The impacts of trade liberalization on informal labor markets: an evaluation of the Brazilian case.

Lourenco Paz

Syracuse University

12. March 2012

The Impacts of Trade Liberalization on Informal Labor Markets:

An Evaluation of the Brazilian Case.

Lourenço S. Paz
110 Eggers Hall
Department of Economics
Syracuse University
Syracuse, NY, 13244, USA
lspaz@maxwell.syr.edu

March 26, 2012

Abstract

Several developing countries that underwent trade liberalization experienced an increase in the share of informal workers in manufacturing industries. This phenomenon deserves careful examination because informal jobs are not only generally viewed as low-quality and low-paying jobs, but they also account for more than 30% of the workforce in some countries. In this paper, I examine the effects of the Brazilian trade liberalization episode (1989-2001) on the industry-level share of informal workers and on the average formal and informal wages. I find that a percentage point decrease in import tariffs increases the informality share by 0.09 percentage points and the average informal wage by 0.06%, and decreases the average formal wage by 0.05%. A similar change in foreign import tariffs decreases the informality share by 0.17 percentage points and the average informal wage by 0.34%, and increases the average formal wage by 0.32%. The results are found to be robust to endogeneity and self-selection concerns, which are addressed using instrumental variables and a switching regressions approach.

Keywords: informal labor markets, trade liberalization, Brazil

JEL classification: F16, F12, O17

1. Introduction

The existence of jobs that do not meet legal requirements (hereafter called informal jobs) is a common phenomenon worldwide (Schneider and Enste, 2000), and in developing countries they account for a significant share of the workforce. For instance, at least 30% of all jobs in Brazil and Colombia are informal. Trade liberalization episodes in Latin America were accompanied by almost no change in the industry share of employment, as found by Hanson and Harrison (1999) for Mexico and Pavcnik et al. (2004) for Brazil. Another significant feature of trade liberalization in the region was a substantial increase in the share of informal workers in the manufacturing sector (Perry et al., 2007). This last phenomenon is illustrated in Figure 1, which shows that the share of informal workers in Brazil's manufacturing sector increased from 12% to 20.4% following the country's trade liberalization in the 1990s, whereas the share of informal workers in the services sector remained stable. Because of the conceptual and empirical challenges of identifying informal workers, the issue of labor informality has not received much attention from researchers. However, the experience with trade liberalization in Latin America suggests that labor informality may be a relevant margin of adjustment to trade policy changes and is thus an issue that requires a careful investigation.

There is increasing evidence that in Latin America the existence of informality is related to the costs of having a legal contract (Portes et al., 1989), with payroll taxes accounting for the majority of this cost, as discussed in Neri (2002) for Brazil and in Pratap and Quentin (2006) for Argentina. Three papers (Goldberg and Pavcnik, 2003; Alemán-Castilla, 2006; and Paz, 2012) have built on this finding to develop theoretical models of the effects of trade liberalization on informal labor markets, specifically the impact of trade liberalization on the industry-level share

of informal workers and on average formal and informal wages.[1]

The purpose of this paper is to assess the predictions of these theoretical models using data from Brazil's trade liberalization episode (1989-2001). There are several reasons why Brazil is a good case study. First, the definition of labor informality commonly used in the theoretical literature is directly observable in Brazilian household surveys through the questions about employers' labor regulation compliance. Second, as a result of the change in trade policy, Brazil experienced a major decrease in its import tariffs, and later in the 1990s, its trade partners reduced their import tariffs as well, leading to large increases in both Brazil's imports and exports. Third, Brazil's labor institutions and regulations were stable during the trade liberalization period. This is a helpful feature because several other countries that implemented trade liberalization programs (e.g., Chile) also reformed their labor regulations.

The empirical results provide strong evidence that a decrease in Brazil's trade partners' import tariffs increases the industry-level average formal wage and decreases the share of informal workers in Brazil, while a decrease in Brazilian import tariffs has the opposite effect. Moreover, the decrease in the trade partners' import tariffs has a larger effect than the decrease in Brazil's import tariffs. For the average informal wage, the results may not be statistically significant, depending on the identification strategy used. When the results are significant, a reduction in the foreign trade partners' import tariff decreases the average informal wage, while a decrease in the Brazilian import tariff increases the average informal wage. Again, the magnitude of the former effect is larger than the latter. Furthermore, the

[1] For details concerning the theoretical literature, see Goldberg and Pavcnik (2003), Alemán-Castilla (2006), and Paz (2012).

magnitudes of these effects on the average formal and informal wages are inversely related to the worker likelihood of having an informal job. Thus, although multilateral trade liberalization may reduce informality and increase the average formal wage, the empirical results suggest that the benefits from trade liberalization are not the same for all workers. These findings still hold after several robustness checks, including testing for endogeneity of import tariffs and running 'placebo' type regressions to test whether pre-existing trends in the data are driving the results.

This paper is connected to the empirical literature on trade liberalization and informal labor markets. It is closely related to Goldberg and Pavcnik (2003) and Alemán-Castilla (2006). Goldberg and Pavcnik (2003) used data on Brazil and Colombia and found that import tariffs have a small effect on the informality share in Colombia and no effect in Brazil. Alemán-Castilla (2006) used data on Mexico and found that a decline in U.S. tariffs reduces the informality share in the Mexican tradable sector; a decrease in Mexican import tariffs has no effect; and the reduction in the trade partner import tariff leads to an increase in the difference between the average formal and informal wages.

However, this paper improves on these previous studies in several important respects. First, I use a definition of informality that is as close as possible to the definition used in the theoretical models. In contrast, Goldberg and Pavcnik (2003) considered self-employed and even employers as informal workers, and Alemán-Castilla (2006) counted as informal workers even those workers in jobs that complied with labor regulations but where the firm employed

less than six people.[2] Second, given that labor regulation enforcement is a key determinant of informal jobs, I address its omission and the simultaneous determination of import tariffs and informality outcomes in the empirical specifications through the use of an instrumental variable for Brazilian import tariffs. Thus far the literature has ignored these issues. Third, in order to obtain consistent estimates of the trade policy effects on the average formal and informal wages, I address the issue of worker self-selection into informal jobs by employing a switching regressions technique that overcomes the usual problem in the literature of using clearly endogenous regressors (see e.g., Alemán-Castilla, 2006).

The remainder of the paper is organized as follows. Section 2 presents the theoretical models of informality and their testable hypotheses. In section 3, I discuss the empirical specifications used to assess these predictions. The data used is described in section 4, where I also provide a brief historical background of the Brazilian trade liberalization episode. Section 5 presents the empirical results and several robustness checks. I offer some conclusions in section 6.

2. Theoretical Background

In this section I first discuss definitions and measures of labor informality and then briefly review the relevant theory from Goldberg and Pavcnik (2003), Alemán-Castilla (2006), and Paz (2012) along with their testable hypothesis related to the effects of trade policy changes on industry-level outcomes such as the share of informal workers and average wages

[2] Alemán-Castilla (2006) also considered as informal workers those employed by firms that did not provide health insurance to workers, even though labor regulations do not require firms to provide health insurance.

of formal and informal workers.[3] All three models assume homogenous labor as the only factor of production, which is inelastically supplied by identical households. This means that in equilibrium, it is up to the firm to decide whether to offer formal or informal jobs.

2.1 Definitions and Measures of Labor Informality

A large strand of the literature defines informality as being based solely on compliance with regulations.[4] For example, Schneider and Enste (2000, p. 79) define the informal economy as the "*legal value-added creating activities which are not taxed or registered and where the largest part can be classified as clandestine labor, which means that unpaid or `pure' household production, voluntary nonprofit (social) services and criminal activities are excluded"*. According to Portes et al. (1989, p.30), "*the best-known economic effect of the informalization process is to reduce the costs of labor substantially".* Among these labor costs, the payroll tax is the largest, typically accounting for 15 to 30% of the wage.[5] Furthermore, whether or not firms comply with the payroll tax is arguably central to the root distinction between formal and informal jobs in Argentina (Pratap and Quentin, 2006) and Brazil (Neri, 2002), for the simple reason that in both cases employers tend to follow other labor regulations.

Using payroll tax compliance to distinguish between formal and informal jobs, Table 1 shows that informality is present in every manufacturing industry in Brazil. Furthermore, Goldberg and Pavcnik (2003) find that within-industry variation accounted for almost all

[3] More attention is devoted to Paz (2012) model because it provides most of the testable hypotheses investigated in this paper.

[4] In contrast, the International Labor Organization (ILO, 2001) defines informal jobs as those offered by firms with five or less workers regardless of compliance with labor regulations.

[5] Schneider and Enste (2000) provide an in-depth discussion of the factors influencing regulation compliance.

variation in informality over time in Colombia and for about 85% of the variation in Brazil, which means that the changes in the share of informal jobs occurred within manufacturing industries.[6]

The payroll tax compliance definition of informality and the previous paragraph finding regarding within industry variation suggest three measures of informality-related outcomes in an analysis of the impacts of trade liberalization on labor markets. The first measure of interest is the share of informal workers in industry-level employment since it is viewed as a determinant of worker welfare. Given that workers normally prefer formal to informal jobs, an increase in the share of informal workers is generally associated with a reduction in workers' welfare. The average wages of formal and informal workers are the two other outcomes that are also of interest because knowing the impact of trade liberalization on these variables allows us to evaluate changes in an important component of wage inequality. Moreover, the average wages also form an important and easily measurable part of worker welfare. With this background, I turn next to the three theoretical models and their testable hypotheses regarding the effects of trade liberalization on these three measures of informality.

2.2 The Goldberg and Pavcnik (2003) Model

The Goldberg and Pavcnik (2003) model is based on the dual labor market framework proposed by Saint-Paul (1996). The model consists of a representative firm at the industry level that faces a stochastic demand curve. The firm can offer two types of labor contracts, formal or

[6] The figure of 85% for Brazil is confirmed by my dataset.

informal. The key assumption of this type of model is that the firm's ability to monitor workers' performance depends on the formality status of the workers, even if formal and informal workers perform the same task. Because formal workers cannot be monitored perfectly, they must be offered efficiency wages, which also depend on the endogenous probability of being fired without reason. Informal workers receive reservation wages and can thus be monitored perfectly as long as the firm pays the cost of monitoring. The firm faces the following trade-off between offering informal versus formal labor contracts. Formal workers have a large adjustment cost (since changes in the firing probability increase the efficiency wages) and a low marginal cost, whereas informal workers have no adjustment costs but a high marginal cost due to the large monitoring costs. This means that the equilibrium outcome in this model is that informal workers are the first to be hired and fired in response to demand fluctuations, but formal workers are hired and fired in response to permanent changes in demand.[7]

The trade policy change studied by Goldberg and Pavcnik (2003) is a decrease in the domestic import tariff, which is modeled through a reduction in the mean around which demand fluctuates, i.e. through a permanent decrease in the expected output price. This permanent decrease in expected price reduces the optimal level of formal employment. As a result, formal workers are fired but the number of informal workers remains the same. This decrease in formal employment increases the share of informal workers, which leads to the first testable hypothesis of the theoretical literature on labor informality.

