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MARGINS OF LABOR MARKET ADJUSTMENT TO TRADE

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ABSTRACT

We use both longitudinal administrative data and cross-sectional household survey data to study the margins of labor market adjustment following Brazil's early 1990s trade liberalization. We document how workers and regional labor markets adjust to trade-induced changes in local labor demand, examining various adjustment margins, including earnings and wage changes; interregional migration; shifts between tradable and nontradable employment; and shifts between formal employment, informal employment, and non-employment. Our results provide insight into the regional labor market effects of trade, and have important implications for policies that address informal employment and that assist trade-displaced workers.

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1 Introduction

Since at least 1941, when Stolper and Samuelson published their seminal paper, economists have known that trade is likely to create winners and losers. A voluminous empirical literature then followed, investigating the differences in trade's effects on workers with different skills or employed in different industries. However, starting in the late 2000s, a number of authors documented substantial differences in the effects of trade and import competition on workers in geographic regions with different patterns of industrial specialization. Examples of this recent literature include Topalova (2007) and Kovak (2013), who investigated the regional effects of trade liberalization in India and Brazil respectively, and Autor, Dorn and Hanson (2013), who documented the effects of increased Chinese imports on U.S. local labor markets.[1] A robust conclusion from this literature is that trade's costs and benefits are unevenly distributed geographically, not just across industries or skills.

Given the substantial effects of trade liberalization across local labor markets, it is important to understand how workers and regional labor markets adjusted to these changes in local labor demand. Documenting these adjustments is essential to understanding the processes behind trade-displaced workers' labor market outcomes. In this paper, we examine various potential adjustment margins including earnings and wage changes; interregional migration; shifts between tradable and nontradable employment; and shifts between formal employment, informal employment, and non-employment. We compare outcomes for workers and regional labor markets facing larger and smaller tariff reductions, finding a rich pattern of labor market adjustment over time.

We make extensive use of longitudinal administrative data (RAIS) covering the Brazilian formal labor market between 1986 and 2010. These data cover the universe of formally employed workers and allow us to follow them over time and across firms, sectors, and regions. However, the RAIS data do not cover workers outside formal employment. To study the effects of liberalization on non-employment or informal employment, which are quite common in the Brazilian context, we use repeated cross-section data from decennial Demographic Censuses from 1970 to 2010. These data are representative at fine geographic levels and provide information on employment status, including informality, but do not allow one to follow individual workers over time.

Our empirical strategy exploits the fact that regions with different industry mixes are differently affected by Brazil's early 1990s trade liberalization. We find that workers initially employed in regions facing larger tariff declines (i) spend less and less time formally employed relative to workers in regions facing smaller tariff declines; (ii) are more likely to transition into nontradable sector employment, but these transitions do not make up for employment losses in the tradable sector; (iii) face similar losses when initially employed in tradable or nontradable sectors; and (iv) do

[1] Other papers using a similar approach include Costa, Garred and Pessoa (2016), Edmonds, Pavcnik and Topalova (2010), Hakobyan and McLaren (2016), Hasan, Mitra and Ural (2006), Hasan, Mitra, Ranjan and Ahsan (2012), Kondo (2014), McCaig (2011), Topalova (2010), and many others.

not respond to depressed local labor market conditions by migrating to more favorably affected regions. We also show that harder-hit locations experience relative increases in non-employment and in informal employment in the medium run (1991 to 2000). However, in the long run (1991 to 2010) non-employment does not respond, and informal employment strongly increases. These results suggest that after many years the informal sector absorbs a significant portion of formerly trade-displaced workers who spent years non-employed following liberalization. Surprisingly, we find no statistically significant long-run effect of liberalization on informal sector earnings or wages, which sharply contrasts with the formal-sector earnings results documented in Dix-Carneiro and Kovak (forthcoming).

This paper relates to three literatures investigating the labor market effects of trade. First, we contribute to a recent but fast growing literature on the regional effects of trade, including Topalova (2007), Autor et al. (2013), Kovak (2013), Hakobyan and McLaren (2016) and Dix-Carneiro and Kovak (forthcoming). Second, our paper relates to a recent literature on worker-level effects of trade using longitudinal administrative datasets such as Menezes-Filho and Muendler (2011), Autor, Dorn, Hanson and Song (2014), Dauth, Findeisen and Suedekum (2014), and Utar (2017). Our paper differs from much of this prior literature by studying i) regional rather than industry shocks, ii) a discrete shock, allowing us to measure dynamic responses to liberalization, and iii) transitions into the nontradable sector and informal employment, which are salient features of the Brazilian context.[2] Finally, our paper relates to the literature on trade and informality (Goldberg and Pavcnik 2003, Menezes-Filho and Muendler 2011, Bosch, Goñi-Pacchioni and Maloney 2012, McCaig and Pavcnik 2014, Paz 2014, Cruces, Porto and Viollaz 2014). While much of the previous work on the Brazilian trade liberalization episode found no significant effects of tariff reductions on informality, our work finds large effects, especially in the long run. As we discuss, these differences in findings can be reconciled by differences in research design, unit of analysis, sectoral coverage, and time horizons.

Our results have important implications regarding the regional labor market effects of trade. We show that labor market outcomes for formally employed workers initially employed in regions more exposed to foreign competition steadily deteriorate over time relative to those in less exposed regions. These worker-level findings are similar to the region-level results on formal labor market outcomes in Dix-Carneiro and Kovak (forthcoming). However, they contrast with standard spatial equilibrium models (e.g. Blanchard and Katz (1992) and Bound and Holzer (2000)) and the empirical findings of Jacobson, LaLonde and Sullivan (1993), in which workers' labor market outcomes eventually partially recover. Additionally, we show that non-employment strongly increases in harder-hit locations in the years immediately following liberalization, but that employment in these locations recovers in the longer run. This employment recovery is entirely accounted for by

[2] A notable exception is Menezes-Filho and Muendler (2011). Although they do not consider regional shocks, they do study the same liberalization episode in Brazil and examine worker transitions into non-manufacturing and informality.

an increase in informal employment in harder-hit locations. In other words, after going through long periods of non-employment, trade-displaced formal-sector workers appear to eventually settle for the fallback option of informal employment. An important implication is that policies discouraging informal employment may increase non-employment following a trade policy shock, as trade-displaced workers cannot be as easily absorbed by the informal sector. Finally, we show that the tradable and non-tradable sectors are closely integrated in the Brazilian labor market. This cross-sector integration implies that policies such as Trade Adjustment Assistance in the United States, which target only industries that are directly affected by import competition, omit large numbers of workers whose employment and earnings prospects were sharply but indirectly affected by liberalization.

Our paper is structured as follows. Section 2 describes the history and institutional context of Brazil's early 1990s trade liberalization. Section 3 describes the data sources used throughout the paper. Section 4 explains why trade liberalization had heterogeneous effects across regions and shows how we measure trade-induced local labor demand shocks. Section 5 investigates the effects of liberalization on worker-level labor market outcomes using longitudinal data from RAIS. Section 6 complements this analysis by investigating the effects of liberalization on the structure of local labor markets, with an emphasis on how regional formal employment, informal employment, and non-employment responded to the trade shocks. Section 7 concludes.

2 Trade Liberalization in Brazil

Brazil's early 1990s trade liberalization provides an excellent setting in which to study the labor market effects of changes in trade policy. The unilateral trade liberalization involved large declines in average trade barriers and featured substantial variation in tariff cuts across industries. As we will argue below, this variation was plausibly exogenous to counterfactual industry performance, making it possible to estimate causal effects of liberalization. As a result, many papers have examined the labor market effects of trade liberalization in the Brazilian context.[3]

In the late 1980s and early 1990s, Brazil ended nearly one hundred years of extremely high trade barriers imposed as part of an import substituting industrialization policy.[4] In 1987, nominal tariffs were high, but the degree of protection actually experienced by a given industry often deviated substantially from the nominal tariff rate due to i) a variety of non-tariff barriers such

[3]Examples include Arbache, Dickerson and Green (2004), Dix-Carneiro and Kovak (forthcoming), Goldberg and Pavcnik (2003), Gonzaga, Filho and Terra (2006), Kovak (2013), Krishna, Poole and Senses (2014), Menezes-Filho and Muendler (2011), Pavcnik, Blom, Goldberg and Schady (2004), Paz (2014), Schor (2004), and Soares and Hirata (2016) among many others.

[4]Although Brazil was a founding signatory of the General Agreement on Tariffs and Trade (GATT) in 1947, it maintained high trade barriers through an exemption in Article XVIII Section B, granted to developing countries facing balance of payments problems (Abreu 2004). Hence, trade policy changes during the period under study were unilateral.

as suspended import licenses for many goods and ii) a system of "special customs regimes" that lowered or removed tariffs for many transactions (Kume, Piani and de Souza 2003).[5] In 1988 and 1989, in an effort to increase transparency in trade policy, the government reduced tariff redundancy by cutting nominal tariffs and eliminating certain special regimes and trade-related taxes, but there was no effect on the level of protection faced by Brazilian producers (Kume 1990).

Liberalization effectively began in March 1990, when the newly elected administration of President Collor suddenly and unexpectedly abolished the list of suspended import licenses and removed nearly all of the remaining special customs regimes (Kume et al. 2003). These policies were replaced by a set of import tariffs providing the same protective structure, as measured by the gap between prices internal and external to Brazil, in a process known as tariffication (*tarificação*) (de Carvalho, Jr. 1992). In some industries, this process required modest tariff increases to account for the lost protection from abolishing import bans.[6] Although these changes did not substantially affect the protective structure, they left tariffs as the main instrument of trade policy, such that tariff levels in 1990 and later provide an accurate measure of protection.

The main phase of trade liberalization occurred between 1990 and 1995, with a gradual reduction in import tariffs culminating with the introduction of Mercosur. Tariffs fell from an average of 30.5 percent to 12.8 percent, and remained relatively stable thereafter.[7] Along with this large average decline came substantial heterogeneity in tariff cuts across industries, with some industries such as agriculture and mining facing small tariff changes, and others such as apparel and rubber facing declines of more than 30 percentage points. We measure liberalization using long-differences in the log of one plus the tariff rate from 1990 to 1995, shown in Figure 1. During this time period, tariffs accurately measure the degree of protection faced by Brazilian producers, and tariff reductions from 1990 to 1995 reflect the full extent of liberalization faced by each industry. We do not rely on the timing of tariff cuts between 1990 and 1995, because this timing was chosen to maintain support for the liberalization plan, cutting tariffs on intermediate inputs earlier and consumer goods later (Kume et al. 2003).

As discussed below, along with regional differences in industry mix, the cross-industry variation in tariff cuts provides the identifying variation in our analysis. Following the argument in Goldberg and Pavcnik (2005), we note that the tariff cuts were nearly perfectly correlated with the pre-liberalization tariff levels (correlation coefficient = -0.90). These initial tariff levels reflected a protective structure initially imposed in 1957 (Kume et al. 2003), decades before liberalization. This

[5] These policies were imposed quite extensively. In January 1987, 38 percent of individual tariff lines were subject to suspended import licenses, which effectively banned imports of the goods in question (Authors' calculations from *Bulletin International des Douanes* no.6 v.11 supplement 2). In 1987, 74 percent of imports were subject to a special customs regime (de Carvalho, Jr. 1992).

[6] Appendix Figure A1 shows the time series of tariffs. Note the tariff increases in 1990 for the auto and electronic equipment industries.

[7] Simple averages of tariff rates across *Nível 50* industries, as reported in Kume et al. (2003). See Appendix A.1 for details on tariff data.

feature left little scope for political economy concerns that might otherwise have driven systematic endogeneity of tariff cuts to counterfactual industry performance.

To check for any remaining spurious correlation between tariff cuts and other steadily evolving industry factors, we regress pre-liberalization (1980-1991) changes in industry employment and average monthly earnings on the 1990-1995 tariff reductions, with detailed results reported in Appendix B.1. We attempted a variety of alternative specifications and emphasize that the results should be interpreted with care, as they include only 20 tradable-industry observations. Most specifications exhibit no statistically significant relationship, but heteroskedasticity-weighted specifications place heavy weight on agriculture and find a positive relationship. Agriculture was initially the least protected industry, and it experienced approximately no tariff reduction. It also had declining wages and employment before liberalization, driving the positive relationship with tariff reductions. Consistent with earlier work, when omitting agriculture, tariff cuts are unrelated to pre-liberalization earnings trends (Krishna, Poole and Senses 2011). Given these varying results, we include controls for pre-liberalization trends in all of the analyses presented below, to account for any potential spurious correlation. Consistent with the notion that the tariff changes were exogenous in practice, these pre-liberalization controls have little influence on the vast majority of our results.

3 Data

Our main data source for individual labor market outcomes is the *Relação Anual de Informações Sociais* (RAIS), spanning the period from 1986 to 2010. This is an administrative dataset assembled yearly by the Brazilian Ministry of Labor, providing a high quality census of the Brazilian formal labor market (De Negri, de Castro, de Souza and Arbache 2001, Saboia and Tolipan 1985). Accurate information in RAIS is required for workers to receive payments from several government benefits programs, and firms face fines for failure to report, so both agents have an incentive to provide accurate information. RAIS includes nearly all formally employed workers, meaning those with a signed work card (*carteira assinada*), providing them access to the benefits and labor protections afforded by the legal employment system. It omits interns, domestic workers, and other minor employment categories, along with those without signed work cards, including the self-employed. These data have recently been used by Dix-Carneiro (2014), Helpman, Itskhoki, Muendler and Redding (forthcoming), Krishna et al. (2014), Lopes de Melo (2013), and Menezes-Filho and Muendler (2011), though these papers utilize shorter panels. The data consist of job records including worker and establishment identifiers, allowing us to track workers and establishments over time. We utilize the establishment's geographic location (municipality) and industry; worker-level information including gender, age, and education (9 categories); and job-level information such as the date of accession, date of separation, tenure, occupation, and average monthly earnings.

These data have various advantages relative to previous work on the effects of trade on local labor markets. First, because we study a discrete policy shock, we can use the RAIS data to infer the dynamics of adjustment to trade liberalization, in contrast to studies of steadily evolving shocks such as Chinese trade, as emphasized by Autor et al. (2014). Second, RAIS is a census rather than a sample, so it is representative at fine geographic levels.[8] Third, the panel dimension of the data allows us to track workers over time as they potentially transition between jobs, sectors, and regions.

As is typically the case in administrative employment datasets, the limitation of RAIS is a lack of information on workers who are not formally employed. When a worker does not appear in the database in a given month, we can conclude that they are not formally employed at that time. However, we cannot tell whether the worker is out of the labor force, unemployed, informally employed, or self-employed. This is important in the Brazilian context, with informality rates often exceeding 50 percent of all employed workers during our sample period.[9] When we need information on individuals who are not formally employed, or information before 1986, we supplement the analysis using the decennial Brazilian Demographic Census, covering 1970-2010. While these data do not permit following individuals over time, they allow us to study the effects of liberalization on the regional employment structure by covering the entire population, including the informally employed, unemployed, and those outside the labor force.[10] We classify as informally employed workers without a signed work card, paralleling the formality definition in RAIS and following much of the literature on Brazilian informality.[11] Because the Census is a household survey and workers face no penalties for reporting informal status, this measure accurately reflects informality.

4 Regional Tariff Reductions

Our empirical analyses compare the evolution of labor market outcomes for workers and regions facing large tariff declines to those facing smaller tariff declines. Intuitively, regions experience larger declines in labor demand when their most important industries face larger liberalization-induced price declines (Topalova 2007). Kovak (2013) presents a specific-factors model of regional economies capturing this intuition, in which the regional labor demand shock resulting from liberalization is

$$\sum_i \beta_{ri} \hat{P}_i, \qquad \text{where} \quad \beta_{ri} \equiv \frac{\lambda_{ri} \frac{1}{\varphi_i}}{\sum_j \lambda_{rj} \frac{1}{\varphi_j}}. \tag{1}$$

[8] The National Household Survey (*Pesquisa Nacional por Amostra de Domicílios* - PNAD) would be a natural alternative data source for a yearly analysis, but it only provides geographic information at the state level, does not allow one to follow individual workers over time, and provides a much smaller sample.

[9] See Appendix B.2 for descriptive statistics on informal employment.

[10] See Appendix A.3 for more detail on the Demographic Census data.

[11] The work-card based definition of formality is standard in papers using household survey data to study Brazilian informality, including Goldberg and Pavcnik (2003), Menezes-Filho and Muendler (2011), Bosch et al. (2012), Paz (2014), and many others.

Hats represent proportional changes, r indexes regions, i indexes tradable-sector industries, φ_i is the cost share of non-labor factors, and λ_{ri} is the share of regional labor initially allocated to tradable industry i. $\hat{P}_i$ is the liberalization-induced price change facing industry i, and (1) is a weighted average of these price changes across tradable industries, with more weight on industries capturing larger shares of initial regional employment.[12] Thus, although all regions face the same vector of liberalization-induced price changes, differences in the regional industry mix generate regional variation in labor demand shocks.

We operationalize this shock measure by defining the "regional tariff reduction" (RTR), which utilizes only liberalization-induced variation in prices, replacing $\hat{P}_i$ with the change in log of one plus the tariff rate.

$$RTR_r = -\sum_i \beta_{ri} d\ln(1+\tau_i) \tag{2}$$

τ_i is the tariff rate in industry i, and d represents the long difference from 1990-1995, the period of Brazilian trade liberalization. We calculate tariff reductions using data from Kume et al. (2003), λ_{ri} using the 1991 Census, and φ_i using 1990 National Accounts data from IBGE.[13] Together, these allow us to calculate the weights, β_{ri}. Note that RTR_r is more positive in regions facing larger tariff *reductions*, which simplifies the interpretation of our results, since nearly all regions faced tariff declines during liberalization.

Figure 2 maps the spatial variation in RTR_r. We define a set of consistently identifiable regions based on the "microregion" definition of the Brazilian Statistical Agency (IBGE), which groups together economically integrated contiguous municipalities with similar geographic and productive characteristics (IBGE 2002).[14] Regions facing larger tariff reductions are presented as lighter and yellower, while regions facing smaller cuts are shown as darker and bluer. The region at the 10th percentile faced a tariff reduction of 0.2 percentage points, while the region at the 90th percentile faced a 10.7 percentage point decline. Hence, in interpreting the regression estimates below, we compare regions whose values of RTR_r differ by 10 percentage points, closely approximating the 90-10 gap of 10.5 percentage points. Note that there is substantial variation in the tariff shocks even

[12] Following Kovak (2013), we drop the nontradable sector in the calculation of local trade-induced shocks, based on the assumption that nontradable prices move with tradable prices. In Dix-Carneiro and Kovak (forthcoming), we confirm this assumption using a measure of local nontradables prices.

[13] See Appendix A.4 for more detail on the construction of (2). We use the Census to calculate λ_{ri} because it allows for a more detailed industry definition than what is available in RAIS (see Appendix A.1) and because the Census allows us to calculate weights that are representative of overall employment, rather than just formal employment.

[14] We consistently identify 475 regions for analyses falling within 1986-2010 and 405 markets for analyses using data from 1980 and earlier. Our geographic classification is a slightly aggregated version of the one in Kovak (2013), accounting for additional boundary changes during the longer sample period. The analysis omits 11 microregions, shown with a cross-hatched pattern Figure 2. These include i) Manaus, which was part of a Free Trade Area and hence not subject to tariff cuts during liberalization; ii) the microregions that constitute the state of Tocantins, which was created in 1988 and hence not consistently identifiable throughout our sample period; and iii) a few other municipalities that are omitted from RAIS in the 1980s. The inclusion or exclusion of these regions when possible has no substantive effect on the results.

among local labor markets within the same state. As we include state fixed effects in our analyses to control for state-level policy differences such as minimum wages, these within-state differences provide the identifying variation in our study.[15]

5 Worker-Level Analysis

5.1 Worker-Level Empirical Specification

We utilize the panel dimension of the RAIS data to follow individual workers over time, tracking the evolution of labor market outcomes for workers initially employed in regions facing larger tariff reductions vs. those initially in regions facing smaller tariff cuts. Our main analysis focuses on a panel of workers who were initially employed in the tradable sector in December 1989, just before trade liberalization began. In particular, we restrict attention to workers aged 25-44 in December 1989 (who remain of working age through 2010) and whose highest paying job was in the tradable sector. For computational tractability, we take a 15% sample of individuals meeting these criteria in regions with more than 2,000 tradable sector workers in 1989 and include all relevant workers from smaller regions, weighting appropriately in subsequent analyses. This process yields 585,078 individuals in our main tradable sector sample. In Section 5.6, we also consider an alternate population of workers initially employed in the nontradable sector, in order to investigate the transmission of the trade shock into this indirectly affected sector. All other restrictions and sampling procedures are the same, yielding a sample of 973,703 nontradable sector workers. Table 1 provides summary statistics for the tradable sector and nontradable sector samples.

We use the following specification to compare the evolution of labor market outcomes for workers initially in regions facing larger vs. smaller tariff reductions.

$$y_{irt} = \theta_t RTR_r + \alpha_{st} + X_{ir,1989}\Phi_t + \epsilon_{irt}, \tag{3}$$

where i indexes individuals, t indexes years following the start of liberalization ($t \in [1990 - 2010]$), and r is the worker's initial region of employment in December 1989. Note that a worker's initial region r is fixed throughout the analysis, even if they are employed elsewhere in later years. y_{irt} represents various worker-level post-liberalization outcomes, which we define below. $X_{ir,1989}$ is a rich set of worker-level controls including demographics (9 education category indicators, gender, age, age-squared), initial job characteristics for the highest-paying job in December 1989 (84 occupation category indicators, 14 tradable industry indicators, 12 nontradable industry indicators, tenure at the plant), initial employer characteristics (log employment, exporting indicator, log exports, importing indicator, log imports), and initial region characteristics (pre-liberalization (1986-89)

[15] A regression of RTR_r on state fixed effects yields an R^2 of 0.36; i.e. 64% of the variation in RTR_r is not explained by state effects. Our main conclusions are unaffected by the inclusion or exclusion of state fixed effects.

earnings growth and formal employment growth, and pre-liberalization growth in the outcome of interest).[16] This specification compares subsequent labor market outcomes for two otherwise observationally equivalent workers who in 1989 happened to live in regions facing different local trade shocks. Since RTR_r does not vary over time, always reflecting tariff reductions from 1990 to 1995, the estimates of θ_t trace out the cumulative effects of regional tariff reductions on the worker's outcome y_{irt} as of year t. Note that we estimate (3) separately for each year $t \in [1990, 2010]$, allowing the regression coefficients (θ_t, Φ_t) and state fixed effects (α_{st}) to differ across years.

5.2 Employment

We begin by examining how the regional tariff reduction in a worker's initial region affected their subsequent formal employment status. We calculate the cumulative average number of months formally employed per year from 1990 to year t.

$$\frac{1}{t-1989}\sum_{s=1990}^{t} Months_{is}, \tag{4}$$

where $Months_{is}$ is the number of months individual i was formally employed in year s.[17] Note that $Months_{is}$ includes formal employment in any location, even if the individual moves away from their initial region following liberalization. Figure 3 reports the effects of liberalization on this dependent variable, using specification (3). Each point in the figure represents the regression coefficient θ_t for the relevant year. The negative estimates imply that workers initially employed in harder hit regions experience relative declines in employment in the formal sector. The 2010 point estimate is -4.7, implying that a worker whose initial region faced a 10 percentage point larger tariff decline (approximately the 90-10 gap in RTR_r) on average worked in the formal sector for 9.9 fewer total months between 1990 and 2010. This is a large effect, given that the unconditional average number of total months worked in the formal sector during this time period for workers in our sample is 125 months.[18] In contrast to conventional wisdom, negatively-affected workers' average employment outcomes do not recover during the 15 years following liberalization. In fact, the effects *grow* over time, implying steady relative declines in formal employment for workers initially in regions facing

[16] Firm-level imports and exports for 1990 come from customs data assembled by the *Secretaria de Comércio Exterior* (SECEX). The pre-liberalization outcome controls are calculated as follows. We draw a sample of workers in December 1986, paralleling the main sample, and estimate a version of (3) replacing RTR_r with region indicators. These first step region indicator coefficients enter as controls in equation (3). Note that when examining accumulated earnings, we are unable to normalize by pre-1986 earnings, so we instead include the pre-liberalization control related to months formally employed. For migration-related outcomes, we additionally control for the 1986-1991 probability of out-migration, obtained from the Census.

[17] RAIS reports the month of accession and separation (if any) for each job, so that we can observe formal employment at the monthly level.

[18] The employment measure in (4) is cumulative, in the sense that it calculates average months employed from 1990 to subsequent year t. Appendix B.3 presents an alternative non-cumulative measure, the fraction of year t in which the worker was formally employed, with similarly growing effects over time.

larger tariff reductions.

This pattern of growing individual-level formal employment effects is similar to our earlier findings, which used a region-level rather than worker-level research design (Dix-Carneiro and Kovak forthcoming). In that paper, we present evidence that the surprising growing effects of liberalization on earnings result from dynamics in labor demand that gradually amplify the short-run effect of the shock. These dynamics are driven by a combination of slow capital reallocation and agglomeration economies. In that context, a liberalization-induced decline in labor demand lowers wages and employment rates on impact. Then, through depreciation and reinvestment elsewhere, capital slowly reallocates away from the region, reducing regional workers' marginal product and further reducing earnings and employment. Agglomeration economies amplify this effect, reducing marginal products as regional economic activity contracts. In Dix-Carneiro and Kovak (forthcoming), we present qualitative and quantitative empirical evidence supporting this mechanism.

In Section 5.4 below, we document the robustness of these growing employment effects to alternative specification choices and to controlling for a variety of post-liberalization economic shocks. Appendix B.4 demonstrates that these large and growing effects on formal employment apply to a variety of worker subsamples, including workers who were initially highly connected to the formal labor market (employed for at least 36 or 42 out of 48 months during 1986-1989), to both more educated workers (high school degree or more) and less educated workers (less than high school), and to younger (initially age 25-34) and older (age 35-44) workers.

