Trade and Labor Market Institutions: A Tale of Two Liberalizations

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Abstract

How do labor market policies interact with trade reforms? Do minimum wage regulation and employment protection legislation hamper the gains from trade? Are these regulations effective in protecting workers from import competition? I answer these questions by studying how labor market institutions at the time of a trade reform determine the dynamic adjustment to trade. I first document that for a large group of developing countries (1) unemployment increases following a trade reform, and (2) the response is stronger when the firing costs are lower and the statutory minimum wage is higher. I interpret this evidence through the lens of a model of international trade, featuring heterogeneous firms, endogenous industry dynamics and search and matching frictions in a dual labor market. I calibrate the model to match the pre-liberalization firm and labor market dynamics in Colombia and Mexico, two countries that differed by the labor regulations in place at the time of trade liberalization, and I solve the full transition path towards the new steady state. I show that lower firing costs and higher minimum wage enhance firm selection following a trade liberalization, fostering short- and long-run gains from trade at the expense of higher job reallocation between and within industries, and higher unemployment. Taken together, these two institutions can explain around 30% of the short-run and up to 60% of the long-run cross-country difference in unemployment response to a fall in trade costs. Finally, I find that a strong efficiency-equity trade-off arises as an economy reduces *employment rigidities* in favor of stronger downward *wage rigidities*.

Keywords: Trade reforms, labor market institutions, unemployment, transitional dynamics, gains from trade, inequality

JEL Classification: E24, F12, F16, L11

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1 Introduction

Over the past 50 years, most developing countries have embarked on programs of trade liberalization and become integrated into the global product market.[1] Empirically, trade reforms have been shown to trigger significant employment adjustments, sometimes with adverse effects on labor markets, in most cases with a prolonged increase in unemployment (Figure 1).[2] While workers reallocation constitutes an important margin of labor market adjustment in response to trade shocks,[3] growing concerns is forming about the role of labor market institutions in distorting the adjustments to trade, thus hampering the potential gains from trade.[4]

In this paper I study how labor market regulations interact with the dynamics of labor market adjustments to trade liberalization. Labor regulations in place at the eve of a trade reform vary greatly among countries. Some countries adopted free-trade policies with flexible labor market institutions, while others did so with more rigid ones.[5] Nevertheless, at the time of trade opening, most of the local labor markets were highly regulated but with limited active labor market policies.[6] Table 1 reproduces this evidence and reports the statutory minimum wage, measures of firing restrictions (employment protection legislation, EPL) and unemployment insurance (UI) for a sample of developing countries at the time of a trade reform. The burden of regulation on employment protection was high in the majority of the countries in the sample. The total firing costs per employee, which consists of costs associated with advance notice (AN) and severance payments (SP), were about 6 months of real average wage, a value more than twice higher than that observed for instance in France between the ′80s and ′90s, and almost three times higher than that in place in Italy during the same two decades.[7] On the other hand, unemployment insurance was limited in

[1] See Rodrik (1993) for a comprehensive overview of the trade policy reforms in developing countries.

[2] On the effect of trade openness on unemployment and inequality in developing countries, see, for instance, Revenga (1997) and Airola and Juhn (2008) for the case of Mexico, Currie and Harrison (1997) for Morocco, Goldberg and Pavcnik (2004) for Colombia, Kpodar (2007) for Algeria, Peluffo (2013) for Uruguay, Nicita (2008) for Madagascar, Balat and Porto (2007) for Zambia, Hasan et al. (2012) for India and Menezes-Filho and Muendler (2011) and Dix-Carneiro and Kovak (2017) for Brazil. See Bellon (2016) for an cross-country study.

[3] For a summary about the margins of adjustment to trade in developing countries, consequence of trade reforms and policy recommendation, see Hoekman and Porto (2010) and Pavcnik (2017).

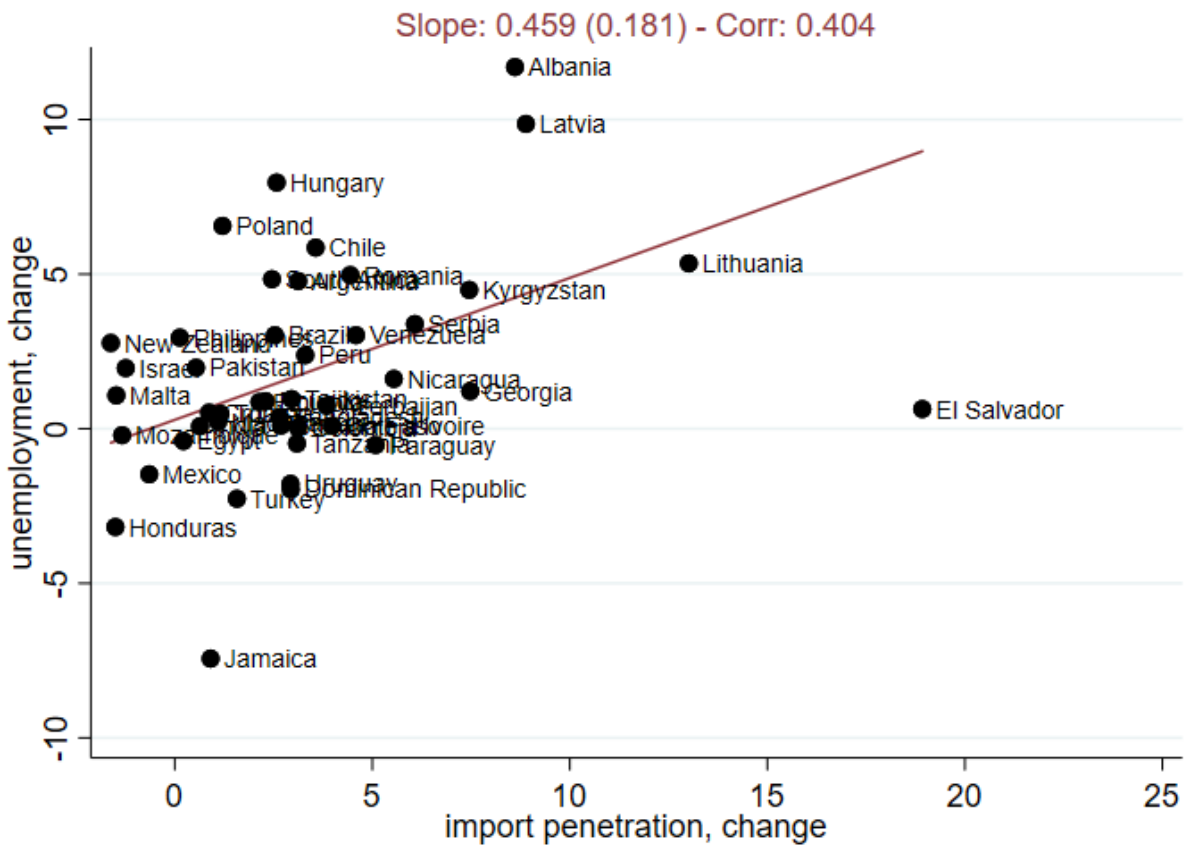
[4] Concerns about the interaction between trade reforms and institutions have been manifested, among the others, in Zagha et al. (2005) and in Rodrik (2008).

[5] Freeman (2007) and Freeman (2010) document large cross-country differences in labor institutions for a spectrum of developing countries, with particular focus on government regulations, as dismissal costs, social security and minimum wage policies. See Heckman and Pages (2004) for a description of the labor market institutions in place in LAC countries, the nature of the reforms implemented, and the link with trade liberalization.

[6] In a report prepared by the World Bank for Latin America and the Caribbean, Burki and Perry (1997) write that "labor market reform is the area of structural reform where the least progress has been made in the region". In the same spirit, the IADB (1997) concludes: "labor code reforms have been few and not very deep," adding that "current labor legislation may have hindered the re-absorption of workers who were displaced during the reform process". See Forteza and Rama (2006) for a summary.

[7] Source: FRdB Labor Institution v.1 database

Figure 1: **Import Penetration and the Labor Market**



Note: Import penetration is constructed as total imports divided by GDP minus net export. Changes of import penetration, unemployment rate and income inequality are computed over a window of ten years around the date of trade reform reported in Sachs and Warner (1995). Each observation is weighted by the country average population over the same period. Source: ILO-stat, WBI and author′s calculations.

most of the countries, with an average coverage equal to 17 percent of total unemployment, an average gross replacement ratio after one year of dismissal no larger than 16 percent of the average real wage in the country, and more than 50 percent of the countries with no unemployment insurance available. Finally, the statutory minimum wage averaged 37 percent (with a maximum of 70 percent) of real average wage at the time of the reform; nevertheless, some countries had no minimum wage legislation in place.

Is unemployment response to a reduction in trade costs stronger when the labor market is more flexible? Are labor market regulations a burden for trade adjustments? If so, why? And what are their distributional implications? To address these questions, I develop and estimate a small open-economy model of firm dynamics with a rich institutional environment, and I numerically characterize the transitional dynamics triggered by a reduction in trade costs under different combinations of labor market regulations in place.

The model combines endogenous firm dynamics with costly employment adjustment and

Table 1: **Labor Market Institutions**

	Minimum/Mean	EPL		UI	
	wage	AN	SP	benefits	coverage
Average	0.37	1.14	4.86	15.63	17.22
St. Dev.	0.18	0.77	4.35	21.52	27.16
Median	0.34	1	3.33	0	0
LAC	0.39	1.07	7.35	6.04	5.45
East Europe	0.36	1.44	3.09	19.95	18.05
Asia	0.43	0.92	3.91	11.35	20.10
Africa	0.24	1.16	2.71	16.62	8.05

Note: The minimum wage is expressed as a share of the average yearly wage. EPL refers to the employment protection legislation and it is measured by the months of advance notice (AN) and the level of severance payment (SP, expressed in average monthly wage). Both AN and SP are expressed as a multiple of average real monthly wage. UI refers to unemployment insurance and is measured using the average replacement rate within one year of dismissal (benefits) and percent of unemployed covered (coverage). Source: FRdB Labor Institution v.1 database and authors′ calculation.

search and matching frictions in the labor market in a standard trade environment. The economy consists of a non-tradable sector, populated by a continuum of homogeneous firms producing service goods, and a tradable sector, populated by a continuum of heterogeneous firms, producing differentiated industrial goods, engaging in international trade, and subject to two major labor market regulations: (1) firing restrictions, modelled as a tax on employment reduction; (2) a statutory minimum wage, modelled as a legal minimum contribution each employer in the industrial sector is forced to provide to employees.

A reduction in trade costs has two major effects in the model. First, it induces greater competition in the product market. Access to foreign markets becomes cheaper and domestic consumers substitute home-produced varieties with foreign varieties. Import penetration reduces the revenues of low-productivity domestic firms which are forced to lower wages, and depending on productivity level and number of employees, to adjust their workforce downwards, and eventually exit. Second, a drop in trade costs gives incentives for exporters to increase the share of products sold in the foreign market and for high-productivity, non-exporting firms to start serving the foreign market. The revenue premium from exporting increases, and exporting firms start rising their wage and expanding their size.

In this framework, the labor market regulations in place determine the direction and the magnitude of employment adjustment after a trade shock, with implications for job volatility, worker reallocation and unemployment. On the one hand, employment protection exerts a *stabilization effect* after trade openings, by increasing hoarding of labor, reducing employment volatility and preventing workers to flow into unemployment. On the other hand, minimum wage induces an *amplification effect*, increasing the cost of labor and making the domestic firms respond to foreign competition with larger worker displacement.

In the quantitative exercise I focus on the trade reforms of Colombia and Mexico. These

two countries constitute two relevant case studies for several reasons. First, between the end of the 1980's and the beginning of the 1990's, both Colombia and Mexico went through a massive series of external economic liberalizations, and witnessed an unprecedented expansion of the imports of goods and services within ten years after the implementation of the reform.[8] Second, Colombia and Mexico opened up to trade under very different labor market institutions. In particular, Colombia massively cut firing costs while Mexico kept a rigid labor market. At the time of the trade reform, firms contributions for worker dismissal in Colombia were roughly equivalent to one month's wage, less than one third of the value reported for Mexico. Furthermore, Colombia kept very high minimum wage, Mexico did the opposite. At the time of liberalization, the average statutory minimum wage was more than half of the average market wage in Colombia, and no more than one third in Mexico.[9] Finally, these countries witnessed different dynamics in unemployment, informal employment and income inequality following the trade reform: while in Mexico unemployment didn't rise and the informal sector didn't expand significantly, Colombia experienced the opposite and faced a much larger surge in income dispersion.

In order to discipline the model, I exploit firm-level data for the manufacturing sectors of both countries during the years preceding the trade reform, and I use indirect inference to calibrate key parameters in the model. The estimated model replicates the size distribution of firms, the distribution of employment, producer entry and exit rates and export dynamics observed in the Mexican and Colombian economies. It also matches the wage dispersion across producers, although they are not part of the estimation targets. Then, I use the calibrated model to study a general equilibrium transition path in response to a trade liberalization reform under counterfactual labor market institutions.

First, I replicate the reforms adopted in both countries and I solve for the full transition path towards the new steady state. To do so, I implement the observed once-and-for-all cut in import tariffs together with a reduction in non-tariff barriers (NTB, henceforth) that matches the observed increase in the revenue premium from export, while I maintain the regulations in the labor market equal to the observed. The predictions of the model are consistent with the differences in the dynamic response between Colombia and Mexico: the model predicts a larger increase of unemployment rate in the Colombian economy, jointly with a larger reduction in the employment share of manufacturing, and a larger increase in the job reallocation rate.

Next, I quantify the role played by each institution under alternative counterfactual scenarios. In particular, I first implement a reform in the labor market with a once-and-for-all change in one of the institutions in place. Once the new steady state is reached, I replicate

[8] In Colombia, the imports share of GDP increased by around 39 percent, going from 13.81 to 19.17. In Mexico the figure went from 10.98 to 17.89, with an increase of 64 percent. Source: World Development Indicator Database, https://data.worldbank.org.

[9] No unemployment insurance was in place at the time of the reform in both countries. See section 5 for a discussion.

the trade reforms adopted in both countries and I track the dynamics of unemployment along the transition to the new equilibrium. Then, I compare this response with the one obtained without implementing any change in labor regulations. The main result is that unemployment reacts more strongly the less stringent the employment protection legislation and the stricter the minimum wage policy. I find that the *wage rigidity* induced by the statutory minimum wage in Colombia accounts between 25% and 30% of the unemployment response in the short- and long-run respectively. The *employment rigidity* induced by the employment protection legislation has the opposite effect: larger firing costs have a negative effect on unemployment response and can explain up to 23% of the unemployment response in Mexico. Taken together, these two institutions quantitatively accounts for approximately one third of the difference between countries in the unemployment response generated on impact by a reduction in trade costs, and up to 60% of the long-run difference.

To study the distributional consequences of these reforms, I evaluate the efficiency-equity properties of trade reforms implemented under alternative level of minimum wage and employment protection. To do so, I compare workers' aggregate welfare implied by the structural model against 1) welfare dispersion and 2) share of workers unemployed. Counterfactual experiments indicate that a reduction in trade costs under the observed labor market institutions improved long-run aggregate welfare more in Colombia than Mexico at a cost of a higher welfare dispersion and larger unemployment. On the other hand, while larger trade openness would increase both aggregate welfare, welfare dispersion and unemployment by themselves, the effects on these two margins were significantly reinforced by the higher statutory minimum wage in place in Colombia, and were hampered by the more stringent employment protection legislation in place in Mexico. Finally, I show that a positive transfer to the unemployed fully financed with payroll taxes can mitigate the increase in welfare dispersion triggered by a trade liberalization by supporting displaced workers, at a cost of lower aggregate welfare gains from trade and higher unemployment.

The remainder of the paper is structured as follows. I first outline the relation of this paper with the existing literature. Section 2 discusses cross-country evidence on the effect of trade liberalization on unemployment and income inequality and highlights the role of labor market institutions. Section 3 outlines the structural model, defines a notion of equilibrium along the transition path from low- to high- trade openness, and lays out the mechanisms of the labor markets. Section 5 describes the trade reforms of Colombia and Mexico and the different institutional backgrounds in place. Section 6 explains the calibration strategy. Section 7 explores the quantitative implication of the model, it numerically characterizes the transitional dynamics after a trade reform under the different labor market policies and it lays out their efficiency-equity trade-off. Section 8 concludes. The Appendix contains technical details on the model, description of the data used, further empirical evidence and quantitative results.

1.1 Review of related literature

This paper relates to a number of literatures. First, it contributes to the recent literature that studies the joint effects of labor market frictions and trade reforms. To this extent, this paper is close to Helpman and Itskhoki (2010), Helpman et al. (2010) and Felbermayr et al. (2016) who focus on the long-run impact of globalization and labor market rigidities on job volatility, unemployment rate and the distribution of wages.[10] Within this literature, Fajgelbaum (2016) embeds job-to-job transition into a trade environment to study how search frictions impede exporting firms to grow in response to reduction in trade costs. Cosar et al. (2016) estimate a structural steady-state model using Colombian firm-level data to quantify the contribution of trade and labor market reforms on the observed increase in wage inequality and job volatility. Unlike these papers, I focus on the consequences of labor market institutions for transitional dynamics in a framework where firms costly adjust employment and workers transit from employment to unemployment as a response to a fall in trade costs. I quantitatively characterize the differential impact of trade reforms on unemployment rate and income inequality along the entire transition path between different steady states, through ongoing productivity shocks, endogenous firm entry and exit, and endogenous job creation and destruction. More importantly, I study the complementarities between labor-market policies and trade reforms, a margin the trade literature has largely abstracted from (Atkin and Khandelwal, 2020).

Existing models with transitional dynamics have primarily focused on two main key dimensions: the reallocation of workers with different levels of human capital across sectors, and reallocation of heterogeneous jobs between firms within the same sector, in frameworks with labor market frictions. Papers like Cosar (2013) and Dix-Carneiro (2014) belong to the first group: they develop models where workers slowly accumulate sector-specific human capital, and can costly switch between sectors, to study the distributional response to a trade shock.[11] This paper instead belongs to the literature that focuses on the role of employment adjustments, preventing firms to instantaneously adjust to changes in the product market. To this extent, it is close to Itskhoki and Helpman (2015) who use a two-country two-sector model to study how jobs and workers reallocate along the entire transition path after a change in trade costs, and to Bellon (2016) who develops a model of directed search in the labor market and costly firms′ screening of workers to micro-found the dynamic response of inequality to a trade liberalization. These papers also show that lower trade costs could

[10] Empirical papers on this subject include, among others, Amiti and Cameron (2012) and Helpman et al. (2017).

[11] Empirical evidence has shown instead that most of the workers and job reallocation after a trade liberalization occurs within sectors. Wacziarg and Wallack (2004) use 25 episodes of trade liberalization to provide evidence of weak intersectoral labor movements after a trade reform. Haltiwanger et al. (2004) document the association between job turnover and openness in Latin America.Bernanrd et al. (2003) estimates substantial effect of a trade liberalization on inter-sectoral job turnover using the US Census of Manufacturing.

induce a short-run increase in unemployment and income inequality. Unlike these papers, my model links the response of unemployment to the regulations in place at the time of a trade reform, a feature they both abstract from, generating in comparison much richer responses of firms to a trade liberalization.

Finally, this paper speaks about the effects of labor market institutions on unemployment, aggregate income and income inequality. To this regard, this paper follows Bentolila and Bertola (1990), Hopenhayn and Rogerson (1993), and, among all, to Alvarez and Veracierto (2000), who explore to which extent differences in labor market policies, such as minimum wages, firing restrictions, unemployment insurance, and unions, can generate differences in labor-market performance and aggregate efficiency. Kambourov (2009) uses a general equilibrium model of international trade to study the effect of firing costs on the speed of inter-sectoral reallocation of workers after a trade shock. Instead, I focus on the intra-sectoral reallocation of labor triggered by a fall in trade costs, and the potential increase in unemployment during transition. Dix-Carneiro and Kovak (2017) and McCaig and Pavcnik (2014) document that shifts into or out of unemployment and non-employment constitute important margins of labor market adjustment to trade. To this purpose, search and matching frictions in the labor market allow me to study how a reduction in trade costs links to worker displacement and unemployment in a setting where labor market institutions induce rigidities on both quantities and wages.

2 Aggregate evidence

In this section, I document the dynamics of the unemployment rate around episodes of trade liberalization. In particular, I focus on a subset of countries who embraced a trade reform during the last 50 years. I track the labor marker dynamics in each country before and after the trade reform and I relate it to the degree of employment protection, minimum wages and unemployment insurance observed at the time of trade liberalization.

