Trade Liberalization and Labor Informality: Inspecting the Mechanisms*

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January 2013

Resumen

This paper provides evidence on the link between trade reforms and labor informality in Argentina and identifies some of the mechanisms via which this relationship operates using a long time series spanning the 1980-2001 period. This long time series of data and an instrumental variables approach provide a strong identification strategy. The main relationship is first formalized through a theoretical model for an import competing industry. Faced with an increase in foreign competition, firms reduce production and the demand for labor in the short-run, and they can also substitute informal for formal workers, increasing tax evasion to absorb part of the negative shock. In the longer run, when labor can move across sectors and wages adjust, a new reallocation of workers between formality and informality occurs reducing the informality rate, and affecting also the informality rate of the non tradable sector through a wealth effect. The empirical findings indicate, first, that trade liberalization impacted positively on labor informality at the industry level, and the magnitud of this effect depends on the size of the firms in each industry. When small firms prevail, the substitution of informal workers for formal workers is a mechanisms at play, but this effect fades away with the size of the firms. Second, evidence from time-series variation of the data reveal that, conditional on the structure of sectoral protection, the informality trend in the manufacturing sector moved jointly to the average tariff, while the opposite occurred in the non-traded sector. This is an important contribution of the study. The effect identified for manufacturing industries in the short-run reverts in the longer-run, and the non-tradable sector is also impacted by a trade liberalization episode through general equilibrium effects.
JEL CODES: F13, F14

Key Words: Trade liberalization; labor informality; short-run mechanisms; long-run mechanisms; Argentina

*This paper is part of my Ph.D. Thesis at Universidad Nacional de La Plata, Argentina. I thank my directors, Guillermo Cruces and Guido Porto, for their guidance and support.

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1. Introduction

While trade liberalization should lead to a reallocation of factors from protected to comparative advantage sectors, the empirical evidence for developing countries often unveils more complex dynamic responses (Menezes-Filho and Muendler, 2011; Wacziarg and Wallack, 2004). In the literature, this is typically explained by limited factor mobility caused by reallocation costs (Artuç et al., 2010; Atolia, 2007; Dix-Carneiro, 2011). In this paper, I focus instead on informality as an additional trade adjustment mechanism. Informality is indeed a relevant margin of adjustment for labor demand and labor supply in developing countries (Levy, 2008; Bérgolo and Cruces, 2013) and it can be affected by trade reforms (Currie and Harrison, 1997; Goldberg and Pavcnik, 2003). I build on this literature to explain how trade reforms affect labor informality and to identify the short- and long-run operating mechanisms. To this end, I develop a model where firms simultaneously utilize both formal and informal workers and I contrast the predictions of this model with a long time series of trade reforms and informality for Argentina.

The starting point of the study is a formalization of the relationship between labor informality and trade policy changes through a model of an import-competing industry where formal and informal workers are perfect substitutes in production.[1] In the short-run, labor is immobile across sectors, wages are fixed, and adjustment takes place via unemployment. In the long-run, labor reallocates and markets clear. In contrast to most of the existing literature, the model avoids the extreme cases of fully formal or informal firms (with either all or none of their workers registered) by incorporating simple insights from the tax evasion literature. For each possible size of a firm in this industry, there is an optimal mix of formal and informal labor that depends on the probability of being detected and on the fines associated with detection. The link between informality and trade operates through several mechanisms.

[1] In the related literature, the common starting point is that trade liberalization exposes local firms to increased foreign competition. These firms need to reduce costs, and this could be done by either not fulfilling labor market regulations, replacing permanent workers with part-time labor, outsourcing some of their activities to firms operating in the informal sector, or laying off workers who subsequently seek employment in the informal sector.

First, faced with an increase in trade exposure, manufacturing firms reduce the size of their labor force, but they also can increase the fraction of informal workers as an adjustment mechanism. Thus, increasing tax evasion could be a strategy to smooth the negative shock. Second, the non-traded sector can also be affected through general equilibrium effects. In the long run, when labor can move across sector and wages adjust, unemployed individuals from manufacturing firms can move to an expanding non-traded sector where they can be hired, either formally or informally. The informality rate in the manufacturing sector falls, while a wealth effect in the non-traded sector may lead to an increase in informality in that sector.[2]

The empirical work studies the link between trade reforms and labor informality in Argentina using a long time series spanning the 1980-2001 period. This was a period of a substantial increase in overall labor informality, and of important trade policy changes, with substantial time-series and inter-industry variation in tariffs for the manufacturing sector. The main findings indicate, first, that trade liberalization impacted positively on labor informality at the industry level, and that the magnitude of this effect depends on the size of the firms in each industry. When small firms prevail, there is evidence of substitution of informal workers for formal workers, but this effect fades away as average firm size within industry increases. Second, evidence from the time-series variation of the data reveals that, conditional on the structure of sectoral protection, the informality trend in the manufacturing sector has a positive correlation with the average tariff, while the opposite occurs in the non-traded sector.

The contribution to this literature is twofold. The model innovates in allowing both extensive (register workers or not) and intensive (which fraction of workers should be registered) margins for labor informality at the firm level. The model shows that studies of informality can benefit from the substantial body of work in

[2]There are other potential mechanisms in the literature. Goldberg and Pavcnik (2003) and Fiess and Fugazza (2008) argue that new firms entering into the market in response to the opportunities created by trade reforms are likely to start being small and informal. An opposing argument is that trade liberalization reduces the incidence of labor informality because some firms will find it more profitable to enter the formal sector rather than to remain informal, while the least productive informal firms will be forced to exit the industry (Alemán-Castilla, 2006; Fiess and Fugazza, 2008).

the tax evasion literature. This modeling strategy lets to accommodate the stylized facts on the negative correlation between labor informality and firm size, and allows to rationalize the heterogeneous impact of trade reforms that is found in the data. Moreover, the analysis highlights the importance of employment registration and tax evasion as an additional channel of labor demand adjustment.

The second contribution is empirical. Besides finding that most of the effects take place for small and medium firms, the distinction between short and long run effects sheds new light on previous empirical findings. The increase in informality following trade liberalization that I identify for manufacturing industries in the short-run is reverted in the longer-run. I also find substantial effects in the non-tradable sector, which I can rationalize as a general equilibrium effect within the theoretical model. These results can help explain the conflicting available evidence. Goldberg and Pavcnik (2003), Bosch et al. (2012), and Paz (2012) find little evidence of a significant impact of trade policy changes on informality in Brazil and Colombia. By contrast, Acosta y Montes-Rojas (2010) predict an increase in labor informality in Argentina, while Alemán-Castilla (2006) predicts a decrease in informality in Mexico. I argue these heterogeneous results could be confounded by the different mechanisms uncovered in this study.

The remainder of the paper is organized as follows. In Section 2 I focus on conceptual aspects that are relevant for this study. On the one hand, a discussion about different trade liberalization measures and their appropriateness for this study is presented. On the other hand, alternative labor informality definitions are analyzed and their possibilities of implementation are discussed. In Section 3 I introduce the data used along the study and describe the relationship between trade reforms and labor informality in Argentina through simple correlations and in order to identify some of the mechanisms via which this relationship operates. In Section 4 I introduce a theoretical model that is consistent with the proposed mechanisms. In Section 5 I present the empirical strategy and the regression analysis, while Section 6 concludes.

2. Data and relevant definitions

2.1. Trade liberalization

The measurement of trade policy is not an easy task. It has proven hard to empirically capture trade liberalization in a suitable manner by means of a single indicator or measure. The use of imports, exports, or both as proxies of a country's openness has the shortcoming that both imports and exports are determined simultaneously with the variable of interest, e.g. wages, prices, etc. (Goldberg and Pavcnik, 2004). Even though non-tariff barriers, such as import licenses and quotas, are an alternative to the use of trade flows, they are more difficult to measure accurately. This type of measure is usually captured by a coverage ratio at some level of industry aggregation. The coverage ratio measures the participation of imports in an industry aggregate that is subject to non-tariff barriers. However, this measure does not capture the true level of protection. For instance, an industry may have the same coverage ratio in two different years, but due to changes in demand the non-tariff barrier could be more or less restrictive in one of the years (Goldberg and Pavcnik, 2007). As a result, the comparison among industries or time periods is difficult in this case.

On the contrary, tariff barriers are relatively easier to measure and comparable over time. They are usually imposed as ad-valorem taxes on imported goods representing a price-based form of trade protection. As such, they are transparent, relatively easier to measure, comparable across industries and over time, and their magnitude reflects the true restrictiveness of the trade barrier (Goldberg and Pavcnik, 2007). Even though countries use non-tariff barriers, its coverage ratio is usually highly correlated with tariffs. Galiani and Porto (2010) found that the correlation between tariff and non-tariff barriers in Argentina was positive but very small (around 0.03). This result suggests that, on the one hand, the omission of non-tariff barriers in an econometric model would be less problematic in terms of estimation consistency. On the other hand, a positive correlation assures that a reduction in tariffs will not be associated to a simultaneous increase in non-tariff barriers, un-

doing the effect of the first measure. Hence, despite the possible overstatements of the tariff effect in an econometric model, its coefficient will capture the combined effect of trade policy in each industry.

Import tariff data used in this study comes from Galiani and Porto (2010). They obtained data on ad-valorem import tariffs from the Guía Práctica del Exportador e Importador, a publication that provides current tariffs at the most disaggregated level of the Nomenclatura Arancelaria y Derechos de Importación (NADI) or the Harmonized System according to the period considered.[3]

Provided that different trade policy decisions and institutional arrangements were made during the analyzed period (like the adoption of Mercosur in the nineties), the authors defined a tariff measure up to 1991 that adds a statistics rate[4] to the tariffs in place in the middle of the year, and from 1992 the tariff measure comprises an extra-Mercosur tariff, the statistics rate, a minimum specific import tax,[5] and a convergence factor in 2001.[6] In order to match the tariff measure to the industry aggregation level of the Argentinean Encuesta Permanente de Hogares (EPH) that is based on the ISIC classification (International Standard Industrial Classification), the authors aggregated tariff data until the measure obtained was compatible with the 3 digits ISIC level. To this end, an iterative process was established where the median tariff of each sub-category was calculated. The final result was therefore the median of the medians of each subcategory. The Argentinean Instituto Nacional de Estadísticas y Censos (INDEC) used the ISIC Revision 2 until 1991 and moved to Revision 3 afterwards. As a result, two tariffs series were obtained. The authors finally generated a unified tariff series for the whole period using an intermediate classification elaborated by the World Bank and adjusted them to take into account

[3]The NADI was the classification used until 1992 when it was replaced by the Nomenclatura del Comercio Exterior (NCE). In 1993 the Sistema Armonizado de Designación y Codificación de Mercancías was adopted. Then, Mercosur countries established a common classification named Nomenclatura Común del Mercosur (NCM).