Along with the transitions out of formal employment documented in Figure 3, workers also adjust between tradable and nontradable sector employment. Recall that all of the workers in our main sample were initially employed in the tradable sector just prior to liberalization. In Figure 4, we examine the average number of months formally employed per year, as in (4), but separate months into those worked in tradable and nontradable sector employment. As expected, formal employment losses were concentrated in the tradable sector, which makes sense given that trade liberalization directly affected the tradable sector and the workers in our sample were initially employed in tradable industries. In contrast, nontradable employment offsets a fraction of the employment losses in the tradable sector, indicating that some tradable sector workers facing larger regional tariff reductions transitioned into nontradable employment. These reallocations into the nontradable sector allowed some workers initially in negatively affected regions to spend more time formally employed.[19] However, they were not large enough to offset the substantial losses in the tradable sector, such that overall months formally employed still decline in the hardest-hit locations, as seen in Figure 3.

[19]This result parallels that of Menezes-Filho and Muendler (2011), who show that manufacturing workers whose industry faced a larger tariff decline were more likely to switch into formal employment in a non-manufacturing industry.

5.3 Earnings

Together with changes along the employment margin, workers' formal earnings may have responded to liberalization-induced changes in labor demand as well. It is important to keep in mind that *formal* earnings effects are likely to be upper bounds on the *overall* earnings effects, since workers losing formal earnings may partially offset these losses through earnings in the informal sector. Although informal earnings are unobserved in the RAIS worker panel, in Section 6.2 we use Census data to document substantial shifts into informality in regions facing larger tariff reductions.

Following Autor et al. (2014), we calculate a worker's average yearly earnings from 1990 to each subsequent year t as a multiple of the worker's average pre-liberalization (1986-89) yearly earnings:

$$\frac{\frac{1}{t-1989}\sum_{s=1990}^{t} Earnings_{is}}{MeanEarnings_{i,1986-89}}, \tag{5}$$

$$\text{where } MeanEarnings_{i,1986-89} \equiv \frac{\sum_{s=1986}^{1989} Earnings_{is}}{\sum_{s=1986}^{1989} Months_{is}} \times 12$$

The numerator is the worker's average post-liberalization formal earnings from 1990 to t, and the denominator is the worker's average pre-liberalization formal earnings from 1986 to 1989.[20] Note that formal earnings may decline due to lower wages or due to fewer months or fewer hours worked in the formal sector. We use this measure because it accounts for worker heterogeneity in initial earnings while still being well defined for workers with zero earnings after 1989, avoiding sample selection issues. We then regress this earnings measure for each year t on the regional tariff reduction (RTR_r) and the extensive set of controls described above. Figure 5 shows the results. The point estimate in 2010 is -0.85, implying that over the course of 21 years, a worker whose initial region faced a 10 percentage point larger tariff decline lost 1.8 times their yearly pre-liberalization formal earnings, in relative terms.[21] As with employment, these formal earnings results correspond closely to the regional analysis in Dix-Carneiro and Kovak (forthcoming).[22]

[20] Employers' report workers' individual average monthly earnings during employed months in a given year. We construct individual yearly earnings by multiplying average monthly earnings by the number of months employed in the year and then summing across employers.

[21] Note that the earnings measure in (5) is cumulative, in the sense that it averages earnings between 1990 and subsequent year t. Appendix B.3 presents an alternative non-cumulative measure, earnings in year t as a multiple of average pre-liberalization earnings, with similarly growing effects over time.

[22] Figure 3 in Dix-Carneiro and Kovak (forthcoming) shows that by 2010 a region facing a 10 percentage point larger tariff reduction experienced a 15.9 percent larger decline in formal earnings. Appendix Figure B4 shows that tradable-sector workers initially in the same region experienced a 3.9 percent larger decline in the probability of working in the formal sector by 2010. Combining these estimates, we can calculate the expected decline in individual yearly earnings as a share of initial yearly earnings.

$$\frac{E^{2010} \cdot P^{2010} - E^{1990} \cdot P^{1990}}{E^{1990} \cdot P^{1990}} = \frac{E^{2010} \cdot P^{2010}}{E^{1990} \cdot P^{1990}} - 1 = (1 - 0.159)(1 - 0.039) - 1 = -0.192$$

where E is average earnings and P is the probability of formal employment in the given year. We compare this predicted average decline in individual yearly earnings of 19.2 percent to the parallel estimate of 16.4 percent in

5.4 Robustness

We have implemented a variety of robustness tests demonstrating that the formal employment effects in Figure 3 and the formal earnings effects in Figure 5 are robust to alternative measurement and specification choices and to controlling for salient economic shocks occurring after liberalization. A detailed discussion appears in Appendix B.5, and we summarize the findings here.

We first calculate alternative regional tariff reductions using effective rates of protection, which account for tariff changes on industry output and industry inputs. Because changes in effective rates of protection are somewhat larger than changes in output tariffs, the resulting regression estimates are smaller by approximately the same proportion, but we continue to observe growing effects over time, and predicted effects on employment and wages are very similar to those in the main analysis. We also estimate (3) omitting fixed effects for the worker's initial industry and/or their initial occupation. These alternative specifications thus capture the direct effects of liberalization on industries and occupations at the national level and are a bit larger than those controlling for industry and occupation fixed effects, and we continue to find substantial growth in liberalization's effects over time.

Many salient economic shocks hit the Brazilian economy in the years following trade liberalization, and we introduce controls to ensure that these subsequent shocks are not driving our results. We control for regional tariff reductions occurring after liberalization, using tariff changes from 1995 to each subsequent year t. Exchange rate movements, particularly the large devaluations in 1999 and 2002, could also confound our results if they were correlated with the tariff changes occurring during liberalization. We construct industry-specific real exchange rate changes from 1990 to each year $t > 1995$, and calculate regional exchange rate shocks as weighted averages, following (2). We control for the wave of privatization in the early 2000s using the initial (1995) share of employment at state-owned firms or the changes in this share from 1995 to each year $t > 1995$. Finally, we control for changes in commodity prices. This is particularly important given the commodity-intensive nature of Brazilian output and the substantial increase in commodity prices beginning in 2004. We use IMF commodity price data to construct the change in price for 19 separate commodities, and generate regional weighted averages of these price changes.

In all cases, when controlling for these post-liberalization shocks we continue to find large and growing effects of liberalization on local formal employment and formal earnings. This robustness applies to the main tradable-sector sample and the nontradable-sector sample discussed below in Section 5.6. Together, these results imply that our findings are robust to alternative measurement and specification choices and that the growing effects we observe over time are not driven by subsequent shocks to the Brazilian economy. Rather, they reflect growing effects of liberalization

Appendix Figure B5. These magnitudes are quite similar in spite of the fact that Figure 3 in Dix-Carneiro and Kovak (forthcoming) includes all formal workers, while Figures B4 and B5 include only workers initially employed in the formal tradable sector.

over time.[23]

5.5 Migration

Workers whose initial regions faced larger tariff reductions may have chosen to migrate to more positively affected labor markets. In earlier work, we used cross-sectional information from the Census to document that regional working-age population does not respond to RTR_r, suggesting that workers did not systematically move away from harder-hit regions (Dix-Carneiro and Kovak forthcoming). Here, we are able to utilize the panel dimension of the RAIS data to follow individual workers over time to see whether those initially employed in regions facing larger tariff reductions were more likely to obtain formal employment elsewhere. Note that if migrants leave the formal sector, they leave the RAIS sample, and their migration will not be observed. To lessen potential bias due to differential attrition from formal employment, we calculate the share of formally employed months spent away from the initial region:

$$\frac{MonthsAway_{it}}{Months_{it}}. \tag{6}$$

This measure mitigates selection concerns by conditioning on formal employment and because the vast majority of individuals in our sample spend at least one month in the formal sector between 1990 and 2009.

Figure 6 reports the relationship between (6) and RTR_r for the tradable worker panel (similar results for the nontradable panel appear in Appendix Figure B9). The estimates are small and not nearly statistically significantly different from zero. The negative point estimates suggest that, if anything, workers initially employed in regions facing larger tariff declines were *less* likely to migrate to a formal job elsewhere than workers initially employed in more favorably affected regions. More generally, the only way that this analysis would miss a substantial migration response would be if migrating workers are systematically more likely to switch from formal employment to informal employment upon migration. While this is possible ex-ante, the lack of working-age population response documented in Dix-Carneiro and Kovak (forthcoming) rules out this possibility. Hence, we find no evidence for systematic migration responses to liberalization-induced labor demand shocks.

5.6 Nontradable Sector Workers

Recall that the empirical results discussed so far in this section apply to workers who initially worked in tradable industries prior to liberalization, i.e. those in industries directly affected by the tariff shock. We also implemented all of these analyses using an alternate group of workers

[23] See Dix-Carneiro and Kovak (forthcoming) for a more extensive set of robustness tests and alternative commodity price controls.

who were initially employed in the nontradable sector. Our objective is to see whether workers outside tradable sectors are insulated from the local effects trade liberalization, or whether the tradable and nontradable labor markets are sufficiently integrated that regional trade shocks affect both sectors' workers similarly. This integration may occur through changes in consumer demand for local nontradables or because workers compete for jobs in both the tradable and nontradable sectors.

For all outcomes, workers initially employed in the nontradable sector experience similar effects of liberalization to those of initially tradable sector workers. For example, Figure 7 reports the effects of regional tariff reductions on the average number of months formally employed per year from 1990 to year t, as in (4). As with tradable sector workers, the effects are large and grow over time, indicating that nontradable sector workers initially employed in regions facing larger tariff reductions spend less and less time formally employed compared to workers initially employed in more favorably affected regions. The long-run (2010) point estimate for the nontradable sector is -2.7, which implies that a worker whose initial region faced a 10 percentage point larger tariff decline on average worked in the formal sector for 5.7 fewer total months between 1990 and 2010, compared to an unconditional average of 129 months worked in the formal sector for the nontradable sector sample. This large effect implies that the tradable and nontradable sectors were sufficiently integrated that the direct effects of liberalization in the tradable sector spill over into the nontradable sector. However, the nontradable sector effect is 43 percent smaller than that in the tradable sector (Figure 3), indicating that workers in the nontradable sector were somewhat insulated from the direct employment effects of liberalization.

The integration of nontradable and tradable sector labor markets is further reinforced by Figure 8, which breaks the employment analysis of Figure 7 into months spent in tradable and nontradable employment. The results are quite different from those for tradable sector workers in Figure 4. The biggest formal employment losses for workers initially in the *nontradable* sector occur in the *tradable* sector. Only in the last years of our sample do nontradable sector employment losses become significantly different from zero, while tradable sector losses are large and significant throughout the post-liberalization period. This means that in favorably affected markets, nontradable sector workers regularly transition to tradable employment, but that these transitions become less and less common in markets facing larger tariff declines, driving much the overall formal employment losses faced by nontradable sector workers.

The other outcomes considered above also exhibit similar patterns in the nontradable and tradable sectors. Appendix B.3 presents results for migration, earnings, and alternative employment measures, and Appendix B.5 documents the robustness of the nontradable-sample results to alternative specifications and controls for post-liberalization shocks, using the same specifications summarized in Section 5.4.

5.7 Summary of Worker-Level Analysis

The results in this section document substantial and growing effects of trade liberalization on workers' formal employment and earnings for 15 years following the end of liberalization. Labor market outcomes of workers initially employed in harder-hit places steadily deteriorate over time and never recover. Adversely affected workers spend less time formally employed and exhibit declining formal earnings compared to workers initially employed in other regions. These findings at the individual level are similar to the region-level results of Dix-Carneiro and Kovak (forthcoming), who find large and growing effects on regional formal employment and earnings.

We also found evidence of various adjustment margins within formal employment. Workers initially in the tradable sector are more likely to transition into nontradable employment when facing more negative shocks. However, these sectoral transitions are too small on average to compensate for losses in the tradable sector. We find minimal effect of regional shocks on inter-regional worker mobility. Although this finding is similar to earlier work, it remains surprising that workers do not migrate in the face of substantially depressed relative labor market conditions in harder-hit regions. Rather, on average, worker adjustment appears to operate along other margins within a given region.

Finally, the evidence strongly supports the conclusion that formal tradable and nontradable sectors are strongly integrated. Workers initially employed in the nontradable sector experienced similar employment and earnings effects to those initially employed in the tradable sector, though with smaller magnitude. Employment losses for initially tradable sector workers were partly offset by transitions into nontradable employment. More strikingly, employment losses for initially nontradable sector workers occurred primarily through reduced subsequent transitions into tradable employment, highlighting the close integration of the two sectors.

6 Regional Analysis

In the preceding analyses, we focused on outcomes for formally employed workers. The formal sector is of particular interest for a variety of reasons. It is more capital intensive, dynamic, and productive than the informal sector, and formal jobs are generally seen as being of much higher quality than informal jobs (LaPorta and Schleifer 2008, Bacchetta, Ernst and Bustamante 2009, Fajnzylber, Maloney and Montes-Rojas 2011, LaPorta and Schleifer 2014). Formal employment gives workers access to all of the benefits and labor protections afforded them by the legal employment system, while informal jobs generally provide minimal benefits and fail to comply with various labor regulations. Hence, transitions out of formal employment are likely to involve important declines in worker wellbeing even if displaced workers later find informal employment.

In this section we seek to better understand what happens to workers in harder-hit regions once they leave the formal sector. Although the longitudinal data in RAIS do not provide information

on workers outside the formal sector, we turn to Census data, which allow us to examine the roles of informal employment and non-employment in regional labor market adjustment.[24] Recall that the Census reports whether a worker has a signed work card, giving them access to the worker rights and protections afforded them by formal employment. Workers without a signed work card are informally employed.[25] Trade policy's effects on informality are also of independent interest, as evidenced by a large and growing academic literature.[26] Import competition may increase pressure on firms to cut costs by neglecting to comply with labor regulations, and informal jobs are often characterized as providing fewer opportunities for training and advancement and generally less favorable working conditions (Goldberg and Pavcnik 2007, Bacchetta et al. 2009). Together, these concerns have made informality a prominent issue in public debates over globalization in the developing world (Bacchetta et al. 2009).

6.1 Regional Empirical Specification

While the RAIS data allow us to follow workers over time, they do not allow us to observe the worker's status outside formal employment. In order to study margins of labor market adjustment involving informal employment or non-employment, we utilize decennial Census data and an empirical approach that examines outcomes at the region level rather than the worker level.[27] In particular, we estimate specifications of the following form,

$$y_{rt} - y_{r,1991} = \theta_t RTR_r + \alpha_{st} + \gamma_t \Delta y_{r,\text{pre}} + \epsilon_{rt}. \tag{7}$$

We estimate this specification separately for each post-liberalization Census year $t \in \{2000, 2010\}$. y_{rt} is a labor market outcome in region r and year t, RTR_r is the regional tariff reduction defined in (2), α_{st} are state fixed effects (allowed to vary by year), and $\Delta y_{r,\text{pre}}$ is a pre-liberalization change in the outcome (either 1980-1991 or 1970-1980). We use 1991 as the base year for outcome changes because that is the closest Census year to the beginning of liberalization. Since RTR_r does not vary over time, always reflecting tariff reductions from 1990 to 1995, the estimates of θ_t trace out the cumulative effects of regional tariff reductions on the regional outcome y_r as of year t. Table 2 presents summary statistics on the regional outcomes examined in the following analyses.[28]

[24] We focus on non-employment, which includes both unemployment and out of the labor force. This approach allows us to avoid changing labor force definitions over time and captures transitions into unemployment and out of the labor force, both of which may be affected by trade reform.

[25] See footnote 11 for papers using the same definition of informality.

[26] See Goldberg and Pavcnik (2007) and Paz (2014) for literature reviews with relevant citations.

[27] In order to maintain consistent regional definitions across Censuses from 1970-2010, the analysis in this section partitions Brazil into 405 regions.

[28] Table 2 reports unweighted means and standard deviations across time-consistent microregions. Note that these may differ from similar figures at the national level because of variation in regional populations. See Appendix B.2 for national informality rates etc.

6.2 Regional Labor Market Structure

We have already documented that workers initially employed in regions facing larger tariff reductions spend less and less time formally employed than otherwise similar workers initially in more favorably affected regions. Yet from the RAIS data alone, one can not observe whether these displaced formal workers find informal employment or become non-employed. To shed light on this question, we use the regional empirical strategy just described to examine the effects of liberalization on the regional shares of working-age (18-64) individuals that are not employed or are informally employed. To ensure that our results are not driven by changes in the regional composition of workers, we control for worker demographics and education, following an approach similar to that of Goldberg and Pavcnik (2003). Separately for each Census year t and each employment category $c \in \{\text{non-employed, informal, informal employee, self-employed}\}$, we estimate regressions of the following form.

$$\mathbf{1}(category_{irt} = c) = \mu_{rt}^{c} + X_{it}\beta_{t}^{c} + e_{irt}^{c}, \tag{8}$$

The dependent variable is an indicator for the employment status of individual i in region r in year t, μ_{rt}^{c} are region fixed effects (allowed to vary across years), and X_{it} is a set of worker controls including 5 age bins, gender indicator, and indicators for individual years of education. The regional fixed effect estimates, $\hat{\mu}_{rt}^{c}$, then capture the share of working-age individuals in the region who have the relevant employment status, purged of variation related to these observable worker characteristics. We use these adjusted employment status shares as dependent variables in regional analyses following (7). Note that this research design explains differences across regions in the growth of informal or non-employed shares of the regional working-age population, rather than aggregate national trends in these shares.[29]

The results appear in Table 3. Columns (1) - (3) examine changes from 1991 to 2000, while columns (4) - (6) examine changes from 1991 to 2010. We control for pre-liberalization share changes for 1980-1991, 1970-1980, and both. Information on formality is unavailable in 1970, so 1970-1980 pre-trends always refer to the non-employed share. All columns include state fixed effects. Panel A shows that regions facing larger tariff declines experience relative increases in the share of the working age population that is not employed. The estimate of 0.301 in column (3) implies that by 2000 a region facing a 10 percentage point larger regional tariff reduction exhibited a 3.01 percentage point larger increase in the non-employed share. This is a large difference, accounting for 7.6 percent of the baseline average non-employment rate across regions of 0.397 (Table 2). Panel B shows that harder hit regions experience somewhat smaller increases in the share of working-age population that is informally employed. By 2010, however, the situation is different. The informal effect increases by even more, while the non-employed effect is small and statistically indistinguishable from zero. Column (6) of Panel B implies that by 2010 a region facing a 10

[29] See Appendix B.2 for information on national informality rates.

percentage point larger regional tariff reduction exhibited a 5.28 percentage point larger increase in the informally employed share of the working age population. In the absence of substantial interregional migration, as documented above, these results suggest that many workers whose regions faced larger tariff declines were non-employed in the years just following liberalization, but that many of these individuals later found employment in the informal sector. Appendix B.6.1 reinforces this interpretation by presenting similar findings for a consistent birth cohort across 1991, 2000, and 2010, ensuring that the results are not driven by compositional change in the working-age population. Hence, transitions to informal employment often occurred following a lengthy spell of non-employment. Meghir, Narita and Robin (2015) support this interpretation, showing (in their Table 1) very frequent transitions of unemployed workers to informal employment.[30]

Panels C and D of Table 3 split informal employment into informal employee and self-employed status. These results are merely suggestive, as the prevalence of independent contractors blurs the distinction between informal employment and self-employment, and for practical purposes self-employment is often similar to informal employment in that workers often do not enjoy government mandated benefits such as job security, employer social security contributions, etc. The medium-run increase in informality reflects an increase in the share of informal employees, while the long-run effect reflects increased self-employment.[31] This pattern suggests that after long non-employed spells, workers have few traditional employment options and must resort to self-employment. The availability of an informal option may therefore help mitigate long-run employment losses in harder hit regions. Understanding this interaction between trade policy and labor market policies relating to informality is an important topic for future work. We show in Appendix B.6.2 that the results in Table 3 are quite consistent across education levels. We also emphasize that the effects estimated in Table 3 capture *relative* effects of trade liberalization across regions facing larger and smaller tariff reductions, not aggregate national effects.[32]

The substantial effect of liberalization on local informal employment in Table 3 may appear to contradict other results in the literature studying the response of Brazilian informality to trade policy changes. The apparent conflict is resolved by noting differences in methodology and observed adjustment patterns. For example, Goldberg and Pavcnik (2003) do not find an effect of trade policy on informality, a finding corroborated by Bosch et al. (2012). These papers restrict attention to manufacturing sectors and relate changes in within-industry informality to changes in industry-

[30] Transitions from unemployment to informal employment are 4 to 5 times more frequent than transitions from unemployment to formal employment.

[31] de Paula and Scheinkman (2010) present convincing evidence for a mechanism in which increased informality begets more informality in the presence of value-added taxes (VAT). Because purchases from informal firms do not generate VAT credits, buyers have an incentive to become informal when more of their suppliers are informal. However, since the long-run increase in informality that we document reflects primarily self-employment, it is unlikely to be driven by this mechanism.

[32] This point applies to cross-sectional analyses at the region or industry levels, including Goldberg and Pavcnik (2003), Menezes-Filho and Muendler (2011), and Bosch et al. (2012). See Appendix B.2 for aggregate trends in informality at the national level.

specific tariffs. This industry-level approach does not capture any informality responses that occur through inter-sectoral shifts and omits non-manufacturing sectors entirely. As shown in Appendix B.2, during the 1990s, informal shares increased in manufacturing industries, which faced larger tariff cuts, and informal shares declined in agriculture and mining, which faced more positive tariff changes.[33] Our region-level approach captures these shifts between formal and informal employment that occur across industries, including those outside manufacturing.

Menezes-Filho and Muendler (2011) employ an alternative research design, utilizing worker panel data from the *Pesquisa Mensal de Emprego* (PME) to examine yearly employment transitions for individual workers initially employed in manufacturing. This approach has the benefit of observing worker-level transitions between formal employment, informal employment, and non-employment rather than relying on repeated cross-sections, but is limited by observing transitions only at the yearly frequency. They find no significant relationship between tariff reductions and the likelihood of transitioning into informal employment, but do find that output tariff declines lead to increased transitions into non-employment. These findings are consistent with our results if, as suggested by Table 3, many displaced formal sector workers spend more than a year in non-employment before eventually obtaining informal employment. Our findings more closely parallel those of McCaig and Pavcnik (2014), who find substantial shifts from household (informal) to enterprise (formal) employment in Vietnam in response to the U.S.-Vietnam Bilateral Trade Agreement.[34]

To complete the picture of liberalization's effects on regional labor market structure, we examine changes in the shares of regional employment falling in the following four categories: formal tradable, formal nontradable, informal tradable, and informal nontradable. This analysis allows us to understand the role of shifts across sectors vs. changes in informality within sectors. The results appear in Table 4.[35] Formal tradable employment is clearly the category hardest hit when facing larger regional tariff reductions. The offsetting growth in informal employment that we saw in Panel B of Table 3 does not reflect a shift toward nontradables, but occurs primarily within the tradable sector. Putting these results in context, in Figure 4 we found that formal tradable sector workers were more likely to transition into formal nontradable sector employment when the initial region faced a more negative labor demand shock. Yet here we generally find small positive or insignificant coefficients for the regional formal nontradable employment share, indicating that this portion of the labor market does not expand to absorb the tradable sector workers transitioning into nontradable employment. What, then, happened to workers initially in the formal nontradable sector? Recall from Figure 8 that the biggest employment losses for formal workers initially in the

[33] Appendix Figure B1 provides a breakdown of informality changes by more detailed industry.

[34] Paz (2014) and Cruces et al. (2014) provide two other recent examples that find significant effects of tariff changes on informality using different methodologies.

[35] Note that although these categories partition all employed workers, the coefficients do not precisely sum to zero because of differences in weighting and pre-trends across outcomes.

nontradable sector occurred in the tradable sector. This means that formal nontradable workers often transition to formal tradable employment, but these transitions occur much less frequently in markets facing larger tariff declines. It is likely that these formal nontradable sector workers who are no longer able to find formal tradable or nontradable employment drive a large portion of the growth in informal tradable employment seen in Table 4.

6.3 Regional Earnings

Given that many formally employed workers in regions facing larger tariff declines transitioned to informal employment, we now examine the effects of liberalization on regional informal and overall earnings (including both formal and informal workers). In Dix-Carneiro and Kovak (forthcoming), we show that regions facing larger tariff reductions experience declining formal sector earnings compared to other regions and that this difference grows steadily over time following liberalization. We expect similar results for informal and overall regional earnings because the previous section documented large shifts between regional formal and informal employment and because there is substantial overlap in the industry composition of the formal and informal sectors (Appendix B.2). As in the employment share analysis, we control for changes in the composition of the regional workforce by estimating regressions of the following form.

$$\ln(earn_{irt}) = \mu_{rt} + X_{it}\beta_t + e_{irt} \tag{9}$$

The dependent variable is log earnings for worker i in region r in year t, μ_{rt} are region fixed effects (allowed to vary across years), and X_{it} is the same set of worker controls used in (8). The regional fixed effect estimates, $\hat{\mu}_{rt}$, which we refer to as regional earnings premia, then capture average log earnings in the region, purged of variation related to observable worker characteristics.[36]

Table 5 reports the results of estimating the relationship between regional earnings premia and regional tariff reductions, as in (7). Panel A restricts attention to informal workers, i.e. those without a signed work card, including both informal employees and the self-employed. The results in columns (1) - (3) show that by 2000, informal earnings declined substantially in regions facing larger tariff reductions, compared to those in other regions. The estimate in column (3) of -0.433 implies that a region facing a 10 percentage point larger tariff decline experienced a 4.33 percentage point larger proportional decline in earnings among informal workers. In contrast, by 2010, these effects have largely disappeared, as seen in much smaller and statistically insignificant point estimates. Appendix B.7.1 shows that the earnings effects in Table 5 are robust to using more detailed worker

[36]Note that we do not control for industry fixed effects in (9), paralleling the employment category analysis in (8). This choice allows us to capture both the direct effects of tariff reductions in a worker's industry and the indirect effects, operating through regional equilibrium (Hakobyan and McLaren 2016, Acemoglu, Autor, Dorn, Hanson and Price 2016). Differences from the similar informal and overall earnings results in Dix-Carneiro and Kovak (forthcoming) result primarily from the exclusion of these industry fixed effects. See Appendix Table B14 for results controlling for industry fixed effects when calculating regional earnings premia.

controls when calculating regional earnings premia, following a consistent birth cohort across years, and examining hourly wages rather than monthly earnings.