The event study I conduct mainly draws from four data sources. To identify periods of trade openness, I use the liberalization dates reported by Wacziarg and Welch (2003), which are based on those developed by Sachs and Warner (1995), and I construct a country-specific dummy variable taking value one in each period after this date. To capture the strength of different labor market institutions, I rely on the data provided by the Fondazione Rodolfo de Benedetti (FRdb-IMF labor institutions database v.1).[12] In particular, I use the ratio between the statutory minimum wage in place and the average market wage as a proxy for the minimum wage legislation, while I use the average number of months of advance notice in case of dismissal plus the average compensation for dismissal over different seniority horizons

[12]The FRdb-IMF labor institutions database collects information on minimum wages, unemployment benefits and employment protection legislation around the world. It covers a set of 91 countries and a time span from 1980 to 2005. Source: http://www.frdb.org/page/data/categoria/international-data

to identify differences in employment protection regulation. Finally, I proxy unemployment benefits using a coverage weighted average replacement rate at one year of dismissal. The series for unemployment rate are constructed using data from ILO-Stat database while information on population, nominal and real GDP, imports and exports, employment, rate of inflation and exchange rate is taken from the World Development Indicators (henceforth the WDI) provided by the World Bank merged with the Penn World Table version 9.0.[13]

Overall, I gather data for 40 countries, spanning on average 30 years around their respective timing of liberalization, and covering 6 main regions (7 countries in East-Europe, 15 in the LAC region, 8 in Africa and 10 in Middle- and South-Asia). Appendix A reports definition, source and summary statistics of the data.[14]

2.1 Trade reform, unemployment and inequality

The first hypothesis I investigate is whether unemployment rate has been relatively higher after a trade reform. To this purpose, I estimate the following cross-country equation,

$$y_{it} = \alpha \mathbf{1}_{\{t \geq t_i^*\}} + \gamma_t + \upsilon_i + \eta_i (t - t_i^*) + \delta X_{it} + \epsilon_{it} \tag{1}$$

where y_{it} is unemployment rate for country i at time t, υ_i is a dummy variable for country i, meant to capture country-specific averages, γ_t is a dummy variable for year t, included to filter out year-specific fixed effects, and η_i are country-specific time trends, capturing country differences in long-run movements of unemp_{it}. The variable $\mathbf{1}_{\{t \geq t_i^*\}}$ is a country-specific indicator taking value one at any year t from the date of liberalization, t_i^*, forward, and it is meant to isolate permanent shifts in the average value of y_{it} occurred after the trade reform. Finally, X_{it} is a vector of controls, including among the others population growth, real GDP per capita growth and employment growth.

Table 2 displays the estimates for the impact of a trade reform on the unemployment rate. In particular, I report the OLS estimates of α, together with robust standard errors, clustered at country level (in brackets), for a number of possible and alternative specifications of equation (1). The estimates suggest a non-negligible increase in unemployment rate in the aftermath of a trade reform: conditional on the full set of observables, the unemployment rate is roughly 1.6 percentage points higher after a trade liberalization.[15]

[13] For a detailed description of the data and the data sources, see Appendix A.

[14] The liberalization dates capture the reduction in tariffs on imports and the expansion in imports flows observed across countries in the last 40 years and the average timing it occurred. Applied tariffs on imports are on average 10 percentage points lower after a liberalization episode, and the share of imported goods in domestic output is twice as large as before.

[15] The liberalization dates used in the main specification are based on what Wacziarg and Welch (2003) labelled *de-jure* criteria on trade regulations, e.g. tariffs on imports and other non-tariffs barriers, the existence monopolies, the discrepancy between official and black market exchange rate and the presence of a socialist regime. Alternative dates, based on *de-facto* criteria (5+ percent growth in the share of trade merchandise in GDP between two consecutive periods) have been proposed in the literature. I explore the robustness of the main results to the choice of liberalization date in the supplementary section.

Table 2: **Trade Liberalization and Unemployment**

	unemp_{it}			
VARIABLES	(2.1)	(2.2)	(2.3)	(2.4)
Liberalization dummy				
$\mathbf{1}_{\{t \geq t_i^*\}}$	2.248	1.769	1.566	1.551
	[0.205]***	[0.319]***	[0.316]***	[0.308]***
R-squared	0.731	0.753	0.860	0.888
Observations	1095	1095	1095	1086
Country FE	yes	yes	yes	yes
Year FE	no	yes	yes	yes
Country trend	no	no	yes	yes
Controls	no	no	no	yes

Note: unemp_{it} refers to the unemployment rate in country i at time t. $\mathbf{1}_{\{t \geq t_i^*\}}$ is a country-specific dummy variable taking value one in each period after the trade liberalization, t_i^*. Controls include population growth, real GDP per capita and its square, real GDP per capita growth, employment growth, investment share of GDP, the rate of price inflation on household consumption goods, the market exchange rate of the national currency w.r.t the US dollar, and indicators for the occurrence of banking, currency, and sovereign debt crises. Robust standard errors are clustered at country level (in parenthesis). Source: ILO-stat, WBI, Penn-Table 9.0 and author's calculations. *** p<0.01, ** p<0.05, * p<0.1.

2.2 Trade reform and labor market institutions

The second hypothesis I investigate in this paper is whether the institutional features of the local labor markets determined the response of unemployment to a trade shock. To test it, I extend the specification used in Kambourov (2009) and I estimate the following cross-country equation,

$$y_{it} = \alpha \mathbf{1}_{\{t \geq t_i^*\}} + \beta \mathbf{1}_{\{t \geq t_i^*\}} z_i + \gamma_t + \upsilon_i + \eta_i (t - t_i^*) + \delta X_{it} + \epsilon_{it} \tag{2}$$

where the interaction terms $\mathbf{1}_{\{t \geq t_i^*\}} z_i$, are included to estimate cross-country differences in unemployment rate and income inequality in periods of post-liberalization that are systematically associated to the degree of a particular labor market institutions, z_i, meaning employment protection, minimum wage and unemployment insurance.

Table 3 reports the estimates of equation (2) for a number of different specifications. The estimates from the specification with full set of controls (columns 3 in Table 3) predict the following responses. The unemployment rate would be 0.4780 percentage points higher after a trade reform if the minimum wage at the time of trade opening were 10 percentage points larger. Using the same estimates, one month more in the average firing costs predicts a 0.183 percentage points-lower unemployment rate in the aftermath of a trade reform, while a ten percent higher benefits to the unemployment predicts unemployment rate to increase by 0.738 percentage points more after a trade reform.

The event study in this section indicates that labor market institutions are key to understand the response of unemployment following trade liberalization. First, a trade reform is followed on average by a positive and significant response of unemployment. Second, the re-

Table 3: **Trade Reforms and Labor Market Institutions**

	unemp_{it}			
VARIABLES	(2.1)	(2.2)	(2.3)	(2.4)
Liberalization dummy				
$\mathbf{1}_{\{t\geq t_i^*\}}$	0.136	2.487	0.865	-0.0405
	[0.530]	[0.536]***	[0.335]**	[0.792]
Liberalization dummy × Min-wage				
$\mathbf{1}_{\{t\geq t_i^*\}}\underline{\text{w}}_i$	2.722			4.796
	[1.255]**			[1.375]***
Liberalization dummy × EPL				
$\mathbf{1}_{\{t\geq t_i^*\}}\text{epl}_i$		-0.242		-0.183
		[0.0553]***		[0.0669]***
Liberalization dummy × UB				
$\mathbf{1}_{\{t\geq t_i^*\}}\text{ub}_i$			0.121	0.0738
			[0.0370]***	[0.0426]*
R-squared	0.901	0.904	0.911	0.926
Observations	894	894	902	720
Country FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Country trend	yes	yes	yes	yes
Controls	yes	yes	yes	yes

Note: unemp_{it} refers to the unemployment rate and income inequality in country i at time t. $\mathbf{1}_{\{t\geq t_i^*\}}$ is a country-specific dummy variable taking value one in each period after the trade liberalization, t_i^*. epl_i, $\underline{\text{w}}_i$ and ub_i refer to employment legislation, minimum wage regulation and unemployment insurance in place at the time of liberalization. Controls include population growth, real GDP per capita and its square, real GDP per capita growth, employment growth, investment share of GDP, the rate of price inflation on household consumption goods, the market exchange rate of the national currency w.r.t the US dollar, and indicators for the occurrence of banking, currency, and sovereign debt crises. Robust standard errors are clustered at country level (in parenthesis). Source: ILO-stat, WBI, Penn-Table 9.0 and author's calculations. *** p<0.01, ** p<0.05, * p<0.1.

sponse is tightly linked to the labor market institutions in place at the time of liberalization. In particular, unemployment response is higher the lower the costs of dismissing workers and the larger the minimum wage and the transfer to the unemployed. [16]

In the next section I propose a structural model of firm dynamics operating in a frictional labor market and engaging in international trade that allows me to study the effect of trade reform on frictional unemployment, to disentangle the role of each labor market institution from the effect of other characteristics, and study their distributional consequences.

3 The model

Time is discrete and indexed by t. The dependence of time is made explicit to highlight non-stationarity in the model. I consider an economy populated by three types of agents: a unitary measure of workers-consumers, an endogenous measure of firms operating in the

[16] These results should not be viewed as causal evidence of the effect of labor market institutions yet. In particular, country-specific unobserved heterogeneity in the labor market, or other possible sources of endogeneity, cannot be fully ruled out as drivers of the observed results. Moreover, Harrison and Hanson (1999) have criticized the ability of the liberalization dates to correctly capture trade openness (see Rodriguez and Rodrik (2000) for a critique) Nevertheless, in the supplementary section I address some limitations of the empirical strategy though several robustness checks.

industrial sector and a fixed measure of firms producing service goods. Workers are ex-ante homogeneous and risk neutral. They can be employed in the industrial sector, employed in the service sectors, or they can be unemployed. Firms in the service sector are homogeneous and operate in a perfectly competitive market under constant return to scale in production. Firms in the industrial sector are heterogeneous: they produce a differentiated industrial variety and operate under monopolistic competition in the product market. The labor market for service jobs is frictionless, whereas the labor market for industrial jobs is subject to search and matching frictions and multiple labor market regulations are enforced. In particular, industrial wages are subject to a statutory minimum wage level, industrial firms are subject to linear firing costs in case of individual dismissal and workers who separate from industrial firms and fail to form a new match are granted a lump-sum benefit. eventually financed with payroll taxes on industrial firms. Finally, workers to live hand-to-mouth: no savings technology is available to them, hence they cannot insure against firm-level productivity shocks, unemployment shocks and eventual changes in trade costs.

3.1 Preferences

Workers derive utility from the consumption of a homogeneous, service good, s_t, and from the consumption of a CES composite of industrial differentiated varieties, c_t, defined as

$$c_t = \left(\int_0^{N_t} c_t(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}} \tag{3}$$

where N_t denotes the measure of industrial varieties ω available at time t, while $\sigma > 1$ denotes the elasticity of substitution between these varieties. Services and industrial goods are combined by means of a Cobb-Douglas function,

$$u_t = c_t^{\gamma} s_t^{1-\gamma}, \tag{4}$$

where $\gamma \in (0, 1)$ is the fraction of expenditure on the composite industrial good. In each period t, workers maximize their the expected discounted value of their utility stream, denoted by $\mathcal{U}_t$, and equal to

$$\mathcal{U}_t = \sum_{j=t}^{\infty} \frac{u_j}{(1 + r_j)^{j-t}} \tag{5}$$

where $r_j > 0$ denotes the discount rate at time $j \geq t$.

3.2 Labor market

Workers can obtain a job in the service sector with certainty: the service sector labor market is frictionless. If they choose to get a job in the services, they earn a wage $w_{s,t}$. In what

follows, without loss of generality, I choose the wage in the services to be the numeraire of the economy. Therefore, I set $w_{s,t} = 1$, $\forall t$.

The industrial sector labor market is subject to search and matching frictions. To hire workers, industrial firms need to post vacancies. Workers search for industrial jobs randomly. Each period, the aggregate measure of new *industrial matches* depends on the measure of workers seeking a job, U_t, and the measure of vacancies posted, v_t, and it is governed by the following constant-returns-to-scale matching function:[17]

$$m_t(v_t, U_t) = \frac{v_t U_t}{(v_t^\theta + U_t^\theta)^{\frac{1}{\theta}}} \tag{6}$$

where $\theta > 0$ governs the elasticity of new matches to the measure of searching workers. This matching function implies a probability of filling a vacancy for industrial firms, ϕ_t, equal to

$$\phi_t = \frac{m_t(v_t, U_t)}{v_t} = \frac{U_t}{(v_t^\theta + U_t^\theta)^{\frac{1}{\theta}}} \tag{7}$$

and probability of finding a job for workers, $\widetilde{\phi}_t$, equal to

$$\widetilde{\phi}_t = \frac{m_t(v_t, U_t)}{U_t} = \frac{v_t}{(v_t^\theta + U_t^\theta)^{\frac{1}{\theta}}} = (1 - \phi_t^\theta)^{\frac{1}{\theta}} \tag{8}$$

As in Bertola and Caballero (1994), workers who get matched with an industrial firm enter a bargaining stage to determined the wage rate, $w_t(z, \ell)$, which will be function of the characteristics of the firm they will work for. Workers who fail to get matched end up being unemployed. At the end of the matching process, the population is split into workers employed in the services, $L_{s,t}$, workers employed in the industrial sector, $L_{q,t}$, and unemployed workers, $L_{u,t}$.

3.3 Production

Firms in the service sector are homogeneous: they all produce the same service good using labor only.[18] Unemployed workers sustain themselves by home-producing $b < 1$ units of service goods. The total production of service sector is then equal to

$$s_t = L_{s,t} + bL_{u,t} \tag{9}$$

[17] This functional form for the matching function has been introduced first in den Haan and Watson (2000) and used in Cosar (2013), Fajgelbaum (2016) and Cosar et al. (2016).

[18] Since firms in this sector are homogenous in terms of productivity and produce a unique homogenous good, the analysis does not change if they are allowed to hire one or multiple workers, as long as they remain price takers. See for instance, Helpman and Itskhoki (2010).

Firms in the industrial sectors are heterogeneous. Each of them produces a unique product, ω, and is subject to an idiosyncratic productivity shock, z, which follows an AR(1) process,

$$z_{t+1} = \rho_z z_t + \sigma_z \epsilon_{z,t} \tag{10}$$

where $\rho_z \in (0,1)$, $\sigma_z > 0$ and $\epsilon_{z,t} \sim N(0,1)$, $\forall t$. Denote by $\Gamma(z'|z)$ the the conditional probability distribution induced by (10). To produce, firms combine labor, ℓ_t, and final goods used as intermediates, m_t, through a Cobb-Douglas production technology,

$$q_t(\omega) = z_t \ell_t^{\alpha} m_t^{1-\alpha} \tag{11}$$

where $\alpha \in (0,1]$ is the employment elasticity of output, whereas m_t combines differentiated varieties used as intermediates,

$$m_t = \left(\int_0^{N_t} m_t(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}} \tag{12}$$

using the same elasticity, σ, as for final consumption.

3.4 Revenues and intermediates

Denote by $p_{s,t}$ the price of a unit of service sector good, by $p_t(\omega)$ the home-price of an industrial variety ω, and by P_t the ideal domestic price index for the aggregate industrial good, defined as follows

$$P_t = \left(\int_0^{N_t} p_t(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}} \tag{13}$$

Service goods are sold in a perfectly competitive market. Perfect competition and constant return to scale in production makes the price charged for unit of service good be equal to the marginal cost, implying, in equilibrium, zero profits and the equality between price and wage, that is $p_{s,t} = w_{s,t}$, $\forall t$.

The industrial sector is modelled following Melitz (2003). Differentiated industrial goods are sold in monopolistically competitive markets and are purchased by consumers as final consumption good and by firm as intermediate inputs. Standard optimization solution implies the total demand for any variety ω at time t can be written as

$$q_t(\omega) = D_t p_t(\omega)^{-\sigma} \tag{14}$$

where D_t denotes the aggregate size of the market and it is constant across all varieties. Given (14), the gross revenue function for a firm producing variety ω can be written as

$$G_t(\omega) = p_t(\omega) q_t(\omega) = D_t^{\frac{1}{\sigma}} q_t(\omega)^{\frac{\sigma-1}{\sigma}} \tag{15}$$

Because of the CES structure of consumer preferences, monopolistic competition leads to downward sloping demand and decreasing marginal revenue functions, since consumers' marginal utility from a particular variety declines with firms' supply.

Firms determine their output level $q(\omega)$ by choosing their intermediate input m given current productivity z end employment ℓ. Intermediate inputs are purchased to maximize (15) net of material costs. Substituting equation (11) into (15) the net revenue function can be expressed in terms of current period productivity, z, and employment values, ℓ:

$$R_t(z,\ell) = \max_{m\geq 0} \quad \{G_t(zm^{1-\alpha}\ell^{\alpha}) - P_t m\} \tag{16}$$

The solution to this optimization problem yields the following expression for the net revenue function,

$$R_t(z,\ell) = \Delta_t \left(z\ell^{\alpha}\right)^{\frac{\sigma-1}{\sigma-(1-\alpha)(\sigma-1)}} \tag{17}$$

where Δ_t is a revenue shifter, equal to $\Theta \left[D_t^{\frac{1}{\sigma}} P_t^{-(1-\alpha)\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-(1-\alpha)(\sigma-1)}} > 0$, and $\Theta = \frac{\sigma-(1-\alpha)(\sigma-1)}{(1-\alpha)(\sigma-1)} \left(\frac{(1-\alpha)(\sigma-1)}{\sigma}\right)^{\frac{\sigma}{\sigma-(1-\alpha)(\sigma-1)}} > 0$ is a constant.

3.5 Industrial firms' problem

At the beginning of a period t, incumbent firms decide whether to keep operating or not. Conditional on operating, they observe a new productivity level, z', and enter the interim stage of the period with an inherited stock of employees, ℓ. Conditional on the new realization of the productivity shock, each incumbent firm decides how many workers to employ in the current period, that is, whether to hire new employees, or to fire some of the existing employees, or to keep the same payroll. The value of a firm entering the interim stage with productivity z' and employees ℓ is thus equal to

$$\tilde{V}_t(z',\ell) = \max\{\tilde{V}_t^h(z',\ell), \tilde{V}_t^i(z',\ell), \tilde{V}_t^f(z',\ell)\} \tag{18}$$

where $\tilde{V}_t^h(z',\ell)$ is the firm's value of expanding, equal to

$$\tilde{V}_t^h(z',\ell) = \max_{\{\ell'>\ell\}} \quad \{\pi_t(z',\ell') - C(\ell,\ell') + V_{t+1}(z',\ell')\} \tag{19}$$

$\tilde{V}_t^i(z',\ell)$ is the firm's value of being inactive, equal to

$$\tilde{V}_t^i(z',\ell) = \pi_t(z',\ell) + V_{t+1}(z',\ell) \tag{20}$$

and $\tilde{V}_t^f(z',\ell)$ is the firm's value of downsizing, equal to

$$\tilde{V}_t^f(z',\ell) = \max_{\{\ell'<\ell\}} \quad \{\pi_t(z',\ell') - C(\ell,\ell') + V_{t+1}(z',\ell')\} \tag{21}$$

In equations (19)-(21), $\pi_t(z',\ell)$ is the gross profit at time t, defined as

$$\pi_t(z',\ell') = R_t(z',\ell') - \max\{\underline{w}_t, w_t(z',\ell')\}\ell' \tag{22}$$

where $\max\{\underline{w}, w_t(z',\ell')\}\ell'$ is the wage bill paid by the employer, while $V_{t+1}(z',\ell')$ is the firm continuation value at the beginning of time $t+1$. A solution to the problem of the firm is a sequence of policy functions for hiring $\mathbf{1}_t^h(z',\ell)$, resting $\mathbf{1}_t^i(z',\ell)$, and firing $\mathbf{1}_t^f(z',\ell)$, defined as

$$\mathbf{1}^s(z',\ell) = \begin{cases} 1 & \text{if} \quad \tilde{V}_t^s(z',\ell) = \max\{\tilde{V}_t^h(z',\ell), \tilde{V}_t^i(z',\ell), \tilde{V}_t^f(z',\ell)\} \\ 0 & \text{otherwise} \end{cases}$$

for $s \in \{h,i,f\}$ and $\forall t$, and policy function for employment, $L_t(z',\ell)$, $\forall t$. The problem of the industrial firms is characterized by three main features. First, the wage rate, $w_t(z',\ell')$, depends on firms' productivity and on the stocks of employees in firm's hand. This is the case because (1) search frictions create *rents* that are split between employers and employees and (2) the marginal revenue is *decreasing* in labor.[19] Second, the wage rate is subject to a the legal constraint imposed by the statutory minimum wage in force, $\underline{w}_t$. Finally, changes in employment are subject to adjustment costs, $C_t(\ell,\ell')$, and described by the following function,

$$C_t(\ell,\ell') = \begin{cases} C_t^h(\ell,\ell') = \frac{c_h}{\lambda_1}\left(\frac{v_t(z',\ell,\ell')}{\ell^{\lambda_2}}\right)^{\lambda_1}, & \text{if} \quad \ell' > \ell \\ C_t^f(\ell,\ell') = c_{f,t}(\ell - \ell'), & \text{if} \quad \ell' < \ell \\ 0, & \text{otherwise} \end{cases} \tag{23}$$

where $v_t(z',\ell,\ell')$ denotes the number of vacancies posted at time t by a hiring firm with productivity z' and initial stock of employed, ℓ, and it is equal to

$$v_t(z',\ell,\ell') = \frac{\ell' - \ell}{\phi_t} \tag{24}$$

The hiring cost profile is endogenously time-varying, as it depends on the job filling rate, ϕ_t along the transition path, and it is function of three main parameters, i.e. the parameter $c_h > 0$ that governs the overall cost of adjustment, the parameter $\lambda_1 > 0$ that governs the convexity of the cost with respect to the size of employment adjustment, and $\lambda_2 > 0$

[19] The wage rate is negotiated through the *intra-firm bargaining* protocol proposed by Stole and Zwiebel (1996). See section 3.8 for a description

governing the relative cost faced by small and large employers.[20] On the other hand, the firing costs are described by a single parameters, $c_{f,t}$, which is assumed to be constant, unless subject to an exogenous reform. Finally, I assume that firing costs are collected by the government and are rebated back to consumers, while the adjustment costs of hiring are incurred in terms of service good.

