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ABSTRACT

Enforcement of Labor Regulation and the Labor Market Effects of Trade: Evidence from Brazil

How does enforcement of labor regulations shape the labor market effects of trade? To tackle this question, we exploit the Brazilian trade liberalization episode and exogenous variation in the intensity of both the trade shock and enforcement across local labor markets. Regions with stricter enforcement observed no increase in informal employment but large disemployment effects. Regions with weaker enforcement had no employment losses but substantial increases in informality. All effects are concentrated on unskilled workers, with no effects on skilled workers. The results indicate that informality acts as a buffer that reduces trade-induced adjustment costs in the labor market.

JEL Classification: F16, J46, K31

Keywords: trade, enforcement of labor regulations, informality

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1 Introduction

Many developing countries, most notably in Latin America, underwent major trade liberalization episodes in the 1980s and early 1990s (Goldberg and Pavcnik, 2007). Despite the expected large gains from trade, concerns about the potential adverse effects on labor market outcomes have always been present,[1] specially in developing countries that are often characterized by poor labor market functioning, low state capacity and high poverty and inequality levels. In particular, one major concern is that trade opening could lead to a reallocation from formal to informal jobs, specially among less skilled workers (e.g. Goldberg and Pavcnik, 2003). These concerns are justified by the perception that informal jobs are inferior occupations relatively to formal ones, as informal workers are not covered by labor regulation (e.g. minimum wages) nor social security. Thus, this trade-induced informality effect could represent a potentially large welfare loss from trade opening.

However, informality can also represent greater *de facto* flexibility in the labor market, specially in the presence of burdensome and strict labor regulations. This greater flexibility could in principle allow firms and workers to cope better with adverse economic shocks, in which case the informal sector could help reducing job losses during bad times relatively to a counterfactual scenario with perfect enforcement and no informality.[2] This conjecture has important implications for how one interprets the labor market effects from trade and its potential welfare consequences. It also bears important policy implications, as it implies that the strictness and rigidity of labor market regulations (and its enforcement) can have first order interaction effects with trade reforms.

In this paper we directly tackle these issues by exploiting Brazil's large scale, unilateral trade liberalization episode of the early 1990's. Brazil is an attractive empirical setting for at least three reasons. First, the trade liberalization had heterogeneous and substantial effects across local labor markets in Brazil (e.g. Kovak, 2013; Dix-Carneiro and Kovak, 2017a,b). Second, just before the beginning of the trade liberalization process, in 1988, Brazil underwent a major Constitutional reform that substantially increased the restrictiveness and the direct costs associated to labor regulation (Barros and Corseuil, 2004).[3] Third, enforcement of labor regulation varies greatly across regions in Brazil

[1] A recent literature has consistently documented that local labor markets whose employment is concentrated in industries facing larger tariff cuts are more negatively affected than those concentrated in industries facing lower tariff cuts. See, for example Autor et al. (2013); Kovak (2013); Costa et al. (2016); Dix-Carneiro et al. (2017); Dix-Carneiro and Kovak (2017a,b).

[2] Dix-Carneiro and Kovak (2017a) find evidence that is consistent with this conjecture, but only in the long run: regions that are hit harder by the trade liberalization observe increases in non-employment and informal employment in the mid-run (1991-2000), but in the long run (19921–2010) the effects on non-employment vanish and on informal employment persist (and even amplify).

[3] According to the employment index in Botero et al. (2004), the cost of labor regulation in Brazil is

(Almeida and Carneiro, 2012). We exploit the geographic variation in the intensity of trade shocks and enforcement of labor regulation to assess if, and to what extent, the presence of stricter enforcement of a costly regulatory framework shapes the labor market responses to trade liberalization.

We construct a measure of local, trade-induced shocks based on changes in tariffs at the industry level combined with the initial (pre-trade shock) employment composition by industries across regions (e.g. Topalova, 2010; Kovak, 2013). An important identification assumption is the exogeneity of these shocks relatively to (unobserved) pre-existing trends in local labor markets. Previous papers that use the same regional trade shock document direct supportive evidence of this assumption (Kovak, 2013; Dix-Carneiro and Kovak, 2017a,b; Dix-Carneiro et al., 2017).

Another key aspect of our empirical strategy is the measurement of enforcement intensity across local economies. In Brazil, enforcement of labor regulation is the sole responsibility of the Ministry of Labor and the technology of enforcement is relatively simple (Almeida and Carneiro, 2012): labor inspectors are assigned to labor offices (L.O.) located in municipalities across the country and they travel by car to inspect firms. Hence, the greater the distance to the nearest L.O., the least likely firms are to be inspected and the weaker enforcement of labor regulation is likely to be (all things equal). We thus use the distance to the nearest labor office as a proxy for enforcement capacity in that local market. Since the locations of L.O. could in principle be determined in response to the labor market effects of the trade reform itself, we collect new data on the date of creation of all labor offices in Brazil and we restrict our analysis to offices created before the trade opening process started. Hence, we are able to construct a measure of enforcement capacity that is pre-determined relatively to future trade shocks and labor market conditions.

We start by examining the basic results of the regional trade shocks on labor market outcomes. We use individual-level Census data from 1990 and 2000 to compute local labor market outcomes net of the influence of socio-demographic variables (e.g. gender, schooling and age). Consistently with previous studies, we show that in the medium run (1991-2000) regions more exposed to trade liberalization observed higher informality and greater non-employment relatively to regions less exposed.[4] Differently from previous studies, however, we also examine how these effects are distributed across workers of

around 20 percent above the mean and median of 85 countries in the world and more than 2.5 times as large as in the United States.

[4]Contrary to previous studies (such as Dix-Carneiro and Kovak, 2017a), we focus only on the mid-run (1991-2000) and not on the longer run (1991-2010). We do so because we are interested in investigating the interaction between enforcement of labor regulation and trade shocks, and to what extent it reduces/amplifies the labor market effects of trade in the aftermath of a trade opening episode.

different skill levels. The results are striking. The average effects of higher informality and non-employment are almost entirely driven by low skill workers, while we find little effect on skilled workers.

Having established that the trade shock increased informality and non-employment and that these effects were concentrated on low skill workers, we examine the heterogeneity of these effects across enforcement levels. For that, we use a direct measure of enforcement intensity, namely, the ratio of the total number of inspections to the total number of formal firms in a given local market. Since this measure is potentially affected by unobserved, time-varying determinants of local labor market outcomes, we use distance to the nearest L.O. as an instrument in a limited information maximum likelihood estimator. As mentioned above, we construct our instrument using only the L.O. created before the trade opening started to make sure that our measure of enforcement capacity is pre-determined relatively to (future) trade shocks and labor market conditions.

The results show that regions adversely affected by the tariff shock that had more intense labor enforcement suffered lower informality effects but greater non-employment effects relatively to regions that had lower levels of enforcement. Symmetrically, regions with lower enforcement had greater informality effects but lower non-employment effects. Again, all the effects are concentrated on low-skill workers, with no effects on high-skill ones. Low-skill workers located in regions with low enforcement levels (i.e. the first decile of the enforcement distribution) would experience an increase of 4.6 percentage points in informality but no effect on employment. For regions with the highest levels of enforcement (i.e. the 10th decile of the enforcement distribution), the effects are reversed: low-skill workers experience no informality effects but an increase of 6.5 percentage points in non-employment rates. These effects are large, as they correspond to 53.4 and 162 percent of a standard deviation is decadal changes in informality and non-employment rates, respectively. Thus, we find direct evidence that stricter enforcement of labor regulation substantially amplifies disemployment effects by not allowing firms and workers to resort to informal contracts. In contrast, in regions with low enforcement the informal sector *de facto* acted as a buffer to the adverse local demand shocks brought about the trade liberalization process.

To rationalize the fact that trade liberalization leads to an increase in informality, we adapt the argument developed by Ulyssea (2018).[5] If one considers an unilateral

[5]The simplest argument to rationalize the result that trade liberalization leads to an increase in informality relies on the following idea: once domestic firms are exposed to greater competition from foreign firms, they respond by trying to reduce labor costs through greater use of informal labor, which is not subject to labor regulations. Without further elaboration, however, this argument is not consistent with basic micro theory, as profit-maximizing firms should have shifted to informal labor even prior to the trade reforms (Goldberg and Pavcnik, 2003).

trade opening as a negative price shock to domestic firms, the framework predicts an increase in *labor* informality through two channels. First, more firms would decide to enter the informal sector, and informal firms can only hire informal workers. This is the *extensive margin of informality*. Second, *formal firms* would now be pressured by greater competition (lower prices), which would induce them to hire a greater share of *informal workers*. This is the *intensive margin of informality*. The government can target these margins separately and the enforcement measure considered in this paper – inspections of formal firms by the Ministry of Labor – refers to the intensive margin alone. In such a framework, formal firms located in regions with stricter enforcement would not be able to adjust through the intensive margin of informality and would be more likely to simply reduce their labor force. Hence, if one considers an unilateral trade opening as a negative price shock to domestic firms, then this framework is able to rationalize all of our results (see Section 3 for a more in depth discussion).

Our paper contributes to three different literature streams. First, the literature on trade and local labor markets, which includes (but is not restricted to) Topalova (2010), Kovak (2013), Autor et al. (2013), Hakobyan and McLaren (2016), and Dix-Carneiro and Kovak (2017a,b). Second, this paper also relates to the literature on trade and informality, which until recently had found little or no effect of trade liberalization on informality (Goldberg and Pavcnik, 2003; Menezes-Filho and Muendler, 2011; Bosch and Esteban-Pretel, 2012). In contrast, Dix-Carneiro and Kovak (2017a,b) find significant effects of trade liberalization on informality, which as discussed by the authors can be reconciled by differences in research design, unit of analysis, and time horizons. Differently from both literature streams, we focus on a new dimension: the interaction between the enforcement of labor regulation and trade policies, and how these interactions shape the labor market adjustment to trade shocks. Also importantly, we document that the effects of trade opening on informality and non-employment are mostly concentrated on low skill workers, both on average and across different enforcement levels. Finally, our paper also dialogues to the literature that argues that informality can also be seen as introducing *de facto* flexibility to otherwise very rigid formal labor markets that are subject to burdensome and costly regulatory frameworks (e.g. Meghir et al., 2015; Ulyssea, 2018). In particular, in an earlier paper Boeri and Garibaldi (2005) argue that, despite advances in monitoring capacity by the government, informality is "tolerated" because it attenuates unemployment. Similarly, Ulyssea (2010) quantitatively shows in a two-sector matching model that when the government cracks down on informality (by increasing enforcement), unemployment increases and total welfare decreases. Even though our empirical results refer to a very different setting, they are consistent with the mechanisms highlighted in both papers.

