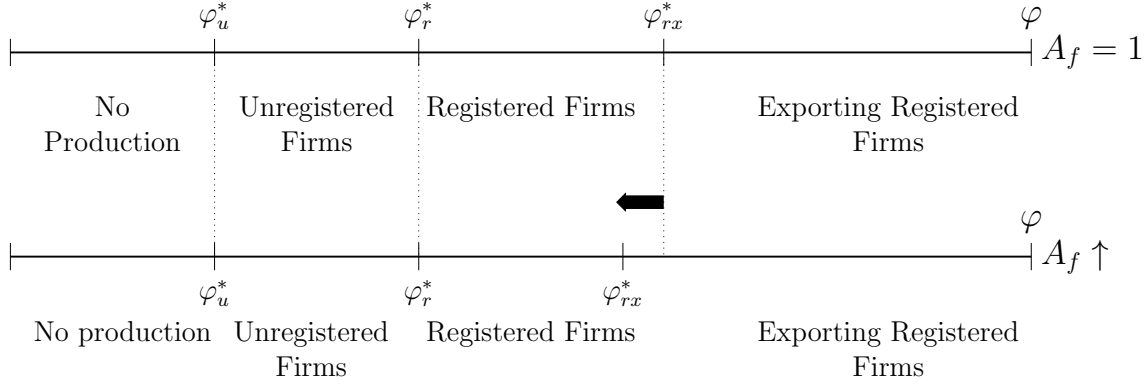
Figure 3.11: Share of Formal Employment
when domestic demand declines



It is worth mentioning that for a significant reduction of the domestic demand, say 80 per cent drop, the productivity threshold for registered-exporting firms, φ_{rx}^* , shifts to the left. Thus, firms that were not productive enough to export become exporters because there is not enough demand in the domestic market. In terms of informality, results are the same, even when the domestic demand approaches zero. As Figure 3.11b shows, as demand drops, so does the share of formal labour in exporting-registered firms.

I model an increase in the demand for imports as an increase of A_f . Since firms working only to provide the domestic market are not affected by the rise in the demand for imports given this theoretical framework's set-up, their profit functions are not altered in any way. Thus, the extensive margin of informality does not change when A_f raises. However, as Figure 3.12 shows, when the demand for imports increases, registered-exporting firms' threshold, φ_{rx}^* , shifts to the left. The magnitude of the shift increases with the demand for imports. When it raises, firms that used to lack productivity to find profitable to join the international market, start to export.

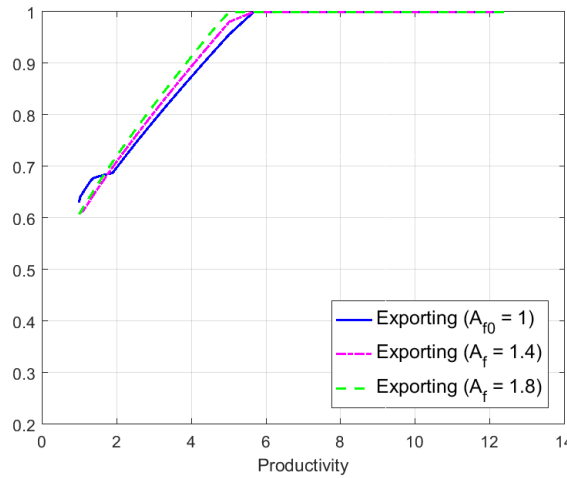
Figure 3.12: Enlargement of Foreign Demand



Since registered-exporting firms become, on average, less productive, they also hire less formal employment. As Figure 3.13 shows, when A_f increases, exporting firms' reallocation of labour does not change much for each level of productivity. Hence, higher foreign demand translates into a rise in intensive-informal employment.

The model is consistent with the empirical findings on Chapter 2. First, I find that as unregistered firms require a higher productivity level to enter the market, the extensive margin of informality diminishes. Second, I find that registered firms, both exporting and non-exporting, reallocate labour towards informal workers. Hence, the intensive margin of informality increases.

Figure 3.13: Share of Formal Employment when demand for imports increases



3.6 Conclusions

This chapter provides a theoretical framework for firms decisions on informality. The model aims to shed light on the findings presented in Chapter 2, where empirical results show that informal labour exists in two margins and that these margins react in opposite directions when the economy opens to trade.

I model profit maximization problem for registered and unregistered firms using a Melitz (2003)-type model. Registered firms are able to choose between formal and informal workers. In this way, they face a trade-off between hiring cheaper-informal workers and risking getting caught or, hiring more expensive-formal workers. Unregistered firms are transgressing the law just by operating as such. Thus, if audited, they face a fine. However, if not, they pay lower costs of operation. Furthermore, firms are also able to export if they find it profitable to do so.

After numerically solving each firm type's problem, I find that firms' choice on informality depends on their productivity level. The least productive firms serve the domestic market as unregistered firms. Firms with productivity level in the middle of the productivity distribution solely supply the domestic market as registered firms, and the most productive firms sell in the foreign market as well as at home. Also, results show that unregistered firms choose never to export as it is not profitable to do so regardless of productivity level. Furthermore, registered firms (exporting and non-exporting) reallocate labour towards formal employment as their productivity level increases.

When doing comparative statics, I find that as the probability of inspection changes, registered firms re-adjust costs by changing their share of formal employment and in this way, their profits remain unaltered. Conversely, unregistered firms do not have this adjustment mechanism as they only hire informal workers. Hence, if their probability of inspection increases, their profits decrease and they require to be more productive to enter the market.

Similarly, when increasing registered firms' fine, I find that these firms re-adjust labour composition and hire more formal workers. Conversely, when unregistered firms' fine declines, firms grow in size. Moreover, if fines decline is substantial, firms selling to the domestic market would only operate as unregistered firms. Hence, policies aiming at reducing informal labour should not be so forgiving with unregistered firms as the incentives to pay for formality could disappear. Furthermore, I find that when increasing the payroll tax, unregistered firms gain ground over unregistered ones, which means that fewer firms are productive enough to register given the costs of formality.