3.6 Firms′ entry and exit

At the beginning of period t, incumbent firms choose whether to keep operating or not: they compare the expected value of entering the interim stage with ℓ workers in hand against the outside option of closing down.[21] The ex-ante value of a firm with initial productivity z and employment, ℓ is thus equal to

$$V_t(z,\ell) = \max\left\{0, \frac{1-\delta}{1+r_t}\int_{z'\in\mathcal{Z}}\left(\tilde{V}_t(z',\ell) - c^o\right)\Gamma(z'|z)\right\} \tag{25}$$

where $\delta > 0$ is a fixed exogenous probability of firm death, c^o denotes a fixed operating cost, and $\Gamma(z'|z)$ denotes the transition function for productivity shocks. A solution to the problem of the firm is a sequence of policy functions for exit, $\mathbf{1}_t^o(z,\ell)$ defined as

$$\mathbf{1}_t^o(z,\ell) = \begin{cases} 1 & \text{if} \quad \tilde{V}_t(z',\ell) > c^o \\ 0 & \text{otherwise} \end{cases}$$

Each period, a large pool of potential firms decide whether to enter the industry and start a new business: they compare the expected value of operating, evaluated at the ergodic productivity distribution of the productivity shock, with the sunk cost of creating a new firm, $c_e\phi_t^{-\lambda_1}$, inclusive of capital fixed costs and initial hiring costs. With a positive measure of entrant firms in equilibrium, $N_{e,t} \geq 0$, a free entry condition must hold:

$$V_t^e = \int_{z\in\mathcal{Z}} \tilde{V}_t(z,1)\Gamma^e(z)dz \leq c_e\phi_t^{-\lambda_1}, \quad \text{with equality if} \quad N_{e,t} > 0 \tag{26}$$

where $\Gamma^e(z)$ is a time-invariant ergodic distribution of productivity shock derived from equation (10).

[20] Yashiv (2000) provides empirical evidence in favour of convex vacancy hiring costs. Other papers that include convexity adjustment costs in net employment include Nilsen et al. (2007) and Cooper et al. (2007).

[21] Notice that bankruptcy can be an attractive option for firms because (1) it allows to save on wage bills (plus taxes) of employees, (2) it allows to save on fixed costs of operation and (3) it allows to save on firing costs in case of dismissal of employees.

3.7 Workers′ problem

In this section I turn to describe the problems of the workers. Consider a worker who enter period t not employed in the industrial sector. At the beginning of period t, this worker has two different options: to work in the service sector or to search for a job in the industrial sector. Call J_t^o, J_t^s and J_t^u, the value of being not-employed in the industrial sector at the beginning of period t, the value of working in the service sector and the value of searching for a job in the industrial sector, respectively. The value of being not-employed in the industry at the beginning of period t reads as follows:

$$J_t^o = \frac{1}{1+r_t} \max\{J_t^s, J_t^u\} \tag{27}$$

where the value of being employed in the services, J_t^s, is equal to

$$J_t^s = \max_{c_{s,t}} \quad c_{s,t} + J_{t+1}^o \quad \text{s.t.} \quad P_t c_{s,t} \leq w_{s,t} = 1$$

where P_t denotes the aggregate price index in the economy, while the value of searching for a job in the industry, J_t^u is equal to

$$J_t^u = J_t^{u,h} + \widetilde{\phi}_t \int_{z' \in \mathcal{Z}} \int_{\ell \in \mathcal{L}} \max\{0, J_t^{e,h}(z', L_t(z', \ell)) - J_t^{u,h}\} g_t(z', \ell) dz' d\ell \tag{28}$$

where $J_t^{u,h}$ is the value of being unemployed at the interim stage of the period,

$$J_t^{u,h} = \max_{c_{u,t}} \quad c_{u,t} + J_{t+1}^o \quad \text{s.t.} \quad P_t c_{u,t} \leq b + b_t^u + \Pi_t + T_t \tag{29}$$

while $J_t^{e,h}(z', \ell')$ is the value of being employed at the interim stage of the period,

$$J_t^{e,h}(z', \ell') = \max_{c_{e,t}} \quad c_{e,t} + J_{t+1}^e(z', \ell') \quad \text{s.t.} \quad P_t c_{e,t} \leq \max\{\underline{w}_t, w_t(z', \ell')\} + \Pi_t + T_t \tag{30}$$

In equation (28), $g_t(z', \ell)$ denotes the distribution of vacancies posted in the interim stage of the period by hiring firms with productivity z' and ℓ stock of employees, whereas the term $\max\{0, J_t^{e,h}(z', L_t(z', \ell)) - J_t^{u,h}\}$ is the option value of accepting a job in the industrial sector.[22] In equation (29), b_t^u denotes any lump-sum transfer from government to unemployed workers. Finally, in equation (30), $J_{t+1}^e(z', \ell')$ denotes the continuation value of being employed in firm (z', ℓ').

With no savings technology available, the supply of workers searching for a employment in the industrial sector depends on their income outside the sector, i.e., their outside options. Because workers are free to direct their search to any type of job, in any equilibrium with

[22] In equation (28) it is acknowledged that the optimal employment choice, $L_t(z', \ell)$ is functions of the state variables (z', ℓ), over which the expectation is taken.

both sectors in operation and strictly positive measure of employees in the industrial sector, workers must be indifferent between J_t^s and J_t^u, so that $J_t^s = J_t^u$, $\forall t$.[23] Using condition (27), it must be that J_t^s and J_t^u are all equal to

$$J_t^o = \frac{1}{1+r_t}\left[c_{s,t} + J_{t+1}^o\right] \tag{31}$$

The equalization between value of searching for a job the industrial sector and the outside values works through the adjustment in the matching rates, $\tilde{\phi}_t$. Suppose $J_t^u > J_t^s$. If so, all job seekers would direct their search towards industrial jobs. As more and more workers apply, the contact rate with a hiring firm decreases up to the point where the value of searching for an industrial jobs is as profitable as the values of the outside options. The opposite, that is an increase in the workers' contact rate, would happen if $J_t^u < J_t^s$.

Consider now the problem of a worker who is employed in the industrial sector at the beginning of period t. This worker can separate from his job either because the firm decides to exit the industry, or because, after observing the new productivity level, the firm wants to contract her scale. In this case, the worker joins the pool of searchers and enjoy a value equal to J_t^o. On the other hand, if a worker keeps her job in the industrial sector, she will receive a new wage payment, $w_t(z', \ell') \geq \underline{w}$, conditional on the realization of the productivity shock and will start the next period employed. Industrial workers do not have the option of searching on-the-job.[24] Denote by $p_t^o(z, \ell)$ the probability for a worker of being dismissed because of firm exit and by $p_t^f(z', \ell)$ the probability for a worker of being fired by a contracting firm. Therefore, the value of being employed at the beginning of period t is equal to

$$J_t^e(z, \ell) = p_t^o(z, \ell) J_t^u + (1 - p_t^o(z, \ell)) \int_{z' \in \mathcal{Z}} \max\left\{J_t^u, J_t^c(z', \ell)\right\} \Gamma(z'|z) \tag{32}$$

where $J_t^c(z', \ell)$ is the value of continuing to work for the same employer, equal to

$$J_t^c(z', \ell) = p_t^f(z', \ell)) J_t^u + \frac{(1 - p_t^f(z', \ell))}{1+r_t} J_t^{e,h}(z', L_t(z', \ell)) \tag{33}$$

Notice that hiring and firing policies determine the probability of retaining a job in the future, impacting value and the stability of being employed for a given employer.

[23] As in Helpman et al. (2010), this feature of the model makes the equilibrium job finding rate decreasing in workers' income outside industrial jobs. This mechanism trace back at least to the Harris and Todaro (1970) model. See Cosar et al. (2016) for a discussion.

[24] Workers could at any moment leave their job and join the pool of job seekers. However, since in the model all the employers have to ensure at least the value of searching for a formal job to their employees, no workers have incentive to quit.

3.8 Wages

Wages for industrial employees are determined using the Binmore et al. (1986) bargaining solution, generalized to a setting when marginal returns are diminishing.[25] At the time of bargaining the labor market is already closed and the costs of posting vacancies are sunk. Upon matching, firms and workers meet and bargain simultaneously and on a one-to-one basis. Failing to reach an agreement would imply a loss for firms (who cannot recover back the costs of posting vacancies and cannot contact other workers in the current period to replace the existing ones) and for workers (who would instead forgo wage payments in the current period). The threats of a temporary disruption of production due to a breakdown of negotiations generates a surplus to split between parties, which is equal to the marginal flow surplus.[26] At the time of determining wages, firms marginal flow surplus is equal to:

$$\Pi_t^{\text{firm}}(z', \ell') = \frac{\partial R_t(z', \ell')}{\partial \ell'} - \frac{\partial w_t(z', \ell')\ell'}{\partial \ell'} \tag{34}$$

while worker marginal flow surplus equals the difference between wages and home production:

$$\Pi_t^{\text{worker}}(z', \ell') = w_{it}(z', \ell') - b \tag{35}$$

The bargaining problem consists of maximizing the joint marginal flow surplus subject to the participation constraints, ensuring a non-negative surplus accruing to the worker,

$$\max_{w_t(z', \ell')} \quad \Pi_t^{\text{firm}}(z', \ell')^{1-\beta} \Pi_t^{\text{worker}}(z', \ell')^{\beta}$$
$$\text{s.t.} \quad J_t^{e,h}(z', \ell') \geq J_t^{u,h}$$

where $\beta \in (0, 1)$ is the worker bargaining power in the wage negotiation.

Consider a firm currently hiring workers. New workers generate positive rents at a hiring firm, making the wage solution of the bargaining problem be implicitly determined by the following Nash sharing rule:

$$\beta \Pi_t^{\text{firm}}(z', \ell') = (1 - \beta) \Pi_t^{\text{worker}}(z', \ell') \tag{36}$$

Denote by $w_t^{\text{h}}(z', \ell')$ the solution to this problem. Consider instead an incumbent firm firing workers. In this case, the existing matches do not generate any more positive rents, making the worker participation constraint of the problem be binding. To see this, notice that, at the time of bargaining, firms has already chosen a level of employment up to the

[25] A similar strategy has been employed by Hall and Milgrom (2008) within a single-worker firm model and more recently by Elsby and Gottfries (2019) in multi-worker firm model.

[26] Hall and Milgrom (2008) argue that threat of a permanent suspension of negotiations is not credible in this protocol. Regardless of a breakdown in the current period, the firm will rather prefer to resume negotiations with the same workers in the subsequent period instead of replacing him with a different worker.

point where optimality condition is re-established, i.e. up to a level where $\Pi_t^{\text{firm}}(z', \ell') = -c_{f,t} - \frac{\partial V_{t+1}(z',\ell')}{\partial \ell'} < 0$. The Nash splitting rule would then imply a negative total flow surplus, invalidating the participation constraint. Therefore, the unique wage solution of the bargaining problem between a worker and a firing firm is the one ensuring the participation constraint is satisfied:

$$J_t^{e,h}(z', \ell') = J_t^{u,h} \tag{37}$$

which implies the following wage for workers at a firing firm,

$$w_t^{\text{f}}(z', \ell') = J_t^{u,h} - J_{t+1}^{e}(z', \ell') \tag{38}$$

Notice that this bargaining protocol generated dispersion of wage of workers also across firing firms, since workers who continue to be employed enjoy the continuation value $J_{t+1}^{e}(z', \ell')$. Finally, consider a resting firm. In this case, depending on stock of workers employed and productivity level, the existing matches could generate positive rents - if revenues are large but not enough to cover hiring costs and expand - making the wage solution be at the interior, or negative rents, - if revenues are low but not enough to make job destruction a viable option - driving the wage solution to the corner. Therefore, the wage for workers at a resting firm is equal to the maximum of the previous two, i.e.

$$w_t^{\text{i}}(z', \ell') = \max\{w_t^{\text{h}}(z', \ell'), w_t^{\text{f}}(z', \ell')\} \tag{39}$$

4 Open economy

I now turn to describe the open-economy version of this model. I consider two countries, home h and foreign f, and I assume the home-economy to be small relative to the foreign one: under this assumption foreign conditions do not react to changes in the home-policies. I assume markets are internationally segmented and only industrial varieties can be traded across borders. Service goods are assumed to be non-tradable. Denote by $N_{h,t}$ the measure of varieties produced in the home-country and by $N_{f,t} = N_t - N_{h,t}$ the measure of varieties produced abroad.

4.1 Prices and aggregates

Let $p_t(\omega^*)$ be the free on board (FOB) price of a variety ω^* produced in the foreign country, denominated in foreign currency and exogenous to home-country conditions. Denote by $P_{f,t}$ the price index of imports,

$$P_{f,t} = \left(\int_0^{N_{f,t}} p_t(\omega^*)^{1-\sigma} d\omega^* \right)^{\frac{1}{1-\sigma}} \tag{40}$$

and by $P_{h,t}$ the be the price index of domestic varieties,

$$P_{h,t} = \left(\int_{N_{f,t}}^{N_t} p_t(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}} \tag{41}$$

An ideal home price index for the aggregate industrial good, P_t, can written as

$$P_t = \left(P_{h,t}^{1-\sigma} + (\tau_{c,t}\tau_{a,t}k_t P_{f,t})^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \tag{42}$$

where $\tau_{c,t} \geq 1$ denotes iceberg cost trade, $\tau_{a,t} - 1 \geq 0$ denotes ad-valorem tariff on imports and k_t is the equilibrium exchange rate. Since the exchange rate adjusts in general equilibrium to clear the trade balance, and foreign economy is exogenous to changes in the home-country, we can normalize the foreign price index and set $P_{f,t} = 1$. Finally, let the foreign price of domestic good exported abroad be $p_t^*(\omega)$, denominated in foreign currency. An ideal foreign market price index for exported goods, denominated in foreign currency, is defined as

$$P_{h,t}^* = \left(\int_{N_{f,t}}^{N_t} \mathbf{1}_t^x(\omega) p_t^*(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}} \tag{43}$$

where $\mathbf{1}_t^x(\omega)$ is an indicator function that equals one if variety ω is exported, zero otherwise.

Let $D_{h,t}$ be the aggregate size of the domestic market and let $D_{f,t}$ denote the aggregate size of the foreign market, expressed in units of foreign currency, and assumed to be exogenous to the home-country.[27] Given the domestic and the foreign price indexes, the total domestic demand for any domestic variety $\omega \in (N_{f,t}, N_t]$ at time t can be written as

$$q_t(\omega) = D_{h,t} p_t(\omega)^{-\sigma} \tag{44}$$

Similarly, the total domestic demand for any imported variety $\omega^* \in [0, N_{f,t}]$ reads as

$$q_t(\omega^*) = D_{h,t} [\tau_{a,t}\tau_{c,t}k_t p_t(\omega^*)]^{-\sigma} \tag{45}$$

whereas the total foreign demand for any domestic variety $\omega \in (N_{f,t}, N_t]$ exported abroad is equal to

$$q_t(\omega) = D_{f,t} p_t^*(\omega)^{-\sigma} \tag{46}$$

Given the demand functions (44) and (46), the gross revenue function of non-exporting domestic firms can be written as

$$G_{h,t}(\omega) = D_{h,t}^{\frac{1}{\sigma}} q(\omega)^{\frac{\sigma-1}{\sigma}} \tag{47}$$

[27] See the supplementary section for a full derivation of $D_{h,t}$.

whereas the gross revenues of an exporting domestic firms are equal to

$$G_{f,t}(\omega) = [D_{h,t} + k_t^{\sigma}\tau_{c,t}^{-(\sigma-1)}D_{f,t}]^{\frac{1}{\sigma}}q(\omega)^{\frac{\sigma-1}{\sigma}} = G_{h,t}(\omega)[1+d_{f,t}]^{\frac{1}{\sigma}} \tag{48}$$

where $d_{f,t}$ is the *revenue premium from exporting*, defined as the ratio between the foreign market capacity and the domestic revenues,

$$d_{f,t} = k_t^{\sigma}\tau_{c,t}^{-(\sigma-1)}\frac{D_{f,t}}{D_{h,t}} > 0 \tag{49}$$

and capturing the extra revenue generated by exporting, conditional on output.

4.2 Export decision

Each period t, before taking input decisions, incumbent firms decide whether to sell their product abroad or not. Participation in the export market is a static decision for the industrial producers, who bear a fixed cost of exporting c_x. Given output levels $q(\omega)$, firms choose to export so to maximize their current gross sales revenues, i.e.

$$G_t(q(\omega)) = \max\{G_{h,t}(q(\omega)), G_{f,t}(q(\omega)) - c_x\} \tag{50}$$

where $G_{h,t}(q(\omega))$ and $G_{f,t}(q(\omega))$ are defined in equations (47) and (48).

A solution for policy export participation, $\mathbf{1}_t^x$ is an indicator function defined as follows:

$$\mathbf{1}_t^x = \begin{cases} 1 & \text{if} \quad G_{f,t}(q(\omega)) - c_x > G_{h,t}(q(\omega)) \\ 0, & \text{otherwise} \end{cases} \tag{51}$$

Using equations (47) and (48) the total gross revenues can be written as a function of the export participation policy, policy (51),

$$G_t(q(\omega)) = D_{h,t}^{\frac{1}{\sigma}}[1+\mathbf{1}_t^x d_{f,t}]^{\frac{1}{\sigma}}q(\omega)^{\frac{\sigma-1}{\sigma}} - c_x\mathbf{1}_t^x \tag{52}$$

4.3 Trade balance

Given the domestic demand for foreign variety ω^* in equation (45), the value of aggregate imports expressed in unit of local currency, and before tariffs on import are imposed, is equal to

$$\int_0^{N_{f,t}} D_{h,t}[\tau_{a,t}\tau_{c,t}k_t p_t(\omega^*)]^{1-\sigma}d\omega^* = D_{h,t}(\tau_{c,t}\tau_{a,t}k_t)^{1-\sigma} \tag{53}$$

where the equivalence comes from the definition of price index for imported varieties, given in equation (40). Taking tariffs into account, the domestic demand for foreign currency

equals

$$\frac{D_{h,t}}{\tau_{a,t}}(\tau_{c,t}\tau_{a,t}k_t)^{1-\sigma} = D_{h,t}\tau_{a,t}^{-\sigma}(\tau_{c,t}k_t)^{1-\sigma} \tag{54}$$

Given the foreign foreign demand for domestic variety ω in equation (46), the value of aggregate exports, expressed in domestic currency, is equal to

$$\frac{k_t}{\tau_{c,t}}\int_{N_{f,t}}^{N_t}\mathbf{1}_t^x(\omega)D_{f,t}p_t^*(\omega)^{1-\sigma}d\omega = \frac{k_t}{\tau_{c,t}}D_{f,t}P_{h,t}^{*1-\sigma} \tag{55}$$

where the equivalence comes from the definition of price index for domestic varieties exported abroad, given in equation (43).

4.4 Government

Government revenues are collected from two different sources, namely tariffs on imports

$$D_{h,t}\tau_{a,t}^{-\sigma}(\tau_{c,t}k_t)^{1-\sigma}(\tau_{a,t}-1) \tag{56}$$

and firing costs,

$$c_{f,t}\int_{z\in\mathcal{Z}}\int_{\ell\in\mathcal{L}}\mathbf{1}_t^f(z',\ell)(\ell-\ell')\tilde{\psi}_t(z',\ell)dz'd\ell \tag{57}$$

Government revenues are returned to unemployed worker in form of unemployment benefit (if positive) and, what left, to each worker in the form of lump-sum transfers.