[4]The statistics rate is an additional ad-valorem levy which the government adds to certain goods. Its purpose is to finance the collection of statistical data.

[5]The minimum specific import taxes were originated as anti-dumping measures for certain import categories.

[6]The convergence factor was established by law in June 2001. It was calculated as $cf = 1 - \frac{1+e}{2}$ where e is the price of 1 euro.

the progressive tariffs adjustment applied to imports originating in Mercosur countries.[7] This import tariffs series from Galiani and Porto's study was then combined with the EPH data for the 1980-2001 period. The final database contains information on trade protection and microdata for 24 manufacturing industries.

2.2. Labor informality

The term labor informality is ambiguous from a theoretical perspective and difficult to be empirically implemented. The literature distinguishes between two alternative definitions of this labor market phenomenon. On the one hand, the "productive" definition focuses on the type of firm and employment while, on the other hand, the "social protection" definition is concerned with the compliance with labor market regulations, mainly labor protection (Gasparini and Tornarolli, 2009).

According to the International Labor Organization (1991), the "productive" definition stands for those firms with low capital endowment, using primitive technologies and unskilled labor, and then with low productivity. Several measurement problems cause this informality perspective to be difficult to implement empirically: the level of capital is not usually reported in surveys, the notion of primate technology is difficult to define and the productivity level is not directly observable. In practice, this notion of informality is implemented using information about the type of employment, the type of firm and workers' skills.

Alternatively, the "social protection" definition classifies informal firms as those not complying with labor markets norms as contracts, labor taxes and labor regulations. Then their workers have no rights to labor protection or social benefits linked to employment. The empirical limitation in this case has to do with the difficulties associated with the comparison of this concept across countries. Firstly, labor protection and social security include a large number of dimensions that differ across countries, depending on the design and extent of their systems.[8] Secondly, household

[7] The Commercial Liberalization Program included in the Asunción Pact (1991) established a progressive, automatic and linear reduction in the tariffs assigned to imports from the Mercosur countries.

[8] Labor protection dimensions include: contracts, severance payments, advanced notice, right to be unionized, vacations, workplace safety, and many more. Social security benefits include: pension,

surveys widely differ on the coverage of labor protection and social security issues. For instance, some surveys ask about social benefits and others do not. And even when surveys include questions about certain items, they could be too different to make a comparison across countries possible. The right to receive a pension when retired is the social security benefit more frequently asked in Latin-American household surveys. As such, an informal worker is empirically defined as the person that does not have the right to receive a pension linked to his employment when retired.

As long as several measurement problems exist to empirically implement the "productive" definition of labor informality, and provided that only the Argentinean case will be analyzed, this study will use the "social protection" perspective of informality. A worker will be classified as informal when he does not possess the right to receive a pension when retired.

Beyond the theoretical definition and the empirical implementation of the labor informality concept, there exists a controversial aspect of this phenomenon due to its association to lower wages and inferior labor conditions. Several studies have found that workers with the same observable characteristics earn lower wages when they are informal employees.[9] However, this negative relationship cannot be interpreted in causal terms and welfare comparisons drawn from these results may lead to misleading conclusions. An informal worker differs from a formal one in several dimensions and not just on the wage received. In a market with no distortions, workers would equate the utility obtained in each type of job, that is to say, the whole set of benefits and not just wages (Maloney, 2003). If wages were the same in formal and informal jobs, the informal one could be considered inferior because of the lost benefits. However, if some workers considered flexibility as an amenity, an informal job would be a superior option for them. Moreover, higher formal wages compensate formal workers for income taxes paid in order to support the provision of public goods from which informal workers cannot be excluded. For all these reasons, an informal job is not necessarily an inferior option.

health insurance, and other insurances and benefits.

[9] Gasparini and Tornarolli (2009) for Latin American countries; Ulyssea (2006) in the case of Brazil; Marcouiller et al. (2007) for Peru and El Salvador.

Connected with the last point, the twofold perspective of labor informality appears. On the one hand, as exclusion from state benefits and, on the other hand, as workers' escape decision. Some workers, by means of an implicit cost-benefit analysis, may choose not to belong to formal institutions if they positively assess present consumption and/or flexibility (Perry et al., 2007). However, in the case of Argentina this twofold perspective may not be appropriate to describe workers' informality status. Evidence suggests that informal workers face restrictions in order to obtain a formal job (Waisgrais and Sarabia, 2008). They are usually dissatisfied with their jobs, regardless of the occupational category they belong to. The conclusion is that informal workers want to enter into formality, but they find restrictions to do it.

The microdata on the characteristics of workers and households come from EPH. Up to 1991 this survey just covered the Greater Buenos Aires area. From 1992 to 1997 the coverage was extended to the 15 main cities and since then the 28 main cities have been surveyed. In 2009 the coverage was extended to 31 cities. Given these changes in the geographic coverage of the survey, this study will only analyze the Greater Buenos Aires agglomeration in order to consider trade policy changes of the eighties. Even though this decision implies the loss of observation since 1992, the Greater Buenos Aires area represents, on average, 72 % of the surveyed population during 1992-1997 and 53 % during the 1998-2001 period. Moreover, this agglomeration has shown the highest industrial activity participation with respect to other surveyed regions (20 % on average). The limited available information on workers' characteristics before 1980 determined that the analyzed period extends from 1980 to 2001. During this period the survey was carried out twice a year, in May and October, and was named EPH-Puntual.

Table 1 presents the characterization of formal and informal workers from the manufacturing sector during the 1980-2001 period. Salaried workers aged 15-65 are considered in this descriptive analysis.[10] Results show that informal workers from manufacturing industries have persistently received a lower hourly wage (at 1999 prices) than the wage paid to formal workers. Regarding hours of work, the same

[10]The EPH asks about the right to receive a pension when retired to salaried workers only.

behavior is found. The hours of work gap has widened from 1992 to 2001: in 1992 it reached the minimum at 1.27 hours of work, while in 2001 a formal worker worked 8 additional hours than an informal worker.

Informal workers are also characterized by a higher proportion of women, a lower average age, and a lower proportion of married individuals and household heads with respect to formal workers. The number of kids under 15 is usually greater in informal workers' households, while the equivalized household income (at 1999 prices) has always been lower. If the spouse of the household head was considered a secondary worker the conclusion would be, in accordance with Galiani and Weinschelbaum (2011), that secondary workers have a greater participation among informal workers.

Regarding educational level, both formal and informal workers are characterized by a higher proportion of unskilled individuals, although this is higher among informal workers. Finally, 90 % of the formal workers are employed in large firms while only 55 % of the informal workers are in that position.

3. Trade Reforms and Labor Informality: the Mechanisms

This section introduces the relationship between trade reforms and labor informality in Argentina and identifies some of the mechanisms via which this relationship operates. The goal here is to motivate the analysis by showing the basic correlations that are studied in depth below. To do this, tariff protection data is combined with labor informality survey data. The overlap between the tariff data of Galiani and Porto (2010) and the informality data from the EPH allows working with a long time series spanning the 1980-2001 period.

Table 2 reports sample sizes from various EPHs, the average tariff and its standard deviation, and the average informality rate for manufactures, the non-tradable sector and total economy. These simple descriptive statistics uncover the basic correlation that is studied in this paper: while the average tariff fell 38 % between 1980 and 2001, the national level of informality increased by 94 %.

This correlation is further explored in Figure 1. Trade policy changed over the period, with two very noticeable episodes of tariff cuts. Protection was highest in 1980 and 1985. The mean tariff was around 40 % (with protection in some industries reaching 55 %). The average tariff was cut by 10 percentage points between 1986 and 1989 and, in fact, the entire distribution of industry tariffs moved downward (the 75th percentile was, in general, below the 25th percentile of the first two years).[11] Since 1990, Argentina implemented a broad program of trade liberalization that includes unilateral tariff reductions and the adoption of Mercosur, a regional trade agreement with Brazil, Paraguay and Uruguay in 1991. During this period the mean tariff fell 10 additional percentage points and a lower variability across industries was also observed.[12] Figure 2 provides some insights into the nature of trade policy reforms. It depicts the change in the level of protection faced by manufacturing industries during the 1980-2000 period. The left panel shows that import tariffs fell for each of the industries and, more importantly, a change in the structure of protection occurred. In other words, trade liberalization did not impact equally across industries. Those that had received the highest level of protection experienced the most drastic reductions, while industries with the lowest tariff levels faced the lowest reductions. This differential pattern of tariff reduction across industries can be observed in the right panel of Figure 2.

The informality rate in manufactures, by contrast, showed an increasing trend over time with a rise superior to 100 % between 1980 and 2001. While the eighties witnessed the greatest increase, the informality rate grew at a slow pace during the nineties. The informality reduction of 1991-1994 is interesting to notice. In 1994, considered as the most significant year in terms of labor reforms,[13] the informality

[11] As noted by Galiani and Porto (2010), this decade was also characterized by the use of non-tariff barriers, which our measure of ad-valorem tariff does not capture. Non-tariff barriers were fully eliminated by the year 1988. The implications are investigated below. Note also the increase in tariffs in 1989 due to a hyperinflation crisis.

[12] Note the slight increase in tariff level in 2001, probably explained by an attempt to prevent a fiscal crisis.

[13] According to Torre and Gerchunoff (1999), by early 1994 the success of the government in the labor flexibilization objective had been limited and ineffective. Then, a more gradual process that agreed with trade unions and employers was implemented. This new perspective allowed the government to pass several laws which generated some changes. For instance, the proportion of salaried workers covered by flexible contracts grew from 6.3 % in 1995 to 17 % in 1997. Despite

rate recovered its increasing trend reaching peaks of 32.4 % (in 1996) and 33.5 % (in 1999).[14] The informality trend in the non-traded sector was also increasing,[15] although the level was higher in this sector.

Beyond this clear pattern of correlation, trade policy changes may have a causal impact on the informality trend. In the manufacturing sector trade policy can affect informality through its impact on firms' size. Manufacturing firms exposed to a trade liberalization episode reduce the size of their labor force and can find it optimal to change its composition, substituting formal with informal workers who are typically cheaper. Thus, increasing tax evasion could be a strategy to smooth the negative shock. The non-traded sector can also be affected by trade policy via general equilibrium effects. After an episode of trade liberalization unemployed individuals from manufacturing firms can move to an expanding non-traded sector, where they can be hired formally or informally. These are some of the different mechanisms this paper explores.

