

The impact of minimum wages on informal labor markets in a small open economy: The case of Costa Rica

ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Master Thesis

Msc. Economics & Business - International Economics

August 27, 2019

Abstract

In this paper I examine the impact of minimum wages on informality in a small open economy. First, I use a theoretical model that is a version of the model from Bernard et al. (2007), which includes labor market imperfections and asymmetric countries. Second, I confirm some of the main findings from the model using an empirical strategy. I estimate a 10% increase in the minimum wage-to-wage ratio is associated with an overall increase of 1.8% in informal employment. The impact also differs by skill level, with a lower impact for high skilled workers and a higher impact for low skilled workers. Import tariffs are also associated with lower informal employment. I also find minimum wages have an effect on wages for workers in the formal and informal sector. The estimates by skill level indicate an increase in minimum wages is associated with a higher increase in the wages of high skilled workers than of low skilled workers.

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1. Introduction and literature review

The existence of informal employment in developing countries is a well-known phenomenon. Indeed, in some of the largest Latin American countries such as Brazil, Argentina and Colombia the share of informal workers is 38%, 48% and 55%, respectively (ILO, 2019). While most policy makers are aware of this issue, little has been done. Organisms like the Organisation for Economic Co-operation and Development (OECD) and the Inter-American Development Bank (IDB) have argued high minimum wages could be an important reason behind the high informal employment rates (see IDB, 2002; OECD, 2016).

For the case of Costa Rica, the OECD has signaled the minimum wage as one of the reasons that could be discouraging formal employment (OECD, 2018). Indeed, the minimum wage for unskilled workers amounts to 70% of the median wage of full time workers in the country, a number above all OECD countries, except Turkey (OECD, 2018). The country also experiences a high informal employment rate, which has seen an increase in the last years, going from 40% to 46% during the period 2010 - 2019 (INEC, 2019). Informality also affects workers differently based on their characteristics, for e.g. it is higher for less skilled workers and in industries where lower skilled labor is abundant, as can be seen in Table 1.

The definition of informal employment varies across studies and most of them included what could be considered a lax definition of informality. According to Goldberg & Pavncik (2003) informal employment is normally measured as the sector that does not comply with labor market regulations and does not provide worker benefits. According to the authors a broader definition could add temporary or part-time workers even if they are in formal establishments. Their research studied the impact of trade liberalization in informality in Brazil and Colombia, for which they defined as workers in formal sector as those who have a signed work card that entitles them to work benefits (case of Brazil) or whether workers comply with social security taxes (case of Colombia). Another definition comes from Gindling & Terrel (2004; 2005), who define formal workers as the covered sector and informal workers as the uncovered sector. According to their definition covered sector are paid employees, and uncovered sector self-employed workers¹. Alemán-Castilla (2006) defines on his empirical model informal employment as those workers complying with payroll tax, however he also considers workers employed in firms smaller than five workers or employees without health insurance. Paz (2014) studied the impact of trade liberalization in Brazil, but focusing only on the manufacturing sector. He defines informality using only payroll tax compliance. For the effects of this paper the informal employment variable used will be the one defined by the National Statistics Institute (INEC) from Costa Rica, which is based on the guidelines and statistical manuals from the ILO (INEC, 2019). Informal workers are then those who are employees and do not get social protection paid by the employer or self-employed workers with unincorporated enterprises (INEC, 2019)².

Comparing the definitions of informal employment between the studies by Gindling & Terrel (2004; 2005) and this research two things are worth noticing: first, the rate of informal

¹ It is important to note that no official statistics of formality or informality was available from the official household data by the time they published their research

² The definition also includes employees who get paid in kind, employees who do not get paid at all and own-account workers with temporary jobs.

employment is higher now than it was during the period Gindling & Terrel (2004; 2005) published their research. Informal employment was on average 36% of the employed population from 1988 to 2000, versus 42% on average for 2010 to 2019. Second, using the current official statistics we can differentiate between independent (self-paid employees) and dependent (paid employees). As can be seen on Table 1 from the Appendix, on average for the period 2010 – 2019, 19% of independent workers work on formality³, while 31% of dependent workers worked under informality. This means that there are both formal and informal workers in what Gindling & Terrel (2004; 2005) call the covered and uncovered sector.

The above mentioned are the main motivations for this research. To make a more comprehensive analysis this document has two methodologies. The first one considers a theoretical model similar to Bernard et al. (2007), with heterogeneous firms, skilled and unskilled labor and skilled and unskilled intensive goods of production. The model is adapted to fit some of the main characteristics of a small and open-to-trade developing country, following the papers from Demidova & Rodríguez-Clare (2009; 2013). The main goal of the theoretical model is to understand how minimum wages affect informality and wages in both skilled and unskilled sectors. It does so by endogenizing the decision of the firms whether to comply or not with the minimum wage. I also use it to test a second policy implication, i.e. I test whether import tariffs have an effect on informality rates, a hypothesis derived from new trade theory using firm heterogeneity models (Demidova & Rodríguez-Clare, 2009; 2013).

The second methodology tests some of the predictions from the model using costarrican household data, more specifically I test the impact of minimum wages on informal employment status and on workers' wages. This research is related to a set of literature on the effect of minimum wages on informality and wages. Gindling & Terrel (1995) did the first studies on the effectiveness of the minimum wages in Costa Rica. They studied the evolution of eight industries during the 1976 – 1991 period and found that a third of the workers in the covered sector earn below the minimum wage, and almost the same proportion earned below the minimum wage in the uncovered sector. Later on, Gindling & Terrel (2004; 2005) study the effect of minimum wages on labor market outcomes, focusing on wages and employment. They found that minimum wages have a positive effect on the wages from workers in the covered sector, but no effect on the wages of the uncovered sector. It also has a negative effect on employment for workers in the covered sector, more specifically they found that an increase of 10% in minimum wages decreases employment in the covered sector by 1.09% and decreases by 0.62% the number of hours worked in the covered sector. The model from Gindling & Terrel (2005) employs a robust methodology and takes advantage of the simplification of the minimum wage structure performed in Costa Rica during the period 1987 to 1999, when the country went from 500 to only 19 minimum wages⁴.

³ It is important to note the share of self-employed workers working under informality increased considerably during the 2010 – 2019 period, going from 70% in the third quarter of 2010 to 93% in the first quarter of 2019.

⁴ Before 1997 the minimum wage of workers in Costa Rica was established by matching them to a detailed industry category and then to a skill level. Professionals were also assigned a separate minimum wage (engineers, accountants, etc.). After 1997 the industry component was eliminated and the country added a set of minimum wages by educational attainment, leaving the country with 19 minimum wages. For a more detailed explanation of the process see Gindling & Terrel (2004).

As Gindling & Terrel (2005) described, minimum wages can be hypothesized as binding in Costa Rica, since they account for a high portion of the country's median wages. The minimum wage represented on average a 67% of the median wage of private sector workers during the 2010 – 2019 period⁵. This makes the country a great resource to study the impact of changes on the minimum wages on the labour market, as it affects a big proportion of the labor force. Costa Rica has several minimum wages and while the rule is most of the time to adjust them by inflation (Gindling & Terrel, 2005), not all minimum wages had the same increase during the period of study. A full description of the minimum wage adjustment for every year of the period of study can be found on Table 2 in the Appendix. Wages were also adjusted every semester from 2010 to 2016 and annually onwards. This variation in the setting of minimum wages provides a great resource to study the impact of variation in minimum wages throughout the labor market.

