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Gender, Informal Employment and Trade Liberalization in Mexico

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Abstract

We study how trade liberalization affects formal employment across gender. We propose a theoretical mechanism to explain how male and female formal employment shares can respond differently to trade liberalization through labor reallocation across tradable and non-tradable sectors. Using Mexican data over the period 1993-2001, we find that tariff cuts increase the probability of working formally for both men and women within 4-digit manufacturing industries. The formalization of jobs within tradable sectors is driven by large firms. Constructing a regional tariff measure, we find that regional exposure to trade liberalization increases the probability of working formally in the manufacturing sector for both men and women, and especially for men. However in the service sectors, the probability of working formally decreases for low-skilled women.

JEL classification: F11, F16, F63, O17

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1 Introduction

Trade integration episodes are expected to foster economic development by reallocating resources towards more productive sectors and firms. However, the impact of international trade on labor markets is controversial, as it can also contribute to an increase in inequality (see Goldberg and Pavcnik, 2007 and Hanson, 2007 among others). Labor markets in developing countries are characterized by a dual system where formal and informal jobs coexist, and by gender inequalities. Informal jobs tend to offer lower earning opportunities, worse working conditions and little social safety nets compared to formal jobs. Therefore, reducing informality rates, as well as gender gaps, is a crucial aspect of policies tackling the issues of inequality and poverty. Recent studies have shown that trade liberalization affects informality rates (Dix-Carneiro and Kovak, 2017a, McCaig and Pavcnik, 2014 and references herein), as well as gender differences in the labor market (Juhn et al., 2014, Sauré and Zoabi, 2014, Gaddis and Pieters, 2017 among others). However, the potential impact of trade liberalization on gender differences in formal and informal employment has been so far overlooked. This paper is the first to present a theoretical and empirical analysis of the relationship between trade integration and gender-specific formal employment. Exploiting sharp tariff cuts in Mexico during the 1990s, this analysis offers a comprehensive picture of the effect of trade openness on formality rates across gender, both at the sectoral and local labor market level.

In Mexico, the gender gap in the employment to population ratio has been around 40 percentage points for decades. At the same time, informal employment is an important phenomenon since it affects more than 50 percent of all workers (Jütting and De Laiglesia, 2009). A joint analysis of informal employment and its gender composition is necessary to improve our understanding of the impact of globalization on the labor market, and it is motivated by several observations. Firstly, sectors have different female labor shares as well as different shares of formal jobs. As trade integration benefits some sectors at the expense of others, it is likely to change formal employment shares, and differently for men and

women. Secondly, trade liberalization is likely to generate a "formal-biased technological change" since it favors the most productive firms that are more intensive in formal labor because of their size and technology. Finally, there is evidence in support of a stronger complementarity between capital and female labor than between capital and male labor.[1] These differences in the substitution between female and male labor to capital may also affect the relationship between trade liberalization and labor allocations.

Our analysis is developed in three steps. First, we present some facts on employment patterns in Mexico over the period 1993 and 2001. Considering both manufacturing and service industries, we observe that: (i) employment and formal employment shares have declined in service sectors while they have increased in manufacturing sectors; (ii) formal labor shares are greater for women than men both in manufacturing and in service sectors; and (iii) female intensity in formal jobs has increased only in manufacturing sectors.[2]

Second, we develop a general equilibrium model where trade liberalization affects the formal employment shares of men and women differently. We follow Blum (2008) and Dix-Carneiro and Kovak (2015) and use a multi-sector Ricardo-Viner model with two types of labor. Our framework allows for formal and informal jobs and introduce sectoral heterogeneity in formal job intensity. We find that trade liberalization increases the demand for formal labor if comparative advantage sectors are relatively more intensive in formal jobs.[3] We derive the conditions under which the formalization of jobs at the regional level differs across men and women. More specifically, we find that trade liberalization increases the demand for male labor by a larger amount relative to female labor in formal jobs if comparative advantage sectors are relatively more intensive in formal jobs, and if male labor is

[1] Black and Spitz-Oener (2010) show how technological change can increase women's productivity relative to men's through a decline in routine task inputs. Juhn et al. (2014) develop a model where firms upgrade their technology with trade integration which lowers their need for physically demanding tasks and thus increases their demand for female labor.

[2] Our analysis includes manufacturing sectors, also referred to as tradable sectors, and service sectors, also called non-tradable sectors.

[3] Figure 4 in the online Appendix shows that over the 1990s Mexican manufacturing sectors with large net export shares are on average more intensive in formal labor than manufacturing sectors with low net export shares.

relatively more substitutable for capital than female labor.[4]

Finally, we conduct an empirical analysis of the relationship between Mexican import tariffs on U.S. products and the probability of holding a formal job for men and women. Mexico represents an interesting case study for at least three reasons. First, among NAFTA members, Mexico was the country with the highest tariffs and experienced the largest cut during the NAFTA phase-in. Over the period 1993-2001, Mexican import tariffs on U.S. products declined on average by 14 percent. Second, Mexico has a large informal sector which increased in the 1990s. Finally, the Mexican labor market exhibits striking gender differences. The extremely low female labor force participation is one illustration of this: less than 40 percent of women participated to the labor force in the early 1990s, and this share remained below 50 percent in the early 2000s.

We use individual data from the Mexican labor force survey called Encuesta Nacional de Empleo Urbano (ENEU). This survey enables us to identify whether working individuals belong to the formal or informal segment of the labor market. To characterize the informal segment, we focus on wage employment. We define informal employees as those who do not have access to health insurance and social security coverage which are mandated benefits for legal labor contracts. Additionally, the ENEU provides information on individuals' industry affiliation at the 4-digit level, and location at the municipality level. This enables us to precisely match individuals to tariff changes at a disaggregated sectoral level and to local exposure to tariffs. The local labor market approach allows us to evaluate the general equilibrium effects of trade for a regional economy and to disentangle the effects of trade liberalization across tradable and non-tradable sectors. In fact, the non-tradable industries may be indirectly affected by changes in tariffs through spillovers and labor reallocation across sectors.

Our estimation strategy uses a linear probability model to examine the effect of trade on the probability of being in formal employment. We take two approaches: one at the industry level exploiting time-variation in industry tariffs and the other at the municipality

[4]This is a common assumption since the seminal article of Galor and Weil (1996).

level exploiting differences in industry-mix across municipalities and constructing gender-specific local exposures to tariffs. For each approach we provide a set of robustness checks to account for possible confounding factors and additional threats to identification. At the 4-digit industry level, we find that individuals working in an industry experiencing the average reduction in tariffs of 14 percentage points experience an increase in the probability of holding a formal job by 2 percentage points relative to individuals in industries facing no reduction in tariffs. Our findings show no gender differences within disaggregated industries. We additionally find that this formalization of jobs within industries is driven by big firms, while informality increases with trade liberalization in very small firms. These findings are consistent with a reallocation of employment into trade-oriented firms that are larger and more intensive in formal jobs.

The regional effect of trade liberalization is captured by constructing a local measure of exposure to tariffs at the municipality level, where the sectoral tariffs are weighted by sectoral employment shares in each municipality.[5] Exploiting the regional variation in exposure to tariffs, we find that men living in a municipality experiencing the average reduction in tariffs of 14 percentage points are almost 6 percentage points more likely to hold a formal job than men in municipalities facing no reduction in tariffs. However, on average women do not experience an increase in the probability of holding a formal job. This result is related to the effect of local tariffs on manufacturing sectors and to the spillover effect on service sectors. In the manufacturing sector, we find that trade liberalization increases the probability of working in the formal sector for both women and men. Our results at the regional level show that the formalization effect in manufacturing sectors is larger than what we obtain within 4-digit manufacturing sectors. This suggests that regional liberalization generates labor reallocation across 4-digit manufacturing industries, which contributes to a formalization of employment in manufacturing industries. The formalization effect is bigger among men, in particular for highly educated workers. These results are consistent

[5]We use the term "region" to refer to local labor markets. Notice that these local labor markets correspond to "municipalities" in the empirical part that uses ENEU data.

with a Ricardo-Viner model in which the CA sectors are more intensive in formal labor and where male labor is relatively more substitutable for capital than female labor.

In the service sectors, in contrast to the manufacturing sectors, trade liberalization increases the probability of working informally only among low-skilled women. Using a different sample of working-age individuals, which includes individuals not in paid employment, we find that the increase in informality in the service sector is partly related to women entering the labor market with informal jobs in the service sector.

The paper is structured as follows. Section 2 describes the novel contributions of this paper with respect to the existing literature. Section 3 provides a description of the data, and an industry decomposition of changes in the formal employment share. Section 4 proposes a theoretical framework and derives predictions to be tested. Section 5 describes the empirical strategy. The empirical results and robustness checks are presented in Section 6 for the industry level approach and in Section 7 for the local labor market approach. Finally, section 8 concludes.

2 Related Literature

This paper is related to several strands of literature. Firstly, our paper relates to studies on trade and informality. A branch of this literature has paid attention to industry-level response of formal and informal employment to trade shocks. Goldberg and Pavcnik (2003), Menezes-Filho and Muendler (2011), and Bosch et al. (2012) find no or minimal effect of trade liberalization on informality within sectors in Brazil. Paz (2014) and McCaig and Pavcnik (2014) find that reductions in trading partner tariffs decrease informality in Brazil and Vietnam respectively.[6] In contrast, we look at how changes in Mexican import tariff on U.S. products affected formal employment in Mexico during the 1990s. Similarly to Aleman-Castilla (2006), we find that a reduction in the Mexican tariff increases formality

[6] Becker (2017) proposes a model with firm heterogeneity which shows that trade liberalization reduces informal employment.

rates within-industry. We show that this result is robust to controlling for the U.S. import tariff. Our analysis contributes to the literature on trade and informality at the sector level with several novel insights. First, we show that, within 4-digit industries women and men are similarly affected in their formal employment probability. Second, we find that the effect differs across firms' size. Considering trade liberalization in Argentina, Cruces et al. (2017) find that industries with a large share of employment concentrated in small firms, experience an increase in informality. We complement their analysis using individual data and find that workers in small firms have a higher probability of holding an informal job when sectoral tariffs decline. On the contrary, workers in bigger firms experience an increase in formal employment probability with a drop in the sectoral tariff.

Our work also relates to the literature that adopts a local labor market approach to analyze the relationship between regional trade exposure and labor market outcomes. For instance, we relate to studies on wages (Chiquiar, 2008 for Mexico; Kovak, 2013 and Dix-Carneiro and Kovak, 2015 for Brazil), employment (Autor et al., 2013 for the U.S., Dix-Carneiro and Kovak, 2017a for Brazil and references herein), child labor and poverty (Edmonds et al., 2009; Edmonds et al., 2010; Topalova, 2010; Kiskatos and Sparrow, 2015). More recently, Autor et al. (2018) studied how adverse local labor market shocks due to rising import penetration affect marriage, fertility, and children's living circumstances. Our theoretical model is related to Dix-Carneiro and Kovak (2015), where they use two types of workers. Unlike them, we explore gender differences, rather than educational differences, and we focus on employment rather than wages. Moreover, we add the formality dimension and have two types of jobs, formal and informal. Our empirical analysis complements the literature on trade and local labor markets by considering gender differences across formal and informal employment during Mexican trade liberalization. Previous work on developing countries found limited effects of trade liberalization on informality (Goldberg and Pavcnik, 2003, Menezes-Filho and Muendler, 2011, Bosch et al., 2012, Paz, 2014, McCaig and Pavcnik, 2014 among others). Adopting a long difference identification strategy

for Brazil, Dix-Carneiro and Kovak (2017a) find that regions facing larger tariff cuts experienced prolonged declines in formal sector employment and earnings relative to other regions. In this paper, we rely on yearly variation in tariffs between 1993 and 2001 and find different results. Specifically, we show that regional exposure to Mexican import tariff reductions lead to an increase in the probability of formal employment for men only. Moreover, we find that regional liberalization affect tradable and non-tradable sectors differently. A stronger exposure to tariffs reduction leads to a higher probability of formal employment in the tradable sectors for both men and women. In turn, however, it also increases informal employment probability in non-tradable industries for women only. As we discuss later, our different results may be driven by the specific sample used (only urban areas), methodology (shorter run evaluation) and country setting. In the case of Mexico, export-oriented sectors benefited from the fall in Mexican tariffs as intermediate inputs became cheaper. Indeed, Mexican exports to the U.S. use a very high share of U.S. inputs (de Gortari, 2017). It is also worth pointing out that our findings are in line with Atkin (2016) who documents a formal employment boom in Mexican export-oriented manufacturing industries over the 1990s while the employment share of the manufacturing sector has been increasing at the expense of the services sector in Mexico. Besides, our results are also in line with some results of Menezes-Filho and Muendler (2011) who find (Table 9) that lower intermediate-input tariffs are associated with significantly lower odds of transitions into unemployment and out of the labor force, resulting in significantly more transitions into formality. However, reductions in product-market tariffs have opposite effects.

Finally, our approach closely relates to a growing number of papers emphasizing the gender-specific effects of international trade. This literature proposes different channels to investigate the effect of trade liberalization on gender gaps in labor force participation and wages. Trade liberalization can contribute to a reduction in the gender gap due to taste-based discrimination through a competition effect (see Black and Brainerd, 2004 and Ben Yahmed, 2012 among others). Other papers stress the importance of male and female

differences in productive characteristics and how their returns evolve with trade integration (Aguayo-Tellez et al., 2010; Juhn et al., 2013; Juhn et al., 2014; Sauré and Zoabi, 2014; Do et al., 2016; Gaddis and Pieters (2017)). Unlike previous studies on Mexico, i.e., Aguayo-Tellez et al. (2010) and Juhn et al. (2014), this paper focuses on the impact of Mexico's trade liberalization on gender differences considering not only formal employment but also informal employment. Our results show that trade liberalization has gender-specific effect on formality, especially in service sectors. To account for shifts between employment and non-employment, we extend our analysis using the whole sample of the working-age population. Differently from Gaddis and Pieters (2017) who use Brazilian data, we find that the Mexican trade liberalization over the 1990s contributed to a small increase in female paid employment probability, but did not lead to a significant change in male paid employment probability. While Gaddis and Pieters (2017) do not differentiate formal from informal employment, we show that this dimension is important. The smaller formalization effect of trade among women is partly due to women moving from non-employment into informal jobs with exposure to tariff reductions. To the best of our knowledge, this is the first paper to investigate the effects of trade liberalization on formal and informal employment by gender.