The correlation between tariffs and informality in the manufacturing sector is intriguing but it hides short-run versus long-run impacts. The short-run impacts can be seen by comparing the cross-sectional relationship between changes in tariffs and changes in informality across industries. This relationship is plot in Figure 3 separately for small and medium size industries, large industries and total.[16] The pattern in small and medium size industries indicates that industries exposed to larger tariff cuts experienced an increase in the informality rate. The relationship for large industries is close to zero and a similar pattern appears in the aggregate.

This short-run mechanism may in turn affect the long-run aggregate correlation between the national average tariff and the average informality rate in manufactures. This is because the unconditional correlation depicted in Figure 1 may be conta-

this fact, the field of labor market relationships was the one where the liberalization policies of the nineties found more difficulties and obstacles.

[14]These peaks coincide with foreign financial crises that affected the domestic economy.

[15]Labor informality rate in the non-tradable sector was computed excluding the public sector.

[16]Industries were classified according to the average size of their firms. Small industries are those with firms of an average size lower than 15 workers; medium size industries have firms with an average size between 16 and 50 workers; and large industries comprise firms of an average size of at least 50 workers. Figure 3 is robust to different industries' size definitions. See Section 5.3 for more details.

minated by the short-run forces. To explore this, I estimate a model of informality using cross-section data and running the informality status of a worker on individual characteristics, industry tariffs, industry dummies and year dummies. These year dummies capture the level of informality at different time periods, conditional on other observed covariates. This conditional informality rate was then plotted on the average national tariff. Results are in Figure 4. The correlation is now positive, indicating a pattern of decreasing informality over time while the average national tariff decreases and once the effect of industry tariffs in the short-run was accounted for. On the contrary, labor informality is negatively correlated with the average national tariff in the non-traded sector, suggesting that general equilibrium effects after trade liberalization lead to an increase in labor informality in this sector.

4. Theoretical model

In this section, I introduce a theoretical model to describe the relationship between informality and trade liberalization. I want to study how firms adjust the composition of their labor force and I want to distinguish the short-run and long-run adjustments. In contrast with other studies of this type, I do not rely on ex-ante segmentation of the labor market between informal and formal workers, nor on ex-ante segmentation of firms by sectors, with firms fully formal or fully informal. I instead adopt a more parsimonious and realistic setting where workers are homogeneous, and the formality status of a given job or worker depends on whether firms decide optimally to pay or evade the taxes corresponding to their workers as a function of the associated cost. Thus, firms can simultaneously have registered and unregistered workers. I assume that workers are homogeneous, with formal workers enjoying social insurance benefits (and firms paying the respective taxes and contributions), while firms evade payroll taxes on informal workers who do not receive these benefits. Formal workers cost more, by definition. However, informality increases the probability of tax audits and related fines. In consequence, firms can find it optimal to mix formal and informal workers in its labor force. In Goldberg and

Pavcnik (2003) model firms can behave similarly, but they hire workers from two pools -a pool of formal, and a pool of informal workers-. In the model developed by Alemán-Castilla (2006), firms do not mix formal and informal workers.[17]

Intuitively, an increase in foreign competition due to a reduction in import tariffs implies a profitability loss. In the short-run, firms reduce production and the demand for labor and they can also substitute informal for formal jobs,[18] increasing tax evasion to absorb part of the negative shock. In the longer run, when labor can move across sectors and wages adjust, a new reallocation of workers between formality and informality occurs, affecting also the informality rate of the non tradable sector through general equilibrium effects.

Firms produce a homogeneous tradable product facing a given international price p^* and a tariff t. Output y is produced by combining technology a and labor L in a Cobb-Douglas production function

$$(1)\quad y(a, L) = a^{\beta} L^{(1-\beta)} = a^{\beta}(l_i + l_f)^{(1-\beta)},$$

where l_i and l_f are the number of informal and formal workers. There is a continuum of firms with different productivity levels a.[19] Firms draw their productivity parameter a from the distribution $g(a)$ with positive support over $(0, \infty)$ and cumulative distribution $G(a)$.

Labor is homogeneous. Firms can choose whether to pay social insurance contributions for their 'formal workers' l_f. If they do not pay, workers are 'informal'

[17] Goldberg and Pavcnik (2003) present a dynamic efficiency wage model where, after a price reduction, formal workers attach less value to their job. The formal wage increases to counterbalance the increased incentives to shirk, and makes formal workers more expensive. As a result, the optimal share of the formal sector declines. Alemán-Castilla (2006), who develops a dynamic industry model with firm heterogeneity where real wages increase after trade liberalization, reaches a different conclusion. As a consequence, there is a reallocation of market shares and profits from the least productive to the most productive firms, with an ambiguous effect on the employment share of the informal sector.

[18] For presentation purposes, I sometimes refer to firms substituting formal for informal workers. Strictly speaking, in this context with homogeneous workers, what happens is that firms reduce the number of jobs with associated contributions and increase those where they evade taxes. This can happen through firing and hiring of new workers with different conditions, or through changes in the nature of existing employment relationships.

[19] The parameter a can also be interpreted as the stock of 'managerial ability' of the firm. See Galiani and Weinschelbaum (2011).

and firms face a probability of being detected and fined. The probability of detection depends on firm size and on employment composition (formal-informal). The probability increases with firm's size and, conditional on size, it decreases with the proportion of formal to informal workers in its labor force. Given the size of a firm, the higher the proportion of informal workers in its labor force is, the harder cheating the tax authority becomes (Kleven et al., 2009). For simplicity, I assume that when firm's size exceeds a threshold $\overline{L}$, the detection is certain. The value $\overline{L}$ reflects the detection technology used by the tax authority. I model this as follows:[20]

$$(2)\quad q(l_i, l_f) = \begin{cases} q_1(l_i, l_f) + q_2(l_i, l_f) & \text{if } L < \overline{L} \\ 1 & \text{if } L \geqslant \overline{L}, \end{cases}$$

with

$$\frac{\partial q_1}{\partial l_i} = \frac{\partial q_1}{\partial l_f} > 0,$$

$$\frac{\partial q_2}{\partial l_i} > 0,\ \frac{\partial q_2}{\partial l_f} < 0.$$

The function $q_1(l_i, l_f)$ captures the effect of firm's size while $q_2(l_i, l_f)$ captures the effect of the composition of its labor force between formal and informal workers.[21] An additional unit of l_i leads to the same increase in the probability of detection through the 'size effect' than an additional unit of l_f. However, the impact through the 'composition effect' has the opposite sign, and the reduction in the probability of detection for an additional unit of l_f does not necessarily compensate the increase from an additional unit of l_i. I assume the 'size effect' dominates the 'composition effect' for formal employment, that is, that the probability of detection is strictly increasing both in l_i and l_f:

$$\frac{\partial q_1}{\partial l_f} > -\frac{\partial q_2}{\partial l_f}.$$

[20] I take some elements from Levy (2008) to model the relationship between the probability of detection, firm's size and employment composition.

[21] Both $q_1(l_i, l_f)$ and $q_2(l_i, l_f)$ depends linearly on l_i and l_f.

When a firm is detected evading social insurance contributions, it has to pay a monetary fine m for each informal worker.

Formal and informal workers are perfect substitutes in production, but the unit cost of l_i and l_f is not the same for the firm. Formal workers' wage is w_f and the cost of social insurance contributions is a fraction s of this wage.[22] The cost of hiring a formal worker is then $w_f(1+s)$. Informal workers' wage is w_i and the firm pays a fine m with probability $q(l_i, l_f)$ on each of them. The cost of an informal worker is $w_i + q(l_i, l_f)m$.

Firms hire informal workers when the benefit of evading social insurance contributions is higher than the cost. The benefit is the difference between formal and informal workers' labor costs, while the cost is the fine they have to pay for each informal worker.

For small firms, the probability of detection will be ordinarily small, and firms will thus hire a large proportion of informal workers. As firms become larger due to productivity differences, the probability of detection increases. For each possible firm's size, an optimal mix (l_i, l_f) exists. This optimal mix favors the inclusion of formal workers l_f as the size of the labor force increases because of the increase in marginal costs. Formal employment reduces $q(l_i, l_f)$ through the composition effect, but firms continue hiring informal workers because the expected cost of l_i is lower than the cost of l_f.

Firms become fully formal when firm size reaches the threshold $\overline{L}$ and the probability of detection equals unity. This is an equilibrium only if the fine is sufficiently high, given the wage differential between formal and informal workers. In what follows, I assume this is the case.[23] Profit maximization implies that firms hire formal labor so that to equate the value of the marginal product of labor with the cost of labor (wage plus contributions):

$$(3)\quad l_f^* = \left(\frac{p(1+t)a^{\beta}(1-\beta)}{w_f(1+s)} \right)^{\frac{1}{\beta}}.$$

[22] Note that s can also include other type of formal labor costs, as severance pay.

[23] For example, if there is no wage differential and $w_f = w_i$, the equilibrium requires that $m > w_f s$, so that the fine has to be greater than the social security contribution paid on formal labor.

For firms below the threshold $\overline{L}$, the optimal mix (l_i, l_f) maximizes profits:

$$(4)\ \max_{(l_i,l_f)} \pi = p(1+t)a^{\beta}(l_i+l_f)^{1-\beta} - w_f(1+s)l_f - [w_i + q(l_i,l_f)m]l_i.$$

The first order conditions are:

$$(5)\ p(1+t)a^{\beta}(1-\beta)(l_i+l_f)^{-\beta} - w_f(1+s) - ml_i\frac{\partial q}{\partial l_f} = 0,$$

$$(6)\ p(1+t)a^{\beta}(1-\beta)(l_i+l_f)^{-\beta} - w_i - q(l_i,l_f)m - ml_i\frac{\partial q}{\partial l_i} = 0.$$

This system of first order conditions implicitly defines the optimal factor mix. The closed-form factor demand solutions depend on the functional form of the evasion technology detection $q(l_i, l_f)$. These issues are discussed in the Appendix.