The reduction in magnitude of the informal earnings effect is in sharp contrast to the effects of regional tariff reductions on formal sector earnings, which grow substantially over time. This contrast is somewhat puzzling; we expected informal wages to fall along with formal sector wages. The industry distributions of formal and informal output are similar (Ulyssea (2014) and Appendix B.2), so we expect similar declines in labor demand in both sectors. Also, displaced formal sector workers flood into informal employment (Figure 3 and Table 3), which we expect to lower informal workers' wages. A potential explanation for the lack of effect on informal wages is that consumers in harder hit regions experience declining incomes and shift toward lower-priced, lower quality goods produced in the informal sector. Such an increase in demand for informal goods may help offset wage declines for informally employed workers.[37] in Appendix B.7.2, we estimate versions of Table 5 separately for more and less educated workers, finding that the long-run recovery of informal earnings occurs exclusively among less-skilled workers. This pattern is consistent with the hypothesis just mentioned if lower quality products are disproportionately produced using less educated workers.[38] That said, in the absence of regional consumption data distinguishing between formal and informal goods, we are unable to rigorously test this hypothesis and leave it as a topic for future work.

Other potential explanations are less plausible. First, because informal firms are generally less capital intensive than firms in the formal sector (LaPorta and Schleifer 2008, Fajnzylber et al. 2011), it is unlikely that regional capital reallocates away from formal firms and toward informal firms, holding up informal wages. Second, displaced formal sector workers who move into informal employment may have more favorable unobserved characteristics than average informal workers, even after controlling for education and other demographics we use when calculating regional wage premia. In the absence of panel data on informal workers we can not strictly rule out selection on worker unobservables. However, in Appendix B.7.1, we present suggestive evidence against this mechanism by documenting consistent informal earnings results when sequentially including more detailed and flexible worker controls when calculating regional informal earnings premia. If selection on unobservables accompanies selection on observables, then we would observe changes as we control for more detailed information on worker observables. The absence of such changes

[37] Burstein, Eichenbaum and Rebelo (2005) show that lower quality goods gain market share in recessions, while McKenzie and Schargrodsky (2011) make a similar argument in the context of the 2002 economic crisis in Argentina. While there is little direct evidence on the relative quality of goods produced by formal and informal firms, it is well known that informal firms are significantly smaller than formal firms (LaPorta and Schleifer 2014, Meghir et al. 2015, Ulyssea 2014), and Kugler and Verhoogen (2011) show that larger firms produce higher quality goods than small firms, on average. Moreover, LaPorta and Schleifer (2008) show that informal firms use lower quality inputs and speculate that they produce lower quality outputs as a result.

[38] Similarly, Appendix B.7.3 shows that the long-run recovery in informal earnings occurs primarily among self-employed workers. This pattern may also suggest a shift toward lower quality products, to the extent that lower quality products are disproportionately produced by the self-employed.

partly mitigates concerns about selection on unobservables.[39]

Finally, we examine the effect of liberalization on overall wages, for formal and informal workers together. This analysis helps rule out concerns regarding worker selection into informality, based on the following reasoning. When combining formal and informal workers together, the confounding influence of worker selection into informality nets out, as long as the quality of the regional workforce stays constant. If the informal earnings results were driven by worker selection alone, we should find growing effects of liberalization on overall regional earnings. Panel B of Table 5 shows that this is not the case. It finds roughly constant earnings effects over time, with substantial effects in both 2000 and 2010. This pattern is consistent with continuously declining formal sector earnings and recovery in informal earnings (net of composition).

Together these results show that declining labor demand in regions facing larger tariff declines led many workers to shift into informal employment or lose employment all together. In the long-run, many of these non-employed workers become self-employed to ensure they have some earnings. Although we cannot make strict welfare claims without more detailed information on workers and jobs in the informal sector, it is quite likely that the observed increases in non-employment and informality both imply substantial declines in workers' labor market outcomes given the apparently undesirable nature of many informal jobs in comparison to formal jobs. Nonetheless, the long-run shifts into informal employment suggest that the informal sector provides a fallback for trade-displaced workers who might have remained unemployed in the absence of an informal option or a more flexible formal labor market.

7 Conclusion

This paper examines various potential margins of labor market adjustment following a large trade liberalization in Brazil. Using both longitudinal administrative data and cross-sectional household survey data, we document a rich pattern of adjustment both at the worker level and the regional level. A worker's initial region of employment is very important in determining their subsequent labor market outcomes. Workers initially employed in regions facing larger tariff declines spend less and less time formally employed and earn less and less in the formal sector than a worker initially employed in a more favorable affected region. Consistent with the importance of geographic location, we find no evidence for equalizing inter-regional mobility in response to these sharp differences across labor markets, implying that any worker adjustment occurs primarily within region. These worker-level findings complement our previous region-level analyses of the formal labor market (Dix-Carneiro and Kovak forthcoming), and reinforce the central role of local labor markets in determining workers' outcomes during a period of structural change.

Although changes in trade policy are directly incident upon workers in tradable industries, we

[39] See Altonji, Elder and Taber (2005) for a more formal version of this kind of argument.

find similarly sized effects in the nontradable sector, implying close integration of the two sectors at the regional level. Consistent with this interpretation, in regions facing larger tariff declines, workers are more likely to transition from the tradable sector to the nontradable sector, although these reallocations are not large enough to offset employment declines in the formal tradable sector. This close integration across sectors raises concerns about policies providing targeted compensation for workers in industries experiencing increased import competition, such as Trade Adjustment Assistance in the U.S. When regional labor markets are reasonably integrated across sectors, even workers whose industry did not directly face a trade shock experience the labor market effects of that shock. Policies with industry targeting will fail to address declining earnings and employment rates for for these indirectly affected workers.

We also document substantial effects of trade liberalization on regional rates of informal employment. Our results suggest that in regions facing larger tariff declines, after long periods of non-employment, trade-displaced formal-sector workers eventually settle for the fallback option of informal employment. This pattern suggests that in the absence of increased flexibility in the formal labor market, policies discouraging informal employment may increase non-employment following a trade policy shock, as trade-displaced workers cannot be as easily absorbed by the informal sector. Although this paper focuses on a middle-income country with a large informal share of employment, with the emergence of the so-called "gig economy" an increasing share of high-income country jobs come with minimal job security, no benefits, and possibly part-time work. Our findings on informality are therefore increasingly relevant to the labor market effects of globalization in high-income contexts as well. More generally, understanding these deeper interactions between labor regulations and changes in trade policies is an important avenue for future work.

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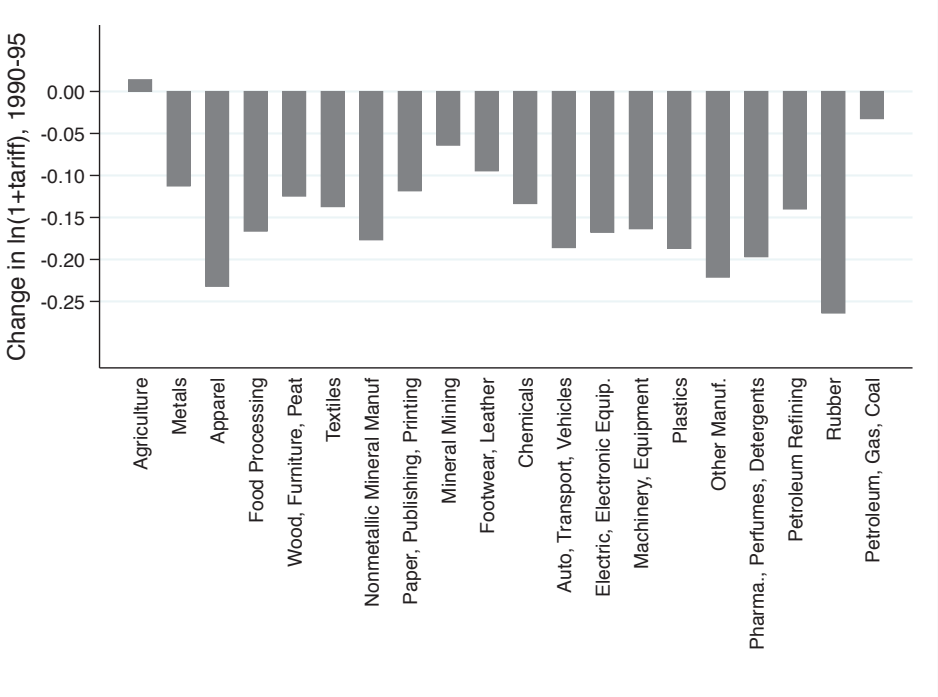
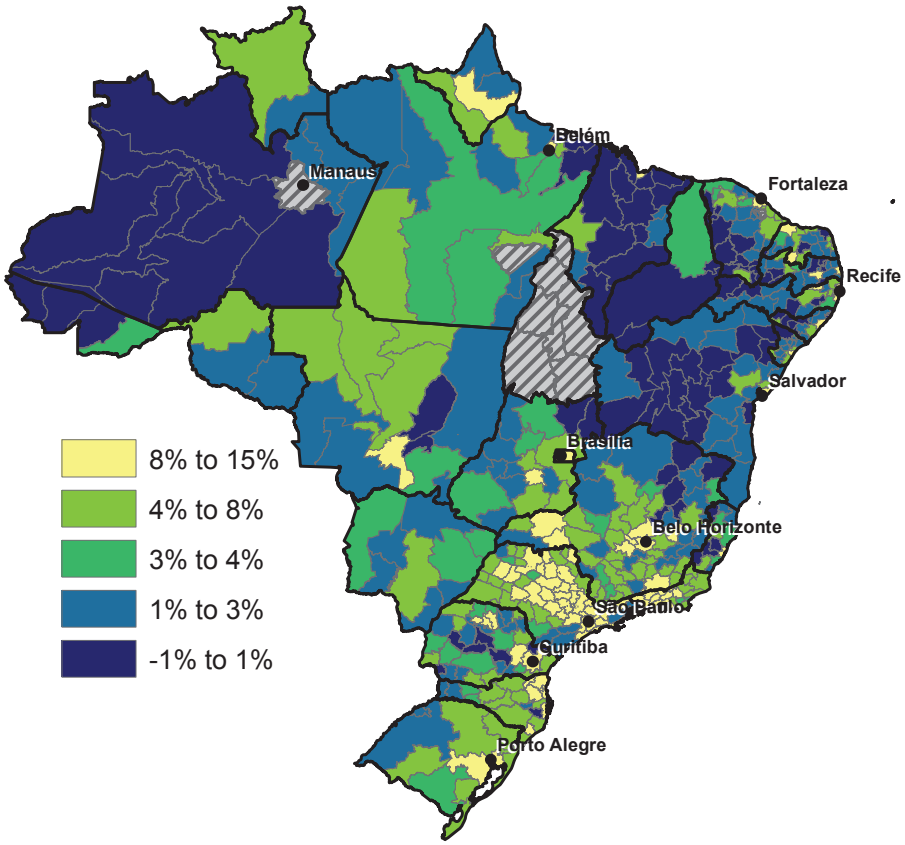
Figure 1: Tariff Changes



Tariff data from Kume et al. (2003), aggregated to allow consistent industry definitions across data sources. See Appendix Table A1 for details of the industry classification. Industries sorted based on 1991 national employment (largest on the left, and smallest on the right)

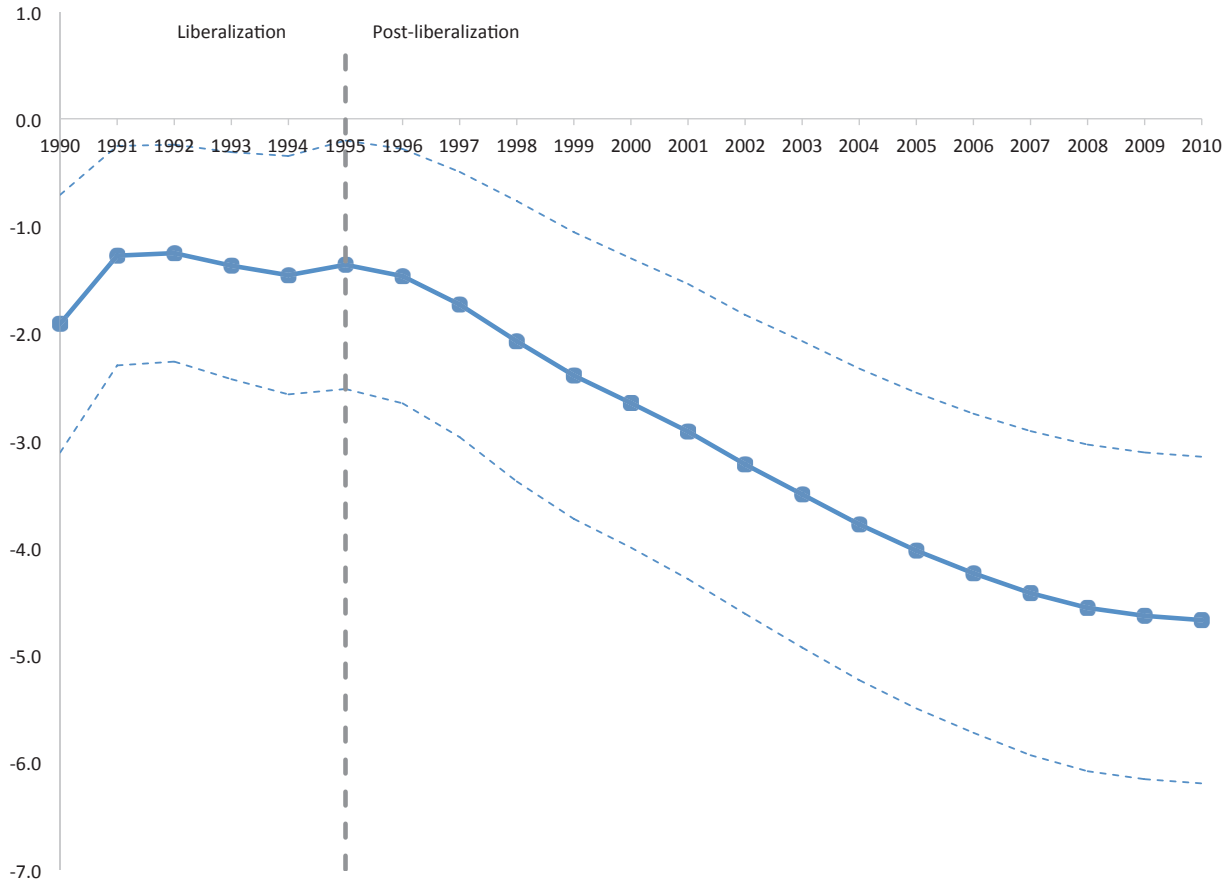
Figure 2: Regional Tariff Reductions



	percentile				
mean	10	25	50	75	90
0.044	0.002	0.012	0.031	0.066	0.107

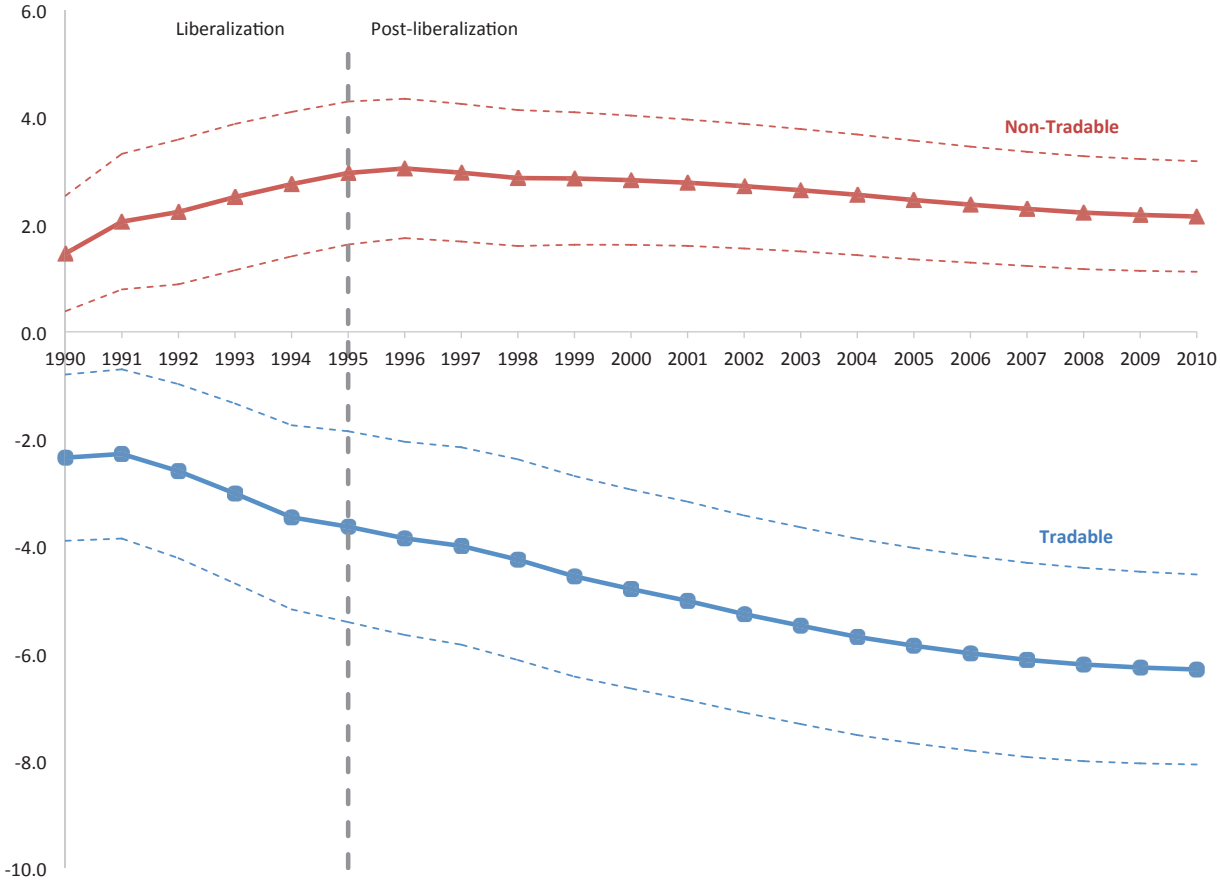
Local labor markets reflect microregions defined by IBGE, aggregated slightly to account for border changes between 1986 and 2010. Regions are colored based on the regional tariff reduction measure, RTR_r, defined in (2). Regions facing larger tariff reductions are presented as lighter and yellower, while regions facing smaller cuts are shown as darker and bluer. Dark lines represent state borders, gray lines represent consistent microregion borders, and cross-hatched migroregions are omitted from the analysis. These microregions were either i) part of a Free Trade Area ii) part of the state of Tocantins and not consistently identifiable over time, or iii) not included in the RAIS sample before 1990.

Figure 3: Cumulative Average Months Formally Employed Per Year - Tradable Worker Sample - 1990-2010



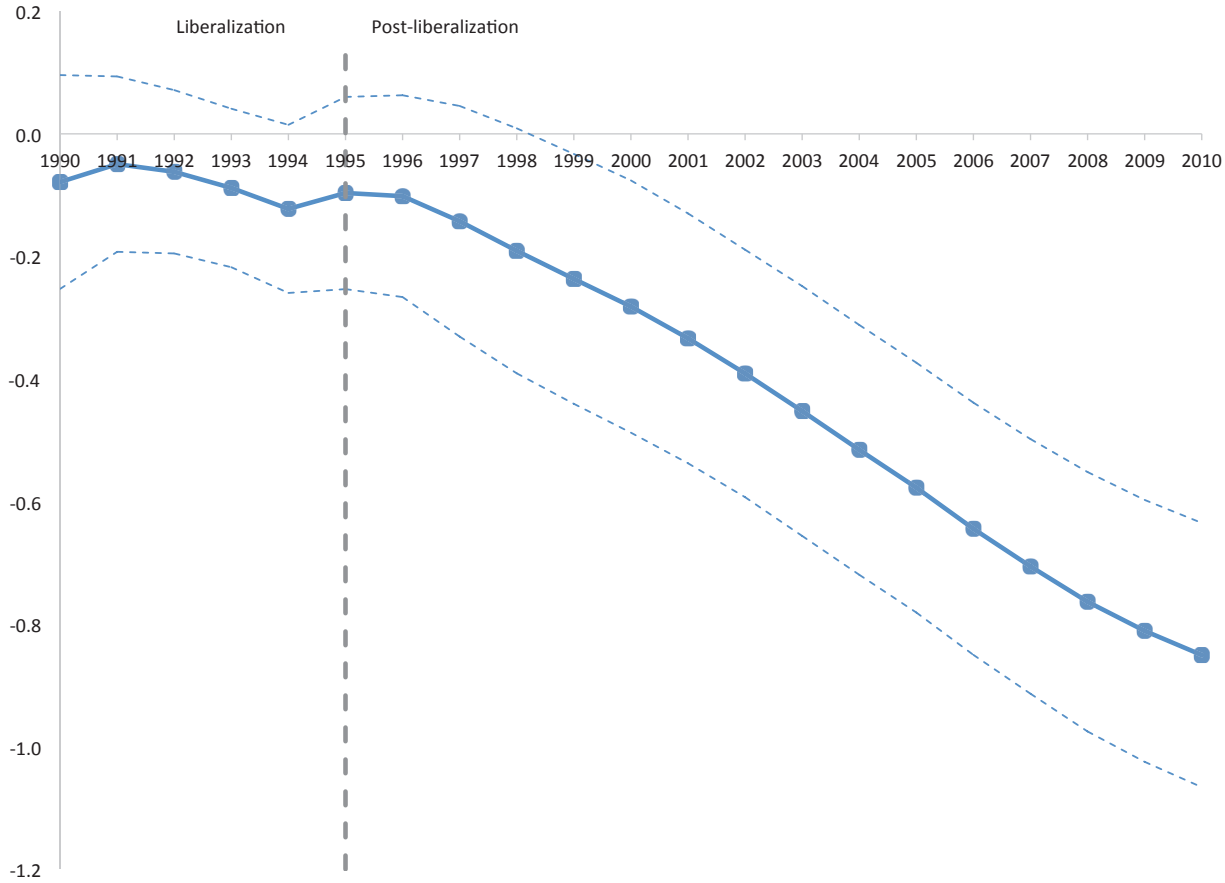
Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the average months formally employed per year from 1990 to the year listed on the x-axis. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller average share of the relevant years formally employed than workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 106 mesoregion clusters.

Figure 4: Average Months Formally Employed in Tradable or Nontradable Sectors Per Year - Tradable Worker Sample - 1990-2010



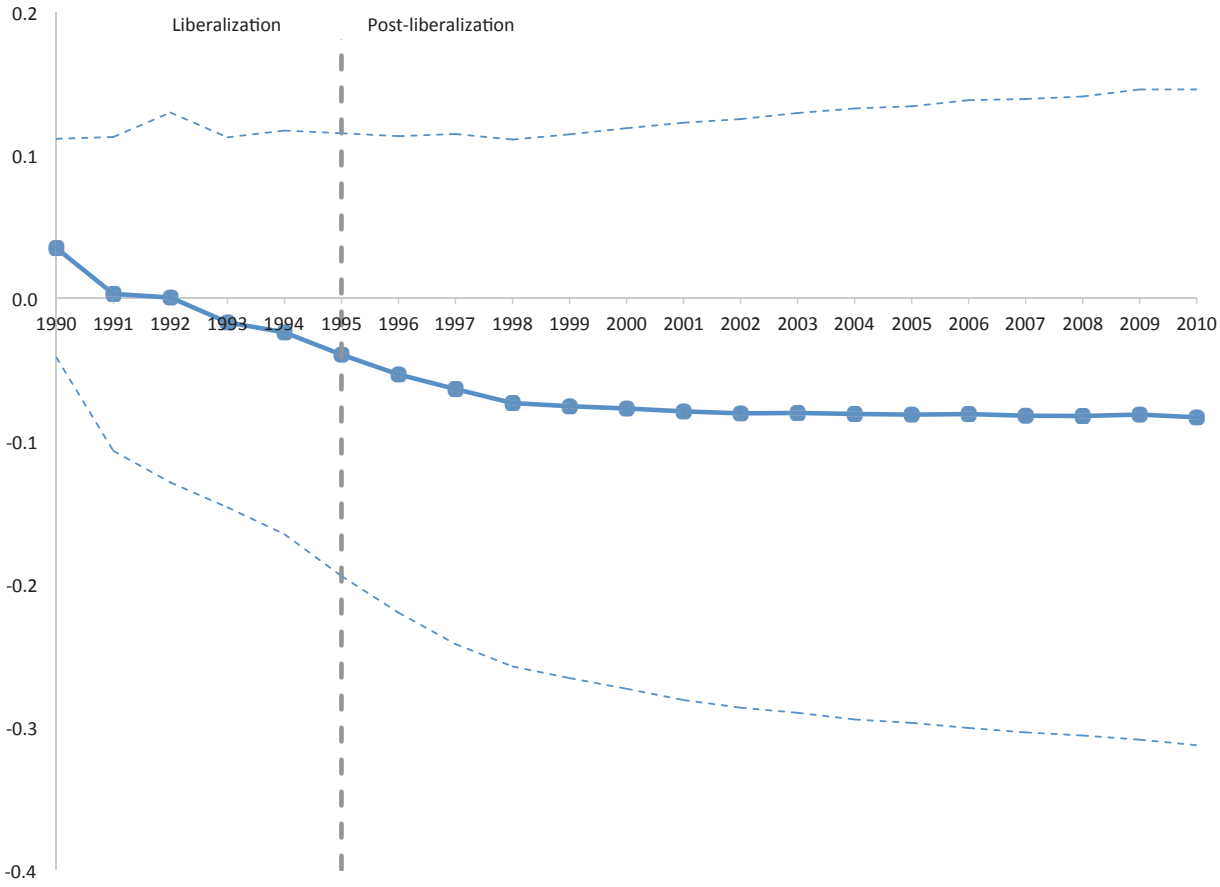
Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the average months formally employed in the relevant sector per year from 1990 to the year listed on the x-axis. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative (positive) estimates imply that workers initially in regions facing larger tariff reductions spend a smaller (larger) average share of the relevant years formally employed in the relevant sector than workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 106 mesoregion clusters.