3 Formal Employment Shares in Mexico

3.1 Data

The data used in this study come from the Encuesta Nacional de Empleo Urban (ENEU), which is a quarterly labor force survey conducted by the Mexican National Institute of Statistics (INEGI). This survey provides information on individuals' socio-economic characteristics, firm size, industry affiliation at the 4-digit level (CAE), and location at the municipality level.[7] The survey is representative of cities with over 100,000 inhabitants,

[7]This survey has been used by several authors, including for example Robertson (2004), Verhoogen (2008), and Bosch and Manacorda (2010).

and covers only urban areas. The primary sampling units are municipalities. Over time the sample size of the survey has constantly increased as cities were added every year. The total number of municipalities over the the period 1993-2001 is 216, with municipalities entering and exiting every year. To avoid any selection issue, we decided to take the most conservative approach, and keep all municipalities reported in each year over the period 1993-2001.[8]

Our main sample is restricted to working individuals between the ages of 16 and 60. We distinguish three types of employment: formal and informal wage employment, and self-employment.[9] Informal wage workers are employees who report not having health insurance or social security coverage, although their status should entitle them to access to these mandated benefits. Self-employed individuals report being "own-account workers" (trabajador por su cuenta) as their main job. Self-employed individuals differ from employers as they own very small businesses; more than 80% of them have no employees. However the ENEU survey does not allow us to clearly distinguish between formal and informal self-employment. Therefore, our preferred measure for distinguishing formal from informal employment only considers wage workers. In the robustness checks, we extend the definition of informal employment, including both informal wage employment and self-employment. Additional descriptive statistics on formal and informal employees and the self-employed are provided in Table 10 in Appendix A.

To capture variation in trade liberalization, we merge the ENEU labor force survey with Mexican import ad-valorem tariffs on U.S. products at the 4-digit level from Iacovone and Javorcik (2010). Additionally, since NAFTA also lowered U.S. tariffs on Mexican exports to the U.S., it is important to control for this contemporaneous change in trade policy. Therefore, in our sensitivity analysis we use U.S. import tariffs from Feenstra et al.

[8]See Table 8 in Appendix A for details on the sample size. Alternative approaches suggest focusing on the subset of municipalities that are always surveyed in the sample period. Our results are not affected by the sample choice, which indicates that the composition of municipalities in the ENEU is not correlated to changes in trade policy.

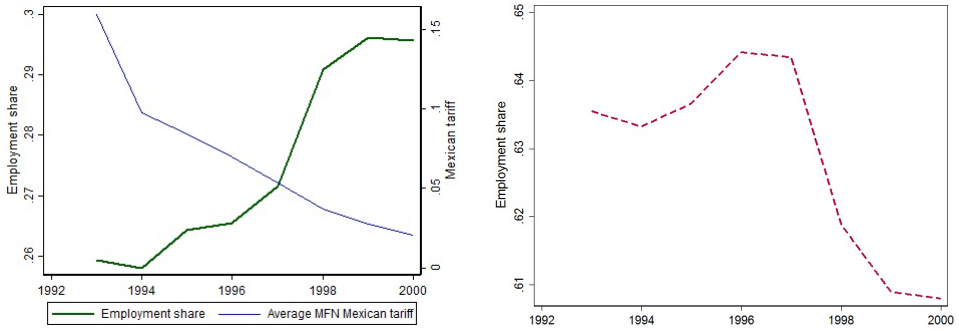
[9]To account for shifts between employment and non-employment, we replicate our analysis using the sample of working-age individuals, including individuals in unemployment and out of the labor force.

(2002).[10] More details on our industry and regional tariff measures are provided in Section 5.1 and in Appendix A.

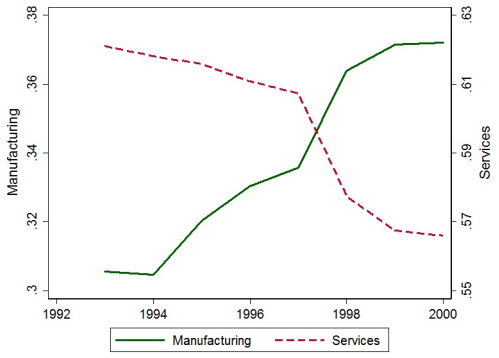
3.2 Trade Liberalization and Employment Shares

After a long period of import substitution strategy, Mexico started to move toward a liberalized trade regime in the 1980s. In 1994 it joined NAFTA and substantially lowered its tariffs on the U.S. and Canadian markets. Figure 1 shows the evolution of employment shares and formal employment shares in the manufacturing and service sectors, and the drop in the average Mexican import tariff on U.S. products during the 1990s.

Figure 1: Employment Trends and Mexican Tariffs



(a) Employment share in manufacturing sectors (b) Employment share in service sectors



(c) Formal employment shares in manufacturing and services

Source: Authors' calculations based on the ENEU, Mexico.

[10] See Schott's web page $http://faculty.som.yale.edu/peterschott/sub_cv.htm$.

Mexican import tariffs on U.S. products were reduced on average by 14 percentage points, from more than 15 percent in 1993 to less than 1.5 percent in 2003 (panels *a*). At the same time, the employment share in the manufacturing sector has increased at the expense of the employment share in the service sector (panels *a* and *b*). The drop in the Mexican average tariff applied to U.S. products also coincides with the reallocation of formal employment from manufacturing to service sectors (panel *c*).

Figure 2 shows how formal employment has changed differently for male and female employees during the trade liberalization period. Overall, female employees have a higher formality rate (between 80 and 75%) than male employees (between 70 and 74%). However, the gender gap in the formality rate among wage workers has been shrinking. It was almost 10 percentage points in 1993, and was reduced to about 4 percentage points in 2001. The formality rate has increased in the manufacturing sectors for both men and women (panel *b*). In contrast, in the service sector, the formality rate has decreased for women, while it has remained fairly stable for men (panel *c*). The next section provides a decomposition analysis of changes in the female share among formal employees.

3.3 Between and Within-Industry Decomposition

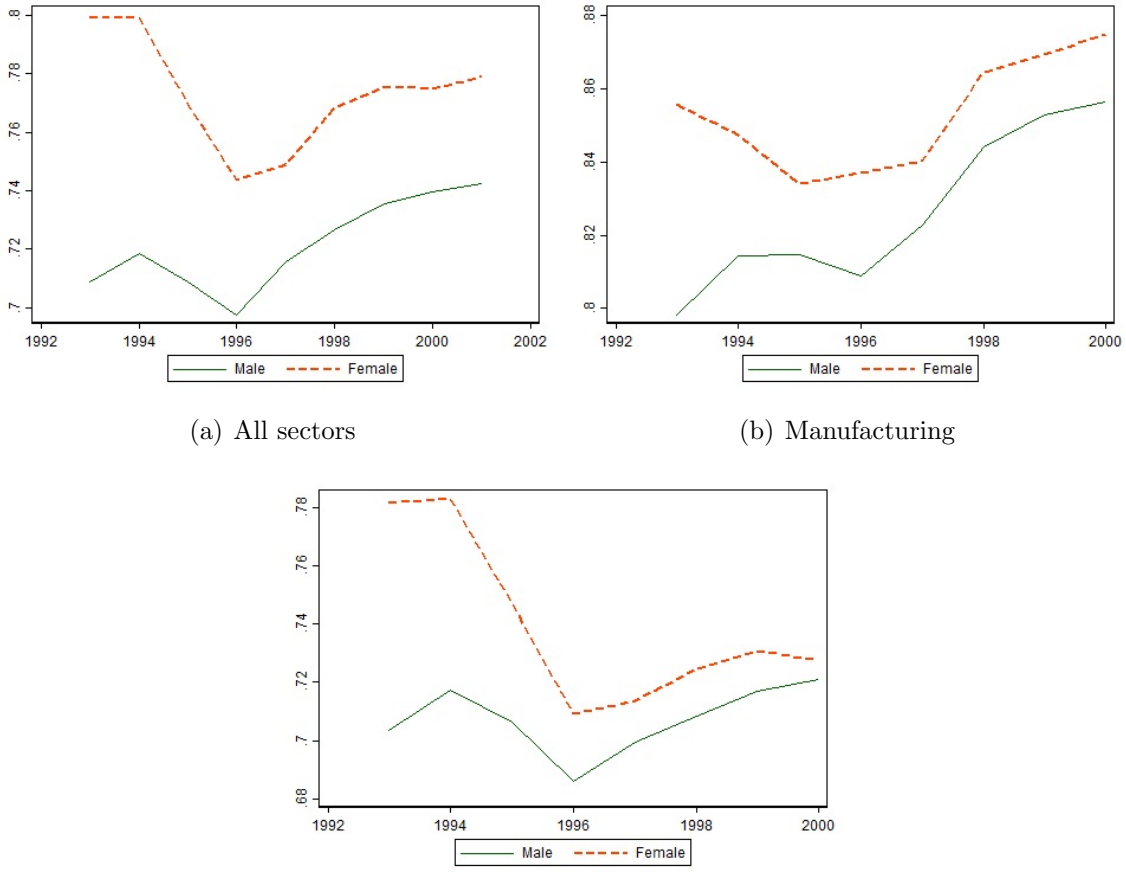
In this section, we decompose the change in men and women's formal employment shares (henceforth FS) into within and between-industry changes. The decomposition is expressed as follows:

$$\Delta FS_{gt} = \sum_{s} \Delta FS_{gst} \times E_{gs} + \sum_{i} \Delta E_{gst} \times FS_{gs} \tag{1}$$

where FS_{gt} denotes the share of formal employees in total employment of group $g = \{f, m\}$, where f denotes female and m denotes male. $\Delta FS_{gt} = FS_{gt} - FS_{gt-1}$ is the change in the formal employment share over the period. FS_{gst} denotes the share of formal employees in industry s employment of group g and E_{gs} is industry s employment of group g.

The first term on the right-hand side of equation (1) is the within-industry component

Figure 2: Formality rate among wage workers



(a) All sectors

(b) Manufacturing

(c) Services

Source: Authors' calculations based on the ENEU, Mexico.

and represents the part of the aggregate change in FS_{gt} due to changes in industry specific FS_{gst}, holding constant the employment shares of industries. The second term is the between-industry component. It reflects changes in the aggregate FS_{gt} due to changes in the employment shares of industries, holding constant the industry specific FS_{gst}.

Tables 1 and 2 present the decomposition using a different level of industry disaggregation and a different sample of industries. The decomposition is done first over the entire sample period, and then using two different sub-samples: 1994-1998 and 1998-2001. Table 1 presents the decomposition into between and within industry changes at the 1-digit level of disaggregation using the sample of workers in the manufacturing and the service

sectors. Column (1) in Table 1 shows that the share of formal employees among male

Table 1: Decomposition across 1-digit sectors

	Total	Within	Between
	(1)	(2)	(3)
		1994-2001	
Female	-.02	-.027	.007
Male	.024	.021	.003
		1994-1998	
Female	-.031	-.038	.007
Male	.008	.004	.004
		1998-2001	
Female	.011	.011	-.001
Male	.016	.016	0

Notes: Two 1-digit sectors, manufacturing and service sectors, only.

employees has increased in the overall economy by 2.4 percentage points, but it has decreased among women by 2 percentage points. These changes are driven by within 1-digit industry changes. In the manufacturing sector, the FS has substantially increased over the period, especially for men, while the FS in the service sector was in decline until 1996 and especially for women (see Figure 2). Reallocation of employment from the service to manufacturing sectors (between-industry change) contributed to a small increase in the overall FS.

Table 2 focuses only on the manufacturing sectors and relates changes in aggregate FS into between and within 4-digit industries changes. Between 1994 and 2001, women's FS increased by more than 2 percentage points, and by almost 4 percentage points for men. This increase in the overall manufacturing FS is explained by both within and between 4-digit industry changes. Within-industry changes contribute positively to the increase in the FS for both men and women. The reallocation of labor into manufacturing industries with a high FS has also contributed to the increase in the aggregate FS, except between 1994 and 1998 for women.

Overall, the increase in the FS has been more pronounced for men than for women. Both within and between-industry changes explain changes in the share of formal jobs

Table 2: Decomposition across 4-digit manufacturing sectors

	Total (1)	Within (2)	Between (3)
		1994-2001	
Female	.021	.028	-.007
Male	.039	.027	.012
		1994-1998	
Female	.006	.017	-.011
Male	.028	.017	.011
		1998-2001	
Female	.012	.011	.002
Male	.011	.007	.004

Notes: More than 250 4-digit sectors. Only manufacturing sectors.

in wage employment but within-industry changes explain a bigger share of the aggregate change. In the following sections we investigate theoretically and empirically how trade liberalization contributes to those changes. Our theoretical model focuses on how trade liberalization affects formal employment shares through between industry reallocation in different ways for men and for women. We borrow from recent trade models to explain the changes in formal employment shares within tradable industries. We then conduct an empirical investigation of the impact of trade on female and male formal employment through both within and between industry reallocation.

4 Theoretical Framework

The Ricardo-Viner model developed in this section follows Kovak (2013) in using Jones (1975) to model each region within a country as a specific-factor economy. Then, similarly to Blum (2008) and Dix-Carneiro and Kovak (2015), we consider a structure with two labor factors, in this case female and male labor, and analyze labor reallocation across tradable and non-tradable sectors. Finally, to study how employment reallocation across sectors following trade liberalization affects female and male formal employment, we introduce sectoral heterogeneity in formal job intensity. The following sections present the setup of

the model and then highlight the effect of trade liberalization on male and female formality rates at the regional level.

4.1 The Setup

We consider a country composed of several regions, indexed by r, that produces N goods, M of which are internationally tradable and can be either imported or exported. Since the focus is on a particular region, we suppress the subscript r on all terms. Production uses capital, K, and two types of labor, female and male labor, L_f and L_m. Labor is assumed to be supplied inelastically, fully employed, and perfectly mobile across industries but not across regions. Capital is not mobile between sectors or regions in the short-run. Technologies may differ across sectors, but are the same across regions within each sector. Production exhibits constant returns to scale, and factors and goods markets are competitive. All regions face the same prices for the tradable goods, which are taken as given on the international market.