4.1. Trade liberalization effects: Comparative statics

As discussed above, firms view trade liberalization in manufacturing as a loss of profitability. The correlations that motivated our analysis, however, suggested that the effects of tariff cuts might differ according to the time-frame considered. While the model of the previous section is static, it is possible to incorporate the short- and long-run distinctions by making some assumptions about the nature of the adjustment. Specifically, I assume that in the short-run labor is immobile across sectors, and wages are fixed.[24] Faced with an increase in trade exposure due to a reduction in tariff t, firms fire workers and adjust their optimal formal-informal mix. These workers become unemployed and do not move to another sector. In the long-run, instead, labor can move across sectors, and as workers move and wages adjust, the unemployed find jobs and the gains from trade materialize, reaching a new equilibrium.

[24]There is abundant evidence to support these assumptions. See, for instance, Menezes-Filho and Muendler (2011), Peluffo (2010), Attanasio et al. (2004), Wacziarg and Wallack (2004), Currie and Harrison (1997), and Papageorgiou et al. (1991).

To derive the short-run impacts, I need to work out the comparative static results of a change in the tariff t. This is done in the Appendix. The case of fully-formal firms is simple. Informal employment is not affect, by definition, and formal employment drops with the tariff cut:

$$(7)\quad \frac{\partial l_f^*}{\partial t} = \frac{1}{\beta(1+t)} l_f^* > 0.$$

For mixed-firms, those that hire both formal and informal workers, the analytical solution is harder. Assuming linear detection technology, the expressions for the changes in l_i and l_f are:

$$(8)\quad \frac{\partial l_i}{\partial t} = -\phi\left[m\left(\frac{\partial q_1}{\partial l_f} + \frac{\partial q_2}{\partial l_f}\right)\right] < 0,$$

and

$$(9)\quad \frac{\partial l_f}{\partial t} = -\phi\left[-2m\left(\frac{\partial q_1}{\partial l_i} + \frac{\partial q_2}{\partial l_i}\right) + m\left(\frac{\partial q_1}{\partial l_f} + \frac{\partial q_2}{\partial l_f}\right)\right] > 0,$$

where $\phi = \frac{1}{|H|} p a^{\beta}(1-\beta)(l_i + l_f)^{-\beta}$ and $|H| > 0$ is the determinant of the Hessian matrix associated to the profit maximizing problem.[25]

Following a loss of trade protection, firms reduce total labor demand (the sum of (8) and (9) is positive) and change the composition of the labor force substituting informal workers for formal workers. Firms can absorb the negative shock by increasing the level of evasion to mitigate the loss of profits. Note that informality introduces an additional mechanism of firm adjustment to trade. In fact, the decline in labor demand is actually lower than the fall that would have occurred in the absence of the adjustment margin that labor informality allows. Mathematically, the sum of (8) and (9) is lower than (7).

In the empirical analysis, I study the relationship between tariffs and the probability of informal employment for a random worker employed in a given industry. This is in part because I work with labor survey data instead of firm-level data. To

[25] Under a more general detection function, it is necessary to put restrictions on the second derivative of $q(l_i, l_f)$ to pin down the sign of the responses of l_i and l_f to a tariff change.

take the model to the data, I thus need to derive the theoretical change in the informality rate of industry j. The informality rate is defined as the fraction of informal workers (L_i^j) in the total labor force ($L_i^j + L_f^j$) in industry j:

$$(10)\quad I^j = \frac{L_i^j}{L_i^j + L_f^j}.$$

In large industries, where firms are likely to be large too, the informality rate will not be much affected by the level of tariff protection. For small- and medium-size industries, instead, the impact of a change in t is:

$$(11)\quad \frac{\partial I^j}{\partial t} = \frac{\partial L_i^j}{\partial t}\left[\frac{L_f^j}{(L_i^j + L_f^j)^2}\right] - \frac{\partial L_f^j}{\partial t}\left[\frac{L_i^j}{(L_i^j + L_f^j)^2}\right] < 0.$$

This shows that a fall in tariffs increases the informality rate because total employment declines while informal employment increases. This effect also depends on firms' size in industry j because size determines the intensity of substitution between formal and informal employment. For instance, firms larger than $\overline{L}$ before and after the change in t will not experience any change in their labor force composition, while smaller firms will hire more informal workers according to the change in the probability of detection they face. To see this, I can derive (8) and (9) with respect to size. To the first order, this derivative is:

$$(12)\quad \frac{\partial[\partial l_i/\partial t]}{\partial(l_f + l_i)} = \frac{\phi\beta}{(l_i + l_f)}\left[m\left(\frac{\partial q_1}{\partial l_f} + \frac{\partial q_2}{\partial l_f}\right)\right] > 0,$$

$$(13)\quad \frac{\partial[\partial l_f/\partial t]}{\partial(l_f + l_i)} = \frac{\phi\beta}{(l_i + l_f)}\left[-2m\left(\frac{\partial q_1}{\partial l_i} + \frac{\partial q_2}{\partial l_i}\right) + m\left(\frac{\partial q_1}{\partial l_f} + \frac{\partial q_2}{\partial l_f}\right)\right] < 0.$$

The increase (decrease) in informal (formal) labor demand fades away with firm's size. Thus, the effect of tariffs on the informality rate of industry j will be smaller the larger the firms in this industry.

Figure 5 illustrate these mechanisms. Below the threshold $\overline{L}$, tariffs negatively

affect the rate of informality, and this effect is increasing on the size of the firms in the industry.[26] For an industry with many firms larger than $\overline{L}$, the impact on the informality rate will be negligible. For smaller industries, the impact will be negative, and statistically stronger.

In the long run, productive factors can move across sectors and wages adjust. Part of the unemployed labor force from the manufacturing industries will be absorbed in the same sector at a lower wage. This reduces the cost of formal employment and, consequently, labor informality should, in the long-run, decrease in manufactures. By the same token, the increase in labor supply in the non-tradable sector could bring wages down, thus reducing informality. However, trade liberalization makes the economy wealthier in real terms (through gains of trade and efficiency). This could imply higher spending, and higher demand in the non-tradable sector, with a subsequent increase in labor demand. This effect goes in the opposite direction to that of a larger labor supply. The final effect on the informality rate of non-tradables depends on which effect dominates. If the wealth effect is large enough, labor informality will increase in the non-tradable sector due to the higher costs of formalization that a higher wage level represents.

5. Empirical Analysis

The aim of the empirical work is to identify the causal impact of trade liberalization on informality in Argentina and to inspect the short-run and long-run operating mechanisms. To this end, I estimate the two-step empirical model of Galiani and Porto (2010) with an instrumental variables estimator. The basic econometric model exploits the fact that the import tariffs and labor informality data comprise a long time series of cross-sectional data. As argued below, this and the instrumental variables approach, provide a strong identification strategy. Further, I can exploit the cross-sectional variation to estimate the short-run mechanisms, and the time-series variation to estimate the long-run mechanisms.

[26] Note that the effect of tariffs on the informality rate is negative and increases with the size of the firms in the industry at a decreasing pace: $\frac{\partial^2 I^j / \partial t}{\partial (L_i + L_f)^2} < 0$. See Appendix.

5.1. Short-run Mechanisms

I begin with the short-run and the cross-sectional data. The short-run is defined as a scenario without wage adjustment in the labor market so that, when a shock occurs (for example a trade policy shock), only employment (possibly both formal and informal) adjusts. This is a plausible definition of the short-run for the purposes of the analysis. The model is:

$$(14)\quad y_{ijt} = \mathbf{x}'_{ijt}\beta_x + \beta_\tau \ln \tau_{jt} + I_j + T_t + \varepsilon_{ijt},$$

where y_{ijt} is the informality status of individual i employed in industry j at time t, τ_{jt} is the tariff on industry j at t, and the vector $\mathbf{x}$ includes individual characteristics, such as gender, age, marital status, indicator variables for head of household and education, as well as household characteristics such as the number of children and household income (in equivalent-adult units). The baseline model also includes industry I_j and time T_t fixed effects.

Based on the theoretical model of section 4, the effect of trade policy changes is expected to be different depending on the size of the firms in each industry. Large firms are more visible and face a greater probability of detection. As a result, the labor force of a large firm will be mostly formal, with few informal workers. The opposite happens in small- and medium-size firms which face a lower probability of detection and thus may evade social security contributions. In order to capture these heterogeneous impacts, industries were classified as small, medium or large according to the average size of their firms in 1980. An industry is small when the average size of the firms in 1980 is lower than 15 workers; medium, when the average size of the firms is between 16 and 50 workers; and large when firms have at least 50 workers on average. Model (14) is expanded with industry-size indicator variables (S_{gj}) and with interaction terms with tariffs ($S_{gj} \ln \tau_{jt}$):

$$(15)\quad y_{ijt} = \mathbf{x}'_{ijt}\beta_x + \beta_\tau \ln \tau_{jt} + \sum_g \beta_g S_{gj} \ln \tau_{jt} + \sum_g \beta_{gs} S_{gj} + I_j + T_t + \varepsilon_{ijt},$$

where g indexes the initial size of each industry. The coefficients of the interaction terms, β_g, can be interpreted as the differential impact of trade on informal employment in industries that differ in their initial size. The sample mostly comprises large industries.[27] In light of the predictions of the theoretical model the average effect is expected to be negligible, while an increasing pattern in industry size should appear estimating model (15).

This specification allows me to account for several confounding factors for the impacts of trade policy, β_τ and β_g. Industry and time fixed effects control for industry-specific characteristics and aggregate shocks related to the business cycle or policy decisions. For instance, if the government raises tariffs during a recession and workers move from formality to informality, β_τ and β_g could be biased upward because of the business cycle effect. Time fixed effects will also allow me to control for political economy changes related to the labor market, such as variations in tax regimes and social security contributions, regulations regarding type of contracts, etc. Similarly, unobserved industry characteristics that are time invariant, such as the ability to form a lobby, industry productivity or capital intensity, could affect industry tariffs and informal employment. The inclusion of industry fixed effects controls for these unobserved factors that could be correlated with tariffs and have an independent effect on informal employment.

In addition, the data span a long time series of active trade policy. As pointed out before, trade liberalization not only reduced tariffs but also changed the structure of protection across industries. A "before-after" comparison of a single episode of trade liberalization would be missing out the important fact that such a comparison would be between an initial pattern of trade protection and another one with lower protection, but not between autarky and free trade (Goldberg and Pavcnik, 2007). The time series of cross-sections overcomes this limitation by allowing for the comparison of trends in trade reforms and those in the outcome variable.