My model identification is similar to Gindling & Terrel (2005), but my main independent variable is similar to Comola & de Mello (2010), who studied the impact of a real increase in minimum wages in Indonesia after a decentralization of minimum wages in 2001. They use the ratio of minimum wage to median wage (Kaitz Index) as independent variable. The authors find evidence of an increase in informal employment and a decrease in formal employment. They also found the overall net employment effect to be positive. I also include import tariffs as an exogenous variable and use it to test if changes in tariffs have an impact on informal employment. The impact of trade liberalization on informality has been studied by Goldberg & Pavcnik (2001), Goldberg & Pavcnik (2003) and Attanasio, Goldberg & Pavcnik (2002). They study the large trade barrier reductions undergoing Colombia and Brazil during the decades of the 80's and 90's. The authors found no evidence of the impact of trade liberalization on informal employment for Brazil and evidence for Colombia only in the period before a labor market reform. The reform introduced flexibility in the market by reducing firing costs. One of their main conclusions is that firms are more likely to operate in informality as a response to trade liberalization if the country has rigid labor markets. Alemán-Castilla (2006) studied the effect of NAFTA on informality in Mexico, but he found no effect for the import tariff on informality. Later on, a similar assumption was tested by Paz (2014), where he tested trade liberalization on the manufacturing industry from Brazil. Paz (2014) first develops a theoretical model that is an extended version from Melitz (2003), but where the home economy has two firm entry cut-off conditions, one for producing formally to the home market and one for producing to the foreign market. On his model a decrease in import tariffs will increase informality if the effect on the export cut-off is bigger than the effect on the formal employment cut-off⁶. He tested his model empirically for Brazil's manufacturing industry using household data and found that a 10-percentage-point decrease in import tariffs increase the expected informality share by 1.29%. the effect on employment is dependent on the labor market conditions.

My empirical results show that minimum wages are associated with a decrease in formal employment and an increase informal employment. It also shows that minimum wages have an impact on the wages of both formal and informal workers. Gindling & Terrel (2005) found no

⁵ The minimum wage of reference for this case is the minimum wage floor.

⁶ On his model a decrease in import tariffs reduces the formal production cut-off because the increased imports forces firms to promote production and keep trade flows balanced. For more details see Paz (2014).

effect on wages for informal workers, however other studies did find evidence of the effect of minimum wages on the wages of informal workers, for e.g. a study conducted in Argentina (Khamis, 2008). This is explained through the lighthouse effect, where minimum wages give signals to employers in the informal sector of socially accepted minimum levels of pay (ILO, 2015).

I also estimate the impact of an increase in minimum wages for formal and informal workers by skill level and show that minimum wages have a higher positive impact on the wages of skilled workers in the formal sector. Therefore, high minimum wages could be benefitting high skilled workers more than low skilled workers.

My results also show that an increase in import tariffs is associated with a reduction in informal employment, more specifically a 10% increase in import tariff is associated with a 0.4 – 0.8% reduction in informal employment. This is on the lower bound of the effects found on the literature, lower than the results from Paz (2014) and the pre labor reform effects found by Goldberg & Pavcnik (2003) for Colombia⁷.

The paper is organized as follows, section two presents stylized facts about informality in Costa Rica. In section three I present the theoretical model and the simulation results. Section four introduces the datasets used for the empirical analysis, section four presents the methodology and results. Section five offers some conclusions.

⁷ It is important to recall the authors did not find a significant effect in Brazil and no significant event for Colombia post labor reforms. The estimates pre-labor reforms indicate a 10% increase in import tariffs reduces informal employment by 0.9 – 1.1%, depending on model specification.

2. Informality stylized facts

On this section I will describe some of the main characteristics of informal workers using the Continuous Employment Survey (ECE) from the National Statistics Institute (INEC)⁸⁹.

Fact 1. Informality is present across all industries, but it is higher for industries with abundance of either small firms or low skilled workers. As can be seen in Table 1 informality is present in all industries with different intensities and it has experienced significant variation through time. The latter can be observed by comparing 2010 to 2019. Industries like Agriculture, Wholesale and Retail, Transportation and Storage and Households as Employers present high levels of informality and low shares of high skilled workers. Industries like Construction, Professional and Scientific Services, Arts and Entertainment have high levels of informality even though they display higher shares of skilled workers, but they are also industries where a high share of the employment comes from small firms (1 – 9 employees). Industries such as Electricity, Gas and Steam Supply, Finance and insurance, Education and Health Care activities show low levels of informality and high shares of skilled workers.

Table 1. Descriptive characteristics by industry of informality, skill level and employment by firm size for the period 2010 - 2019¹⁰

	Informality share		Skill level share			Employment shares by firm size		
	2010	2018	Skilled	Middle skilled	Low skilled	1 to 9	10 to 29	30 or more
Agriculture, livestock, forestry	52%	54%	3%	35%	62%	54%	7%	39%
Mining and quarrying	47%	67%	12%	64%	25%	48%	25%	27%
Manufacturing industries	38%	47%	14%	72%	14%	48%	12%	40%
Electricity, gas, steam supply	5%	6%	47%	40%	14%	16%	16%	68%
Water supply & evacuation	41%	38%	7%	44%	49%	72%	15%	12%
Construction	65%	71%	16%	32%	53%	68%	15%	17%
Wholesale and Retail	52%	53%	11%	76%	13%	69%	16%	15%
Transportation and storage	56%	63%	6%	85%	9%	67%	10%	23%
Accommodation and food services	41%	56%	8%	73%	19%	65%	15%	20%
Information and communications	27%	22%	65%	33%	3%	32%	22%	46%
Finance and insurance	7%	5%	55%	40%	5%	25%	29%	46%
Real estate activities	45%	41%	43%	32%	25%	61%	22%	17%
Professional, scientific activities	35%	50%	74%	23%	3%	73%	12%	16%
Administrative services	18%	37%	11%	71%	18%	39%	22%	39%
Education	26%	39%	73%	15%	12%	32%	29%	39%
Health care activities	26%	30%	56%	33%	11%	60%	27%	13%
Arts, entertainment	54%	57%	38%	47%	15%	68%	19%	13%
Other services	79%	88%	15%	63%	22%	91%	5%	3%
Households as employers	87%	89%	0%	21%	79%	100%	0%	0%

⁸ Includes only private sector employees, since minimum wages do not apply for public sector. Public sector industries were excluded from the analysis.

⁹ <http://www.inec.go.cr>

¹⁰ For skill level share and employment by firm size, the statistics displayed are simple average for the period 2010 - 2019

Fact 2. Small firms account for most of the informal employment. Table 2 displays the share of informal employment by firm size. By 2010 the share of informal employment in small firms was 82% and this number increased to 89% by 2019. The table also shows that most of the informal employment occurs at small firms. By 2019 small firms accounted for 80% of all informal employment. Large firms account for a small percentage of informal employment (<5%).

Table 2. Employment shares by firm size and informal employment as a share of total employment by firm size

Number of employees	Informality share		Employment status by firm size				Employment growth rate	
	2010	2019	2010		2019		2010 – 2019	
			Formal	Informal	Formal	Informal	Formal	Informal
1 to 3	82%	89%	20%	75%	13%	80%	30%	145%
4 to 9	51%	53%	17%	15%	15%	13%	83%	91%
10 to 29	26%	25%	19%	6%	20%	5%	105%	92%
30 or more	10%	7%	44%	4%	53%	3%	139%	54%

Source: Encuesta Continua de Empleo, INEC (2019)

Fact 3. Labor growth differs by firm size and formal-informal status. Following Goldberg & Pavcnik (2003) firms will recur to informal employment as a response to increased foreign competition. As can be seen on Table 2 informal employment had the highest growth in small firms, while formal employment had the highest growth in large firms (+30). The channel through which this happens is normally explained as follows: trade liberalization increases foreign competition and therefore firms recur to cost-reducing strategies, such as reducing worker's benefits. In a firm heterogeneity setting like the one from Melitz (2003) or Bernard et al. (2007) smaller firms are less productive, therefore it is expected small firms incur more to this cost-reduction strategy compared to larger firms, resulting in the phenomenon shown above. While the trade liberalization period in Costa Rica was mainly during the period 1980 – 2000, the average tariff has also decreased during the period 2010 – 2019 (see Table 3 in the Appendix).