[7] This assumption is at odds with the labor regulations of several countries, including Brazil, which have special labor contracts for temporary workers that have lower labor costs than permanent employees.

Hypothesis 1: A decrease in domestic import tariffs leads to an increase in the share of informal workers in the industry's total employment.

Although not discussed in Goldberg and Pavcnik (2003), their model can also be used to predict the effects of a decrease in domestic in import tariff on the average formal wage. As seen earlier, a decrease in the domestic import tariff reduces formal employment. As a result, formal workers feel less secure about their jobs because the expected value of being employed moves closer to the expected value of being unemployed. Thus, the firm will raise formal workers' wages so that they will have a lot to lose if they are caught shirking. This leads to the second testable hypothesis:

Hypothesis 2: A decrease in domestic import tariffs leads to an increase in the industry-level average formal wage.

2.3 The Alemán-Castilla (2006) Model

The next two theoretical models - Alemán-Castilla (2006) and Paz (2012) - use a heterogeneous firm framework based on the Melitz (2003) model, in which monopolistically competitive firms have heterogeneous productivity and face a fixed cost of production every period. If a firm exports, it will also incur a per period fixed export cost and a variable iceberg-type cost that is proportional to the volume exported. In equilibrium, the existence of fixed costs causes some firms to have negative profits, and they exit the market soon after learning their productivity draw. This leads to the definition of the entry cut-off, which is the minimum

productivity (or the maximum marginal cost) level required for a firm to have zero profit. Similarly, not every firm engages in exporting. This leads to the definition of the export cut-off, which is the minimum productivity level needed to earn zero profit from exporting.

Alemán-Castilla (2006) builds upon a two symmetric country (Home and Foreign) version of the Melitz (2003) model by adding another decision at the firm-level: whether or not to pay an ad valorem payroll tax (i.e. whether to offer formal or informal jobs, respectively). If the firm complies with the payroll tax, its labor cost increases, but it also enjoys higher productivity and access to foreign markets.[8] On the other hand, if the firm does not comply with the payroll tax and it is audited by the government, which has a probability of occurring of less than one, the firm must pay a fine that is proportional to its profit. This creates a third cut-off, called the informality cut-off, which is the minimum productivity level needed for zero profit when the firm employs formal workers. Under some assumptions made by Alemán-Castilla (2006), the informality cut-off lies between the entry and the export cut-offs. Thus, in equilibrium, compliance with the payroll tax is not profitable for low productivity firms that also have low levels of employment, sales, and profits, and serve only the domestic market.

The trade policy change considered by Alemán-Castilla (2006) is a symmetric multilateral trade liberalization – that is, an equal magnitude decrease in domestic and foreign variable trade costs - which can also be interpreted as both countries reducing their import tariffs. Because such a policy change induces an increase in the sales, profits, and formal employment of the firms that already export, formal employment increases. The increase in

[8] Alemán-Castilla (2006) suggests that this increase in productivity could come from subsidized official loans, for example.

expected profits attracts more entrants that, together with the current exporters, increase the demand for workers, which results in higher wages. The increase in wages causes the entry productivity cut-off to increase (or the marginal cost cut-off to decrease). As a result, the operating firms with the lowest productivity will now earn negative profits and exit the market. Because the firms exiting the market employ informal workers, informal employment will decrease. Another consequence of the increase in wages is that firms that only serve domestic markets will shrink in terms of output, sales and employment. This decrease in demand will increase the informal productivity cut-off that makes formal employment profitable. Thus firms with productivity equal to the informality cut-off that previously hired formal workers will now switch to informal workers, which will increase informal employment and decrease formal employment. Thus, in the Alemán-Castilla (2006) model, the symmetric trade liberalization has an ambiguous effect on the industry-level share of informal workers.

2.4 The Paz (2012) Model

The Paz (2012) model also considers payroll tax compliance as the key distinction between formal and informal workers. In this model, if a firm hires a formal worker, it has to pay an ad valorem payroll tax and incur a tax preparation and record keeping expenditure, which is a per worker cost.[9] Any firm in the economy can be audited by the government and, if the firm is caught not complying with the payroll tax, it has to pay an ad valorem fine based on

[9] Evans (2003) provides evidence about the large private costs of tax compliance; Boisvert et al. (2001) provides specific evidence on the cost of payroll tax compliance in Brazil.

the wages paid to the informal workers.[10] Although the likelihood of an audit is less than one for firms that serve only the domestic market, it equals one for firms that export because all international trade transactions are monitored by the government.[11,12] In contrast to the Alemán-Castilla (2006) model, in the Paz (2012) model, firms' productivity levels do not change according to the type of job offered. However, the payroll tax mechanism in Paz (2012) requires firms to pay different wages in order to prevent corner solutions, such as all workers in an industry being either formal or informal.[13] Thus, Paz (2012) embeds the payroll tax mechanism in a small open economy (SOE) version of the Davis and Harrigan (2011) model, which is an extension of the Melitz (2003) model in which firms display wage heterogeneity in addition to productivity heterogeneity.[14]

In the Paz (2012) model, the firms' marginal costs are determined by their individual wage-productivity ratios, which are used to define the entry and export cut-offs. In equilibrium, firms with low marginal cost have positive profits from exporting. These exporting firms are large in terms of employment, revenues, and profits. Because the audit likelihood for an exporting firm is one, exporters will find it cheaper to employ only formal workers. Firms with marginal costs above the export cutoff are the ones serving only the domestic market and they will choose formal or informal labor contracts so as to minimize their expected labor costs. This

[10] The tax formula used by Paz (2012) is the one used in practice in Brazil, as determined by Laws 8212 and 9876.
[11] Munk (2008) discusses the administrative cost of several types of taxes and suggests that border tariffs are both the easiest to implement and the cheapest in terms of administrative costs.
[12] In equilibrium, this audit likelihood generates a large share of small firms hiring only informal workers and large firms hiring only formal workers. This theoretical prediction is supported by the Brazilian survey data, discussed in Paz (2012).
[13] Table 1 presents evidence that the share of informal workers is positive and less than one in every manufacturing industry in Brazil, which suggests that corner solutions are not realistic.
[14] A small open economy version of the Melitz (2003) model is provided by Demidova and Rodriguez-Clare (2011). Davies and Paz (2011) also present a small open economy model based on a simplified version of Melitz (2003) model.

leads to an informality cut-off based on both the productivity and the wage paid by the firm. If a firm's productivity is low and its wage is above the informality cut-off, it will find cheaper to hire formal workers; otherwise the firm will hire informal workers because of the relatively high per worker payroll tax compliance cost.

Next, Paz (2012) conducts a comparative static exercise of changes in Home and Foreign import tariffs, in which Home is a SOE, i.e. its policies do not affect Foreign except for the trade flow between the two countries. Paz (2012) also consider the case in which Home and Foreign are two large economies (TLE) that are identical except for having different labor force sizes. But in this case the comparative statics do not lead to testable hypothesis due to ambiguity in the signs of the derivatives.[15]

2.4.1 Predicted Effects of a Decrease in Foreign Import Tariff

A decrease in the foreign import tariff affects domestic firms through three channels. The first channel is an increase in the volume exported, which raises formal employment by current exporting firms, and hence bids up wages. The second and third channels operate through the entry and export cut-offs respectively.

The increase in wages lead to a reduction in the marginal cost entry cut-off, so those domestic firms that have the highest marginal cost exit the market since they will earn negative profits. Because some of these firms would have employed formal workers while others would have employed informal workers, the decrease in the entry marginal cut-off will reduce both

[15] Demidova and Rodriguez-Clare (2011) show that in a Melitz model with two asymmetric large economies additional assumptions are needed to determine whether the entry and the export cut-offs increase or decrease.

formal and informal employment. On the other hand, the export marginal cost cut-off increases, therefore firms located at this threshold that employed informal workers will switch to formal workers.[16] As a result, the share of informal workers can increase or decrease. This happens because informal employment decreases, and formal employment can expand or contract. After imposing some reasonable conditions on the elasticity of substitution, on the payroll tax parameters, and on the joint distribution of productivity and wage, Paz (2012) finds that Foreign trade liberalization reduces the informality share. This leads to the third testable hypothesis.

Hypothesis 3: A reduction in the Foreign import tariff decreases the share of informal workers in total industry employment.

The wage heterogeneity present in the Paz (2012) model also generates testable predictions regarding average formal wages. Paz (2012) finds it is not possible to determine the effect of a decrease in Foreign tariff on the average informal wage unless the model is fully parameterized.

A decrease in the Foreign import tariff will increase domestic wages, causing the average formal wage to go up. Nevertheless, the changes on entry and export cut-offs lead to changes in the job composition, since the wages of the destroyed jobs are different from the wages of the created jobs. But, Paz (2012) makes the additional assumption that wages and

[16] Notice that the free-entry equilibrium equation implies that the export cut-off moves in the opposite direction of the entry cut-off.

productivity are *ex ante* positively correlated, as in Davis and Harrigan (2011). As a consequence, the overall increase in average formal wages dominates any changes in the average formal wage caused by adjustments in the entry and export cut-offs. This leads to the fourth testable prediction.

Hypothesis 4: A reduction in the Foreign import tariff leads to an increase in the industry-level average formal wage.

2.4.2 Predicted Effects of a Decrease in Home Import Tariff

Now, I consider a decrease in the domestic import tariff, which also affects the informality share through the three channels discussed previously. The first channel is an increase in the demand for the imported goods, which forces wages to go down in order to boost Home exports to offset the increase in imports. As a result, similarly to the Foreign tariff decrease, the marginal cost export cut-off increases, and formal jobs are created.

The marginal cost entry cut-off decrease which destroys both formal and informal jobs. Under the same assumptions discussed before, Paz (2012) finds that a decrease in Home import tariff decreases the share of informal workers, which is the opposite of Hypothesis 1 prediction. This leads to the fifth testable hypothesis.

Hypothesis 5: A reduction in the Home import tariff decreases the share of informal workers in total industry employment.