Each sector s, either tradable or non-tradable, is characterized by an exogenous share of formal jobs, α_s. More specifically, men and women can be hired as formal or informal workers within the same sector. Formal employment for each gender group g, with $g = \{f, m\}$, and sector s, is defined as $L_{\varphi gs} = \alpha_s L_{gs}$, where φ stands for formal. The term α_s captures sector heterogeneity in formal labor intensity.[11]

This set-up generates a link between male and female formality rates and trade liberalization, which is the focus of the next section. The model is presented in its entirety in Appendix F, where we explicitly solve for the endogenous variables, such as factor returns, sectoral employment allocations, sectoral output, and prices of non-tradable goods.

[11] We assume that formal labor intensity in a sector is the same across gender. Our results would hold if we allow the formal labor intensity to differ between men and women within each sector.

4.2 Trade and Formal Employment

4.2.1 Trade and Formal Employment at the Sector Level

The model does not endogenize within-industry changes in formal employment. Changes in the share of formal labor in a sector, $\hat{\alpha}_s = \hat{L}_{\varphi gs} - \hat{L}_{gs}$ could increase with trade through two channels. First, firms may increase their demand for formal labor with "formal-biased technological change". Exporters may invest in new technologies that require firm-specific knowledge or specific training of workers giving firms incentive to retain workers and provide formal contracts. Second, trade liberalization can increase the share of formal labor at the sectoral level by reallocating employment to trade-oriented firms, which are more intensive in formal jobs (see Aleman-Castilla (2006), Nataraj (2011) and McCaig and Pavcnik (2014) among others). In fact, it is well established that trade integration induces employment reallocation across heterogeneous firms within sectors. Since trade-oriented firms tend to be larger and employ more skilled workers, they should also be more likely to hire formal workers.

The theoretical model of this paper does not focus on changes in α_s. Rather, we use our model to explore the effects of trade liberalization on regional gender gap in formality rates through labor reallocation *between* sectors. We discuss in section 4.2.2 how trade liberalization may affect the formality rate of men and women at the regional level in different ways.

4.2.2 Trade and Formal Employment at the Regional Level

This section adopts a local labor market approach and investigates how the demand for formal labor evolves with trade liberalization in a regional economy. The share of group g formal employment is given by:

$$\frac{L_{\varphi g}}{L_g} = \frac{\sum_s \alpha_s L_{gs}}{\sum_s L_{gs}} \tag{2}$$

where we consider a particular region and suppress the subscript r on all terms. Notice that the change in formal employment share can be written as: $\hat{L}_{\varphi g} - \hat{L}_g$. Since labor supply is fixed at the regional level, $\hat{L}_g = 0$, the change in formal labor share is equal to the change in the level of formal labor:

$$\hat{L}_{\varphi f} = \sum_s \lambda_{\varphi fs} \times \hat{L}_{fs}(p_s, \sigma^f_{fk,s}, \sigma^m_{fk,s}, \theta) \tag{3}$$

$$\hat{L}_{\varphi m} = \sum_s \lambda_{\varphi ms} \times \hat{L}_{ms}(p_s, \sigma^m_{mk,s}, \sigma^f_{mk,s}, \theta) \tag{4}$$

where $\lambda_{\varphi fs} = \frac{\alpha_s L_{fs}}{L_{\varphi f}}$ and $\lambda_{\varphi ms} = \frac{\alpha_s L_{ms}}{L_{\varphi m}}$ represent the fraction of female and male formal employment in industry s. $\hat{L}_{fs}$ and $\hat{L}_{ms}$ represent the change in the demand for female and male labor in sector s, which depend on different elements. Firstly, on the price of the good produced in sector s, p_s. Secondly, on the elasticity of substitution between factor g and the specific capital K_s with respect to the relative price of factors L_g, and K_s; elasticities are denoted $\sigma^g_{fk,s}$ and $\sigma^g_{mk,s}$. And finally on a vector θ representing the cost shares of each factor of production, $\theta = \{\theta_{fs}, \theta_{ms}, \theta_{ks}\}$.[12]

Moving from autarky to trade integration corresponds to an increase in the price of the goods in which the country has comparative advantage (henceforth CA), $\hat{p}_s > 0$. As explained in Appendix F, the change in sector s labor demand goes in the same direction as the price change. Therefore, trade liberalization affects female and male labor demand in a given sector in the same direction. However, the proportion of this change will differ, and this is because the substitution between male labor and capital differs from the substitution between female labor and capital.

To understand what happens to employment at the regional level, we need to consider the endowment of the industry specific factor, K_s, across regions. In our model, if region r is relatively well endowed with industry s specific factor, then that region allocates a

[12] See equations 22 and 23 in Appendix F for more details.

greater share of its labor to industry s. Similarly, an increase in the price of that industry s has a larger positive effect on employment in that region r compared to other regions. Therefore, the formalization of regional employment is greater in comparative advantage sectors that are larger, more intensive in formal labor (i.e. large $\lambda_{\varphi gs}$), and with a more elastic labor demand, meaning that they absorb a larger amount of labor from non-CA sectors.[13]

Prediction 1. *At the regional level, formal employment increases if CA sectors in that region are larger, more intensive in formal labor, and have more elastic labor demands than the comparative disadvantage sectors.*

We now use our model to make predictions about changes in female and male formal employment shares at the regional level. We use equations (3) and (4) to compute the differential change in formal employment :

$$\hat{L}_{\varphi m} - \hat{L}_{\varphi f} = \sum_s \lambda_{\varphi ms} \times \hat{L}_{ms}(p_s, \sigma^f_{fk,s}, \sigma^m_{fk,s}, \theta) - \sum_s \lambda_{\varphi fs} \times \hat{L}_{fs}(p_s, \sigma^m_{mk,s}, \sigma^f_{mk,s}, \theta) \quad (5)$$

where $\hat{L}_{ms}$ and $\hat{L}_{fs}$ are characterized by equations (22) and (23) in Appendix F. We will use equation (5) to analyze how a particular region's gender gap in formal employment is affected by changes in the price of goods.

First, we follow Galor and Weil (1996) and assume that male labor is relatively more substitutable for capital than female labor. In this case, after a price increase, male labor demand should increase more than female labor demand in CA sectors. Second, if CA sectors are more intensive in formal labor than non-CA sectors, then trade liberalization also increases the overall share of formal jobs. This happens because labor is reallocated from less to more formal intensive sectors.[14] Under these two conditions, trade liberalization

[13]Note that equations (3) and (4) can be expressed for all sectors s, and for a subset of sectors such as the tradable sectors only.

[14]Combining export data from CEPII with ENEU survey, we show that over the 1990s Mexican manufac-

generates more male than female formal jobs.

Prediction 2. *Within a region, trade liberalization increases the share of male formal employment by a larger amount relative to female labor demand if: a) in CA sectors, male labor is relatively more substitutable for capital than female labor, and b) CA sectors are larger and more intensive in formal labor than non-CA sectors.*

Although all regions face the same changes in international prices, each region has a different industry mix meaning that the effect of trade on the gender gap in formal employment differs across regions. The magnitude of the change in regional gender gap in formal employment depends on the size of the CA sectors and on the concentration of men and women across sectors in that region. More specifically, in a given region, if men are concentrated in relatively large CA sectors, then this region experiences a greater increase in men formal employment relative to women.

We now move to the empirical investigation and study the effects of trade liberalization on formal employment across gender in Mexico. We will use Predictions 1 and 2 to interpret our results.

5 Empirical Strategy

This section describes the measures of trade policy used to capture the relationship between trade liberalization and the probability of working as a formal employee at the sectoral and regional level.

turing sectors with large net export shares are on average more intensive in formal labor than manufacturing sectors with low net export shares. See Figure 4 in the online Appendix E.2.

5.1 Measures of Trade Liberalization

We take two different approaches to capture trade liberalization. The first approach uses ad-valorem Mexican import tariffs on U.S. products, τ_{st}, to study the effect of trade policy on gender sorting across formal and informal jobs within 4-digit manufacturing industries.[15] This tariff measure varies across manufacturing sectors and years.

The second approach consists in constructing a Mexican import tariff measure at the municipality level to capture potential labor reallocation across sectors, tradable and non-tradable, and highlight spillover effects of trade liberalization on non-tradable sectors. Following the literature on the local effects of trade, we use an employment-weighted average tariff of tradable industries active in each municipality. The original tariff is defined at the industry level and is the same across regions. Since we apply weights defined at the industry and municipality level, the regional tariff varies across municipalities and over time.

Following our theoretical model, we construct weights using formal employment in each industry and municipality. Additionally, our theoretical mechanism indicates that men and women in a given region might be exposed to trade liberalization in different ways because they work in different industries facing different tariff declines. Therefore, our measure also uses gender-specific employment weights. The local tariff varies across municipalities, years and gender. This weighted-average tariff is related to other measures used in the literature on local effects of trade with heterogeneous labor as in Autor et al. (2018) for men and women, and in Dix-Carneiro and Kovak (2015) for skilled and unskilled workers.

Finally, we follow Kovak (2013) and do not include non-tradable sectors in the weighted average. Therefore, our weights only consider formal employees in tradable industries in each municipality.[16] To avoid endogeneity issues due to changes in the industry mix over

[15] See Appendix A for a description of Mexican import tariffs.

[16] An alternative approach consists in assigning a zero tariff to non-tradable industries, as in Topalova (2010). This approach is preferable only if workers cannot freely move from tradable to non-tradable sectors. Using this alternative local tariff measure, which accounts for the share of people working in the non-tradable sectors, confirms our main findings. Results are available upon request.

time, our weights are based on the employment structure of each municipality, using the first year in which the municipality enters the survey.[17]

The gender-specific municipality tariff is then constructed as follows:

$$\tau_{grt} = \frac{\sum_s^M Form\ Empl_{grs,1993} \times \tau_{st}}{\sum_s^M Form\ Empl_{grs,1993}} \tag{6}$$

where g indicates gender $g = \{\text{female, male}\}$, r indicates the municipality, s the industry within the subset of manufacturing tradable industries, $s = 1, ..., M$, and t indicates time.

5.2 Regression Analysis

Industry-specific tariffs and within-industry formalization

We start by considering the importance of increased trade openness on male and female employment in formal and informal jobs within sectors. The following linear probability model (henceforth LPM) is estimated on the sample of formal and informal workers in manufacturing industries:

$$F_{isrt} = \alpha X_{isrt} + \beta_1 \tau_{st} + \beta_2 \tau_{st} \times female + \mu_s + u_r + v_t + \epsilon_{isrt} \tag{7}$$

where F_{isrt} is an indicator that takes the value one if individual i is employed as a formal worker in industry s, region r at time t, and zero if the individual works as an informal employee. X_{isrt} is a vector of specific individual and household characteristics which includes a female dummy, age, age square, number of years of education, migration background, whether the individual lives with a partner, is the head of the household, the number of household members, the highest level of education in the household, and the share of household members holding a formal job. τ_{st} is the Mexican import tariff at the 4-digit industry level, and $\tau_{st} \times female$ is the interaction term between the import tariff and the female

[17] We have also computed the municipality average tariff using alternative weights, such as the employment structures in 1992, using the subset of municipalities already surveyed in 1992. The results do not change.

indicator. μ_s, u_r, and v_t are a set of 4-digit sector, municipality, and year fixed-effects. To allow for different effects of trade liberalization on high versus low-skilled workers, we also interact the tariff variable with an indicator variable equals to one if the individual has more than nine years of education.

The coefficient β_2 captures the differential effect of trade liberalization on the probability of women holding a formal job compared to men. The sum between the coefficients β_1 and β_2 gives the average marginal effect of a change in the Mexican import tariff on the female probability of being a formal employee within a tradable sector. To account for firm heterogeneity, we use a similar specification as equation (7), and interact our tariff measure with firm size. More precisely, we compute four firm-size categories: 1) firms with 10 or fewer employees, 2) firms with 11 to 50 employees, 3) firms with 51 to 250 employees, and finally 4) firms with more than 250 employees. To limit the risk of potential threats to identification, we later perform a set of robustness checks. First, we consider other channels that might be responsible for changes in the formal and informal employment. Then, we tackle additional concerns regarding threat to internal validity using an instrumental variable approach.

Municipality-specific tariffs and formalization in local labor markets

To estimate the effect of trade liberalization on the formalization of jobs at the local level, we use gender-specific municipality tariff described in equation (6). This local tariff varies across gender, municipalities and years. We estimate the following equation:

$$F_{irt} = \alpha X_{irt} + \beta_1 \tau_{mrt} \times male_i + \beta_2 \tau_{frt} \times female_i + u_r + v_t + \epsilon_{irt} \tag{8}$$

where F_{irt} is an indicator that takes the value one if individual i is employed as a formal worker in region r at time t, and zero if the individual works as an informal employee. X_{isrt} is a vector of specific individual characteristics similar to the one used in the specification at the industry level defined by equation (7). τ_{mrt} and τ_{frt} are male and female exposure to the Mexican import tariff in municipality r at time t. We interact the gender-specific

municipality tariffs with the corresponding gender dummy. Therefore, β_1 and β_2 captures the effect of regional trade liberalization on men's and women's probability of holding a formal job respectively. We control for municipality fixed-effects u_r and year fixed-effects v_t. Since we want to identify the average trade liberalization effect within a municipality, and not the average effect within an industry and municipality, we do not control for industry fixed-effects.

We allow for different effects of trade liberalization depending on level of education by interacting the regional tariff variable with an indicator variable equals to one if the individual has more than nine years of education. Additionally, to disentangle the effects of local exposure to trade liberalization across tradable and non-tradable sectors, we interact the regional tariff variable with a 1-digit service sector dummy. Similarly to the industry level regressions, we later perform a set of robustness checks.

6 Empirical Results within Tradable Industries

We begin by examining the effect of sector specific tariffs on the probability of holding a formal job within 4-digit tradable sectors and explore the role of firm heterogeneity. The estimates of equation (7) are reported in Table 3.

The negative coefficient associated with sectoral tariffs τ_{st} indicates that trade liberalization leads to a formalization of jobs within 4-digit manufacturing industries. According to column (1), individuals working in an industry that experienced the average reduction in tariffs of 14 percentage points are 2 percentage points more likely to hold a formal job than individuals in an industry facing no reduction in tariffs. In column (2), the interaction between sectoral tariffs and the female dummy is insignificant. The impact of trade liberalization on formal employment within 4-digit sectors does not vary across gender. In columns (3) and (4) we consider the role of education and interact sectoral tariffs with workers' level of education. Column (3) shows that trade liberalization does not affect high and low skilled workers differently. Column (4) confirms a similar result for gender.