4.5 Mechanisms

Trade openness, unemployment and inequality - The evolution of the unemployment rate after a trade reform is tightly linked to the employment adjustments of firms and to the reallocation of workers across employers. A reduction in trade costs boosts cross-border flows of goods for intermediate and final consumption. Lowering trade barriers produces two opposing forces. On the one hand, it increases *import penetration* of foreign varieties in the domestic market and reduces revenues in small, low-productive, non-exporting firms, that respond, on impact, by displacing workers or by adjusting wages downward. On the other hand, trade liberalization magnifies the value of participating in the foreign market: large, high-productive firms can benefit from higher foreign market revenues by starting exporting or by increasing their *export flows*, and respond to lower trade costs by expanding their size. However, because of search frictions in the labor market and convexity in the hiring costs, exporting firms grow slowly, making reallocation of workers toward larger and higher productive employers sluggish. Moreover, since the hiring costs per worker vary with size, the rate at which industrial firms adjust employment and wages in response to shocks depends upon their size. After the initial response, labor market dynamics is governed by larger

firms. Along the transition towards the new steady state, low-productivity firms become less responsive to shocks, employment is reallocated towards larger and more-stable firms and job turnover is triggered by the larger revenue steepness of exporting firms.

Polarization in the marginal revenue product of firms translates into higher wages paid by exporting firms and lower wages paid by import competing firms. On impact, the distribution of wages across firms becomes more dispersed and remains so along the transition towards the new equilibrium. Dispersion of income will reflect dispersion of wage on one side, but will also react to job reallocation from the industrial to the service sector and worker reallocation out of employment on the other side.

Labor market institutions enter the picture by introducing *price* and *quantity rigidity*, which distorts the adjustments in labor demand and wage payments after a trade shock, with effects on employment volatility, workers turnover and, ultimately, unemployment rate and income inequality.

Effect of firing costs - In partial equilibrium, higher firing costs make firms employment less volatile by discouraging labor adjustments to fluctuations in revenues. To this extent, employment protection legislation introduces a *quantity rigidity*: as in Bertola and Caballero (1994), higher firing costs increase the cost of downsizing after a negative productivity shock, hampering labor mobility and increasing labor hoarding, thus keeping alive unproductive matches that would otherwise disappear. In general equilibrium, the opposite effect arises. Stricter EPL increases the future costs of hiring, both directly, by rising the expected costs of dismissing workers, as in Hopenhayn and Rogerson (1993), and indirectly, by modifying the firms probability of filling vacancies. Firms react by posting less vacancies, generating a positive pressure on unemployment. Accordingly, the effect of firing costs on unemployment is ambiguous. The effect of firing costs on the dispersion of income after trade reform is ambiguous too. Lower firing costs increase firms' selection and shift the firm size distribution rightward, inducing a less dispersed distribution for the marginal revenue product of labor, thus reducing wage dispersion across firms. On the other hand, this increases the value of employment in the industrial sector. In order for the no-arbitrage condition between sectors to hold, this effect has to be offset by a further reduction in the job finding probability, which contributes to increase income inequality through unemployment and workers reallocation across sectors.

Effect of minimum wage - A binding statutory minimum wage introduces a *price rigidity*: higher minimum wage prevents firms to cut wages in response to a negative productivity shock. It rather magnifies the downward adjustment of employment, leading to larger job displacement. In the aftermath of trade reform, a high minimum wage is likely to hurt small, low-productivity firm relatively more, since the constraint on wage is relatively more likely to be binding. On the other hand, a higher minimum wage induces a selection mechanism, by shifting the productivity/size threshold for operating in the industry rightward, and reducing the dispersion of wages across firms. As the economy approaches the new steady state,

only high-productivity firms survive, inducing a new distribution for the marginal revenue product of labor which in turn feeds back into the distribution of wages, the distribution of new vacancy for jobs and the job filling rate, confounding the net effect of a high minimum wage on unemployment rate and inequality.

Non-tradable service sector - The consequence of a trade reform for the employment in the non-tradable sector are ambiguous too. As in Melitz (2003), trade openness triggers concentration of industrial employment in the hands of a smaller measure of high-productivity, exporting firms. As long the as the expansion of those firms does not compensate the workforce displacement of low-productivity firms, workers are permanently forced out the industrial employment, either into unemployment or into services. The extent to which the service sector can operate as buffer for workers who are displaced depends on the *no-arbitrage condition* between the values of searching for a job in the industrial sector and the value of working in the services. Regulations in the labor market modify employment concentration by inducing firm selection, with consequences for employment reallocation across sectors.

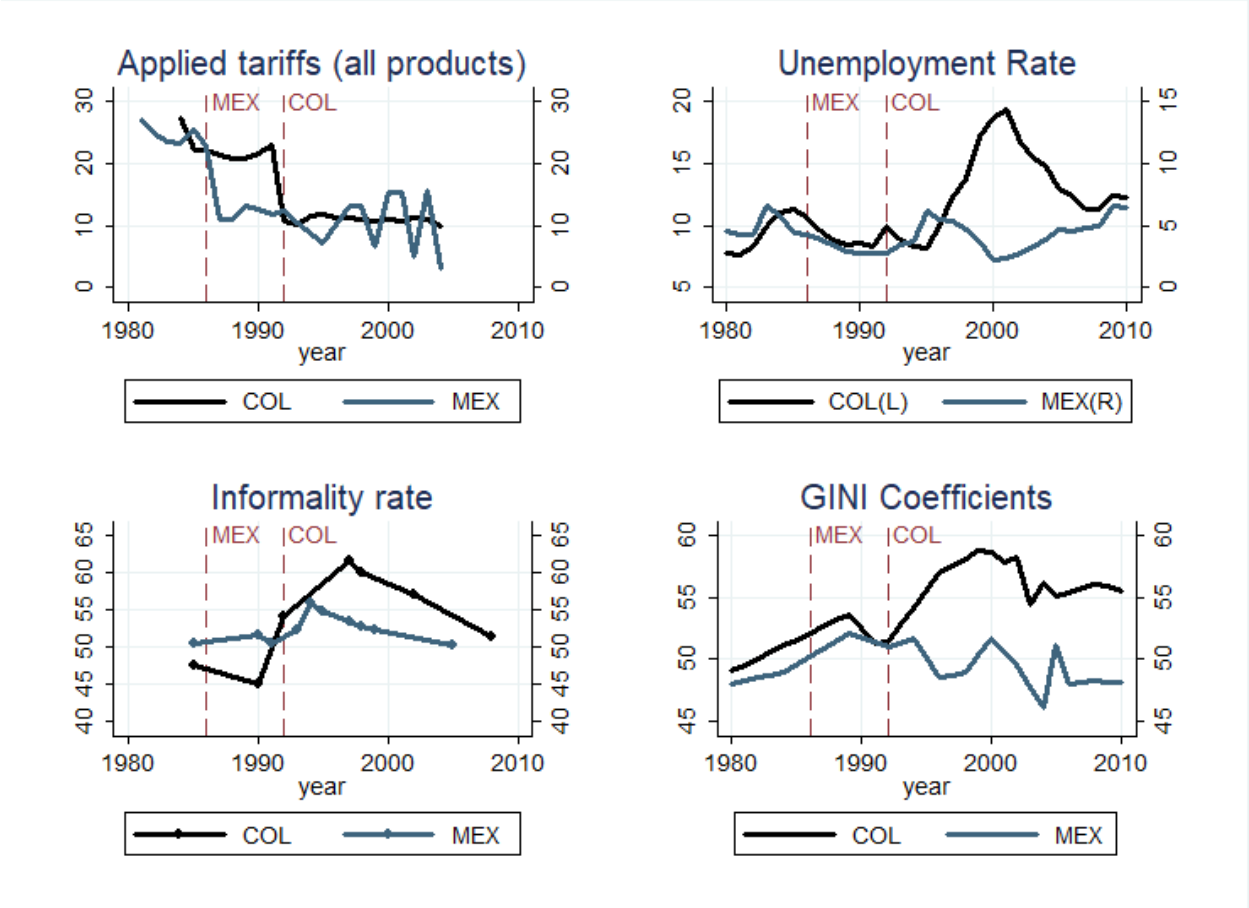
Finally, in the Appendix B, I discuss the notion of recursive competitive equilibrium for this economy and provide the conditions that characterize it.

5 The cases of Colombia and Mexico

To explore the mechanisms proposed above, I compare the cases of Colombia and Mexico. Between the end of the 1980′s and the beginning of the 1990′s, both Colombia and Mexico went through a massive series of trade and investment reforms. As part of the *Apertura* (opening) plan, from 1985 to 1994 Colombia gradually liberalized its trading regime by reducing the tariff levels and virtually eliminating all the non-tariff barriers to trade, a process that culminated in the drastic reductions of 1990-91. In this decade, the average tariff across all industry declined from 21 to about 11 percent (Goldberg and Pavcnik, 2004), with a drop from 50 to 13 in the only manufacturing sector. As for protection through non-tariff barriers, the average coverage ratio went from 72.2 percent in 1986 to 10.3 percent in 1992 (Attanasio et al., 2004a). Throughout the 1990s, further trade reforms were implemented, including bilateral trade agreements with other Latin American countries in 1993-94.

During the second half of the ′80s, after more than a decades of pursuing an import-substitution industrialization strategy, Mexico initiated a radical liberalization of its external sector as well. In 1984, Mexico pursued a policy of privatization and liberalization in order to attract foreign direct investment (Henry, 1999). In 1985, a program of stabilization and structural adjustment was implemented, including trade liberalization. After signing the General Agreement on Tariffs and Trade (GATT) in 1985, official prices for imports were entirely abolished. Import licensing requirements were scaled back to about a quarter of their previous levels - the domestic production value covered by import licensing went from

Figure 2: **Mexico VS Colombia**



Note: This figures report the evolution of average tariffs on imports, unemployment rate, informality rate and income inequality (GINI coefficient on income) before and after the trade liberalization for Colombia and Mexico.

92.2 percent in 1985 to less than 20 percent by 1989 - while the production-weighted tariff averages fell from 23 per cent in 1986 (Dornbusch and Werner, 1994) to 12.5 per cent in 1989 (Puyana, 2010). Eventually, with the entry into force of the North America Free Trade Agreement (NAFTA) in 1994, almost 70 per cent of U.S. imports from Mexico and 50 per cent of U.S. exports to Mexico received duty-free treatment, the average Mexican tariff rate dropped from 12 percent in 1993 to 1.3 percent in 2001 and the U.S. tariffs on imports from Mexico fell from around 2 percent to 0.2 per cent (Kose et al., 2004).

Adjusting to these episode of trade liberalization triggered a substantial reallocation of resources between and within production sectors of the Mexican and the Colombian economy. However, the trade openings in Colombia was followed by different patterns of unemployment, informality and income inequality compared to Mexico. Panel B in Figure 2 report the evolution of the unemployment rate in both countries from 1980 to 2010. The stock of jobless workers dramatically increased in Colombia, going from an average of roughly 10 percent before 1992 to almost 20 per cent in 1998. As opposed to Colombia, Mexican unemployment only slightly increased along this period, experiencing a single upward spike in

Table 4: **Pre- and post-reforms conditions**

	COLOMBIA		**MEXICO**	
	Pre	**Post**	**Pre**	**Post**
Trade barriers				
Tariffs (%)	21.1	11.0	23.0	12.5
NTB (%)	73.2	10.3	92.2	13.4
Export dynamics				
Share exporting firms	0.119	0.301	0.216	0.359
Export revenue share	0.134	0.225	0.212	0.267
Trade balance, % GDP	4.660	-3.289	6.283	-1.118
Unemployment/Informality				
Unemployment rate	0.091	0.129	0.049	0.041
Informality rate	0.463	0.567	0.504	0.525
Job turnover rate	0.165	0.226	0.168	0.181
Manufacturing share	0.313	0.273	0.260	0.249
Income Inequality				
GINI	50.04	56.01	48.97	49.50
$90^{th}/10^{th}$ ratio	3.44	4.23	3.27	3.27
Labor market institutions				
Firing costs	0.50	0.083	0.27	
Minimum wage	0.54		0.33	
Unemployment benefits	0		0	

Note: "Pre" and "Post" refer to pre- and post-liberalization periods as defined by Sachs and Warner (1995). Firing costs and minimum wages are expressed as multiple of the average yearly real wage (source: FRdB Database). The unemployment benefits refer to the coverage rate (source: FRdB Database). The unemployment rate is from the ILO-stat database. The informality rate for Colombia is constructed using the National Household Survey Program (Encuesta Nacional de Hogares, ENH) while the informality rate for Mexico is constructed using the Mexican Employment Survey (Encuesta Nacional de Empleo Urbano, ENEU).

1995 during the Mexican "peso crisis", and reverting back afterwards. As for unemployment, Colombia experienced a significant surge in the rate of informal employment, an increase in job turnover and a rise in income inequality, measured by the Gini coefficient, after 1992 (see panel E in Figure 2).[28] In contrast, inequality did not increase in Mexico (it slightly decreased after 2000) and informal employment mirrored the evolution of the unemployment rate.[29]

The labor market institutions in place at the time of trade liberalization were very different between Colombia and Mexico. Table 4 reports the values of firing costs, minimum wage and unemployment insurance observed in both countries before and after the year of

[28]Informality rate refers to the share of wage and salary workers without social security benefits plus the share of workers in firms with less than five employees.

[29]This evidence on inequality is reinforced when I compare the income share held by the households at the lowest 10 per cent of the income distribution over the shares held by the richest 10 per cent across countries. See Table 4.

reform. On the one hand, Colombia massively cut dismissal costs at the beginning of the 90s, while Mexico kept a rigid labor market. At the time of trade reform, Colombian employers were required to deposit a contribution equal to 8 percent of the yearly real annual wage (corresponding to roughly one month) into a savings fund, eventually accessible to workers in the event of separation, whereas in Mexico the severance payment legislation, defined under Labor Law Article 165, prescribed an obligation of 90 days (roughly three months) of minimum daily salary for each year of service.[30] Moreover, the advance notice for termination of indefinite contracts in Colombia was set to 15 days a year whereas in Mexico it was kept to one month (Heckman and Pages, 2000), and the compensation for dismissal due to economic reasons for one-year tenure workers was reduced to 45 days, one third than what observed in Mexico.[31] On the other hand, the minimum wage legislation in Colombia was much stricter than Mexico. At the beginnings of the 1990s, the average statutory minimum wage in Colombia amounted to roughly 50 percent of the average market wage, versus 34 percent in Mexico.[32] For the same period, Bell (1997) reports values for the minimum wage of white and blue collar workers in Mexican manufacturing sector, amounting, respectively, to 22 and 42 percent of their average wage in 1984. The same figures reported for Colombia amount to 39 percent for high-skill workers, 52 percent for low-skill workers, and 73 percent for apprentice workers in 1987.[33] Notice that, in both countries, at the time of trade openings no unemployment insurance system was in place (FRdB-IMF, 2018).

6 Bringing the model to the data

Assuming that both economies were in steady state before the trade reform, I fit the model respectively to the periods 1981-1990 for Colombia and 1984-1986 for Mexico, so to replicate the pre-liberalization behavior of these two economies. The model is set to fit the distribution of employment in the autarckic steady-state, together with the size distribution of plants, export dynamics and plant turnover.

[30]Source: Kugler (1999) for Colombia and Grandolini and Cerda (1998) - based on information provided by the Instituto Mexicano de Seguridad Social (IMSS)- for Mexico.
[31]Source: Kambourov (2009) and IADB Report (1997) based on information from Ministries of Labour.
[32]Source: ILO-stat. When the figures are missing, I construct them converting the annual nominal minimum wage reported by the ILO-stat into real minimum wage (at 2005 constant prices) using the PPP conversion factor, and then dividing them by the average real wage observed in the same year.
[33]Bell (1997) documents a divergent trend in the real value of the legally imposed minimum wage in Mexico and Colombia in the 1980s, leading by 1990 to a level equal to just 13% of the average unskilled manufacturing wage in Mexico and roughly 53% of the average unskilled wage in Colombia. As explained in Maloney and Mendez (2004), the difference between these two patterns can be partly explained by the wage indexation to past inflation (*salario minimo movil*), imposed by the Constitution in Colombia and not present in Mexico.

Table 5: **Calibration**

Panel A: External Parameters

Description	Symbol	COLOMBIA Value	MEXICO Value	Source
Discount rate (%)	r	10.9	6.46	Ruhl and Willis (2017) / Riaño (2009)
Service share (%)	$1-\gamma$	52.4	49.9	ECLAC-CEPAL
Service wage (2012 USD)	w_s	3165.67	5680.13	author's calculation
Elasticity varieties	σ	6.43		Baier and Bergstrand (2001)
Matching elasticity	θ	1.84		Fajgelbaum (2016)
Bargaining power	β	0.5		standard
Exporter revenue premium	d_f	1.135	1.271	export-sales ratio

Panel B: Policy Parameters

Description	Symbol	COLOMBIA Value	MEXICO Value	Source
Tariffs	τ_a-1	0.21	0.23	Goldberg and Pavcnik (2004) / Dornbusch and Werner (1994)
Iceberg costs	τ_c-1	1.52		Anderson and Van Wincoop (2001)
Firing costs/mean wage	$c_f/\overline{w}$	0.50	0.27	FRdB-IMF (2018)
Minimum/mean wage	$\underline{w}/\overline{w}$	0.54	0.33	FRdB-IMF (2018) / Bell (1997)
Unemployment benefit	b^u	0		FRdB-IMF (2018)

Note: This table reports the list of parameters either directly calibrated into the model or taken from the literature.

6.1 Parametrization

A number of parameters are taken from outside the model. Panel A in Table 5 describes them and their sources. I fix a time period in the model equal to one year and population is normalized to one. I set the discount rate, r, to be consistent with an observed average real borrowing rates of 6.46% in Mexico as in Riaño (2009), and 10.9% in Colombia as in Ruhl and Willis (2017). I use information from the ECLAC-CEPAL database to compute the average share of service sector value added out of GDP during the sample periods, and I set $1-\gamma$ equal to 0.499 for Mexico and 0.524 for Colombia. The elasticity of substitution between varieties, σ, is taken from Baier and Bergstrand (2001), who estimate a value equal to 6.43. Following Fajgelbaum (2016), I fix the parameter governing the elasticity of matching function, θ, equal to 1.84, and I set the worker bargaining power, β equal to one half in both countries. As a numeraire of these economies, I calculate the average annual service sector wage (or equivalently, the price of the service good), to be equal to $w_s = \$3165.67$ in 2012 US dollars for Colombia and to $w_s = \$5680.13$ in 2012 US dollars for Mexico during the reference period.[34]

The remaining parameter calibrated without solving the model is the exporter revenue premium, $d_{f,t}$, which is treated as exogenous in the estimation algorithm, and assumed to fixed in the autarkic steady state, i.e. $d_{f,0} = d_f$. To calibrate d_f, I match the average share

[34]See the Appendix for details on the source and the construction of the external parameters.

of output exported abroad out of total output, which in the model is equal to

$$1 - \frac{1}{(1+d_f)^{\sigma}}$$

Using the calibrated values of σ, I find values for d_f equal to 0.134 in Colombia and to 0.212 in Mexico.[35] Finally, I choose the *policy* parameters, i.e. the tariffs on imports, τ_a, the firing costs, c_f, the minimum wage, $\underline{w}$, and unemployment benefit, b^u, to be consistent with the values observed in both countries before the reforms (see panel B in Table 5). Finally, I set the iceberg costs, τ_c to 1.52, as in Anderson and Van Wincoop (2001).

6.2 Internal calibration

6.2.1 Moment Selection and Identification

This leaves a vector of 11 *structural* parameters, $\vartheta = \{c_o, c_x, c_e, c_h, \lambda_1, \lambda_2, \rho_z, \sigma_z, \alpha, \delta, b\}$, plus the size of the domestic market, D_h, which is endogenously determined as an equilibrium outcome.

These parameters are calibrated using indirect inference.[36] In the specific, let $\overline{m}(\vartheta)$ be a vector of $g \geq \dim[\vartheta]$ moment conditions, defined as

$$\overline{m}(\vartheta) = \overline{m} - m(\vartheta)$$

where $\overline{m}$ is a vector of sample statistics while $m(\vartheta)$ is a vector of simulation-based statistics. The vector of parameters' values, $\hat{\vartheta}$ can be defined as the argument that minimize the following objective function,

$$\hat{\vartheta} = arg \min_{\vartheta \in \Theta} \quad \overline{m}(\vartheta)' \hat{\Sigma} \overline{m}(\vartheta) \tag{58}$$

where $\hat{\Sigma}$ is a $g \times g$ symmetric positive definite matrix. To implement this estimation, for a given guess of the parameter vector, ϑ_0, I solve the dynamic programming problem in the pre-reform stationary equilibrium, and I find the relevant policy functions for firms and workers. I use these policy functions to simulate the behaviour of large pool of plants and workers over a large number of periods, I discard the first T periods to mitigate the effect of the initial conditions, and use the remaining observations to compute the same moments, $m(\vartheta_0)$, as those constructed from the data. I then search over the parameter space, Θ, and update the initial guess until the vector of moments generated by simulating the model is close enough to the vector of statistics obtained from the data. In the estimation algorithm,

[35] These values are obtained using the Colombian Annual Manufacturer Survey for the period 1981-1990, and from the Mexican Annual Industrial Survey for the period 1984-1986. See the section on estimation for a description of the data.