The reduction in all wages caused by the domestic import tariff leads to a decrease in the average formal wages. Again, under the additional assumption that wages and productivity are *ex ante* positively correlated, the overall decrease in average formal wages to dominate any changes in the average formal wage resulting from adjustments in the entry and export cut-offs. This leads to the sixth testable hypothesis.

Hypothesis 6: A reduction in the domestic tariff leads to a decrease in the industry-level average formal wage.

3. Econometric Methodology

In this section, I develop the econometric specifications used to assess the testable hypotheses outlined in the previous section. In this context, Brazil is the domestic country, while the foreign country consists of Brazil's trade partners aggregated into a single country. Hereafter, for the sake of simplicity, Brazil's import tariff is called import tariff and the import tariff imposed on Brazilian exports by the foreign country is called export tariff.

3.1 Basic Econometric Model of Informality Share

The predictions concerning the effects of changes in the import and export tariffs on the industry-level share of informal workers are first assessed using the econometric model defined in equation (1):

$$share_{jt} = \beta_0 + \beta_1 \tau_{jt} + \beta_2 \tau^*_{jt} + \boldsymbol{\alpha} * \mathbf{year_t} + \boldsymbol{\gamma} * \mathbf{industry_j} + u_{jt} \quad (1)$$

where $share_{jt}$ is the share of informal workers employed in industry *j* in year *t*, $\mathbf{year_t}$ is a vector of year indicator variables, $\mathbf{industry_j}$ is a vector of industry indicator variables, and u_{jt} is the error term. Hypothesis 1 predicts that a decrease in the import tariff (τ) increases the share of informal workers ($\beta_1 < 0$), while Hypothesis 5 predicts the opposite, i.e. $\beta_1 > 0$. Hypothesis 3 implies that a decrease in the export tariff (τ^*) reduces the informality share ($\beta_2 > 0$).

The year effects are included in the specification to control for economy-wide shocks, such as business cycles and exchange rates. For instance, if firms employing formal workers are more likely to reduce employment during a recession, and, at the same time, the government raises tariffs in response to the recession, a spurious relationship will be found between tariffs and the share of informal workers unless year effects are used.

Moreover, some industry-specific characteristics that are correlated with right-hand side variables are certainly omitted, which will lead to inconsistent estimates. One example is the ability of firms to hide their operations from the government. It is easier to hide an apparel firm, which can be small, than a steel mill, which cannot be small due to technological constraints. However, as long as these industry characteristics are stable over time, adding a vector of industry indicators ($\mathbf{industry_j}$) to the econometric specification addresses this problem. Thus, once year and industry effects are included, the identification of β_1 and β_2 will come from the within-industry variation of the tariffs over time, as postulated in Goldberg and Pavcnik (2003), Alemán-Castilla (2006), and Paz (2012).

It is important to note that the specification in equation (1) omits labor regulation enforcement, which is industry-time variant. For instance, a decrease in the import tariff

reduces payroll tax revenues. In order to raise revenues, the government may increase either payroll taxes or enforcement, both of which affect informality in the Alemán-Castilla (2006) and Paz (2012) models. However, the data indicate that payroll taxes did not change during the trade liberalization episode in Brazil (AEPS, 2005). In addition, enforcement data in the form of establishments visited by auditors are only available at a highly aggregated level (AEPS, 2005).[17] Another problem resulting from omitting payroll tax enforcement from the specification is that the potential loss in payroll tax revenue may have affected the setting of the import tariff, generating reverse causation between the share of informal workers and the import tariff.

To address these issues I have used the Colombian import tariff set during Colombia's trade liberalization episode (from 1984 to the middle of the 1990s) as an instrument for the Brazilian import tariff. I match the year preceding the trade liberalization in Colombia (1984) to the year preceding trade reform in Brazil (1989). Hence, the 1984 Colombian tariff level is used as an instrument for the 1989 Brazilian import tariff, and so on.

The correlation between these two import tariffs derives from the fact that prior to their trade liberalization episodes, both the Colombian and Brazilian governments believed that their import substitution industrialization policies (which implied high levels of trade protection) were welfare enhancing. In addition, the import substitution development policy was considered to be an institution, even a historical legacy that could not be changed easily.[18] At a

[17] The audited establishment series starts in 1992, when 112,327 establishments were visited. The number of visits increased to 144,069 in 1994, but declined to 89,000 visits in 2001. The total audited establishments series for Brazil is available from IBGE (2011) from 1996 onward. This series indicates that the number of establishments increases monotonically every year, which causes the share of establishments audited per year to change over time.

[18] The idea that a country engaged in a import substitution development policy suddenly changes its mind toward trade liberalization was originally developed in Karacaovali (2011).

certain point, however, governments realize that the gains from import substitution may not be as large as expected, and change their development policies by decreasing trade protection across all industries.[19] This means that the Brazilian and Colombian tariffs moved in the same direction (downward) as a result of this willingness to liberalize trade due to the change in development policy. Thus, the Brazilian and Colombian tariffs should exhibit a positive correlation.

I believe the Colombian import tariff is a valid instrument for the Brazilian import tariff for the following reasons. First, Colombian tariffs are not affected by future Brazilian tariffs, because trade between these two countries is very small relative to their other partners. Second, according to Goldberg and Pavcnik (2005), in the early 1980s the Colombian government negotiated with the World Trade Organization (WTO) to set tariffs to achieve a uniform tariff of 13% across industries. As a consequence, Colombian policy-makers were less able to allow informality concerns to affect the tariff reduction. Third, the pre-reform protection patterns in Brazil and Colombia were different. As shown in Table 2, Colombia offered more protection to the light manufacturing sector (e.g. apparel and footwear), which has a large share of informal workers, while Brazil offered more protection to capital good industries (e.g. machinery and transportation equipment), which employ few informal workers. Therefore, the possible effect of Colombia's informality on its tariffs appears to be uncorrelated with the effect of Brazil's informality on Brazilian tariffs.

Equation (1) is estimated using ordinary least squares (OLS), two-stage least squares

[19] For instance, governments that adopted import substitution development policies could contrast their own economic performance with the performance of countries such as South Korea, which adopted different development policies.

(2SLS), Tobit, and IVTobit. The last two estimators are used because the dependent variable (i.e., share of informal workers) falls within the [0,1] interval. In all cases, the standard errors are clustered at the industry level due to the likely presence of within-cluster correlation (Stock and Watson, 2008).

3.2 Augmented Econometric Model of Informality Share

Although not included in any of the theoretical models discussed earlier, worker heterogeneity may lead to self-selection into formal or informal jobs provided that the benefits and costs of formality change according to worker characteristics. Table 1 presents the average characteristics of formal and informal worker for each manufacturing industry in Brazil. It is important to note first that the average characteristics of workers are different across industries. Second, the characteristics of formal and informal workers are very similar for some industries, such as paper products and footwear, but significantly different for others, such as non-metallic mineral products and chemicals.[20]

If industries have different skill requirements, then the industry fixed effects will be correlated with worker characteristics (currently in the error term), and the estimates will not be consistent. To address this issue, I augment the econometric specification in equation (1) to incorporate workers' observable characteristics:

[20] The literature, e.g. Goldberg and Pavcnik (2003) and Alemán-Castilla (2006), presents descriptive statistics of the characteristics of formal and informal workers at a very aggregated level, which gives the impression that the characteristics are very different. However, when presented at a more disaggregated level, as in Table 1, worker characteristics are similar for several industries.

$$informal^{*}_{ijt} =$$

$$\beta_0 + \beta_1 \tau_{jt} + \beta_2 \tau^{*}_{jt} + \boldsymbol{\alpha} * \mathbf{year_t} + \boldsymbol{\gamma} * \mathbf{industry_j} + \boldsymbol{\psi} * \mathbf{characteristics_i} + \varepsilon_{ijt} \qquad (2)$$

Here I use worker level pooled cross-section data with their respective sample weights. The new dependent variable is the probability of having an informal job (*informal*$_{ijt}$*); **characteristics$_{ijt}$** is a matrix of observable worker characteristics such as age, age^2, years of education, gender, region of residence, and an indicator if another person in the household has a formal job (*otherformal$_{ijt}$*); and ε_{ijt} is the unobservable error term. The inclusion of *otherformal$_{ijt}$* is based on the point made in Roberts (1989) and Pratap and Quentin (2006) that some benefits related to formal employment (e.g., retirement and pension benefits) may be extended to the worker's family, and hence the incentive for pursuing a formal job may be reduced if another household member already has a formal job. In this specification, an increase in the probability of having an informal job is assumed to be equivalent to an increase in the expected share of informal workers. Again, Hypothesis 1 predicts $\beta_1 < 0$, Hypothesis 5 predicts $\beta_1 > 0$, and Hypothesis 3 predicts $\beta_2 > 0$.

Equation (2) is similar to the two-step approach used by Goldberg and Pavcnik (2003) and Alemán-Castilla (2006), where the first step models the likelihood of having an informal job as a linear probability model that is estimated separately for every year of the sample, controlling for the observable characteristics of the individuals and for industry affiliation by including a set of industry indicators.[21] In the second step, these estimated industry affiliation effects are linearly regressed (OLS) on trade related measures, in addition to time and industry

[21] These indicators are intended to capture the variation in informal employment that is due to industry affiliation rather than worker characteristics.

indicators. The main difference between my approach and the Goldberg and Pavcnik (2003) and Alemán-Castilla (2006) approaches is that my specification constrains the coefficients of the workers' observable characteristics to be the same across all years of the sample. This does not appear to be a very strong restriction because the worker characteristic coefficients estimated by Goldberg and Pavcnik (2003) using data for Brazil changed very little over time.

Equation (2) can be estimated as a linear probability model using OLS and 2SLS. However, neither estimator accounts for the dichotomous nature of the observed dependent variable, which can lead to several econometric problems. To address this issue, I consider $informal^{*}_{ijt}$ as a latent variable, and define the observable variable $informal_{ijt}$ to be "1" if $informal^{*}_{ijt} > 0$ and "0" otherwise, and then use Probit and IVProbit techniques to obtain consistent estimates. For all four estimators, the standard errors are clustered according to industry by year.