The remaining of the paper is structured as follows. Section 2 briefly describes the data and the measure of trade shock used. Section 3 describes the empirical strategy, while Section 4 presents the empirical results. Section 5 concludes and points to future steps.

2 Background and Data

2.1 Trade Liberalization and Local Trade Shocks in Brazil

Until 1990, Brazil was characterized by a complex system of protection against foreign competition that included both tariff and non-tariff barriers (Kume et al., 2003), and therefore nominal tariffs did not represent the *de facto* level of protection faced by industries in the country. During the 1988-1989 period, however, there was a first move toward reforming the structure of protection, which reduced tariff redundancy and special regimes, among other measures. Additionally, in March 1990 the newly elected president unexpectedly eliminated non-tariff barriers, typically replacing them with higher import tariffs in a process known as "tariffication". This implied that, starting in 1990, tariffs became the main trade policy instrument and therefore also accurately reflected the actual level of protection faced by Brazilian products.[6]

From 1990 until 1995, Brazil implemented a major unilateral reduction in trade tariffs.[7] During this period, the average tariff fell from 30.5 percent to 12.8 percent and the standard deviation fell from 14.9 percent to 7.4 percent.[8] Hence, not only the overall level of protection decreased but also the variation across industries was substantially reduced. Figure 1 shows the percentage change in tariffs across the main industries, which is one of the sources of variation we exploit in our identification strategy, as discussed ahead. As the Figure shows, there was substantial variation across sectors in tariff reductions. Moreover, tariff cuts were strongly and negatively correlated with pre-liberalization tariff levels: industries with initially higher levels of protection (i.e. tariffs) experienced larger tariff reductions (Kovak, 2013).

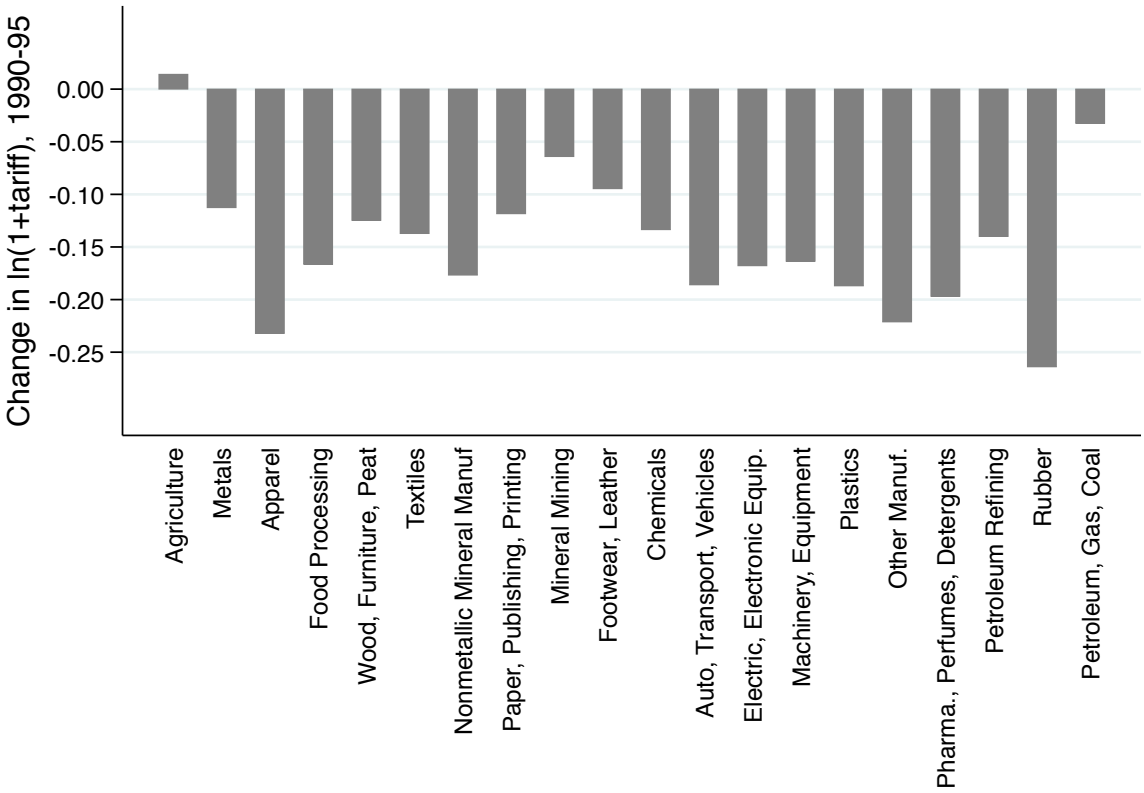
Our measure of local trade shocks exploits the fact regions that were more specialized

[6] A more detailed description of the trade liberalization in Brazil can be found in (Kovak, 2013; Dix-Carneiro and Kovak, 2017b; Dix-Carneiro et al., 2017).

[7] There were minor changes in tariffs after 1995, which are not relevant compared to the changes that occurred in the 1990-1995 period (see Dix-Carneiro et al., 2017)

[8] We consider changes in output tariffs to construct the measure of local trade shocks discussed in the next subsection. Alternatively, one could use effective rates of protection, which incorporate both input and output tariffs. However, at the level of industry classification used here – which is standard in the literature – changes in input and output tariffs are highly correlated. Indeed, the regional tariff changes computed using either measure (output tariffs or effective rates of protection) are almost perfectly correlated (Dix-Carneiro et al., 2017), and the choice of measure does not affect the results.

Figure 1: Changes in log(1 + tariff), 1990-1995



Source: Dix-Carneiro and Kovak (2017b).

in industries that experienced larger tariff reductions are more likely to have been more adversely affected by the trade opening episode. Put differently, the trade liberalization episode is more likely to represent a substantial negative labor demand shock in regions that had a larger fraction of its labor force employed in industries that observed larger tariff reductions, relatively to regions that had a larger fraction of its employment in industries less affected. We thus use tariff data from Kume et al. (2003) to construct the "Regional Tariff Change" (RTC) as proposed by Kovak (2013):

$$RTC_r = \sum_i \beta_{ri} d\ln(1+\tau_i) \tag{1}$$

where

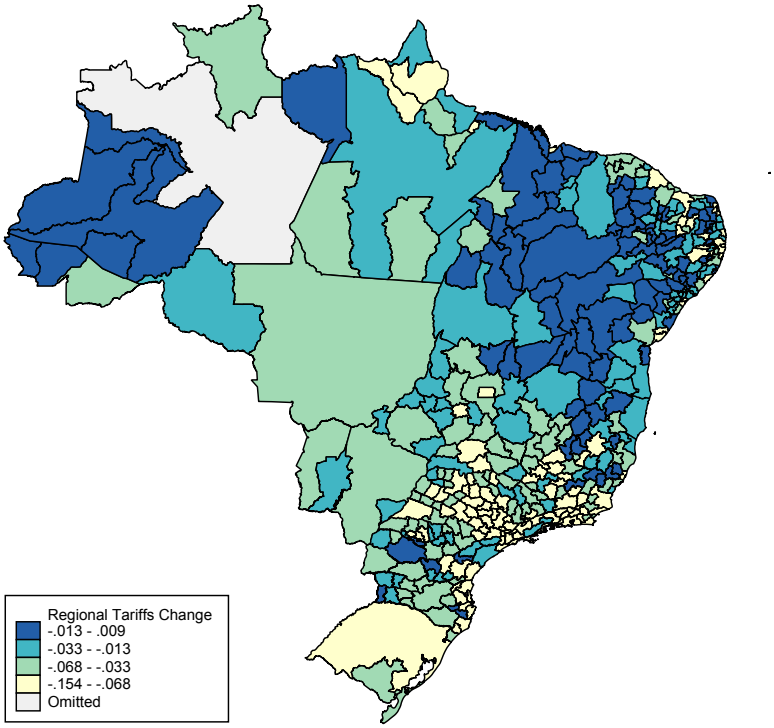
$$\beta_{ri} = \frac{\frac{\lambda_{ri}}{\theta_i}}{\sum_i \frac{\lambda_{ri}}{\theta_i}}$$

and $\lambda_{ri} = \frac{L_{ri}}{L_r}$ is the fraction of regional labor allocated to industry i at region r; and θ_i

is is equal to one minus wage bill share of industry i.

Since we further investigate heterogenous effects of trade liberalization on skilled and unskilled workers separately, we calculated different measures for skilled and unskilled workers, which we denote $RTC_{r,k}$, where k denotes the skill group. For that, we compute weights that are specific to the two skill groups, which are given by $\lambda_{rik} = \frac{L_{rik}}{L_{rk}}$.[9] Figure 2 shows how the regional trade shock, RTC_r, varies across micro-regions in Brazil.[10]

Figure 2: Regional Tariff Changes



2.2 Labor Regulations and Enforcement

In Brazil, the permissible types of labor contracts, their conditions and terms for termination are completely regulated by a labor code based on the civil law system, the *Consolidação das Leis Trabalhistas* (CLT), which dates back to 1943. As part of the labor regulations in Brazil, a formal workers is required to hold a work booklet that is

[9]This skill-specific measure is not directly connected to a model, as is the case of RTC_r (expression 1), and can be seen as a first order approximation. See Dix-Carneiro and Kovak (2015) for a more general discussion within a specific-factors model of regional economies with two types of workers.

[10]In the Appendix we present the robustness analysis using alternative measures of local trade shocks (such as the ratio of imports to production and import penetration coefficient), and the results remain largely unchanged.

issued by the Ministry of Labor, and which must be signed by the employer and contains the worker's entire formal labor history. Having the labor contract registered in this booklet in principle entitles workers to a series of benefits, such as the 13th monthly salary, unemployment insurance, severance payment, a one-month paid vacation, and at least 50 percent premium for overtime hours.