Table 3: Within-Industry Tariff Changes

Dependent variable	Probability of Working Formally among Employees in Manufacturing Sectors				
	(1)	(2)	(3)	(4)	(5)
τ_{st}	-0.140***	-0.142***	-0.135***	-0.130**	0.330***
	(0.052)	(0.051)	(0.051)	(0.052)	(0.083)
$\tau_{st}\times$ female		0.004	0.003	-0.011	
		(0.035)	(0.035)	(0.037)	
$\tau_{st}\times$ he			-0.016	-0.031	
			(0.017)	(0.020)	
$\tau_{st}\times$ he $\times$ female				0.044	
				(0.031)	
$\tau_{st}\times$ firm 11-50					-0.313***
					(0.079)
$\tau_{st}\times$ firm 51-250					-0.384***
					(0.084)
$\tau_{st}\times$ firm 251+					-0.448***
					(0.075)
firm 11-50					0.432***
					(0.008))
firm 51-250					0.597***
					(0.010)
firm 251+					0.618***
					(0.009)
Observations	674,206	674,206	674,206	674,206	672,173
R-squared	0.262	0.262	0.262	0.262	0.426
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality	Yes	Yes	Yes	Yes	Yes
4-digit sector FE	Yes	Yes	Yes	Yes	Yes

Notes: The regressions are LPM estimations of equation (7) for the period 1993-2001. Only manufacturing sectors. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment. *he* is a dummy variable equal to 1 when the individual has more than 9 years of education. Individual controls include age and age^2, years of education, a female dummy, whether she/he lives with a partner, is the head of the household, has migrated, the number of household members, the highest level of education in the household and the share of household members holding a formal job. Heteroskedasticity-robust standard errors clustered at the sector-year level are reported in parentheses. $***$, $**$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

Overall, both men and women, regardless of their level of education, have higher chances of being formal employees if they work in an industry that experiences a decline in tariff.

As discussed in Section 4.2, the increases in the probability of formal employment within tradable industries following trade liberalization may be due to a reallocation of employment towards trade-oriented firms. These firms, which are expanding to exploit larger exporting opportunities, tend also to be more intensive in formal jobs (see Nataraj (2011) and McCaig and Pavcnik (2014) among others). To further investigate the effect of trade liberalization on formal employment within tradable sectors, in the last column of Table 3 we consider the role of firm heterogeneity. Although we do not observe the specific firm in which workers are employed, we have information about the size of the company, measured by number of employees, where each individual works. Since trade-oriented firms are bigger than firms operating only in the domestic market, firm size captures part of the difference between exporting and domestic firms. Column (5) shows how firm size is related to formality and how the effect of trade policy differs across firms within each sector. We control for four classes of firm size: firms with 10 or fewer employees, firms with between 11 and 50 employees, firms with between 51 and 250 employees, and finally firms with more than 250 employees.[18] The estimated coefficients of the firm size dummies show that the probability of holding a formal job is higher in larger firms. This finding is in line with the literature on firms and informality, which shows that informal firms tend to be smaller (see La Porta and Shleifer (2014) and McCaig and Pavcnik (2015) among others). Considering the effect of a change in trade policy, we find that workers in smaller firms are less likely to hold a formal job with a drop in tariffs. Trade liberalization increases the probability of holding a formal job only for workers in medium and large firms (more than 50 employees), with the largest effect for firms with more than 250 employees. Finally, we find no gender differences in the effect of tariffs across firms.[19] Findings in column (5) suggest that trade-oriented firms are more likely to employ formal workers and drive

[18]The baseline category is 10 or fewer employees.
[19]Results available upon request.

the increase in the probability of being formally employed within sectors following trade liberalization.

6.1 Sensitivity Analysis

To evaluate the effect of trade liberalization on employment composition we use Mexican tariffs as our main measure of trade policy. However other changes might be both responsible for changes in formality rates and correlated with Mexican trade liberalization. For instance, changes in the composition of the labor force, sectoral gender composition, and others contemporaneous shocks such as inflows of foreign direct investment, exchange rate volatility, and changes in U.S. import tariffs. Therefore, Table 4 accounts for these potential omitted variables.

To address the issue of worker selection on unobservable characteristics, we have included in all regressions individual determinants of labor force participation and formal work status that are related to the household characteristics. In particular, we control for marital status (whether she/he lives with a partner), head of the household, migration background, the number of household members, the highest level of education in the household, and the share of household members holding a formal job. All these characteristics are interacted with the gender dummy to allow for different selection processes by gender.[20] To further control for changes in the composition of the labor force, all columns in Table 4 control for birth-year cohorts fixed-effects. This enables us to account for cohort-specific unobservable characteristics related to the labor market entry of new cohorts. To take into consideration the relationship between changes in tariffs and changes in the gender composition of sectors, columns (2) to (4) include the lag of the sector-specific share of female

[20]Living with a partner increases the probability of working formally for men but has no effect for women. Similarly, the head of the household is more likely to hold a formal job, especially among male heads of household. Both findings are consistent with a traditional division of roles within the household. Migration reduces the probability of holding a formal job, and even more so for women. The probability of having a formal job increases with the share of household members holding a formal job which corresponds to a social norm and/or network effect. This effect is stronger for men. Similar results are found for Brazil in Ben Yahmed (2018).

workers. This latter is constructed as the number of female workers in a given sector over the total number of workers in that sector.

To account for other contemporaneous shocks, in columns (3) and (4) we include inflows of foreign direct investment entering Mexico and exchange rate movements, respectively. Data on FDI inflows come from the OECD International direct investment database (Isic Rev. 3 classification). The quarterly real exchange rate between Mexico and the U.S. is obtained from the Central Bank of Mexico. Finally, since NAFTA is a multilateral agreement by which the United States reciprocally lowered import tariff to products from Mexico, column (5) includes U.S. import tariffs.[21] A decrease in the U.S. tariff increases the probability of being formally employed. This result can be related to the findings in Paz (2014) and McCaig and Pavcnik (2014), who show that reductions in trading partners' tariffs lead to a decrease in informality in Brazil and Vietnam respectively. Column (5) shows that the formalization effect related to the reduction in Mexican import tariff is unaltered, and its magnitude is slightly reduced by the introduction of U.S. tariffs. Overall, the results in Table 4 confirm our benchmark findings in Table 3. A decrease in tariffs contributes to the formalization of jobs within 4-digit industries for all individuals, irrespective of skill level or gender.

The online appendix provides additional robustness checks. In Table 11, we control for sector specific pre-trends in formality rates. More precisely, we control for sector-specific changes in formal labor share over the two preceding years, i.e., Δ formality$_{s,(t-1)-(t-3)}$. Note that pre-trends over a fixed period of time are controlled by the sector fixed-effects. The magnitude of the estimated coefficient is marginally decreased but our benchmark results are confirmed. The formalization effect seems unrelated to pre-existing trends in formality rates across industries facing different tariff declines.

Finally, we test the sensitivity of our results to alternative measures of formal employment. So far we have focused on wage employment and distinguished formal from informal employees using information on access to mandated benefits. We also use an al-

[21] U.S. import tariff data are from Feenstra et al. (2002).

Table 4: Within-Industry Tariff Changes and Additional Controls

Dependent variable	Probability of Working Formally among Employees in Manufacturing Sectors				
	(1)	(2)	(3)	(4)	(5)
τ_{st}	-0.147***	-0.148***	-0.150***	-0.150***	-0.127**
	(0.051)	(0.051)	(0.052)	(0.052)	(0.062)
τ_{st} ×female	0.009	0.007	0.007	0.007	0.006
	(0.036)	(0.036)	(0.036)	(0.036)	(0.053)
female share$_{s,t-1}$		0.025	0.023	0.023	0.058
		(0.027)	(0.028)	(0.028)	(0.036)
FDI$_{st}$			0.000*	0.000*	-0.000**
			(0.000)	(0.000)	(0.000)
RERMEXUSq				-0.000	-0.000
				(0.000)	(0.000)
$\tau_{US,st}$					-0.255**
					(0.112)
Observations	674,206	673,105	669,967	669,967	357,253
R-squared	0.265	0.265	0.265	0.265	0.299
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality	Yes	Yes	Yes	Yes	Yes
4-digit sector FE	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes

Notes: The regressions are LPM estimations of equation (7) for the period 1993-2001. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment. The real exchange rate is computed as $RER = e \times CPI(US)/CPI(Mex)$, where e is the nominal exchange rate in US dollars. U.S. tariff is the U.S. import tariff applied to Mexico. Individual controls include age, age^2, years of education, a female dummy, whether she/he lives with a partner, is the head of the household, has migrated, the number of household members, the highest level of education in the household and the share of household members holding a formal job. Standard errors are clustered at the sector-year level. $***, **$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

ternative definition of informality that includes self-employed workers who own small firms (see Henley et al., 2009).[22] Table 12 in the online appendix shows that the trade-induced formalization of employment within 4-digit industries remains significant when we include self-employment in the informality category. Columns (2) to (4) shows that now the formalization effect is stronger for women, especially low-skilled women. This can be explained by the lower propensity of women to enter self-employment compared to men.

[22]Notice that self-employed workers in the ENEU survey report very small businesses. In fact more than 80 percent of the self-employed have no employees.

6.2 Additional Threats to Identification

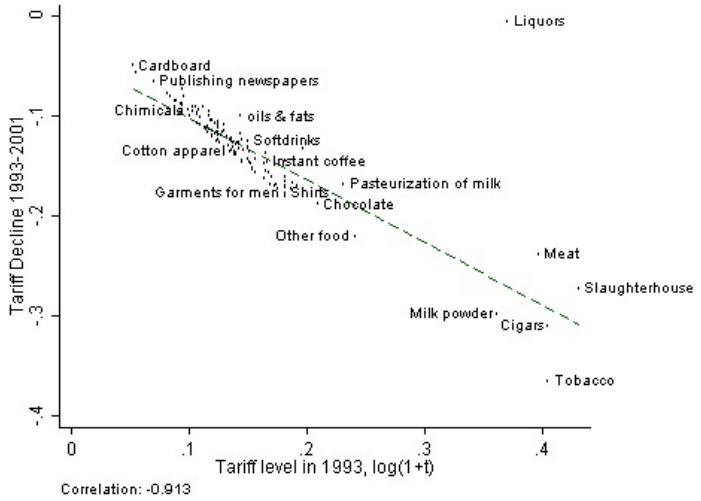
In this section we consider additional concerns regarding threats to internal validity coming from simultaneous causality or others omitted variable bias. Simultaneous causality may arise in different circumstances. Policy-makers may negotiate different tariff cuts on industries with high formal employment levels or industries with a higher concentration of more productive and formal firms may be able to lobby for smaller tariff cuts. Nevertheless, several observations indicate that it is unlikely that these concerns are significant in the case of trade liberalization in Mexico. Qualitative analysis of the political economy of liberalization in Mexico indicates the reduction in bilateral tariff barriers as the major economic goal of the government. To recover from difficult economic times throughout most of the 1980s, the government tried to stimulate economic growth through entering NAFTA. The reduction of almost all tariffs on U.S. products resulted in an average reduction of 14 percentage points, from more than 15 percent in 1993 to less than 1.5 percent in 2003.

To provide additional support for the exogeneity of tariffs, we produce a graphical analysis of the tariff cuts during the Mexico's liberalization. Figure 3 shows that industries with the highest pre-NAFTA tariff levels (in 1993) experience the biggest tariff declines between 1993 and 2001, with a correlation of -0,91.[23] This pattern is similar to the one reported for Columbia by Goldberg and Pavcnik (2005) and for Brazil by Kovak (2013). Following the argument in these papers, since the reduction in tariffs was almost entirely determined by pre-liberalization levels and given that we control for sector time-invariant characteristics, tariffs are unlikely to be endogenous in our specification.

Remaining concerns about endogeneity are addressed by using instrumental variables technique. To instrument for tariffs, we exploit the initial level of protection in 1993, which provides industry variation, and we interact it with the real exchange rate between Mexico and the U.S., which provides time variation. Therefore, our instrument varies across sectors and years and exploits sector-specific changes in competitiveness due to real exchange rate

[23] The only exception concerns the manufacture of liquors, for which tariff has remained high.

Figure 3: Tariff Changes and Pre-NAFTA Tariff Levels



Source: Authors' calculation based on tariff data from Iacovone and Javorcik (2010)

variations. The instrument is exogenous as, first, the peso devaluation in December 1994 is considered largely unexpected, meaning that firms could not adjust in advance to absorb this shock (see Verhoogen, 2008). Moreover, we also control for year fixed-effects so that the macroeconomic impacts of the peso devaluation and real exchange rate fluctuations are taken into account. Additionally, any relationship between pre-NAFTA tariff levels and unobserved sector characteristics are controlled by sector fixed-effects. IV estimates are reported in Table (5).

Column (1) replicates the results of our benchmark OLS regression, which shows the formalization effect of tariff cuts within 4-digit sectors. In column (2) we instrument tariffs with the initial sector tariff level in 1993 interacted with the nominal exchange rate . The coefficient is close to the OLS estimate. In column (3) and (4) we use the real exchange rate interacted with the initial sector tariff level as IV for tariffs. In column (4) we also instrument for the interaction term with the female dummy. The coefficient of tariff remains negative and significant, but its magnitude is bigger than the OLS estimates. When using the real exchange rate in the IV strategy, we find that a 14-percentage-point drop in tariffs

Table 5: Within-Industry Tariff Changes and IV Strategy

Dependent variable	Probability of Working Formally among Employees in Manufacturing sectors			
	(1)	(2)	(3)	(4)
	OLS	IV	IV	IV
IV		$\tau_{s,1993} \times$ ER	$\tau_{s,1993} \times$ RER	$\tau_{s,1993} \times$ RER
τ_{st}	-0.149***	-0.165**	-0.525***	-0.526***
	(0.054)	(0.075)	(0.188)	(0.183)
$\tau_{st} \times$ female				0.001
				(0.056)
Observations	674,222	674,222	674,222	674,222
R-squared	0.251	0.029	0.173	0.173
Year FE	Yes	Yes	Yes	Yes
Municipality	Yes	Yes	Yes	Yes
4-digit sector FE	Yes	Yes	Yes	Yes
IV F-stat		56.6	20.10	10.12

Notes: The regressions are LPM estimations of equation (7) for the period 1993-2001. Only manufacturing sectors. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment. Additional controls include age, age^2, years of education, a female dummy, whether she/he lives with a partner, is the head of the household, has migrated, the number of household members, the highest level of education in the household and the share of household members holding a formal job. Heteroskedasticity-robust standard errors clustered at sector-year level are reported in parentheses. $***$, $**$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

leads to an increase of 7 percentage points in the probability of working formally, instead of 2 percentage points according to the OLS estimate. Similarly to our benchmark results in Table 3, we find no significant gender differences.