Even in this setting, tariffs may be endogenous for at least four reasons. First, the initial tariff reductions may have been the continuation of a previous tendency to

[27] 11 out of the 24 industries were classified as small or medium-size, while the remaining 13 were classified as large industries.

trade liberalization (Topalova, 2010). Second, trade reforms are part of the political and economic process. As such, the differential pattern of tariff reductions across industries may be reflecting political economy factors. For instance, relatively less efficient industries or those with higher lobbying ability may enjoy higher levels of protection. If these industries also had higher informality rates, such a positive association between trade protection and labor informality would only be spurious. Third, unionization, and the power to influence sector protection may also be a source of bias, especially if union membership changed over time (Marshall and Groisman, 2005). Finally, another concern is the potential bias in the estimated effects due to the omission of other trade policy instruments such as non-tariff barriers (which our tariff data do not cover).[28]

I deal with the endogeneity issue by instrumenting tariffs. I propose two instruments. The first is a measure of the average exchange rate faced by each industry, as in Park et al. (2010) and Brambilla et al. (2012). The instrument z^1 is defined as:

$$(16)\quad z^1_{jt} = \sum_c e^c_t * \theta^c_{j,1980},$$

where e^c_t is the exchange rate of country c (relative to the Argentine peso) at time t and $\theta^c_{j,1980}$ is the share of country c in Argentine imports of product j in 1980. Given this share, a higher exchange rate of country c will generate higher imports from this country.[29] Tariffs may increase to protect industry j, or may fall to secure the gains from tarde. This instrumental variable is thus based on the variation in the exchange rates of all trading partners—a change arguably exogenous to the model—and on each industry exposure to those changes, given their initial share on Argentine imports of product j. By fixing the shares $\theta^c_{j,1980}$ at the 1980 level, I seek

[28] Even though the existing evidence shows only a small correlation between tariffs and non-tariff barriers (Galiani and Porto, 2010), there can be biases if tariff cuts are hidden behind, for instance, quotas or other forms of trade controls.

[29] Since I need to build the instrument for the whole 1980-2001 period, I focus only on major Argentine trade partners, namely Brazil, Chile, the United States and the European Union. This is due to data limitations. Imports value data come from UN Comtrade and exchange rates data from World Development Indicators (WDI).

to predetermine this value for all t, ensuring that tariff changes generated through exchange rates variations are exogenous.[30]

For the second instrument, I interact industry tariffs in the first period (1980) with a three-category variable that captures three stages of Argentine trade policy, namely the initial period with high tariffs (years 1980 to 1985), the flat-tariff period of 1986 to 1989, and the last decade, from 1990 to 2001. A similar approach was proposed by Topalova (2010). The instrument z^2 is defined as:

$$(17) \quad z^2_{jt} = \tau_{j,1980} * Post_t,$$

where $\tau_{j,1980}$ is the initial sectoral tariff and $Post_t$ are the indicator variables. The validity of this instrument can be seen in Figure 2. Tariff changes are linearly related to the initial level of protection. Those industries that traditionally received the highest level of protection, experience the most drastic reductions, while industries with the lowest tariff levels in 1980, face the lowest reductions. Further, the initial level of protection can reasonably be thought of as exogenous in the model.

Table 3 reports results from the first stage regressions, where tariffs and their interactions with initial industry size in 1980 are instrumented with z^1_{jt}, z^2_{jt} and their interaction with industry size. The instruments work very well. They are all highly statistically significant and have a lot of explanatory power. An increase in the average exchange rate leads to tariff reductions in all industries, with a smaller effect in medium-size industries. On the other hand, a higher level of protection in 1980 is associated with lower tariffs and the effect is larger for large industries. These results confirm that the observed tariff changes are indeed related to the initial level of protection and also to the initial size of industries.

Short-run cross-section results are reported in Table 4. OLS results are in columns 1-2 and IV results are in columns 3-6. In column 1, I estimate the model in (14), without interactions with firm size indicators. As suggested by the theoretical

[30]The exclusion restriction may fail if exchange rate variations had a direct effect on informality at the industry level. The inclusion of time period fixed effects allows to control for these type of effects.

framework, the effect of the sectoral tariffs on labor informality at the industry level is indistinguishable from zero. When the model does not allow for different responses according to the initial size of the industries, the effects may compensate each other and thus be statistically weak. If I instead allow for heterogeneous effects by initial industry size (column 2), results show that tariffs have a direct negative impact on the informality rate only in small- and medium-size industries (significant at the 1 and 10 percent level respectively).

In column 3, I report IV estimates of tariff on informality, without firm-size interactions. The coefficient is negative, but not statistically significant. As before, this hides the stronger negative impacts on small- and medium-size firms, which is uncovered in column 4. A 10 % tariff reduction leads to an increase of 1.2 percentage points in labor informality in small industries and 0.64 percentage points in medium size industries. An industry that faced a 39 % tariff reduction over the period, as the manufacture of wearing apparel (initially small industry), increases its informality rate in 4.7 percentage points. Thus, trade liberalization explains 31 % of the observed informality change in this industry (from 40 % in 1980 to 55 % in 2001).

Next, I perform two robustness tests. In column 5, I include the average industry wage as an additional control variable. This is for consistency with the hypothesis that the wage adjustment associated to an episode of trade liberalization is a mechanism that operates in the long-run. This has no effect on the estimated impacts, as was expected if wage adjustments take place in the long-run. As a final robustness test, to account for other potential confounding factors, I include initial industry characteristics, namely the share of skilled workers and the size of the labor force in 1980, interacted with the variable $Post_t$ (which captures the trade policy stages). This exercise seeks to control for industry specific trends. The IV results, in column 6, show, as before, that reductions in average tariffs lead to increases in labor informality. The magnitudes of the coefficients are larger than previous estimates, especially for small industries.

5.2. Long-Run Mechanisms

In this section, I explore the long-run mechanisms using the time series variability in the data. To look at general equilibrium effects, I investigate impacts on both the tradable and non-tradable sectors.

I begin with the traded sector. The cross-section evidence shows a positive relationship between trade liberalization and labor informality during 1980-2001, particularly in initially small and medium size industries. This average effect at the industry level may, however, intensify or revert over time. To study these effects I estimate the impact of trade liberalization on labor informality, conditional on the structure of sectoral protection (Galiani and Porto, 2010). To implement this, I recover the time fixed effects estimated in model (15) and use those as measures of the residual informality rate at time t once all the cross-section covariates are accounted for. Then, in a second stage, I regress the residual informality rate on the average national tariff of the economy:

$$\hat{T}_t = \mathbf{m}_t'\alpha_m + \alpha_\tau \ln \tau_t + \nu_t, \tag{18}$$

where $\mathbf{m}_t$ is a vector of controls. Because the dependent variable in this second stage is estimated, I estimate equation (18) with weighted least squares, using the inverse of the estimates of the variance of the time fixed effects from the first stage as weights.

Results from the second stage are in Table 5. I control for $\mathbf{m}$ in (18), which includes the ratio of the labor force in tradable to non-tradable sectors (column 1 and 3) and the ratio between the average wage of formal and informal workers in the manufacturing sector (columns 2 and 4). Columns 1 and 2 show the OLS coefficients. The average tariff is positively associated to the labor informality trend in the manufacturing sector, after controlling for the structure of sectoral protection and allowing for long-run (wage) adjustment. In columns 3 and 4, I report the IV coefficients, where the instrument is the average exchange rate of major trade

partners.[31] IV estimates do not differ from OLS estimates. The average tariff impacts positively on the labor informality trend of the manufacturing sector, conditional on the structure of sectoral protection. Estimates range between 0.066 and 0.093.

This evidence indicates that the negative cross-sectional relationship identified above reverts in the longer run (in the manufacturing sector). The inter-industry differences in tariff cuts causes informality increases in small- and medium-size industries. As argued in the theoretical model, this is because the loss of profitability of manufacturing firms induces them to adjust the informality rate. Given this structure of sectoral protection, however, aggregate labor informality in manufactures declines with the average tariff. This is because, as wages decline in response to the outflow of formal (and informal) workers, the cost of formality is reduced in the long-run. In terms of Figure 1, the slope of the curve that shows the labor informality trend in the manufacturing sector would have been steeper in absence of trade liberalization.

I now turn to the non-traded sector. This sector may also be affected by the changes in average protection because of general equilibrium effects. To investigate those effects, I use a similar estimation strategy. The first stage is run on workers in the non-traded sector and thus the model does not include trade policy variables. In the second state, I regress the residual average informality rate on the average national tariff. Results are in columns 5-8 of Table 5. Both the OLS (columns 5 and 6) and IV (columns 7 and 8) estimates reveal that aggregate trade protection affects negatively and significantly the labor informality trend in the non-traded sector. In particular, the IV estimate is around -0.097 in both specifications.[32] Several factors can explain this result. In terms of the model, the mechanism at play is wage adjustment. When tariffs are reduced, manufacturing firms reduce their labor demand and also increase the use of informal labor. Those workers that are laid

[31] As before, the first stage regressions use z^1_{jt}, z^2_{jt} and their interactions with indicator variables of initial size of industries as instrumental variables. For the second stage, I use the average of z^1_{jt} over time to instrument the average tariff.

[32] The second stage controls for the ratio between the labor force in tradable and non-tradable sectors and the ratio between the average wage of formal and informal workers in the non-tradable sector.

off move to the non-traded sector. An increase in labor supply is combined with an increase in labor demand due to a wealth effect (real income can increase after a liberalization of trade). If the wealth effect is large enough, higher wages will result in higher formality costs, increasing the informality rate in the non-traded sector. This mechanism can be magnified if, for instance, the non-traded sector uses imported inputs. In terms of Figure 1, in absence of trade liberalization episodes, the non-tradables labor informality trend would have been flatter.

5.3. Robustness to industries' size definition

Previous estimations are based on an industries' size definition that is arbitrary. I classified an industry as small when the average size of the firms in 1980 was lower than 15 workers; medium, when the average size of the firms in 1980 was between 16 and 50 workers; and large when firms had at least 50 workers on average in 1980. In this section I test whether the results are robust to different industries' size definitions.

First, I change the definition of medium-size and large firms and classify an industry as medium-size when its firms had between 16 and 100 workers on average in 1980. Then, an industry is defined as large when firms had at least 100 workers on average in 1980. The second definition also moves the boundary between small- and medium-size industries. I classify an industry as small in 1980 when its firms had up to 25 workers on average; medium, when the average size of the firms in 1980 was between 26 and 100; and large, when firms had at least 100 workers on average in 1980.