I also study the effect of opening up to trade. I find that when domestic demand decreases and demand for imports increases, the extensive margin of informality reduces as unregistered firms require a higher level of productivity to operate as such. Also, I show that the intensive margin of informality increases because registered firms, exporting and otherwise, reallocate labour towards informal-cheaper workers as a response to an increase in import competition. In this way, the model presented in this chapter is consistent with the empirical findings in Chapter 2 for the Peruvian Economy.

Conclusion

The effect that globalisation has on labour markets is a long-lasting concern in the literature (Harrison et al., 2011; Goldberg and Pavcnik, 2007). The large scale trade liberalisation implemented by developing countries in the past four decades highlights the importance of understanding who are the winners and who are the losers of globalisation. As Pavcnik (2017) points out, many times, the presumption is that developed countries are the winners and developing countries are the losers. Setting out the discussion in those terms forgets that there are winners and losers within each country. This thesis focuses on labour markets and more specifically, on informal labour, aiming to address the different ways in which inequality is present in a developing country such as Peru.

This thesis is a set of essays that explore informality taking into account two dimensions that were overlooked until now. Instead of assuming informality is binary, I bring attention to the intensive margin of informality. In this way, I propose a novel approach that acknowledges the prevalence of informal workers in formal firms. Consequently, I show that informal employment affects the labour market in a variety of ways.

Taking these two margins seriously, I start by describing the characteristics of workers that engage in different degrees on informality by emphasising the role of gender. In chapter 1, I find that the informality-wage gap is substantial, and this is especially true for the extensive margin of informality. Furthermore, results show that the gender wage gap goes hand in hand with the informality-wage penalty

in this margin. Also, through a descriptive analysis, I confirm that the demographic characteristics that describe a person employed in the extensive margin of informality are not the same as the ones that describe intensive-informal workers.

In chapter 2, I look at the effect of globalisation on informality and uncover the implications of considering informal workers in registered firms and unregistered firms separately. By studying the impact of trade in this manner, I can show that each margin of informality reacts in opposite directions. In this way, I hope to contribute to the literature that links trade and informality. I claim that when informal workers are put together, these two contrary effects become one and the mechanisms behind are obscured.

Precisely to bring light to these mechanisms, I construct a theoretical model in chapter 3. This model is similar to Melitz (2003)'s framework, but I include a probability of inspection that is increasing in size and distinct for registered and unregistered firms. With the aid of this model, I can show that the least productive firms choose not to register and that mid-productive firms register. I also confirm that their share of formal employment is increasing in productivity. Furthermore, I find that exporting firms are only registered and prefer to hire mostly formal workers. I also show how firms react when there is an increase in import competition and find that given the model's features, firms' actions are consistent with the empirical findings discussed in chapter 2.

My work is not without limitations. There is still a lot of work to be done exploring these two margins of informality for the whole economy. In chapters 1 and 2, I focused on the manufacturing sector. However, the data for all other sectors in the economy is available. Moreover, the database's richness would also allow for a local labour market approach. For a country as centralised as Peru, shifting the focus from industries to geography might bring some new and interesting conclusions.

Furthermore, chapter 3 is a partial equilibrium model, and as such, it does not model the labour market. The next step would be to build on the conclusions I

reach in partial equilibrium and expand it to general equilibrium. Afterwards, the model should be estimated. Since the model studies firms' decisions in terms of informality, the ideal dataset would be a firm-level dataset. However, it is possible to estimate it also with the available data.

I hope my work makes a contribution on two fronts. First, it expands the discussion on informality in the academic arena. Studying the intensive margin of informality and distinguishing it from the extensive margin is still at the fringe of the literature. Studying labour market effects in the developing world without acknowledging the existence, importance and diversity of the informal sector engenders myopic results. Currently, 61 per cent of all people who work around the world make their living in the informal economy. This means that 2 billion people are being left behind by the economic system because of the way they are employed. While the standard approach to research on labour markets thinks of employment in terms of wage work, knowing who the employer is, and having a decent place of work, we know that most people in the world never experienced that type of working conditions.⁸ New research areas may and will open in the academic literature if it innovates on the definition of employment and payment, and recognises the relevance of the informal economy.

Second, I aspire for my work to join the call on governments to bring attention to informal workers' issues at the center of the political discussion in the developing world, especially on the intensive margin. As the global network *Women in Informal Employment: Globalizing and Organizing* (WIEGO) writes in their goal statement, "most of the world's workers make their living in the informal economy, where earnings are typically low but costs and risks are high". I share their belief that poverty and inequality can only be reduced by raising the earnings and lowering the risks of these workers.

⁸More information to be found in WIEGO's website: <https://www.wiego.org/about-us>.

Appendix A

Appendix to Chapter 1

A.1 Sample construction

Table A.1: Employed and Unemployed population per year - All Industries

	2007		2008		2009		2010		2011		2012		2013		2014	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
Employed	46582	71%	45357	71%	46516	72%	45984	72%	52314	72%	52147	71%	62384	95%	61726	70%
Unemployed	3632	6%	2995	5%	2881	4%	2699	4%	2893	4%	2706	4%	2949	4%	2698	3%
Not looking for a job	15233	23%	15292	24%	15303	24%	15038	24%	17750	24%	18394	28%	22557	34%	23345	27%
Missing Value	102	0%	118	0%	67	0%	89	0%	135	0%	82	0%	92	0%	102	0%
Total	65,549	100%	63,762	100%	64,767	100%	63,810	100%	73,092	100%	73,329	112%	87,982	134%	87,871	100%

Source: ENAHO 2007-2014.