7 Empirical Results for Local Labor Markets

We now adopt a local labor market approach and estimate the effect of changes in the gender-specific regional tariff on female and male formal employment. Since we do not control for disaggregated industry fixed-effects, this section accounts for between-sector labor movements within regions. Our benchmark estimation is equation (8), and results are reported in Table (6).

The literature on the regional effects of trade liberalization does not account for gender

differences, and uses a local tariff measure weighted by overall employment in each industry and region. To compare our results with previous findings, in column (1) we use a local tariff measure not interacted with a gender dummy. We obtain no significant effect of changes in local exposure to tariffs on the average probability of working formally. Columns (2) to (5) use gender-specific local tariffs, as described in Section 5.1, and interact them with gender dummies. Our results show a gender dimension of regional trade liberalization.

More specifically, in column (2), we allow for heterogeneous effects between men and women, and find that men's probability of working formally is significantly affected by changes in regional exposure to tariff barriers. Men living in a region experiencing a 14-percentage-point reduction in tariffs are almost 6 percentage points (14×0.416) more likely to hold a formal job compared to men in an unaffected region. However, women's probability of working formally is not significantly affected. In column (3), we control for the individual level of education and interact it with the gender-specific tariff measures. The increase in male formal employment is stronger for high-skilled men. Similarly, high-skilled women are also more likely to work formally in a municipality exposed to a reduction in tariffs.

Over the 1990s, the formality rate evolved differently in the tradable and non-tradable sectors (see Figure 2). Thus, in column (4), we exploit the regional variation in tariffs to establish different effects in the manufacturing and service sectors. In the manufacturing sector, the probability of working formally, both for men and women, increases in regions experiencing a reduction in their average tariff. This formalization of employment is greater for male workers, whose probability increases by 10 percentage points with a decline in local tariffs of 14 percentage points (14×0.727). For women, the probability of holding a formal employment increases by 8 percentage points (14×0.597). The gender difference is statistically different. Comparing Tables (6) and (3), we see that the formalization effect of trade across manufacturing sectors is larger than the formalization effect within 4-digit manufacturing sectors. This suggests that regional liberalization generates labor

reallocation across 4-digit manufacturing industries, which contributes to a formalization of employment in these industries, especially for men.

We now examine the effect of regional liberalization on formal employment in the service sectors. In column (4), for both men and women, the tariff coefficient is positive and significant. Nevertheless, for men, it is more than compensated by the negative coefficient associated with τ_{mrt}. Therefore, men's probability of holding a formal job increases with regional trade liberalization in the service sector as well, though less than in the manufacturing sector. In contrast, women employed in the service sectors experience a 3-percentage-point reduction in their probability of working formally following a 14-percentage-point decrease in local tariffs.

In column (5), we add the level of education, and find that the effect of regional tariffs differs across gender, sectors and levels of education. In the manufacturing sector, a 14-percentage-point decline in the municipality tariff leads to a 12-percentage-point increase in high-skilled men's probability of finding a formal job. The effect is smaller but still positive for high-skilled women, whose probability of holding a formal job increases by 10 percentage points.[24] In the service sector, the probability of holding a formal job *decreases* with trade liberalization for low-skilled women only. More specifically, the probability of working formally in the service sector falls by 5 percentage points for women with a low level of educational, while highly educated women are not significantly affected. Highly educated men working in the service sector experience a formalization of jobs, whereas low-skilled men do not. To summarize, we find that in the tradable sectors all workers are more likely to work formally when exposed to tariff reductions, and this formalization effect increases with workers' level of education. Similarly in the non-tradable sector, higher education reduces the odds of working informally following a decline in regional tariffs. This happens despite the exposure to regional trade liberalization increasing the probability of working informally for low-skilled women.

[24]The linear combination $\tau_{frt} \times fe + \tau_{frt} \times fe \times he$ is significant at the 5% level. The effect on high-skilled women is statistically different from the effect on high-skilled men at the 1% level.

Table 6: Municipality Exposure to Tariffs

Dependent variable	Probability of Working Formally among Employees in Manufacturing and Service sectors				
	(1)	(2)	(3)	(4)	(5)
τ_{rt}	-0.162				
	(0.214)				
τ_{mrt}		-0.416**	-0.372**	-0.727***	-0.662***
		(0.174)	(0.179)	(0.168)	(0.172)
τ_{mrt} × he			-0.119**		-0.229***
			(0.057)		(0.060)
τ_{mrt} × Serv				0.439***	0.403***
				(0.094)	(0.098)
τ_{mrt}× Serv× he					0.129*
					(0.072)
τ_{frt}		-0.026	0.037	-0.597***	-0.561***
		(0.151)	(0.152)	(0.157)	(0.160)
τ_{frt} × he			-0.168***		-0.160***
			(0.050)		(0.054)
τ_{frt} × Serv				0.803***	0.934***
				(0.091)	(0.095)
τ_{frt} × Serv × he					-0.236***
					(0.071)
Observations	2,648,682	2,648,682	2,648,682	2,648,682	2,648,682
R-squared	0.102	0.103	0.103	0.127	0.128
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes
4-digit sector FE	No	No	No	No	No

Notes: The regressions are LPM estimations of equation (8) for the period 1993-2001. The sample is composed of workers in both the tradable and non-tradable sectors. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment. The local tariff in columns (2) to (5) is calculated as in equation (6) using as a weight municipality and sectoral formal employment in 1993. The variable τ_{mrt} takes positive values for males, and it is equal to zero for females. Similarly the variable τ_{frt} takes positive values for females, and it is equal to zero for males. Individual controls include age and age^2, years of education, a female dummy, whether she/he lives with a partner, is the head of the household, has migrated, the number of household members, the highest level of education in the household and the share of household members holding a formal job. Columns (3) and (5) also include a high level of education dummy (*he*) for individuals with more than 9 years of education and its interaction with a female dummy. Columns (4) and (5) include a dummy for the service sectors and all necessary interactions with the female and high education dummies. Heteroskedasticity-robust standard errors clustered by municipality-year pairs are reported in parentheses. ***, **, and * indicate significance at the 1, 5 and 10 percent levels respectively.

Our results suggest that women and men have been affected differently by trade liberalization. In the manufacturing sector, the formalization of jobs occurred for both men and women, but with different magnitudes. Following our theoretical framework, we interpret the changes in formal employment as driven by reallocation of employment across sectors. The formalization of employment in the tradable sector corresponds to a situation in which comparative advantage sectors, which expand through trade, are intensive in formal labor compared to other tradable and non-tradable sectors. Figure 4 in the online appendix confirms this for Mexico. During the 1990s Mexican manufacturing sectors with large net export shares are on average more intensive in formal labor than manufacturing sectors with low net export shares. We can also use our model to interpret the finding that the likelihood of holding a formal job has experienced a greater increase for men than for women. In fact, Prediction 2 states that trade liberalization leads to a greater increase in the male formal employment share relative to female formal employment share in cases where male labor is relatively more substitutable for capital than female labor in the CA sectors.

7.1 Robustness Checks for Local Labor Markets

We now replicate the benchmark estimation for the local labor market approach controlling for potential confounding factors. Table 7 shows the results. To address the issue of worker selection on unobservable characteristics, we have included in all regressions individual determinants of labor force participation and formal work status that are related to the household characteristics. To eliminate any bias due to labor market entry of new cohorts during the 1990s, and changing characteristics of the labor force, we include in all columns 5-year birth-cohort dummies. We also control for lagged municipality characteristics, such as the female share and average level of education in the working population.[25] Therefore, our results should not reflect changes in the composition of the labor force in municipalities

[25]The female share in a municipality's working population is computed as the number of female workers divided by the total number of workers in that municipality.

facing different tariff exposure.

Columns (3) to (5) in Table 7, control for other macroeconomic contemporary shocks. We add the inflow of FDI at the municipality level, which is computed as the employment weighted average of FDI inflows across industries in each municipality. Additionaly, we also control for any macroeconomic impact of peso fluctuations using the quarterly real exchange rate.

To account for the nature of the trade reform, i.e., import liberalization versus export market liberalization, we add gender-specific local exposure to U.S. import tariffs in columns (2) to (5). The reduction in U.S. tariffs increases the probability of holding a formal job for women and only in column (2). The inclusion of this variable does not alter the magnitude or significance of the Mexican tariff. The exposure to Mexican tariff reductions does not capture the effect of exposure to concomitant reductions in U.S. tariffs.

To better explore the role of a trade partner's tariffs reduction on formal employment, we replicate the analysis focusing exclusively on U.S. local exposure. The results are in Table 13 in Appendix C. We find that reductions in U.S. tariffs have similar effects to reductions in Mexican import tariff, increasing formal employment probability for men overall. High-skilled women are more likely to work formally if they live in a region exposed to a significant reduction in U.S. tariffs. However, low-skilled women are less likely to work formally. Reductions in U.S. tariffs increase the probability of working formally in the manufacturing sectors for both men and women, but reduce the probability to work formally for women in the service sectors.

To address the issue of pre-existing trends we control for municipalies' trends in formality rates in the previous two years using a time-rolling window. Results are shown in Table 14 in Appendix C and confirm that the results are not merely driven by differences in pre-existing trends across regions facing different tariff declines.

In another sensitivity check, we account for a broader definition of employment, and include self-employed individuals in the informal employment category. Table 15 reports

Table 7: Municipality Exposure to Tariffs and Additional Controls

Dependent variable	Probability of Working Formally among Employees in Manufacturing and Service sectors				
	(1)	(2)	(3)	(4)	(5)
τ_{mrt}	-0.439***	-0.434**	-0.425**	-0.783***	-0.745***
	(0.169)	(0.168)	(0.169)	(0.173)	(0.176)
τ_{mrt} × he					-0.149**
					(0.060)
τ_{mrt}× Serv				0.471***	0.431***
				(0.102)	(0.105)
τ_{mrt} ×Serv×he					0.130*
					(0.076)
τ_{frt}	-0.078	-0.033	-0.035	-0.768***	-0.726***
	(0.146)	(0.147)	(0.147)	(0.162)	(0.164)
τ_{frt} ×he					-0.169***
					(0.054)
τ_{frt} ×Serv				0.939***	1.057***
				(0.098)	(0.101)
τ_{frt} ×Serv×he					-0.211***
					(0.075)
$\tau_{US,mrt}$		-0.123	-0.044	-0.075	-0.083
		(0.203)	(0.235)	(0.231)	(0.229)
$\tau_{US,frt}$		-0.427*	-0.303	-0.051	-0.060
		(0.248)	(0.268)	(0.258)	(0.256)
FDI $_{r,t}$			0.000***	0.000*	0.000*
			(0.000)	(0.000)	(0.000)
RER$_{q,MEX-US}$			0.001***	0.001***	0.000***
			(0.000)	(0.000)	(0.000)
Educ working pop $_{r,t-1}$	0.003	0.003	0.005	0.005	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Female share $_{r,t-1}$	-0.509***	-0.539***	-0.476***	-0.344***	-0.357***
	(0.082)	(0.088)	(0.091)	(0.090)	(0.090)
Female share $_{r,t-1}$× fe	0.250***	0.261***	0.203***	0.143**	0.156**
	(0.064)	(0.067)	(0.075)	(0.064)	(0.064)
Observations	2,647,786	2,615,443	2,313,412	2,313,412	2,313,412
R-squared	0.114	0.112	0.113	0.139	0.140
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality	Yes	Yes	Yes	Yes	Yes
4-digit sector FE	No	No	No	No	No
Birth-cohort FE	Yes	Yes	Yes	Yes	Yes

Notes: The regressions are LPM estimations of equation (8) for the period 1993-2001. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment. The local tariff is calculated as in equation (6) using as a weight municipality and sectoral employment in 1993. The variable τ_{mrt} takes positive values for males, and it is equal to zero for females. Similarly the variable τ_{frt} takes positive values for females, and it is equal to zero for males. $\tau_{US,mrt}$ and $\tau_{US,frt}$ are gender specific U.S. import tariffs. The sample is composed of workers in both tradable and non-tradable sectors. Individual controls include age, age^2, years of education, a female dummy, whether she/he lives with a partner, is the head of the household, has migrated, the number of household members, the highest level of education in the household and the share of household members holding a formal job. Heteroskedasticity-robust standard errors clustered by municipality-year pairs are reported in parentheses. $***$,$**$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

the results and confirms our benchmark findings for the effect of trade liberalization on regional labor markets. Similarly to the benchmark results in Table 6, we find that, in the manufacturing sector, the probability of being in formal employment increases, while in the service sectors informal employment increases for low-skilled women.

Our results on the effect of regional trade liberalization contrasts with those of others studies on the effect of trade on informality. More specifically, Dix-Carneiro and Kovak (2017a) find that Brazilian micro-regions more exposed to tariff reductions, experienced an increase in informality even 20 years after the trade reform. Our different results may be driven by the specific sample used, country setting and methodology. More precisely, our focus on gender differences seems relevant because men and women might be affected differently by trade policy. In fact, in those municipalities exposed to large tariff reductions we find an increase in formality only for men. This result is different from what we find when pooling men and women together, column (1) in Table 6, where the effect of the trade reform on informality is insignificant.