3.3 Econometric Model of Average Formal and Informal Wages

Recall that Hypotheses 2, 4, and 6 concern the average formal wages. Schmidt and Zimmermann (1991) show that the different characteristics of workers lead to different wages. Thus, worker characteristics will affect not only the wage but also the type of labor contract, as discussed earlier. To address these issues I employ a switching regression model (Maddala, 1983), also called Tobit type 5 (Amemiya, 1985). The first step is to model the employment regime (formal or informal) selection. For this purpose I use the equation (2) that is estimated by IVProbit. Next, using the predicted values of $informal^{*}_{ijt}$ I compute the inverse Mills ratio for each worker. The inverse Mills ratio is given by $\Lambda(z) = \phi(z)/\Phi(z)$, where $\phi(z)$ is the probability

distribution function of a standard normal and $\Phi(z)$ is the cumulative distribution of a standard normal. Finally, to control for worker self-selection I incorporate this calculated ratio into an augmented Mincer earnings equation for each employment regime, which also includes import and export tariffs and year and industry effects. This earnings equation is (3) for formal workers and (4) for informal workers.

$$wage_{ijt}^{for} =$$

$$\delta_1^{for}\tau_{jt} + \delta_2^{for}\tau_{jt}^{*} + \boldsymbol{\alpha}^{for} * \mathbf{year_t} + \boldsymbol{\gamma}^{for} * \mathbf{industry_j} - \sigma_{\varepsilon\nu_1}\Lambda\left(-\iota\widehat{nformal}_{ijt}^{*}\right) + \upsilon_{1,ijt} \quad (3)$$

$$wage_{ijt}^{inf} =$$

$$\delta_1^{inf}\tau_{jt} + \delta_2^{inf}\tau_{jt}^{*} + \boldsymbol{\alpha}^{inf} * \mathbf{year_t} + \boldsymbol{\gamma}^{inf} * \mathbf{industry_j} + \sigma_{\varepsilon\nu_2}\Lambda\left(\iota\widehat{nformal}_{ijt}^{*}\right) + \upsilon_{3,ijt} \quad (4)$$

The self-selection into formal or informal labor contract works through a non-zero correlation among ε, ν_1, and ν_2 that, if not controlled for, can bias the estimates of the effect of tariffs on wages. If this correlation is non-zero, the estimated coefficient of the inverse Mills ratio will be statistically significant. Identification in this specification is achieved either by having at least one variable in the regime selection equation that is not present in the wage equations, which is *otherformail*$_{ijt}$, or through the non-linearity of Λ functional form. The latter identification strategy is effective as long as there is a large variation in $\iota\widehat{nformal}_{ijt}^{*}$ across observations (Cameron and Trivedi, 2005, p. 551), which is the case with the Brazilian data used in this paper.

The marginal effect of the export tariff on the formal wage is

$\hat{\delta}_2^{for} + \hat{\sigma}_{\varepsilon v_1}\hat{\beta}_2\Lambda\left(-\widehat{\imath nformal}_{ijt}^*\right)[\widehat{\imath nformal}_{ijt}^* - \Lambda\left(-\widehat{\imath nformal}_{ijt}^*\right)]$ and is predicted to be positive by Hypothesis 6. The marginal effect of the export tariff on the informal wage is $\hat{\delta}_2^{inf} - \hat{\sigma}_{\varepsilon v_2}\hat{\beta}_2\Lambda\left(\widehat{\imath nformal}_{ijt}^*\right)[\widehat{\imath nformal}_{ijt}^* + \Lambda\left(\widehat{\imath nformal}_{ijt}^*\right)]$. Similar marginal effects can be calculated for the import tariff, with Hypothesis 2 predicting a negative sign for average formal wage, while Hypothesis 6 predicts a positive sign.

I estimate these switching regressions using a two-step method that consists of first calculating Λ with the predicted values from the IVProbit estimate, and then estimating equation (3) using the observations for formal workers and equation (4) using the observations for informal workers. Although this method is inefficient relative to maximum likelihood, it requires weaker distributional assumptions and imposes a lighter computational burden (Cameron and Trivedi, 2005 p. 550). Given the concern about the possible endogeneity of the import tariff variable, both wage equations are estimated using 2SLS and OLS. Because Λ is a generated regressor, standard errors are calculated by a 500-repetition bootstrap that takes into account the original sample weights when conducting the resample.

4. Data and Historical Background

In this section I present the data used in the econometric estimates. First, I describe the Brazilian worker-level data in detail. Next, I provide a brief historical background on the Brazilian trade liberalization episode. I then describe the sources of the import and export tariff data and the aggregation procedures used.

4.1 Worker Data

Despite the illegal nature of informal labor markets, Brazil conducts an annual household survey called Pesquisa Nacional por Amostra de Domicílios (PNAD) that asks workers about their demographics, employment characteristics, and their employers' labor regulation compliance. This survey is conducted by the IBGE-Instituto Brasileiro de Geografia e Estatística (Brazilian Bureau of Geography and Statistics) and covers the entire country, with the exception of Northern rural areas. [22] PNAD was not conducted in the census years of 1991 and 2000, and was not conducted in 1994 due to a lack of funds. For 1991 and 2000, I use Brazilian census microdata from IPUMS-International (Minnesota Population Center, 2007), which contains the very same questions as the PNAD survey. Thus, with the exception of 1994, I use annual data for the 1989-2001 period.[23]

Following Neri (2002), Pratap and Quentin (2006), and Paz (2012), I define an informal job as one for which the employer pays no payroll tax.[24] The payroll tax compliance question has very few missing observations, which account for at most 0.3% in each year of the sample. Workers do not have incentives to lie because the questionnaire is confidential and cannot be used as evidence in court. More importantly, informal workers in Brazil suffer no penalty if caught by the authorities; only employers are penalized. Finally, workers are aware of their

[22] Together these areas account for less than 5% of the Brazilian population and have no manufacturing activity.

[23] Goldberg and Pavcnik (2003) used a different survey for Brazil, the Monthly Employment Survey-PME, and considered not only firm employees but also the self-employed and employers. The PME covers only a few metropolitan areas that account for approximately 40% of Brazil's population and about 60% of Brazil's GDP.

[24] Goldberg and Pavcnik (2003) define an informal job as one without a written contract. Jobs without written contracts are part of the set of jobs that I define as informal, and account for approximately 98% of the informal jobs in my sample.

status since a small share of the payroll tax is deducted from their wages.

The hourly wage is calculated as the monthly wage divided by four times the hours worked per week. The industry aggregation level used is dictated by the PNAD industry classification, which consists of 16 manufacturing industries. I dropped the few observations that had missing data for any of the worker characteristics used. Following the theoretical models, only employees are considered, and they must be between 15 and 65 years-of-age. The age cut off was chosen to exclude people that are not eligible to pay social security contributions because they are not authorized to work, either because they are too young (the minimum age to work is 14) or they are already receiving social security benefits (i.e., older than 65). If a worker had multiple jobs, only the information about the main job was used. The petroleum refining and petrochemicals industry was excluded from the analysis because it is composed of government-owned firms that employ a small number of workers, and by definition always comply with tax regulations. The share of informal workers in industry *j* in year *t* consists of the average of the informality indicator weighted by the sample weights provided by the PNAD census. A total of 775,331 observations remained in the data set and were included in the analysis.

4.2 Background on Brazilian Trade Liberalization and Tariff Data

Until the end of the 1980s, Brazil's trade policy was driven by an import substitution development policy and by the country's balance of payments deficits.[25] The former implied different levels and types of protection across industries, in particular high tariffs and non-tariff

[25] Kume et al. (2003) provide a good description of Brazil's trade policy in the 1980s and 1990s.

barriers on imported goods that competed with similar domestic products. The latter resulted in increased tariffs across all industries to curb imports. Moreover, Brazil used its status as a developing country under article XVIII of the General Agreement on Tariffs and Trade (GATT) to avoid participating in all tariff reduction rounds.

However, in 1988 Brazil unilaterally decided to change its trade policy by reducing its tariffs to a level that would still prevent imports, but it did not change its non-tariff barriers (NTBs) (see Kume et al., 2003). In 1990, Brazil's new president drastically reduced NTBs and adopted nominal tariff reductions scheduled to start in 1990 and end in 1994. The actual decrease in tariffs was not identical across industries and it can be seen as the difference between the maximum and the minimum import tariffs in Table 2. Moreover, the tariff reductions did not follow the planned schedule. Nonetheless, the tariff reduction had real effects on the economy, as imports of manufactured goods increased by more than 200% and import penetration increased from 5.7% to 11.6% in the 1990-1998 period. The 1989-2001 Brazilian import tariff data comes from Kume et al. (2003) and was originally aggregated by industry value-added at IBGE's Nível 50 industry classification. Using industry value added as weights, I further aggregated the data into the 15 manufacturing industries shown in Table 2.

Brazilian firms' access to foreign markets also changed during the 1989-2001 period, for three reasons. First, the GATT Uruguay Round negotiations led the U.S., Japan, the European Union, and other developed countries to decrease the tariffs levied on several trade partners, including Brazil. Second, starting in 1991, the Mercosur customs union almost eliminated tariffs for the majority of goods traded among its members, namely Argentina, Brazil, Paraguay, and Uruguay. Third, in order to join the WTO during the 1990s, China decreased its import tariffs on

WTO members. These tariff reductions by Brazil's trade partners can be seen as the difference between the maximum and the minimum export tariff in Table 2, and were accompanied by a 68% increase in Brazil's exports of manufactured goods during the 1990-1998 period.

Brazil's trade partners considered here are Argentina, China, Japan, the U.S., France, Italy, Germany, the United Kingdom, Belgium-Luxemburg, the Netherlands, Portugal, and Spain, which together accounted for more than 60% of Brazil's manufacturing exports during the 1989-2001 period. This choice of countries was dictated by data availability. The export tariff variable used in the estimates consists of the simple average of each Brazil trade partner's import tariff for each of my 15 industries.

The data on Argentina's import tariffs on Brazilian goods for the 1991-2001 period come from Freund et al. (2008) and are at the 4-digit ISIC level. The 3-digit ISIC level data for 1990 come from Liftschitz (1991). I used 1990 data for 1989 because there are no data available for this year. Then, I aggregated the data into my 15-industry classification by simple average. The U.S. data come from Feenstra et al (2002) at Standard International Trade Classification (SITC). The import tariff on Brazilian goods is calculated as the ratio between import duties and customs value, which I further aggregated to my 15 industry classification using simple average.[26]

For the remaining countries, I used the 1974-2006 Trade, Production, and Protection (TPP) data at the 3-digit ISIC level from Nicita and Olarreaga (2006).[27] Each trade partner's

[26]The values, calculated as the ratio between import duties and customs value, are very close to the Nicita and Olarreaga (2006) data when available; however, one discrepancy occurred with the 1989 tariff for the food and beverage industry. My calculations indicated a tariff of 137.59% (an outlier considering this series' values over time), while the TPP data indicate 4.16 %. I chose to use the latter value.