Fact 4. Wage growth varies by skill level and employment status. During the 2010 – 2019 period, wages from high skilled workers in the formal sector grew faster than wages from high skilled workers in the informal sector. Wages from low skilled workers in the formal sector grew at a lower rate than wages from low skilled workers in the informal sector. Several reasons could explain this phenomenon, such as industry or occupation composition of workers. Another possible reason is that binding minimum wages create a substitution effect, lowering demand for low-wage/skill workers and simultaneously increase the demand of high skilled workers (ILO, 2015). Following the latter assumption, minimum wage complying employers (formal sector) would experience this substitution effect, but non-complying employers (informal sector) would not. The latter would result on the phenomenon seen on Table 3.

Table 3. Wage growth by employment status and skill level, 2010 - 2019

	Formal	Informal
High skilled	2.89%	1.4%
Middle skilled	3.61%	2.0%
Low skilled	3.72%	4.5%

Source: Encuesta Continua de Empleo, INEC 2019

I argue that the latter 4 facts could be explained by a framework of firm heterogeneity with difference in relative factor endowments. I use the model from Bernard et al. (2007) and add imperfect labor markets and asymmetric countries. The latter characteristic is used to avoid any significant feedback effects from the small economy to the large economy. On this model firms incur in informality as a response to increased labor costs or trade liberalization. This is a result of firms' cost-optimization strategy. The model will be detailed on the next section.

3. Theoretical model

3.1 The model

This section is organized as follows. First, I describe the main assumptions for the theoretical model on a closed economy and derive the main characteristics of the economy. Second, the model is extended by opening the economy to trade and the new equilibrium conditions are derived. The first two parts are based on the model from Bernard et al. (2007). The third part introduces new assumptions on labor markets, asymmetry between countries in total factor endowments and import tariffs. The fourth part introduces the propositions and the relevant numerical simulations. Assumptions for the main parameters can be found on Table 5 from the Appendix.

3.1.1 Preferences and demand

The representative consumer's utility function is modeled as in Bernard et al. (2007) and depends on the consumption from two industries (i) containing a large number of varieties (ω). The upper tier of the utility function is assumed to be Cobb-Douglas, while the lower tier is assumed to be a CES type. This characteristic allows industry outputs to be substitutable, but also allows for consumers to exhibit Dixit-Stiglitz preferences ('love of variety').

The preferences of the representative consumer are then given by:

$$U = \frac{C_1^{\alpha_1} C_2^{\alpha_2}}{\alpha_1 \alpha_2}, C_i = \left[\int_{\omega \in \Omega_i} q_i(\omega)^\rho d\omega \right]^{\frac{1}{\rho}}, P_i = \left[\int_{\omega \in \Omega_i} p_i(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}} \quad (1)$$

Where $\alpha_1 + \alpha_2 = 1$ and $\sigma = \frac{1}{1-\rho} > 1$. The elasticity of substitution between varieties is the same in both industries ($\alpha_1 = \alpha$) and σ is the constant elasticity of substitution across varieties. Just as in Bernard et al. (2007) total demand for a single variety is given by:

$$q_1(\omega) = \alpha_1 \left(\frac{P_2}{P_1} \right)^{\alpha_2} \left(\frac{p_1(\omega)}{P_1} \right)^{-\sigma} \frac{I}{P_u} \quad (2)$$

$$q_2(\omega) = \alpha_2 \left(\frac{P_2}{P_1} \right)^{\alpha_1} \left(\frac{p_1(\omega)}{P_1} \right)^{-\sigma} \frac{I}{P_u} \quad (3)$$

Where I is the household's income and P_u is the cost (price) per unit utility, which is given by $P_u = P_1^{\alpha_1} P_2^{\alpha_2}$. Using this we can also obtain the revenues function for a single variety:

$$r_i(\omega) = p_i(\omega) q_i(\omega) = \alpha_i \left(\frac{p_i(\omega)}{P_i} \right)^{1-\sigma} I \quad (4)$$

3.1.2 Production

A single firm produces facing a costs function, which depends on fixed and variable costs. Both fixed and variables costs use multiple factors of production (skilled and unskilled labor). The intensity of use of the factors of production vary across firms. All firms in an given industry share the same fixed cost (f_i), but variable cost depends on firm's productivity (ϕ). The cost function takes the following Cobb-Douglas form:

$$\Gamma_i = \left[f + \frac{q_i}{\phi} \right] w_s^{\beta_i} w_u^{1-\beta_i} \quad (5)$$

Whereas q_i is the production of variety i , which requires both skilled (l_s) and unskilled labor (l_u). Following Bernard et al. (2007) sector 1 is assumed to be skill intensive relative to industry 2. Skilled wages at home are set as the numeraire ($w_s = 1$). Firms choose a combination of skilled and unskilled labor so that costs per unit output are minimized. The production function for variety i is given by:

$$q_i = \phi \frac{l_s^{\beta_i} l_u^{1-\beta_i}}{\beta_i^{\beta_i} (1-\beta_i)^{1-\beta_i}} \quad (6)$$

Solving the maximization problem leads to the following profit maximizing price:

$$p_i(\phi) = \frac{\sigma}{\sigma-1} \frac{w_s^{\beta_i} w_u^{1-\beta_i}}{\phi} \quad (7)$$

3.1.3 Firm entry and exit

There is a large (unbounded) number of prospective entrants in the industry. To enter firms must do an investment modeled as fixed entry cost $f_e > 0$ (sunk costs). Firms do not know their productivity with certainty until they start producing, which is modeled as a process where firms draw their productivity parameter ϕ from a uniform distribution $g(\phi)$ and a cumulative distribution $G(\phi)$. There is a minimum required productivity to start producing ϕ^* . If the drawn productivity is below the required level ($\phi < \phi^*$), firms decide to exit the market and not produce. The condition to start with production is given by:

$$\pi(\phi_i) = \frac{r(\phi_i)}{\sigma} - f_e w_s^{\beta_i} w_u^{1-\beta_i} \geq 0 \quad (8)$$

Where ϕ_i^* is the productivity parameter of the least productive firm to enter the market and produce for the domestic market, such that $r(\phi_i^*) = \sigma f_e w_s^{\beta_i} w_u^{1-\beta_i}$, known as the Zero Cutoff Profit Condition.