Figure 5: Cumulative Average Earnings - Tradable Worker Sample - 1990-2010



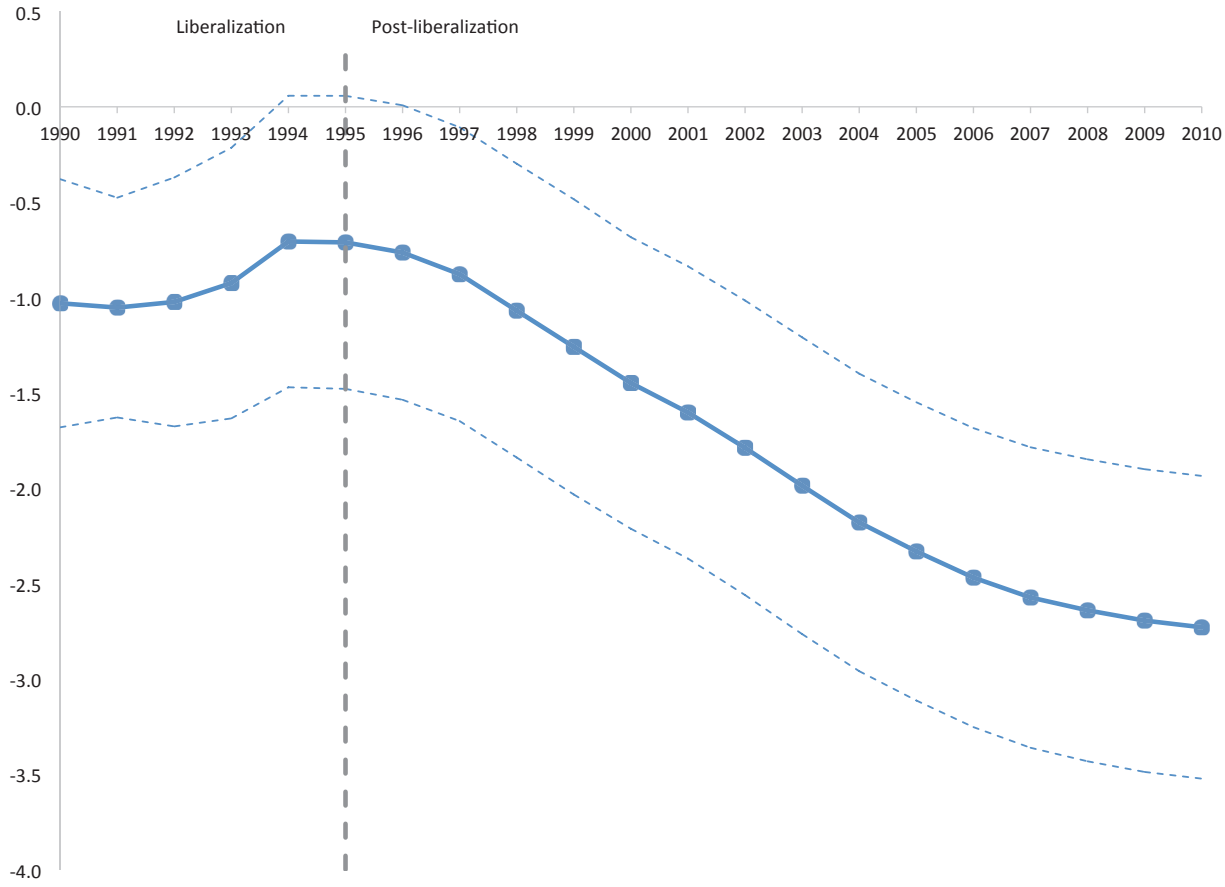
Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the average yearly earnings from 1990 to the year listed on the x-axis, expressed as a multiple of the worker's pre-liberalization (1986-89) average yearly earnings. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions experience earnings reductions compared to workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 106 mesoregion clusters.

Figure 6: Fraction of Formally Employed Months in a New Region - Tradable Worker Sample - 1990-2010



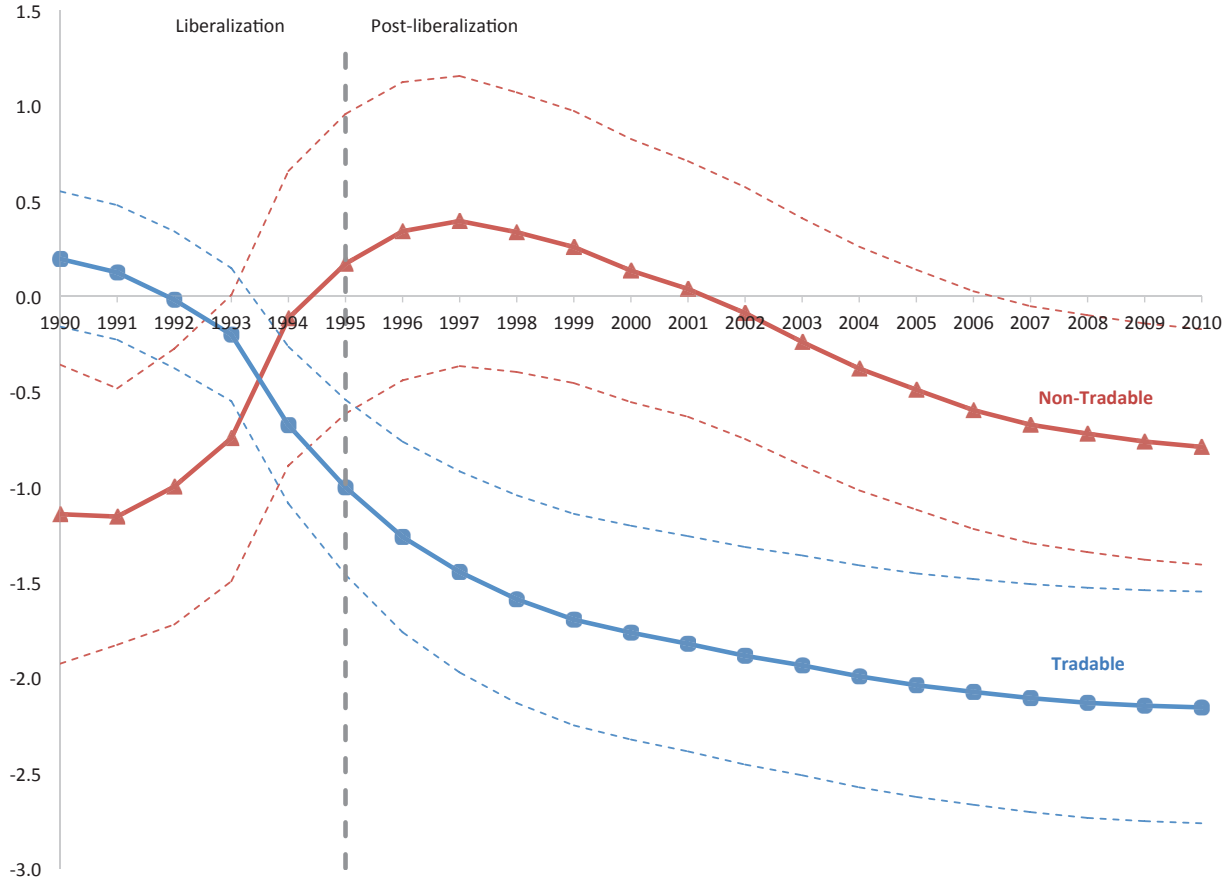
Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the fraction of formally employed months in the year listed on the x-axis spent outside the initial region. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller share of their formal employment outside the initial region than did workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 106 mesoregion clusters.

Figure 7: Cumulative Average Months Formally Employed Per Year - Nontradable Worker Sample - 1990-2010



Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the average months formally employed per year from 1990 to the year listed on the x-axis. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller average share of the relevant years formally employed than workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 111 mesoregion clusters.

Figure 8: Average Months Formally Employed in Tradable or Nontradable Sectors Per Year - Nontradable Worker Sample - 1990-2010



Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the average months formally employed in the relevant sector per year from 1990 to the year listed on the x-axis. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative (positive) estimates imply that workers initially in regions facing larger tariff reductions spend a smaller (larger) average share of the relevant years formally employed in the relevant sector than workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 111 mesoregion clusters.

Table 1: Individual Analysis Summary Statistics

	Tradable Sector Sample		Nontradable Sector Sample	
	mean	std. dev.	mean	std. dev.
Education				
Illiterate	0.02	0.13	0.01	0.11
4th grade incomplete	0.13	0.33	0.10	0.30
4th grade complete	0.25	0.43	0.18	0.38
8th grade incomplete	0.19	0.39	0.14	0.34
8th grade complete	0.15	0.35	0.14	0.35
High School incomplete	0.05	0.21	0.06	0.23
High School complete	0.13	0.34	0.21	0.41
College incomplete	0.02	0.15	0.04	0.19
College complete	0.07	0.26	0.13	0.33
Female	0.24	0.43	0.32	0.46
Age	32.8	5.4	32.8	5.5
December 1989 Earnings (in 2010 R$)	1,906	2,447	1,837	2,669
1989 Yearly Earnings (in 2010 R$)	19,170	23,822	18,683	26,002
Average Annualized Earnings 1986-1989 (in 2010 R$)	18,997	21,058	18,065	21,596
Months formally employed per year				
1990	10.2	3.5	9.9	3.8
1990-1995	8.2	3.8	8.2	3.9
1990-2000	7.1	3.7	7.2	3.9
1990-2005	6.4	3.7	6.6	3.9
1990-2010	6.0	3.7	6.1	3.9
Migration				
Employed in a different region in 1994 than in 1989	0.09	0.29	0.11	0.31
Employed in a different region in 2000 than in 1989	0.10	0.31	0.12	0.32
Observations	585,078		973,703	

RAIS data. Weighted to account for 15% sample of individuals in regions with more than 2000 traded sector workers in 1989 and 100% sample in other regions. All monetary values reported in 2010 R$. In Dec 31, 2010, a US dollar was worth 1.66 Brazilian Reais.

Table 2: Regional Analysis Summary Statistics

	1991		2000		2010	
	mean	std. dev.	mean	std. dev.	mean	std. dev.
Shares of Working-Age Population						
Not-employed	0.397	0.046	0.399	0.059	0.355	0.076
Informal	0.418	0.090	0.435	0.082	0.370	0.077
Informal employee	0.225	0.062	0.221	0.045	0.216	0.061
Self-employed	0.193	0.081	0.214	0.084	0.154	0.040
Shares of Employment						
Formal tradable	0.111	0.094	0.102	0.074	0.121	0.082
Formal nontradable	0.191	0.092	0.172	0.085	0.292	0.101
Informal tradable	0.394	0.203	0.323	0.176	0.259	0.153
Informal nontradable	0.304	0.078	0.403	0.078	0.328	0.056
Average informal earnings (in 2010 R$)	731	396	941	435	890	379
Average overall earnings (in 2010 R$)	708	337	890	363	938	326
Observations	405		405		405	

Decennial Census data. Reports unweighted means and standard deviations across time-consistent microregions. Note that these may differ from similar figures at the national level because of variation in regional populations. See Appendix B.2 for national informality rates etc. All monetary values reported in 2010 R$. In Dec 31, 2010, a US dollar was worth 1.66 Brazilian Reais.

Table 3: Employment Category Shares of Regional Working-Age Population - 2000, 2010

	1991-2000			1991-2010		
Change in share:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Not-employed						
Regional Tariff Reduction *(RTR)*	0.301***	0.306***	0.301***	-0.024	-0.029	-0.023
	(0.043)	(0.040)	(0.043)	(0.057)	(0.055)	(0.058)
Not-employed share pre-trend (80-91)	0.036		0.028	-0.074		-0.035
	(0.045)		(0.057)	(0.057)		(0.071)
Not-employed share pre-trend (70-80)		-0.031	-0.012		0.084*	0.060
		(0.044)	(0.055)		(0.049)	(0.060)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.479	0.479	0.479	0.584	0.585	0.585
Panel B: Informal						
Regional Tariff Reduction *(RTR)*	0.170***	0.192***	0.213***	0.486***	0.463***	0.528***
	(0.050)	(0.043)	(0.053)	(0.066)	(0.067)	(0.077)
Informal share pre-trend (80-91)	0.015		-0.044	-0.079		-0.136**
	(0.042)		(0.047)	(0.060)		(0.068)
Not-employed share pre-trend (70-80)		0.076	0.112*		-0.000	0.110*
		(0.048)	(0.058)		(0.057)	(0.058)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.328	0.334	0.336	0.564	0.559	0.567
Panel C: Informal employee						
Regional Tariff Reduction *(RTR)*	0.297***	0.268***	0.312***	-0.032	0.039	0.033
	(0.031)	(0.035)	(0.037)	(0.071)	(0.094)	(0.090)
Informal employee share pre-trend (80-91)	-0.096**		-0.112***	0.082		0.015
	(0.038)		(0.041)	(0.099)		(0.091)
Not-employed share pre-trend (70-80)		-0.003	0.046		0.199**	0.192**
		(0.053)	(0.056)		(0.093)	(0.084)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.538	0.526	0.540	0.552	0.562	0.562
Panel D: Self-employed						
Regional Tariff Reduction *(RTR)*	-0.098**	-0.084**	-0.071*	0.428***	0.371***	0.402***
	(0.045)	(0.037)	(0.040)	(0.068)	(0.075)	(0.080)
Self-employed share pre-trend (80-91)	-0.058		-0.107*	-0.325***		-0.280**
	(0.067)		(0.060)	(0.081)		(0.106)
Not-employed share pre-trend (70-80)		0.083	0.121**		-0.209***	-0.110
		(0.060)	(0.061)		(0.075)	(0.093)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.180	0.186	0.198	0.660	0.644	0.664

Decennial Census data. Positive (negative) coefficient estimates for the regional tariff reduction (RTR) imply larger increases (decreases) in the relevant employment category share in regions facing larger tariff reductions. The informal share in Panel B covers both informal employees and the self-employed, shown separately in Panels C and D, respectively. Changes in employment shares are calculated controlling for regional worker composition (see text for details). Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to the non-employed share. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 4: Employment Category × Sector Shares of Regional Employment - 2000, 2010

	1991-2000			1991-2010		
Change in share:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Formal tradable						
Regional Tariff Reduction *(RTR)*	-0.405***	-0.456***	-0.408***	-0.505***	-0.615***	-0.503***
	(0.041)	(0.047)	(0.041)	(0.052)	(0.080)	(0.051)
Formal tradable share pre-trend (80-91)	0.168		0.167	0.378**		0.379***
	(0.103)		(0.102)	(0.145)		(0.143)
Not-employed share pre-trend (70-80)		-0.016	-0.007		-0.018	0.005
		(0.030)	(0.027)		(0.050)	(0.043)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.710	0.698	0.710	0.648	0.610	0.648
Panel B: Formal nontradable						
Regional Tariff Reduction *(RTR)*	-0.050	-0.114**	-0.063	-0.034	-0.045	-0.042
	(0.062)	(0.044)	(0.063)	(0.094)	(0.058)	(0.094)
Formal nontradable share pre-trend (80-91)	0.097		0.103	0.004		0.007
	(0.077)		(0.078)	(0.117)		(0.118)
Not-employed share pre-trend (70-80)		-0.057	-0.062*		-0.034	-0.034
		(0.035)	(0.034)		(0.053)	(0.054)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.396	0.393	0.405	0.598	0.599	0.599
Panel C: Informal tradable						
Regional Tariff Reduction *(RTR)*	0.619***	0.597***	0.604***	0.944***	0.870***	0.882***
	(0.047)	(0.043)	(0.046)	(0.080)	(0.073)	(0.081)
Informal tradable share pre-trend (80-91)	-0.019		-0.007	-0.058		-0.012
	(0.032)		(0.034)	(0.039)		(0.040)
Not-employed share pre-trend (70-80)		-0.047	-0.038		-0.166**	-0.153**
		(0.053)	(0.054)		(0.070)	(0.067)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.719	0.719	0.719	0.733	0.736	0.736
Panel D: Informal nontradable						
Regional Tariff Reduction *(RTR)*	0.022	0.031	0.051	-0.058	-0.090	0.013
	(0.048)	(0.045)	(0.045)	(0.080)	(0.081)	(0.081)
Informal nontradable share pre-trend (80-91)	-0.094		-0.113	-0.506***		-0.549***
	(0.095)		(0.090)	(0.089)		(0.082)
Not-employed share pre-trend (70-80)		0.108*	0.117**		0.230**	0.274***
		(0.055)	(0.051)		(0.093)	(0.085)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.322	0.329	0.335	0.566	0.531	0.601

Decennial Census data. Positive (negative) coefficient estimates for the regional tariff reduction (RTR) imply larger increases (decreases) in the relevant employment × sector category share in regions facing larger tariff reductions. Changes in employment × sector shares are calculated controlling for regional worker composition (see text for details). Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to the non-employed share. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 5: Regional Informal and Overall Earnings Premia - 2000, 2010

	1991-2000			1991-2010		
Change in log earnings premia:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Informal						
Regional tariff reduction (RTR)	-0.432***	-0.636***	-0.433***	-0.015	-0.307	-0.021
	(0.148)	(0.144)	(0.156)	(0.251)	(0.262)	(0.234)
Informal earnings pre-trend (80-91)	-0.163***		-0.163***	-0.222**		-0.222**
	(0.049)		(0.048)	(0.089)		(0.089)
Overall earnings pre-trend (70-80)		0.008	-0.001		0.006	-0.006
		(0.055)	(0.054)		(0.093)	(0.092)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.699	0.683	0.699	0.697	0.684	0.697
Panel B: Overall						
Regional tariff reduction (RTR)	-0.392***	-0.718***	-0.495***	-0.405*	-0.874***	-0.535**
	(0.119)	(0.132)	(0.136)	(0.237)	(0.254)	(0.206)
Overall earnings pre-trend (80-91)	-0.224***		-0.224***	-0.332***		-0.332***
	(0.055)		(0.053)	(0.088)		(0.084)
Overall earnings pre-trend (70-80)		-0.102*	-0.102*		-0.137	-0.137
		(0.053)	(0.052)		(0.098)	(0.098)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.738	0.719	0.743	0.718	0.697	0.722

Decennial Census data. Negative coefficient estimates for the regional tariff reduction (RTR) imply larger decreases in earnings in regions facing larger tariff reductions. Regional earnings premia are calculated controlling for regional worker composition (see text for details). Panel A examines earnings for informal workers only, while Panel B examines earnings for all workers, including both formal and informal. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to overall earnings. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

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A Data and Definitions

A.1 Tariffs

Tariff data come from Kume et al. (2003), who report nominal tariffs and effective rates of protection from 1987 to 1998 using the Brazilian industry classification *Nível* 50. We aggregate these tariffs slightly to an industry classification that is consistent with the Demographic Census data used to construct local tariff shock measures. The classification is presented in Table A1. In aggregating, we weight each *Nível* 50 industry by its 1990 industry value added, as reported in IBGE National Accounts data. Figure A1 shows the evolution of nominal tariffs from 1987 to 1998 for the ten largest industries. The phases of Brazilian liberalization are visible (see Section 2 for a discussion and citations). Large nominal tariff cuts from 1987-1989 had little effect on protection, due to the presence of substantial nontariff barriers and tariff exemptions. In 1990, the majority of nontariff barriers and tariff exemptions were abolished, being replaced by tariffs providing equivalent protection; note the increase in tariffs in some industries in 1990. During liberalization, from 1990 to 1994, tariffs fell in all industries, then were relatively stable from 1995 onward.

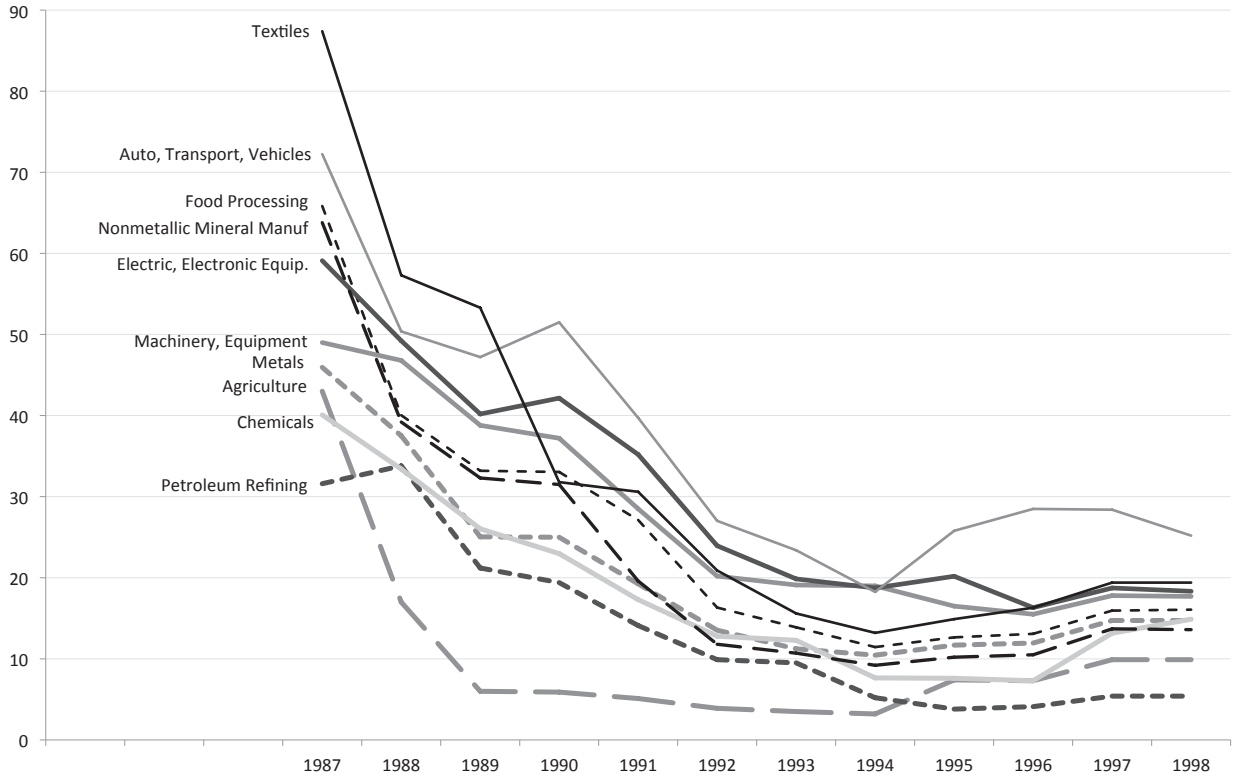
In Section B.5 we calculate post-liberalization tariff changes using UNCTAD TRAINS and use these to control for tariff changes occurring after liberalization.

Table A1: Consistent Industry Classification Across Censuses and Tariff Data

	Industry	Industry Name	Nível 50	1970, 1980, 1991 Census (*atividade*)	2000, 2010 Census (*CNAE-Dom*)
Tradable	1	Agriculture	1	011-037, 041, 042, 581	1101-1118, 1201-1209, 1300, 1401, 1402, 2001, 2002, 5001, 5002
	2	Mineral Mining (except combustibles)	2	050, 053-059	12000, 13001, 13002, 14001-14004
	3	Petroleum and Gas Extraction and Coal Mining	3	051-052	10000, 11000
	4	Nonmetallic Mineral Goods Manufacturing	4	100	26010, 26091, 26092
	5	Iron and Steel, Nonferrous, and Other Metal Production and Processing	5-7	110	27001-27003, 28001, 28002
	8	Machinery, Equipment, Commercial Installation Manufacturing, and Tractor Manufacturing	8	120	29001
	10	Electrical, Electronic, and Communication Equipment and Components Manufacturing	10-11	130	29002, 30000, 31001, 31002, 32000, 33003
	12	Automobile, Transportation, and Vehicle Parts Manufacturing	12-13	140	34001, 34003, 35010, 35020, 35030, 35090
	14	Wood Products, Furniture Manufacturing, and Peat Production	14	150, 151, 160	20000, 36010
	15	Paper Manufacturing, Publishing, and Printing	15	170, 290	21001, 21002, 22000
	16	Rubber Product Manufacturing	16	180	25010
	17	Chemical Product Manufacturing	17,19	200	23010, 23030, 23400, 24010, 24090
	18	Petroleum Refining and Petrochemical Manufacturing	18	201, 202, 352, 477	23020
	20	Pharmaceutical Products, Perfumes and Detergents Manufacturing	20	210, 220	24020, 24030
	21	Plastic Products Manufacturing	21	230	25020
	22	Textiles Manufacturing	22	240, 241	17001, 17002
	23	Apparel and Apparel Accessories Manufacturing	23	250,532	18001, 18002
	24	Footwear and Leather and Hide Products Manufacturing	24	190, 251	19011, 19012, 19020
	25	Food Processing (Coffee, Plant Products, Meat, Dairy, Sugar, Oils, Beverages, and Other)	25,31	260, 261, 270, 280	15010, 15021, 15022, 15030, 15041-15043, 15050, 16000
	32	Miscellaneous Other Products Manufacturing	32	300	33001, 33002, 33004, 33005, 36090, 37000
Nontradable	91	Utilities	33	351, 353	40010, 40020, 41000
	92	Construction	34	340, 524	45001-45005
	93	Wholesale and Retail Trade	35	410-424, 582, 583	50010, 50030, 50040, 50050, 53010, 53020, 53030, 53041, 53042, 53050, 53061-53068, 53070, 53080, 53090, 53101, 53102, 55020
	94	Financial Institutions	38	451-453, 585, 612	65000, 66000, 67010, 67020
	95	Real Estate and Corporate Services	40, 41	461-464, 543, 552, 571-578, 584, 589	63022, 70001, 71020, 72010, 74011, 74012, 74021, 74022, 74030, 74040, 74050, 74090, 92013, 92014, 92015, 92020
	96	Transportation and Communications	36, 37	471-476, 481, 482, 588	60010, 60020, 60031, 60032, 60040, 60091, 60092, 61000, 62000, 63010, 63021, 64010, 64020, 91010
	97	Private Services	39, 43	511, 512, 521-523, 525, 531, 533, 541, 542, 544, 545, 551, 577, 586, 587, 613-619, 622-624, 632, 901, 902	1500, 50020, 53111, 53112, 53113, 55010, 55030, 63030, 70002, 71010, 71030, 72020, 73000, 74060, 80011, 80012, 80090, 85011, 85012, 85013, 85020, 85030, 90000, 91020, 91091, 91092, 92011, 92012, 92030, 92040, 93010, 93020, 93030, 93091, 93092, 95000
	98	Public Administration	42	354, 610, 611, 621, 631, 711-717, 721-727	75011-75017, 75020

Consistent industry classification used in generating local tariff shocks from *Nível* 50 tariff data in Kume et al. (2003) and Decennial Census data.