[36] See, for instance, McFadden (1989), Pakes and Pollard (1989) and Gourieroux and Monfort (1996)

Table 6: **Moment Selections**

	COLOMBIA		MEXICO	
Moments	**Data**	**Model**	**Data**	**Model**
Firm-level moments				
$\mathbf{E}[\ln l_t]$	3.619	3.797	3.303	3.122
$\mathbf{E}[\ln g_t]$	5.430	5.432	4.559	4.741
$\mathbf{E}[\mathbf{1}_t^x]$	11.89	10.86	21.56	20.29
$\text{corr}[\mathbf{1}_t^x, \mathbf{1}_{t-1}^x]$	9.10	8.953	14.0	14.05
$\mathbf{E}[\mathbf{1}_t^x \vert \mathbf{1}_{t-1}^x = 0]$	2.71	2.018	3.91	4.041
Log-employment distribution				
20^{th} perctile	2.676	2.831	1.946	2.085
40^{th} perctile	3.178	3.343	2.944	2.622
60^{th} perctile	3.720	3.927	3.761	3.323
80^{th} perctile	4.450	4.662	4.625	4.066
Firm size distribution				
1-49 employees	70.81	70.94	82.66	83.08
50-99 employees	14.01	13.63	9.18	9.423
100-199 employees	7.90	8.132	4.55	5.010
200-499 employees	5.21	5.294	2.30	1.909
Aggregate moments				
Job turnover rate	16.54	14.95	16.08	14.23
Exit rate	12.38	10.87	11.01	11.32
Labor share	45.01	44.26	34.10	34.01
Average (industrial) wage	18.87	19.21	3.02	3.001
Vacancy rate	2.27	2.39	1.51	1.39

Note: This table reports selected data-based and model-implied moment statistics used in the estimation.

I choose $\hat{\Sigma}$ to be an identity matrix. In order to deal with non-smoothness of the objective function and avoid local minima, I use a genetic algorithm to search over the parametric space and solve the optimization problem in equation (58).[37]

To construct the relevant firm-level moment conditions, I use information on Colombian manufacturing plants collected in the Annual Manufacturer Survey (*Encuesta Anual Manufacturera* - EAM) and provided by the Colombian National Statistics Department (DANE) while, for Mexico, I rely on the Annual Industrial Survey (*Encuesta Industrial Anual*, EIA) produced by the National Institute of Statistics, Geography and Information (INEGI), which

[37]Genetic algorithm is global stochastic search method based on a natural selection process that mimics biological evolution. Is is usually employed to solve optimization problems in which the objective function is discontinuous, non-differentiable, stochastic, or highly non-linear. See Malhotra et al. (2011)

Table 7: **Estimates from Method of Simulated Moments**

		COLOMBIA	MEXICO
Description	**Symbol**	**Value**	**Value**
Fixed cost of operating	c_o	7.094	5.991
Fixed cost of exporting	c_x	120.59	52.82
Cost of entry ($= V^e$)	c_e	55.63	69.01
Constant, hiring costs	c_h	0.616	0.859
Convexity, hiring costs	λ_1	2.474	2.469
Scale effect, hiring costs	λ_2	0.813	0.103
Productivity persistency	ρ_z	0.963	0.959
Innovation volatility	σ_z	0.143	0.164
Employment elasticity	α	0.224	0.115
Exogenous firm exit	δ	0.037	0.010
Home production	b	0.419	0.405
Objective Function, % deviation		**4.97**	**7.31**

Note: This table reports the estimates for the *structural* parameters estimates using MSM, $\vartheta = \{c_o, c_x, c_e, c_h, \lambda_1, \lambda_2, \rho_z, \sigma_z, \alpha, \delta, b\}$.

contains information on Mexican manufacturing firms.[38,39] Both data have annual frequency, and provide with standard information on revenues, number of registered employees and their remuneration, export decision, material and other inputs usage, for a number of consecutive periods.

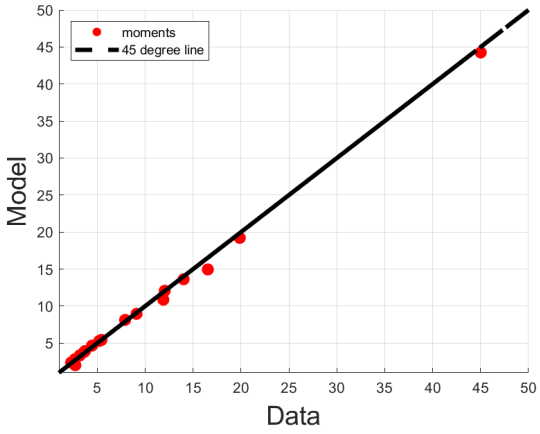
Table 6 reports the list of firm-level statistics and other aggregate moments used in the calibration algorithm. For both countries, I employ 18 moments, divided in three main groups. The first set of moments consists of mean and cross-sectional variance for the log of employment, $\mathrm{E}[\ln l_t]$ and the log of gross revenues $\mathrm{E}[\ln g_t]$ (expressed, in both countries, in terms of thousands of 1977 LCU), the mean for the export decision, $\mathrm{E}[\mathbf{1}_t^x]$, an indicator taking value one any time a plant reports positive exports, zero otherwise, the autocorrelation of export decision, $\mathbf{corr}[\mathbf{1}_t^x, \mathbf{1}_{t-1}^x]$, and the entry rate into export for non-exporting firms, i.e. $\mathbf{E}[\mathbf{1}_t^x | \mathbf{1}_{t-1}^x = 0]$. The second group of moments includes the quantiles of the log employment distribution and the firm distribution across selected size bins, while the last set of moments include aggregate statistics such as the firm exit rate, the job turnover rate, the average

[38]The Colombian Annual Manufacturer Survey has been used, among the others, by Roberts and Tybout (1996) and Cosar et al. (2016). After cleaning, the dataset covers 152,580 plant-year observations for employers with more than 10 employees over the sample period, 1981-1990.

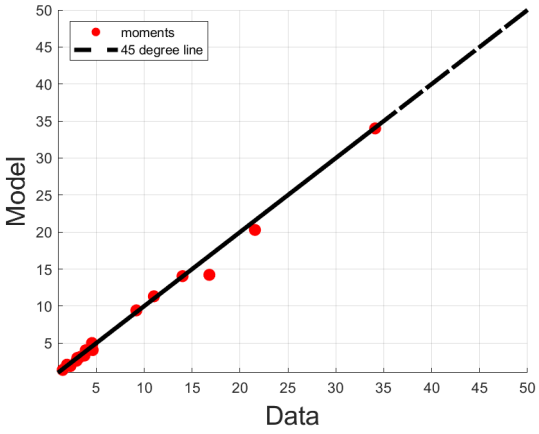
[39]The Mexican Annual Industrial Survey appears, among the others, in Tybout and Westbrook (1995) and Riaño (2009). After cleaning, it covers 9,657 firm-year observations for employers with more than 5 employees over the sample periods, 1984-1986.

Figure 3: **Estimation fit**

(a) Colombia



(b) Mexico



Note: This figure reports data and model-based statistics for Colombia (LHS) and Mexico (RHS)

wage, the payment compensation share of revenues and vacancy rate.[40,41]

In what follows, I discuss how these statistics will help identify the parameters in ϑ. Even though the model does not admit any closed-form map from a particular parameter to a specific moment, still each moment carries information about the underlying structural parameters. The average firm exit rate will discipline the magnitude of the fixed cost of operating a firm, c_o, as larger fixed costs will force a larger share of businesses to shut down, while the share of exporting firms will identify the costs of exporting, c_x, since lower fixed costs will induce a larger number firms to sell their product in the foreign markets.

As in Hopenhayn (1992), the cost of starting a business, c_e, will be such that the free entry condition is satisfied with a strictly positive mass of firms entering each period. The vacancy rate will be informative of the overall cost of hiring, c_h as lower hiring costs will shrink the optimal inaction region for employment, inducing firms to post more vacancy on average. The moments describing the distribution of log employment and the job turnover rate will discipline the persistency and volatility of firm productivity, ρ_z and σ_z, whereas the firm-size distribution will identify the parameters governing the convexity of the adjustment costs, λ_1 and the relative stability of large versus small firms, λ_2. The exogenous firm hazard rate δ will be determined by the average firm size. Finally, the average log revenues, average wage and the labor compensation share will pin down the the employment elasticity of revenue α

[40]While I observe entry and exit of plants for Colombia, the same does not happen for Mexico. To circumvent this problem, I follow Riaño (2009) and I use information from the "Job Flows in Latin America" dataset, a database constructed by the Inter-American Development Bank using administrative records collected by the Mexican Social Security Institute (Institudo Mexicano del Seguro Social, IMSS). From this dataset, I obtain the average firm exit rate and the job turnover rate used in the estimation.
[41]The labor share is taken from Guerriero (2012), while the average wage rate in the industrial is taken from Bell (1997) and reported in percent deviation relative to the average wage in the service sector.

and the workers outside option b, since these parameters determine the magnitude of rents accruing to firms and workers, through the definition of firm and worker surplus and solution of the bargaining problem.

6.2.2 Point estimates and model fit

Table 7 reports the point-wise estimates for ϑ, while Figure 3 summarizes the estimation fit scattering data and model-based statistics. The model is able to replicate the Colombian and the Mexican plant-level data fairly well, with an average absolute deviation between data-based and model-based moments equal, respectively, to 3.90% and 7.98% percent. The model is also able to match the firm size distribution in each countries, and it correctly captures the share of exporters, the average wage, the labor share, vacancy rate and exit rate. It correctly replicates the log-employment distribution in Colombia, while it does slightly overestimates the left tail of the log-employment distribution in Mexico.

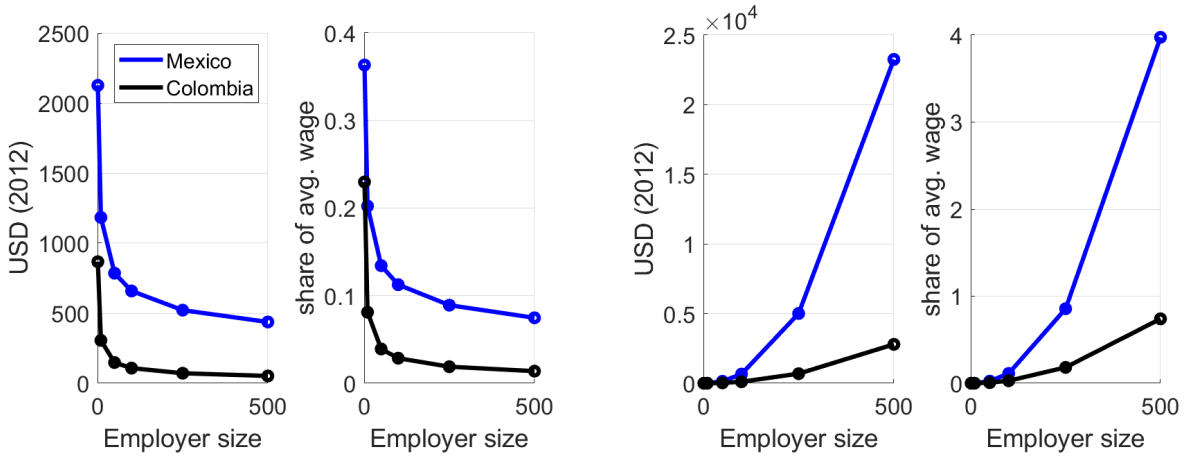
Expressed in 2012 price level, the estimation predicts a per-period annual fixed cost of operating equal to 7.091 x 3,165.7 USD= 22,447.8 USD in Colombia and to 5.991 x 5,680.1 USD = 34,029.7 USD in Mexico; a per-period fixed cost of exporting equal to 120.59 x 3,165.7 USD=381,748.1 USD in Colombia and to 52.82 x 5,680.1 USD =300,024.5 USD in Mexico; and an initial sunk cost of setting up a business equal to 55.63 x 3,165.7 USD = 176,106.2 USD in Colombia and to 69.01 x 5,680.1 USD = 391,985.8 USD in Mexico.

The estimation also predicts similar values of home production, b, between the two countries. In particular, unemployed workers in both countries are able to secure around 40% of the average wage in the service sector. These values corresponds to 1,325.5 USD in Colombia, and to 2,301.3 USD in Mexico. On the other hand, home production is roughly equal to 98.81 percent of the statutory minimum wage in place in Mexico, whereas it is only 55.01 percent of the statutory minimum wage in Colombia.

The estimates for the parameters of the vacancy cost functions imply a significantly larger and more convex hiring costs in Mexico than Colombia. Panel A of Figure 4 displays the estimates for the cost of hiring a single worker as a function of the current workforce of the plant, expressed in USD and as a share of the average wage in the industrial sector. For a firm of ten employees this cost is estimated to be around 306.1 USD Colombia and 1,183.5 USD in Mexico. In panel B, I report the per-worker cost faced by a plant expanding its workforce by one percent, as a function of the original workforce. The cost profile is much larger in Mexico, where it amounts to 23,251.9 USD in a firm with a 500 employees, compared to Colombia, where the same figure is equal to 2,793.5 USD. Since the estimates for the mean reversion of the productivity process, ρ_z, are not statistically different between the two countries (both equal to 0.96), the differences in the adjustment cost will play a dominant role in shaping the magnitude of employment dynamics in response to a productivity innovation. The volatility of the productivity innovations, σ_z, is however lower in Colombia (0.146%) than

Figure 4: **Calibrated hiring costs, by firm size**

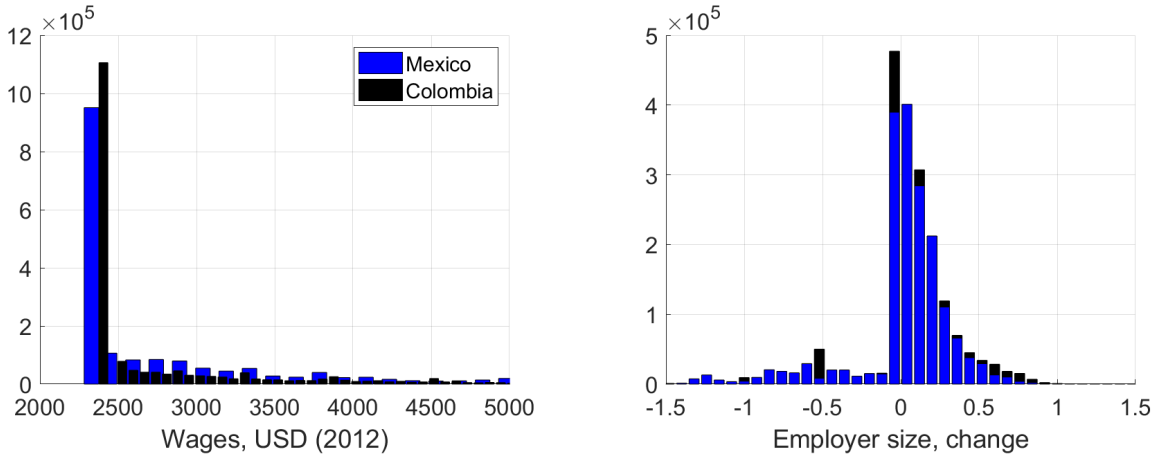
(a) single worker (b) one percent of workforce, per worker



Note: This figure reports the hiring cost profile for a single worker (panel a) and for a one percent increase of the total workforce (panel b) as a function of current number of employees.

Figure 5: **Wage and firm-size change distributions**

(a) wages (b) firm size changes

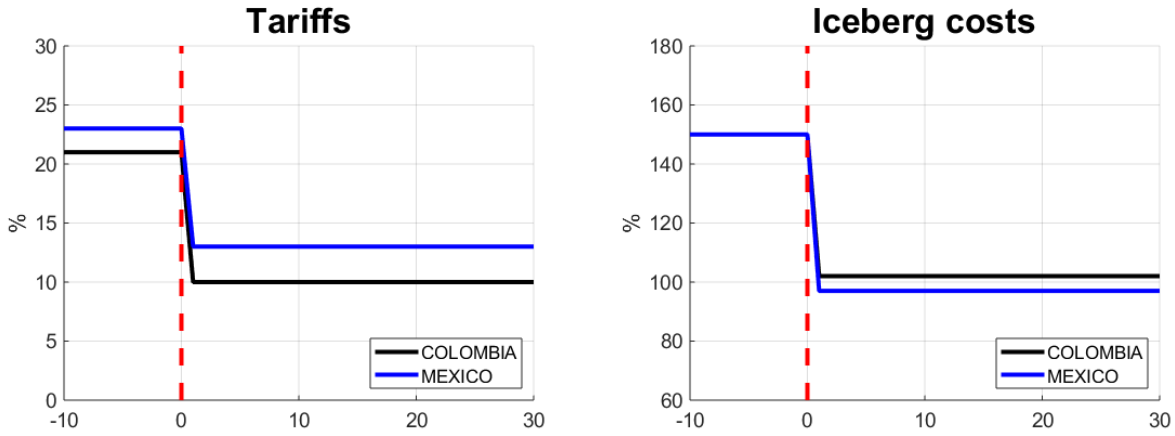


Note: This figure reports the model-based distribution of wages and employer size changes for Colombia (black line) and Mexico (blue line).

Mexico (0.164%), with effects on the frequency of the employment adjustments. Finally, the estimation suggests that a share between 0.69 (Colombia) and 0.91 (Mexico) of the model-implied exit rate can be attributed to adverse productivity shocks, while the remaining due to factors exogenous to the model and captured by the estimates of δ.

As documented in Bell (1997), there is a larger share of employers paying a salary lower than 1.5 times the minimum wage in Colombia (81%) than Mexico (72%). At the same time, employment adjustments is lumpier in Colombia: the employment inaction region,

Figure 6: **Simulated trade policy**



Note: This figure reports the implemented changes in tariffs and iceberg costs in Colombia (black line) and Mexico (blue line).

measured by the share of employers in the cross-section adjusting their size no more than 1% of their workforce between two consecutive periods - amounts to 20 percent in Colombia, 5 percentage points more than Mexico. In the Appendix, I validate the calibration by the discussing an array of aggregate and firm-level non-targeted moments the model is able to replicate.

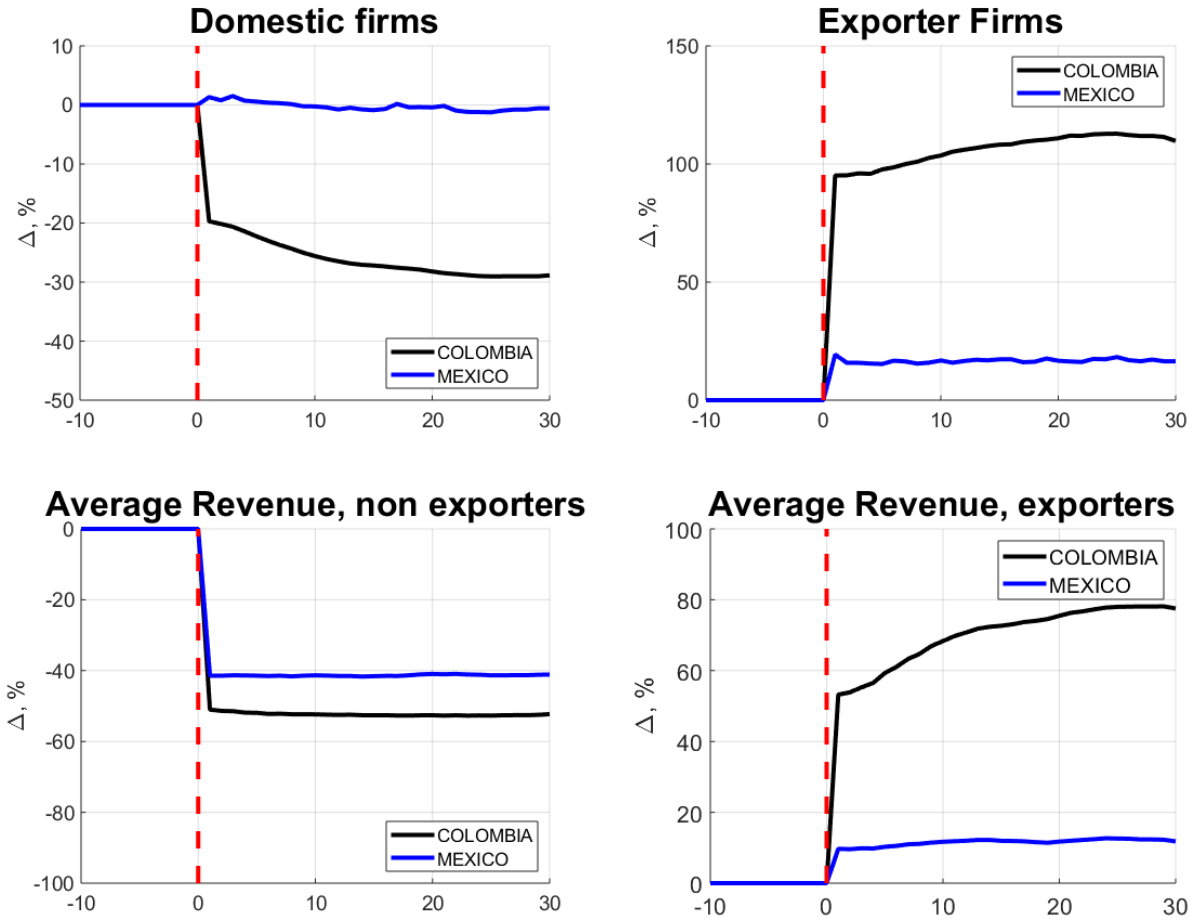
7 The Trade Reforms

In this section I use the calibrated version of the model to explore the quantitative implications of the observed trade liberalizations. The goal of this exercise is to determine (1) the ability of the model to replicate the dynamic response of unemployment, sectoral employment and job volatility to a drop in trade costs observed in Colombia and Mexico, and (2) the ability of the model to capture the documented differences in aggregate dynamics between these two countries.