Table A.2: Sample Composition by Industry and Year

	2007	2008	2009	2010	2011	2012	2013	2014	Total	Share of Total
Agriculture	17,047	16,583	17,124	16,541	19,001	18,425	21,892	21,975	148,588	36.0%
Fishing	319	292	311	294	363	341	408	399	2,727	0.7%
Mining	634	629	644	636	793	799	889	860	5,884	1.4%
Manufacturing	3,931	3,839	3,793	3,771	4,109	4,045	4,876	4,428	32,792	7.9%
Electricity	82	119	105	97	89	82	128	132	834	0.2%
Construction	1,744	1,740	1,963	2,139	2,496	2,564	3,244	3,234	19,124	4.6%
Retail	8,227	7,775	7,851	7,767	8,944	9,112	10,732	10,544	70,952	17.2%
Hospitality	2,613	2,655	2,726	2,910	3,170	3,301	3,967	3,959	25,301	6.1%
Transport	2,807	2,860	2,948	2,840	3,372	3,174	3,793	3,836	25,630	6.2%
Financial Intermediation	174	204	220	228	245	299	384	428	2,182	0.5%
Real Estate	1,295	1,264	1,344	1,355	1,565	1,588	2,015	2,027	12,453	3.0%
Public Administration	1,777	1,861	1,923	1,987	2,144	2,324	2,670	2,735	17,421	4.2%
Education	2,329	2,213	2,209	2,176	2,537	2,638	3,063	3,006	20,171	4.9%
Health	752	729	787	705	819	898	1,262	1,278	7,230	1.8%
Other Services	1,341	1,364	1,400	1,402	1,545	1,480	1,790	1,751	12,073	2.9%
Households	1,508	1,228	1,165	1,132	1,120	1,072	1,270	1,131	9,626	2.3%
International Organisations	2	2	3	4	2	5	1	3	22	0.0%
Total	46,582	45,357	46,516	45,984	52,314	52,147	62,384	61,726	413,010	100.0%

Source: ENAHO 2007-2014.

Table A.3: Sample in Manufacturing (ISIC 2 digit) - Period: 2007-2014

	Number of workers	Share of total
Food products and beverages	8,800	26.84
Textiles	4,761	14.52
Wearing apparel; dressing and dyeing of textiles	4,647	14.17
Furniture	3,913	11.93
Fabricated metal products, except machinery	2,155	6.57
Wood and of products, except furniture	1,754	5.35
Other non-metallic mineral products	1,407	4.29
Tanning and dressing of leather	1,228	3.74
Publishing, printing and reproduction	839	2.56
Machinery and equipment	775	2.36
Chemicals and chemical products	613	1.87
Other transport equipment	361	1.1
Rubber and plastics products	359	1.09
Basic metals	341	1.04
Medical, precision and optical instruments	169	0.52
Manufacture of paper and paper products	156	0.48
Recycling	145	0.44
Electrical machinery and apparatus	139	0.42
Motor vehicles, trailers and semi-trail	135	0.41
Coke and refined petroleum products	59	0.18
Tobacco products	18	0.05
Radio, television and communication equipment	13	0.04
Office, accounting and computing machinery	5	0.02
Total below the dashed line	839	2.56
Total	32,792	100

Source: ENAHO 2007-2014.

Notes: All observations below the dashed line are eliminated as the number of workers is too small to be representative of the industry at 2 digit.

Table A.4: Employment in Manufacturing

	2007		2008		2009		2010		2011		2012		2013		2014	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Food products and beverages	987	25.7%	958	25.4%	1,026	27.9%	1,015	27.5%	1,165	29.1%	1,116	28.5%	1,366	28.8%	1,167	27.1%
Textiles	682	17.7%	635	16.8%	569	15.4%	520	14.1%	585	14.6%	498	12.7%	679	14.3%	593	13.8%
Wearing apparel	573	14.9%	608	16.1%	521	14.1%	540	14.6%	508	12.7%	575	14.7%	700	14.8%	622	14.4%
Tanning and dressing	124	3.2%	135	3.6%	126	3.4%	144	3.9%	145	3.6%	184	4.7%	185	3.9%	185	4.3%
Wood products, except furniture	209	5.4%	174	4.6%	188	5.1%	228	6.2%	232	5.8%	215	5.5%	244	5.1%	264	6.1%
Publishing and printing	104	2.7%	108	2.9%	89	2.4%	113	3.1%	94	2.3%	96	2.5%	118	2.5%	117	2.7%
Chemicals and its products	81	2.1%	58	1.5%	72	2.0%	62	1.7%	69	1.7%	78	2.0%	106	2.2%	87	2.0%
Rubber and plastics products	36	0.9%	44	1.2%	55	1.5%	35	0.9%	39	1.0%	45	1.1%	65	1.4%	40	0.9%
Other non-metallic minerals	152	4.0%	152	4.0%	174	4.7%	173	4.7%	202	5.0%	157	4.0%	201	4.2%	196	4.6%
Basic metals	27	0.7%	29	0.8%	59	1.6%	53	1.4%	44	1.1%	32	0.8%	49	1.0%	48	1.1%
Fabricated metal products	250	6.5%	220	5.8%	233	6.3%	220	6.0%	283	7.1%	285	7.3%	344	7.3%	320	7.4%
Machinery and equipment	92	2.4%	72	1.9%	58	1.6%	94	2.5%	114	2.8%	98	2.5%	132	2.8%	115	2.7%
Other transport equipment	37	1.0%	47	1.2%	36	1.0%	43	1.2%	54	1.3%	45	1.1%	46	1.0%	53	1.2%
Furniture	490	12.7%	530	14.1%	477	13.0%	451	12.2%	468	11.7%	492	12.6%	506	10.7%	499	11.6%
Total	3,844	100.0%	3,770	100.0%	3,683	100.0%	3,691	100.0%	4,002	100.0%	3,916	100.0%	4,741	100.0%	4,306	100.0%

Source: ENAHO 2007-2014.