Additionally, our data only cover urban areas. Because of occupation and industry composition, these areas might be affected differently than rural areas. It is important to notice that, over our sample period, Mexican urban areas are characterized by a large and increasing share of employment in manufacturing sectors. These sectors have been directly and positively affected by the NAFTA multilateral agreement. In this respect, our results are consistent with the findings in Atkin (2016), who documents a formal employment boom in Mexican export-oriented manufacturing industries: between 1989 and 1999, 65% of the growth in formal employment in manufacturing industries stem from export-oriented industries. Moreover, he shows that many of those new jobs were low-skilled jobs, which may have facilitated the move from informal to formal jobs for informal workers with low skills. It is also worth noting that our findings are in line with some of the findings in Menezes-Filho and Muendler (2011). In Table 9 they show that lower intermediate-input

tariffs are associated with significantly lower odds of transitioning into unemployment and out of the labor force, resulting in a significantly higher number of transitions into formality. However, reductions in product-market tariffs have the opposite effect. In the case of Mexico, export-oriented sectors benefited from the drop in Mexican tariffs as intermediate inputs became cheaper. Indeed, Mexican exports to the U.S. use a very high share of U.S. inputs (de Gortari, 2017). Differences in global supply-chains may be partially responsible for differing effects of import tariff reductions on formal employment across countries.

Finally, unlike Dix-Carneiro and Kovak (2017a) who exploit decennial changes, we use annual time series variation in tariffs. Therefore our estimates capture the short-run effects of trade policy. To compare our findings to longer-term studies such as Dix-Carneiro and Kovak (2017a), we also adopt a long difference identification strategy. We use data for 1993 and 2000 to evaluate the effect of local exposure to tariff reduction on formal employment probability. Our strategy is described in Appendix D, and results are presented in Table 16. Although the signs of the coefficients are similar to our benchmark results in Table 6, the long difference strategy shows no significant effect of trade liberalization on formal employment probability. Our need to control for past trends, which are created using municipality information during the 1980s, introduces a limitation. In fact, this information is available only for a small subset of municipalities. This might explain the lack of precision in the estimates.

7.2 Employment Margins

Our theoretical framework stresses labor reallocation across sectors as a mechanism through which trade affects formal relative to informal employment. An alternative mechanism is related to shifts between employment and non-employment (Menezes-Filho and Muendler, 2011; Gaddis and Pieters, 2017). We then explore additional employment margins to evaluate the impact of trade liberalization on formality across gender, and use an alternative sample composed of the whole working-age population. In addition to individuals in formal

and informal paid employment, our new sample also includes individuals who are not in paid employment, either because they are unemployed or out of the labor force. Table 17 in the online Appendix presents the results. In column (1), the dependent variable takes the value 1 if the individual is in paid employment (either in formal or informal employment), and the value 0 if the individual is not in paid employment (either unemployed or out of the labor force). Column (1) shows that trade liberalization contributes to a small increase in female paid employment probability, but did not lead to a significant change in male paid employment probability. These findings differ from those in Gaddis and Pieters (2017) for Brazil, where the exposure to trade liberalization has instead reduced labor force participation for both men and women.

We then consider shifts from formal employment into informal employment and non-employment. Specifically, columns (2) to (5) use as a dependent variable a categorical variable equal to 1 if the individual holds a formal job, and to 0 if she/he is either an informal worker, unemployed or out of the labor force. Column (2) shows that both women and men are more likely to be formally employed with stronger exposure to trade liberalization. This differs from our benchmark results, in column (2) of Table 6, where the effect of local tariffs is insignificant for women. Therefore, we conclude that exposure to tariff reduction has contributed to the movement of women from non-employment into formal employment. Using Brazilian household panel data, Menezes-Filho and Muendler (2011) find that a reduction in intermediate inputs tariffs decreases the probability of transitions from formal employment into unemployment and non-participation. In other words, it increases the probability of remaining in or moving to formal employment. Meanwhile, they find the opposite effect for reductions in product market tariffs. Similarly to their findings for intermediate input tariffs, we find that the likelihood of formal employment relative to other employment statuses has increased with Mexican tariff reductions.

Comparing tradable and non-tradable sectors, column (4) shows that accounting for the employment margin confirms the formalization effect of trade liberalization in the manu-

facturing sector, and the informalization of female jobs in the service sector. Similarly to the benchmark results, column (5) shows that the decrease in women's formal employment probability in the service sectors is driven by low-skilled women.

8 Conclusions

In this paper we theoretically and empirically analyze the link between trade liberalization and formal employment, allowing for gender differences. We estimate how changes in trade policy affects men's and women's probability of holding a formal job both at the industry and municipality level using Mexican individual data and tariff information at the 4-digit industry category. We find that a fall in the Mexican tariff generates a formalization of employment within 4-digit manufacturing sectors for both men and women, especially for those employed in large firms. We interpret the within-industry findings as evidence of labor reallocation towards trade-oriented firms with higher formal job shares.

Constructing a weighted average of tariffs at the municipality level, we show that the local effects of changes in trade policy vary across gender and sectors. We find that, in the manufacturing sector, trade liberalization increased the probability of working formally for both women and men, and especially for men. Consistent with our theoretical predictions, the results at the local level can be explained by the reallocation of employment into comparative advantage sectors, which are relatively more intensive in formal jobs, and where male labor is relatively more substitutable for capital than female labor. Regional trade liberalization contributes to the formalization of jobs in tradable sectors, but not necessarily in the non-tradable sectors. We find that, in the service sectors, women, especially those with a low educational level, experience an increase in informality. The increase in informality among female employees in the service sector may raise challenges for gender equality.

Our main contribution is to extend previous studies on globalisation and gender by analyzing the effect of trade liberalization on gender differences in access to formal jobs.

The paper remains silent about the potential impact of trade liberalization on male and female wages in formal and informal jobs. Exploring this channel may further improve our understanding of gender inequality in the labor market, and additional research is needed in this direction.

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Online Appendix

Gender, Informal Employment and Trade liberalization in Mexico

Appendix A provides data information and additional descriptive statistics. Appendices B and C provide robustness checks for the empirical analysis at the industry and local labor market levels. Appendix F provides the derivations of the model.

A Data Appendix

Mexican import ad-valorem tariffs on U.S. products at the 4-digit level follow CAE classification. Tariff data were originally available at the 8-digit Harmonized System (HS), and are matched to the Mexican CMAP classification as explained in Iacovone and Javorcik (2010) and Iacovone et al. (2015). We use a correspondence table to link tariff classification at the CMAP to ENEU industry-employment classification at the CAE level.[26] Since CMAP classification is more disaggregated than the CAE classification, we average Mexican import tariffs at the 4-digit of the CAE classification.

We exploit the ENEU survey to gather information on formal and informal employees, as well as self-employed individuals in urban areas over the period 1993-2001. We drop agricultural and mining sectors due to the very limited number of observations. Thus, the non-manufacturing sectors essentially include the services sectors. Table 8 provides summary statistics on the number of municipalities and 4-digit industries in our sample, as well as on the number of observations. Between 1993 and 2001, 216 different municipalities have been surveyed, although not continuously. In a given year, we have data on 180 municipalities on average. This results in about 6,000 observations per municipality and year on average.

[26] We thank Beata Javorcik for providing us with the Mexican tariff data and Eric Verhoogen for the correspondence table between CMAP and CAE.

Table 8: Summary Statistics on the data set

Variable	Number per year			Observations per year			Observations
	mean	max	min	mean	max	min	1993-2001
Municipality	180	202	131	5,938	13,552	1	3,172,253
Industry (4-digit)	257	259	254	15,696	50,037	1	3,172,253
... with import tariff	114	126	90	3,357	13,766	1	738,638

Notes: Calculation based on the ENEU data for the period 1993-2001. Column 1 displays the mean, minimum and maximum number of municipality/industry per year. Column 2 displays the mean, minimum and maximum number of observations per municipality/industry and year. Column 3 displays the overall number of observations per municipality/industry over the whole period. The sample is composed of formal and informal employees, and self-employed between 16 and 60 years old. Industries with information on Mexican import tariff applied on U.S. goods are manufacturing industries.

Table 9 provides statistics on the change in municipality tariffs over the 1990s for different measures of local tariff. The evolution of municipality exposure to Mexican tariffs is given in the first four columns. Column (1) describes the standard local tariff measure that weights sector tariff with municipality×sector employment. The second column gives a local tariff measure that accounts for the size of the formal sector. In fact, the sectoral tariff is weighted by municipality×sector *formal* employment. Both local tariff measures have decreased on average by 14 percentage points and they have similar distributions. The third column gives the women's exposure to tariff change as the sector tariff is weighted by female formal employment while the fourth columns gives the male exposure to tariff change. On average, women have been exposed to slightly bigger tariff drops (15.1 percentage points) compared to men (13.8 percentage points). This reflects the different distribution of men and women across tradable industries. Women were working in industries that experienced stronger tariff reductions between 1993 and 2001. The last two columns show the female and male exposure to reductions in the US tariffs and the pattern is very similar.

Table 10 provides descriptive statistics on the sample of men and women working as formal employees, informal employees or self-employed. Focusing on 1993, we observe that employees are on average younger than self-employed individuals, especially among women. Formal employees have higher levels of education than informal employees and the

Table 9: Municipality Exposure to Tariff Change 1993-2001

	Mexican tariff (import tariff)			US tariff (export tariff)		
	$\Delta\tau_{rt}$	$\Delta\tau_{frt}$	$\Delta\tau_{mrt}$	$\Delta\tau_{US,rt}$	$\Delta\tau_{US,frt}$	$\Delta\tau_{US,mrt}$
	(1)	(2)	(3)	(4)	(5)	(6)
Mean	-.143	-.151	-.138	-.016	-.015	-.016
p25	-.152	-.17	-.145	-.019	-.02	-.021
p50	-.142	-.1465	-.137	-.008	-.008	-.008
p75	-.13	-.1335	-.128	-.004	-.002	-.004

Notes: The sample is composed of 119 municipalities surveyed both in 1993 and 2001. Column (1) uses the standard local tariff measure that weights sector tariff with municipality×sector employment. Local tariffs in columns (2) and (3) give changes in female and male exposure to Mexican tariffs as constructed as in equation (6). Column (4) provides changes in exposure to US tariffs using overall employment weights. Columns (5) and (6) give changes in female and male exposure to US tariffs using gender-specific formal employment weights similarly to equation (6).

self-employed. Female formal employees are slightly more educated than their male counterparts, however we observe the reverse among informal employees and especially among self-employed. Self-employed women have on average more children and work fewer hours than female employees, which might indicate that self-employment is a way for women to combine work and family responsibilities. Informal employees receive on average the lowest hourly wages. The employment category with the highest average hourly earnings is self-employment for men and formal wage employment for women. Finally, formal wage workers are employed in bigger firms compared to informal wage workers.

Table 10: Descriptive Statistics on the Sample of Working Individuals

	Formal		Informal		Self-employed	
	Men	Women	Men	Women	Men	Women
Age	33.25	31.14	29.48	28.38	37.75	38.12
Years of schooling	10.04	9.67	9.01	9.39	8.73	7.38
Primary education or less	0.28	0.26	0.35	0.29	0.44	0.55
Secondary education	0.43	0.47	0.44	0.46	0.33	0.26
Tertiary education	0.29	0.27	0.21	0.25	0.23	0.19
Live in couple	0.70	0.41	0.53	0.31	0.76	0.56
Number of children	.	1.38	.	1.23	.	3.19
Has migrated	0.01	0.00	0.01	0.00	0.00	0.00
Head of the household	0.67	0.15	0.48	0.13	0.75	0.25
Household size	2.29	2.63	2.54	2.79	2.24	2.49
Share of formal employees	0.36	0.52	0.25	0.37	0.23	0.31
Max education level in household	11.55	12.24	10.79	11.98	10.64	10.53
Work less than 35 hours a week	0.08	0.21	0.13	0.25	0.23	0.53
...between 35 and 48 hours a week	0.66	0.65	0.53	0.55	0.41	0.21
...more than 48 hours a week	0.22	0.07	0.29	0.15	0.24	0.08
Log hourly earnings	3.82	3.86	3.54	3.58	3.89	3.67
Work in a firm with less than 10 empl.	0.10	0.08	0.55	0.39	1	1
...with 11 to 50 employees	0.15	0.12	0.12	0.15	0	0
...51 to 250 employees	0.13	0.09	0.05	0.05	0	0
...more than 250 people	0.62	0.71	0.28	0.40	0	0
N	107,091	63,296	43,791	15,873	30,663	11,217

Notes: Calculation based on the ENEU data for 1993.

B Robustness Checks Within Tradable Industries

Table 11: Within-industry Tariffs and Additional Controls

Controls	Benchmark		Past formality trend		Past formality trend & US tariffs		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
τ_{st}	-0.154***	-0.144***	-0.132***	-0.121**	-0.128**	-0.117*	-0.117*
	(0.052)	(0.052)	(0.049)	(0.049)	(0.059)	(0.060)	(0.060)
τ_{st} × female	0.036	0.039	0.038	0.041	0.042	0.055	0.055
	(0.034)	(0.036)	(0.034)	(0.036)	(0.051)	(0.055)	(0.055)
τ_{st}× he		-0.027		-0.028*		-0.027	-0.027
		(0.017)		(0.017)		(0.023)	(0.023)
τ_{st}× he × female		-0.017		-0.016		-0.045	-0.045
		(0.025)		(0.025)		(0.038)	(0.038)
Δ formality$_{s,(t-1)-(t-3)}$			0.122***	0.122***	0.122***	0.122***	0.122***
			(0.022)	(0.022)	(0.032)	(0.032)	(0.032)
$\tau_{US,st}$					-0.265**	-0.265**	-0.265**
					(0.107)	(0.107)	(0.107)
Observations	674,206	674,206	674,206	674,206	360,928	360,928	360,928
R-squared	0.259	0.259	0.259	0.259	0.292	0.292	0.292
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4-digit sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The regressions are LPM estimations of equation (7) for the period 1993-2001.The sample includes manufacturing sectors only in municipalities already surveyd in 1990 to control for past trends in formality rates. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment. *he* is a dummy variable equal to 1 when the individual has more than 9 years of education. Individual controls include age and age^2, years of education, a female dummy, whether she/he lives with a partner, is the head of the household, has migrated, the number of household members, the highest level of education in the household and the share of household members holding a formal job. Δ formality$_{s,(t-1)-(t-3)}$ is the change in formal labor share in sector s over the two preceding years. Heteroskedasticity-robust standard errors clustered at the sector-year level are reported in parentheses. $***, **$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