Figure A1: Tariffs - 1987-1998



Nominal tariffs from Kume et al. (2003), aggregated to the industry classification presented in Table A1. The ten largest industries by 1990 value added are shown.

A.2 RAIS Data

The *Relação Anual de Informações Sociais* (RAIS) is a high quality census of the Brazilian formal labor market. Originally, RAIS was created as an operational tool for the Brazilian government to i) monitor the entry of foreign workers into the labor market; ii) oversee the records of the FGTS (*Fundo de Garantia do Tempo de Serviço*) program, a national benefits program consisting of employers' contributions to each of its employees; iii) provide information for administering several government benefits programs such as unemployment insurance; and iv) generate statistics regarding the formal labor market. Today it is the main tool used by the government to enable the payment of the "*abono salarial*" to eligible workers. This is a government program that pays one additional minimum wage at the end of the year to workers whose average monthly wage was not greater than two times the minimum wage, and whose job information was correctly declared in RAIS, among other minor requirements. Thus, workers have an incentive to ensure that their employer is filing the required information. Moreover, firms are required to file, and face fines until they do so. Together, these requirements ensure that the data in RAIS are accurate and complete.

Observations in the data are indexed by a worker ID number, the *Programa de Integração Social* (PIS), and an establishment registration number, the *Cadastro Nacional da Pessoa Jurídica* (CNPJ). Both of these identifiers are consistent over time, allowing one to track workers and establishments across years. Establishment industry is reported using the *Subsetor* IBGE classification, which includes 12 manufacturing industries, 2 primary industries, 11 nontradable industries, and 1 other/ignored.[40] Worker education is reported using the following 9 education categories (listing corresponding years of education in parentheses): illiterate (0), primary school dropout (1-3), primary school graduate (4), middle school dropout (5-7), middle school graduate (8), high school dropout (9-10), high school graduate (11), college dropout (12-14), and college graduate ($\geq$ 15).

In each year, and for each job, RAIS reports average earnings throughout the year, and earnings in December.[41] We construct individual yearly earnings by multiplying average monthly earnings by the number of months employed in the year and then summing across employers.

A.3 Demographic Census

We utilize information from the long form of the Demographic Censuses (*Censo Demográfico*) for 1970, 1980, 1991, 2000, and 2010. The long form micro data reflect a 5 percent sample of the population in 1970, 1980, and 2010, a 5.8 percent sample in 1991, and a 6 percent sample in 2000. The primary benefit of the Census for our purposes is the ability to observe those outside formal employment, who are not present in the RAIS database.

Although our main analysis focuses on monthly earnings, following the information available in RAIS, the Census provides weekly hours information from 1991-2010, allowing us to calculate hourly wages as monthly earnings divided by 4.33 times weekly hours. Census results for monthly earnings and hourly wages are very similar. In 1970 and 1980, hours information is presented in 5 rough bins. Thus, when calculating pre-liberalization trends using data from 1970 and 1980, we use monthly earnings even when examining hourly wage outcomes.

[40] A less aggregate industry classification (CNAE) is available from 1994 onward, but we need a consistent classification from 1986-2010, so we use *Subsetor* IBGE.

[41] From 1994 onward, RAIS reports hours, making it possible to calculate hourly wages. However, since we need a consistent measure from 1986-2010, we focus on monthly earnings.

In 1991-2010, the Census asks whether each worker has a signed work card. This is the standard definition of formal employment, and is necessary for a worker to appear in the RAIS sample. Thus, we use this as our primary definition of formal employment. In 1980 and 1991, there is an alternative proxy for formal employment, reporting whether the worker's job includes contributions to the national social security system. When calculating pre-liberalization outcome trends for 1980-1991, we use this alternative measure to identify formally employed workers. The social security contributions proxy appears to be a good one; in 1991, when both measures are available, 95.9 percent of workers would be classified identically when using either measure. In 1970, there is no information on formality, so pre-liberalization outcome trends for 1970-1980 are calculated for all workers.

The definition of employment changes across Census years. In 1970 it includes those reporting working or looking for work during August 1970 (the questionnaire does not separately identify working vs. looking for work). In 1980 it includes those who report working during the year prior to September 1, 1980. In 1991 it includes those reporting working regularly or occasionally during the year prior to September 1, 1991. In 2000 and 2010 it includes those who report paid work, temporary leave, unpaid work, or cultivation for own consumption during the week of July 23-29 in 2000 and July 25-31 in 2010. Note that the employment concept changes substantially across years. This highlights yet another benefit of using RAIS as our primary data source, since the employment concept in RAIS is consistent throughout the sample. Yet, while the changes complicate the interpretation of Census-based employment rates over time, there is no reason to expect systematic differences across regions to result from the changing employment concept. Thus, our cross-region identification strategy should be valid when using the Census to measure employment in spite of these measurement issues.

A.4 Regional Tariff Reductions

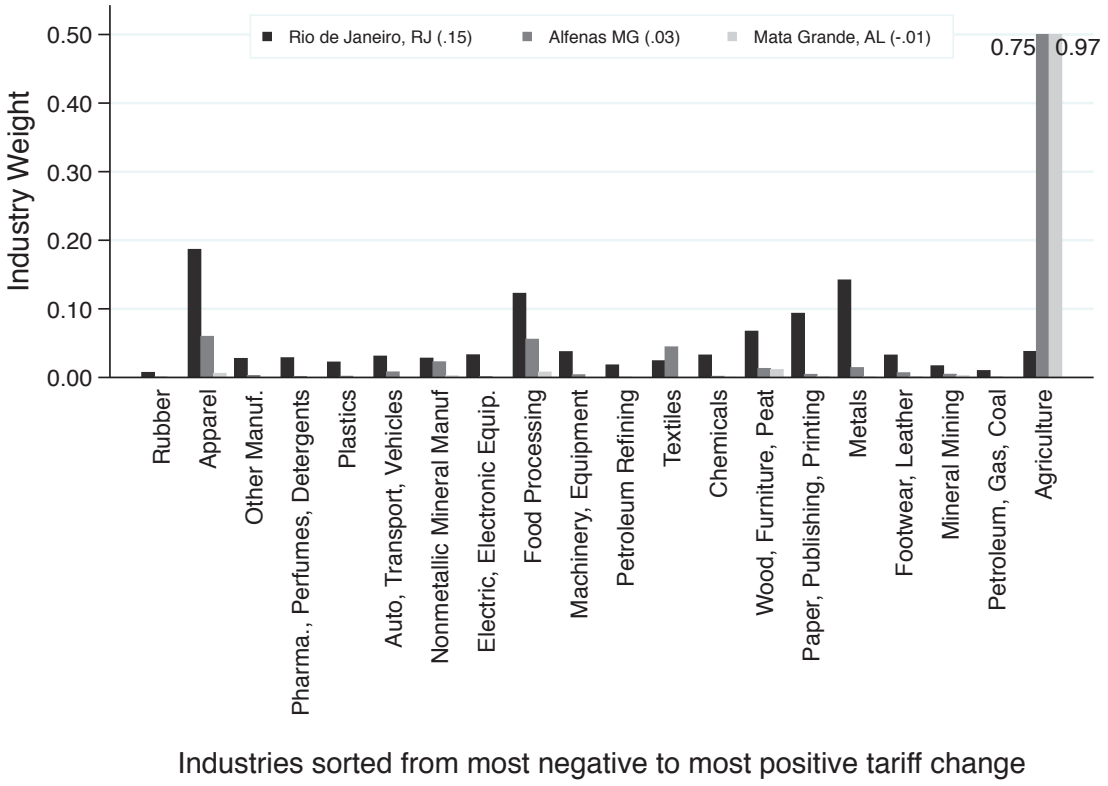
Regional tariff reductions, defined in (2), are constructed using information from various sources. Tariff changes come from Kume et al. (2003), and are aggregated from the *Nível* 50 level to the industry classification presented in Table A1 using 1990 value-added weights from the IBGE National Accounts. Figure 1 shows the resulting industry-level variation in tariff changes.

The weights, β_{ri} in (2) depend upon the initial regional industry distribution (λ_{ri}) and the specific-factor share in production (φ_i). We calculate the λ_{ri} using the 1991 Census. We use the Census because it provides a less aggregate industry definition than what is available in RAIS, and because the Census allows us to calculate weights that are representative of overall employment, rather than just formal employment. We calculate the φ_i using data from the Use Table of the 1990 National Accounts from IBGE. The table "*Componentes do Valor Adicionado*" provides the wagebill (*Remunerações*) and gross operating surplus (*Excedente Operacional Bruto Inclusive Rendimento de Autônomos*), which reflects the share of income earned by capital. We define φ_i as capital's share of the sum of these two components.

Because Brazilian local labor markets differ substantially in the industry distribution of their employment, the weights β_{ri} vary across regions. Figure A2 demonstrates how variation in industry mix leads to variation in RTR_r. The figure shows the initial industry distribution of employment for the regions facing the largest tariff reduction (Rio de Janeiro) the median tariff reduction (Alfenas in southwestern Minas Gerais state), and the smallest tariff reduction (actually a small increase, Mata Grande in northwest Alagoas state). The industries on the x-axis are sorted from the most

negative to the most positive tariff change. Rio de Janeiro has more weight on the left side of the diagram, by virtue of specializing in manufacturing, particularly in apparel and food processing industries, which faced quite large tariff reductions. Thus, its regional tariff reduction is quite large. Alfenas is a coffee growing and processing region, which also has some apparel employment, balancing the large tariff declines in apparel and food processing against the small tariff increase in agriculture. Mata Grande is located in a sparsely populated mountainous region, and is almost exclusively agricultural, leading it to experience a small tariff increase overall. Thus, although all regions faced the same set of tariff reductions across industries, variation in the industry distribution of employment in each region generates substantial variation in RTR_r.

Figure A2: Variation Underlying Regional Tariff Reduction



Industry distribution of 1991 employment in the regions facing the largest (Rio de Janeiro, RJ), median (Alfenas, MG) and smallest (Mata Grande, AL) regional tariff reduction. Industries sorted from the most negative to the most positive tariff change (see Figure 1). More weight on the left side of the figure leads to a larger regional tariff reduction, and more weight on the right side leads to a smaller regional tariff reduction.

B Supplemental Empirical Results

B.1 Industry-Level Outcome Pre-Trends vs. Tariff Reductions

Along with regional variation in the industrial composition of employment, our analysis relies on variation in tariff cuts across industries. Here we analyze the relationship between tariff cuts during liberalization (1990-1995) and trends in industry wages and employment before liberalization, 1980-1991. We calculate these pre-liberalization outcome trends using the Demographic Census, to provide a longer pre-liberalization period than what is available in RAIS, which starts in 1986.

We implemented a variety of specifications, with results reported in Table B1. In all specifications, the independent variable is the proportional reduction in one plus the tariff rate.

$$-\Delta_{1990-95}\ln(1+\tau_i)$$

In panels A-C the dependent variable is the change in log industry earnings. Panel A uses average log earnings; Panel B uses average log earnings residuals controlling for individual age, sex, education, and formal status; and Panel C uses average log earnings residuals controlling for these individual characteristics and region fixed effects. In Panel D, the dependent variable is the change in industry log employment. Column (1) weights industries equally, and presents standard errors based on pairwise bootstrap of the t-statistic, to improve small sample properties with only 20 tradable industry observations. Column (2) uses the same estimator, but drops agriculture. Column (3) uses heteroskedasticity weights and presents heteroskedasticity-robust standard errors, which are likely understated in this small sample (MacKinnon 2011). Column (4) uses the same estimator, but drops agriculture. In all cases, the results should be seen primarily as suggestive, because the analysis uses only 19 or 20 observations.

Nearly all of the earnings estimates are positive, indicating larger tariff reductions in industries experiencing more positive wage growth prior to liberalization. The majority of the estimates are insignificantly different from zero, with the exception of weighted results in Panels A and B. These specifications heavily weight agriculture, which exhibited declining wages prior to liberalization and experienced essentially no tariff reductions during liberalization, driving the strong positive relationship. By dropping agriculture, Column (4) confirms that the significant relationship is driven by agriculture. The employment estimates are larger, and change sign across columns. Given the diversity of findings across earnings and employment specifications, this exercise is somewhat inconclusive. Tariff cuts may or may not have been substantially correlated with pre-liberalization outcome trends. These findings motivate us to control for pre-liberalization outcome trends whenever possible throughout the paper. This ensures that our results are robust to potential spurious correlation between liberalization-induced labor demand shocks and ongoing trends.

Table B1: Pre-Liberalization Industry Trends - 1980-1991

1980-1991 change in log:	unweighted, bootstrapped (1)	unweighted, bootstrapped, omitting agriculture (2)	weighted (3)	weighted, omitting agriculture (4)
Panel A: average earnings				
Industry tariff reduction	0.345	0.111	1.029***	0.510
	(0.322)	(0.354)	(0.139)	(0.582)
Panel B: earnings premia (with individual controls)				
Industry tariff reduction	0.203	-0.017	0.610***	-0.235
	(0.273)	(0.311)	(0.157)	(0.350)
Panel C: earnings premia (with individual and region controls)				
Industry tariff reduction	0.135	0.044	0.184	0.018
	(0.177)	(0.209)	(0.158)	(0.222)
Panel D: employment				
Industry tariff reduction	-1.624	-2.696**	0.687	-1.651
	(1.272)	(1.361)	(0.417)	(1.894)
Observations	20	19	20	19

Decennial Census data. 20 industry observations (19 omitting agriculture). See text for details of dependent and independent variable construction. Column (1) weights industries equally, and presents standard errors based on pairwise bootstrap of the t-statistic. Column (2) uses the same estimator as Column (1), but drops agriculture. Column (3) uses heteroskedasticity weights and presents heteroskedasticity-robust standard errors. Column (4) uses the same estimator as Column (3), but drops agriculture. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

B.2 Informal Sector Descriptives

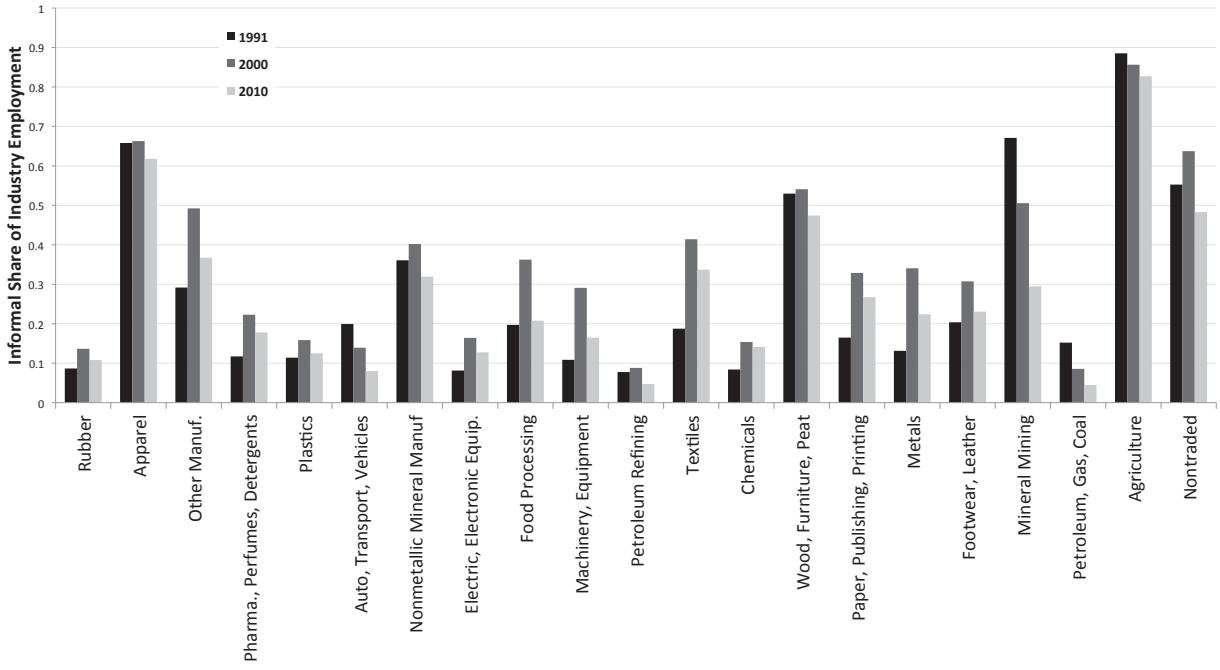
The following results provide some descriptive evidence on the informal sector in Brazil. Informality is defined as working without a signed work card (*Carteira de Trabalho e Previdência Social*), which entitles workers to benefits and labor protections afforded them by the legal employment system. Table B2 shows that the overall rate of informality increased from 1991 to 2000, before decreasing substantially from 2000 to 2010. Rates of informality are highest in agriculture and much lower in manufacturing. Figure B1 breaks out informality rates in the manufacturing sector into individual industries. Figure B2 focuses on the year 2000 and shows the industry distribution of formal and informal employment. There is very substantial overlap in the industry distributions of formal and informal employment. The biggest differences occur in agriculture, which comprises a much larger share of informal employment, and food processing and metals, which comprise larger shares of formal employment. In contrast, the nontradable share is nearly identical for formal and informal employment. Figure B3 shows the industry distribution for informal employees and the self-employed, which together comprise overall informal employment. These distributions are quite similar, with the exception of agriculture, which makes up a larger share of self-employment, and nontraded employment, comprising a larger share of informal employees.

Table B2: Informal Share of Employment - 1991-2010

	1991	2000	2010
Overall	0.58	0.64	0.49
Agriculture	0.89	0.86	0.83
Mining	0.61	0.45	0.21
Manufacturing	0.28	0.39	0.29
Nontradable	0.55	0.64	0.48

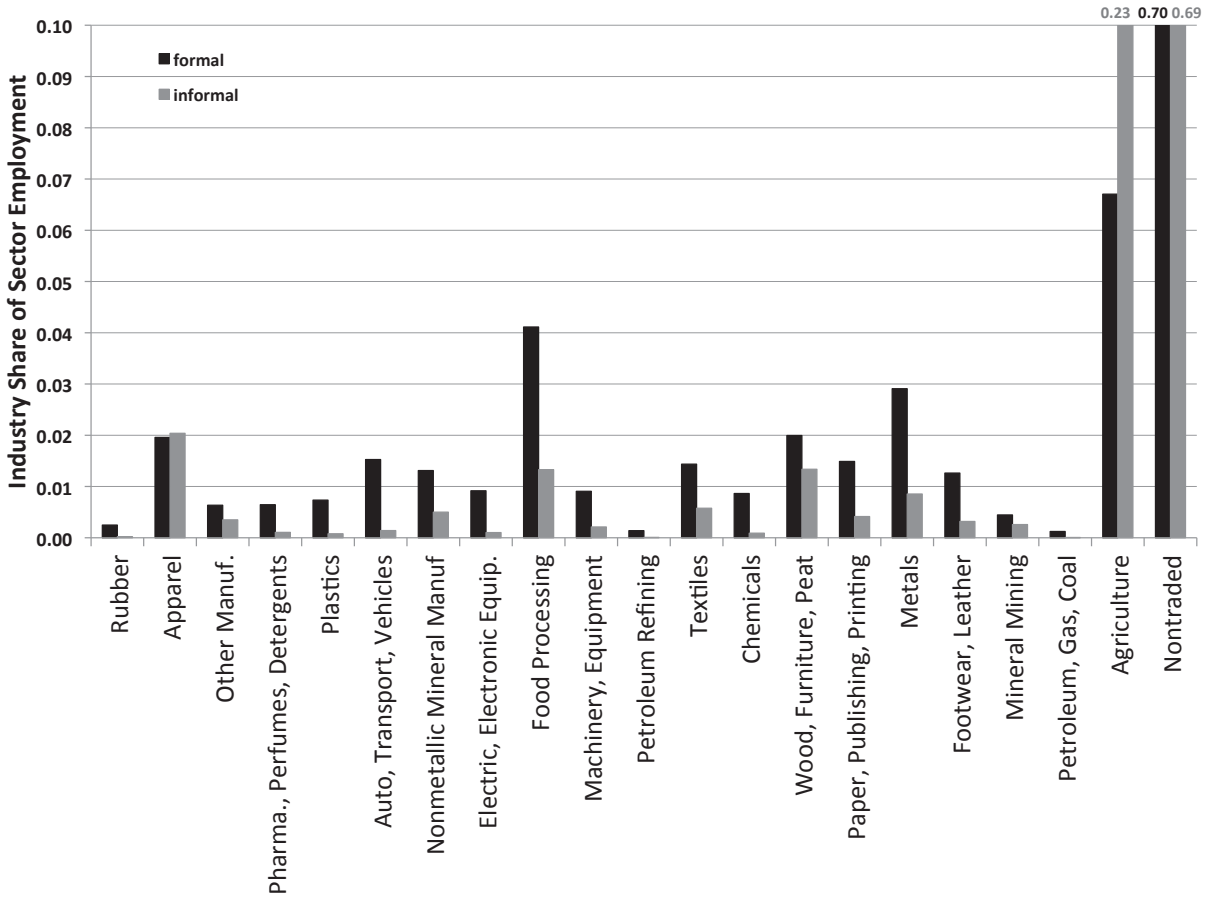
Author's calculations using Brazilian Demographic Census data for workers age 18-64. Informality defined as employment without a signed work card.

Figure B1: Informal Share of Employment by Industry - 1991-2010



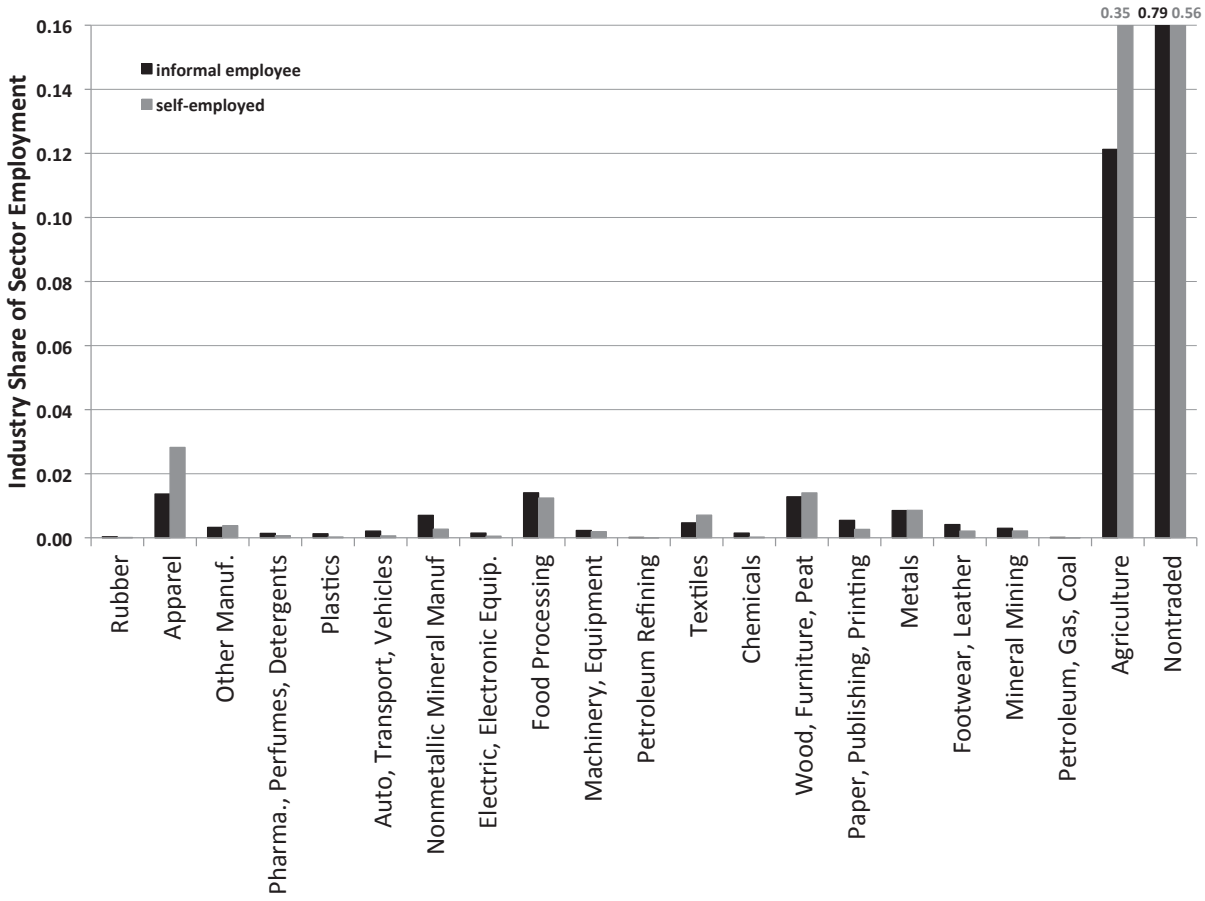
Authors' calculations using Brazilian Demographic Census data for workers age 18-64. Informality defined as employment without a signed work card. Industries sorted from most negative to most positive tariff change (with the exception of the nontraded sector).

Figure B2: Industry Distribution of Formal and Informal Employment - 2000



Authors' calculations using year 2000 Brazilian Demographic Census data for workers age 18-64. Informality defined as employment without a signed work card. Industries sorted from most negative to most positive tariff change (with the exception of the nontraded sector).