A.2 Departments by Poverty level

2007

Low income: Apurimac, Ayacucho, Cajamarca, Huanuco

Middle income: Amazonas, Cusco, Loreto, Pasco, Piura, Puno, San Martin, Ancash, Junin, La Libertad, Lambayeque, Ucayali

High income: Arequipa, Ica, Lima, Moquegua, Tacna, Tumbes, Madre de Dios

2008

Low income: Huancavelica, Apurimac

Middle income: Amazonas, Ayacucho, Cajamarca, Cusco, Huanuco, Loreto, Pasco, Puno, Piura

High income: Ancash, Junin, La Libertad, Lambayeque, Moquegua, San Martin, Ucayali , Lima, Tacna, Arequipa, Ica, Madre de Dios

2009

Low income: Apurimac, Huancavelica, Amazonas, Ayacucho, Cajamarca, Huanuco, Loreto, Pasco, Puno, San Martin

Middle income: Cusco, Piura, Ancash, Junin, La Libertad, Lambayeque, Ucayali

High income: Arequipa, Ica, Lima, Moquegua, Tacna, Tumbes, Madre de Dios

2010

Low income: Apurimac, Huancavelica, Amazonas, Ayacucho, Cajamarca, Cusco, Huanuco, Loreto, Piura, Puno

Middle income: Lambayeque, Pasco, San Martin, Ancash, Junin, La Libertad, Ucayali

High income: Arequipa, Ica, Lima, Moquegua, Tacna, Tumbes, Madre de Dios

2011

Low income: Apurimac, Ayacucho, Cajamarca, Huancavelica, Huanuco, Ama-

zonas, Loreto, Pasco, Piura, Puno

Middle income: Ancash, Cusco, Junin, La Libertad, Lambayeque, San Martin, Lima, Tacna

High income: Arequipa, Ica, Moquegua, Tumbes, Ucayali, Madre de Dios

2012

Low income: Apurimac, Ayacucho, Cajamarca, Huancavelica, Amazonas, Huanuco, Loreto, Pasco, Piura, Puno

Middle income: Ancash, Cusco, Junin, La Libertad, Lambayeque, San Martin, Arequipa, Lima, Tacna, Tumbes, Ucayali

High income: Ica, Moquegua, Madre de Dios

2013

Low income: Amazonas, Ayacucho, Cajamarca, Huancavelica, Pasco, Apurimac, Huanuco, Loreto, Piura

Middle income: La Libertad, Puno, San Martin, Ancash, Cusco, Junin, Lambayeque

High income: Callao, Lima, Tacna, Tumbes, Ucayali, Arequipa, Moquegua, Ica, Madre de Dios

2014

Low income: Amazonas, Ayacucho, Cajamarca, Huancavelica, Apurimac, Huanuco, Loreto, Pasco

Middle income: La Libertad, Piura, Puno, San Martin, Ancash, Cusco, Junin, Lambayeque

High income: Callao, Lima, Moquegua, Tacna, Tumbes, Ucayali, Arequipa, Madre de Dios, Ica

A.3 Robustness Estimations

Table A.5: Extensive Margin Estimations (2007- 2011)

	Dependent Variable: $\ln(wages)$					
	All			Men		
	OLS	Heckman [†]		OLS	Heckman [†]	
	(1)	(2)		(3)	(4)	(5)
Extensive-Informal Indicator	-0.8149*** (0.049)	-0.8107*** (0.047)		-0.5831*** (0.034)	-0.5899*** (0.039)	-1.1396*** (0.094)
Men	0.8197*** (0.082)	0.8148*** (0.081)				-1.1271*** (0.091)
Married/Cohabitant	0.0394 (0.043)	0.0349 (0.044)		0.2632*** (0.023)	0.2118*** (0.022)	-0.1810*** (0.035)
Age: 30-44	0.2134*** (0.047)	0.2131*** (0.046)		0.2362*** (0.025)	0.1685*** (0.025)	0.1523* (0.086)
Age: 45-64	0.1434** (0.058)	0.1463*** (0.055)		0.1761*** (0.033)	0.1279*** (0.039)	0.0531 (0.107)
Age: > 65	-0.2856*** (0.092)	-0.2909*** (0.096)		-0.4938*** (0.080)	-0.5510*** (0.099)	-0.1738* (0.096)
Primary Education	0.3768*** (0.119)	0.4061*** (0.121)		0.3892*** (0.133)	0.4029*** (0.138)	0.1822*** (0.061)
Secondary Education	0.7354*** (0.146)	0.7728*** (0.149)		0.6088*** (0.151)	0.6389*** (0.148)	0.5448*** (0.087)
Technical Education	0.9026*** (0.146)	0.9456*** (0.148)		0.7485*** (0.149)	0.7698*** (0.149)	0.7554*** (0.087)
UG-PG degree	1.0630*** (0.168)	1.1043*** (0.170)		0.9316*** (0.164)	0.9825*** (0.157)	0.8580*** (0.131)
Middle Income Department	0.2839*** (0.036)	0.2864*** (0.036)		0.1945*** (0.031)	0.1699*** (0.029)	0.3169*** (0.050)
High Income Department	0.6037*** (0.061)	0.6170*** (0.062)		0.4369*** (0.035)	0.4006*** (0.030)	0.7011*** (0.077)
Wald test of indep. eqns. (rho = 0)						
$\chi^2(1)$		1.88			218.30	6.36
$Prob > \chi^2$		0.1699			0.0000	0.0117
Observations	17640	18329		10242	10375	7398
R^2	0.57			0.37		0.52

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include year and industry fixed effects.

[†] Results are from a Heckman maximum likelihood estimation.