Table 12: Within-Industry Tariff Changes and Self-Employment

Dependent variable	Probability of Working Formally among Employees in Manufacturing Sectors			
	(1)	(2)	(3)	(4)
τ_{st}	-0.463***	-0.375***	-0.390***	-0.374***
	(0.113)	(0.092)	(0.093)	(0.092)
τ_{st} × female		-0.188**	-0.184**	-0.226***
		(0.080)	(0.080)	(0.081)
τ_{st} × he			0.043**	0.000
			(0.020)	(0.022)
τ_{st} × he × female				0.134***
				(0.033)
Observations	738,622	738,622	738,622	738,622
R-squared	0.362	0.362	0.362	0.363
Year FE	Yes	Yes	Yes	Yes
Municipality	Yes	Yes	Yes	Yes
4-digit sector FE	Yes	Yes	Yes	Yes

Notes: The regressions are LPM estimations of equation (7) for the period 1993-2001. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment or in self-employment. Individual controls include age, age^2, years of education, a female dummy, whether she/he lives with a partner, is the head of the household, has migrated, the number of household members, the highest level of education in the household and the share of household members holding a formal job. Columns (1) to (4) provides estimates of the effect of changes in 4-digit sector tariff lines on the probability of holding a formal job within 4-digit manufacturing sectors. Columns (3) and (4) include a dummy for higher level of education (*he*) for those individuals with more than 9 years of education, and its interaction with the female dummy respectively. Standard errors are clustered at the sector-year level. $***, **$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

C Robustness Checks for Local Labor Markets

Table 13: Municipality Exposure to U.S. Import Tariffs

Dependent variable	Probability of Working Formally Employees in Manufacturing and Service sectors			
	(1)	(2)	(3)	(4)
$\tau_{US,mrt}$	-0.626***	-0.447*	-1.217***	-1.145***
	(0.212)	(0.247)	(0.311)	(0.324)
$\tau_{US,mrt}$ × he		-0.517**		-0.274
		(0.262)		(0.232)
$\tau_{US,mrt}$ × Serv			0.766*	0.835*
			(0.406)	(0.442)
$\tau_{US,mrt}$ × Serv × he				-0.084
				(0.338)
$\tau_{US,frt}$	0.130	0.481*	-1.575***	-1.534***
	(0.249)	(0.276)	(0.392)	(0.413)
$\tau_{US,frt}$ × he		-0.566***		-0.159
		(0.211)		(0.238)
$\tau_{US,frt}$ × Serv			2.569***	3.103***
			(0.470)	(0.521)
$\tau_{US,frt}$ × Serv × he				-1.193***
				(0.341)
Educ working $pop_{r,t-1}$	0.004	0.004	0.003	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
Female $share_{r,t-1}$	-0.518***	-0.533***	-0.422***	-0.435***
	(0.086)	(0.085)	(0.085)	(0.085)
Female $share_{r,t-1}$× fe	0.238***	0.304***	0.188***	0.201***
	(0.066)	(0.066)	(0.060)	(0.060)
Observations	2,618,322	2,618,322	2,618,322	2,618,322
R-squared	0.112	0.101	0.136	0.137
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
Birth-cohort FE	Yes	Yes	Yes	Yes

Notes: The regressions are LPM estimations of equation (8) for the period 1993-2001. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment. Individual controls are the same as in Table (6). Columns (2) and (4) also include a high level of education dummy (he) for individuals with more than 9 years of education, and its interaction with the female dummy. Columns (3) and (4) also include a service sector dummy and its interaction with the female dummy. Standard errors are clustered at the municipality-year level. $***, **$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

Table 14: Municipality Exposure to Tariffs and Additional Controls

Controls	Benchmark		Past formality trend		Past formality trend & US tariffs		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
τ_{mrt}	-0.220	-0.484***	-0.137	-0.402***	-0.129	-0.377***	-0.271*
	(0.144)	(0.143)	(0.129)	(0.132)	(0.132)	(0.135)	(0.142)
τ_{mrt} ×he							-0.340***
							(0.074)
τ_{mrt} × Serv		0.353***		0.353***		0.341***	0.405***
		(0.116)		(0.116)		(0.118)	(0.130)
τ_{mrt} ×Serv×he							-0.093
							(0.086)
τ_{frt}	0.055	-0.387***	0.125	-0.312**	0.138	-0.320**	-0.268*
	(0.128)	(0.142)	(0.112)	(0.132)	(0.117)	(0.136)	(0.139)
τ_{frt} ×he							-0.206***
							(0.066)
τ_{frt} ×Serv		0.659***		0.649***		0.650***	0.851***
		(0.112)		(0.112)		(0.113)	(0.119)
τ_{frt} ×Serv×he							-0.386***
							(0.089)
Δ formality$_{r,(t-1)-(t-3)}$			0.213***	0.204***	0.225***	0.216***	0.214***
			(0.026)	(0.026)	(0.028)	(0.027)	(0.027)
$\tau_{US,mrt}$×ma					-0.156	-0.243	-0.257
					(0.229)	(0.225)	(0.220)
$\tau_{US,frt}$×fe					-0.178	-0.061	-0.086
					(0.272)	(0.257)	(0.255)
Observations	2,224,035	2,224,035	2,224,035	2,224,035	2,202,066	2,202,066	2,202,066
R-squared	0.103	0.129	0.103	0.129	0.101	0.127	0.129
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The regressions are LPM estimations of equation (8) for the period 1993-2001. Smaller sample of muncipalities with information on formality rates in $t-3$: 63 municipalities in 1993, 143 municipalities in 2001. Individual controls are the same as in Table (6). Standard errors are clustered at the municipality-year level. $***, **$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

Table 15: Municipality Exposure to Tariffs and Self-Employment

Dependent variable	Probability of Working Formally			
	Employees and Self-employed in Manufacturing and Service sectors			
	(1)	(2)	(3)	(4)
τ_{mrt}	-0.223	-0.152	-0.749***	-0.699***
	(0.164)	(0.168)	(0.156)	(0.160)
τ_{mrt}×he		-0.194***		-0.188***
		(0.065)		(0.062)
τ_mrt×Serv			0.800***	0.820***
			(0.115)	(0.120)
τ_{mrt}×Serv×he				-0.013
				(0.076)
τ_{frt}	-0.107	-0.064	-1.188***	-1.170***
	(0.145)	(0.147)	(0.183)	(0.188)
τ_{frt}×he		-0.120*		-0.079
		(0.066)		(0.077)
τ_{frt}×Serv			1.439***	1.579***
			(0.148)	(0.153)
τ_{frt}×Serv×he				-0.309***
				(0.091)
Education working $pop_{r,t-1}$	-0.001	-0.001	-0.000	-0.000
	(0.003)	(0.003)	(0.002)	(0.003)
Female share $_{r,t-1}$	-0.371***	-0.389***	-0.144*	-0.164**
	(0.080)	(0.080)	(0.077)	(0.077)
Female share $_{r,t-1}$× fe	-0.042	-0.017	-0.299***	-0.277***
	(0.089)	(0.089)	(0.090)	(0.090)
Observations	3,126,066	3,126,066	3,126,066	3,126,066
R-squared	0.080	0.081	0.112	0.114
Year FE	Yes	Yes	Yes	Yes
Municipality	Yes	Yes	Yes	Yes
Birth-cohort FE	Yes	Yes	Yes	Yes

Notes: The regressions are LPM estimations of equation (8) for the period 1993-2001. The dependent variable equals 1 if the individual is in formal wage employment and 0 if in informal wage employment or in self-employment. The local tariff is calculated as in equation (6) using as a weight municipality and sectoral formal employment in 1993. The variable τ_{mrt} takes positive values for males, and it is equal to zero for females. Similarly the variable τ_{frt} takes positive values for females, and it is equal to zero for males. Individual controls are the same as in Table (6). Columns (2) and (4) also include a high level of education dummy (he) for individuals with more than 9 years of education, and its interaction with the female dummy. Columns (3) and (4) also include a service sector dummy and its interaction with the female dummy Standard errors are clustered at the municipality-year level. $***, **$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

D Long-run Estimates of Local Exposure to Tariffs

To analyze the long-term effect of local exposure to tariff changes, we follow Dix-Carneiro and Kovak (2017a) estimate a specification of the following form:

$$\Delta PF_{gr,2000-1993} = \theta \Delta \tau_{gr,2000-1993} + \Delta X_{r,2000-1993} + \alpha_{s,2000} + \Delta PF_{gr,1993-1986} + \epsilon_{r,t} \quad (9)$$

the dependent variable, $\Delta PF_{gr,2000-1993}$, is the change in the probability of formal employment in region r between 1993 and 2000 for group g. Group g is either all individuals pooled together, or $g = \{female, male\}$ when we distinguish by gender. $\Delta \tau_{gr,2000-1993}$ is the change in the local tariff and $\Delta X_{r,2000-1993}$ is the change in municipality characteristics between 1993 and 2000. We control for the education level of the working population and the female share. $\alpha_{s,2000}$ are state fixed-effects and $\Delta PF_{gr,1993-1986}$ is a pre-NAFTA trend in the outcome.

The probability of formal employment for each year and municipality PF_{grt} is calculated in a first-step following a similar approach than Goldberg and Pavcnik (2003):

$$Formal_{irt} = X_{irt} + M_{grt} + \epsilon_{irt}.$$

The dependent variable is an indicator variable equal to one if individual i in municipality r is formally employed at time t. X_{irt} is a set of individual controls including a female dummy, age, age squared, years of education, whether she/he lives with a partner, is the head of the household, has migrated, the number of household members, the highest level of education in the household and the share of household members holding a formal job. The municipality fixed-effects M_{grt} are estimated for each year and gender group separetely. They capture the probability of being in formal employment, cancelling out the effect of individual characteristics. In that way, we control for changes in the composition of the working population. We then use the adjusted municipality probability of formal employment to compute the dependent variable and the pre-trend in equation (9). The results

based on 63 municipalities for which we have data during the mid-1980s are presented in Table 16.

Table 16: Municipality Exposure to Tariffs between 1993 and 2000

Dependent variable	Adjusted Probability of Formal Employment		
	(1)	(2)	(3)
	No gender	Gender	Gender & sector
$\Delta\tau_{r,2000-1993}$	0.626		
	(0.651)		
$\Delta\tau_{mr,2000-1993}$		-0.276	
		(0.506))	
$\Delta\tau_{fr,2000-1993}$		0.727	
		(0.516)	
$\Delta\tau_{mr,2000-1993}\times$Manuf			-0.665
			(1.236)
$\Delta\tau_{mr,2000-1993}\times$Serv			-0.549
			(0.395)
$\Delta\tau_{fr,2000-1993}\times$Manuf			-0.920
			(0.554)
$\Delta\tau_{fr,2000-1993}\times$Serv			0.682
			(0.647)
$\Delta PF_{gr,1993-1986}$	-0.485**	-0.301***	-0.413***
	(0.181)	(0.099)	(0.112)
Educ working pop $_{r,t-1}$	0.021	0.026*	0.037***
	(0.015)	(0.013)	(0.011)
Female share $_{r,t-1}$	-0.276	-0.758*	-0.682
	(0.579)	(0.414)	(0.460)
Female share $_{r,t-1}\times$ fe		0.333**	0.343*
		(0.129)	(0.175)
Observations	63	122	242
R-squared	0.641	0.458	0.386
State-Year FE	Yes	Yes	Yes

Notes: The regressions are estimations of equation (9) for the period 1993-2000. The dependent variable is the change in the adjusted probability of formal employment at the municipality level $\Delta PF_{gr,t}$. In column (1), $PF_{r,t}$ varies by municipality-year. In column (2), $PF_{r,t}$ varies by municipality-year and gender. In column (3), $PF_{r,t}$ varies by municipality-year, gender and 1-digit sector. Columns (2) and (3) include a female dummy. Column (3) also includes a service sector dummy and its interaction with the female dummy. Standard errors are clustered at the municipality-year level. $***, **$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

E Employment Margin

Table 17: Municipality Exposure to Tariffs and the Employment margin

Dependent variable	Employment	Formal wage employment			
	(1)	(2)	(3)	(4)	(5)
τ_{mrt}	-0.004	-0.224***	-0.179**	-0.466***	-0.473***
	(0.038)	(0.077)	(0.083)	(0.108)	(0.110)
τ_{mrt} ×he			-0.106**		-0.038
			(0.043)		(0.057)
τ_{mrt} × Serv				0.522***	0.591***
				(0.134)	(0.137)
τ_{mrt} ×Serv×he					-0.123
					(0.106)
τ_{frt}	-0.097***	-0.108*	-0.019	-0.200***	-0.205***
	(0.029)	(0.061)	(0.067)	(0.067)	(0.068)
τ_{frt} ×he			-0.277***		-0.021
			(0.065)		(0.026)
τ_{frt} ×Serv				0.309***	0.512***
				(0.066)	(0.070)
τ_{frt} ×Serv×he					-0.474***
					(0.120)
Educ working $pop_{r,t-1}$	-0.001	-0.002*	-0.003*	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female share $_{r,t-1}$	0.077**	-0.364***	-0.359***	-0.337***	-0.331***
	(0.036)	(0.054)	(0.054)	(0.059)	(0.059)
Female share $_{r,t-1}$× fe	1.183***	0.829***	0.821***	0.391***	0.384***
	(0.030)	(0.053)	(0.053)	(0.065)	(0.066)
Observations	7,767,738	7,194,824	7,194,824	7,193,669	7,193,669
R-squared	0.289	0.171	0.171	0.230	0.234
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes
Birth cohort FE	Yes	Yes	Yes	Yes	Yes

Notes: The sample includes individuals aged 16 to 60 years in formal employment, informal employment, unemployed or out of the labor force. We exclude employers from the sample as we did not include them in the benchmark sample. In column 1, the dependent variable takes the value 1 if the individual is in paid (formal or informal) employment and takes the value 0 if the individual is unemployed or out of the labor force. In columns 2 to 5, the dependent variable takes the value 1 if the individual is in formal employment and takes the value 0 if the individual is in informal employment, unemployed or out of the labor force. Individual controls are the same as in Table (6). Standard errors are clustered at the municipality-year level. $***, **$, and $*$ indicate significance at the 1, 5 and 10 percent levels respectively.

F Theory Appendix

E.1. Model Derivations

This section develops the general equilibrium model from which we obtain the change in formal labor demands in section 4, equations (3) and (4). We follow Blum (2008) and Kovak (2013), and deviate from the latter by having two types of labor, male and female labor, and from both papers by having two types of job within each sector, formal and informal jobs.