Starting from the stationary equilibrium calibrated with high trade costs, I shock the economy with an unexpected once-and-for-all reduction of trade barriers, causing a proportional increase in the value of foreign absorption.[42] Figure 6 displays the simulated change in tariffs and iceberg cost in both countries. The magnitude of the drop in tariffs is chosen so to mimic the the reduction observed after the trade liberalization (first row, Table 4), while the drop in iceberg costs is modelled to match the increase in the aggregate revenue share of exports (fourth row, Table 4). Therefore, following these two changes, I track unemployment

[42]While the trade shock is unexpected at time of being implemented, agents in the model perfectly foresight the entire path for trade costs once the shock has already happened.

Figure 7: **Transitional dynamics after a trade reform**



Note: This figure displays the transitional dynamics following a trade liberalization in Colombia (black line) and Mexico (blue line).

rate and other aggregates along the transition to the new steady state. Unless explicitly stated, I keep firing costs, $c_{f,t}$ and statutory minimum wage, $\underline{w}_t$, fixed to the baseline value for the entire transition path. Finally, I keep also the interest rate fixed at the baseline level, $r_t = r_0, \forall t \geq 1$.[43]

Trade dynamics - Figure 7 reports the transitional dynamics for the measure of domestic firms in the industrial (manufacturing) sector, the measure of exporting manufacturers, and average revenues of exporters and non-exporters after an unexpected and permanent fall in trade costs in Colombia (black line) and Mexico (blue line). The model generates a rich dynamics towards the new steady state. The transition following a trade reform may take a long time, depending on the magnitude and the speed of employment adjustment. A fall

[43]This assumption bears implications for the dynamics of firms and workers. Having the same interest rate along the transition path implies a constant value of searching for a job in the tradable sector in each period after the shock. As long as trade openness triggers an increase in the value of employment in the manufacturing sector, the equilibrium no-arbitrage condition requires a drop (rise) in the job finding (filling) rate, with implications for the firm vacancy posting decisions of firms and the unemployment rate.

in trade costs reduces by 20 percent the number of domestic firms in Colombia and the impact response undershoots the long-run values, which is 30 percent lower the baseline steady-state. As in Itskhoki and Helpman (2015), the share of exporters increases on impact but may undershoot the long-run value, since high-productivity firms gradually attain their optimal size. A different dynamics is experienced in the Mexican economy where the number of domestic firms doesn't drop after a trade reforms, showing lack of selection and leaving unchanged industrial concentration. Moreover, exporting firms fail to expand along the transition, and increase their size by less than 20 percent.

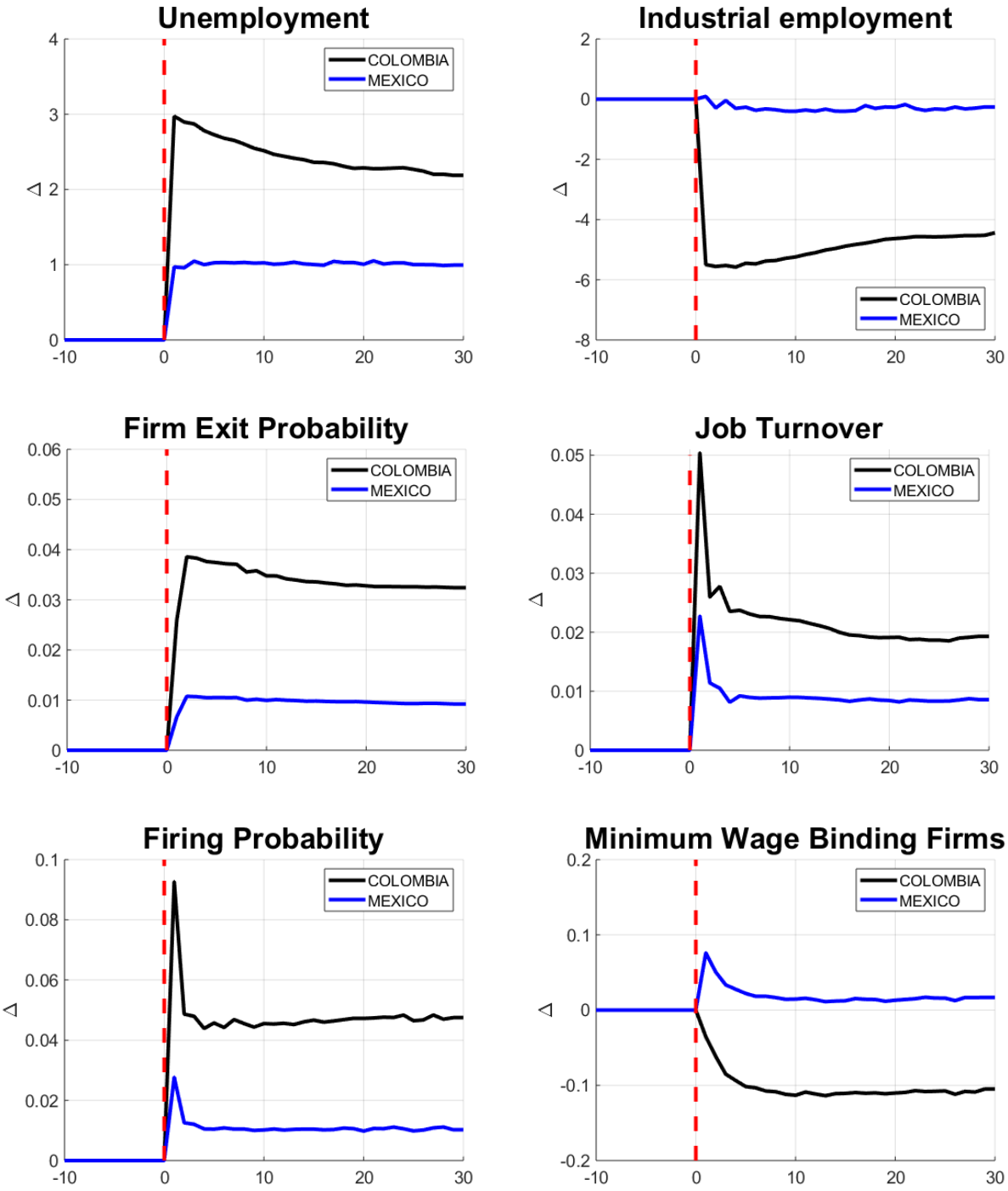
Despite having only a sunk-cost of export, the model also generates a rich trade dynamics along the intensive margin. In Colombia, revenues of exporters expand over several years before reaching the steady state. This happens because new exporter can't immediately adjusts their exports volume to the optimal level. While the optimal export–sales ratio is only determined by the size of the export market and remains constant along the transition, firm-level revenues is function of employment, which evolves sluggishly depending of frictions, adjustment costs and labor regulations.

Employment adjustments - The upper panel of figure 8 reports the unemployment rate and employment in the industrial sector. The simulated dynamics of the unemployment rate closely resembles the observed dynamics in Colombia and Mexico discussed in section 5. The model predicts that unemployment rate increases by three percentage points in Colombia, whereas it rises only by one percentage points in Mexico. Furthermore, unemployment in Colombia responds non monotonically along the transition: it jumps in the short-run by 3 percentage points, and it is only partially re-absorbed (by roughly one third) in the long run. Similar to the aggregate evidence in Section 5,employment is driven out of the tradable sector in Colombia, shrinking by about 5 percentage points on impact. This drop overshoot the long-run value, where exporters slowly expand along the transition. Mirroring the dynamics in domestic firms, industrial employment in Mexico barely changes.

To explore the mechanisms behind the impulse response and dig into of the drivers of the differential response between Colombia and Mexico, middle and lower panels of Figure 8 reports the dynamics of firm exit rate and job turnover rate, the evolution in firing probabilities, due to either firm closing or individual dismissal, of tradable firms and the share of firms paying the minimum wage along the transition towards the new steady state. Figure 9 display the evolution of average productivity in the tradable sector, the average size of industrial firms overall, and broken by exporters and non-exporters.

First, removing trade barriers triggers large employment adjustment. Firing probability and firm exit rate rise on impact in both countries, and stays high in the long run. On the other hand, employment downward adjustments are significantly amplified in Colombia, where the workers probability of being fired rises on impact four times more as in Mexico. As a result, job turnover increases more in Colombia than Mexico and remains higher in the long-run, resembling the aggregate evidence discussed in section 5. At the same time, also

Figure 8: **Employment adjustments to a trade reforms**

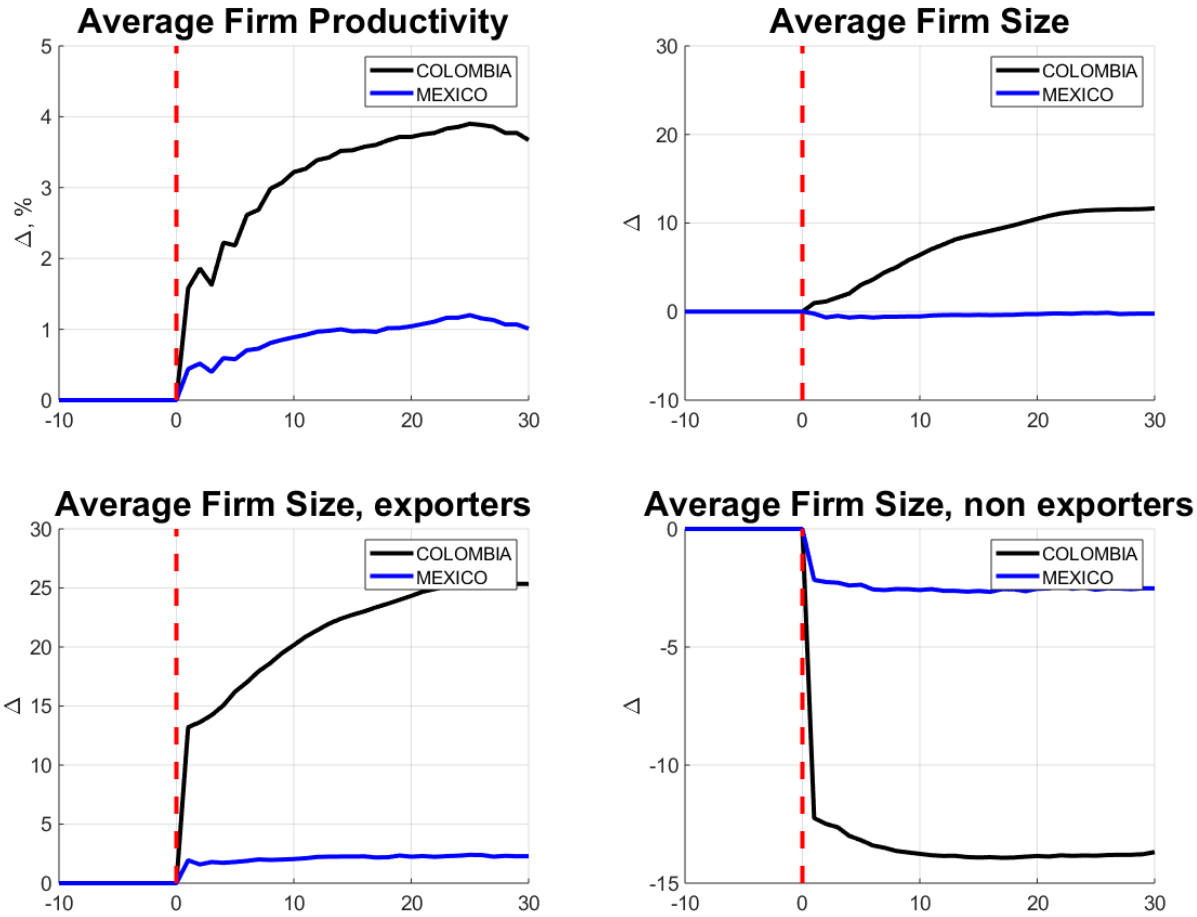


Note: This figure displays the transitional dynamics following a trade liberalization in Colombia (black line) and Mexico (blue line).

vacancy posting grows substantially more in Colombia, because of lower hiring costs and greater firm selection.

As a result of the employment adjustments to trade, job reallocation significantly rises in

Figure 9: **Dynamics of selection after a trade reform**



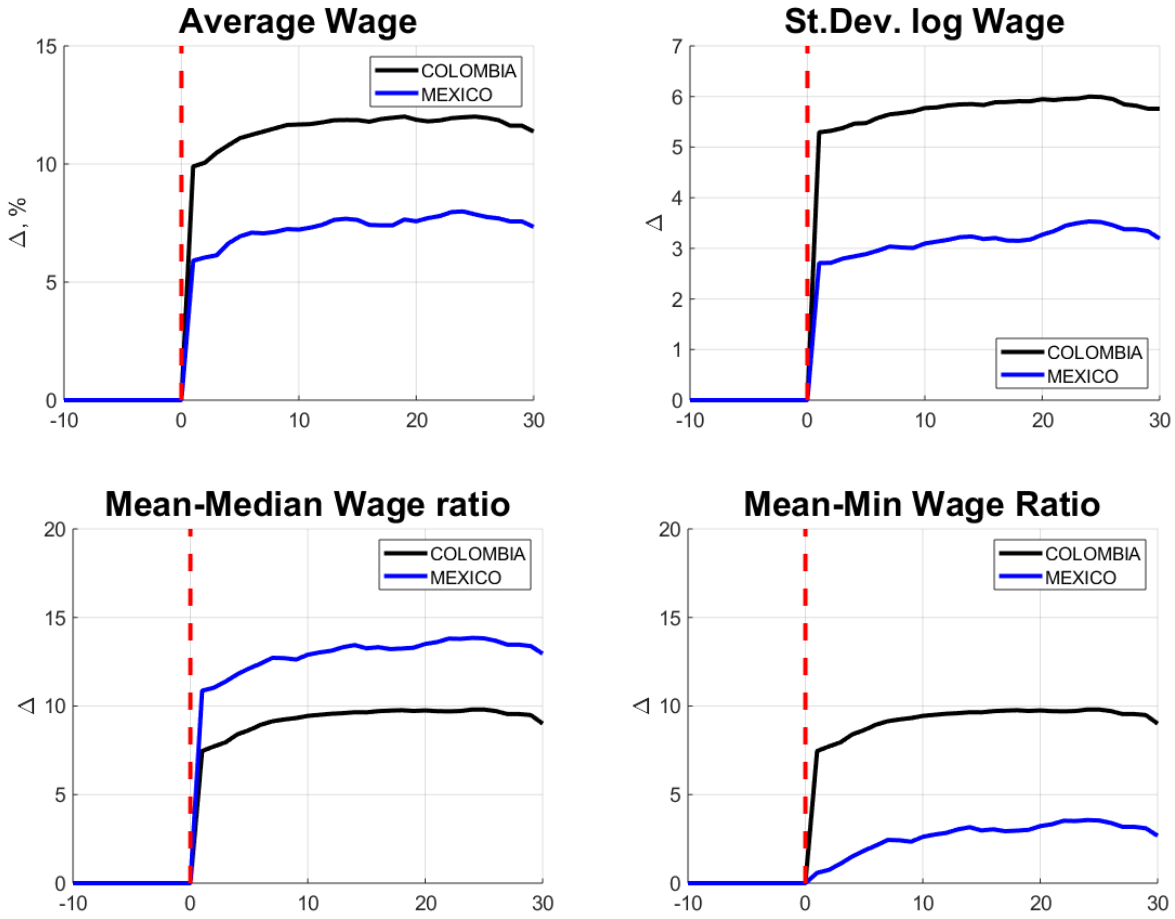
Note: This figure displays the margins of adjustments along the transition path following a trade liberalization in Colombia (black line) and Mexico (blue line).

the short run, whereas it fades out in the long run, because of long-run rigthward shift in the firm size distribution. Differently than Cosar et al. (2016) and Dix-Carneiro et al. (2018), the increase in job volatility is not driven by the large sensitivity of high-productivity firms to productivity shocks, but from the large displacement of low-productivity firms following a reduction in trade frictions.

Mexican firms respond to foreign competition with larger wage cuts instead of employment adjustments. The share of employers paying the minimum wage increases by fifteen percent in Mexico, whereas it drops in Colombia, where larger firm growth translate into larger wage growth along the transition.

At the aggregate level, lower selection and larger wage cuts in Mexico prevent workers reallocation across firms and hamper firm turnover, with the effect of crowding out higher-productivity entrants, hence depressing average firm size in the Mexixan tradable sector compared to Colombia.

Figure 10: **Wage inequality after a trade reform**



Note: This figure displays the transitional dynamics of average wage and wage inequality following a trade liberalization in Colombia (black line) and Mexico (blue line).

Taking stock, greater job destruction contributes to increase unemployment in Colombia, particularly in the short run. First, low-productivity non-exporting incumbents react on impact and shrink. Second, high-productivity exporting firms expand slowly. Search and matching frictions and convex adjustment costs prevent exporting firms to jump immediately to the new optimal size, forcing dismissed workforce to temporarily reallocate out of the industrial sector. At the aggregate level, unemployment duration of displaced workers stays higher along the transition path. It follows that, as in Dix-Carneiro et al. (2021), unemployment and employment share of manufacturing overshoot in the short-run. Contrarily, unemployment in Mexico is only driven by workers moving out of the non-tradable sector to look for jobs in tradable firms, pushing unemployment rate up because of lack of firm expansion.

Wage dynamics - Finally, Figure 10 displays the dynamics of the average real wage and measures of wage inequality following the trade shock. As a results of larger trade exposure

and lower aggregate domestic price, average real wage increases in both countries. Moreover, higher revenues dispersion between exporters and non-exporting firms results into higher wage dispersion after the trade reform. On the other hand, the source of wage inequality are different between the two countries. Higher minimum wage in Colombia hampers the increase in the mean to median wage ratio relative to Mexico, where the median wage falls relative to the mean because of larger downward wage adjustment. Instead, larger selection and workers reallocation in Colombia resulted into higher average wage relative to the minimum, with an increase more than two times as in Mexico. Overall, the second effect dominates making the standard deviation of log wages in Colombia increasing by more than 2 percentage points compared to Mexico, a finding in lines with the aggregate evidence reported in Section 5.

7.1 The role of labor market institutions

To isolate the contribution of each labor market institutions, I conduct a series of counterfactual exercises using the structure of the calibrated model. The goal of this exercise is to determine to which extent the labor market institutions in place affects the labor market adjustments to a trade liberalization.

In particular, I consider two alternative scenarios, one for each country. The first counterfacual is a trade liberalization implemented in Colombia under the minimum wage regulation observed in Mexico. The second countefactual is trade liberalization implemented in Mexico under the employment protection legislation observed in Colombia. Within each country, differences in the impulse response across simulation must have a causal interpretation: they are only driven by differences in the initial regulations in place.