Figure B3: Industry Distribution of Informal Employees and Self-Employment - 2000



Authors' calculations using year 2000 Brazilian Demographic Census data for informal workers age 18-64. Informality defined as employment without a signed work card. Industries sorted from most negative to most positive tariff change (with the exception of the nontraded sector).

B.3 Additional Worker-Level Outcomes

This section presents supplementary results to complement those discussed in Section 5. Each figure presents estimates of θ_t from (3) for additional outcomes not discussed in the main text.

First, we present additional outcomes for the sample of workers initially employed in the formal tradable sector. Figure B4 examines the effects of regional tariff reductions on the share of the year formally employed.

$$\frac{Months_{it}}{12} \tag{10}$$

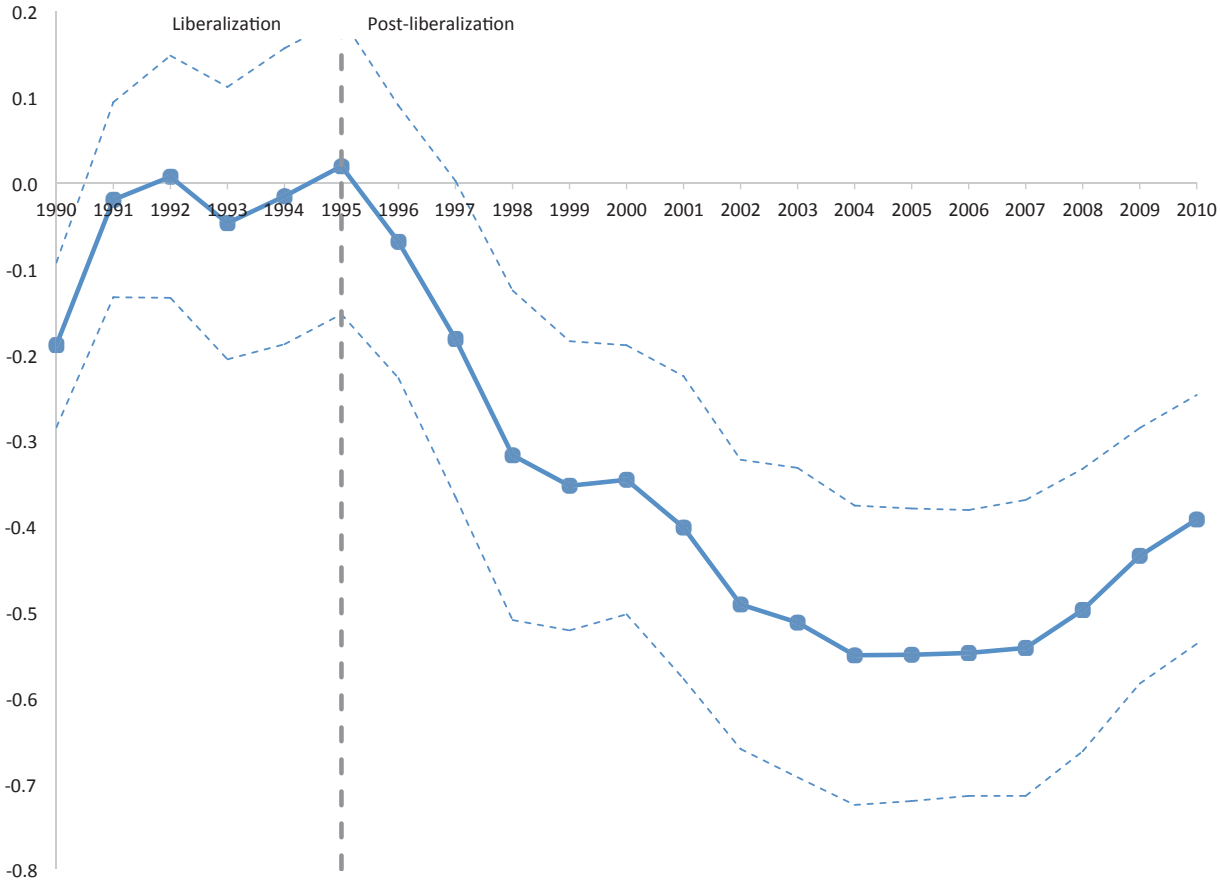
Workers initially employed in regions experiencing larger tariff reductions spend a smaller and smaller fraction of the year formally employed compared to workers initially employed in other regions. The largest effect, -0.55, appears in 2004, implying that on average a worker whose initial region faced a 10 percentage point larger tariff reduction spent 0.66 fewer months in formal employment. Figure B5 examines the effects of regional tariff reductions on average yearly earnings in the formal sector.

$$\frac{Earnings_{it}}{MeanEarnings_{i,1986-89}} \tag{11}$$

This measure is a yearly version of the cumulative measure in (5). The results in Figure B5 parallel those in Figure 5, with workers whose initial regions faced larger tariff reductions experience declining formal earnings compared to those in more favorably affected regions.

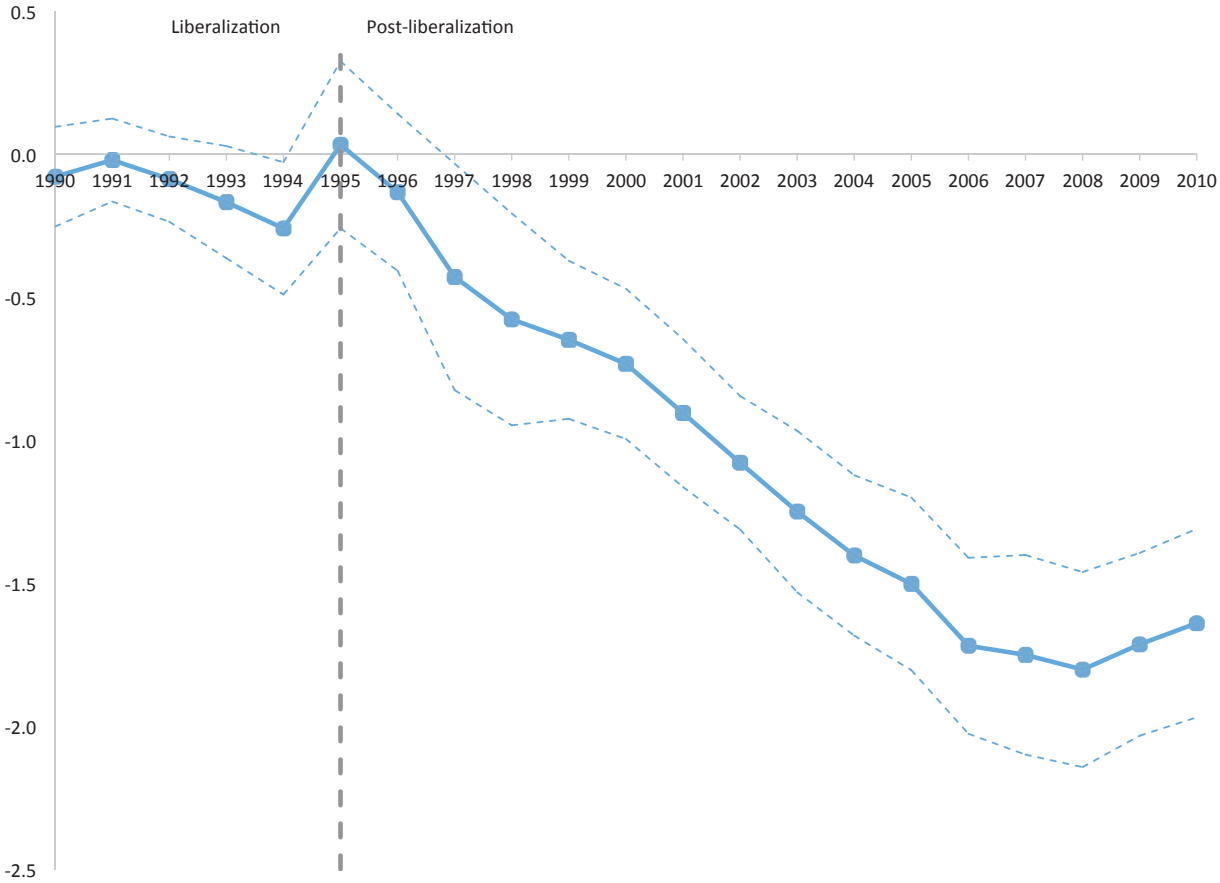
We then turn to the sample of workers initially employed in the formal nontradable sector. Figure B6 examines (10), the fraction of the year formally employed, finding similar results to those for tradable sector workers, but with somewhat smaller magnitudes. Figure B7 examines cumulative average earnings (5), finding resutls that parallel those for the tradable sector. Workers initially in harder-hit regions experience declining earnings compared to those initially in other regions. Figure B8 finds similar results for the yearly non-cumulative earnings measure in (11). Finally, Figure B9 examines the fraction of formally employed months in a new region, (6). As in the tradable sector, if anything, the negative point estimates imply that workers initially in regions facing larger tariff reductions were less likely to migrate to a formal job elsewhere than workers initially in more favorably affected regions.

Figure B4: Fraction of the Year Formally Employed - Tradable Worker Sample - 1990-2010



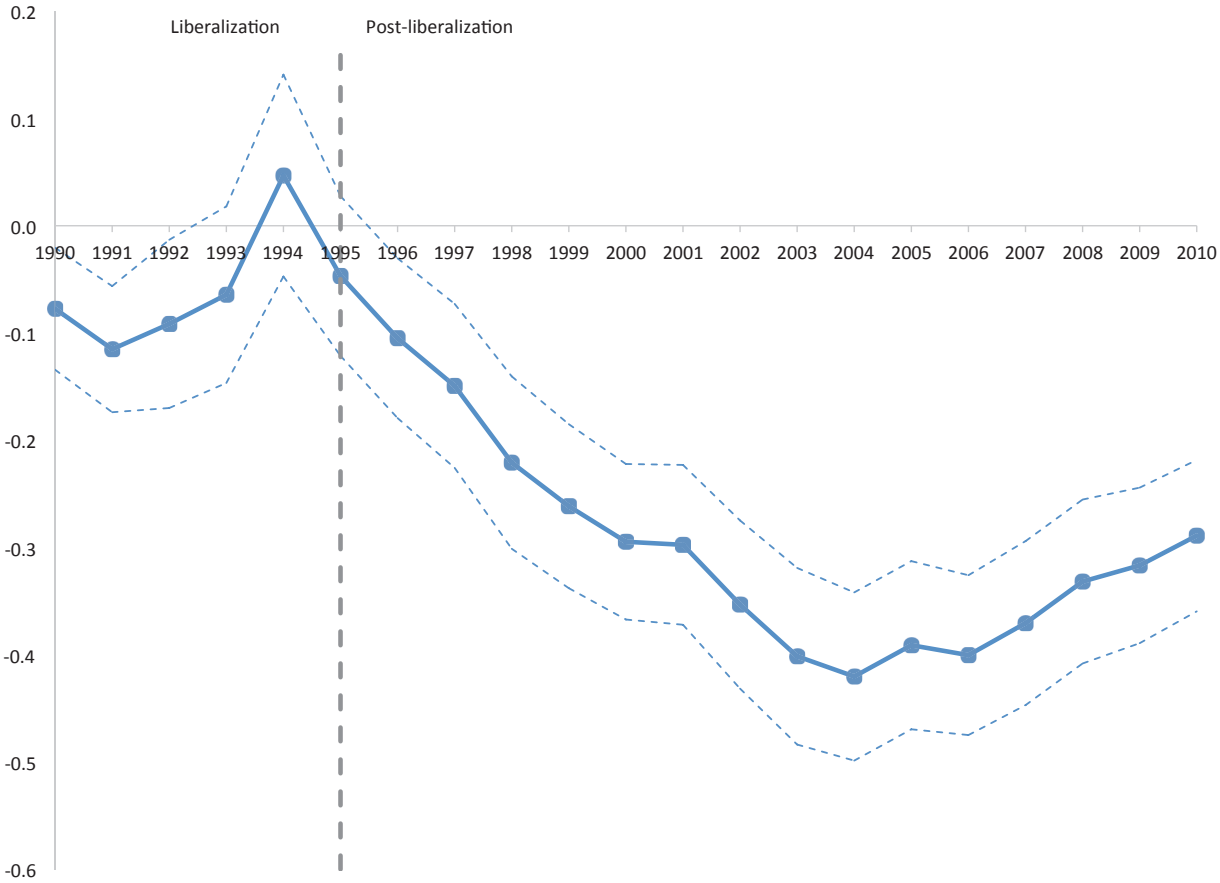
Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the share of the year formally employed in the year listed on the x-axis. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller share of the year formally employed than workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 106 mesoregion clusters.

Figure B5: Average Yearly Earnings - Tradable Worker Sample - 1990-2010



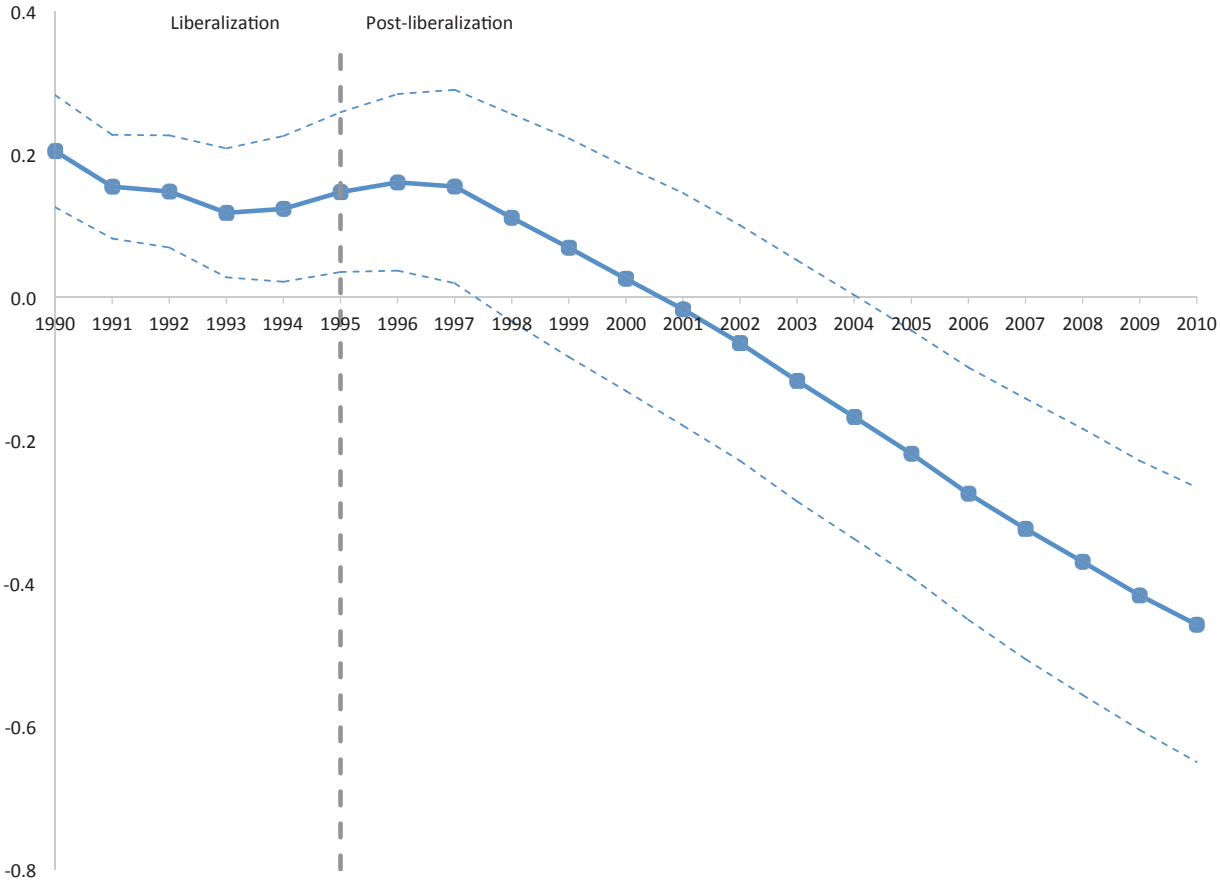
Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the average yearly earnings in the year listed on the x-axis, expressed as a multiple of the worker's pre-liberalization (1986-89) average yearly earnings. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions experience earnings reductions compared to workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 106 mesoregion clusters.

Figure B6: Fraction of the Year Formally Employed - Nontradable Worker Sample - 1990-2010



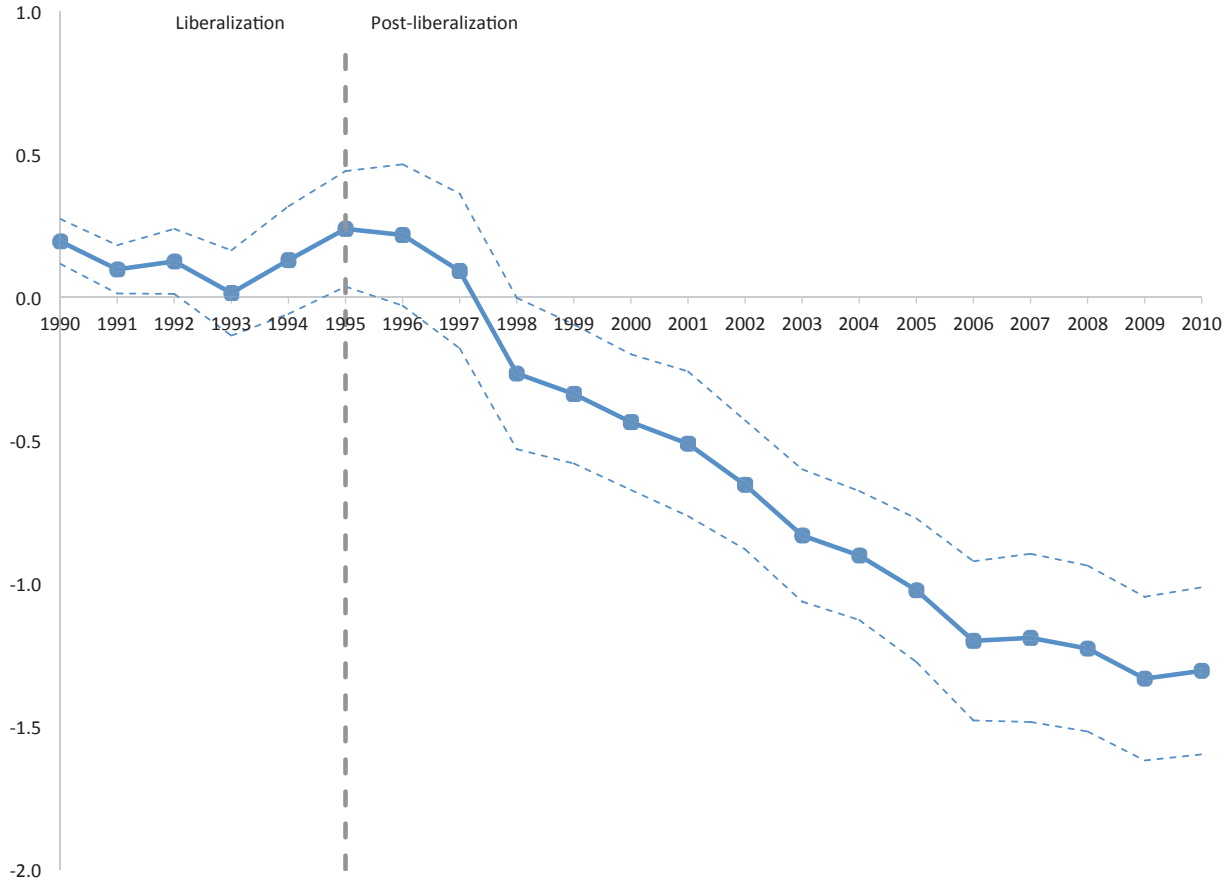
Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the share of the year formally employed in the year listed on the x-axis. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller share of the year formally employed than workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 111 mesoregion clusters.

Figure B7: Cumulative Average Earnings - Nontradable Worker Sample - 1990-2010



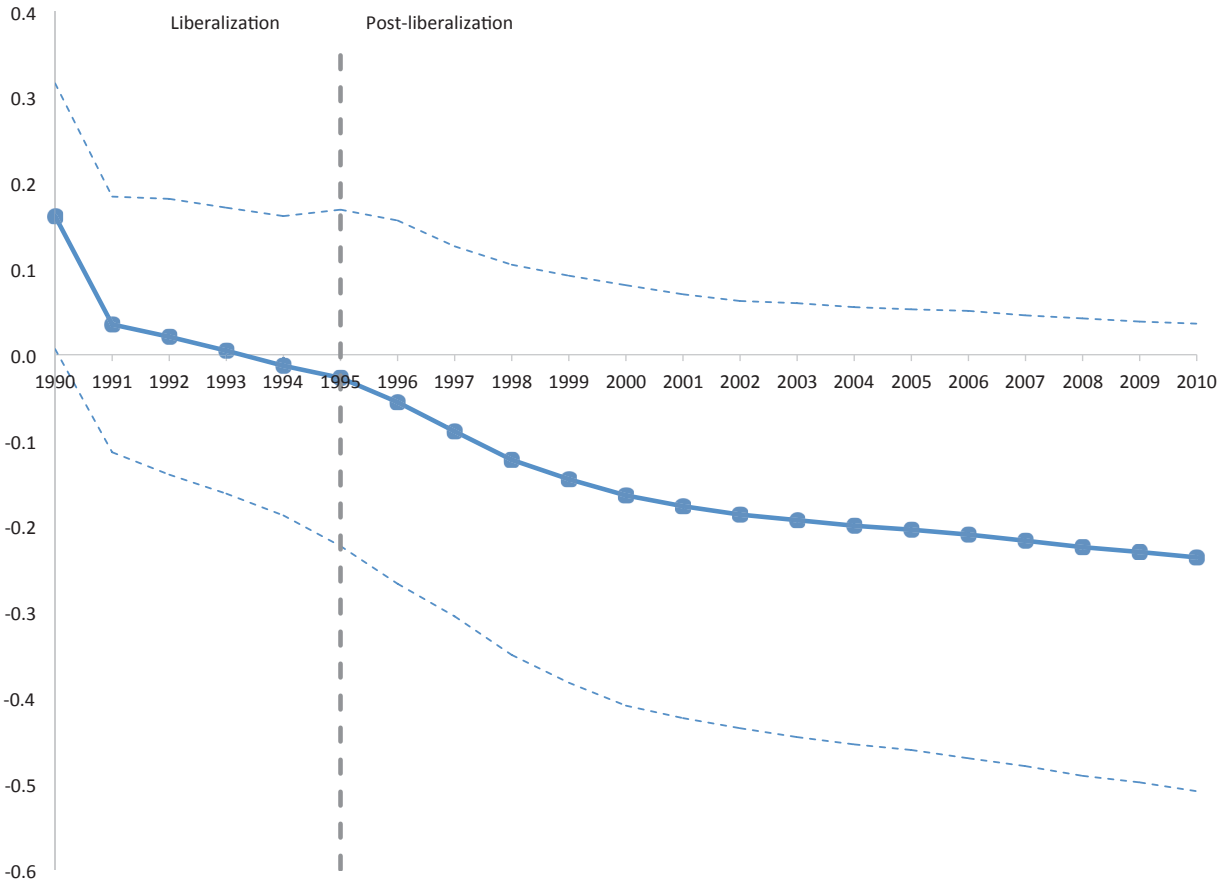
Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the average yearly earnings from 1990 to the year listed on the x-axis, expressed as a multiple of the worker's pre-liberalization (1986-89) average yearly earnings. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions experience earnings reductions compared to workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 111 mesoregion clusters.

Figure B8: Average Yearly Earnings - Nontradable Worker Sample - 1990-2010



Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the average yearly earnings in the year listed on the x-axis, expressed as a multiple of the worker's pre-liberalization (1986-89) average yearly earnings. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions experience earnings reductions compared to workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 111 mesoregion clusters.

Figure B9: Fraction of Formally Employed Months in a New Region - Nontradable Worker Sample - 1990-2010



Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the fraction of formally employed months in the year listed on the x-axis spent outside the initial region. The independent variable is the regional tariff reduction (RTR_r), defined in (2). Note that RTR_r always reflects tariff reductions from 1990-1995. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller share of their formal employment outside the initial region than did workers in other regions. The vertical bar indicates that liberalization began in 1990 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 111 mesoregion clusters.

B.4 Worker-Level Subsamples

Tables B3 and B4 present worker-level employment results for different subsamples of our worker panels, in order to get a sense for potential heterogeneity among workers with different initial characteristics just before liberalization. Note that the theoretical framework underlying our analysis assumes homogenous labor, so these results are merely suggestive. See Dix-Carneiro and Kovak (2015) for an analysis of the regional effects of liberalization with two worker types.

In both tables B3 and B4, Panel B restricts the sample to include only workers with strong labor force attachment prior to liberalization, i.e. at least 36 months of formal employment during January 1986 - December 1989. Panel C further restricts the sample to require at least 42 months of formal employment during the same time period. Panels D and E split the sample by education level – those with a high school degree or more in Panel D and those with less than a high school degree in Panel E. Panels F and G split the sample by age – those age 25-34 on December 31, 1989 in Panel F and those age 35-44 in Panel G.

In none of these subsamples are the results substantially different from those in the main specification, including the full sample. We had anticipated potentially weaker effects on those strongly attached to the formal labor market and larger effects on older and less educated workers, but do not find significant differences across these groups.