We consider a country composed of several regions r. Each region is composed of several industries indexed $s = \{1, ...N\}$. Production uses capital, K, female labor L_f and male labor L_m. Labor is assumed to be perfectly mobile across industries but not across regions, supplied inelastically, and fully employed. The elasticity of substitution between female labor and capital differ from the elasticity of substitution between male labor and capital. Capital is assumed to be region and sector specific in the short-run. We also assume that production technologies exhibit constant returns to scale, and that factors and goods markets are competitive. Technologies may differ across sectors but are the same across regions for each sector.

The set of exogenous variables is composed by: prices of tradable goods, factor supplies, sectoral capital allocation, preferences, and technologies. The endogenous variables to be determined are: factor returns, prices of non-tradable goods, sectoral employment allocations, and sectoral output. In what follows, we only consider a particular region and suppress the subscript r on all terms. The equilibrium is characterized by the following set

of equations:

$$a_{ks}y_s = K_s \qquad \forall s, \qquad s = 1, 2, ..., N \tag{10}$$

$$\sum_{s=1}^{N} a_{gs}y_s = L_g \qquad g = (f, m) \tag{11}$$

$$a_{fs}w_f + a_{ms}w_m + a_{ks}r_s = p_s \qquad \forall s \tag{12}$$

$$c_s = \frac{\kappa I}{p_s} \qquad s = M+1, M+2, ..., N \tag{13}$$

where a_{ks} and a_{gs} are unit input coefficients for each factor of production in sector s, with $g = \{f, m\}$. w_f and w_m are female and male wage respectively, r_s is the specific factor return in sector s, y_s and p_s are respectively the output and output price in industry s. Equations (10) and (11) represent full employment conditions for the specific factor in sector s, K_s, and for mobile factors, L_g. Equation (12) represents the zero profit condition. Equation (13) is the aggregate demand for non-tradable goods, with c_s the Cobb-Douglas demand of the non-tradable good in sector s. Tradable and non-tradable goods are indexed $s = 1, ..., M$ and $s = M+1, ..., N$ respectively. The exogenous share of formal jobs in each sector is denoted α_s. Therefore, group g formal employment in sector s is defined as:

$$L_{\varphi gs} = \alpha_s L_{gs} \tag{14}$$

Differentiating the above system of equilibrium conditions and using Jones' algebra, we obtain:

$$\hat{p}_s = \theta_{fs}\hat{w}_f + \theta_{ms}\hat{w}_m + \theta_{ks}\hat{r}_s = \sum_g \theta_{gs}\hat{w}_g + \theta_{ks}\hat{r}_s \tag{15}$$

$$\hat{L}_{gs} = \hat{a}_{gs} - \hat{a}_{ks} + \hat{K}_s \tag{16}$$

$$\hat{K}_s = \hat{a}_{ks} + \hat{y}_s \tag{17}$$

where hats represents proportional change, $\theta_{gs} = \frac{a_{gs}w_g}{p_s}$ and $\theta_{ks} = \frac{a_{ks}r_s}{p_s}$ are cost shares of

factors L_g and K_s in sector s. Using equation (17) inside equation (16), gives labor demand in industry s:

$$\hat{L}_{gs} = \hat{a}_{gs} - \hat{a}_{ks} \tag{18}$$

For each sector s, the elasticity of substitution between labor factor L_g and the specific factor K_s with respect to the relative returns of factors L_g and K_s is defined as:

$$\sigma^g_{gk,s} = \frac{\hat{a}_{ks} - \hat{a}_{gs}}{\hat{w}_g - \hat{r}_s} \tag{19}$$

We can rewrite the female and male labor demands in sector s, equation (18), using the elasticity of substitution in equation (19), to get:

$$\hat{L}_{fs} = -\sigma^f_{fk,s}(\hat{w}_f - \hat{r}_s) - \sigma^m_{fk,s}(\hat{w}_m - \hat{r}_s) + \hat{K}_s \tag{20}$$

$$\hat{L}_{ms} = -\sigma^m_{mk,s}(\hat{w}_f - \hat{r}_s) - \sigma^f_{fk,s}(\hat{w}_m - \hat{r}_s) + \hat{K}_s \tag{21}$$

We want now to express the change in female and male labor demands in sector s as functions of prices. Using the differentiated zero-profit condition, equation (15), the fact that K_s is fixed and specific to each sector (so that $\hat{K}_s = 0$, $\forall s$), and that cost shares add up to one, the change in labor demands in sector s becomes:

$$\hat{L}_{fs} = -\left[\sigma^f_{fk,s}\frac{\theta_{ks}+\theta_{fs}}{\theta_{ks}} + \sigma^m_{fk,s}\frac{\theta_{f,s}}{\theta_{ks}}\right](\hat{w}_f - \hat{p}_s) - \left[\sigma^m_{fk,s}\frac{\theta_{ks}+\theta_{ms}}{\theta_{ks}} + \sigma^f_{fk,s}\frac{\theta_{f,s}}{\theta_{ks}}\right](\hat{w}_m - \hat{p}_s) \tag{22}$$

$$\hat{L}_{ms} = -\left[\sigma^m_{mk,s}\frac{\theta_{ks}+\theta_{ms}}{\theta_{ks}} + \sigma^f_{mk,s}\frac{\theta_{m,s}}{\theta_{ks}}\right](\hat{w}_m - \hat{p}_s) - \left[\sigma^f_{mk,s}\frac{\theta_{ks}+\theta_{ms}}{\theta_{ks}} + \sigma^m_{mk,s}\frac{\theta_{m,s}}{\theta_{ks}}\right](\hat{w}_f - \hat{p}_s) \tag{23}$$

where $\sigma^g_{gk,s}$ is the elasticity of substitution between factor L_g and the specific factor K_s with respect to the relative factor prices of L_g and K_s in each sector s, $\theta_{f,s}$ and $\theta_{m,s}$ are cost share of factors L_f and L_m respectively. Finally, $\hat{w}_f$ and $\hat{w}_f$ are factors price changes, which depend on p_s as in equations (27) and (28).

Equations (22) and (23) shows that the demand for labor L_g in sector s increases with the price of good s and decreases with the wage paid to factor L_g. As standard in the Ricardo-Viner set up, the magnitude of the wage change is always smaller than the price change, so that the change in sectoral labor demand follows the sign of the price change. The intuition for this result is as follows. Following an increase in the price of good s, factors demands increase in sector s. Labor is mobile across sectors, therefore workers move to sector s until wages are equalized across sectors. Since capital is sector-specific and fixed in the short run, it becomes a scarce resource in sector s. Thus, the rental rate of capital, r_s, increases more than the price, p_s. Therefore, the wage increases, but proportionally less than the price.

In the following section, we derive equilibrium wage equations for men and women in order to to analyze the effect of an increase in the price of goods on labor demand.

Deriving male and female wages.

To solve for the wages of men and women, we use the following system of equations:

$$\hat{L}_f = \sum_s \lambda_{fs}\Big(\sigma^f_{fk,s}(\hat{r}_s - \hat{w}_f) + \sigma^m_{fk,s}(\hat{r}_s - \hat{w}_m)\Big) \tag{24}$$

$$\hat{L}_m = \sum_s \lambda_{ms}\Big(\sigma^m_{mk,s}(\hat{r}_s - \hat{w}_m) + \sigma^f_{mk,s}(\hat{r}_s - \hat{w}_f)\Big) \tag{25}$$

$$\hat{p}_s = \theta_{fs}\hat{w}_f + \theta_{ms}\hat{w}_m + \theta_{ks}\hat{r}_s \quad \forall s \tag{26}$$

where λ_{fs} and λ_{ms} are the fraction of female and male labor used in sector s respectively. Equations (24) to (26) can be written in matrix form and solved for factor prices to get:

$$\begin{bmatrix} \hat{R} \\ \hat{W} \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix}^{-1} \begin{bmatrix} \hat{P} \\ \hat{L} \end{bmatrix}$$

where $\hat{R}$ and $\hat{P}$ are $(N \times 1)$ column vectors; $\hat{W}$ and $\hat{L}$ are (2×1) column vectors; A, B, C

and D are elements of the block matrices. Exploiting the fact that labor supply is fixed, $\hat{L}_f = \hat{L}_m = 0$, and the rule for the inversion of partitioned matrices, we can solve for the equilibrium values of $\hat{w}_f$ and $\hat{w}_m$. This gives:

$$\hat{w}_f = \frac{1}{\Delta} \sum_{s=1}^{N} \frac{1}{\theta_{ks}} \Big[\Psi_1 (\sigma^f_{fk,s} + \sigma^m_{fk,s}) \lambda_{fs} - \Psi_2 (\sigma^m_{mk,s} + \sigma^f_{mk,s}) \lambda_{ms} \Big] \hat{p}_s \tag{27}$$

$$\hat{w}_m = \frac{1}{\Delta} \sum_{s=1}^{N} \frac{1}{\theta_{ks}} \Big[\Psi_3 (\sigma^m_{mk,s} + \sigma^f_{mk,s}) \lambda_{ms} - \Psi_4 (\sigma^f_{fk,s} + \sigma^m_{fk,s}) \lambda_{fs} \Big] \hat{p}_s \tag{28}$$

where

$$\Psi_1 = \sum_{s=1}^{N} \lambda_{sm} \left(\sigma^m_{mk,s} \frac{\theta_{ks} + \theta_{ms}}{\theta_{ks}} + \sigma^f_{mk,s} \frac{\theta_{ms}}{\theta_{ks}} \right)$$

$$\Psi_2 = \sum_{s=1}^{N} \lambda_{sm} \left(\sigma^f_{mk,s} \frac{\theta_{ks} + \theta_{fs}}{\theta_{ks}} + \sigma^m_{mk,s} \frac{\theta_{fs}}{\theta_{ks}} \right)$$

$$\Psi_3 = \sum_{s=1}^{N} \lambda_{sf} \left(\sigma^f_{fk,s} \frac{\theta_{ks} + \theta_{fs}}{\theta_{ks}} + \sigma^f_{mk,s} \frac{\theta_{fs}}{\theta_{ks}} \right)$$

$$\Psi_4 = \sum_{s=1}^{N} \lambda_{sf} \left(\sigma^m_{fk,s} \frac{\theta_{ks} + \theta_{ms}}{\theta_{ks}} + \sigma^f_{fk,s} \frac{\theta_{ms}}{\theta_{ks}} \right)$$

$$\Delta = \Psi_4 \times \Psi_2 - \Psi_3 \times \Psi_1$$

Equations (27) and (28) shows that a price increase in industry s increases the regional wage. Substituting equations (27) and (28) into (22) and (23) we obtain the relationship between female and male labor demands in sector s and a price change in good s.

The effects of trade on female and male employment at the sector level.

Moving from autarky to trade integration corresponds to an increase in the price of the CA sector, $\hat{p}_s > 0$. The price increase in sector s raises the amount of both types of labor

hired by sector s, but not necessarily in the same proportion. If in sector s, male labor is relatively more substitutable for capital than female labor, and the fraction of male labor is bigger than the fraction of female labor, the price raise leads to a larger increase in male labour demand than in female labour demand.[27]

Accordingly, trade liberalization leads to a larger increase in male labor compared to female labor in those CA sectors where male labor demand is relatively more elastic than female labor demand and the fraction of male labor is bigger than the fraction of female labor.

The non-tradable good prices

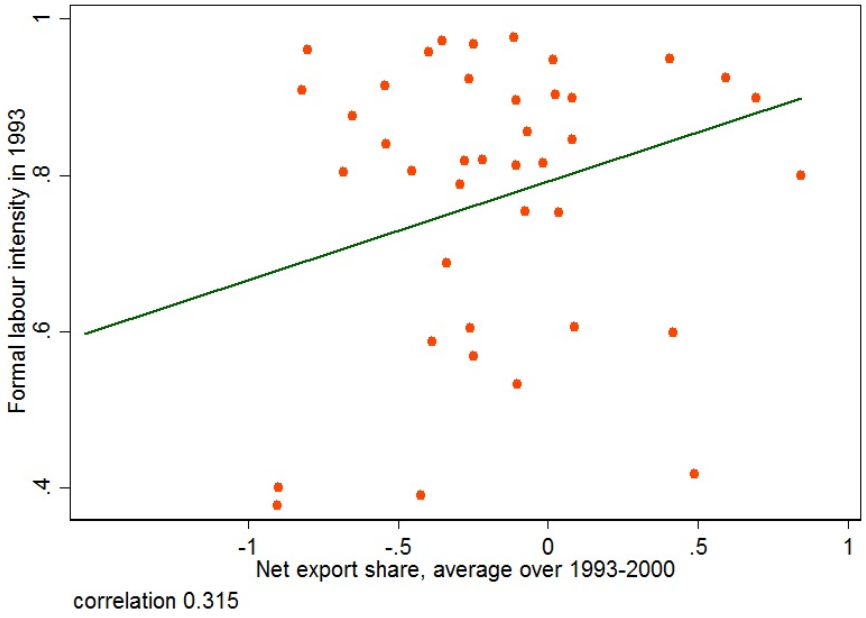
The presence of non-tradable sectors does not alter the results obtained in equations (27) and (28). To solve for the non-tradable equilibrium good prices we need to assume specific consumers' preferences. For this we follow Blum (2008) and Kovak (2013) in assuming Cobb-Douglas preferences to solve for the supply and demand of the non-tradable goods produced in sectors $i = M + 1, ..., N$, as well as their equilibrium prices.

E.2. CA Sectors and Formal Labor in Mexico

The theoretical predictions depend on CA sectors being more formal labor intensive than non-CA sectors. To verify this assumption, we plot formal labor intensity in 1993 against average net export share. Figure 4 shows that sectors with higher net export share ($\frac{exports-imports}{production}$) are associated with higher formal labor intensity ($\frac{formal\ labor_s}{total\ labor_s}$) at the start of the period in 1993.

[27] The fact that male labor is more substitutable than female can also be stated in terms of labor demand elasticities: in this case the demand for male labor is more elastic than the demand for female labor. The labor demand elasticity for labor factor g is defined as $\frac{\partial L_{gs}}{\partial(w_g/p_s)}\frac{w_g/p_s}{L_{gs}}$.

Figure 4: Formal Labor Intensity and Trade Share at the Sector Level



Notes: Sector level information at the 3-digit level for manufacturing industries. Formal labor intensity in 1993 calculated with the ENEU data from INEGI, Mexico. Trade shares are calculated using TradeProd database from CEPII, developed by De Sousa et al. (2012).