[27] Argentina and the U.S. had missing data for several years in the TPP dataset.

import tariff is the simple average tariff rate in percentage points that must be paid for the good at the border of the importing country by a most favored nation (*tar_savg_mfn*). I aggregated each partner's export tariff data by simple average into my 15-industry classification. There are no data for China for the 1989-1991 period, so for these years I assumed the same tariff level as was in effect in 1992.

The instrument for import tariffs is constructed using Colombian import tariff data at the 4-digit ISIC level for the 1984-1998 period from the Colombian National Planning Department (DNP), which were further aggregated to my 15 industry classification using simple average.

5. Empirical Evidence

In this section, I first estimate the specifications concerning the share of informal workers. Then, the predictions about the average formal wages are assessed. Finally, I conduct several econometric robustness checks by estimating different specifications, which confirm that the results obtained are not sensitive to the specifications chosen and are not due to pre-existing trends in the data.

5.1 Share of informal workers

The first empirical exercise is to estimate equation (1) to assess the effects of changes in export and import tariffs on the industry-level share of informal workers. Table 3 reports these estimates. The results for the OLS and Tobit estimators (without year and industry indicators) are presented in columns (1) and (2), respectively. As predicted by Hypothesis 1 and contrary to

Hypothesis 5 in both cases the import tariff coefficient is negative and statistically significant. And Hypothesis 3 is corroborated by an estimated positive coefficient for the export tariff that is also statistically significant. The results in column (1) suggest that a percentage point decrease in import tariffs causes a 0.34 percentage point increase in the industry-level informality share and that a percentage point decrease in export tariffs causes the informality share to decrease by 0.38 percentage points. The null hypothesis that the magnitude of the two effects is equal cannot be rejected for either specification. As shown in columns (3) and (4), when year and industry effects are included, the estimated coefficients in both the OLS and Tobit specifications do not have the expected signs and are no longer statistically significant.

When the endogeneity of Brazil's import tariffs is taken into account, the 2SLS estimates (see column (5)) have the same signs as before but now they are not statistically significant. The excluded instrument (Colombian tariff) is not statistically significant in the first-stage regression. Furthermore, the Kleibergen-Paap LM statistic *p*-value of 0.253 implies that the null hypothesis that the included and excluded instrument matrix does not have full rank cannot be rejected; in other words, the model is not identified. The IVTobit estimate reported in column (6) shows similar results.

Table 4 presents the results for the worker-level specification described by equation (2), which accounts for the role of worker heterogeneity in the type of labor contract offered. Column (1) reports the OLS estimated coefficients for the linear probability model, which are not statistically significant. The Probit estimated coefficients, column (2), have the predicted signs from Hypotheses 1 and 3, but only the export tariff is statistically significant. The null hypothesis of both tariff coefficients being equal to zero is rejected at the 1% level, as is the null

hypothesis that the tariff coefficients are of equal magnitude.

The 2SLS estimated coefficients in column (3) have the expected sign, with the import tariff statistically significant at the 10% level (*p*-value of 0.071) and the export tariff statistically significant at the 5% level. These results suggest that a ten percentage point decrease in import tariffs increases the expected informality share by 0.92 percentage points, while a ten percentage point decrease in export tariffs reduces the informality share by 1.71 percentage points. The null hypothesis that both coefficients are zero is rejected at the 1% level, but the null hypothesis of equal magnitude of the coefficients is not rejected. The first stage regression *F*-statistic is 33,952 and the excluded instrument is statistically significant at the 1% level. The null hypothesis of under-identification of the Kleinberger-Paap test is rejected at the 10% level (*p*-value of 0.076). The Colombian tariff can be considered a relevant instrument because the Kleibergen-Paap rK Wald *F*-statistic of 16.14 is very close to the Stock-Yogo 10% maximum IV relative bias critical value of 16.38. Exogeneity of the import tariff is rejected at the 5% level by the Hausman test.

The IVProbit estimated coefficients in column (4) have the same signs as before but only the export tariff is statistically significant. The marginal effects calculated at the average imply that a ten percentage point decrease in the import tariff increases the informality share by 3.77 percentage points, while a ten percentage point decrease in export tariffs reduces the informality share by 7 percentage points. The null hypothesis that both tariff coefficients are zero is rejected at the 1% level, as is the null hypothesis that the tariff effects are of equal magnitude. The Wald exogeneity test does not reject the null hypothesis of exogeneity of the import tariff.

Although not reported in Table 4, the majority of worker characteristic variables are statistically significant, which means that workers characteristics do matter for their job formality status. The $otherformal_{ijt}$ variable is negative and statistically significant in columns (1)-(4), yet the rationale for including it in the model suggests a positive sign. This negative sign may be due to the possible collinearity between this variable and other worker characteristics. As long as this collinearity is not severe, it should pose no problem for the identification of the switching regressions model. The specifications in columns (5) and (6) do not include the $otherformal_{ijt}$ variable. Thus, if there were strong collinearity, large changes in the estimated coefficients would be expected. But this is not the case here since the estimates in these columns are very close to those in columns (3) and (4), respectively.

5.2 Formal and Informal Average Wages

To assess the predictions in Hypotheses 2, 4, and 6 concerning the effect of import and export tariffs on formal average wages, I first estimate equation (3) for formal workers and equation (4) for informal workers. The first identification case considered has the inverse Mills ratio calculated using the predicted values from the IVProbit model (as in column (4) of Table 4), which includes the $otherformal_{ijt}$ variable, a variable that is not present in the wage equations. The results are reported in Table 5. For the 2SLS estimates, column (1), only the export tariff coefficient is statistically significant and it has a negative sign. The first stage *F*-statistic is 109,815 and the Colombian tariff is statistically significant. The null hypothesis of exogeneity of the import tariff is not rejected at the 5% level. This motivates the estimation of the formal wage equation by OLS, as shown in column (2). The estimated export tariff

coefficient is again negative and statistically significant, but now the import tariff is positive and statistically significant, which contradicts Hypothesis 2 but supports Hypothesis 6. The marginal effects are calculated at the average value of workers characteristics ($\widehat{informal}^{*}_{ijt}$ = -1.0873). The results indicate that a percentage point decrease in the export tariff increases the formal wage by 0.32%, whereas a percentage point decrease in the import tariff decreases the formal wage by 0.05%. In particular, the coefficients decrease in absolute value and do not change signs as $\widehat{informal}^{*}_{ijt}$ approaches zero. The null hypothesis of both effects having the same magnitude for the average worker is rejected at the 1% level.

The 2SLS results for the average informal wage (see column (3)) indicate that neither the import nor the export tariffs are statistically significant, and that the null hypothesis that both tariff coefficients are equal to zero cannot be rejected at the 5 % level. The null hypothesis that both effects have the same magnitude for the average worker cannot be rejected at the 10% level. In the first stage regression, the excluded instrument (Colombian tariff) is statistically significant at the 1% level and the null hypothesis of exogeneity of the import tariff is not rejected at the 5% level. The OLS estimates are presented in column (4), where the export tariff coefficient is not statistically significant but the import tariff is positive and statistically significant at the 10% level. The null hypothesis that both coefficients are equal to zero is not rejected at the 5% level. In all Table 5 estimates, the inverse Mills ratio is statistically significant, which highlights the importance of controlling for self-selection into informal jobs when assessing the effect of tariffs on wages.

In the second identification case, the inverse Mills ratio is now calculated using the predicted values from the IVProbit specification reported in column (6) of Table 4, which does

not include the $otherformal_{ijt}$ variable. So, the identification now comes through the IVProbit's non-linearity. I re-estimate the wage equations (3) and (4), and present the results in Table 6.

Column (1) presents the 2SLS estimates of the formal wage equation, where the export tariff coefficient is negative, the import tariff coefficient is positive, and both are statistically significant. These results contradict Hypothesis 2 but confirm Hypotheses 4 and 6. The first stage *F*-statistic is 109,815, and the excluded instrument is statistically significant. But the null hypothesis of exogeneity of the import tariff is not rejected at the 5% level. Column (2) reports the formal wage equation estimated by OLS. Here the estimated coefficient for the export tariff is again negative and statistically significant. The import tariff is positive but is now statistically significant only at the 10% level. The marginal effects calculated for the average worker indicate that a percentage point decrease in the export tariff leads to a 0.32% reduction in average formal wages. For a percentage point decrease in import tariffs, the effect is a 0.045% increase in average formal wages. The null hypothesis of equal magnitude of the tariff effects for the average worker is rejected at the 1% level.

The 2SLS estimates for the informal average wage, shown in column (3), indicate that the import tariff is negative and not statistically significant, whereas the export tariff is positive and statistically significant at the 1% level. The null hypothesis of exogeneity of the import tariff is not rejected at the 5% level. Column (4) presents the OLS estimates, which are very similar to the 2SLS results, except that now the negative import tariff coefficient is statistically significant at the 10% level. The marginal effects calculated for the average worker indicate that a percentage point decrease in the export tariff causes a 0.34% reduction in average informal wages and that a percentage point reduction in the import tariff increases average informal

wages by 0.06%.

5.3 Robustness checks

Several robustness checks were undertaken to investigate how sensitive the previous results are to outliers, the construction of the export tariff variable, the way in which worker characteristics enter the econometric specifications, the omission of the export tariff, and any pre-existing trends in the data.

The first robustness exercise checks whether the results are driven by outliers. To do this, the tariff variables are replaced by log(*1+tariff),* because this nonlinear and monotonic transformation reduces the influence of large values in the estimates. The new results are very similar to the previous estimates and are thus omitted.

The second robustness check consists of excluding Argentinean data from the export tariff construction. The reason for conducting this test is that Argentina's import tariff applied to Brazilian goods may not be exogenous because the Mercosur Customs Unions internal tariffs were negotiated among its members. Thus, to address this concern, I recalculated the export tariff variable without Argentina's tariffs, and then re-estimated the specifications in Tables 3, 4, 5, and 6. The resulting estimates were similar and thus omitted.

A third robustness check entails replacing the variables *age* and *education* with a set of dummies for age ranges and education achievements in order to address the concern that non-linearity in the returns to education and experience may affect the tariffs' estimated coefficients. The specifications in Tables 4, 5, and 6 are re-estimated and the results are similar. Therefore they are omitted.