Table B3: Cumulative Average Months Formally Employed Per Year - Subsamples - Tradable Worker Sample - 1995, 2000, 2005, 2010

Cumulative Average Months Formally Employed Per Year	1990-1995 (1)	1990-2000 (2)	1990-2005 (3)	1990-2010 (4)
Panel A: Main specification				
Regional tariff reduction (RTR)	-1.362**	-2.65***	-4.026***	-4.675***
	(0.591)	(0.688)	(0.751)	(0.777)
Panel B: Attached (≥36 months formally employed during Jan 1986 - Dec 1989)				
Regional tariff reduction (RTR)	-1.889***	-3.172***	-4.531***	-5.122***
	(0.597)	(0.688)	(0.754)	(0.775)
Panel C: Strongly attached (≥42 months formally employed during Jan 1986 - Dec 1989)				
Regional tariff reduction (RTR)	-1.735***	-3.092***	-4.422***	-5.017***
	(0.628)	(0.711)	(0.767)	(0.778)
Panel D: More educated (high school degree or more)				
Regional tariff reduction (RTR)	-2.312***	-3.119***	-4.051***	-4.608***
	(0.758)	(0.800)	(0.850)	(0.862)
Panel E: Less educated (less than high school)				
Regional tariff reduction (RTR)	-1.158*	-2.492***	-3.934***	-4.598***
	(0.642)	(0.771)	(0.834)	(0.862)
Panel F: Younger (age 25-34 on Dec 31, 1989)				
Regional tariff reduction (RTR)	-1.238*	-2.300***	-3.561***	-4.285***
	(0.639)	(0.734)	(0.784)	(0.799)
Panel G: Older (age 35-44 on Dec 31, 1989)				
Regional tariff reduction (RTR)	-1.004	-2.534***	-4.030***	-4.536***
	(0.621)	(0.764)	(0.809)	(0.806)
State fixed effects (26)	✓	✓	✓	✓

The dependent variable is the average months formally employed per year from 1990 to the year listed in the column heading. Note that RTR_r always reflects tariff reductions from 1990-1995. Panel A replicates the results shown in Figure 3 for the relevant years. Subsequent panels show results for various worker subsamples, described in the panel headings. Observations: Panel A: 585,078, Panel B: 417,908, Panel C: 351,482, Panel D: 126,560, Panel E: 458,514, Panel F: 364,392, Panel G: 220,686. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller average share of the relevant years formally employed than workers in other regions. Standard errors adjusted for 106 mesoregion clusters. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B4: Cumulative Average Months Formally Employed Per Year - Subsamples - Nontradable Worker Sample - 1995, 2000, 2005, 2010

Cumulative Average Months Formally Employed Per Year	1990-1995 (1)	1990-2000 (2)	1990-2005 (3)	1990-2010 (4)
Panel A: Main specification				
Regional tariff reduction (RTR)	-0.711*	-1.448***	-2.331***	-2.729***
	(0.392)	(0.390)	(0.399)	(0.405)
Panel B: Attached (≥36 months formally employed during Jan 1986 - Dec 1989)				
Regional tariff reduction (RTR)	-0.513	-1.289***	-2.117***	-2.442***
	(0.403)	(0.389)	(0.396)	(0.400)
Panel C: Strongly attached (≥42 months formally employed during Jan 1986 - Dec 1989)				
Regional tariff reduction (RTR)	-0.160	-0.978**	-1.779***	-2.093***
	(0.419)	(0.395)	(0.403)	(0.412)
Panel D: More educated (high school degree or more)				
Regional tariff reduction (RTR)	-1.176***	-1.973***	-2.681***	-2.964***
	(0.385)	(0.364)	(0.346)	(0.338)
Panel E: Less educated (less than high school)				
Regional tariff reduction (RTR)	-0.549	-1.131**	-2.027***	-2.454***
	(0.468)	(0.486)	(0.504)	(0.516)
Panel F: Younger (age 25-34 on Dec 31, 1989)				
Regional tariff reduction (RTR)	-0.739**	-1.427***	-2.346***	-2.876***
	(0.356)	(0.384)	(0.416)	(0.439)
Panel G: Older (age 35-44 on Dec 31, 1989)				
Regional tariff reduction (RTR)	-0.515	-1.361***	-2.121***	-2.347***
	(0.487)	(0.459)	(0.459)	(0.454)
State fixed effects (26)	✓	✓	✓	✓

The dependent variable is the average months formally employed per year from 1990 to the year listed in the column heading. Note that RTR_r always reflects tariff reductions from 1990-1995. Panel A replicates the results shown in Figure 7 for the relevant years. Subsequent panels show results for various worker subsamples, described in the panel headings. Observations: Panel A: 973,703, Panel B: 656,177, Panel C: 537,122, Panel D: 363,418, Panel E: 610,285, Panel F: 609,013, Panel G: 364,690. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller average share of the relevant years formally employed than workers in other regions. Standard errors adjusted for 111 mesoregion clusters. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

B.5 Worker-Level Robustness

Tables B5 - B8 present robustness tests for the earnings and employment effects in the tradable and nontradable worker samples. Table B5 corresponds to Figure 3, Table B6 corresponds to Figure 7, Table B7 corresponds to Figure 5, and Table B8 corresponds to Figure B7. In each table, Panel A replicates the findings in the main specification for 1995, 2000, 2005, and 2010.

In Tables B5 - B8, Panel B calculates RTR_r using effective rates of protection rather than nominal tariffs. Effective rates of protection capture the overall effect of liberalization on producers in a given industry, accounting for tariff changes on industry inputs and outputs. Kume et al. (2003) provide effective rates of protection along with the nominal tariffs used in our main analysis. The magnitude of the changes in effective rates of protection is larger than for nominal tariffs, so the associated regression coefficients are smaller by roughly the same proportion. Panel C estimates (3) without controlling for fixed effects reflecting the worker's initial industry of employment prior to liberalization. Panel D omits both initial industry and initial occupation fixed effects.

The remaining panels control for salient shocks to the Brazilian labor market that occurred after liberalization. Panel E controls for tariff changes occurring after liberalization. We calculate post-liberalization regional tariff reductions as in (2), but use tariff reductions between 1995 and year $t > 1995$. Because the Kume et al. (2003) data end in 1998, we use UNCTAD TRAINS to construct post-liberalization tariff reductions. The TRAINS data are reported by 6-digit HS codes. In order to maintain as much industry variation as possible, we created an industry mapping from HS codes to Census industry codes, which yields 44 consistently identifiable tradable industries. This provides more industry detail than the main industry definition in Table A1.

Panel F controls for changes in real exchange rates. We construct regional real exchange rate shocks as follows. We begin with real exchange rates between Brazil and its trading partners, calculated from Revision 7.1 of the Penn World Tables. We then calculate each country's 1989 shares of Brazil's imports and exports in each industry using Comtrade. As with post-liberalization tariff changes, we use the industry definition mapping from HS codes to Census industries. Industry-specific real exchange rates are weighted averages of country-specific real exchange rates, weighting either by the 1989 import share or export share. We define industry-level real exchange rate shocks as the change in log industry real exchange rate from 1990 to each subsequent year. Finally we create regional real exchange rate shocks as weighted averages of industry real exchange rate shocks, where the region's industry weights are given by the 1991 industry distribution of employment.

Substantial privatization in Brazil began in 1991 with the administration of President Collor, but significantly increased during President Cardoso's administration (1995-2002). Beginning in 1995, the RAIS data allow us to identify as state-owned any firm at least partly owned by the government. In panel G, we control for the 1995 share of regional employment in state-owned firms, while in panel H we control for the change in state-owned firm employment share from 1995 to each subsequent year t.

Finally, Panel I controls for commodity price changes, which is particularly important later in our sample, given the commodity-intensive nature of Brazilian output and the substantial increase in commodity prices beginning in 2004. We calculate commodity price changes using the IMF Primary Commodity Price Series, which allows us to measure prices for 19 separate commodities. We calculate the change in log price index from 1991 to each subsequent year for each IMF commodity and then generate regional weighted averages of these price changes, where weights reflect the relevant commodity's share of regional employment in 1991. Appendix B.8.4 in Dix-Carneiro and

Kovak (forthcoming) presents extensive detail on the commodity price boom and the IMF data underlying this commodity price change control.

For all of these robustness tests, our main results are confirmed. The regional effects of liberalization on formal earnings and employment grow substantially over time, and in most cases the magnitudes remain quite similar to those in our main specifications. Thus, neither the measurement and specification choices considered here nor the extensive set of post-liberalization shocks we control for drives our results.

Table B5: Cumulative Average Months Formally Employed Per Year - Robustness - Tradable Worker Sample - 1995, 2000, 2005, 2010

Cumulative Average Months Formally Employed Per Year	1990-1995 (1)	1990-2000 (2)	1990-2005 (3)	1990-2010 (4)
Panel A: Main specification				
Regional tariff reduction (RTR)	-1.362**	-2.65***	-4.026***	-4.675***
	(0.591)	(0.688)	(0.751)	(0.777)
Panel B: RTR using effective rates of protection				
Regional tariff reduction (RTR)	-1.046***	-1.692***	-2.462***	-2.832***
	(0.389)	(0.440)	(0.492)	(0.510)
Panel C: Omitting initial industry fixed effects				
Regional tariff reduction (RTR)	-1.592***	-3.021***	-4.449***	-5.144***
	(0.564)	(0.679)	(0.758)	(0.791)
Panel D: Omitting initial industry and occupation fixed effects				
Regional tariff reduction (RTR)	-1.134*	-3.000***	-4.785***	-5.651***
	(0.574)	(0.732)	(0.842)	(0.887)
Panel E: Post-liberalization tariff reductions				
Regional tariff reduction (RTR)	-1.362**	-2.649***	-3.669***	-5.119***
	(0.591)	(0.696)	(0.798)	(0.921)
Post-liberalization (1995 to t) regional tariff reductions	n/a	11.591	13.346	5.211
		(13.534)	(14.702)	(4.572)
Panel F: Exchange rates				
Regional tariff reduction (RTR)	-1.365**	-2.127***	-3.506***	-5.031***
	(0.659)	(0.705)	(0.796)	(0.881)
Import-weighted real exchange rate	0.277	0.855*	-2.413	-0.267
	(0.381)	(0.467)	(1.633)	(0.725)
Export-weighted real exchange rate	-1.013	-3.995***	0.972	-1.070
	(0.949)	(1.259)	(1.520)	(1.153)
Panel G: Privatization: initial state-owned employment share				
Regional tariff reduction (RTR)	-1.359*	-2.477***	-3.748***	-4.402***
	(0.708)	(0.771)	(0.823)	(0.839)
State-owned share of 1995 employment	-0.007	-0.455	-0.731	-0.717
	(0.755)	(0.618)	(0.592)	(0.573)
Panel H: Privatization: change in state-owned employment share, 1995 to t				
Regional tariff reduction (RTR)	-1.362**	-2.618***	-3.901***	-4.493***
	(0.591)	(0.731)	(0.831)	(0.854)
Change in state-owned employment share	n/a	0.138	0.525	0.637
		(0.780)	(0.869)	(0.789)
Panel I: Commodity price change controls				
Regional tariff reduction (RTR)	-0.831	-3.358***	-3.913***	-6.909***
	(0.685)	(0.974)	(0.779)	(1.646)
Regional commodity price changes	1.570*	1.031	-1.012	-1.526*
	(0.812)	(0.844)	(1.469)	(0.829)
State fixed effects (26)	✓	✓	✓	✓

The dependent variable is the average months formally employed per year from 1990 to the year listed in the column heading. Note that RTR_r always reflects tariff reductions from 1990-1995. Panel A replicates the results shown in Figure 3 for the relevant years. Subsequent panels show robustness tests, described in the text. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller average share of the relevant years formally employed than workers in other regions. Standard errors adjusted for 106 mesoregion clusters.

Table B6: Cumulative Average Months Formally Employed Per Year - Robustness - Nontradable Worker Sample - 1995, 2000, 2005, 2010

Cumulative Average Months Formally Employed Per Year	1990-1995 (1)	1990-2000 (2)	1990-2005 (3)	1990-2010 (4)
Panel A: Main specification				
Regional tariff reduction (RTR)	-0.711*	-1.448***	-2.331***	-2.729***
	(0.392)	(0.390)	(0.399)	(0.405)
Panel B: RTR using effective rates of protection				
Regional tariff reduction (RTR)	-0.477*	-0.999***	-1.570***	-1.843***
	(0.246)	(0.254)	(0.264)	(0.268)
Panel C: Omitting initial industry fixed effects				
Regional tariff reduction (RTR)	-1.046**	-1.727***	-2.496***	-2.821***
	(0.407)	(0.403)	(0.416)	(0.420)
Panel D: Omitting initial industry and occupation fixed effects				
Regional tariff reduction (RTR)	-1.309***	-2.167***	-3.096***	-3.458***
	(0.410)	(0.425)	(0.454)	(0.466)
Panel E: Post-liberalization tariff reductions				
Regional tariff reduction (RTR)	-0.806**	-1.591***	-2.297***	-3.064***
	(0.393)	(0.396)	(0.491)	(0.449)
Post-liberalization (1995 to t) regional tariff reductions	n/a	6.013	5.679	1.895
		(7.599)	(8.903)	(1.840)
Panel F: Exchange rates				
Regional tariff reduction (RTR)	-1.142***	-1.638***	-2.775***	-3.638***
	(0.406)	(0.417)	(0.437)	(0.454)
Import-weighted real exchange rate	0.040	0.218	-0.877	-0.691*
	(0.225)	(0.350)	(1.080)	(0.360)
Export-weighted real exchange rate	-2.021***	-2.818**	-2.211*	-1.750***
	(0.514)	(1.118)	(1.271)	(0.614)
Panel G: Privatization: initial state-owned employment share				
Regional tariff reduction (RTR)	-1.299***	-2.029***	-2.789***	-3.141***
	(0.381)	(0.418)	(0.464)	(0.476)
State-owned share of 1995 employment	1.435***	1.288**	0.936*	0.715
	(0.461)	(0.498)	(0.498)	(0.475)
Panel H: Privatization: change in state-owned employment share, 1995 to t				
Regional tariff reduction (RTR)	-0.806**	-1.844***	-2.771***	-3.118***
	(0.393)	(0.408)	(0.439)	(0.459)
Change in state-owned employment share	n/a	-1.351**	-1.344**	-0.906*
		(0.574)	(0.541)	(0.526)
Panel I: Commodity price change controls				
Regional tariff reduction (RTR)	-0.492	-1.243	-2.406***	-2.944**
	(0.534)	(0.756)	(0.422)	(1.207)
Regional commodity price changes	0.938	-0.531	-0.922	-0.035
	(0.698)	(0.871)	(0.994)	(0.700)
State fixed effects (26)	✓	✓	✓	✓

The dependent variable is the average months formally employed per year from 1990 to the year listed in the column heading. Note that RTR_r always reflects tariff reductions from 1990-1995. Panel A replicates the results shown in Figure 7 for the relevant years. Subsequent panels show robustness tests, described in the text. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions spend a smaller average share of the relevant years formally employed than workers in other regions. Standard errors adjusted for 111 mesoregion clusters.

Table B7: Cumulative Average Earnings - Robustness - Tradable Worker Sample - 1990, 2000, 2005, 2010

Cumulative Average Earnings	1990-1995 (1)	1990-2000 (2)	1990-2005 (3)	1990-2010 (4)
Panel A: Main specification				
Regional tariff reduction (RTR)	-0.097	-0.282***	-0.578***	-0.850***
	(0.080)	(0.105)	(0.104)	(0.110)
Panel B: RTR using effective rates of protection				
Regional tariff reduction (RTR)	-0.073	-0.160**	-0.325***	-0.487***
	(0.047)	(0.067)	(0.077)	(0.085)
Panel C: Omitting initial industry fixed effects				
Regional tariff reduction (RTR)	-0.070	-0.297**	-0.606***	-0.897***
	(0.093)	(0.115)	(0.114)	(0.121)
Panel D: Omitting initial industry and occupation fixed effects				
Regional tariff reduction (RTR)	-0.035	-0.278**	-0.622***	-0.941***
	(0.105)	(0.124)	(0.120)	(0.126)
Panel E: Post-liberalization tariff reductions				
Regional tariff reduction (RTR)	-0.097	-0.282***	-0.548***	-0.801***
	(0.080)	(0.102)	(0.117)	(0.119)
Post-liberalization (1995 to t) regional tariff reductions	n/a	-1.002	1.092	-0.580
		(2.691)	(2.647)	(0.579)
Panel F: Exchange rates				
Regional tariff reduction (RTR)	-0.110	-0.158*	-0.560***	-0.888***
	(0.083)	(0.084)	(0.103)	(0.109)
Import-weighted real exchange rate	0.072	0.203**	-0.184	-0.057
	(0.052)	(0.079)	(0.211)	(0.076)
Export-weighted real exchange rate	-0.360***	-0.684***	-0.072	-0.084
	(0.111)	(0.197)	(0.206)	(0.178)
Panel G: Privatization: initial state-owned employment share				
Regional tariff reduction (RTR)	-0.084	-0.262**	-0.547***	-0.819***
	(0.092)	(0.120)	(0.126)	(0.135)
State-owned share of 1995 employment	-0.032	-0.052	-0.079	-0.081
	(0.135)	(0.143)	(0.139)	(0.139)
Panel H: Privatization: change in state-owned employment share, 1995 to t				
Regional tariff reduction (RTR)	-0.097	-0.282**	-0.559***	-0.804***
	(0.080)	(0.111)	(0.123)	(0.135)
Change in state-owned employment share	n/a	-0.001	0.076	0.162
		(0.157)	(0.164)	(0.175)
Panel I: Commodity price change controls				
Regional tariff reduction (RTR)	-0.019	-0.229*	-0.538***	-0.804***
	(0.101)	(0.119)	(0.099)	(0.254)
Regional commodity price changes	0.230	-0.077	-0.352	0.031
	(0.170)	(0.171)	(0.218)	(0.174)
State fixed effects (26)	✓	✓	✓	✓

The dependent variable is the average yearly earnings from 1990 to the year listed in the column heading, expressed as a multiple of the worker's pre-liberalization (1986-89) average yearly earnings. Note that RTR_r always reflects tariff reductions from 1990-1995. Panel A replicates the results shown in Figure 5 for the relevant years. Subsequent panels show robustness tests, described in the text. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions experience earnings reductions compared to workers in other regions. Standard errors adjusted for 106 mesoregion clusters.

Table B8: Cumulative Average Earnings - Robustness - Nontradable Worker Sample - 1990, 2000, 2005, 2010

Cumulative Average Earnings	1990-1995 (1)	1990-2000 (2)	1990-2005 (3)	1990-2010 (4)
Panel A: Main specification				
Regional tariff reduction (RTR)	0.147**	0.026	-0.219**	-0.458***
	(0.057)	(0.080)	(0.088)	(0.098)
Panel B: RTR using effective rates of protection				
Regional tariff reduction (RTR)	0.061	-0.033	-0.191***	-0.346***
	(0.037)	(0.051)	(0.056)	(0.063)
Panel C: Omitting initial industry fixed effects				
Regional tariff reduction (RTR)	0.037	-0.100	-0.327***	-0.544***
	(0.058)	(0.082)	(0.091)	(0.100)
Panel D: Omitting initial industry and occupation fixed effects				
Regional tariff reduction (RTR)	0.009	-0.163**	-0.423***	-0.665**
	(0.057)	(0.081)	(0.091)	(0.102)
Panel E: Post-liberalization tariff reductions				
Regional tariff reduction (RTR)	0.090	-0.057	-0.374***	-0.523***
	(0.056)	(0.079)	(0.120)	(0.106)
Post-liberalization (1995 to t) regional tariff reductions	n/a	0.179	-2.336	-0.283
		(1.832)	(2.766)	(0.625)
Panel F: Exchange rates				
Regional tariff reduction (RTR)	0.083	-0.034	-0.295***	-0.636***
	(0.065)	(0.092)	(0.099)	(0.100)
Import-weighted real exchange rate	0.044	0.043	-0.035	-0.036
	(0.034)	(0.060)	(0.207)	(0.082)
Export-weighted real exchange rate	-0.173**	-0.085	0.019	-0.256*
	(0.078)	(0.177)	(0.298)	(0.144)
Panel G: Privatization: initial state-owned employment share				
Regional tariff reduction (RTR)	-0.004	-0.174**	-0.409***	-0.655***
	(0.050)	(0.081)	(0.098)	(0.110)
State-owned share of 1995 employment	0.275***	0.339***	0.306**	0.311**
	(0.079)	(0.109)	(0.122)	(0.132)
Panel H: Privatization: change in state-owned employment share, 1995 to t				
Regional tariff reduction (RTR)	0.090	-0.124	-0.389***	-0.624***
	(0.056)	(0.077)	(0.090)	(0.103)
Change in state-owned employment share	n/a	-0.350***	-0.377***	-0.307**
		(0.109)	(0.128)	(0.136)
Panel I: Commodity price change controls				
Regional tariff reduction (RTR)	0.106	-0.157	-0.319***	-0.629**
	(0.065)	(0.139)	(0.088)	(0.263)
Regional commodity price changes	0.047	0.155	0.229	-0.057
	(0.098)	(0.159)	(0.239)	(0.145)
State fixed effects (26)	✓	✓	✓	✓

The dependent variable is the average yearly earnings from 1990 to the year listed in the column heading, expressed as a multiple of the worker's pre-liberalization (1986-89) average yearly earnings. Note that RTR_r always reflects tariff reductions from 1990-1995. Panel A replicates the results shown in Figure B7 for the relevant years. Subsequent panels show robustness tests, described in the text. The regressions include state fixed effects and extensive controls for worker, initial job, initial employer, and initial region characteristics (see text for details). Negative estimates imply that workers initially in regions facing larger tariff reductions experience earnings reductions compared to workers in other regions. Standard errors adjusted for 111 mesoregion clusters.

B.6 Regional Labor Market Structure

B.6.1 Robustness

Table B9 estimates a version of the regional labor market structure analysis in Table 3, following a consistent cohort of workers over time, those age 25-43 in 1989. This analysis reinforces our interpretation of Table 3 as implying that many workers transition to informal employment following long periods of non-employment. The results for informal workers, including informal employees and the self-employed, are very similar to those in Table 3, indicating that these results are not driven by worker entry and exit from the working-age population over time. The long-run not-employed share responds somewhat differently for this cohort than for the working-age population as a whole. While the not-employed share response decreases substantially between 2000 to 2010 for the consistent cohort (Table B9), it disappears completely for the overall working-age population (Table 3). Thus, while many non-employed workers in the cohort appear to find informal employment in the long run, accounting for the large increase in the informal share effect and the decrease in the non-employed share effect, some of the even larger decline in the non-employed effect in Table 3 reflects worker entry and exit from the working-age population. Note also that in Table 3, the sum of non-employed and informal effects is roughly constant over time, while the sum of these effects grows over time for the consistent cohort in B9. The cohort pattern is more in line with the growing worker-level formal employment effects in Figures 3 and 7.

Table B10 examines the relationship between pre-liberalization changes in employment category shares and regional tariff reductions (RTR_r) during liberalization. Note that our main results in Table 3 control for these pre-liberalization changes, but we present these results for completeness. We find that for regions that would later face larger tariff reductions, the not-employed share of the working-age population decreased more during the 1970s and increased more during the 1980s than in regions facing smaller tariff reductions. Due to the lack of information on informality in the 1970 Census, we can only examine the informal share of working-age population during 1980-1991. This share was increasing more during the 1980s in regions that faced larger tariff reductions during liberalization. These significant pre-liberalization relationships motivate our inclusion of pre-liberalization trend controls in Table 3. That said, Table B11 shows that the non-employed and informal results in Table 3 are very similar even when omitting the pre-liberalization trend controls.

Table B9: Employment Category Shares of Regional Working-Age Population, Following a Consistent Cohort - 2000, 2010

	1991-2000			1991-2010		
Change in share:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Not-employed						
Regional Tariff Reduction *(RTR)*	0.524***	0.535***	0.529***	0.367***	0.366***	0.372***
	(0.054)	(0.053)	(0.054)	(0.063)	(0.064)	(0.064)
Not-employed share pre-trend (80-91)	0.019		0.068	-0.100**		-0.063
	(0.044)		(0.058)	(0.046)		(0.047)
Not-employed share pre-trend (70-80)		0.015	0.068		0.100**	0.051
		(0.046)	(0.057)		(0.046)	(0.047)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.466	0.466	0.468	0.473	0.472	0.474
Panel B: Informal						
Regional Tariff Reduction *(RTR)*	0.156**	0.144**	0.182**	0.582***	0.525***	0.614***
	(0.067)	(0.070)	(0.075)	(0.079)	(0.089)	(0.090)
Informal share pre-trend (80-91)	-0.056		-0.089*	-0.166***		-0.207***
	(0.036)		(0.050)	(0.048)		(0.059)
Not-employed share pre-trend (70-80)		-0.008	0.061		-0.086	0.075
		(0.043)	(0.062)		(0.071)	(0.079)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.207	0.202	0.209	0.465	0.446	0.467
Panel C: Informal employee						
Regional Tariff Reduction *(RTR)*	0.526***	0.444***	0.538***	0.141	0.105	0.182
	(0.044)	(0.043)	(0.048)	(0.110)	(0.130)	(0.127)
Informal employee share pre-trend (80-91)	-0.228***		-0.239***	-0.159		-0.197*
	(0.058)		(0.064)	(0.100)		(0.101)
Not-employed share pre-trend (70-80)		-0.080	0.027		0.006	0.094
		(0.063)	(0.067)		(0.105)	(0.097)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.545	0.498	0.546	0.476	0.467	0.479
Panel D: Self-employed						
Regional Tariff Reduction *(RTR)*	-0.330***	-0.299***	-0.291***	0.430***	0.419***	0.434***
	(0.071)	(0.068)	(0.069)	(0.089)	(0.110)	(0.104)
Self-employed share pre-trend (80-91)	-0.124*		-0.168**	-0.305***		-0.309***
	(0.064)		(0.064)	(0.076)		(0.095)
Not-employed share pre-trend (70-80)		0.071	0.126**		-0.089	0.013
		(0.056)	(0.062)		(0.079)	(0.087)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.326	0.318	0.338	0.633	0.604	0.633

Decennial Census data. Positive (negative) coefficient estimates for the regional tariff reduction (RTR) imply larger increases (decreases) in the relevant employment category share in regions facing larger tariff reductions. The informal share in Panel B covers both informal employees and the self-employed, shown separately in Panels B and C, respectively. Changes in employment shares are calculated controlling for regional worker composition (see text for details). The analysis follows a consistent cohort of workers who were age 27-45 in 1991, 36-54 in 2000, and 46-64 in 2010. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to the non-employed share. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B10: Employment Category Shares Pre-Trends

Change in share:	1980-1991	1970-1980
Panel A: Not-employed		
Regional Tariff Reduction *(RTR)*	0.330***	-0.212***
	(0.068)	(0.072)
State fixed effects (26)	✓	✓
R-squared	0.431	0.314
Panel B: Informal		
Regional Tariff Reduction *(RTR)*	0.295***	n/a
	(0.082)	
State fixed effects (26)	✓	
R-squared	0.383	

Decennial Census data. Positive (negative) coefficient estimates for the regional tariff reduction (RTR) imply larger increases (decreases) in the relevant employment category share during the pre-liberalization period listed in the column heading in regions facing larger tariff reductions. Changes in employment shares are calculated controlling for regional worker composition (see text for details). Due to a lack of information on informality in the 1970 Census, we only examine 1980-1970 pre-trends for the non-employed share. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B11: Employment Category Shares of Regional Working-Age Population - 2000, 2010 - without Pre-Liberalization Trend Controls

Change in share:	1991-2000	1991-2010
Panel A: Not-employed		
Regional Tariff Reduction *(RTR)*	0.313***	-0.049
	(0.038)	(0.053)
State fixed effects (26)	✓	✓
R-squared	0.478	0.581
Panel B: Informal		
Regional Tariff Reduction *(RTR)*	0.175***	0.463***
	(0.045)	(0.063)
State fixed effects (26)	✓	✓
R-squared	0.328	0.559

Decennial Census data. Positive (negative) coefficient estimates for the regional tariff reduction (RTR) imply larger increases (decreases) in the relevant employment category share in regions facing larger tariff reductions. Changes in employment shares are calculated controlling for regional worker composition (see text for details). Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

B.6.2 Results by Education Level

Tables B12 and B13 present versions of the regional labor market structure analysis in Table 3 separately by education level. Table B12 presents results for workers with a high school degree or more, and Table B13 presents results for workers with less than a high school degree. All results are similar across the two education groups.