After entry, firms are indifferent between paying sunk entry costs upon entry or a per period equivalent. Producing firms are exposed every period to a shock with a constant probability which can force them to exit the market. Market entry stops when expected profits equal sunk market entry costs. The free entry condition is:

$$[1 - G(\phi_i^*) \pi(\tilde{\phi}_i^*)] = \theta f_e w_s^{\beta_i} w_u^{1-\beta_i} \quad (9)$$

Where $1 - G(\phi_i^*)$ indicates the ex-ante probability of a successful entry and $\tilde{\phi}_i$ is the weighted average productivity. Just as in Bernard et al. (2007), $\tilde{\phi}_i$ is determined by the ex-post productivity distribution and it depends on the cutoff productivity, such that:

$$\tilde{\phi}_i(\phi_i^*) = \left[\frac{1}{1 - G(\phi_i^*)} \int_{\phi_i^*}^{\infty} \phi^{\sigma-1} g(\phi) d\phi \right]^{\frac{1}{\sigma-1}} \quad (11)$$

3.1.4 Labour markets

The labour market clearing condition requires labour demand to equal labor supplied by each country, with S denoting skilled labour and L denoting unskilled labour. Equations to the left denote this equalization of supply and demand, while the equations to the right stand for the labour demand. The p superscript denotes labor used in production and e refers to labor used for market entry.

$$S_1 + S_2 = \bar{S}, \quad S_i = S_i^p + S_i^e \quad (12)$$

$$L_1 + L_2 = \bar{L}, \quad L_i = L_i^p + L_i^e \quad (13)$$

The model also includes a minimum wage for the unskilled sector in the Home country W^{min} , with $W^{min} \in [0, \infty]$. Labour demand is therefore given by:

$$L_i = \begin{cases} L_i^p + L_i^e & \text{if } w_u^H \geq W^{min} \\ 0 & \text{otherwise} \end{cases} \quad (15)$$

A minimum wage above equilibrium wage will mean an excess of labour supply, if there is an excess oversupply labour will go to informal employment or unemployment.

3.1.5 Open Economy

I assume two economies; Home (H) and Foreign (F). Both countries opened to trade and exporting entails fixed and variable costs for firms. To export firms must incur in a fixed cost f_X that uses skilled and unskilled labor with the same intensities as in production. Variable export costs take the form of iceberg transport costs $\tau > 1$, where $q_i(\varphi)$ units are shipped and $q_i(\varphi)/\tau$ arrive.

The previously described equilibrium conditions of the closed economy will be derived now for the open economy. Price and revenues of sales abroad are given by:

$$p(\varphi)_{iX}^H = \frac{\sigma}{\sigma - 1} \frac{\tau (w_s^{\beta_i})^H (w_u^{1-\beta_i})^H}{\varphi} \quad (16)$$

$$r(\varphi)_{iX}^H = \alpha_i \left(\frac{\tau p(\varphi)_{iX}^H}{P_i^F} \right)^{1-\sigma} I^F \quad (17)$$

Exporting firms face a Zero Cutoff Profit Condition for the foreign market of the form:

$$r(\phi_{iX}^*)^H = \sigma f_X (w_s^{\beta_i})^H (w_u^{1-\beta_i})^H \quad (18)$$

with the assumption that $\phi_{iX}^* \geq \phi_i^*$, i.e. not all firms export. Firms now can produce for the foreign and domestic market, produce only for the domestic market or not produce, depending on their productivity level. Finally, the free entry condition is now given by:

$$[1 - G(\phi_i^*)\pi(\tilde{\phi}_i^*)] + [1 - G(\phi_{iX}^*)\pi(\tilde{\phi}_{iX})] = \theta f_e w_s^{\beta_i} w_u^{1-\beta_i} \quad (19)$$

The labour market supply remains unchanged, however demand now accounts for production for the domestic economy and production for the foreign market.

$$S_1^j + S_2^j = \bar{S}^j, \quad S_i^j = S_i^{j,p} + S_i^{j,pX} + S_i^{j,e} \quad (20)$$

$$L_1^j + L_2^j = \bar{L}^j, \quad L_i^j = L_i^{j,p} + L_i^{j,pX} + L_i^{j,e} \quad (21)$$

The model also includes a minimum wage for the unskilled sector in the Home country W^{min} , with $W^{min} \in [0, \infty]$. Labour demand for the unskilled sector is therefore given by:

$$L_i^j = \begin{cases} L_i^{j,p} + L_i^{j,pX} + L_i^{j,e} & \text{if } w_u^H \geq W^{min} \wedge \varphi \geq \phi_{iX}^* \\ L_i^{j,p} + L_i^{j,e} & \text{if } w_u^H \geq W^{min} \wedge \phi_{iX}^* > \varphi > \phi_i^* \\ 0 & \text{otherwise} \end{cases} \quad (22)$$

Same as before, a minimum wage above equilibrium wage will mean an excess of labour supply, if there is an excess oversupply labour will go to informal employment or unemployment.

3.1.6 Asymmetric countries

An important feature of this model is the introduction of large differences between the size of the economies interacting. The literature on trade heterogeneity is mainly focused on bigger industrialized economies, however Demidova & Rodriguez-Clare (2009; 2013) use the framework set by Melitz (2003) to understand the differences between large and small economies. This model adapts some of the characteristics of the small economy in a standard Melitz type of setting to the model from Bernard et al. (2007). Following Demidova & Rodriguez-Clare (2013) the size of the economies is calibrated to reflect the following characteristics¹¹: (1) The domestic productivity cut-off for firms in Foreign is not affected by changes in Home, (2) the mass of Foreign firms is not affected by changes in Home (it is exogenous), but the number of foreign varieties at home is endogenous, (3) the demand in Foreign for Home goods exported at the price $p(\varphi)_{iX}^H$ is not affected by changes in Home.

¹¹ An important difference to Demidova and Rodríguez-Clare (2009) is that they model demand for a foreign variety as $A p^{-\sigma}$, where A is exogenous and stands for the coefficients of national income and the price Index in foreign country. I increase the asymmetry of the countries in my model, however the coefficient for national income and prices are not treated as exogenous. A is only a generalization when the size of one country tends to infinity.

3.2 Simulation results

On the following section I simulate the impact of minimum wages on an open economy. The simulations are performed in GAMS¹². The economy of interest is assumed to be “small” and relatively more endowed in unskilled labor. The countries are assumed to be on an open economy equilibrium. The tables with the description of the assumptions for the main parameters can be found on Tables 5 and 6 from the Appendix.

As previously mentioned in equation 22, if the wage a firm is willing to pay is below the equilibrium wage then the firm will decide to not produce formally¹³. As can be seen on Table 4, minimum wages may create informality if they are high enough. Also, the impact is higher if Home country is more endowed in unskilled labor. An increase in the minimum wage will not only push firms out of the formal sector, but it will also increase the relative wages of high skilled workers.

The economic explanation for the latter is as follows. If Home country is more endowed in unskilled labor it will specialize in unskilled labor intensive goods. However, if minimum wage is high enough, firms in unskilled labor-intensive goods will decide not to produce formally. The country’s comparative advantage in unskilled labor is reduced, therefore increasing demand for high skilled labor. The increase in demand for high skilled labor increases their equilibrium wage and therefore increasing the ratio of wages between skilled workers and unskilled workers.

Table 4. Impact of minimum wages when countries differ in relative and total factor endowments

Relative endowments	W^{min}	$\frac{w_S^H}{w_u^H}$	u_u
$\frac{L^H}{\bar{S}^H} = \frac{L^F}{\bar{S}^F} = 1$	0.75	0.75	0.2%
$\frac{L^H}{\bar{S}^H} = \frac{L^F}{\bar{S}^F} = 1$	1.25	0.80	20.7%
$\frac{L^H}{\bar{S}^H} = 1.5 > \frac{L^F}{\bar{S}^F} = 1$	0.75	0.05	2.7%
$\frac{L^H}{\bar{S}^H} = 1.5 > \frac{L^F}{\bar{S}^F} = 1$	1.25	0.56	70%

Note: Foreign country is assumed to be 3x larger than Home country

I also simulate the impact of an increased tariff on sector two, the unskilled labor intensive good. As can be seen on Table 5 an increased tariff on sector two reduces the informal employment rate, while also increasing the wages for both the high skilled and unskilled labor. However the effect of tariffs is limited and on my model any tariff above 20% produces the same outcomes in the economy.