Because the role of exports is usually ignored in the literature (see, for example, Goldberg and Pavcnik, 2003), I conduct a fourth robustness exercise in which I re-estimate the specifications in Table 4 columns (1)-(4) without the export tariff variable. The results are presented in Table 7. The import tariff estimated coefficient is positive but not statistically significant in all specifications except for the 2SLS specification, column (3), which exhibited a negative coefficient. The instrument relevance test statistics are slightly better than those in Table 4. The null hypothesis of exogeneity of the import tariff is not rejected for the 2SLS and the IVProbit specifications. These results of no estimated import tariff effect when export tariff is omitted are consistent with the findings of Goldberg and Pavcnik (2003) for Brazil and Alemán-Castilla (2006) for Mexico, and thus can explain why the results in Table 4 differ from the results in Goldberg and Pavcnik (2003).

Next, in order to investigate the consequences of omitting the export tariff variable in the wage equations (3) and (4), I calculate the inverse Mills ratio, using the IVProbit estimates in Table 7 column (4), and then estimate the wage equations. The results are presented in Table 8. Column (1) presents the 2SLS estimate of the formal wage equation. The import tariff coefficient is negative and statistically significant at 5%, which is the opposite of the results in Table 5. In the first stage, the Colombian tariff is statistically significant, and the *F*-statistic is 113,708. The null hypothesis of exogeneity of the import tariff is rejected at the 1% level in the Hausman test. In the OLS estimates, column (2), the estimated coefficient for import tariff is also negative and statistically significant.

For the informal average wage, columns (3) and (4), both the 2SLS and the OLS estimates exhibit positive and statistically significant coefficients for the import tariff. The null

hypothesis of exogeneity of the import tariff is not rejected (*p*-value of 0.957) in the Hausman test. The inverse Mills ratio is statistically significant in all Table 8 specifications. The omission of export tariffs in the wage equations leads to a change in sign in the import tariff coefficients.

Lastly, I check for pre-existing trends that may be driving the results by conducting a placebo-type test, which consists of replacing the 1989-2001 worker-level data with the 1981-1993 worker-level data while still using the 1989-2001 tariff data. Then I re-estimate the specifications from Table 4 columns (1)-(4). The results are presented in Table 9. If the results in Table 4 are driven by pre-existing trends in the data, then the tariff coefficients in Table 9 will be statistically significant. The results do not support the hypothesis of pre-existing trends, since the only tariff coefficient that is statistically significant is in the Probit specification, column (2), and it is the export tariff, which is significant at the 5% level. But, for all the specifications in Table 9, the null hypothesis that both import and export tariff coefficients are zero cannot be rejected at the 5% level.

5.4 Summary of Results

The results presented thus far support the theoretical predictions from Goldberg and Pavcnik (2003) and Paz (2012) concerning the effect of trade policy changes on the industry-level share of informal workers (Hypotheses 1 and 3 respectively). But the results did not support Hypothesis 5 from Paz (2012).

The empirical findings mildly suggest that a decrease in export tariff decreases the average informal wage and the effect of export tariffs are larger in magnitude than import tariff effect on the industry-level average informal wage. Goldberg and Pavcnik (2003) and Paz (2012)

present conflicting predictions concerning the effect of a reduction in the domestic import tariff on the industry-level average formal wage (Hypotheses 2 and 6, respectively). The empirical estimates here support the Paz (2012) prediction. The results here also support the other prediction by Paz (2012) regarding the sign of the effect of export tariffs (Hypothesis 4). Finally, there is evidence that the magnitude of export tariff effect is larger than the import tariff effect on the average formal wage.

6. Conclusions

Recent trade liberalization episodes in developing countries were accompanied by an increase in the share of informal jobs, which are commonly seen as low-wage, low-quality jobs, and also cause payroll tax evasion. This paper has investigated the extent to which trade policy changes affect not only the share of informal jobs but also the average formal and informal wages. To shed some light on this important issue, this paper has assessed the testable predictions from three theoretical models presented in Goldberg and Pavcnik (2003), Alemán-Castilla (2006), and Paz (2012).

Using data from the Brazilian trade liberalization episode (1989-2001), I find strong empirical evidence that a decrease in export tariffs decreases the informality share, but only mild evidence that a decrease in import tariffs results in an increase in the informality share. Moreover, the magnitude of the export tariff effect is statistically significantly larger than the import tariff effect, providing evidence that multilateral trade liberalization can indeed reduce informality. In addition, when the export tariff variable is omitted, not only is an important factor overlooked, but also the estimates of the import tariff effect on the informality share

become statistically insignificant, a result commonly found in the literature. Another important finding of the analysis is that the endogeneity of the import tariff is corroborated by the Hausman test results, which may also help to explain the lack of results in the empirical analysis conducted by Goldberg and Pavcnik (2003).

Regarding the average wage predictions, I find that not controlling for self-selection into informal jobs when estimating the effect of tariffs on wages can seriously bias the estimates. I find strong evidence that a decrease in export tariffs increases the average formal wage, while a decrease in import tariffs has the opposite effect. The magnitude of the export tariff effect is larger than the import tariff effect. Furthermore, the magnitudes of these effects are inversely related to the likelihood of having an informal job, which means that although multilateral trade liberalization may reduce informality and increase the average wage, the benefits from trade liberalization are not the same for all workers. For the average informal wage, the results are not robust to different identification strategies of the selection effect. Statistically significant coefficients are found only under non-linear identification, in which a reduction in the export tariff is found to decrease the average informal wage, while a reduction in the import tariff does not affect it.

Acknowledgements

I would like to thank Nuno Limão for his guidance, and Michael Kremer, Marc Melitz, Devashish Mitra and Derek Laing for suggestions that led to a significant improvement in this paper. Thanks are also due to seminar participants at the NEUDC conference and the Midwest

International Trade meeting. Any remaining errors are mine.

References

AEPS (2005). Anuário Estatístico da Previdencia Social, Suplemento Histórico 2005. Ministério da Previdência, Brasil.

Alemán-Castilla, B. (2006). "The Effect of Trade Liberalization on Informality and Wages: Evidence from Mexico". CEP Discussion Paper No. 763.

Amemiya, T. (1985). Advanced Econometrics. Cambridge, MA: Harvard University Press.

Boisvert, H. and R. Bernard and A. Queiróz (2001). Benchmarking da função finanças: uma análise comparativa do custeio da folha de pagamento. Mimeo.

Cameron, A. and P. Trivedi (2005). Microeconometrics: Methods and Applications. New York, NY. Cambridge University Press.

Davies, R. and L. Paz (2011). Tariffs versus VAT in the presence of heterogeneous firms and an informal sector. International Tax and Public Finance, 18(5), p. 533-554.

Davis, D. and J. Harrigan (2011). Good Jobs, Bad Jobs, and Trade Liberalization. Journal of International Economics, 84, p. 26-36.

Demidova, S. and A. Rodriguez-Clare (2011). The simple analytics of the Melitz Model in a small open economy. NBER Working paper 17521.

Evans, C. (2003). Studying the studies: an overview of recent research into taxation operating costs. Journal of Tax Research, 1, p. 64-92.

Feenstra, R., J. Romalis, and P. Schott (2002). U.S. Imports, Exports and Tariff Data, 1989-2001,

NBER Working Paper 9387.

Freund, C., E. Ornelas, and A. Estevadeordal (2008). Does Regionalism Affect Trade Liberalization towards Non-Members? Quarterly Journal of Economics, 123(4), p. 1531-1575.

Goldberg, P. and N. Pavcnik (2003). The Response of the Informal Sector to Trade Liberalization, Journal of Development Economics, 72, p. 463-496.

Goldberg, P. and N. Pavcnik (2005). Trade, Wages, and the Political Economy of Trade Protection: Evidence from the Colombian Trade Reforms. Journal of International Economics, 66(1), p. 75-105.

Hanson, G. and A. Harrison (1999). Who gains from trade reform? Some remaining puzzles. Journal of Development Economics, 59, p. 125-154.

IBGE (2011). Sistema IBGE de Recuperação Automática – SIDRA. http://www.sidra.ibge.gov.br/.

ILO (2001). Decent work and informal economy. Report VI. International Labour Conference, 90th Session. Geneva: International Labour Office.

Karacaovali, B., (2011). Productivity Matters for Trade Policy: Theory and Evidence. International Economic Review, 52, p. 33-62.

Kreickemeier, U. and Ehher, H. (2009). Firm Heterogeneity and the Labor Market Effects of Trade Liberalization. International Economic Review, 50, p. 187-216.

Kume, H., G. Piani, and C.F. Souza (2003). Instrumentos de Politica Comercial no Periodo 1987-1998 in Corseuil, C. H. and H. Kume (eds.) "A abertura comercial brasileira nos anos 1990: impactos sobre emprego e salário". Rio de Janeiro: Ipea.

Liftschitz, E. (1991). Cálculo de los niveles de protección efectiva legal de los sectores

productors de bienes 1990-1991. Documento de trabajo del proyecto: Competitividad e Integración Internacional de la economia Argentina, SIC-PNUD ARG.86-R01, abril.

Maddala, G. S. (1983). Limited-Dependent and Qualitative Variables in Economics. Cambridge, UK: Cambridge University Press.

Melitz, M. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. Econometrica 71 (6), p. 1695-1725.

Minnesota Population Center (2007). Integrated Public Use Microdata Series - International: Version 3.0. Minneapolis: University of Minnesota.

Munk, K. (2008). Tax-tariff reform with costs of tax administration. International Tax and Public Finance, 15, p. 647-667.

Neri, M. (2002). Decent Work and the Informal Sector in Brazil. Ensaios Economicos EPGE n. 461.

Nicita, A. and M. Olarreaga (2006). Trade, Production and Protection 1976-2004. Mimeo.

Pavcnik, N. and A. Blom and P. Goldberg and N. Schady (2004). Trade Liberalization and Industry Wage Structure: Evidence from Brazil. World Bank Economic Review, 18(3), p. 319-344.

Paz, L. (2012). The effect of Trade Liberalization on payroll tax evasion and labor informality. Syracuse University, Mimeo.

Perry, G., W. Maloney, O. Arias, P. Fajnzylber, A. Mason, and J. Saavedra-Chanduvi (2007). Informality: Exit and Exclusion. World Bank Latin American and Caribbean Studies. Washington, D.C.: The World Bank.

Portes, A., M. Castells and L. Benton (1989). World Underneath: The Origins, Dynamics and Effects of the Informal Economy. The Informal Economy: Studies in Advanced and Less

Developed Countries. Eds. A. Portes, M. Castells, and L. Brenton. Baltimore & London: The John Hopkins University Press.

Pratap, S. and E. Quintin (2006). Are labor markets segmented in developing countries? A semiparametric approach. European Economic Review, 50, p.1817-1841.