In 1988, the new Federal Constitution was enacted and substantially extended the range of labor regulations and workers' benefits. In particular, it increased severance payments by fourfold, reduced the regular work week to forty-four hours, and increased maternity leave to 4 months.[11] In sum, the Brazilian labor regulation introduced in 1943 was already quite detailed, extensive and rigid, leaving almost no room for bilateral negotiations between employers and employees. In addition to that, the changes introduced in 1988 by the Constitution substantially increased the costs associated to hiring a formal worker but in particular the costs of firing workers. According to the employment index in Botero et al. (2004), the cost of labor regulation in Brazil is around 20 percent above the mean and median of 85 countries and more than 2.5 times as large as in the United States. As for labor taxes, not only the rates are high in Brazil but also there are also substantial compliance costs involved.[12]

Given how cumbersome and costly the labor regulation is, both firms and workers have incentives to either partially comply, or avoid it entirely via informal labor contracts. Thus, in such an environment where incentives to formalization are arguably weak, enforcement plays a substantial role in determining not only informality levels, but labor market outcomes more broadly. The Ministry of Labor is directly responsible for enforcing labor regulations, but it only inspects registered firms and therefore it does not tackle informal labor in informal firms. Enforcement is implemented in a very decentralized way, both at the state level (with a labor office called *delegacia do trabalho*) and, within states, at the subregion level through local labor offices called *subdelegacia*. The state level office (*delegacia*) is always located in the state's capital and the local offices (*subdelegacias*) are spread throughout the state in different municipalities. The number of local offices is a function fo the state's size and economic relevance (Almeida and Carneiro, 2012).

Inspectors are allocated to a specific *subdelegacia*, and they must travel by car to inspect any given firm. Most inspections are triggered by anonymous reports, and in-

[11] See De Barros and Corseuil (2004) for a complete description of the changes introduced by the 1988 Constitution.

[12] The time required to pay labor taxes in Brazil is nearly 5 times higher than in the U.S., 491 and 100 hours, respectively. As for the tax rate, when computed as a share of commercial profits – which provides a cross-country comparison – it amounts to 42.1 percent in Brazil, 12.9 percent in Canada and 10 percent in the U.S. (Doing Business, 2007).

spectors are expected to assess compliance with all the relevant dimensions of the labor code (e.g. hours of work) and not only if the worker is formally registered or not. Even though the Ministry of Labor aims at applying an uniform criteria for labor market enforcement throughout the country, there is substantial regional variation in enforcement intensity (Almeida and Carneiro, 2012). In particular, one of the factors that determines regional variation in enforcement is the relative density of local labor offices across regions, which by its turn determines the travel distances that inspectors face in order to carry out the inspections. As we argue in the next subsection, this is a key determinant of the intensity of enforcement across local labor markets.

2.3 Data

We use three datasets in our empirical exercise. The first is the Decennial Population Census, which contains information on individuals' socioeconomic characteristics, as well as labor market outcomes. Particularly important for our exercise, the Census provides information on workers' informality status. We define as informal workers those employees who do not hold a formal contract, which in Brazil is characterized by a "signed work booklet" (as discussed in previous section). Workers who report being employees are directly asked whether they have a formal contract, which is the information we use to define if an employee is formal or not. Our measure of informality therefore excludes the self employed. We do so because the mechanisms that we focus here, and in particular our measures of enforcement, refer to employees only.

Our unit of analysis is the micro-region, which is a collection of contiguous municipalities that are economically integrated. The micro-regions are defined by the National Bureau of Statistics (IBGE) and closely reproduce the idea of local economies that has been extensively used in the recent literature (e.g. Kovak, 2013; David et al., 2013; Dix-Carneiro and Kovak, 2017b; Costa et al., 2016). We use a mapping between municipalities and micro-regions that results in 413 consistent micro-regions between 1990 and 2000, which is our period of analysis. Table 1 provides the descriptive statistics of all variables used in this analysis at the micro-region level. We define low skill workers as those with less than completed high school, and high skill workers as those with at least a high school diploma. Non-employment is defined as those individuals actively looking for jobs (the unemployed) and those out of the labor force. We use this measure (instead of unemployment) to reduce measurement error, as individuals often transit between unemployment and out of the labor force statuses. We start by noticing that both informality and non-employment increased between 1991 and 2000. This was observed among low and high skill workers. In contrast, wages increased during this period and particularly

so among low skill workers. The table also shows table that, on average, micro-regions have suffered a negative trade shock (i.e. greater exposure to foreign competition).

Table 1: Descriptive Statistics – Micro-Regions

	Mean	SD	Min.	Max.
Δ Informality	0.123	0.080	-0.173	0.369
Δ Non-Employment	0.159	0.036	0.023	0.259
Δ Low Skill Informality	0.136	0.086	-0.183	0.389
Δ Low Skill Non-Employment	0.144	0.040	-0.006	0.257
Δ High Skill Informality	0.119	0.117	-0.388	0.583
Δ High Skill Non-Employment	0.081	0.043	-0.112	0.439
Δ Wages	0.030	0.125	-0.406	0.388
Δ Low Skill Wages	0.125	0.136	-0.355	0.62
Δ High Skill Wages	0.004	0.166	-0.449	0.654
RTC	-0.045	0.040	-0.154	0.008
RTC-Unskilled	-0.043	0.039	-0.155	0.009
RTC-Skilled	-0.091	0.035	-0.172	0.014
Share of skilled workers	0.116	0.060	0.019	0.350
Distance L.O. (per 100km)	1.36	1.07	0.05	6.87
Inspections per 100 Firms	7.43	8.13	0.00	67.4

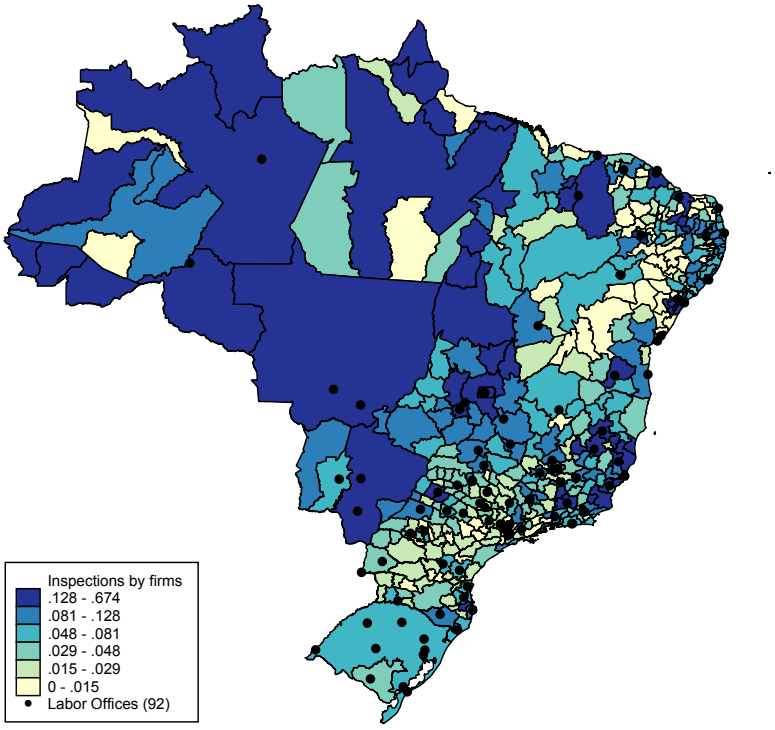
Notes: The Δ variables indicate the variation between 1991 and 2000; RTC denotes the Regional Tariff Changes, Distance to L.O. is the maximum driving distance to the nearest labor office created up to 1990. Inspections per 100 firms is the total number of inspections conducted by the Ministry of Labor in the 1995-1999 period divided by the number of firms multiplied by 100. Skilled workers are defined as those with at least completed high school.

The second data set used contains administrative data from the Ministry of Labor related to enforcement activity. This dataset contains yearly information on the number of firms inspected by municipality from 1995 to 2013; number of inspectors responsible for the auditing process in each state of the country; and the location of all labor offices. We add to this administrative data set a crucial piece of information to our empirical strategy, namely, the date of creation of each local labor office (i.e. *subdelegacia*). For that, it was necessary to directly call each of the 121 labor offices in Brazil to collect this information. Of these, 92 offices were created prior to 1990 (the start year of the trade opening process), 19 offices were created between 1990 and 2000, and the remaining were created after 2000. Finally, we use the data on the driving distance to the nearest labor office in each municipality compiled by Almeida and Carneiro (2012).

In order to aggregate the enforcement-related variables at the micro-region level, we

compute the ratio between the total number of inspections carried out in a given micro-region and the total number of formal firms. We use the number of inspections for the period of 1995 to 1999. We obtained this information directly from the Ministry of Labor. As for the distance, we used the maximum distance to the nearest labor office within a micro-region. Hence, the greater this measure, the weaker the enforcement in a given micro-region.[13] Figure 3 depicts regional variation in enforcement intensity, as well as the location of all 92 *subdelegacias* (local labor offices) created prior to 1990 in Brazil. As the figure shows, there is a lot of variation in the intensity of enforcement and in the density of local labor offices across micro-regions. Indeed, as shown in the bottom of Table 1, on average there were around 7.5 inspections per 100 firms in a given micro-region in the 1995-1999 period, but the most inspected region experienced almost 68 inspections per 100 firms. The average maximum distance between a municipality in a micro-region and a nearest labor office is 136 kilometres, with the minimum and maximum being 5 and 687 kilometres, respectively.

Figure 3: Enforcement of Labor Regulation



Finally, we examine to what extent distance to nearest labor office is related to en-

[13]We experimented with different measures, such as the minimum and the median distance. The results are largely robust to these changes.

forcement level. We do so by regressing the logarithm of our measure of enforcement (ratio of total inspections to number of formal firms) onto dummies of the quartiles of maximum distance to the nearest labor office, which is our measure of enforcement capacity. Table 2 shows a simple regression at the micro-region level between the total inspection by firms (in logs) and quartile dummies of the maximum distance from the nearest labor office. It depicts a clear pattern. Regions located further away from the nearest labor office present lower levels of enforcement, corroborating the visual idea presented in Figure 3 . The correlation is sizeable. It shows a firm in a region in the third quartile of distance is 20% less likely to be inspected than one in a region in the first quartile. All in all, the map and correlation suggest that geographical distance is crucial for labor regulation strictness in a region.