¹² General Algebraic Modeling System

¹³ The model does not differentiate between unemployment and informality. While on practice these two are very different phenomena, for purposes of this model they are the same, i.e. firms have just two choices, either produce formally or not.

Table 5. Impact on relative wages and informality from a gradual increase import tariffs for sector two

Variable	Tariff					
	0%	10%	20%	30%	40%	50%
wr_s^H	0.58	0.57	0.83	0.83	0.83	0.83
wr_u^H	1.02	0.94	1.11	1.11	1.11	1.12
wr_s^H / wr_u^H	0.56	0.60	0.74	0.74	0.74	0.74
Informal employment (%)	70.4%	68.4%	56.5%	56.5%	56.5%	56.2%

My model shows that in a small open economy minimum wages can create informality if they are binding, and the effect of a minimum wage on informality is higher if the economy is relatively endowed in unskilled labor. It also shows that a higher minimum wage increases the wages of both high skilled and unskilled workers, however the wages for high skilled workers benefit more from this and therefore increasing the wr_s^H / wr_u^H ratio. An import tariff on sector two in the small economy can reduce informality, as it increases demand for unskilled workers and therefore their equilibrium wage.

On the next section I will proceed to estimate some of the main results from my theoretical model, more specifically I will proceed to estimate the impact of the minimum wage on informality and on wages from skilled and unskilled workers. I also estimate the impact of an import tariff on informal employment.

4. Econometric methodology

4.1 Data

On this section I describe the data used on my econometric model. The data used comes from a household survey named the Continuous Employment Survey (ECE) and carried out by the National Institute of Statistics and Census (INEC) in collaboration with the Central Bank of Costa Rica¹⁴. The survey started in 2010 and it is a rotating semi panel. The survey is performed quarterly and every quarter 25% of the sample is rotated. This means that around 75% of the sample is preserved after between two surveys. The longest period of time a subject of study can be continuously interviewed on the survey is four quarters. This constraints the possibility of doing a panel data analysis and therefore a cross-section/time-series is performed. The sample consists of 9024 houses (not households) interviewed each quarter.

Minimum wages are available from the Labor Ministry. The Labor Ministry publishes the minimum wage rates. For the period 2010 – 2016 minimum wages every 6 months, while after 2016 they are set on an annual basis. It is a total of 19 rates, which consists of minimum wages established for unskilled, semi-skilled, skilled and specialized workers, and five additional rates depending on educational level. The minimum wage which applies to unskilled workers not covered by any other specific rate is known as the *salario minimo minimorum* and serves as the wage floor, below which no wage can be set with the exception of domestic work which has a separate, and lower, occupational minimum wage. This minimum wage is adjusted annually. Statistics are available from official websites.

The import tariffs are available from the World Integrated Trade Solution, a platform from the World Trade Organization (WTO). The variable used is the weighted average of the Effectively Applied Tariff. Weights are assigned based on trade volumes.

The mean values for the variables used can be seen on Table 5. Some differences worth highlighting are: the informal sector has on average lower wages for the period of study. This leads to a much higher Kaitz index for the informal sector, for which on average the minimum wage is 20% higher than the average wage. The informal sector is also less educated and with a lower share of high skilled workers.

¹⁴ <http://www.inec.go.cr>

Table 5. Descriptive statistics of variables used in model, 2010 - 2019

	Formal	Informal	Total
Kaitz index	0.28	1.20	0.7
Hourly wage (local currency)	2267	1600	1965
Monthly wage (local currency)	450223	223819	347511
Male proportion	0.69	0.60	0.64
Years of education	10.02	8.00	9.03
Skill level (share of total)			
High skilled	0.23	0.08	0.16
Middle skilled	0.55	0.58	0.56
Low skilled	0.21	0.34	0.27
Region (share of total)			
Central	0.72	0.62	0.67
Chorotega	0.06	0.07	0.06
Pacífico central	0.04	0.05	0.05
Brunca	0.04	0.09	0.06
Huetar caribe	0.08	0.08	0.08
Huetar norte	0.06	0.09	0.08
Industry (share of total)			
Agriculture, livestock, forestry	0.11	0.16	0.13
Mining and quarrying	0.00	0.00	0.00
Manufacturing industries	0.16	0.08	0.12
Electricity, gas, steam supply	0.00	0.00	0.00
Water supply, water evacuation	0.00	0.00	0.00
Construction	0.06	0.09	0.07
Wholesale and Retail	0.24	0.21	0.22
Transportation and storage	0.05	0.07	0.06
Accommodation and food services	0.07	0.07	0.07
Information and communications	0.03	0.01	0.02
Financial and insurance activities	0.03	0.00	0.02
Real estate activities	0.01	0.01	0.01
Professional, scientific activities	0.04	0.03	0.04
Administrative services activities	0.09	0.03	0.06
Education	0.03	0.01	0.02
Health care activities	0.02	0.01	0.02
Artistic, entertainment activities	0.01	0.02	0.01
Other service activities	0.02	0.07	0.04
Household activities as an employer	0.02	0.14	0.08

Source: Encuesta Continua de Empleo, INEC (2019)

4.2 Methodology

The main hypothesis is that an increase in the minimum wage is associated with an increase in formal sector employment and workers are displaced into informality. To estimate the impact of minimum wages on informality the following estimation strategy will be used:

$$\begin{aligned}
 emp_{it} = & \beta_0 + \beta_1 Kaitz_{it} + \beta_2 tariff_t + \beta_3 gender_t + \sum_{i=1}^n \beta_i * Skill_{it} \\
 & + \sum_{i=1}^m \beta_i * Kaitz_{it} * Skill_{it} + \sum_{i=1}^j \beta_i * Industry_{it} + \sum_{i=1}^k \beta_i * Occupation_{it} \\
 & + \sum_{i=1}^k \beta_i * Education_{it} + \sum_{i=1}^k \beta_i * region_{it} + \sum_{i=1}^k \beta_i * (Education_{it})^2 \\
 & + \sum_{t=1}^T \gamma_t year_t + \sum_{t=1}^T \gamma_t quarter_t + \varepsilon_{it}
 \end{aligned}$$

Where emp_{it} is a dichotomic variable which is 0 if the individual is employed in the formal sector and 1 if the individual is employed in the informal sector. Individuals are represented by i and the period of time is represented by t . The independent variable is the Kaitz index, the import tariff and a set of control variables. The Kaitz Index is computed as the ratio of the legal minimum wage to the actual wage. The variable used for tariff is used to test the hypothesis whether trade openness amplifies the effect of minimum wages on informality. The variable γ allows to control for endogenous changes in yearly average minimum wages or for seasonal changes within a year, that is time fixed effects. Control variables of interest are skill level, years of education, occupational group, industry (primary industry of worker), region and gender. Squared years of education is used to control for diminishing returns of education. The categorization of workers by skill level used is the one provided by the INEC, on which they classify occupations and categorize them in low skilled, middle skilled and high skilled. This differs from the approach carried out by Gindling & Terrel (2004; 2005) where they use decile of earnings as a proxy for skill level and study the impact all over the distribution. The variable Occupation ($k = 441$) accounts for occupation specific fixed-effects and for potential correlation between wages and minimum wages between occupational categories. Additional terms to account for an interaction between the Kaitz Index and the skill level are added.