Short-run results using these alternative definitions are reported in Table 6, while Table 7 presents the long-run estimations. Columns 1 to 4 in Table 6 summarize cross-section OLS results. Columns 1 and 3 show that tariffs have a direct impact on the informality rate only in small-size industries. The magnitude of the effect is slightly smaller than previous result. Columns 2 and 4 add the average industry wage as an additional control variable. The inclusion of this variable does not affect the estimations. Columns 5 to 8 show IV estimations. Again, I find a negative impact of

sectoral tariffs on labor informality for initially small industries, and the estimated effect is robust to the inclusion of the average industry wage as a control variable.

Columns 1 to 4 in Table 7 show OLS results for the long-run equation (18). I find a positive association between the average tariff and the labor informality trend in the manufacturing sector using both industries' size definitions with the exception of column 4, where I add the ratio between the average wage of formal and informal workers as a control variable using the second classification. The magnitude of the effects is closer to that obtained in previous sections. IV estimates in columns 5 to 8 are positive and statistically significant using both industries' size definitions and model specifications. The estimated impact ranges between 0.084 and 0.121, very close to previous results.

6. Conclusions

In this paper I have examined the link between trade liberalization and labor informality in Argentina using a long time series spanning the 1980-2001 period. This was a period of important trade policy changes, captured with tariff changes in manufacturing industries, and of increasing labor informality.

I postulated various mechanisms via which this relationship operates. First, manufacturing firms exposed to a trade liberalization episode reduce the size of their labor force while at the same time substitute informal workers for formal workers. Thus, increasing tax evasion could be a strategy to smooth the negative shock. Second, the non-traded sector can also be affected through general equilibrium effects. Displaced workers from manufacturing firms can move to an expanding non-traded sector where they can be hired formally or informally.

I examined these relationships empirically and the main findings indicated, first, that trade liberalization impacted positively on labor informality at the industry level, and the magnitude of this effect depends on the size of the firms in each industry. When small firms prevail, the substitution of informal workers for formal workers is a mechanism at play, but this effect fades away with the size of the firms.

Second, evidence from time-series variation of the data established that, conditional on the structure of sectoral protection, the informality trend in the manufacturing sector moved jointly to the average tariff, while the opposite occurred in the non-traded sector. This is an important contribution of the study. The effect identified for manufacturing industries in the short-run reverts in the longer-run, and the non-tradable sector is also impacted by a trade liberalization episode through general equilibrium effects.

I formalized this relationship between labor informality and trade policy changes proposing a model for an import-competing industry with tax evasion, where formal and informal workers are perfect substitutes in production and, in the short-run, labor is immobile across sectors and wages are fixed. For each possible size of a firm in this industry an optimal mix of formal and informal labor exists. Faced with an increase in the trade exposure, firms reduce the size of their labor force and also change it composition, increasing the fraction of informal workers (as a function of the probability of detection by the tax-authority). In the longer-run, when labor can move across sector and wages adjust, the informality rate in the manufacturing sector gets reduced, while a wealth effect in the non-traded sector can lead to an increase in the informality rate.

The model and the empirical results allows me to rationalize some of the short term and long term adjustments observed in countries following trade liberalization episodes. Moreover, I validate empirically the intuition that the tax evasion-formality channel is a relevant labor demand adjustment mechanism that allows some smoothing of the effect of the reforms. This may be one of the reasons why governments in developing countries seem reluctant to increase their enforcement efforts, at least during episodes of reform. While workers suffer in the form of lower quality jobs, this additional margin helps maintain overall employment levels, and this is the trade-off faced by economic policy makers. However, by distinguishing between the short and the long run, the results also indicate that there is an additional dimension for this trade-off. In Argentina's specific case, informality falls in the long run in the tradable sector, but increases for non-tradables.

While greater labor mobility across sectors is usually seen as desirable, I provide an example of one more dimension where it would help economies and labor markets adjust to new equilibria with lower costs. In this case, it would allow for a smoother transition to the long-run equilibrium, avoiding the increase in the informality rate and the emergence of unemployment. Moreover, a wider social protection net not linked to employment (as is the case with most of Latin America's social insurance systems) would mitigate the high costs for those workers that lose their social insurance benefits in the process of adjustment. Trade liberalization policies are likely to go with additional policy interventions to redistribute the gains from trade openness.

Appendix

Firms' optimization problem

Firms maximize the profit function:

$$\underset{(l_i,l_f)}{\text{máx}}\, \pi = p(1+t)a^{\beta}(l_i+l_f)^{1-\beta} - w_f(1+s)l_f - [w_i + q(l_i,l_f)m]l_i$$

First order conditions from the maximizing problem:

$$\frac{\partial \pi}{\partial l_f} = p(1+t)a^{\beta}(1-\beta)(l_i+l_f)^{-\beta} - w_f(1+s) - ml_i\frac{\partial q}{\partial l_f} = 0$$

$$\frac{\partial \pi}{\partial l_i} = p(1+t)a^{\beta}(1-\beta)(l_i+l_f)^{-\beta} - w_i - q(l_i,l_f)m - ml_i\frac{\partial q}{\partial l_i} = 0$$

From these conditions we obtain:

$$\frac{\partial q/\partial l_f}{\partial q/\partial l_i} = \frac{p(1+t)a^{\beta}(1-\beta)(l_i+l_f)^{-\beta} - w_f(1+s)}{p(1+t)a^{\beta}(1-\beta)(l_i+l_f)^{-\beta} - w_i - mq(l_i,l_f)} = \sigma < 1$$

$$(l_i+l_f)^{*} = a\left[\frac{p(1+t)(1-\beta)(1-\sigma)}{w_f(1+s) - \sigma(w_i+mq)}\right]^{\frac{1}{\beta}}$$

Change in labor force composition

A firm facing a tariff (t) reduction adjusts the labor demand for l_i and l_f:

$$\frac{\partial l_i^d}{\partial t} = \frac{-\partial \Pi/\partial t}{|H|}\left[\frac{\partial \Pi_f}{\partial l_f} - \frac{\partial \Pi_i}{\partial l_f}\right]$$

$$\frac{\partial l_f^d}{\partial t} = \frac{-\partial \Pi/\partial t}{|H|}\left[\frac{\partial \Pi_i}{\partial l_i} - \frac{\partial \Pi_f}{\partial l_i}\right]$$

where

$$\Pi_f = \frac{\partial \pi}{\partial l_f},\ \ \Pi_i = \frac{\partial \pi}{\partial l_i},\ \ \frac{\partial \Pi}{\partial t} = \frac{\partial \Pi_i}{\partial t} = \frac{\partial \Pi_f}{\partial t}$$

$$|H| = \lambda_1 + \lambda_2\frac{\partial q}{\partial l_f} + \lambda_3\left(\frac{\partial q}{\partial l_f}\right)^2$$

with $\lambda_1 = -2mp(1+t)\frac{\partial^2 f(l_i,l_f)}{\partial l_f^2}\frac{\partial q}{\partial l_i}$, $\lambda_2 = 2mp(1+t)\frac{\partial^2 f(l_i,l_f)}{\partial l_f \partial l_i}$, $\lambda_3 = -m^2$.

$|H|$ is a quadratic form in $\partial q/\partial l_f$ with a positive root (r_1) and a negative root(r_2). Then $|H| > 0$ and the optimal combination (l_i, l_f) is a maximum if $\partial q/\partial l_f \, \epsilon \, (0, r_1]$.

Replacing second order derivatives and considering that $q(l_i, l_f)$ depends linearly on l_i and l_f:

$$\frac{\partial l_i^d}{\partial t} = \frac{-pa^\beta(1-\beta)(l_i+l_f)^{-\beta}}{|H|}\left[m\left(\frac{\partial q_1}{\partial l_f}+\frac{\partial q_2}{\partial l_f}\right)\right] < 0$$

$$\frac{\partial l_f^d}{\partial t} = \frac{-pa^\beta(1-\beta)(l_i+l_f)^{-\beta}}{|H|}\left[-2m\left(\frac{\partial q_1}{\partial l_i}+\frac{\partial q_2}{\partial l_i}\right)+m\left(\frac{\partial q_1}{\partial l_f}+\frac{\partial q_2}{\partial l_f}\right)\right] > 0$$

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Table 1: Workers' characteristics in the manufacturing sector
Salaried workers between 15 and 65 years old

		1980	1988	1992	1996	2000	2001
Hourly wage	Informal	-	1.947	2.780	2.906	2.728	3.225
			(0.118)	(0.185)	(0.163)	(0.218)	(0.324)
	Formal	-	3.560	3.657	4.179	4.616	4.546
			(0.130)	(0.123)	(0.221)	(0.242)	(0.225)
Weekly hours of work	Informal	44.250	44.492	45.823	42.208	42.888	39.385
		(1.308)	(0.900)	(1.087)	(1.322)	(1.415)	(1.500)
	Formal	47.764	47.426	47.089	46.991	48.267	47.408
		(0.460)	(0.378)	(0.469)	(0.473)	(0.533)	(0.646)
Men (%)	Informal	61.061	57.729	66.446	61.444	61.854	62.438
		(3.879)	(2.797)	(3.298)	(3.383)	(3.461)	(3.682)
	Formal	76.896	78.383	77.015	79.752	78.087	76.328
		(1.420)	(1.371)	(1.738)	(1.945)	(2.079)	(2.299)
Age	Informal	30.202	30.601	29.991	31.699	32.364	32.571
		(1.075)	(0.748)	(0.860)	(0.872)	(0.849)	(0.872)
	Formal	35.477	37.067	37.033	37.444	37.073	37.113
		(0.408)	(0.410)	(0.516)	(0.571)	(0.566)	(0.627)
Unskilled (%)	Informal	80.870	82.205	80.538	75.834	71.909	68.535
		(3.129)	(2.165)	(2.765)	(2.975)	(3.202)	(3.531)
	Formal	75.630	70.629	66.982	63.667	54.456	48.824
		(1.446)	(1.517)	(1.943)	(2.328)	(2.503)	(2.703)
Semiskilled (%)	Informal	18.598	14.406	16.491	21.223	25.023	26.850
		(3.095)	(1.988)	(2.592)	(2.842)	(3.086)	(3.369)
	Formal	20.003	23.042	25.510	29.947	31.880	40.353
		(1.348)	(1.402)	(1.801)	(2.217)	(2.342)	(2.653)
Household heads (%)	Informal	31.567	30.610	38.739	35.758	37.368	41.029
		(3.698)	(2.609)	(3.402)	(3.331)	(3.447)	(3.740)
	Formal	58.245	63.113	59.287	61.685	61.654	58.789
		(1.661)	(1.607)	(2.030)	(2.353)	(2.443)	(2.662)
Secondary workers (%)	Informal	15.26	16.05	13.54	16.25	16.99	16.53
		(0.029)	(0.021)	(0.024)	(0.023)	(0.027)	(0.028)
	Formal	6.23	8.24	10.45	8.87	11.56	13.13
		(0.008)	(0.009)	(0.013)	(0.014)	(0.016)	(0.018)
Number of children at home	Informal	1.124	1.325	1.356	1.400	1.465	1.544
		(0.100)	(0.090)	(0.110)	(0.110)	(0.121)	(0.130)
	Formal	1.155	1.110	1.204	1.038	0.966	0.917
		(0.045)	(0.043)	(0.059)	(0.060)	(0.060)	(0.062)
Equivalized household income	Informal	314.280	286.802	363.478	302.282	311.161	305.162
		(15.936)	(12.125)	(19.415)	(15.826)	(24.256)	(27.349)
	Formal	381.299	410.216	425.345	443.428	531.622	481.615
		(9.647)	(17.376)	(14.519)	(27.189)	(36.278)	(27.469)