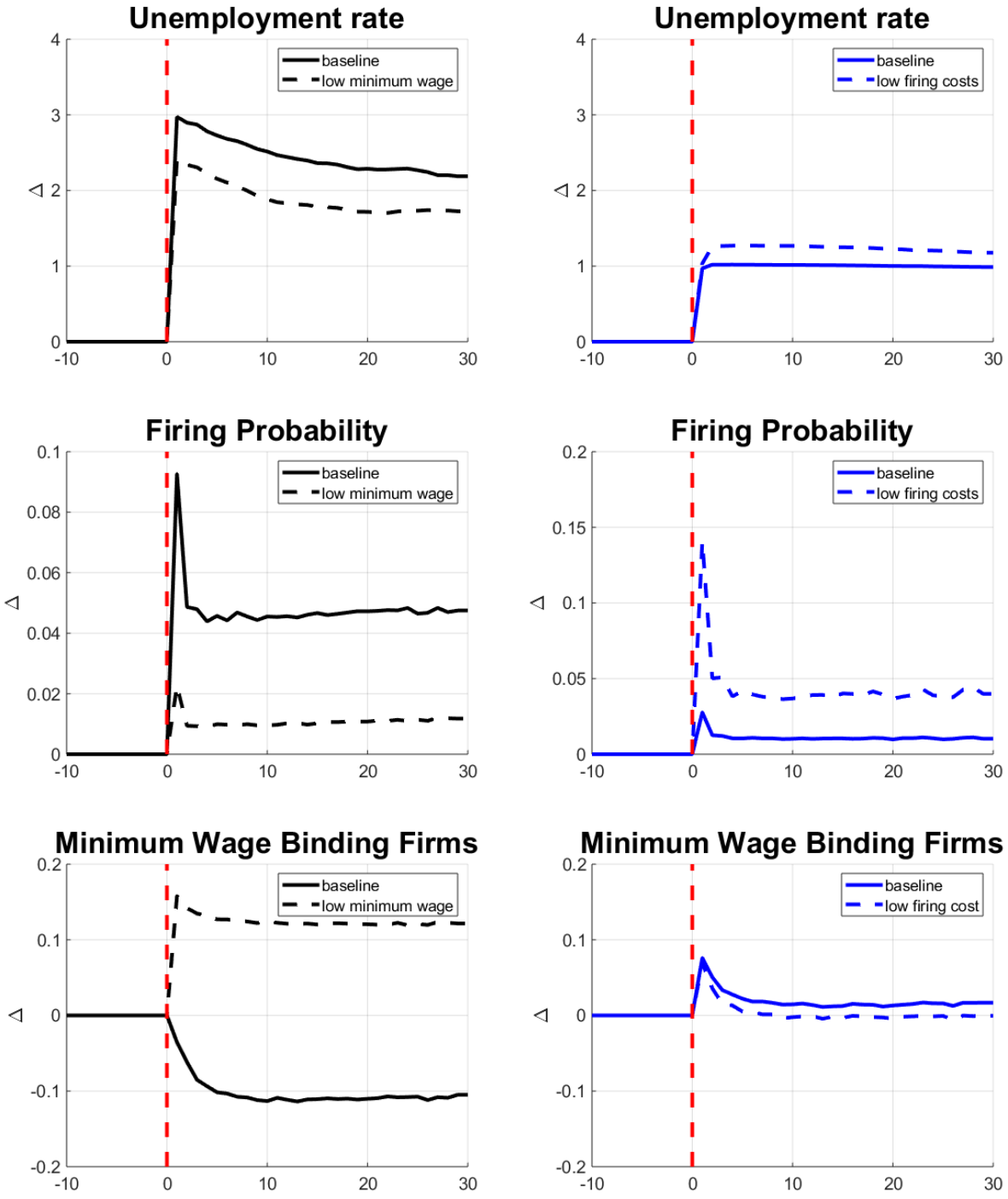
Figure 11 display the dynamics of unemployment rate, firing probability and share of firms paying the minimum wage following a trade reform implemented under baseline and counterfactual initial institutions at different horizons.[44] As in Kambourov (2009), regulations in the labor market are key determinants of the magnitude and the speed of employment adjustment after a trade reform. High firing costs hamper job destruction, low minimum wage foster greater wage cuts. Greater job destruction contributes to increase unemployment, particularly in the short run.

Consistent with the cross-country evidence documented in sections 2.1 and 2.2, the downward *price rigidity* induced by a binding statutory minimum wage observed in Colombia is cause of large unemployment rate as response to a trade shock. The *quantity rigidity* induced by a stricter employment protection legislation in Mexico has the opposite effect. While part of adjustments still happen through wage renegotiation, stricter minimum wage and lower firing costs increase the probability of workers dismissal, both in the short and the long run.

Stricter minimum wage in Colombia pushes up unemployment rate following a trade

[44] Appendix D reports similar counterfactual dynamics for the number of producers, average firm size, average productivity and wages.

Figure 11: **Counterfactual unemployment and firm adjustments**



Note: This figure displays selected margins of adjustments along the transition path following a trade liberalization in Colombia (black line) and Mexico (blue line).

shocks by 0.6 percentage points (from 2.4 to 3 p.p.) in the short run, and by 0.5 p.p. in the long run (from 1.8 to 2.3 p.p.). Higher firing costs pushes down unemployment rate in Mexico by 0.3 percentage points in the long run (from 1 to 1.3 p.p.), while it has almost no effect

on impact. Everything else equal, minimum wage accounts from 25% to 30% of unemployed response in Colombia, while firing costs account up to 23% in Mexico. Taken together, these two institutions quantitatively account for 30% of the difference in unemployment rate between the two countries in the short run, and up to 60% in the long run.

7.2 Gains from trade

Finally, I investigate the gains from trade and the efficiency-equity trade-off generated by the trade reforms under alternative labor regulations. To do so, I define welfare as the average value of being employed in any industrial firm, equal to

$$\mathbf{E}[J_t^e] = \int_{z\in\mathcal{Z}} \int_{\ell\in\mathcal{E}} J_t^e(z,\ell)\tilde{\psi}_t(z,l)dzd\ell \tag{59}$$

where $\psi_t(z,l)$ is the distribution of employment across states at the beginning of period t, while $J_t^e(z,\ell)$ is defined in equation (32).

To study how inclusive are the gains from trade I implement the following strategy: rather than positing the existence of a social welfare function that maps the vector of agents' individual welfare into a single real number, I define and study a policy possibility frontier.[45] The frontier confronts two feasible outcomes for trade reforms implemented under different labor market policies. Taking short and long-run horizons, Figure 12 scatters the average welfare gain for industrial employees versus its cross-sectional dispersion, defined as the cross-sectional standard deviation of the value in equation (32). The figures reports the outcomes for the baseline and two counterfactual trade reforms.

Trade reforms trigger aggregate gains. As in Itskhoki and Helpman (2015), the short-run gains from trade are largely due to the reduction in the price of tradable goods.[46] Under the baseline simulation, long-run gains are larger in Colombia, showing the existence of dynamic gains along the transition and the lack of thereof in Mexico.

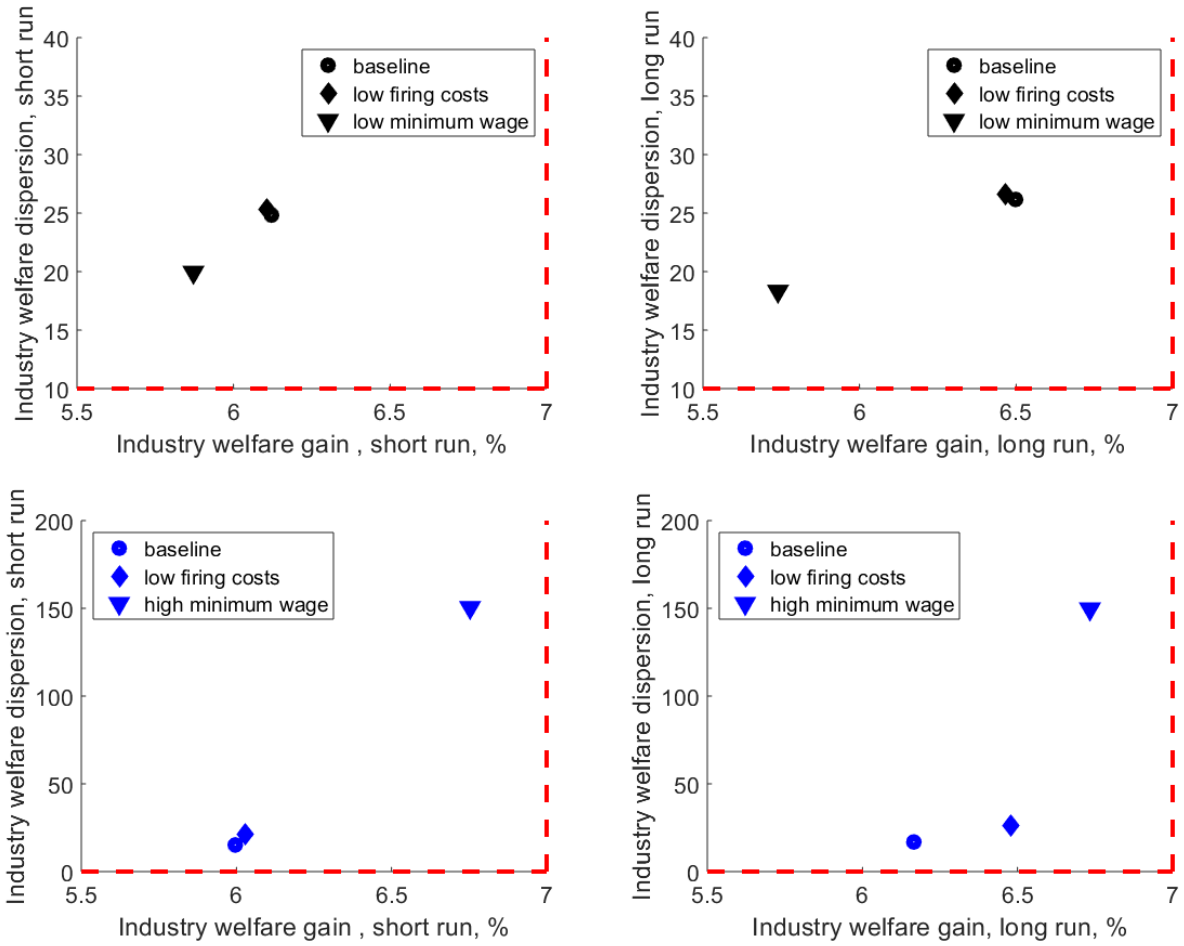
Gains from trade are realized at a cost of larger inequality: one can see the clear trade-off between the two metrics. Lower minimum wage in Colombia would reduce welfare gains from trade by 1 percentage points in the long run despite reducing its dispersion by one third (upper-right block of Figure 13) Lower firing costs in Mexico would increase welfare gains from trade by 0.5 percentage points in the long despite increasing its dispersion from 10 percentage points to 20 percentage points (lower-right block of Figure 13).

Figure 13 reports an alternative trade-off as it scatters the industrial welfare gains versus the unemployment rate in the short- and the long-run for the baseline and two counterfactual scenarios in Colombia and Mexico. Despite being efficient, higher unemployment rate arises

[45] See, for instance, Atkinson (1970) and more recently Antràs et al. (2017) for a discussion of how to map inequality aversion of a social planner into a welfare function.

[46] This is the case in both Mexico and Colombia, where the aggregate price index drops on impact by 10% and 8% respectively.), and remains low in the long run.

Figure 12: **Equity efficiency trade-off**



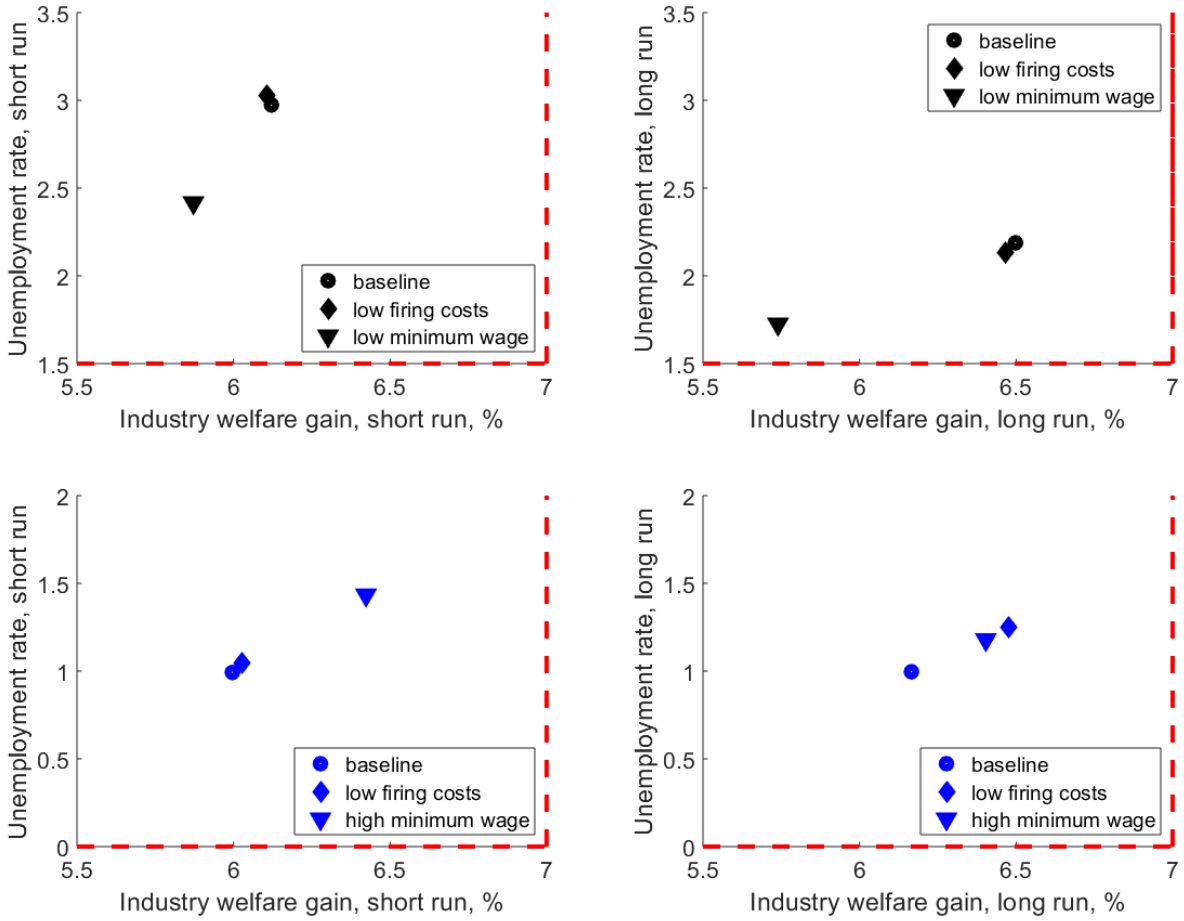
Note: This figure displays average welfare for workers employed in the industrial sector against welfare dispersion in the short (t=1) and long-run for Colombia (black line) and Mexico (blue line)

in conjunction with higher gains from trade. While labor market institutions could spur aggregate welfare from trade integration, they would also reduce the share of workers who would benefit from it, creating room for transfers to make trade policies more equitable across workers.

Unemployment insurance - Finally, I evaluated the implications of a trade reform implemented with a positive transfer to the unemployed. To do so, I set unemployment benefits equal to 5 percent of the initial average industrial wage, and I keep the government budget balanced imposing a payroll tax to the industrial firms. Table 8 compares aggregate welfare gains from trade, welfare dispersion and unemployment rate in the short- and the long-run obtained under this counterfactual alternative against the baseline outcomes.

On the one hand, a positive transfer to the unemployed would help protect dismissed workers thereby reducing the dispersion in welfare gains from trade. Despite the larger increase in unemployment, the standard deviation in welfare would reduce by about 2 per-

Figure 13: **Welfare gains vs unemployment rate**



Note: This figure displays average welfare for workers employed in the industrial sector against unemployment rate in the short (t=1) and long-run for Colombia (black line) and Mexico (blue line)

centage points in Colombia and by 5 percentage points in Mexico. A more equal trade reforms could be achieved at a cost of a slightly lower aggregate gains from trade, that would reduce by less than 0.1 percentage points in the long run.

8 Conclusion

In this paper I investigate how the institutional features of the local labor markets determine the response to a trade liberalization. I use a structural model to characterize the dynamics of trade adjustments following a trade reform implemented under different labor market institutions. I estimate the model to replicate the pre-liberalization firm dynamics in Colombia and Mexico, and I push the state-of-the-art in the trade literature by solving the for the full transition path after a trade reform. I show that the labor market institutions in place at the time of a trade shock determine the magnitude and the speed of how firms adjust

Table 8: **Trade Reforms and Unemployment Benefits**

	COLOMBIA			
	Baseline		UI	
	Short-run	Long-run	Short-run	Long-run
$\Delta\mathbf{E}[J_t^e]$, %	+6.14	+6.49	+6.05	+6.44
$\Delta\mathbf{std}[J_t^e]$, p.p.	+24.83	+26.16	+23.38	+24.78
$\Delta \mathrm{L}_u$, p.p.	+2.97	+2.19	+3.68	+2.78
	MEXICO			
	Baseline		UI	
	Short-run	Long-run	Short-run	Long-run
$\Delta\mathbf{E}[J_t^e]$, %	+6.00	+6.17	+5.99	+6.12
$\Delta\mathbf{std}[J_t^e]$, p.p.	+15.16	+16.88	+10.23	+10.95
$\Delta \mathrm{L}_u$, p.p.	+0.99	+0.99	+1.43	+1.23

employment and wages in response to changes trade costs, pushing higher firm selection the lower firing costs and the higher minimum wage. The nature of adjustment to a trade shock bears significant implications for the magnitude of the gains from trade and how the gains are spread across the population.

The contribution of this paper is twofold. First, it contributes quantitatively and methodologically to the literature that studies the interaction between trade barriers and labor market frictions. To the best of my knowledge, this is the first paper that characterizes the adjustments to a trade reform along the entire transition path between different steady states, through ongoing productivity shocks, endogenous firm entry and exit, and endogenous job creation and destruction. I quantitatively show that steady-state comparison can understate the response of unemployment, sectoral employment and job turnover to a fall in trade cost, and modelling transitional dynamics helps unveil the differences between short- and long-run response of aggregate welfare and welfare inequality.

Second, this paper contributes to the literature that studies the causal impact of regulations on labor market performance, by exploring the implications of trade reforms implemented under various labor market institutions. In particular, by means of a structural model I show that labor market policies in place at the time of a trade reform have sizable consequences for the welfare gains from trade, a channel the literature has not yet been explored. I show that the downward *wage rigidity* induced by a binding minimum wage and *employment flexibility* induced by low firing costs foster firm selection following a reduction in trade costs, spurring average productivity and welfare. Moreover, I show that a significant trade-off between larger aggregate welfare gains and more equal distribution of welfare gains arises as an economy reduces *employment rigidities* in favor of downward *wage rigidities*.

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Online Appendix to
"Trade and Labor Market Institutions: A Tale of Two Liberalizations"

Appendix A. Details on Aggregate Evidence

A.1. Data Source and Definitions

The cross-country empirical evidence is based on 40 countries, for a period spanning between 30 and 40 years around the respective date of trade liberalization. In the specific, the countries covered are Albania (1970-2010), Argentina (1970-2010), Azerbaijan (1980-2010), Bangladesh (1980-2010), Republic of Bolivia (1970-2006), Brazil (1970-2010), Burkina Faso (1980-2010), Chile (1960-1996), Colombia (1970-2010), Cote d′Ivoire (1980-2010), Dominican Republic (1970-2010), Ecuador (1970-2010), Egypt (1980-2019), El Salvador (1970-2009), Ethiopia (1980-2010), Georgia (1980-2010), Hungary (1980-2010), India (1980-2007), Israel (1970-2005), Jamaica (1973-2009), Kyrgyzstan (1980-2010), Latvia (1990-2010), Lithuania (1980-2010), Madagascar (1980-2010), Mexico (1970-2006), Mozambique (1980-2010), New Zealand (1970-2007), Nicaragua (1970-2010), Pakistan (1980-2010), Paraguay (1970-2009), Peru′ (1970-2010), Philippines (1970-2008), Poland (1980-2010), Romania (1985-2010), South Africa (1970-2010), Republic of Tanzania: Mainland (1980-2009), Tunisia (1970-2009), Turkey (1970-2009), Uruguay (1970-2010) and the Bolivarian Republic of Venezuela (1974-2010). [47]

Trade Liberalizations: The liberalization dates are taken from Wacziarg and Welch (2003) and are based on Sachs and Warner (1995) criteria. Sachs and Warner classify an economy as open starting from the first year from which the following five characteristics are continuously met:

1. Average nominal tariff rates (TAR) below 40%;
2. Non-tariff barriers (NTB) covering less than 40% of trade;
3. A black market exchange rate (BMP) depreciated by less than 20% relative to the official exchange rate;
4. Absence of monopoly (XMB) on major exports;

[47] Data on trade liberalization and unemployment is also available for Croatia (1984-2010), Honduras (1970-2010), Malta (1983-2010), Serbia (1990-2014) and Tajikistan (1990-2010). However, since I do not have information on labor market institutions for these countries, I drop them from the sample. The inclusion of these observations in the first regression does not alter any of the results presented.