A similar identification strategy, but using wages as the dependent variable and the minimum wage as the independent variable is used to estimate separately the impact on formal and informal wages. In the case of wages, inflation is also added as an additional variable, given that inflation plays a very important role in wage adjustment, as previously mentioned. The regression equation is the following:

$$\begin{aligned}
w_{it} = & \beta_0 + \beta_1 minwage_{it} + \beta_2 tariff_t + \beta_3 gender_t + \beta_4 inflation_t + \sum_{i=1}^n \beta_i * Skill_{it} \\
& + \sum_{i=1}^m \beta_i * minwage_{it} * Skill_{it} + \sum_{i=1}^j \beta_i * Industry_{it} + \sum_{i=1}^k \beta_i * Occupation_{it} \\
& + \sum_{i=1}^k \beta_i * Education_{it} + \sum_{i=1}^k \beta_i * region_{it} + \sum_{i=1}^k \beta_i * (Education_{it})^2 \\
& + \sum_{t=1}^T \gamma_t year_t + \sum_{t=1}^T \gamma_t quarter_t + \varepsilon_{it}
\end{aligned}$$

In order to check for robustness several identification strategies are performed. First, for employment status different modeling techniques are employed; Ordinary Least Squares (OLS) and Probit model. For both I run the model to measure the impact for all workers on average and then I split by skill level. Second, for the case of wages, two different definitions are used. The first one would be hourly wages, while the second one monthly wages. Finally, all models used robust standard errors.

4.3 Empirical evidence

The main results for the impact on employment status can be seen on Table 3. On the first column the impact on employment status of an increase in the Kaitz Index is estimated overall for all workers. An increase in the Kaitz Index of 10% is associated with an increase in informal employment by 1.8%. In the second column I estimate the same model, but including interaction terms with skill level. The impact of an increase in the Kaitz Index also differs by skill level. For high skilled workers a 10% increase in the Kaitz Index is associated with an increase of 1.4% in informal employment, while for low skilled workers it increases by 3.03%.

The model also estimates the impact of an increase in the import tariff. A 10% increase in the import tariff is associated with a 0.3 – 0.45% decrease in informal employment for all workers overall, which is lower than the effect found by Paz (2014) for Brazil. Paz (2014) found that a 10% increase in import tariff decreases informality share by 1.29% in the manufacturing industry. Goldberg & Pavcnik (2003) found an effect of trade liberalization on informal employment status in Colombia, but no impact for Brazil, which the authors argue can be explained by the difference in rigidity of the labor markets. The authors argue Brazil has a more rigid labor market than Colombia, therefore having less impact. Using the Rigidity Employment Index from the World Bank it can be seen that Costa Rica has a more flexible labor market than Brazil, but less flexible than Colombia¹⁵. Therefore, the significant but lower impact of trade liberalization in Costa Rica is in line with findings from Goldberg & Pavcnik (2003).

To convince the reader about the reliability of these results I do the following exercise. The Kaitz Index had its lowest level in the first quarter of 2011, after which it increased to its peak in the first quarter of 2015. The relative increase in the Index was 5.73%. Using the coefficient for overall employment (0.182) my model predicts an increase in informal employment of 0.010. The

official numbers show an increase of 0.082 in informal employment, i.e. the results are consistent with the descriptive statistics.

Table 3. Impact of an increase in the Kaitz index on employment status

Dependent variable: employment status (0 = formal, 1 = informal)	(1) Emp	(2) Emp
Kaitz	0.182*** (0.00110)	0.139*** (0.00398)
Tariff	-.0467** (.0144056)	-.0749** (.0142721)
Gender	0.00847*** (0.00231)	0.0139*** (0.00229)
Years education	-0.0102*** (0.000317)	-0.0101*** (0.000314)
(Years education)^2	7.73e-05*** (3.77e-06)	7.35e-05*** (3.74e-06)
High skilled * Kaitz		-
Middle skilled * Kaitz		0.000238 (0.00416)
Low skilled * Kaitz		0.164*** (0.00448)
Year dummies (t = 9)	YES	YES
Quarterly dummies	YES	YES
Occupational dummies (k = 441)	YES	YES
Regional dummies (k = 7)	YES	YES
Industry dummies (k = 21)	YES	YES
Observations	249,445	249,445
R-squared	0.441	0.453

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

I also estimate the impact of an increase in the minimum wage on the wages for both formal and informal sector. On the first two columns I estimate the impact on the wages of the formal sector. The first model estimates the impact overall for all workers in the formal sector, while the second model includes interaction terms to account for asymmetric impact by skill level. On columns three and four I replicate the same analysis, but for the informal sector. The results can be seen on table 4. A 1% increase in the minimum wage is associated with an increase in wages for the formal sector by 0.21% and 0.23% in the informal sector. The impact of an increase in the minimum wage differs also by skill level. An increase in the minimum wage is associated with an increase in the wages of high skilled workers in the formal sector by 0.25%, but the increase for wages of low skilled workers in the formal sector is 0.13%. Similarly, for the informal sector the increase of the minimum wage is associated with an increase of 0.23% for wages in the informal sector, but it is associated with an increase of wages of 0.15% for low skilled workers in the informal sector.

Tables with robustness checks can be found in the appendix. This includes an alternative definition of wages using monthly earnings, instead of hourly earnings (Table 8 Appendix). For

the employment status a probit model is used to estimate employment the impact of an increase in the Kaitz index (Table 7 Appendix). As can be seen on the tables there is no change in the qualitative results¹⁶.

Table 4. Impact of an increase in minimum wage on hourly wages

Dependent variable: Hourly earnings	Formal sector		Informal sector	
	Wage	Wage	Wage	Wage
Minwage	0.207*** (0.00926)	0.251*** (0.0137)	0.231*** (0.0195)	0.237*** (0.0350)
Tariff	-.454** (.4374663)	-.478** (.2276627)	.389 (.3836873)	.376 (.3836849)
Gender	-0.0835*** (0.00379)	-0.0838*** (0.00379)	-0.166*** (0.00755)	-0.166*** (0.00755)
Years education	0.0148*** (0.000625)	0.0150*** (0.000625)	0.0263*** (0.000924)	0.0263*** (0.000926)
(Years education)^2	-0.00015*** (6.45e-06)	-0.00015*** (6.49e-06)	-0.00026*** (1.09e-05)	-0.00026*** (1.09e-05)
Inflation	0.529** (0.228)	0.550** (0.228)	0.666* (0.382)	0.679* (0.382)
High skilled * minwage		-		-
Middle skilled * minwage		-0.0766*** (0.0164)		-0.00385 (0.0390)
Low skilled * minwage		-0.125*** (0.0218)		-0.0826* (0.0453)
Year dummies (t = 9)	YES	YES	YES	YES
Quarterly dummies	YES	YES	YES	YES
Occupational dummies (k = 441)	YES	YES	YES	YES
Regional dummies (k = 7)	YES	YES	YES	YES
Industry dummies (k = 21)	YES	YES	YES	YES
Observations	122,073	122,073	127,254	127,254
R-squared	0.361	0.361	0.194	0.194

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

¹⁶ The probit model gives a coefficient of 0.938 overall, which estimated at the mean probability (0.6953) gives an associated 1.16% increase with a 10% increase in the Kaitz index.