Table A.6: Intensive Margin Estimations (2007-2011)

	Dependent Variable: $\ln(wages)$					
	All		Men		Women	
	OLS (1)	Heckman [†] (2)	OLS (3)	Heckman [†] (4)	OLS (5)	Heckman [†] (6)
Intensive-Informal Indicator	-0.4608*** (0.033)	-0.4775*** (0.033)	-0.4046*** (0.038)	-0.3858*** (0.041)	-0.5570*** (0.044)	-0.7493*** (0.090)
Men	0.2767*** (0.030)	0.2371*** (0.027)				
Married/Cohabitant	0.1119*** (0.022)	0.1278*** (0.024)	0.1753*** (0.023)	0.1373** (0.061)	-0.0179 (0.034)	
Age: 30-44	0.1883*** (0.017)	0.1861*** (0.030)	0.2121*** (0.015)	0.1647*** (0.060)	0.1435*** (0.038)	
Age: 45-64	0.2570*** (0.029)	0.2879*** (0.039)	0.2550*** (0.036)	0.2372*** (0.057)	0.2783*** (0.050)	
Age: > 65	-0.0245 (0.091)		0.0088 (0.091)		-0.4029 (0.398)	
Primary Education	0.5513*** (0.203)		0.2551*** (0.076)		0.7117* (0.390)	
Secondary Education	0.7095*** (0.211)	0.0000 (.)	0.3916*** (0.068)	0.0000 (.)	0.8981** (0.387)	
Technical Education	0.8668*** (0.213)	0.1610*** (0.025)	0.5465*** (0.073)	0.1630*** (0.021)	1.0666*** (0.390)	0.0000 (.)
UG-PG degree	1.1549*** (0.221)	0.4517*** (0.036)	0.7938*** (0.084)		1.4311*** (0.403)	0.1386 (0.151)
Middle Income Department	0.0972*** (0.034)	0.0652 (0.041)	0.0815** (0.034)	0.0862* (0.044)	0.1294* (0.071)	0.0503 (0.263)
High Income Department	0.2252*** (0.035)	0.1144*** (0.034)	0.2140*** (0.035)	0.2294*** (0.031)	0.2593** (0.098)	0.0895 (0.273)
Inverse Mills Ratio		1.1797 (3.621)		-4.2314 (11.775)		0.0000 (.)
Observations	7685	6782	5615	4202	2070	279
R^2	0.38	0.35	0.36	0.35	0.38	0.49

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include year and industry fixed effects.

[†] Results are from a Heckman two-stage estimation.

Appendix B

Appendix to Chapter 2

B.1 Additional Estimations

B.1.1 Multinomial Logit

I classify all individuals in three categories. They might be employed in a registered firm as a formal employee or as informal in the intensive margin. Alternatively, they might be hired by an unregistered firm and be informal in the extensive margin. Hence, I estimate the multinomial logit model described in Equation B.1.

$$Status_{\ell jt} = \beta_0 + \beta_\tau OT_{jt} + \beta_g S_{gjt} * OT_{jt} + \beta_s S_{s jt} + \beta_i IT_{jt} + \beta_H \mathbf{H}'_{\ell t} + I_j + Y_t + \epsilon_{\ell jt} \quad (\text{B.1})$$

where

$$Status_{\ell jt} = \begin{cases} = 0 & \text{if individual } \ell \text{ is a formal wkr in a registered firm} \\ = 1 & \text{if individual } \ell \text{ is intensive-informal} \\ = 2 & \text{if individual } \ell \text{ is extensive-informal} \end{cases}$$

where $Status_{\ell jt}$ is a categorical variable describing the informality-formality status

of individual ℓ who works in industry j at time t . The remaining regressors in Equation B.1 are the same controls described in Section 2.4.

The results are in Table B.1. The table reports average marginal effects so that they are comparable with the output from the OLS estimation in Table 2.2. Note that the output tariff average marginal effect takes into account the effect for the interaction terms between tariffs and size indicator, $S_{gjt} * OT_{jt}$. Interestingly, the estimated effect without distinguishing the two margins of informality (Table 2.5) is between the marginal effect found for each margin separately in Table B.1.

I find that a reduction in output tariffs increases the probability to be informal in the intensive margin while reducing the probability to be hired in the extensive margin of informality. This result is robust to the inclusion of input tariffs controls and the coefficients remain almost unchanged when I add input tariffs as regressors (Columns 3 and 4). On the one hand, an increase in import competition translates into registered firms reducing costs by being more likely to hire cheaper workers, i. e. intensive-informal workers. On the other hand, unregistered firms are more likely to either exit the market or hire less workers when import competition increases.

A limitation of the multinomial logit model is the assumption of the “independence of irrelevant alternatives” (IIA) which implies that the relative odds of being a formal worker in a registered firm are unaffected by the relative odds of being informal in any of the margins. A Hausman test for the violation of the IIA assumption is not conclusive.

Table B.1: Multinomial Logit - Average Marginal Effects

	Model 1		Model 2	
	Intensive	Extensive	Intensive	Extensive
	Margin	Margin	Margin	Margin
	(1)	(2)	(3)	(4)
Tariff	-0.0020*** (0.001)	0.0033*** (0.001)	-0.0020*** (0.001)	0.0033*** (0.001)
Input Tariff			0.0002 (0.000)	0.0008* (0.000)
Small Industry	-0.0013 (0.010)	0.0167 (0.010)	-0.0012 (0.010)	0.0157 (0.010)
Medium Industry	-0.0042 (0.008)	0.0194** (0.009)	-0.0043 (0.008)	0.0179** (0.009)
Married	-0.0565*** (0.006)	-0.0075 (0.006)	-0.0565*** (0.006)	-0.0075 (0.006)
Male	0.0417*** (0.005)	-0.1534*** (0.005)	0.0417*** (0.005)	-0.1534*** (0.005)
Primary	0.0497*** (0.019)	-0.1305*** (0.018)	0.0497*** (0.019)	-0.1307*** (0.018)
Secondary	0.0854*** (0.019)	-0.2389*** (0.018)	0.0854*** (0.019)	-0.2391*** (0.018)
Technical	0.0686*** (0.019)	-0.3249*** (0.019)	0.0686*** (0.019)	-0.3251*** (0.019)
UG-PG Educ	0.0613*** (0.020)	-0.3645*** (0.019)	0.0614*** (0.020)	-0.3645*** (0.019)
Quechua Ethnic Group	-0.0172** (0.007)	0.0062 (0.007)	-0.0171** (0.007)	0.0062 (0.007)
Age: 30-44	-0.1140*** (0.006)	0.0002 (0.006)	-0.1140*** (0.006)	0.0003 (0.006)
Age: 45-64	-0.1788*** (0.006)	0.0580*** (0.007)	-0.1788*** (0.006)	0.0580*** (0.007)
Age: > 65	-0.1976*** (0.010)	0.1418*** (0.012)	-0.1976*** (0.010)	0.1419*** (0.012)
Observations	31009	31009	31009	31009