Table 2: Enforcement Production Function

Dep. Variable: $\log(Enforcement\ Intensity)$	
2^{nd} Quartile of Dist. to L.O	-0.229*
	(0.130)
3^{rd} Quartile of Dist. to L.O	-0.329**
	(0.132)
4^{th} Quartile of Dist. to L.O	-0.553***
	(0.156)
Observations	400
R-squared	0.384

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. State fixed-effects included. *Enforcement Intensity* refers to the ratio of total inspections to number of formal firms in each micro-region. Distance to the Labor Office is the maximum distance to the nearest L.O., as discussed in the text.

3 Empirical Strategy

In this section we describe our empirical strategy to identify the basic effects of local trade shocks on labor informality and non-employment, as well as the heterogeneous effects across regions with different enforcement levels. Before proceeding to the empirical specifications, however, it is useful to describe the economic mechanisms that guide our empirical exercise.

3.1 Theoretical framework

The simple argument to rationalize the basic result that trade liberalization leads to an increase in informality relies on the idea that once domestic firms are exposed to greater competition from foreign firms, they would respond by trying to reduce labor costs through greater use of informal labor, which is not subject to labor regulations. However, without further elaboration, this argument is not consistent with basic micro theory, as profit-maximizing firms should have shifted to informal labor even prior to the trade reforms, otherwise this could not be considered an optimal behavior (Goldberg and Pavcnik, 2003). Therefore we rely in a richer framework developed in Ulyssea (2018) to analyze the results.

This section is used merely to illustrate the mechanisms we have in mind. The interested reader is referred to Ulyssea (2018), while the reader only interested in the empirical exercise can skip directly to section 3.2.

In the model firms can exploit two margins of informality. The first is the *extensive margin*, which refers to the decision of whether or not paying entry fees and register the business. The second is the *intensive margin*, which refers to the decision of a formal (registered) firm to hire workers without a formal contract. Firms sort between sectors upon entry based on their expected productivity and sector membership is defined by the extensive margin, and the (in)formal sector is comprised by (un)registered firms. If a firm decides to enter the formal sector, it faces fixed registration costs and higher variable costs due to revenue and labor taxes. The latter can be avoided by hiring informal workers. However, there is an expected cost of being audited by the government, in which case the firm must pay fines in addition to all evaded labor costs and taxes. Because this probability of detection is assumed to be increasing and convex in the number of informal workers, smaller formal firms will hire a larger fraction of their labor force informally and this share is decreasing in firms' size. If a firm enters the informal sector, it avoids registration costs and taxes altogether, but also faces an expected cost of being caught that is increasing in firm's size.[14] Since productivity and size are one-to-one in the model, more productive firms (in expectation) self-select into the formal sector and less productive firms enter the informal sector. Conditional on being formal, less productive firms hire a larger fraction of informal workers.

Firms hire both low and high skill workers, which are aggregated into a composite labor input through a CES production function, where skill shares may differ across formal and informal firms. Indeed, the author's estimates imply that the formal sector

[14]This is a common formulation in the literature, see for example de Paula and Scheinkman (2010) and Leal Ordonez (2014), among others.

is more intensive in high skill workers, which is consistent with the fact that informality is more prevalent among low skill workers. Additionally, the estimation results indicate that the expected cost of hiring informal workers is lower for low skill than high skill individuals, which suggests that higher enforcement would have stronger effects on low skill workers.[15]

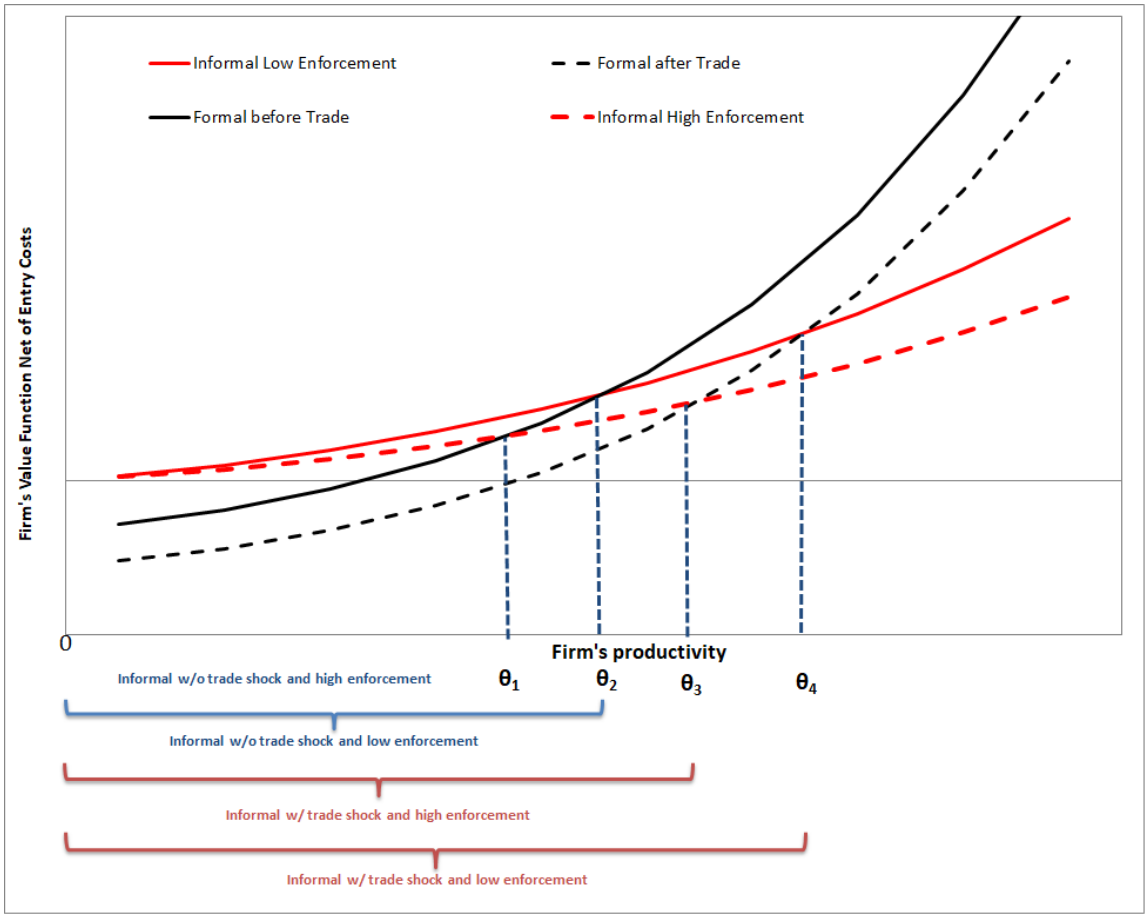
A greater level of enforcement can be interpreted in this model as a greater probability of detection, which in this model is equivalent to an increasing (on firms' size) and convex cost of being informal. As for an unilateral trade opening – as it was the case of Brazil's trade liberalization episode – in this model it would correspond to a negative price shock for domestic firms, both formal and informal. In order to illustrate the mechanism we have in mind, we take the estimated model in Ulyssea (2018) and simulate the value functions of being formal before and after the trade opening shock, which is parameterized as a permanent decline in the equilibrium price. Even though in Ulyssea's model prices (i.e. wages) fully adjust in equilibrium, Figure 4 shows the results of a partial equilibrium simulation, where we show firm's payoffs after a one-time price reduction (equivalent to an increase in real wages). For the sake of expositional simplicity, we assume that the negative price shock only affects formal firms, even though all that is needed is that formal firms are more adversely affected. Moreover, we consider two scenarios for informal firms: low and high enforcement. Figure 4 shows these four curves.

Consider the first the situation prior to the trade shock, where there are two markets, one with a low level and another with a high level of enforcement (dashed red line, solid black and red lines). In the market with a high level of enforcement, all firms with productivity $\theta < \theta_1$ will optimally choose to be informal. In the market with a low level of enforcement, firms with productivity $\theta < \theta_2$ will choose to be informal, which shows that for a given distribution of firm productivity, the market with low level of enforcement will have a larger share of informal firms, as expected.

When the trade shock hits, both the low and high enforcement markets observe an increase in the informality thresholds from θ_1 to θ_3 and θ_2 to θ_4. However, the greatest impact on informality will occur in the market with a lower level of enforcement. It is important to note that one would reach the same conclusion if the shock also hits the informal sector, as long as the value function in the informal sector is not more sensitive to the shock than in the formal sector. Moreover, if we allow informal firms to be directly hit by the trade opening shock, it would have a larger impact on employment, as many of these firms would be pushed out of the market.

[15]The results in Ulyssea (2018) are not directly comparable to ours, but his results show that an uniform increase in enforcement on the intensive margin leads to a stronger decrease in informality among low skill workers.

Figure 4: Trade Opening under Low and High Enforcement



Finally, given that informal firms are more intensive in low skill workers and formal firms tend to hire more informal workers among low skill individuals, the effects discussed above would be stronger among them than among high skill individuals. Therefore, this model implies that one should expect an increase in informality in the aftermath of a unilateral trade shock in markets that have lower levels of enforcement. Conversely, markets that have higher levels of enforcement would observe a smaller increase in informality but a larger decrease in employment. Additionally, these effects should be more pronounced among low skill workers.

3.2 Empirical Strategy

Our empirical strategy consists of two steps. In the first step, we capture the changes in the outcome of interest at the micro-region level, netting out the influence of individuals' socio-demographic characteristics. More concretely, we run the following regressions

at the individual level:

$$Y_{irt} = \sum_r \gamma_{rt} D_{rt} + \mathbf{x}'_{i,t}\beta_t + \epsilon_{i,t} \tag{2}$$

where i indexes individuals, $t = 1991, 2000$ denotes the year, D_{rt} denotes a set of 413 micro-region dummies, and $\mathbf{x}_{i,t}$ is a vector of individual characteristics that includes age, age squared, schooling, gender and race.

The outcomes considered are individual level wages, a dummy for whether the individual is informal and a dummy if she is not employed, which includes both unemployment and out of the labor force statuses. Importantly, the informality dummy considers only those individuals who work as employees in the private sector, and we define as informal those who do not hold a formal contract (*no signed work booklet*). Thus, we are effectively measuring the share of informal *employees* and we exclude the self employed. Since we are analyzing enforcement of labor regulation, which only applies to employees, this informality definition is the most consistent with the goals of our empirical exercise.