5. Conclusions

Costa Rica has a minimum wage set on average at a 78% of the median wage of private sector workers for the period 2010 – 2019. I argue this is a high minimum wage and could be one of the reasons why the levels of informal employment are high in the country. I use first a theoretical model based on the model from Bernard et al (2007) to understand the impact of the minimum wage in a small open economy. My model accounts heterogeneity in firm productivity and allows the modeled economy to produce goods intensive in skilled and unskilled workers. The model indicates that if the minimum wage is above the equilibrium wage firms are willing to pay, they will decide to produce under formality. The model also indicates that less productive firms will be the ones more affected by a high minimum wage. This matches the descriptive statistics, where most of the informal employment happens in firms characterized by either being small or in industries with high levels of unskilled workers.

I then test the impact of the minimum wage to median wage ratio (Kaitz Index) on employment status. To estimate this I use quarterly household data since 2010 and up to 2019, with around 225,000 observations. I find that a 10% increase in the Kaitz Index is associated with an increase in informal employment by 1.8%. The impact is higher for low skilled workers, where an 10% increase in the minimum wage is associated with a 3.03% increase in the probability of being informally employed, while it is lower for high skilled workers, where a 10% increase in the minimum wage is associated with a 1.4% increase in the probability of being informally employed for high skilled workers. The results are similar, but marginally higher, to those from Gindling & Terrel (2005). A potential reason for this could be the difference in the concept of formal and informal employment. The model from Gindling & Terrel (2005) uses a definition of paid employees and self-paid employees as proxy for formal and informal workers and therefore it could be underestimating the impact. I also found no significant effect of changes in average import tariffs on employment status. I also estimate the relationship between import tariffs and informal employment and find that an increase in import tariffs by 10% decreases informal employment by 0.3% - 0.45%.

Finally, I estimate the impact of an increase in minimum wages on the average wage for formal and informal workers. I find that an increase in minimum wages is associated with an increase in wages in both sectors. This is contrary to Gindling & Terrel (2005) who find an impact only on formal workers. This could potentially be 'lighthouse effect', a phenomena where minimum wages are an indicative on the informal sector on what is accepted to pay, even if they do not comply with minimum wages. Additionally, the impact of an increase of the minimum wage varies by skill level of workers. An increase in the minimum wage is associated with a higher increase in average wages for skilled workers, while the impact of wages for low skilled workers is smaller. This should be explored in more detail as minimum wages increases could be increasing inequality among high and low skilled workers.

Appendix

Table 1. Employee type by informal working status and informal employment rates

Date	All employed workers			Paid employees			Self-employed workers		
	Total	Informal	Rate	Total	Informal	Rate	Total	Informal	Rate
III 2010	1,881,514	756,180	40%	1,469,807	467,619	32%	411,707	288,561	70%
IV 2010	1,886,234	746,837	40%	1,500,364	466,431	31%	385,870	280,406	73%
I 2011	1,802,040	667,885	37%	1,424,835	393,684	28%	377,205	274,201	73%
II 2011	1,765,039	651,684	37%	1,397,198	398,749	29%	367,841	252,935	69%
III 2011	1,836,662	665,922	36%	1,460,386	410,827	28%	376,276	255,095	68%
IV 2011	1,918,109	684,957	36%	1,546,387	440,732	29%	371,722	244,225	66%
I 2012	1,994,448	749,038	38%	1,595,149	479,439	30%	399,299	269,599	68%
II 2012	1,968,585	749,878	38%	1,558,578	469,422	30%	410,007	280,456	68%
III 2012	1,998,224	786,646	39%	1,567,138	482,189	31%	431,086	304,457	71%
IV 2012	1,994,166	837,141	42%	1,569,569	517,497	33%	424,597	319,644	75%
I 2013	1,980,685	818,275	41%	1,532,731	494,187	32%	447,954	324,088	72%
II 2013	2,008,405	876,732	44%	1,546,596	512,449	33%	461,809	364,283	79%
III 2013	2,026,738	895,122	44%	1,545,595	521,316	34%	481,143	373,806	78%
IV 2013	2,088,282	918,859	44%	1,605,118	535,736	33%	483,164	383,123	79%
I 2014	2,084,210	900,786	43%	1,616,361	548,634	34%	467,849	352,152	75%
II 2014	2,048,011	867,237	42%	1,596,226	488,353	31%	451,785	378,884	84%
III 2014	2,065,801	884,282	43%	1,617,335	514,431	32%	448,466	369,851	82%
IV 2014	2,059,600	931,718	45%	1,603,121	541,454	34%	456,479	390,264	85%
I 2015	2,051,208	928,734	45%	1,602,311	540,367	34%	448,897	388,367	87%
II 2015	2,087,363	927,521	44%	1,615,791	515,876	32%	471,572	411,645	87%
III 2015	2,063,117	941,983	46%	1,629,542	568,808	35%	433,575	373,175	86%
IV 2015	2,027,518	871,329	43%	1,588,884	504,563	32%	438,634	366,766	84%
I 2016	1,992,741	825,142	41%	1,590,985	492,525	31%	401,756	332,617	83%
II 2016	1,954,756	817,666	42%	1,541,442	471,870	31%	413,314	345,796	84%
III 2016	1,972,128	841,736	43%	1,547,542	484,192	31%	424,586	357,544	84%
IV 2016	2,063,366	922,429	45%	1,608,264	523,461	33%	455,102	398,968	88%
I 2017	2,060,757	890,820	43%	1,611,480	504,811	31%	449,277	386,009	86%
II 2017	2,079,840	918,592	44%	1,603,237	505,005	31%	476,603	413,587	87%
III 2017	2,068,710	892,893	43%	1,600,181	471,300	29%	468,529	421,593	90%
IV 2017	1,995,640	819,201	41%	1,557,873	433,780	28%	437,767	385,421	88%
I 2018	2,004,711	829,465	41%	1,553,676	426,755	27%	451,035	402,710	89%
II 2018	2,160,036	965,127	45%	1,634,728	497,808	30%	525,308	467,319	89%
III 2018	2,138,140	962,091	45%	1,647,392	518,831	31%	490,748	443,260	90%
IV 2018	2,165,323	971,366	45%	1,651,626	503,776	31%	513,697	467,590	91%
I 2019	2,171,766	1,001,784	46%	1,669,927	535,931	32%	501,839	465,853	93%

Table 2. Detailed description of minimum wage adjustment for the period 2010 - 2019

Period	Adjustment
2010 II semester	- 4.20% increase for the minimum wage of non-qualified, semi-qualified and qualified workers. - 3.96% increase for all other minimum wages.
2011 I semester	- 2.63% increase for all minimum wages
2011 II semester	- 2.55% increase for all minimum wages, except non-qualified, semi-qualified, specialized and qualified workers. - 3.50% increase for the monthly minimum wages of non-qualified, semi-qualified and qualified workers.
2012 I semester	- 3.17% increase for all minimum wages
2012 II semester	- 3.00% increase for all minimum wages
2013 I semester	- 3.65% increase for all minimum wages
2013 II semester	- 2.40% increase for all minimum wages
2014 I semester	- 3.78% increase for all minimum wages
2014 II semester	- 4.22% increase for the minimum wage all non-qualified workers (including domestic services). - 4.09% increase for all semi-qualified workers, 4.00% increase for all qualified workers. - 2.35% increase for all other minimum wages.
2015 I semester	- 2.01% increase for all minimum wages, except domestic services. 2.50% increase for domestic services.
2015 II semester	- 0.94% increase for all minimum wages, except domestic services. 1.04% increase for domestic services.
2016 I semester	- 0.67% increase for all minimum wages, except domestic services. 1.00% increase for domestic services.
2016 II semester	- 0.50% increase for all minimum wages, except domestic services. 2.00% increase for domestic services.
2017	- 1.14% increase for all minimum wages, except domestic services. 1.50% increase for domestic services.
2018	- 2.43% increase for all minimum wages, except domestic services. 2.93% increase for domestic services.
2019	- 2.96% increase for all minimum wages, except domestic services. 3.50% increase for domestic services.