Source: Own elaboration based on EPH.
Notes: Standard errors in parenthesis. Hourly wage and equivalized household income in pesos at 1999 prices. Skilled labor comprises workers who have finished college; semiskilled labor comprises workers who have finished secondary school and may have incomplete college education; and unskilled labor comprises workers with no schooling, complete and incomplete primary education, and incomplete secondary education.

Table 2: Tariffs and Informality

Year	EPH	Tariffs		Informality		
		average	std. dev.	National	Manufactures	Non-Traded
1980	1041	40.95	10.17	20.28	15.62	22.94
1985	1048	31.55	6.37	23.19	17.80	25.54
1986	1146	29.98	6.98	24.78	19.55	27.39
1987	2346	29.39	7.55	26.93	21.12	29.71
1988	2431	29.42	7.54	28.94	23.02	31.70
1989	2459	31.65	8.03	29.30	24.51	31.32
1990	1467	20.56	4.64	27.88	24.99	28.96
1991	1583	15.33	5.51	33.05	29.63	34.35
1992	1629	17.43	4.95	32.99	25.63	36.04
1993	1634	21.34	6.27	33.74	26.81	36.51
1994	1477	20.29	5.73	32.18	26.18	34.29
1995	1345	18.52	3.91	34.42	26.86	36.65
1996	1281	19.21	3.73	36.51	31.32	38.07
1997	1379	19.23	3.98	38.26	30.94	40.43
1998	1359	18.8	4.00	37.84	34.10	38.88
1999	1230	18.6	3.96	38.65	34.49	39.68
2000	1184	18.73	3.46	39.34	33.03	40.75
2001	1085	25.51	5.28	39.07	34.01	40.34

Source: Own elaboration based on EPH and Galiani and Porto (2010).
Notes: Average tariff weighted by the employment level in each industry.
The informality rate does not include the public sector.

Table 3: First stage estimations

	Log of tariffs	Log of tariffs*I_S	Log of tariffs*I_M
z^1	-0.271	-0.021	0.048
	[0.020]***	[0.002]***	[0.006]***
$z^1 * I_S$	-0.239	-0.328	0.077
	[0.022]***	[0.017]***	[0.007]***
$z^1 * I_M$	0.168	0.002	0.014
	[0.011]***	[0.001]**	[0.007]**
z^2	-0.094	-0.005	-0.048
	[0.007]***	[0.001]***	[0.004]***
$z^2 * I_S$	0.025	-0.085	0.004
	[0.001]***	[0.001]***	[0.000]***
$z^2 * I_M$	0.020	0.000	-0.089
	[0.001]***	[0.000]	[0.001]***
Observations	26795	26795	26795
R^2	0.74	1.00	1.00

Source: Own elaboration based on EPH and Galiani and Porto (2010).
Note: Standard errors clustered by industry and time in brackets. z^1 is the exchange rate faced by each industry; z^2 is the tariff in 1980 interacted with a three-category variable (each category corresponds to one of the three stages in Argentine trade policy described in section 3). I_S and I_M are indicator variables for initially small and medium-size industries, respectively.
*** significant at 1 %; ** significant at 5 %; * significant at 10 %.

Table 4: Industry tariffs and Informality
OLS and IV estimation

	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
Log of tariffs	0.011	0.019	-0.178	-0.091	-0.087	-0.079
	[0.015]	[0.015]	[0.208]	[0.084]	[0.083]	[0.084]
Log of tariffs*I_S		-0.116		-0.118	-0.118	-0.178
		[0.033]***		[0.039]***	[0.040]***	[0.055]***
Log of tariffs*I_M		-0.035		-0.064	-0.063	-0.079
		[0.019]*		[0.034]*	[0.034]*	[0.036]**
Observations	26795	26795	26795	26795	26795	26795
R^2	0.18	0.18				
Overid. test (p-value)			0.09	0.95	0.94	0.86

Source: Own elaboration based on EPH and Galiani and Porto (2010).
Notes: Standard errors clustered by industry and time in brackets.
*** significant at 1 %; ** significant at 5 %; * significant at 10 %.

Table 5: Average tariff and Informality
OLS and IV estimation

	Traded Sector				Non-Traded Sector			
	OLS	OLS	IV	IV	OLS	OLS	IV	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of average tariff	0.071	0.060	0.093	0.066	-0.114	-0.113	-0.097	-0.097
	[0.010]***	[0.014]***	[0.026]***	[0.030]**	[0.033]***	[0.035]***	[0.017]***	[0.017]***
Relative supply	-1.039	-1.038	-1.190	-1.542	0.069	0.069	0.061	0.06
	[0.112]***	[0.121]***	[0.386]***	[0.244]***	[0.009]***	[0.010]***	[0.006]***	[0.006]***
Relative wage		0.025		0.113		-0.013		0.015
		[0.032]		[0.063]*		[0.060]		[0.023]
Observations	32	32	32	32	32	32	32	32
R^2	0.47	0.48			0.80	0.80		

Source: Own elaboration based on EPH and Galiani and Porto (2010).
Notes: Standard errors clustered by time in brackets.
*** significant at 1 %; ** significant at 5 %; * significant at 10 %.

Table 6: Robustness to industry size definition
Industry tariffs and Informality
OLS and IV estimation

	OLS				IV			
	Definition 1		Definition 2		Definition 1		Definition 2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of tariffs	0.005	0.003	0.004	0.002	-0.061	-0.053	0.076	0.077
	[0.036]	[0.037]	[0.036]	[0.037]	[0.150]	[0.148]	[0.090]	[0.090]
Log of tariffs*I_S	-0.098	-0.097	-0.085	-0.084	-0.158	-0.159	-0.172	-0.172
	[0.047]**	[0.048]**	[0.039]**	[0.040]**	[0.051]***	[0.052]***	[0.051]***	[0.052]***
Log of tariffs*I_M	0.008	0.009	0.017	0.018	-0.064	-0.064	-0.050	-0.051
	[0.035]	[0.036]	[0.035]	[0.036]	[0.041]	[0.042]	[0.044]	[0.045]
Observations	26795	26795	26795	26795	26795	26795	26795	26795
R^2	0.18	0.18	0.18	0.18				
Overid. test (p-value)					0.71	0.69	0.75	0.78

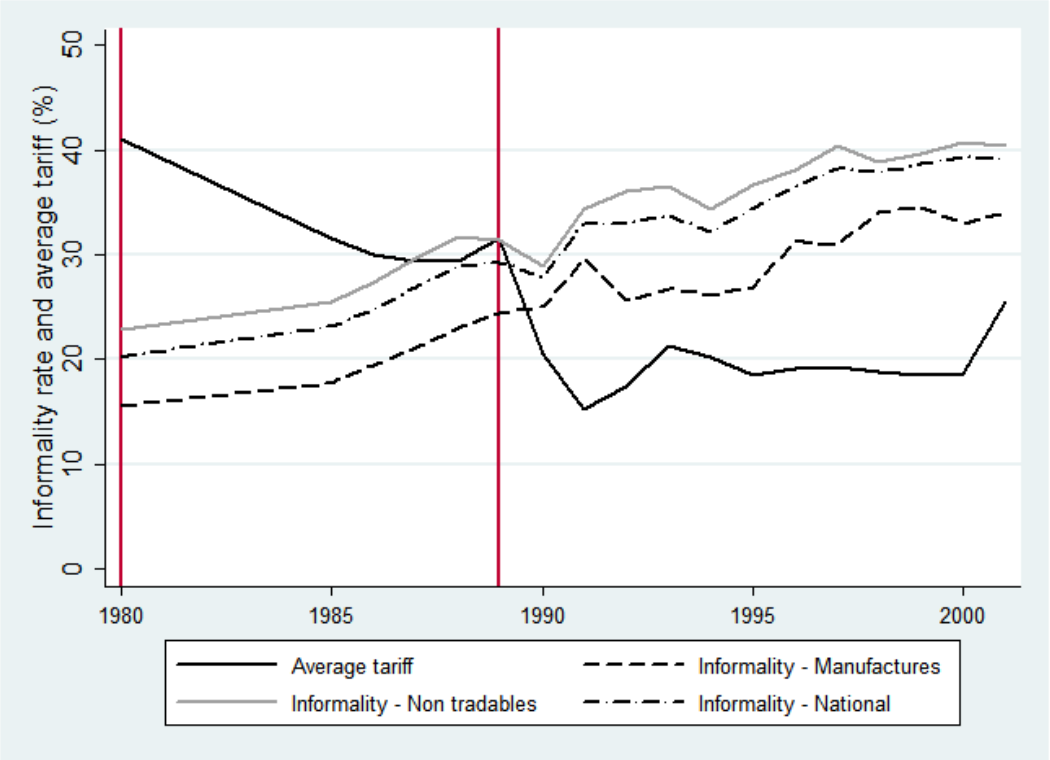
Source: Own elaboration based on EPH and Galiani and Porto (2010).
Notes: Standard errors clustered by industry and time in brackets.
*** significant at 1 %; ** significant at 5 %; * significant at 10 %.