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include industry and year fixed effects. Average industry size included both as dummy and as an interaction with output tariff, where S: <15 workers, M: 16-50 workers, L: >50 workers. The dependent variable is individual's status of informality. Base category is "Formal worker".

B.1.2 Probability to be informal: Logit models

Table B.2: Logit Estimations - Average marginal effects

	Intensive Margin			Extensive Margin		
	Uncond	Size=S	Size=M	Uncond	Size=S	Size=M
	(1)	(2)	(3)	(4)	(5)	(6)
Output Tariff	-0.0007 (0.002)	-0.0119*** (0.004)	-0.0039* (0.002)	0.0032** (0.002)	0.0002 (0.003)	0.0049** (0.002)
Input Tariff	0.0018*** (0.001)	0.0017*** (0.001)	0.0017*** (0.001)	0.0008 (0.001)	0.0008 (0.001)	0.0008 (0.001)
Small Industry	0.0118 (0.022)	0.0118 (0.022)	0.0118 (0.022)	0.0170 (0.019)	0.0170 (0.019)	0.0170 (0.019)
Medium Industry	-0.0050 (0.016)	-0.0050 (0.016)	-0.0050 (0.016)	0.0191 (0.017)	0.0191 (0.017)	0.0191 (0.017)
Married	-0.1175*** (0.013)	-0.1170*** (0.013)	-0.1173*** (0.013)	-0.0203** (0.009)	-0.0204** (0.009)	-0.0202** (0.009)
Male	-0.0666*** (0.009)	-0.0664*** (0.009)	-0.0665*** (0.009)	-0.1569*** (0.014)	-0.1579*** (0.014)	-0.1564*** (0.014)
Primary Education	-0.0522 (0.069)	-0.0514 (0.068)	-0.0524 (0.069)	-0.1407*** (0.027)	-0.1392*** (0.028)	-0.1378*** (0.027)
Secondary Education	-0.1174* (0.070)	-0.1159* (0.069)	-0.1176* (0.071)	-0.2539*** (0.030)	-0.2525*** (0.030)	-0.2498*** (0.030)
Technical Education	-0.2330*** (0.070)	-0.2308*** (0.069)	-0.2328*** (0.070)	-0.3391*** (0.032)	-0.3384*** (0.033)	-0.3348*** (0.033)
UG-PG degree	-0.2678*** (0.074)	-0.2655*** (0.073)	-0.2674*** (0.074)	-0.3819*** (0.032)	-0.3819*** (0.032)	-0.3778*** (0.032)
Quechua ethnicity	-0.0274* (0.014)	-0.0273* (0.014)	-0.0274* (0.014)	0.0061 (0.009)	0.0062 (0.009)	0.0061 (0.009)
Age: 30-44	-0.2324*** (0.016)	-0.2289*** (0.015)	-0.2323*** (0.016)	0.0053 (0.011)	0.0053 (0.011)	0.0053 (0.011)
Age: 45-64	-0.3308*** (0.023)	-0.3274*** (0.022)	-0.3298*** (0.022)	0.0623*** (0.018)	0.0627*** (0.018)	0.0621*** (0.018)
Age: >65	-0.3092*** (0.035)	-0.3056*** (0.036)	-0.3084*** (0.035)	0.1503*** (0.021)	0.1506*** (0.021)	0.1491*** (0.021)
Observations [⊖]		14119			30967	
<i>Pseudo</i> – R^2		0.2082			0.3383	

[⊖] Model 1 (Columns 1-3) eliminates 7 observations and Model 2 (Columns 4-6) eliminates 9 observations because an outcome of the regressors would mean a perfect prediction resulting in an infinite coefficient.

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include department, industry and year fixed effects. Average industry size is classified as S: <15 workers, M: 16-50 workers, L: >50 workers.

B.1.3 Share of informal labour: Fractional models

In this Section I report the results from estimating equations 2.5 and 2.7 using a fractional model. Tables B.3 and B.4 present the results as Average Marginal Effects (AME). I report AME in order to make the results comparable to the OLS

estimations reported in Columns 5-8 in Tables 2.6 and 2.7 in Section 2.4.

Columns 1-3 in Tables B.3 and B.4 present the Average Marginal Effects (AME) from a model that estimates the share of intensive-informal workers on output tariff, average industry size and the interaction of average industry size and output tariff. Columns 4-5 in Tables B.3 and B.4 report the results from estimating a fractional model that also includes a control for input tariffs.

Since I report the average marginal effect, even though I estimate an equation with interaction terms ($S_{gjt} * OT_{jt}$), I have to report the average marginal effect for each covariate separately. Then, the average marginal effect of the output tariffs takes into account its interaction with average industry size. Since I am aware that industry size is crucial in understanding informal labour's behaviour, Columns 2 and 5 report marginal effects conditional on the average industry size being *small* (less than 15 workers) and Columns 3 and 6 present average marginal effects conditional on industries being of *medium* size (between 16 and 50 workers). Columns 1 and 4 show unconditional marginal effects.