Roberts, B. (1989). Employment Structure, Life Cycle, and Life Changes: Formal and Informal Sectors in Guadalajara" in *The Informal Economy: Studies in Advanced and Less Developed Countries,* ed. by A. Portes, M. Castells, and L. A. Breton. Baltimore & London: The John Hopkins University Press.

Saint-Paul, G. (1996). Dual labor market: a macroeconomic perspective. MIT Press.

Schmidt, C. and K. Zimmermann (1991). Work Characteristics, Firm Size and Wages. Review of Economics and Statistics, 73(4), p. 705-710.

Schneider, F. and D. Enste (2000). Shadow Economies: Size, Causes, and Consequences. Journal of Economic Literature, 38, p. 77-114.

Stock, J. and M. Watson (2008). Heteroskedasticity-Robust Standard Errors for Fixed Effect Panel Data Regression. Econometrica, 76 (1), p. 155-174.

Table 1 – Descriptive statistics of worker characteristics in Brazil by industry.

	Share of informal workers				Average informal worker characteristics			Average formal worker characteristics		
Industry	Average	Std. dev.	Min	Max	Education	Age	Share of males	Education	Age	Share of males
Nonmetallic Mineral Products	0.288	0.027	0.242	0.344	4.10	27.03	0.92	5.97	32.45	0.88
Metals Production and Processing	0.122	0.050	0.063	0.205	6.12	28.49	0.92	7.25	33.05	0.89
Machinery, Equipment and Commercial Installation	0.078	0.040	0.034	0.153	6.76	31.11	0.79	7.81	33.39	0.86
Electrical and Electronic Equipment	0.070	0.037	0.027	0.124	7.96	26.89	0.75	8.53	31.03	0.71
Automobile, Truck and Bus	0.056	0.023	0.032	0.104	6.92	31.16	0.83	7.85	33.51	0.87
Wood Sawing and Wood Products	0.325	0.063	0.239	0.424	5.00	27.94	0.94	5.60	31.64	0.87
Pulp and Paper Production, Paper Products, Printing and Publishing	0.134	0.048	0.062	0.208	7.80	28.54	0.70	8.16	31.66	0.76
Rubber Products	0.071	0.037	0.012	0.153	6.37	30.01	0.76	7.11	32.56	0.85
Chemicals and Fertilizer (excludes Petrochemicals)	0.072	0.016	0.048	0.110	5.79	30.26	0.71	7.66	33.70	0.81
Pharmaceutical, Perfumes, Detergents and Candles	0.103	0.028	0.063	0.181	8.23	30.64	0.56	9.02	32.13	0.62
Plastics Products	0.094	0.028	0.047	0.148	6.39	29.05	0.69	7.05	31.30	0.66
Textiles	0.104	0.030	0.055	0.187	5.71	29.71	0.47	6.66	31.34	0.59
Apparel	0.260	0.040	0.186	0.335	6.19	30.72	0.19	6.68	31.11	0.22
Footwear and leather products	0.181	0.030	0.115	0.233	5.62	29.45	0.47	6.16	28.87	0.57
Coffee, Food, Beverage, Animal Feed and Tobacco	0.181	0.029	0.140	0.222	5.17	27.80	0.70	6.51	32.00	0.74

Source: Brazilian PNAD data.

Note: An informal worker is one whose employer does not comply with payroll taxes.

Table 2 – Descriptive statistics of industry-level tariffs in Brazil, Brazil Trade Partners, and Colombia 1989-2001.

	Brazilian Import Tariff				Brazilian Trade Partners Import Tariff				Colombian Import Tariff			
Industry	Average	Std dev	Min	Max	Average	Std dev	Min	Max	Average	Std dev	Min	Max
Nonmetallic Mineral Products	0.194	0.145	0.092	0.638	0.114	0.047	0.057	0.173	0.257	0.123	0.131	0.485
Metals Production and Processing	0.150	0.077	0.080	0.360	0.072	0.032	0.036	0.117	0.193	0.099	0.098	0.391
Machinery, Equipment and Commercial Installation	0.229	0.123	0.116	0.490	0.071	0.032	0.038	0.120	0.142	0.070	0.065	0.306
Electrical and Electronic Equipment	0.259	0.142	0.133	0.607	0.091	0.040	0.045	0.150	0.247	0.148	0.114	0.569
Automobile, Truck and Bus	0.382	0.181	0.191	0.848	0.107	0.049	0.055	0.217	0.229	0.124	0.113	0.491
Wood Sawing and Wood Products	0.172	0.105	0.088	0.500	0.118	0.056	0.051	0.188	0.340	0.184	0.167	0.732
Pulp and Paper Production, Paper Products, Printing and Publishing	0.174	0.125	0.083	0.595	0.072	0.032	0.034	0.115	0.263	0.129	0.128	0.468
Rubber Products	0.255	0.198	0.121	0.820	0.092	0.038	0.048	0.144	0.234	0.098	0.136	0.430
Chemicals and Fertilizer (excludes Petrochemicals)	0.169	0.099	0.070	0.451	0.076	0.027	0.042	0.118	0.138	0.070	0.066	0.272
Pharmaceutical, Perfumes, Detergents and Candles	0.186	0.179	0.046	0.723	0.098	0.049	0.045	0.172	0.218	0.110	0.106	0.397
Plastics Products	0.249	0.144	0.151	0.571	0.129	0.051	0.073	0.204	0.378	0.210	0.179	0.800
Textiles	0.275	0.201	0.132	0.874	0.161	0.061	0.084	0.249	0.418	0.264	0.182	1.023
Apparel	0.362	0.255	0.194	1.027	0.212	0.076	0.122	0.317	0.479	0.316	0.198	1.199
Footwear and leather products	0.232	0.154	0.132	0.741	0.188	0.063	0.109	0.259	0.358	0.206	0.157	0.757
Coffee, Food, Beverage, Animal Feed and Tobacco	0.213	0.131	0.123	0.658	0.267	0.071	0.169	0.341	0.286	0.126	0.137	0.455

Sources: Kume (2003), and others. Note: An import tariff of 0.20 represents a 20% tariff.

Table 3 – Estimates of the effects of trade policy changes on the industry-level share of informal workers.

	Dependent Variable: industry-level share of informal workers					
Independent Variables \ Technique	(1) OLS	(2) Tobit	(3) OLS	(4) Tobit	(5) 2SLS	(6) IVTobit
Import tariff	-0.338***	-0.338***	0.026	0.026	-0.177	-0.177
	(0.104)	(0.103)	(0.061)	(0.056)	(0.167)	(0.173)
Export tariff	0.384**	0.384***	0.095	0.095	0.181	0.181
	(0.138)	(0.137)	(0.123)	(0.113)	(0.143)	(0.148)
Year and Industry effects included?	No	No	Yes	Yes	Yes	Yes
Observations	180	180	180	180	180	180
Under identification Kleibergen-Paap rk LM statistic					1.303	
					[0.253]	
Weak id. Kleibergen-Paap rk Wald F statistic					1.899	
Stock-Yogo 10% max IV relative bias critical values					16.38	
Exogeneity test					2.491	1.323
					[0.114]	[0.250]
Test of both Import tariff=0 and Export tariff=0	10.22***	10.34***	0.33	0.39	0.195	1.82
	[0.002]	[0.001]	[0.722]	[0.676]	[0.376]	[0.402]
Test of Export tariff - |Import tariff| =0	0.06	0.06	0.65	0.77	0.000	0.00
	[0.806]	[0.802]	[0.433]	[0.383]	[0.979]	[0.980]
1st stage *F* statistic					1770	1770
Instrument (estimated coefficients in the 1st stage)						
Export tariff					0.115	0.115
					(0.269)	(0.269)
Colombian tariff					0.146	0.146
					(0.106)	(0.106)

Standard errors clustered on the industry level reported in parentheses, *** p<0.01, ** p<0.05, * p<0.1; p-values reported in brackets.

A constant was included in every stage of all estimated models.

Table 4 – Estimates of the effects of trade policy changes on the probability of a worker having an informal job.

	Dependent Variable: informal job indicator					
	(1)	(2)	(3)	(4)	(5)	(6)
Independent Variables \ Technique	OLS	Probit	2SLS	IVProbit	2SLS	IVProbit
Import tariff	0.013	-0.012	-0.092*	-0.166	-0.103*	-0.189
	(0.033)	(0.127)	(0.051)	(0.247)	(0.053)	(0.252)
Export tariff	0.117	1.517***	0.171**	1.594***	0.166*	1.593***
	(0.076)	(0.403)	(0.082)	(0.429)	(0.085)	(0.439)
Another household member has a formal job	-0.069***	-0.287***	-0.069***	-0.287***		
	(0.004)	(0.015)	(0.004)	(0.015)		
Observations	775331	775331	775331	775331	775331	775331
Under identification test (Kleibergen-Paap rk LM statistic)			3.13*		3.13*	
			[0.076]		[0.077]	
Weak identification test Kleibergen-Paap rk Wald F statistic			16.14		16.14	
Stock-Yogo 10% max IV relative bias critical values			16.38		16.38	
Endogeneity Test			4.244**		4.788**	
			[0.039]		[0.0287]	
Wald Exogeneity test				0.385		0.51
				[0.535]		[0.473]
Test of both Import tariff=0 and Export tariff=0	1.27	14.45***	6.23**	14.16***	6.06**	13.45***
	[0.284]	[0.001]	[0.044]	[0.008]	[0.048]	[0.001]
Test of Export tariff - |Import tariff| =0	1.65	13.96***	0.87	11.72***	0.51	10.91***
	[0.201]	[0.000]	[0.350]	[0.000]	[0.475]	[0.001]
1st stage *F* statistic			33952	33952	34895	34895
Estimated coefficients in the 1st stage						
Colombian tariff (excluded instrument)			0.378***	0.378***	0.378***	0.378***
			(0.003)	(0.003)	(0.003)	(0.003)
Export tariff (included instrument)			-0.044***	-0.044***	-0.044***	-0.044***
			(0.006)	(0.006)	(0.006)	(0.006)

Standard errors on 2nd stage are clustered on industry by year reported in parentheses. Robust standard errors displayed for 1st stage regressions. *** p<0.01, ** p<0.05, * p<0.1; p-values reported in brackets.

Year and industry effects, worker characteristics, and a constant were included in every stage of all estimated models. Sample weights used.

Table 5 – Estimates of the effects of trade policy changes on the average formal and informal wages.