Table 7: Robustness to industry size definition
Average tariff and Informality
OLS and IV estimation

	OLS				IV			
	Definition 1		Definition 2		Definition 1		Definition 2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of average tariff	0.056	0.039	0.053	0.033	0.121	0.085	0.112	0.084
	[0.014]***	[0.019]*	[0.015]***	[0.021]	[0.010]***	[0.028]***	[0.018]***	[0.027]***
Relative supply	-0.844	-0.876	-0.788	-0.830	-1.567	-1.864	-1.380	-1.711
	[0.157]***	[0.153]***	[0.174]***	[0.161]***	[0.130]***	[0.176]***	[0.258]***	[0.178]***
Relative wage		0.047		0.055	0.122			0.112
		[0.036]		[0.037]	[0.070]*			[0.065]
Observations	32	32	32	32	32	32	32	32
R^2	0.37	0.41	0.32	0.39				

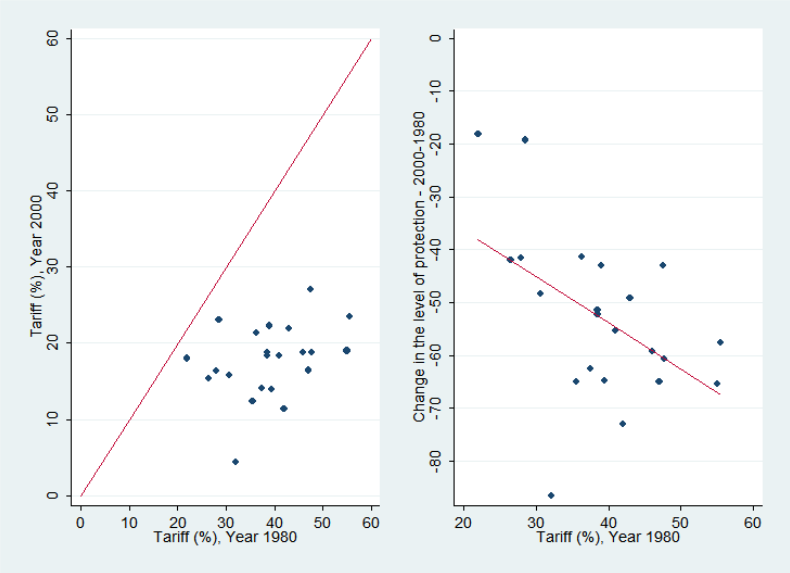
Source: Own elaboration based on EPH and Galiani and Porto (2010).
Notes: Standard errors clustered by time in brackets.
*** significant at 1 %; ** significant at 5 %; * significant at 10 %.

Figure 1
Tariff Reforms and Informality



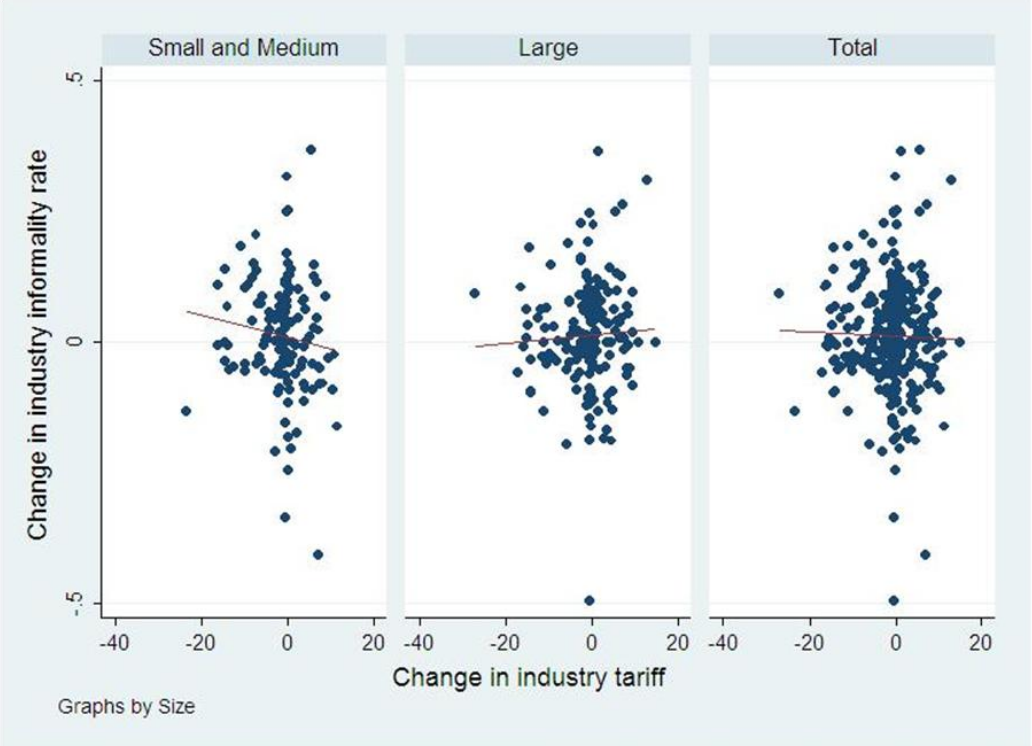
Source: Own elaboration based on EPH and Galiani and Porto (2010).

Figure 2
Changes in Tariff Protection



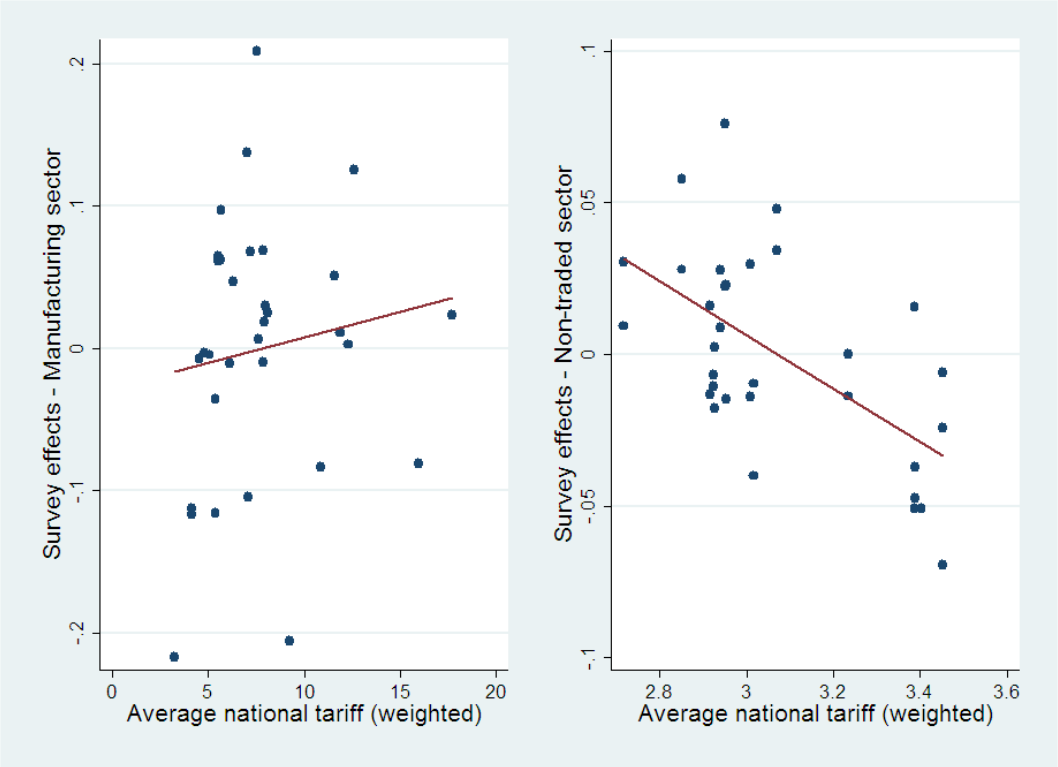
Source: Own elaboration based on EPH and Galiani and Porto (2010).

Figure 3
Short-Run Mechanisms
Changes in Tariffs and in the Informality Rate
Cross-Section



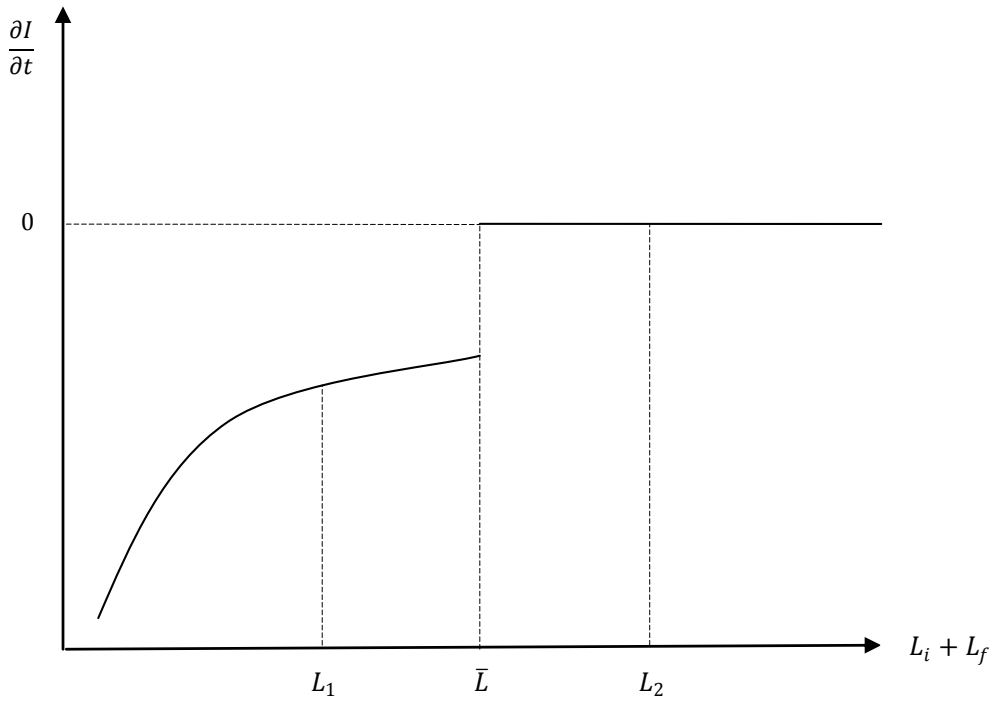
Source: Own elaboration based on EPH and Galiani and Porto (2010).

Figure 4
Long-Run Mechanisms
National Average Tariff and Informality in Manufacturing



Source: Own elaboration based on EPH and Galiani and Porto (2010).

Figure 5
Change in the informality rate and industry size



Source: Own elaboration.