The first step thus provides us with a measure of average wages, informality and non-employment at the micro-region level. In order to assess the heterogeneous effects across skill groups, we also run regression 2 separately for low and high skill workers and obtain separate estimates of $\hat{\gamma}$ by skill level. In the second step, we run regressions in first difference at the micro-region level. The first set of regressions we estimate re-visit the overall labor market impacts of the local trade shock and provide new evidence on the heterogeneity across skill levels. The basic specification is as follows:

$$\Delta\hat{y}_r = \zeta_0 + \zeta_1 RTC_r + u_r \tag{3}$$

where $\Delta\hat{y}_r \equiv \hat{\gamma}_{r,2000} - \hat{\gamma}_{r,1991}$, r indexes the micro-region and ζ_{1t} identifies the relative effect of greater exposure to the trade shock and the change in a given outcome between 1991 and 2000. In all of our regressions, we control for 27 state dummies, which absorb differential state level trends. The inclusion of state dummies is important because many relevant policies and resources are defined at the state level (e.g. police force and a substantial fraction of health and education expenditures). In the Appendix A.2, we also control for some demographic variables at baseline (in 1991) to assess the robustness of our results, and they remain largely unchanged.

Since we are using first-stage estimates as dependent variables in the second stage and aggregated data at the micro-region level, we weight the second-stage regressions by the inverse of the first-stage regression standard-errors.[16] Standard errors are also

[16]Using population to weight the regressions delivers the same results, which are available upon request.

clustered at the meso-region level in all regressions. This a greater level of aggregation, so this clustering allows for correlated errors among neighbouring micro-regions. When estimating heterogeneous effects across skill levels, we use the same specification but with the appropriate $\hat{\gamma}$ estimated separately by skill level. In this case, we use the appropriate definition of RTC discussed in the previous section.

Our main goal is to investigate how enforcement of labor regulations interact with the trade shock in shaping the local labor markets response to trade liberalization. For that, we use the measure of enforcement discussed in Section 2.3, which is the ratio of total inspections between 1995 and 1999 to the number of formal firms in the micro-region. The second stage regression is thus given by:

$$\Delta\hat{y}_r = \alpha_0 + \alpha_1 RTC_r + \alpha_2 RTC_r \times Enforcement_r + \alpha_3 Enforcement_r + \varepsilon_r \qquad (4)$$

where again r denotes the micro-region and we control for state dummies in all regressions.

The measure of enforcement ($Enforcement_r$) is likely to be endogenous, as the government might respond to changes in local labor market conditions by increasing the resources available to enforce the labor regulation in that given market. Conversely, it is also possible that the government relaxes enforcement of labor regulations in face of a negative shock to labor demand. We therefore instrument both $Enforcement_r$ and $RTC_r \times Enforcement_r$ by the maximum distance to the nearest labor office, the distance interacted with RTC_r, and distance interacted with the number of inspectors at state level. The latter aims at capturing the effect of greater resources to conduct inspections available at the state level. Since we control for state dummies and use the interaction, this term captures the fact that for a given distance, states with more inspectors will have more effective enforcement. As Table 2 shows, the maximum distance to the nearest labor office predicts well the intensity of enforcement at the micro-region level. Moreover, since we are using only distance to the labor offices created up until 1990, we are only using the pre-determined enforcement capacity, which is not responding to the (future) local trade shock and local labor market conditions.

4 Results

4.1 Overall Effects on Informality and Non-employment

We start by analyzing the basic results on informality and non-employment. Table 3 shows the estimates of regression 3 using as dependent variable changes in informality and non-employment for all workers (columns 1 and 2), low skill workers (columns 3 and

Table 3: Overall Effects on Informality and Non-Employment

	All		Low Skill		High Skill	
	Inf.	Non-Emp.	Inf.	Non-Emp.	Inf.	Non-Emp.
	(1)	(2)	(3)	(4)	(5)	(6)
RTC	-0.289***	-0.317***				
	(0.080)	(0.043)				
RTC-Unskilled			-0.335***	-0.340***		
			(0.095)	(0.047)		
RTC-Skilled					0.134	-0.097
					(0.172)	(0.063)
Observations	413	413	413	413	413	413
R-squared	0.364	0.368	0.379	0.377	0.306	0.317

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

4) and high skill workers (columns 5 and 6). The first two columns reproduce the same results shown in previous studies (e.g Dix-Carneiro and Kovak, 2017b; Dix-Carneiro et al., 2017): between 1991 and 2000, regions that were exposed to stronger tariff reductions experienced higher increases in informality and non-employment relatively to regions less affected. The effects are statistically significant and economically meaningful. For example, moving a region from the 90th to the 10th percentile of the distribution of RTC_r implies a change of -0.1 log point in the trade shock. Thus, the results from the first two columns of Table 3 imply that a micro-region which was very affected by the trade opening shock experienced an increase of 2.9 $(0.1 \times 0.289 \times 100)$ and 3.2 $(0.1 \times 0.317 \times 100)$ percentage points in informality and non-employment rates, respectively. To put these numbers in perspective, this corresponds to around 23 and 20 percent of the average increase in informality and non-employment across micro-regions in Brazil during the same period (see Table 1). Perhaps more meaningfully, these effects correspond to an increase of approximately 37 and 89 percent of a standard deviation in decadal changes in informality and non-employment rates, respectively.

The novel and more interesting results in Table 3 come from the analysis of heterogeneous effects across skill levels. As the table shows, all the negative effects on informality and non-employment come from the low skill workers, and no effect is observed among high skill workers. Using the same reasoning, moving from the 90th to the 10th percentile of the distribution of RTC_r would imply an increase of 3.3 $(0.1 \times 0.335 \times 100)$ and 3.4 $(0.1 \times 0.34 \times 100)$ percentage points in informality and non-employment rates among low skill workers, respectively. Again using the information from Table 1, these effects ac-

count for 24.2 and 23.6 percent of the average increase in informality and non-employment among low skill workers in Brazil during the 1991-2000 period. These represent 38.4 and 85 percent of a standard deviation in decadal changes in informality and non-employment rates for low skill workers, respectively.

4.2 Heterogeneous Effects across Enforcement Levels: IV Estimates

We now move to our main analysis - the heterogeneous effects of trade liberalization across enforcement levels, as described by regression 4. In this section we focus on the IV results and show all the reduced-form results in Appendix A.1. Before discussing the results, it is important to highlight that our focus lies on how RTC_r affects informality and non-employment in regions with different levels of enforcement. We are therefore most interested in the following parameter:

$$\hat{\zeta}(Enforcement) = \hat{\alpha}_1 + \hat{\alpha}_2 \times Enforcement_r \tag{5}$$

which gives the marginal effect of the regional trade shock for a given enforcement level.

Table 4 shows the first set of IV estimates pooling all workers together. Columns 1 and 3 show the OLS estimate and columns 2 and 4 the IV estimates. Even though we have shown that distance to the labor office predicts well the intensity of enforcement (Table 2), we check for the presence of weak instruments. We report the relevant diagnostic statistics in the bottom of Table 4.[17] Since our standard errors are clustered at the meso-region level, we report the Kleibergen and Paap (2006) test statistics for under-identification and weak instruments. The Kleibergen-Paap LM statistic indicates that we can strongly reject the null that the model is underidentified. However, the Kleibergen and Paap (2006) heteroskedasticity-robust Wald rk F-statistic indeed indicates that the instruments are weak for both outcomes (informality and non-employment).[18] We therefore use the Anderson and Rubin (1949) weak-instrument robust Wald test for assessing the joint significance of our endogenous regressors ($Enforcement_r$ and $Enforcement_r \times RTC_r$). The results strongly reject the null that the endogenous regressors are not jointly significant, which reinforces our confidence on the results.

We find that the endogenous regressors are jointly strongly significant, and the in-

[17] These are the most common test statistics used in analogous empirical contexts. For a recent application see Bastos et al. (2018).

[18] The critical values for the Kleibergen-Paap test have not yet been tabulated in the literature, but the common practice is to compare it to the critical values of Stock and Yogo (2005).

Table 4: Effects on Informality and Non-Employment: IV estimates

	Informality		Non-Employment	
	OLS (1)	IV (2)	OLS (3)	IV (4)
RTC_r	-0.267**	-0.732*	-0.265***	0.217
	(0.127)	(0.390)	(0.053)	(0.258)
$RTC_r \times Enforcement_r$	-0.002	0.089	-0.003	-0.056*
	(0.008)	(0.059)	(0.005)	(0.034)
$Enforcement_r$	0.000	0.011	0.000	-0.003
	(0.001)	(0.007)	(0.000)	(0.003)
Observations	413	413	413	413
Kleibergen-Paap LM statistic	–	10.01	–	8.673
Kleibergen-Paap LM p-value (under-identification)	–	0.007		0.004
Kleibergen-Paap Wald rk F-stat (weak instruments)	–	2.173	–	1.660
Anderson-Rubin Wald test	–	11.92	–	13.20
Anderson-Rubin p-value (robust inference)	–	0.008	–	0.013

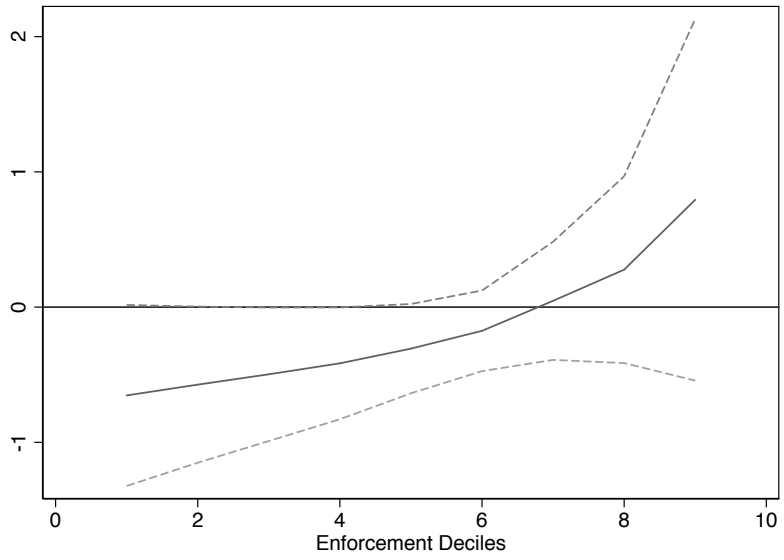
Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. $Enforcement_r$ is given by the total number of inspections conducted by the Ministry of Labor in the 1995-1999 period divided by the number of firms multiplied by 100. All regressions include state dummies.

teraction term is significant at 10 percent for non-employment (column 4).[19] The point estimates go in the expected direction: more enforcement tends to weaken the informality effects and reinforces the non-employment effects. To better assess these heterogenous effects, we plot the $\hat{\zeta}(Enforcement)$ (expression 5) for each decile of the distribution of $Enforcement_r$ and its respective confidence interval using the point estimates and standard errors from our Table 4. Figure 5 shows the results. The direction of the effects goes in the expected direction, however, they are not statistically significant, except for non-employment effects at high levels of enforcement (Panel b).