	Formal Wage		Informal wage	
	(1)	(2)	(3)	(4)
Independent Variables \ Technique	2SLS	OLS	2SLS	OLS
Import tariff	0.026	0.086***	0.126	0.094*
	(0.051)	(0.020)	(0.105)	(0.051)
Export tariff	-0.634***	-0.663***	0.055	0.076
	(0.056)	(0.044)	(0.164)	(0.126)
Inverse mills ratio	0.618***	0.619***	-0.199***	-0.200***
	(0.012)	(0.012)	(0.019)	(0.018)
Observations	640183	640183	135148	135148
F statistic		974,090		133,195
Endogeneity Test	1.635		0.122	
	[0.201]		[0.727]	
Test of both Import tariff=0 and Export tariff=0	206.68***	223.85***	4.96*	6.72**
	[0.000]	[0.000]	[0.084]	[0.035]
Test of Export tariff - |Import tariff| =0	45.85***	198.89***	0.08	0.01
	[0.000]	[0.000]	[0.779]	[0.907]
1st stage *F* statistic	109,815		26,322	
Instruments (estimated coefficient in 1st stage)				
Colombian tariff	0.372***		0.417***	
	(0.001)		(0.003)	
Export tariff	-0.050***		0.037***	
	(0.056)		(0.007)	
Inverse Mills ratio	0.004**		-0.015***	
	(0.001)		(0.002)	

Standard errors are bootstrapped and reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1; p-values reported in brackets.
Year and industry effects, worker characteristics, and a constant were included in every equation. Other household member has a formal job indicator is included only in the selection equation. Sample weights used.

Table 6 – Estimates of the effects of trade policy changes on the average formal and informal wages using non-linear identification

	Formal Wage		Informal wage	
	(1)	(2)	(3)	(4)
Independent Variables \ Technique	2SLS	OLS	2SLS	OLS
Import tariff	0.125**	0.114***	-0.035	-0.088*
	(0.051)	(0.020)	(0.108)	(0.052)
Export tariff	-0.844***	-0.838***	1.357***	1.410***
	(0.056)	(0.044)	(0.204)	(0.149)
Inverse Mills ratio	1.328***	1.327***	-1.224***	-1.239***
	(0.017)	(0.017)	(0.068)	(0.062)
Observations	640183	640183	135148	135148
F statistic		974,090		133,196
Endogeneity Test	0.054		0.314	
	[0.815]		[0.575]	
Test of both Import tariff=0 and Export tariff=0	315.80***	356.59***	107.94***	105.19***
	[0.000]	[0.000]	[0.000]	[0.000]
Test of Export tariff - |Import tariff| =0	94.54***	104.90***	99.29***	320.71***
	[0.000]	[0.000]	[0.000]	[0.000]
1st stage *F* statistic	109,815		27,362	
Instruments (estimated coefficient in 1st stage)				
Colombian tariff	0.372***		0.405***	
	(0.001)		(0.003)	
Export tariff	-0.049***		0.272***	
	(0.003)		(0.008)	
Inverse Mills ratio	0.000		-0.201***	
	(0.001)		(0.003)	

Standard errors are bootstrapped and reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1; p-values reported in brackets.
Both selection and regime equations include year and industry effects, worker characteristics, and a constant. Sample weights used.

Table 7 – Estimates of the effects of trade policy changes on the probability of a worker having an informal job, with export tariff variable excluded.

	Dependent Variable: informal job indicator			
Independent Variables \ Technique	(1)	(2)	(3)	(4)
	OLS	Probit	2SLS	IVProbit
Import tariff	0.024	0.159	-0.034	0.369
	(0.034)	(0.144)	(0.049)	(0.310)
Observations	775331	775331	775331	775331
Under identification test (Kleibergen-Paap rk LM statistic)			3.589*	
			[0.058]	
Weak identification test Kleibergen-Paap rk Wald F statistic			18.42	
Stock-Yogo 10% max IV relative bias critical values			16.38	
Endogeneity Test			1.668	
			[0.197]	
Wald Exogeneity test				0.667
				[0.414]
1st stage *F* statistic			33,862	33,862
Estimated coefficients in the 1st stage				
Colombian tariff (excluded instrument)			0.372***	0.372***
			(0.003)	(0.003)

Standard errors on 2nd stage are clustered on industry by year reported in parentheses. Robust standard errors displayed for 1st stage regressions. *** p<0.01, ** p<0.05, * p<0.1; p-values reported in brackets.

Year and industry effects, worker characteristics, and a constant were included in every stage of all estimated models. Sample weights used.

Table 8 – Estimates of the effects of trade policy changes on the average formal and informal wages, with export tariff variable excluded.

	Formal Wage		Informal wage	
	(1)	(2)	(3)	(4)
Independent Variables \ Technique	2SLS	OLS	2SLS	OLS
Import tariff	-0.198***	-0.043**	0.152**	0.155**
	(0.039)	(0.019)	(0.071)	(0.044)
Inverse Mills ratio	0.643***	0.634***	-0.198***	-0.198***
	(0.012)	(0.011)	(0.019)	(0.019)
Observations	640183	640183	135148	135148
F statistic		1,000,419		136,796
Endogeneity Test	20.711***		0.003	
	[0.000]		[0.957]	
1st stage *F* statistic	113,768		27,294	
Instruments (estimated coefficient in 1st stage)				
Colombian tariff	0.365***		0.416***	
	(0.001)		(0.003)	
Inverse Mills ratio	0.013***		0.029***	
	(0.001)		(0.001)	

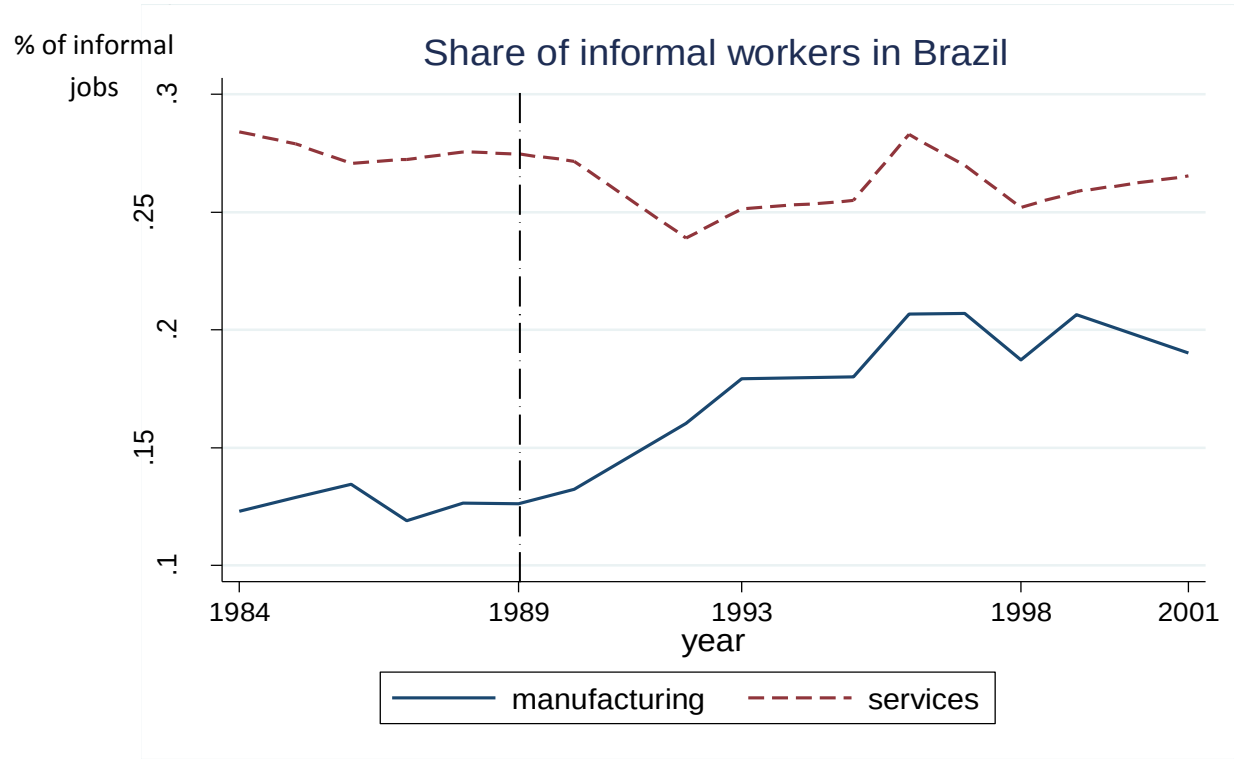
Standard errors are bootstrapped and reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1; p-values reported in brackets.
Year and industry effects, worker characteristics, and a constant were included in every stage of all estimated models. Other household member has a formal job indicator is included only in the selection equation. Sample weights used.

Table 9 – Placebo estimates of the effects of trade policy changes on the probability of a worker having an informal job using 1981-1993 data.

	Dependent Variable: informal job indicator			
	(1)	(2)	(3)	(4)
Independent Variables \ Technique	OLS	Probit	2SLS	IVProbit
Import tariff	0.005	-0.189	0.008	0.447
	(0.025)	(0.142)	(0.069)	(0.478)
Export tariff	-0.025	0.621**	-0.026	0.351
	(0.049)	(0.296)	(0.049)	(0.381)
Observations	520737	520737	520737	520737
Under identification test (Kleibergen-Paap rk LM statistic)			2.95*	
			[0.086]	
Weak identification test Kleibergen-Paap rk Wald F statistic			9.19	
Stock-Yogo 10% max IV relative bias critical values			16.38	
Endogeneity Test			0.001	
			[0.097]	
Wald Exogeneity test				2.296
				[0.130]
Test of both Import tariff=0 and Export tariff=0	0.13	4.78*	0.29	3.99
	[0.879]	[0.091]	[0.865]	[0.136]
1st stage *F* statistic			23,772	23,772
Estimated coefficients in the 1st stage				
Colombian tariff (excluded instrument)			0.302***	0.302***
			(0.003)	(0.003)
Export tariff (included instrument)			-0.012**	-0.012**
			(0.006)	(0.006)

Standard errors on 2nd stage are clustered on industry by year reported in parentheses. Robust standard errors displayed for 1st stage regressions. *** p<0.01, ** p<0.05, * p<0.1; p-values reported in brackets.
Year and industry effects, worker characteristics, $otherformal_{ijt}$, and a constant were included in every stage of all estimated models. Sample weights used.

Figure 1 –Informality share in services and manufacturing in Brazil, 1984-2001



Source: PNAD data.

Note: Dashed vertical line indicates the start of Brazil's trade liberalization