Table B.3: Estimation Share of Intensive-Informal workers:
Average Marginal Effects (AME)

	Fractional Model 1			Fractional Model 2		
	Unconditional AME	AME Conditional on Average Industry Size ≤ 15	AME Conditional on Average Industry Size 16-50	Unconditional AME	AME Conditional on Average Industry Size ≤ 15	AME Conditional on Average Industry Size 16-50
	(1)	(2)	(3)	(4)	(5)	(6)
Output Tariff	-0.0035 (0.003)	-0.0168** (0.008)	-0.0108* (0.006)	-0.0037 (0.003)	-0.0170** (0.008)	-0.0110* (0.006)
Input Tariff				0.0018 (0.006)	0.0018 (0.006)	0.0019 (0.006)
Small Industry	0.0807* (0.045)	0.0807* (0.045)	0.0807* (0.045)	0.0809* (0.045)	0.0809* (0.045)	0.0809* (0.045)
Medium Industry	0.0937** (0.037)	0.0937** (0.037)	0.0937** (0.037)	0.0937** (0.037)	0.0937** (0.037)	0.0937** (0.037)
Observations	660	660	660	660	660	660
R^2	0.0972	0.0972	0.0972	0.0972	0.0972	0.0972

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include industry and year fixed effects. Average industry size included both as dummy and as an interaction with output tariff.

Table B.4: Estimation Share of Extensive-Informal workers:
Average Marginal Effects (AME)

	Fractional Model 1			Fractional Model 2		
	Unconditional AME	AME Conditional on Average Industry Size ≤ 15	AME Conditional on Average Industry Size 16-50	Unconditional AME	AME Conditional on Average Industry Size ≤ 15	AME Conditional on Average Industry Size 16-50
	(1)	(2)	(3)	(4)	(5)	(6)
Output Tariff	0.0054** (0.003)	0.0048 (0.007)	0.0061 (0.004)	0.0049* (0.003)	0.0043 (0.007)	0.0056 (0.004)
Input Tariff				0.0034 (0.005)	0.0038 (0.006)	0.0036 (0.006)
Small Industry	0.2222*** (0.033)	0.2222*** (0.033)	0.2222*** (0.033)	0.2234*** (0.033)	0.2234*** (0.033)	0.2234*** (0.033)
Medium Industry	0.0250 (0.022)	0.0250 (0.022)	0.0250 (0.022)	0.0254 (0.022)	0.0254 (0.022)	0.0254 (0.022)
Observations		695			695	
R^2		0.3128			0.3129	

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include industry and year fixed effects. Average industry size included both as dummy and as an interaction with output tariff.

B.2 Robustness

B.2.1 Period of Analysis: 2007-2011

Table B.5: Intensive Margin of Informality (2007-2011)

	Informality Indicator				Share of Informal Employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output Tariff	0.0016 (0.002)	0.0019 (0.002)	0.0025 (0.002)	0.0024 (0.002)	-0.0019 (0.009)	-0.0021 (0.009)	0.0030 (0.009)	0.0029 (0.009)
Input Tariff				0.0004 (0.003)				0.0018 (0.010)
S*Output Tariff			-0.0091 (0.006)	-0.0090 (0.006)			-0.0267* (0.015)	-0.0267* (0.015)
M*Output Tariff			-0.0054** (0.003)	-0.0054** (0.003)			-0.0171* (0.009)	-0.0170* (0.009)
Small Industry (S)		0.0073 (0.029)	0.0696 (0.056)	0.0699 (0.057)	0.0464 (0.086)	0.2054 (0.147)	0.2053 (0.147)	
Medium Industry (M)		0.0171 (0.025)	0.0521* (0.029)	0.0521* (0.029)	0.0581 (0.063)	0.1508* (0.086)	0.1499* (0.087)	
Married	-0.1350*** (0.012)	-0.1348*** (0.012)	-0.1345*** (0.012)	-0.1345*** (0.012)				
Male	-0.0452*** (0.010)	-0.0452*** (0.010)	-0.0447*** (0.010)	-0.0448*** (0.010)				
Primary Education	-0.1477* (0.087)	-0.1484* (0.087)	-0.1467* (0.087)	-0.1467* (0.087)				
Secondary Education	-0.2288*** (0.083)	-0.2295*** (0.084)	-0.2282*** (0.084)	-0.2282*** (0.084)				
Technical Education	-0.3386*** (0.083)	-0.3393*** (0.083)	-0.3378*** (0.084)	-0.3378*** (0.084)				
UG-PG degree	-0.3628*** (0.090)	-0.3635*** (0.091)	-0.3624*** (0.091)	-0.3624*** (0.091)				
Quechua Ethnic Group=1	-0.0570*** (0.018)	-0.0568*** (0.018)	-0.0565*** (0.018)	-0.0565*** (0.018)				
Age: 30-44	-0.2249*** (0.023)	-0.2249*** (0.023)	-0.2255*** (0.023)	-0.2255*** (0.023)				
Age: 45-64	-0.3262*** (0.033)	-0.3264*** (0.033)	-0.3270*** (0.033)	-0.3270*** (0.033)				
Age: > 65	-0.3623*** (0.057)	-0.3626*** (0.057)	-0.3630*** (0.057)	-0.3630*** (0.057)				
Observations	7697	7697	7697	7697	404	404	404	404
R ²	0.22	0.22	0.22	0.22	0.62	0.62	0.63	0.63

[†] All specifications are conditional on individuals being hired by a registered firm.

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Specifications in Columns 1-4 include department fixed effects. All specifications include industry and year fixed effects. Average industry-year size is classified as S: <15 workers, M: 16-50 workers, L: >50 workers.