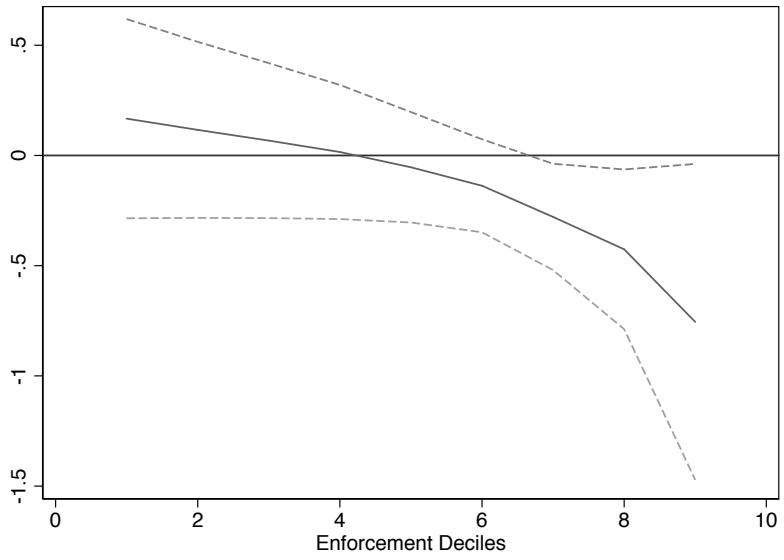
The analysis in the previous section suggests that all the labor market effects from trade opening come from low skill workers. We therefore examine whether the interaction between the trade shock and enforcement intensity also differs across skill levels. Table 5 shows striking results. The IV estimates suggest that there are strong heterogeneous effects on low skill workers for both informality and non-employment, while no significant effect can be detected among high skill workers. We cannot reject the presence of weak instruments, but for low skill workers, we strongly reject that the model is under-identified and the Anderson-Rubin test shows that the endogenous regressors are strongly (jointly) significant. In contrast, we cannot reject that the model is underidentified for high skill workers when we examine the effects on non-employment and for both informality and non-employment we cannot reject that the endogenous regressors are jointly insignificant. Therefore, both the strength of the results and the validity of the instruments come from the sample of low skill workers.

[19] We use the limited information maximum likelihood estimator, as it is known to have better small sample properties than two stage least square in the presence of weak instruments.

Figure 5: Informality and Non-employment Effects Across Enforcement Deciles – All Workers



(a) Informality



(b) Non-employment

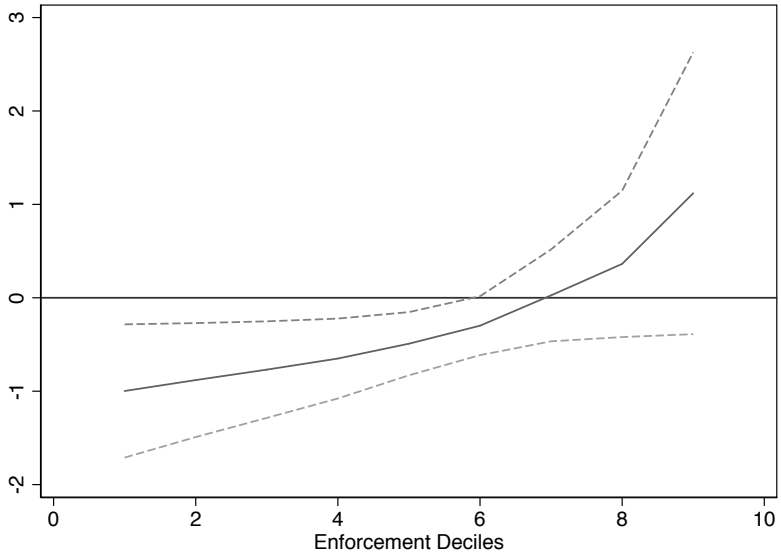
Table 5: Effects on Informality and Non-Employment: IV estimates by skill level

	Low Skill				High Skill			
	Informality		Non-Employment		Informality		Non-Employment	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
RTC_r^U	-0.375**	-1.113***	-0.318***	0.226				
	(0.147)	(0.418)	(0.059)	(0.272)				
$RTC_r^U \times Enforcement_r$	0.005	0.129*	-0.000	-0.066**				
	(0.009)	(0.066)	(0.005)	(0.033)				
RTC_r^S					0.143	-4.641	-0.056	8.729
					(0.227)	(8.079)	(0.096)	(552.429)
$RTC_r^S \times Enforcement_r$					0.001	1.219	-0.005	-2.266
					(0.022)	(1.966)	(0.009)	(145.074)
Inspections	0.000	0.014*	0.000	-0.004	0.000	0.181	-0.001	-0.334
	(0.001)	(0.008)	(0.000)	(0.003)	(0.003)	(0.290)	(0.001)	(21.506)
Observations	413	413	413	413	413	413	413	413
Kleibergen-Paap LM statistic	–	10.40	–	9.592	–	0.714	–	0.113
Kleibergen-Paap LM p-value (under-identification)	–	0.005	–	0.008	–	0.014		0.945
Kleibergen-Paap Wald rk F-stat (weak instruments)	–	2.949	–	2.212	–	0.175	–	0.033
Anderson-Rubin Wald test	–	14.25	–	12.06	–	10.59	–	4.715
Anderson-Rubin p-value (robust inference)	–	0.003	–	0.007	–	0.700		0.194

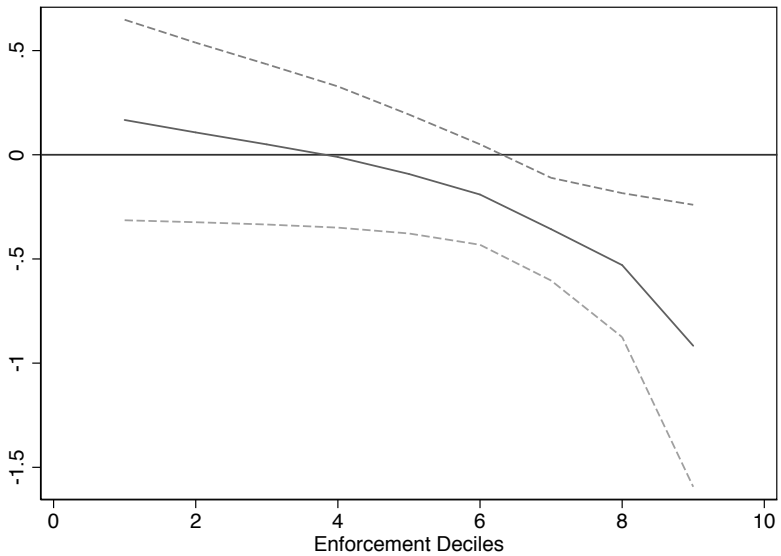
Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. RTC_r^U and RTC_r^S denote the regional trade shock for unskilled and skilled workers, respectively. $Enforcement_r$ is given by the total number of inspections conducted by the Ministry of Labor in the 1995-1999 period divided by the number of firms multiplied by 100. Skilled workers are defined as those with at least completed high school. All regressions include state dummies.

The results in Table 5 make intuitive sense, as enforcement of labor regulations in Brazil is only relevant for less skilled workers (Araujo et al., 2016). Moreover, the results from Section 4.1 already show that low skill workers seem to be the ones baring the adjustment costs from trade opening. Therefore, one could expect that more ore less flexibility via informal employment is most important for low skill workers.

Figure 6: Informality and Non-employment Effects Across Enforcement Deciles – Low Skill Workers



(a) Informality



(b) Non-employment

In Figure 6 we again plot $\hat{\zeta}(Enforcement)$ but using the results for low skill workers from Table 5.[20] The graphs show very a clear pattern: in regions with low levels of enforcement, the regional trade shock produces strong informality effects but no non-employment effects, and in regions with high levels of enforcement the trade shock does not lead to any increase in informality but has very strong disemployment effects. In order to assess the magnitude of these heterogeneous effects, we consider the average intensity of the trade shock, which is an $RTC_r = -0.043$. A region in the first decile of enforcement – which has a very low enforcement intensity, of 0.33 inspections per 100 firms – would experience an increase of 4.6 percentage points in informality but no effect on employment. A region in the 10th decile of enforcement – with 26.3 inspections per 100 firms – would experience no informality effects but an increase of 6.5 percentage points in non-employment rates. Considering the results from Table 3, on average the regional trade shock is associated to an increase of 1.2 and 1.4 percentage points in informality and non-employment, respectively. Therefore, the lack or strength of enforcement can lead to labor market responses in either informality or non-employment that are 4 times as large as the effects observed on average (without accounting for heterogeneity). In terms of standard deviations, these effects correspond to 53.4 and 162 percent of a standard deviation is decadal changes in informality and non-employment rates for low skill workers, respectively.

These results are very much in line with the framework discussed in the previous section. In regions where there is greater enforcement capacity, firms are more likely to be detected by the government and therefore the expected cost of informality is higher. Hence, firms are less likely to respond to an adverse shock by hiring a greater share of their workers informally.[21] We therefore interpret these strong heterogeneous effects as evidence that the intensive margin of informality was an important margin of adjustment to firms.

4.3 Discussion and Wage Effects

The results discussed above suggest that informality indeed acts as an employment buffer when the economy is hit with and adverse shock. On average, regions more adversely affected by the trade shock (greater local tariff reduction) experienced substantial

[20] For the sake of conciseness, we do not show the figures for high skill workers, as the results in Table 5 strongly indicate that the effects are jointly zero and the instruments are not valid. Nevertheless, the figures are available upon request.

[21] It is important to emphasise that our measure of enforcement is mostly relevant for the intensive margin of informality, as the labor offices typically only audit formal firms. Nevertheless, it is also possible that the our measure of enforcement capacity is positively correlated with enforcement of tax regulation, which would also discourage the extensive margin of informality.

increases in both informality and non-employment. However, these effects were very unevenly distributed. Regions with stricter enforcement experienced lower informality effects but greater disemployment effects; symmetrically, regions with lower levels of enforcement experience larger increases in informality but lower disemployment effects.