Table B12: Employment Category Shares of More Educated Regional Working-Age Population - 2000, 2010

	1991-2000			1991-2010		
Change in share:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Not-employed						
Regional Tariff Reduction *(RTR)*	0.206***	0.230***	0.232***	-0.043	-0.019	-0.020
	(0.031)	(0.033)	(0.034)	(0.051)	(0.063)	(0.060)
Not-employed share pre-trend (80-91)	-0.027		-0.022	0.008		0.016
	(0.050)		(0.047)	(0.084)		(0.083)
Not-employed share pre-trend (70-80)		0.100**	0.100**		0.088	0.089
		(0.043)	(0.044)		(0.061)	(0.062)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.508	0.526	0.526	0.580	0.586	0.586
Panel B: Informal						
Regional Tariff Reduction *(RTR)*	0.097**	0.109**	0.098*	0.433***	0.437***	0.415***
	(0.048)	(0.048)	(0.050)	(0.086)	(0.086)	(0.088)
Informal share pre-trend (80-91)	-0.0915		-0.092	-0.187**		-0.172**
	(0.065)		(0.064)	(0.087)		(0.084)
Not-employed share pre-trend (70-80)		-0.003	0.003		-0.094*	-0.082*
		(0.033)	(0.031)		(0.052)	(0.047)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.465	0.461	0.465	0.622	0.619	0.625
Panel C: Informal employee						
Regional Tariff Reduction *(RTR)*	0.047	0.057	0.052	0.219***	0.211***	0.202**
	(0.047)	(0.051)	(0.052)	(0.074)	(0.075)	(0.077)
Informal employee share pre-trend (80-91)	-0.121		-0.126*	-0.248***		-0.231**
	(0.074)		(0.072)	(0.091)		(0.088)
Not-employed share pre-trend (70-80)		0.009	0.018		-0.089*	-0.073
		(0.040)	(0.039)		(0.049)	(0.047)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.507	0.502	0.507	0.641	0.636	0.644
Panel D: Self-employed						
Regional Tariff Reduction *(RTR)*	0.037**	0.045**	0.035*	0.180***	0.202***	0.180***
	(0.017)	(0.017)	(0.018)	(0.020)	(0.023)	(0.021)
Self-employed share pre-trend (80-91)	-0.169***		-0.170***	-0.324***		-0.324***
	(0.056)		(0.055)	(0.062)		(0.062)
Not-employed share pre-trend (70-80)		-0.005	-0.008		0.007	0.003
		(0.017)	(0.017)		(0.018)	(0.016)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.288	0.249	0.288	0.495	0.413	0.495

Decennial Census data. Sample restricted to more educated working-age individuals, those with a high school degree or more. Positive (negative) coefficient estimates for the regional tariff reduction (RTR) imply larger increases (decreases) in the relevant employment category share in regions facing larger tariff reductions. The informal share in Panel B covers both informal employees and the self-employed, shown separately in Panels B and C, respectively. Changes in employment shares are calculated controlling for regional worker composition (see text for details). Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to the non-employed share. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B13: Employment Category Shares of Less Educated Regional Working-Age Population - 2000, 2010

	1991-2000			1991-2010		
Change in share:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Not-employed						
Regional Tariff Reduction *(RTR)*	0.370***	0.382***	0.370***	0.015	-0.001	0.014
	(0.053)	(0.050)	(0.053)	(0.058)	(0.060)	(0.058)
Not-employed share pre-trend (80-91)	0.056		0.061	-0.082*		-0.087
	(0.046)		(0.062)	(0.047)		(0.067)
Not-employed share pre-trend (70-80)		-0.035	0.009		0.056	-0.007
		(0.046)	(0.061)		(0.045)	(0.063)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.487	0.485	0.487	0.519	0.516	0.519
Panel B: Informal						
Regional Tariff Reduction *(RTR)*	0.182***	0.213***	0.238***	0.424***	0.401***	0.450***
	(0.062)	(0.057)	(0.068)	(0.069)	(0.077)	(0.083)
Informal share pre-trend (80-91)	0.020		-0.046	-0.062		-0.092
	(0.039)		(0.047)	(0.054)		(0.069)
Not-employed share pre-trend (70-80)		0.088*	0.128**		-0.020	0.060
		(0.046)	(0.061)		(0.050)	(0.061)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.321	0.328	0.330	0.442	0.439	0.443
Panel C: Informal employee						
Regional Tariff Reduction *(RTR)*	0.482***	0.418***	0.508***	-0.127	-0.052	-0.040
	(0.037)	(0.037)	(0.042)	(0.084)	(0.097)	(0.100)
Informal employee share pre-trend (80-91)	-0.157***		-0.180***	0.053		-0.025
	(0.037)		(0.037)	(0.110)		(0.108)
Not-employed share pre-trend (70-80)		-0.025	0.061		0.199**	0.211***
		(0.056)	(0.058)		(0.088)	(0.078)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.657	0.632	0.660	0.549	0.560	0.560
Panel D: Self-employed						
Regional Tariff Reduction *(RTR)*	-0.232***	-0.203***	-0.190***	0.467***	0.408***	0.439***
	(0.055)	(0.046)	(0.048)	(0.069)	(0.076)	(0.076)
Self-employed share pre-trend (80-91)	-0.046		-0.111**	-0.359***		-0.318***
	(0.064)		(0.054)	(0.073)		(0.105)
Not-employed share pre-trend (70-80)		0.126*	0.168**		-0.226***	-0.107
		(0.065)	(0.069)		(0.068)	(0.089)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.232	0.247	0.257	0.680	0.658	0.683

Decennial Census data. Sample restricted to less educated working-age individuals, those with less than a high school degree. Positive (negative) coefficient estimates for the regional tariff reduction (RTR) imply larger increases (decreases) in the relevant employment category share in regions facing larger tariff reductions. The informal share in Panel B covers both informal employees and the self-employed, shown separately in Panels B and C, respectively. Changes in employment shares are calculated controlling for regional worker composition (see text for details). Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to the non-employed share. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

B.7 Regional Earnings

B.7.1 Robustness

In this section, we present various robustness tests for the regional earnings analysis presented in Table 5.

Table B14 uses an alternative measure of the regional earnings premium for informal workers and for all workers. The regional earnings premium in Table 5 reflects average regional log earnings, controlling for 5 age bins, a gender indicator, and indicators for individual years of education. These controls are needed to net out any changes in worker composition, since we can not follow individual workers over time in the Census data. In Table B14, we additionally control for industry fixed effects. This approach nets out the national direct effect of liberalization in a worker's industry, instead restricting attention to the effects of liberalization on regional equilibrium earnings (Hakobyan and McLaren 2016, Acemoglu et al. 2016). When netting out these direct industry effects, the significant negative earnings effects in Table 5 disappear, with Table B14 finding much smaller, and generally insignificant results. Note that Dix-Carneiro and Kovak (forthcoming) control for industry fixed effects when calculating regional earnings premia, so the informal earnings results presented there are quite similar to those in Table B14.

Tables B15 and B16 further investigate the implications of controlling for worker composition when calculating regional earnings premia. Panel A of both tables replicates the main results from Table 5, for comparison. Panel B calculates regional earnings premia controlling for additional worker-level observable characteristics: an indicator for urban residence, 4 race indicators, and a married indicator. Panel C includes these additional controls, and pairwise interactions between all of the observable characteristics included in Panel B. For both informal earnings in Table B15 and overall earnings in Table B16, these more detailed earnings premium controls have little effect on our conclusions. We still find a lack of robust long-run effect of liberalization on regional informal earnings and reasonably consistently sized effects on overall regional earnings over time, as in the main specifications.

The consistency across panels of tables B15 and B16 helps ameliorate concerns regarding worker selection on unobservables in the Census data. Since the results are consistent when sequentially controlling for more detailed and flexible observable worker characteristics, we are more confident that the results would be similarly robust to controlling for unobservable characteristics. To reinforce this conclusion, Table B17 reports earnings results for a consistent cohort of workers across Census years, those age 25-43 in 1989. These individuals remain of working age throughout our sample period. The results are very similar to those in Table 5, indicating that the results are not driven by changes in the working-age population over time.

Table B18 examines changes in regional hourly wages rather than monthly earnings. This analysis gives us a sense for whether the earnings changes are primarily due to changes in hours worked or changes hourly wages. Recall that continuous hours measures are unavailable prior to 1991, so the pre-liberalization trend controls still utilize earnings rather than wages. The wage results in Table B18 are very similar to the earnings results in Table 5, indicating that the earnings changes primarily reflect changes in hourly wages rather than changes in hours worked.

Table B14: Regional Informal and Overall Earnings Premia Controlling for Industry Fixed Effects - 2000, 2010

	1991-2000			1991-2010		
Change in log earnings premia:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Informal						
Regional tariff reduction (RTR)	0.057	-0.147	0.054	0.190	-0.143	0.170
	(0.153)	(0.151)	(0.161)	(0.237)	(0.272)	(0.229)
Informal earnings pre-trend (80-91)	-0.170***		-0.170***	-0.256***		-0.258***
	(0.050)		(0.049)	(0.087)		(0.085)
Overall earnings pre-trend (70-80)		0.014	-0.003		0.002	-0.025
		(0.061)	(0.058)		(0.101)	(0.097)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.668	0.650	0.668	0.696	0.677	0.696
Panel B: Overall						
Regional tariff reduction (RTR)	0.010	-0.305**	-0.086	0.192	-0.288	0.062
	(0.122)	(0.134)	(0.139)	(0.217)	(0.253)	(0.198)
Overall earnings pre-trend (80-91)	-0.229***		-0.232***	-0.356***		-0.359***
	(0.055)		(0.053)	(0.092)		(0.086)
Overall earnings pre-trend (70-80)		-0.098*	-0.105*		-0.141	-0.150
		(0.056)	(0.053)		(0.102)	(0.098)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.708	0.684	0.714	0.689	0.660	0.695

Decennial Census data. Negative (positive) coefficient estimates for the regional tariff reduction (RTR) imply larger decreases (increases) in earnings in regions facing larger tariff reductions. Regional earnings premia are calculated controlling for regional worker composition and for industry fixed effects (see text for details). Panel A examines earnings for informal workers only, while Panel B examines earnings for all workers, including both formal and informal. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to overall earnings. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment $\times$ sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B15: Regional Informal Earnings Premia with Detailed Worker Controls - 2000, 2010

	1991-2000			1991-2010		
Change in log informal earnings premia:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Main controls						
Regional tariff reduction (RTR)	-0.432***	-0.636***	-0.433***	-0.015	-0.307	-0.021
	(0.148)	(0.144)	(0.156)	(0.251)	(0.262)	(0.234)
Informal earnings pre-trend (80-91)	-0.163***		-0.163***	-0.222**		-0.222**
	(0.049)		(0.048)	(0.089)		(0.089)
Overall earnings pre-trend (70-80)		0.008	-0.001		0.006	-0.006
		(0.055)	(0.054)		(0.093)	(0.092)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.699	0.683	0.699	0.697	0.684	0.697
Panel B: Detailed controls						
Regional tariff reduction (RTR)	-0.206	-0.452***	-0.230	0.076	-0.271	0.050
	(0.138)	(0.135)	(0.142)	(0.227)	(0.248)	(0.208)
Informal earnings pre-trend (80-91)	-0.175***		-0.177***	-0.248***		-0.250***
	(0.046)		(0.045)	(0.076)		(0.075)
Overall earnings pre-trend (70-80)		-0.015	-0.026		-0.015	-0.030
		(0.052)	(0.051)		(0.088)	(0.088)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.669	0.648	0.669	0.702	0.683	0.702
Panel C: Detailed controls with interactions						
Regional tariff reduction (RTR)	-0.203	-0.448***	-0.229	0.102	-0.256	0.072
	(0.135)	(0.132)	(0.138)	(0.214)	(0.240)	(0.200)
Informal earnings pre-trend (80-91)	-0.179***		-0.181***	-0.263***		-0.265***
	(0.044)		(0.044)	(0.072)		(0.071)
Overall earnings pre-trend (70-80)		-0.017	-0.090		-0.018	-0.037
		(0.049)	(0.048)		(0.082)	(0.080)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.659	0.636	0.659	0.699	0.676	0.700

Decennial Census data. Negative (positive) coefficient estimates for the regional tariff reduction (RTR) imply larger decreases (increases) in informal earnings in regions facing larger tariff reductions. Regional earnings premia are calculated controlling for regional worker composition. Panel A uses the worker controls used in the main specifications (Table 5): 5 age-range indicators, sex, and year of education indicators. Panel B includes these controls, and adds an urban indicator, a married indicator, and 4 race indicators. Panel C included all of these controls and pairwise interactions. See text for more detail. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to overall earnings. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B16: Regional Overall Earnings Premia with Detailed Worker Controls - 2000, 2010

	1991-2000			1991-2010		
Change in log overall earnings premia:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Main controls						
Regional tariff reduction (RTR)	-0.392***	-0.718***	-0.495***	-0.405*	-0.874***	-0.535**
	(0.119)	(0.132)	(0.136)	(0.237)	(0.254)	(0.206)
Overall earnings pre-trend (80-91)	-0.224***		-0.224***	-0.332***		-0.332***
	(0.0553)		(0.0529)	(0.0883)		(0.0840)
Overall earnings pre-trend (70-80)		-0.102*	-0.102*		-0.137	-0.137
		(0.0529)	(0.0524)		(0.0983)	(0.0984)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.738	0.719	0.743	0.718	0.697	0.722
Panel B: Detailed controls						
Regional tariff reduction (RTR)	-0.224*	-0.570***	-0.336***	-0.322	-0.796***	-0.456**
	(0.115)	(0.122)	(0.127)	(0.232)	(0.245)	(0.201)
Overall earnings pre-trend (80-91)	-0.233***		-0.233***	-0.330***		-0.330***
	(0.0535)		(0.0516)	(0.0808)		(0.0763)
Overall earnings pre-trend (70-80)		-0.114**	-0.114**		-0.144	-0.144
		(0.0501)	(0.0493)		(0.0951)	(0.0948)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.707	0.684	0.714	0.707	0.684	0.713
Panel C: Detailed controls with interactions						
Regional tariff reduction (RTR)	-0.208*	-0.557***	-0.318**	-0.289	-0.776***	-0.425**
	(0.119)	(0.123)	(0.129)	(0.228)	(0.244)	(0.206)
Overall earnings pre-trend (80-91)	-0.236***		-0.237***	-0.339***		-0.342***
	(0.0520)		(0.0499)	(0.0767)		(0.0718)
Overall earnings pre-trend (70-80)		-0.118**	-0.121**		-0.153*	-0.158*
		(0.0485)	(0.0467)		(0.0867)	(0.0846)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.688	0.663	0.697	0.699	0.673	0.706

Decennial Census data. Negative (positive) coefficient estimates for the regional tariff reduction (RTR) imply larger decreases (increases) in overall earnings in regions facing larger tariff reductions. Regional earnings premia are calculated controlling for regional worker composition. Panel A uses the worker controls used in the main specifications (Table 5): 5 age-range indicators, sex, and year of education indicators. Panel B includes these controls, and adds an urban indicator, a married indicator, and 4 race indicators. Panel C included all of these controls and pairwise interactions. See text for more detail. Pre-trends computed for 1980-1991 and 1970-1980 periods. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B17: Regional Informal Earnings Premia Following Consistent Cohort - 2000, 2010

	1991-2000			1991-2010		
Change in log informal earnings premia:	(1)	(2)	(3)	(4)	(5)	(6)
Regional tariff reduction (RTR)	-0.365**	-0.797***	-0.412**	0.067	-0.508	0.014
	(0.165)	(0.181)	(0.165)	(0.308)	(0.358)	(0.306)
Informal earnings pre-trend (80-91)	-0.285***		-0.297***	-0.389***		-0.405***
	(0.044)		(0.043)	(0.071)		(0.069)
Overall earnings pre-trend (70-80)		-0.052	-0.096		-0.053	-0.115
		(0.067)	(0.063)		(0.111)	(0.102)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.593	0.540	0.598	0.623	0.573	0.626

Decennial Census data. Negative (positive) coefficient estimates for the regional tariff reduction (RTR) imply larger decreases (increases) in informal earnings in regions facing larger tariff reductions. Regional earnings premia are calculated controlling for regional worker composition and following a consistent cohort of workers who were age 27-45 in 1991, 36-54 in 2000, and 46-64 in 2010. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to overall earnings. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B18: Regional Informal and Overall Wage Premia - 2000, 2010

	1991-2000			1991-2010		
Change in log wage premia:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Informal						
Regional tariff reduction (RTR)	-0.493***	-0.783***	-0.507***	0.385	-0.095	0.321
	(0.144)	(0.139)	(0.148)	(0.239)	(0.270)	(0.227)
Informal earnings pre-trend (80-91)	-0.218***		-0.218***	-0.313***		-0.316***
	(0.050)		(0.050)	(0.086)		(0.085)
Overall earnings pre-trend (70-80)		-0.003	-0.014		-0.056	-0.072
		(0.056)	(0.055)		(0.084)	(0.080)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.715	0.690	0.715	0.676	0.646	0.677
Panel B: Overall						
Regional tariff reduction (RTR)	-0.434***	-0.808***	-0.537***	-0.069	-0.664**	-0.249
	(0.118)	(0.134)	(0.131)	(0.229)	(0.268)	(0.213)
Overall earnings pre-trend (80-91)	-0.269***		-0.269***	-0.400***		-0.400***
	(0.057)		(0.054)	(0.088)		(0.081)
Overall earnings pre-trend (70-80)		-0.103*	-0.103*		-0.195**	-0.194**
		(0.056)	(0.055)		(0.088)	(0.083)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.740	0.711	0.745	0.698	0.665	0.708

Decennial Census data. Negative coefficient estimates for the regional tariff reduction (RTR) imply larger decreases in wages in regions facing larger tariff reductions. Regional wage premia are calculated controlling for regional worker composition (see text for details). Panel A examines wages for informal workers only, while Panel B examines wages for all workers, including both formal and informal. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of continuous hours information in the 1970 and 1980 Censuses, pre-trends are based on monthly earnings rather than hourly wages. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to overall earnings. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

B.7.2 Results by Education Level

Tables B19 and B20 present earnings results for informal and all workers, separately by education level. Table B19 restricts attention to workers with a high school degree or more, and finds somewhat larger earnings effects for these workers than for less skilled workers, those with less than a high school degree, in Table B20. Note that the theoretical framework underlying our analysis assumes homogenous labor, so these results are merely suggestive. See Dix-Carneiro and Kovak (2015) for an analysis of the regional effects of liberalization with two worker types.

Table B19: Regional Informal and Overall Earnings Premia for More Educated Workers - 2000, 2010

	1991-2000			1991-2010		
Change in log earnings premia:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Informal						
Regional tariff reduction (RTR)	-0.773***	-0.864***	-0.750***	-0.585***	-0.687***	-0.537***
	(0.129)	(0.115)	(0.127)	(0.163)	(0.184)	(0.168)
Informal earnings pre-trend (80-91)	-0.081		-0.098*	-0.095		-0.129**
	(0.052)		(0.053)	(0.058)		(0.059)
Overall earnings pre-trend (70-80)		-0.069	-0.086		-0.143***	-0.167***
		(0.063)	(0.062)		(0.053)	(0.053)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.739	0.738	0.743	0.752	0.756	0.760
Panel B: Overall						
Regional tariff reduction (RTR)	-0.627***	-0.820***	-0.598***	-0.867***	-1.076***	-0.811***
	(0.137)	(0.121)	(0.131)	(0.173)	(0.208)	(0.198)
Overall earnings pre-trend (80-91)	-0.222**		-0.250***	-0.249***		-0.298***
	(0.084)		(0.077)	(0.085)		(0.073)
Overall earnings pre-trend (70-80)		-0.155***	-0.179***		-0.274***	-0.303***
		(0.053)	(0.050)		(0.057)	(0.058)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.771	0.768	0.789	0.805	0.814	0.828

Decennial Census data. Sample restricted to more educated working-age individuals, those with a high school degree or more. Negative coefficient estimates for the regional tariff reduction (RTR) imply larger decreases in earnings in regions facing larger tariff reductions. Regional earnings premia are calculated controlling for regional worker composition (see text for details). Panel A examines earnings for informal workers only, while Panel B examines earnings for all workers, including both formal and informal. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to overall earnings. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table B20: Regional Informal and Overall Earnings Premia for Less Educated Workers - 2000, 2010

	1991-2000			1991-2010		
Change in log earnings premia:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Informal						
Regional tariff reduction (RTR)	-0.309*	-0.554***	-0.317*	0.286	-0.062	0.291
	(0.174)	(0.164)	(0.181)	(0.305)	(0.308)	(0.273)
Informal earnings pre-trend (80-91)	-0.185***		-0.185***	-0.266***		-0.266***
	(0.051)		(0.049)	(0.089)		(0.087)
Overall earnings pre-trend (70-80)		0.003	-0.008		0.022	0.005
		(0.063	(0.061)		(0.111)	(0.110)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.678	0.659	0.678	0.692	0.675	0.692
Panel B: Overall						
Regional tariff reduction (RTR)	-0.226	-0.590***	-0.335**	-0.089	-0.570*	-0.165
	(0.144)	(0.151)	(0.161)	(0.312)	(0.309)	(0.254)
Overall earnings pre-trend (80-91)	-0.246***		-0.246***	-0.372***		-0.372***
	(0.054)		(0.052)	(0.091)		(0.090)
Overall earnings pre-trend (70-80)		-0.097	-0.096		-0.075	-0.071
		(0.064)	(0.062)		(0.125)	(0.122)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.702	0.675	0.706	0.662	0.631	0.664

Decennial Census data. Sample restricted to less educated working-age individuals, those with a high school degree or more. Negative coefficient estimates for the regional tariff reduction (RTR) imply larger decreases in earnings in regions facing larger tariff reductions. Regional earnings premia are calculated controlling for regional worker composition (see text for details). Panel A examines earnings for informal workers only, while Panel B examines earnings for all workers, including both formal and informal. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to overall earnings. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

B.7.3 Regional Informal Employee and Self-Employed Earnings

Table B21 breaks down the informal earnings results in Panel A of Table 5 into those for informal employees and the self-employed, which together comprise the informal sector. The estimates are less consistent across pre-trend specifications than those in the main text, but one interesting observation is that the recovery in informal wages in harder hit places that occurs by 2010 appears primarily among the self-employed. See Appendix B.2 for more detail on the informal sector and on the industry distribution of informal employees and the self-employed.

Table B21: Regional Informal Employee and Self-Employed Earnings Premia - 2000, 2010

	1991-2000			1991-2010		
Change in log earnings premia:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Informal employees						
Regional tariff reduction (RTR)	-0.516***	-0.715***	-0.583***	-0.321	-0.556**	-0.417**
	(0.127)	(0.124)	(0.134)	(0.241)	(0.212)	(0.210)
Informal employee earnings pre-trend (80-91)	-0.117**		-0.118***	-0.117		-0.120
	(0.045)		(0.044)	(0.077)		(0.075)
Overall earnings pre-trend (70-80)		-0.063	-0.066		-0.096	-0.100
		(0.045)	(0.049)		(0.078)	(0.080)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.704	0.698	0.706	0.661	0.659	0.664
Panel B: Self-employed						
Regional tariff reduction (RTR)	-0.181	-0.535***	-0.142	0.541**	0.037	0.612**
	(0.186)	(0.199)	(0.195)	(0.250)	(0.361)	(0.269)
Self-employed earnings pre-trend (80-91)	-0.285***		-0.283***	-0.403***		-0.399***
	(0.055)		(0.056)	(0.092)		(0.093)
Overall earnings pre-trend (70-80)		0.067	0.043		0.113	0.083
		(0.078)	(0.069)		(0.124)	(0.115)
State fixed effects (26)	✓	✓	✓	✓	✓	✓
R-squared	0.682	0.637	0.682	0.728	0.689	0.729

Decennial Census data. Negative coefficient estimates for the regional tariff reduction (RTR) imply larger decreases in earnings in regions facing larger tariff reductions. Regional earnings premia are calculated controlling for regional worker composition (see text for details). Panel A examines earnings for informal employees only, while Panel B examines earnings for self-employed workers. Pre-trends computed for 1980-1991 and 1970-1980 periods. Due to a lack of information on informality in the 1970 Census, the 1980-1970 pre-trends always refer to overall earnings. 405 microregion observations. Standard errors (in parentheses) adjusted for 90 mesoregion clusters. Weighted by the inverse of the squared standard error of the estimated change in the relevant employment × sector share. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.