Table B.6: Extensive Margin of Informality (2007-2011)

	Informality Indicator				Share of Informal Employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output Tariff	0.0019*** (0.001)	0.0035*** (0.001)	0.0040*** (0.001)	0.0025*** (0.001)	0.0191*** (0.003)	0.0192*** (0.002)	0.0137*** (0.003)	0.0135*** (0.003)
Input Tariff				0.0137*** (0.002)				0.0127 (0.009)
S*Output Tariff			-0.0013 (0.001)	-0.0012 (0.001)			0.0176*** (0.006)	0.0173*** (0.006)
M*Output Tariff			-0.0019 (0.001)	-0.0004 (0.001)			0.0056 (0.007)	0.0061 (0.007)
Small Industry (S)		0.2525*** (0.008)	0.2646*** (0.016)	0.2674*** (0.016)		0.4092*** (0.031)	0.3069*** (0.051)	0.3088*** (0.051)
Medium Industry (M)		0.2353*** (0.009)	0.2524*** (0.015)	0.2440*** (0.015)		0.2108*** (0.039)	0.1772*** (0.056)	0.1728*** (0.057)
Married	-0.0269*** (0.008)	-0.0270*** (0.007)	-0.0268*** (0.007)	-0.0262*** (0.007)				
Male	-0.2183*** (0.008)	-0.2123*** (0.007)	-0.2128*** (0.007)	-0.2143*** (0.007)				
Primary Education	-0.0562*** (0.009)	-0.0386*** (0.010)	-0.0398*** (0.010)	-0.0428*** (0.010)				
Secondary Education	-0.2492*** (0.011)	-0.2017*** (0.011)	-0.2038*** (0.011)	-0.2062*** (0.011)				
Technical Education	-0.4095*** (0.013)	-0.3415*** (0.013)	-0.3433*** (0.013)	-0.3459*** (0.013)				
UG-PG degree	-0.4586*** (0.015)	-0.3948*** (0.015)	-0.3964*** (0.015)	-0.3998*** (0.015)				
Quechua Ethnic Group=1	0.0308*** (0.012)	0.0192* (0.011)	0.0196* (0.011)	0.0191* (0.011)				
Age: 30-44	-0.0289*** (0.009)	-0.0273*** (0.008)	-0.0274*** (0.008)	-0.0266*** (0.008)				
Age: 45-64	0.0342*** (0.010)	0.0363*** (0.009)	0.0361*** (0.009)	0.0355*** (0.009)				
Age: > 65	0.1327*** (0.014)	0.1244*** (0.014)	0.1240*** (0.014)	0.1231*** (0.014)				
Observations	18329	18329	18329	18329	428	428	428	428
R ²	0.17	0.23	0.23	0.23	0.08	0.37	0.38	0.38

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Specifications in Columns 1-4 include department fixed effects. All specifications include industry and year fixed effects. Average industry-year size is classified as S: <15 workers, M: 16-50 workers, L: >50 workers.

B.2.2 Input Tariffs

Table B.7: Linear Probability Models

	All Informal Indicator	Intensive-Informal Indicator		Extensive-Informal Indicator	
	(1)	(2)	(3)	(4)	(6)
Output Tariff	0.0031** (0.001)	0.0023 (0.002)	0.0026 (0.003)	0.0041** (0.002)	0.0051* (0.003)
Input Tariff	-0.0040 (0.003)	-0.0053 (0.004)	0.0018 (0.006)	-0.0027 (0.004)	0.0061 (0.006)
S*Output Tariff	-0.0061*** (0.001)	-0.0140*** (0.004)	-0.0175* (0.009)	-0.0041 (0.003)	-0.0045 (0.008)
M*Output Tariff	-0.0032** (0.001)	-0.0070** (0.003)	-0.0138** (0.007)	0.0010 (0.003)	0.0020 (0.005)
S*Input Tariff	0.0023 (0.003)	0.0065 (0.008)	-0.0246 (0.022)	0.0025 (0.006)	0.0025 (0.016)
M*Input Tariff	0.0138** (0.005)	0.0275** (0.011)	0.0273 (0.018)	0.0150* (0.008)	-0.0237 (0.021)
Small Industry (S)	0.0612*** (0.017)	0.1022*** (0.039)	0.1858** (0.075)	0.0528** (0.022)	0.2659*** (0.054)
Medium Industry (M)	0.0277* (0.015)	0.0265 (0.017)	0.1384** (0.064)	-0.0014 (0.019)	0.0396 (0.037)
Married	-0.0689*** (0.010)	-0.1164*** (0.014)		-0.0187** (0.009)	
Male	-0.1303*** (0.010)	-0.0676*** (0.010)		-0.1724*** (0.019)	
Primary Education	-0.0431 (0.028)	-0.0623 (0.077)		-0.0237 (0.030)	
Secondary Education	-0.1196*** (0.035)	-0.1255 (0.078)		-0.1335*** (0.037)	
Technical Education	-0.2362*** (0.038)	-0.2454*** (0.077)		-0.2225*** (0.040)	
UG-PG degree	-0.2866*** (0.038)	-0.2791*** (0.081)		-0.2556*** (0.041)	
Quechua ethnicity	-0.0039 (0.007)	-0.0279* (0.014)		0.0098 (0.010)	
Age: 30-44	-0.1258*** (0.013)	-0.2403*** (0.017)		0.0074 (0.012)	
Age: 45-64	-0.1252*** (0.019)	-0.3342*** (0.024)		0.0682*** (0.022)	
Age: > 65	-0.0555*** (0.016)	-0.3194*** (0.037)		0.1511*** (0.025)	
Observations	31009	14126	660	31009	695
R ²	0.31	0.25	0.40	0.38	0.76

Notes: Robust standard errors for industrial clusters in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Specifications in Columns 1-4 include department fixed effects. All specifications include industry and year fixed effects. Average industry-year size is classified as S: <15 workers, M: 16-50 workers, L: >50 workers.

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