This heterogeneity, however, is only observed among low skill workers, while high skill workers do not seem to be affected at all by the trade shock. This result is consistent with the fact that low skill workers are more likely to hold an informal contract and are typically employed in lower productivity and smaller formal firms. In that sense, a higher informality elasticity could be expected. Moreover, the minimum wage is likely to be binding for these workers and therefore there might be substantial downward wage rigidity for low skill workers.

Finally, since regions with different levels of enforcement have different abilities to adjust to adverse economic shocks, in principle one could expect heterogeneous effects on wages as well. We investigate this issue by estimating the same specifications as in the previous subsection but using the micro-region's average wages as the outcome of interest. The results in Table 7 again show that the instruments are weak but that we are able to reject the null hypothesis of under-identification, except for high skill workers. However, contrary to our previous estimates on informality and non-employment, the Anderson-Rubin test strongly indicates that the endogenous regressors are jointly insignificant (last two rows). Therefore, even though the results show that regions more adversely affected by the trade shock experienced a substantial reduction in average wages, we do not find evidence that these effects were heterogeneous across regions with difference enforcement levels. Moreover, the average negative effect on wages was once again entirely driven by low skill workers.

Figure 7 plots the marginal effect of the regional trade shock for different deciles of enforcement intensity, which confirms the absence of substantial heterogeneous effects. The marginal effects do show a slightly negative slope, suggesting that regions with less enforcement experienced slightly more intense wage decreases than regions with more enforcement, which is entirely driven by low skill workers.[22] This is consistent with the fact that regions with lower enforcement levels observed higher informality effects and no disemployment effects, and therefore one could expect stronger wage effects (as the quantity adjusts, it is natural to expect some price adjustment). However, given the results in Table 7 and the large standard errors in Figure 7, we believe that the results suggest that even though higher levels of enforcement reduce informality effects and increase disemployment effects, they do induce different price adjustments.

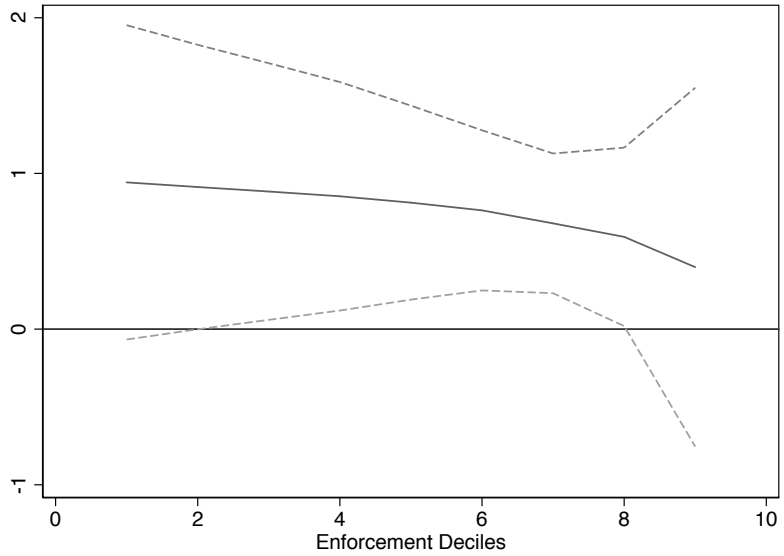
[22] Again, for the sake of conciseness we do not report the graph for high skill workers, which is a statistical zero everywhere with point estimates also very close to zero. Results available upon request.

Table 6: Effects on Wages: IV estimates

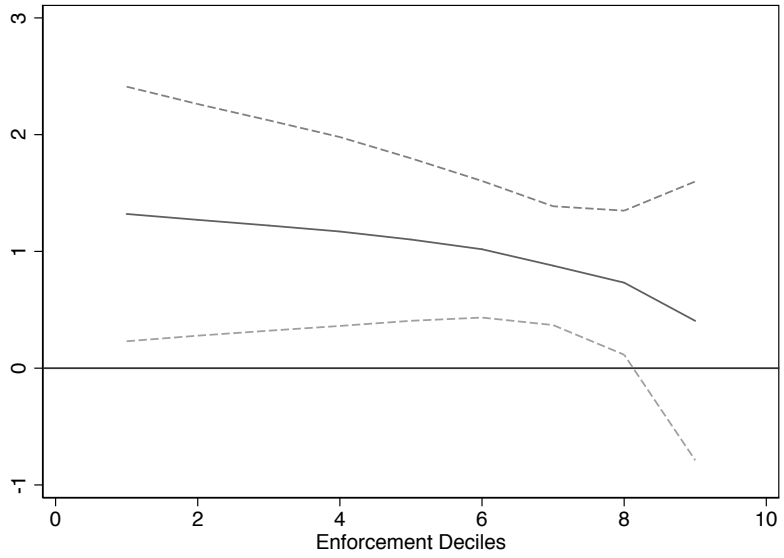
	All Workers		Low Skill		High Skill	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)
RTC	1.061***	0.972*				
	(0.215)	(0.565)				
RTC × Inspections	-0.040***	-0.033				
	(0.014)	(0.061)				
RTC-Unskilled			1.290***	1.371**		
			(0.240)	(0.607)		
RTC-Unskilled × Inspections			-0.037**	-0.056		
			(0.016)	(0.064)		
RTC-Skilled					0.618**	18.043
					(0.303)	(5,167.1)
RTC-Skilled × Inspections					-0.005	-4.567
					(0.026)	(1,338.8)
Inspections	-0.002**	-0.002	-0.002**	-0.005	-0.005*	-0.684
	(0.001)	(0.005)	(0.001)	(0.006)	(0.003)	(198.7)
Observations	413	413	413	413	413	413
Kleibergen-Paap LM statistic	–	9.661	–	10.632	–	0.092
Kleibergen-Paap LM p-value (under-identification)	–	0.008	–	0.005		0.955
Kleibergen-Paap Wald rk F-stat (weak instruments)	–	1.800	–	2.435	–	0.027
Anderson-Rubin Wald test	–	0.671	–	0.941	–	2.140
Anderson-Rubin p-value (robust inference)	–	0.880	–	0.815	–	0.544

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Figure 7: Wage Effects Across Enforcement Deciles



(a) All workers



(b) Low skill workers

5 Final Remarks

This paper investigates how and to what extent enforcement of labor regulations shapes the labor market effects of trade. We do so in the context of Brazil, a country that underwent a major trade liberalization episode in early 1990s, and which is characterized by burdensome labor regulations that are imperfectly enforced. We exploit exogenous variation across regions in both the intensity of the trade shock and of enforcement of labor regulations to assess whether different levels of enforcement lead to heterogeneous trade effects on employment, informality and wages across local labor markets.

The main results of the paper show that, in the aftermath of trade opening, regions with stricter enforcement observed no informality effects but had large disemployment effects. Symmetrically, regions with weaker enforcement had nearly no employment losses but observed a substantial increase in informal employment. All of these effects were concentrated on low skill workers, while high skill workers were largely unaffected. Thus, our results suggest that indeed informality provides greater *de facto* labor market flexibility, which seems to allow both firms and workers to cope better with the adverse local labor market shocks brought about by trade opening.

Even though the literature has extensively shown that on average informal workers have lower earnings and face higher risks than formal ones, our results suggest that trade-induced informality effects do not necessarily represent welfare losses from trade opening. On the contrary, informality can be a second-best relatively to a counterfactual scenario with perfect enforcement and no informality.

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Appendix

A Additional Results

A.1 Reduced-form results

In this section, we show the results of the reduced form regressions of the form:

$$\Delta \hat{y}_{r,t} = \alpha_0 + \alpha_{1t} RTC_r + \nu_r + \alpha_{3t} Distance_r + \alpha_{2t} RTC_j \times Distance_r + \nu_r \qquad \text{(A.1)}$$

where $Distance_r$ denotes the maximum distance to the nearest labor office in micro-region r, where we only consider the labor offices created up until 1990. The regressions follow the main specification used in the text and do not control for any demographic variables. Tables A.1 to A.4 show the results.

Table A.1: Reduced-Form Effects on Informality and Non-employment: All Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
RTC	-0.289***	-0.088	-0.317***	-0.313***
	(0.080)	(0.120)	(0.043)	(0.056)
RTC × Dist. labor office		-0.184*		-0.028
		(0.098)		(0.029)
Distance L.O.		-0.017**		0.001
		(0.008)		(0.003)
Observations	413	413	413	413
R-squared	0.364	0.376	0.368	0.371
F-stat (joint significance)		3.539		28.93
p-value		0.0332		0.000

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Table A.2: Reduced-Form Effects on Informality and Non-employment: Low Skill Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
RTC-Unskilled	-0.335***	-0.092	-0.340***	-0.374***
	(0.095)	(0.157)	(0.047)	(0.058)
RTC-Unskilled × Dist. labor office		-0.254		0.014
		(0.157)		(0.039)
Distance L.O.		-0.020**		0.004
		(0.008)		(0.003)
Observations	413	413	413	413
R-squared	0.379	0.393	0.377	0.379
F-stat (joint significance)		3.328		25.66
p-value		0.040		0.000

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Table A.3: Reduced-Form Effects on Informality and Non-employment: High Skill Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
RTC-Skilled	0.134	0.237	-0.097	-0.126
	(0.172)	(0.272)	(0.063)	(0.086)
RTC-Skilled × Dist. labor office		-0.231**		0.039
		(0.100)		(0.075)
Distance L.O.		-0.005		0.002
		(0.014)		(0.007)
Observations	413	413	413	413
R-squared	0.306	0.325	0.317	0.320
F-stat (joint significance)		3.200		1.601
p-value		0.0454		0.207

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Table A.4: Effects on Wages: Reduced-Forms

	All Workers		Low Skill		High Skill	
	(1)	(2)	(3)	(4)	(5)	(6)
RTC	0.696***	0.658***				
	(0.134)	(0.193)				
RTC × Dist. labor office		-0.006				
		(0.118)				
RTC-Unskilled			0.962***	0.884***		
			(0.152)	(0.231)		
RTC-Unskilled × Dist. labor office				0.050		
				(0.170)		
RTC-Skilled					0.952***	0.728**
					(0.235)	(0.296)
RTC-Skilled × Dist. labor office						0.128
						(0.127)
Distance L.O.		0.006		0.008		0.020
		(0.010)		(0.011)		(0.016)
Observations	413	413	413	413	413	413
R-squared	0.642	0.642	0.640	0.640	0.634	0.635
F-stat (joint significance)	–	11.20	–	17.56	–	11.22
p-value	–	0.000	–	0.000	–	0.000