Table 3. Effectively applied tariff for dutiable imports, weighted average tariff (%)

Year	Import tariff
2010	2.07
2011	2.13
2012	1.76
2013	1.80
2014	1.73
2015	-
2016	1.78

Table 4. Minimum wages in local currency in nominal and real terms¹⁷

Year	Semester	Minimum wage floor	Workers with technical degree	Workers with bachelor's degree	Workers with Licenciate degree	Real minimum wage (wage floor)
2010	II	187043	261499	394785	473758	227619
2011	II	191962	268376	405168	486218	226187
2011	I	198681	275220	415500	498617	229886
2012	II	204979	283944	428671	514423	231772
2012	I	211129	292463	441531	529855	233844
2013	II	218835	303138	457647	549195	232980
2013	I	224087	310413	468630	562376	235543
2014	II	232557	322147	486345	583634	239774
2014	I	242371	329717	497774	597349	242163
2015	II	247243	336344	507779	609356	247380
2015	I	249567	339506	512552	615084	251526
2016	II	251239	341781	515986	619205	254138
2016	I	252495	343490	518566	622301	253500
2017	II	255374	347405	524478	629395	254299
2017	I	255374	347405	524478	629395	252250
2018	II	261580	355847	537223	644689	253845
2018	I	261580	355847	537223	644689	252788
2019	II	269322	366380	553124	663772	257700
Growth rate (2010 - 19)		44%	40%	40%	40%	13%

Table 5. Assumption for main parameters used

Parameter	Description	Value
σ	Elasticity of substitutions between any two varieties	5
φ	Lowest possible productivity parameter	1
τ	Iceberg transport cost parameter	1.05
f_c	Fixed production costs	5
f_e	Per period equivalent of sunk market entry costs	6.711
f_x	Fixed export costs	7
k	Shape parameter of Pareto distribution	8
α_1	Exponent for C1 in utility function	0.5
α_2	Exponent for C2 in utility function	0.5
β_1	Exponent for skilled labor for sector 1 varieties	0.6
β_2	Exponent for skilled labor for sector 2 varieties	0.4
$tariff_2^H$	Tariff on sector 2 imports by country H	0 - 60%

¹⁷ Nominal wage deflated using the official CPI index published by the Central Bank, base year 2015 = 100

Table 6. Assumptions for countries' relative and total endowments

Endowments	Home		Foreign	
	Skilled	Unskilled	Skilled	Unskilled
$\frac{L^H}{S^H} = \frac{L^F}{S^F} = 1$	25	25	75	75
$\frac{L^H}{S^H} = 1.5 > \frac{L^F}{S^F} = 1$	20	30	75	75

Table 7. Definitions for variables used

Variable	Definition	Source
Formal/Informal employment	Definition of formal and informal employment from the INEC, based on the guidelines from the International Labor Organization (ILO).	INEC (ECE)
Wage I	Hourly gross wage earned by the individual on the period of reference	INEC (ECE)
Wage II	Monthly gross wage earned by the individual on the period of reference	INEC (ECE)
Tariff	Effectively Applied tariff (AHS) estimated as a weighted average of all products imported. Source: World Bank, World Integrated Trade Solutions.	WITS, World Bank
Inflation	Interannual growth rate of the official Consumer Price Index.	Central Bank
Minimum wage	Minimum wage established by the National Salaries Council. The minimum wages apply only to the private sector and they are announced every two years for the period 2010 – 2016 and annually from 2017 onwards. Only minimum wages by educational attainment are used, given that they are the only ones that can be matched accurately to each worker. The minimum wages by occupation established by the Ministry of Labor (MTSS) are not necessarily matching to the occupations list from the INEC. The MTSS has a list of 19 minimum wages, some of which are by educational attainment (6) and some specific to a small list of occupations (13). Therefore, for all the other workers with a degree lower than postsecondary education the <i>minimo minimorum wage</i> is used, which is the wage floor in Costa Rica.	Labor Ministry
Real minimum wage	Minimum wage deflated by the Consumer Price Index.	Own estimate
Kaitz Index	Wage/Minimum wage	Own estimate
Geography	Official geographic separation of the country into seven economic territories.	INEC (ECE)
Skill level	Official classification of occupations by skill level from the National Statistics Institution. Three categories are available: High skilled, middle skilled and low skilled.	INEC (ECE)
Industry	Based on the International System of Classification of Industries, revision 4 of the United Nations (ISIC 4). Only upper level of industries is used, for a total of 21 industries.	INEC (ECE)
Occupation	Occupational Classification of Costa Rica 2011 (COCR-2011), adaptation from the International Standard Classification of Occupations (ISCO) 08, International Labour Organization (ILO). Number of occupations is 441.	INEC (ECE)
Education	Years of education	INEC (ECE)

Table 8. Robustness check with Probit model: Impact of an increase in Kaitz Index on employment status

Dependent variable: employment status (0 = formal, 1 = informal)	(1) emp	(2) Emp
Kaitz2_log	0.938*** (0.00824)	0.511*** (0.0172)
Tariff	-1.911*** (.5610095)	-2.041*** (.5691827)
Gender	0.0306*** (0.0101)	0.0376*** (0.0100)
Years education	-0.0490*** (0.00137)	-0.0478*** (0.00139)
(Years education)^2	0.000374*** (1.58e-05)	0.000332*** (1.65e-05)
Inflation	-0.735 (0.573)	-0.860 (0.584)
High skilled * minwage		- -
Middle skilled * rminwage		0.248*** (0.0193)
Low skilled * rminwage		1.391*** (0.0282)
Year dummies	YES	YES
Quarterly dummies	YES	YES
Regional dummies	YES	YES
Industry dummies	YES	YES
Observations	249,044	249,044

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 9. Robustness check – Estimates using monthly earnings

Dependent variable: Monthly earnings	Formal sector		Informal sector	
	Salary	Salary	Salary	Salary
Minwage	0.181*** (0.00886)	0.237*** (0.0130)	0.193*** (0.0214)	0.317*** (0.0355)
Tariff	-1.034 (.2143)	-1.053 (.2142331)	-.867** (.4336121)	-.865** (.4337045)
Gender	-0.148*** (0.00364)	-0.149*** (0.00363)	-0.553*** (0.00865)	-0.554*** (0.00865)
Years education	0.0115*** (0.000585)	0.0117*** (0.000585)	0.0357*** (0.00104)	0.0359*** (0.00104)
(Years education)^2	-0.00012*** (5.82e-06)	-0.00012*** (5.83e-06)	-0.00033*** (1.18e-05)	-0.00033*** (1.19e-05)
Inflation	0.184 (0.216)	0.199 (0.216)	-0.349 (0.433)	-0.342 (0.433)
High skilled * minwage		-		-
Middle skilled * rminwage		-0.0979*** (0.0156)		-0.168*** (0.0401)
Low skilled * rminwage		-0.109*** (0.0208)		-0.141*** (0.0501)
Year dummies	YES	YES	YES	YES
Quarterly dummies	YES	YES	YES	YES
Regional dummies	YES	YES	YES	YES
Industry dummies	YES	YES	YES	YES
Observations	122,128	122,128	127,317	127,317
R-squared	0.366	0.366	0.322	0.322

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