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Table A.5: Effects on Informality and Non-Employment: IV estimates with demographic controls

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
RTC	-0.721**	-0.804**	0.068	-0.065
	(0.351)	(0.323)	(0.240)	(0.173)
RTC × Inspections	0.092	0.082	-0.058*	-0.061*
	(0.057)	(0.061)	(0.032)	(0.035)
Inspections	0.011*	0.011*	-0.003	-0.002
	(0.007)	(0.007)	(0.003)	(0.003)
$\text{Female}_{r,1991}$	0.301	0.456	-0.795***	-0.624**
	(0.470)	(0.483)	(0.256)	(0.255)
High Skill_{1991}		-0.215		-0.200
		(0.201)		(0.142)
Observations	413	413	413	413
Kleibergen-Paap LM statistic	10.21	9.617	8.688	8.474
Kleibergen-Paap LM p-value (under-identification)	0.00605	0.00816	0.0130	0.0147
Kleibergen-Paap Wald rk F-stat (weak instruments)	2.135	2.065	1.632	1.556
Anderson-Rubin Wald test	13.04	15.48	12.25	10.50
Anderson-Rubin p-value (robust inference)	0.005	0.001	0.007	0.0145

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. $\text{Female}_{r,1991}$ is the share of women in the population and High Skill_{1991} is the share of high skill individuals in micro-region r in 1991. The regressions include state dummies.

A.2 IV results controlling for demographics

In this section, we show the results of the IV regressions controlling for the share of females and high skill workers at the micro-region level in 1991. Tables A.5 to A.8 show the results.

Table A.6: Effects on Informality and Non-Employment: IV estimates with demographic controls – Low Skill Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
RTC-Unskilled × Inspections	0.134**	0.127*	-0.068**	-0.070**
	(0.063)	(0.065)	(0.032)	(0.034)
RTC-Unskilled	-1.042***	-1.115***	0.079	-0.073
	(0.383)	(0.357)	(0.256)	(0.177)
$\text{Female}_{r,1991}$	0.590	0.718	-0.787***	-0.598**
	(0.530)	(0.556)	(0.284)	(0.280)
High Skill_{1991}		-0.171		-0.218
		(0.223)		(0.158)
Inspections per 100 Firm	0.014*	0.014*	-0.004	-0.003
	(0.007)	(0.007)	(0.003)	(0.003)
Observations	413	413	413	413
Kleibergen-Paap LM statistic	10.94	9.260	9.651	8.529
Kleibergen-Paap LM p-value (under-identification)	0.004	0.010	0.008	0.014
Kleibergen-Paap Wald rk F-stat (weak instruments)	2.855	2.782	2.166	2.031
Anderson-Rubin Wald test	15.17	16.98	10.63	9.653
Anderson-Rubin p-value (robust inference)	0.002	0.001	0.014	0.022

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. $\text{Female}_{r,1991}$ is the share of women in the population and High Skill_{1991} is the share of high skill individuals in micro-region r in 1991. The regressions include state dummies.

Table A.7: Effects on Informality and Non-Employment: IV estimates with demographic controls – High Skill Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
RTC-Skilled × Inspections	0.585	0.451	-0.433	-0.316
	(0.646)	(0.505)	(2.136)	(0.871)
RTC-Skilled	-2.511	-2.145	1.944	1.500
	(3.037)	(2.504)	(9.632)	(4.321)
$\text{Female}_{r,1991}$	-1.950	-0.256	0.446	-0.149
	(1.534)	(0.876)	(4.027)	(0.604)
High Skill_{1991}		-0.537		0.135
		(0.374)		(0.668)
Inspections per 100 Firm	0.089	0.071	-0.061	-0.044
	(0.094)	(0.074)	(0.312)	(0.128)
Observations	413	413	413	413
Kleibergen-Paap LM statistic	1.847	2.312	0.617	0.842
Kleibergen-Paap LM p-value (under-identification)	0.397	0.033	0.734	0.656
Kleibergen-Paap Wald rk F-stat (weak instruments)	0.503	0.591	0.194	0.262
Anderson-Rubin Wald test	8.993	8.710	5.194	6.695
Anderson-Rubin p-value (robust inference)	0.029	0.315	0.158	0.082

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. $\text{Female}_{r,1991}$ is the share of women in the population and High Skill_{1991} is the share of high skill individuals in micro-region r in 1991. The regressions include state dummies.

Table A.8: Effects on Wages: IV estimates with demographic controls

	All Workers		Low Skill		High Skill	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)
RTC × Inspections	-0.034	-0.021				
	(0.066)	(0.069)				
RTC	1.069**	1.339***				
	(0.527)	(0.373)				
RTC-Unskilled × Inspections			-0.058	-0.050		
			(0.066)	(0.070)		
RTC-Unskilled			1.405**	1.608***		
			(0.553)	(0.389)		
RTC-Skilled × Inspections					-0.178	-0.154
					(0.816)	(0.488)
RTC-Skilled					1.126	1.052
					(3.595)	(2.392)
$\text{Female}_{r,1991}$	0.359	-0.039	0.030	-0.264	-0.075	-0.276
	(0.672)	(0.560)	(0.764)	(0.667)	(1.959)	(0.625)
High Skill_{1991}		0.492*		0.356		0.060
		(0.276)		(0.305)		(0.509)
Inspections	-0.002	-0.004	-0.005	-0.006	-0.032	-0.029
	(0.005)	(0.005)	(0.006)	(0.006)	(0.121)	(0.074)
Observations	413	413	413	413	413	413
Kleibergen-Paap LM statistic	9.191	8.903	10.32	9.075	0.551	0.786
Kleibergen-Paap LM p-value (under-identification)	0.010	0.012	0.006	0.011	0.759	0.351
Kleibergen-Paap Wald rk F-stat (weak instruments)	1.704	1.623	2.306	2.166	0.170	0.238
Anderson-Rubin Wald test	0.868	1.137	0.968	1.504	2.922	3.279
Anderson-Rubin p-value (robust inference)	0.833	0.768	0.809	0.681	0.404	0.675

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. $\text{Female}_{r,1991}$ is the share of women in the population and High Skill_{1991} is the share of high skill individuals in micro-region r in 1991. The regressions include state dummies.

Table A.9: Reduced-Form Effects on Informality and Non-employment: Imports

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
Imports	1.175***	0.229	0.941***	0.758***
	(0.286)	(0.437)	(0.148)	(0.182)
Imports × Dist. L. O.		1.272***		0.241
		(0.451)		(0.192)
Distance L.O.		-0.028***		-0.005
		(0.010)		(0.003)
Observations	413	413	413	413
R-squared	0.373	0.396	0.325	0.329

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

A.3 Results with alternative measures for the trade shock

In this Appendix, we present the results of the benchmark regressions using alternative local trade shock measures. More specifically we use the ratio of imports to production and import penetration coefficient ($M/(Y + M - X)$). Tables A.9 and A.12 show the impact on the overall population. Tables A.10 and A.13 on the low skill workers; and A.11 and A.14 on the high skill ones. The results corroborate our previous main results using the *RTC* shocks. We find that hight import per region GDP (or penetration) increases informality and non-employment. Also, regions less enforced (further way from labor offices) experience higher impact on informality. For the overall population, no significant heterogeneous impact by enforcement level was found. Breaking the sample by the worker skill level, again we find that all this dynamics come from low skill workers.

Table A.10: Reduced-Form Effects on Informality and Non-employment: Imports – Low Skill Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
Imports	1.460***	0.463	1.047***	1.017***
	(0.318)	(0.548)	(0.151)	(0.185)
Imports × Dist. L. O.		1.369**		0.034
		(0.636)		(0.212)
Distance L.O.		-0.029**		-0.001
		(0.011)		(0.004)
Observations	413	413	413	413
R-squared	0.395	0.416	0.343	0.343

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Table A.11: Reduced-Form Effects on Informality and Non-employment: Imports– High Skill Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
Imports	-0.402	-0.414	0.210	0.204
	(0.276)	(0.422)	(0.150)	(0.182)
Imports × Dist. L. O.		0.616		-0.084
		(0.580)		(0.199)
Distance L.O.		0.006		-0.001
		(0.010)		(0.004)
Observations	413	413	413	413
R-squared	0.307	0.319	0.315	0.317

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Table A.12: Reduced-Form Effects on Informality and Non-employment: Penetration Coefficient

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
Penet. Coeff.	1.330***	0.434	0.989***	0.859***
	(0.310)	(0.477)	(0.165)	(0.218)
Penet. Coeff. × Dist. L. O.		1.129**		0.148
		(0.494)		(0.263)
Distance L.O.		-0.023**		-0.003
		(0.010)		(0.003)
Observations	413	413	413	413
R-squared	0.375	0.391	0.319	0.320

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Table A.13: Reduced-Form Effects on Informality and Non-employment: Penetration Coefficient – Low Skill Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
Penet. Coeff.	1.646***	0.737	1.086***	1.131***
	(0.352)	(0.588)	(0.175)	(0.226)
Penet. Coeff. × Dist. L. O.		1.159*		-0.088
		(0.660)		(0.277)
Distance L.O.		-0.024**		0.001
		(0.011)		(0.004)
Observations	413	413	413	413
R-squared	0.396	0.411	0.335	0.335

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.

Table A.14: Reduced-Form Effects on Informality and Non-employment: Penetration Coefficient – High Skill Workers

	Informality		Non-Employment	
	(1)	(2)	(3)	(4)
Penet. Coeff.	-0.513*	-0.450	0.209	0.160
	(0.305)	(0.476)	(0.171)	(0.202)
Penet. Coeff. × Dist. L. O.		0.544		-0.031
		(0.653)		(0.197)
Distance L.O.		0.008		-0.002
		(0.010)		(0.004)
Observations	413	413	413	413
R-squared	0.308	0.319	0.314	0.316

Notes: Standard errors clustered at the meso-region level. Significant at the *** 1 percent, ** 5 percent, and * 10 percent level. The regressions include state dummies.