5. No socialist economic system (SOC), as defined by Kornai (1992), is in place.[48]

Sachs and Warner (1995) selected the these five criteria to cover various types of trade restrictions. Tariffs and NTBs (like for instance, import quotas) increase directly or indirectly (through import substitution) the effective FOB price paid for importing foreign goods. A black market premium on the exchange rate can have effects equivalent to a formal trade restriction: if exporters purchase foreign inputs using foreign currency obtained on the black market, but remit their foreign exchange receipts from exports to the government at the official exchange rate, the black market premium acts as a trade restriction. The state monopoly on exports is included among the trade restriction, since it acts as an alternative form of export subsidy and finally the socialist regime dummy variable accounts for the trade-limiting aspects of centrally-planned economies. However, the threshold values set in the first three criteria are arbitrary. They provide with liberalization dates for 141 countries for which they have enough information. From 1960, the great majority of the countries in the sample experienced a unique episode of trade liberalization and subsequent period of prolonged openness. Within the sample of countries used in this paper, only Bolivia, Ecuador and Jamaica went through a period of temporary liberalization, i.e. a period of full trade opening followed by subsequent failure on one or more of the five criteria listed above. For these countries, the date of reform is taken to be that at which the openness criteria are met without subsequent reversal, thus ignoring the initial episode of openness.

Labor Market Institutions: Measures of labor market institutions are taken from the Fondazione R. de Benedetti (FrdB) Labor Instituion v.1 database. In the paper, I focus on three specific institutions, namely minimum wage and employment protection legislation.

- The minimum wage regulation is identified using the ratio of statutory minimum wage to mean wage. Reported data correspond to the values in effect on July 1st of each year, unless otherwise specified. In countries were several minimum wages were in place, varying by sector or by location, a simple average minimum wage was constructed. Non-statutory minimum wage arrangements in place, like wage grids, or minimum wage determined by collective agreements are excluded.

- The employment protection legislation is measured by sum of the average advance notice periods and the average severance payments, measured after 9 months, 4 and 20 years, and expressed in months. The data are collected and reported for workers with regular contracts of unspecified duration after any trial period, for the case of fair dismissals caused by personal grounds or individual redundancy (economic reason) at the initiative of the employer, and averaged out across different types of workers (high and low skilled, white and blue collars, when differently specified).

[48] A full description of these five variables is provided in the Sachs and Warner (1995).

- Unemployment benefits is constructed as the product of the average gross replacement rate over 1 year after dismissal and the unemployment benefits coverage, so to capture both extensive and intensive margin of the legislation. The gross replacement ratio is defined as levels of statutory entitlements over the average wage, after the first year of unemployment, while the unemployment benefit coverage is constructed as the ratio of the number of UI benefit recipients to the number of unemployed.

Unemployment Rates: Series for unemployment rate are constructed using data from ILO-Stat database, except for Chile, for which I used data from Caputo and Saravia (2014). ILO-Stat defines unemployed a person of working age (from 15 to 64 y.o.) who was (i) without work during the reference period, i.e. was not in paid employment or self-employment, (ii) currently available for work, meaning available for paid employment or self-employment during the reference period, and (iii) seeking work, i.e. had taken specific steps in a specified recent period to seek paid employment or self-employment. For purposes of international comparability, ILO-Stat defines the period of job search as the preceding four weeks, though the definition might vary from country to country. Therefore, the unemployment rate is calculated as the number of persons who are unemployed during the reference period given as a percent of the total number of employed and unemployed persons (i.e., the labour force) in the same reference period.

Controls: Series for GDP, GDP deflator, imports, exports and total population are taken from the World Development Indicator (WDI) Database of the World Bank. For the case of Poland and Paraguay, they are integrated with estimates from the International Financial Statistics (IFS) Database. GDP series are nominal and expressed in current USD price level. Nominal GDP measures the total output of goods and services for final use occurring within the domestic territory of a given country, regardless of the allocation to domestic and foreign claims. Total population refers to all residents regardless of legal status or citizenship. Nominal measures are converted into real values using the associated GDP deflator and expressed at constant 2005 USD price level. The import penetration is constructed by dividing total imports by GDP minus of net exports. Series for employment, rate of inflation and exchange rate are taken from the Penn Table Dataset v.9.0. Total employment refers to the number of persons engaged in production. Inflation rate is constructed as the growth rate of price level for household consumption goods (with price level of USA GDP in 2011 normalized to 1) whereas the exchange rate refers the market value of national currency per USD. Finally, the dates for the occurrence of banking, currency, and sovereign debt crises are taken from Laeven and Valencia (2013). In particular, they define (1) a banking crisis as the first year with signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations) and banking policy intervention measures in response to significant losses in the banking system; (2) a currency crisis as a nominal depreciation of the currency vis-a-vis the U.S. dollar of at least

Table 9: **DESCRIPTIVE STATISTICS**

COUNTRY	LIBERALIZATION		UNEMPLOYMENT		IMPORT PENETRATION		MINIMUM		
	(DE-JURE)	(DE-FACTO)	PRE	POST	PRE	POST	WAGE	EPL	UI
Average	-	-	7.73	10.22	12.96	20.96	0.37	6.01	5.33
St.Dev.	-	-	5.42	5.26	10.43	13.68	0.18	4.47	9.16
Median	-	-	6.10	9.20	9.73	17.36	0.34	4.75	0
ALB	1992	1992	5.53	16.63	3.54	16.15	0.61	2.33	8.39
ARG	1991	1992	4.35	13.55	7.19	8.58	0.28	4.67	1.31
AZE	1995	1995	4.90	7.42	5.45	15.51	0.00	4.17	3.31
BFA	1998	1998	2.60	2.87	6.77	11.55	0.57	1.32	0.00
BGD	1996	1997	2.16	3.86	4.42	9.41	0.58	9.83	0.00
BOL	1986	1986	8.67	8.26	15.22	13.66	n.a.	11.12	0.00
BRA	1991	1991	3.34	8.07	6.35	8.61	0.16	11.75	9.23
CHL	1976	1979	6.65	11.83	9.91	12.42	0.37	4.00	3.40
CIV	1994	1994	9.16	9.21	15.72	20.66	0.74	4.20	0.00
COL	1992	1993	9.18	13.25	5.24	9.22	0.52	1.01	0.00
DOM	1992	2003	19.70	16.53	24.73	15.63	0.54	6.54	0.00
ECU	1991	1999	6.41	9.50	11.43	14.08	0.61	n.a.	0.00
EGY	1995	2000	7.72	9.59	10.09	8.11	0.20	0.36	n.a.
ETH	1996	1996	4.85	6.07	5.94	10.13	0.05	4.02	0.00
GEO	1996	1997	12.02	12.67	2.31	15.16	0.28	2.50	5.22
HUN	1990	1990	0.28	7.53	15.24	32.65	0.42	3.07	37.20
IND	1994	1995	3.95	4.07	3.73	5.20	0.68	5.00	n.a
ISR	1985	1985	5.08	8.73	26.38	30.19	0.48	8.82	7.01
JAM	1989	1992	23.93	15.37	26.90	33.94	0.32	6.17	0.00
KGZ	1994	1995	1.35	7.66	0.92	12.68	0.19	1.17	8.25
LTU	1993	1993	10.13	14.01	14.60	36.68	0.30	4.75	4.09
LVA	1996	1996	6.01	12.82	14.72	33.51	0.32	2.00	8.18
MDG	1996	1997	2.92	3.81	9.08	18.50	0.14	2.44	0.00
MEX	1986	1986	4.93	3.84	4.95	13.77	0.31	8.33	0.00
MOZ	1995	1995	24.06	23.54	29.54	25.98	0.24	16.00	0.00
NIC	1991	1995	12.95	11.30	7.82	19.25	0.36	4.33	0.00
NZL	1987	1989	3.35	7.46	23.02	25.44	0.44	0.44	25.56
PAK	2001	2001	4.55	7.17	6.32	7.57	0.61	6.56	0.00
PER	1991	1992	6.68	8.54	7.98	11.53	0.21	11.22	0.00
PHL	1988	1989	6.15	9.75	11.16	15.60	0.48	7.25	0.00
POL	1990	1990	6.30	14.53	9.03	15.62	0.32	3.67	23.22
PRY	1989	1989	5.99	8.19	13.17	18.27	0.49	4.17	0.00
ROU	1992	1992	3.66	8.24	5.93	16.85	0.48	0.75	15.31
SLV	1989	1990	7.65	7.77	31.29	59.81	0.70	8.39	0.00
TUN	1989	1989	14.31	15.88	22.42	21.03	0.24	2.63	n.a
TUR	1989	1994	10.62	8.06	4.83	10.56	0.00	9.92	0.00
TZA	1995	1995	3.85	3.40	5.99	9.82	n.a	4.94	0.00
URY	1990	2000	11.14	11.76	10.00	14.90	0.34	8.00	3.57
VEN	1996	1996	8.83	11.94	12.84	17.16	0.29	5.17	n.a
ZAF	1991	1995	14.35	23.81	11.65	13.40	0.00	0.67	23.22

Note: "Pre" and "Post" refer to pre- and post-liberalization periods as defined by Sachs and Warner (1995). Source: The liberalization dates are from Sachs and Warner (1995) and Wacziarg and Weich (2003); the unemployment rate is from ILO-stat; the import penetration rate is constructed using data on imports, exports and GDP from the Penn Table Dataset v.9.0; information on the labor market institutions is from FRdB Labor Institution v.1 database.

30 percent that is also at least 10 percentage points higher than the rate of depreciation in the year before; (3) a sovereign crisis as years of sovereign default to private creditors and the years of debt rescheduling.

A.2. Descriptive Statistics

Table 9 reports descriptive statistics for the sample of countries analysed. In particular, for each country I report the liberalization date constructed using Sachs and Warner (1995)′s

criteria, the average unemployment rate and the average import penetration rate before and after the trade reform occurs, and the labor market institutions in place at the time of trade reform. After a trade reform was implemented, the import penetration increase on average by 8 percentage points (from 12.96 to 20.96) while the unemployment rate increased on average by about 2.5 percentage points (from 7.73 to 10.22 percent). At the time of a trade reforms, the cross-country average minimum wage in place wage slightly more than one third (37%) of the average real monthly wage, the average firing costs was slightly less than the equivalent of one year and half salary (16.2 real monthly wages), while slightly more than five percent (5.33%) of the labor force without a job was covered by unemployment insurance.

Appendix B. Details on the Model

B.1. Recursive Competitive Equilibrium

Given aggregate foreign expenditure denominated in foreign currency, $\{D_{f,t}\}_{t=0}^{\infty}$, a sequence of iceberg costs and tariffs on imports, $\{\tau_{c,t}, \tau_{a,t}\}_{t=0}^{\infty}$, a sequence of exogenous labor market policies, $\{c_{f,t}, \underline{w}_t, b_t^u\}_{t=0}^{\infty}$, a path for the interest rate $\{r_t\}_{t=0}^{\infty}$, a transition density function of the Markov process for productivity shock and its ergodic distribution, $\Gamma(z'|z)$ and $\Gamma^e(z)$, a Small Open Economy Recursive Competitive Equilibrium is characterized by a list of value functions for incumbent and potential entrant firms, $\{V_t(z,\ell), V_t^e\}_{t=0}^{\infty}$, a list of value functions for workers, $\{J_t^o, J_t^s, J_t^i, J_t^u, J_t^e(z,\ell), J_t^c(z',\ell)\}_{t=0}^{\infty}$, a list of policy functions for incumbent firms, $\{L_t(z',\ell), \mathbf{1}_t^o(z',\ell), \mathbf{1}_t^h(z',\ell), \mathbf{1}_t^f(z',\ell), \mathbf{1}_t^x(z',\ell)\}_{t=0}^{\infty}$, a list of measures for incumbent and entrant firms $\{N_{h,t}, N_{e,t}\}_{t=0}^{\infty}$, a list of aggregate domestic price indexes and aggregate domestic demand for the industrial composite good $\{D_{h,t}, P_t\}_{t=0}^{\infty}$, a stream of aggregate income $\{I_t\}_{t=0}^{\infty}$ and exchange rates $\{k_t\}_{t=0}^{\infty}$, a list of measures for workers employed in the service sector, workers in the industrial sector, workers searching for jobs in the industrial sector and unemployed workers, $\{L_{s,t}, L_{q,t}, U_t, L_{u,t}\}_{t=0}^{\infty}$, a list of vacancy filling rates, job finding rates and probabilities of being fired, $\{\phi_t, \widetilde{\phi}_t, p_t^o(z,\ell), p_t^f(z',\ell)\}_{t=0}^{\infty}$, a stream of wage schedules for industrial workers at hiring and firing firms, $\{w_t^{\mathrm{h}}(z,\ell), w_t^{\mathrm{f}}(z,\ell)\}_{t=0}^{\infty}$, and a list of probability distributions of firms over the state space (z,ℓ) at the end and at the interim states of the period, $\{\psi_t(z',\ell), \widetilde{\psi}_t(z',\ell')\}_{t=0}^{\infty}$ such that the following conditions are met:

1. the policy functions $\{L_t(z',\ell), \mathbf{1}_t^o(z',\ell), \mathbf{1}_t^h(z',\ell), \mathbf{1}_t^f(z',\ell), \mathbf{1}_t^x(z',\ell)\}_{t=0}^{\infty}$ solve the problem of the incumbent firms in the industrial sector and $\tilde{V}_t(z,\ell)$ and $V_t(z,\ell)$ attain their maximum $\forall t = 0, 1, ...$

2. there is a positive mass of entrant firms in the industrial sector, $N_{e,t} > 0$, in every period t, and V_t^e attains its maximum $\forall t = 0, 1, ...$

3. no-arbitrage conditions holds,

$$J_t^o = J_t^i = J_t^u = J_t^s \quad \forall t = 0, 1, ..., \tag{60}$$

since workers are free to choose between working in the service sector, or searching for formal job in the industrial sector;

4. the probabilities that an industrial worker is fired, $p_t^o(z, \ell)$ and $p_t^f(z', \ell)$, are consistent with firm exit policy function, employment policy function and optimal hiring and firing decisions, i.e.

$$p_t^o(z, \ell) = \delta + (1 - \delta)(1 - \mathbf{1}_t^o(z, \ell)) \qquad p_t^f(z', \ell) = \mathbf{1}_t^f(z', \ell)\left(\frac{\ell - L_t(z', \ell)}{\ell}\right) \tag{61}$$

5. the probability distributions of firms over the state space (z, ℓ) at the end and the interim stage of the period, $\{\psi_t(z', \ell'), \widetilde{\psi}_t(z', \ell)\}_{t=0}^{\infty}$, evolve according to the following laws of motion:

$$\widetilde{\psi}_t(z', \ell) = \begin{cases} (1 - \delta) \int_{z \in \mathcal{Z}} \Omega(z'|z)\psi_{t-1}(z, \ell)\mathbf{1}_t^o(z, \ell)dz, & \text{if} \quad \ell \neq 1 \\ \frac{N_{e,t}}{N_{h,t-1}}\psi_e(z') + (1 - \delta) \int_{z \in \mathcal{Z}} \Omega(z'|z)\psi_{t-1}(z, \ell)\mathbf{1}_t^o(z, \ell)dz, & \text{if} \quad \ell = 1 \end{cases} \tag{62}$$

where $\frac{N_{e,t}}{N_{h,t-1}}$ is the ratio of firms entering in period t over the total mass of firm active at time $t - 1$, and

$$\psi_t(z\prime, \ell') = \frac{\int_{\ell \in \mathcal{L}} \widetilde{\psi}_t(z', \ell)\mathbf{1}_{L_t(z', \ell) = \ell'}d\ell}{\int_{\ell \in \mathcal{L}} \int_{z'' \in \mathcal{Z}} \widetilde{\psi}_t(z'', \ell)\mathbf{1}_{L_t(z'', \ell) = \ell'}dz''d\ell} \tag{63}$$

where $\mathbf{1}_{L_t(z', \ell) = \ell'} = 1$ if $L_t(z', \ell) = \ell'$, 0 otherwise;

6. firms enter the economy up to the point where the free entry condition holds with equality, $V_t^e = c_e\phi_t^{-\lambda_1}$ and the total mass of firms evolve according the following law of motion:

$$N_{h,t} = (1 - \delta)(1 - \mu_t^{exit})N_{h,t-1} + N_{e,t} \tag{64}$$

where μ_t^{exit} is the fraction of firms exiting at time t, determined by the end-of period distribution at time $t - 1$ and the exit policy function at time t:

$$\mu_t^{exit} = \int_{\ell \in \mathcal{L}} \int_{z \in \mathcal{Z}} [1 - \mathbf{1}_t^o(z, \ell)]\psi_{t-1}(z, \ell)dzd\ell \tag{65}$$

7. the wage of industrial employees, $w_t(z', \ell')$ is consistent with the bargaining protocols given in equations (36) and (37) for hiring and firing firms;

8. the labor markets clear, i.e.

- the measure of industrial workers who are employed at time t in the industrial sector, $L_{q,t}$, matches the measure of active jobs in industrial firms:

$$L_{q,t} = N_{h,t} \int_{\ell \in \mathcal{L}} \int_{z' \in \mathcal{Z}} L_t(z', \ell) \widetilde{\psi}_t(z', \ell) dz' d\ell \tag{66}$$

- the measure of workers who are unemployed at the end of the period, $L_{u,t}$, evolves according to the following low of motion:

$$L_{u,t} = (1 - \widetilde{\phi}_t) U_t \tag{67}$$

where $U_t = \tilde{U}_t + L_{u,t-1}$ and

$$\begin{aligned} \tilde{U}_t = \delta N_{h,t-1} \int_{\ell \in \mathcal{L}} \int_{z \in \mathcal{Z}} \ell \psi_{t-1}(z, \ell) dz d\ell + \\ (1-\delta) N_{h,t-1} \int_{\ell \in \mathcal{L}} \int_{z \in \mathcal{Z}} (1 - \mathbf{1}^o_{t-1}(z, \ell)) \ell \psi_{t-1}(z, \ell) dz d\ell + \\ N_{h,t} \int_{\ell \in \mathcal{L}} \int_{z \in \mathcal{Z}} \mathbf{1}^f_t(z', \ell) [\ell - L_t(z', \ell)] \widetilde{\psi}_t(z', \ell) dz' d\ell \end{aligned} \tag{68}$$

- workers who have jobs in one of the sectors and unsuccessful industrial job seekers must sum up to total population, i.e. $L_{q,t} + L_{s,t} + L_{u,t} = 1 \quad \forall t = 0, 1, ...$
- the vacancy filling rate, ϕ_t, and the job finding rate, $\widetilde{\phi}_t$, are consistently determined by the measures of worker searching for industrial jobs in the interim state, U_t, and the measure of vacancy posted by firms,

$$v_t = N_{h,t} \int_{\ell \in \mathcal{L}} \int_{z' \in \mathbf{Z}} \mathbf{1}^h_t(z', \ell) \left(\frac{L_t(z', \ell) - \ell}{\phi_t} \right) \widetilde{\psi}_t(z', \ell) dz' d\ell \tag{69}$$

9. the market for service clears, i.e. total supply of services, equal to the sum of home and market production, $bL_{u,t} + L_{s,t}$, matches the total demand of services, which sums intermediate and final demand,

$$bL_{u,t} + L_{s,t} = \underbrace{N_{h,t}[\overline{c} + c_o + \mu_x c_x] + N_{e,t} c_e}_{\text{intermediate demand}} + \underbrace{(1-\gamma) I_t}_{\text{final demand}} \tag{70}$$

The intermediate demand combines firms' demand for services used to pay fixed operating costs, exporting costs, initial costs of set-up for firms and labor adjustment costs (hiring costs), defined as

$$\overline{c} = N_{h,t} \int_{z' \in \mathcal{Z}} \int_{\ell \in \mathcal{L}} \mathbf{1}^h_t(z', \ell) C^h_t(\ell, L_t(z', \ell)) \tilde{\psi}_t(z', \ell) dz' d\ell \tag{71}$$

The final demand is equal to a share $(1 - \gamma)$ of total income, I_t, which is composed

by total labor income (industrial and service sector wage payments plus value of home production) aggregate profits in the industrial sector distributed to worker-consumers who own the firms and government transfers

$$I_t = \underbrace{[b + b_t^u]L_{u,t} + L_{s,t} + \overline{w}_t N_{h,t}}_{\text{labor income}} + \underbrace{T_t}_{\text{lump-sum transfer}} + \underbrace{N_{h,t} \int_{z' \in \mathcal{Z}} \int_{\ell \in \mathcal{L}} [\pi_t(z', \ell, L_t(z', \ell)) - c_o)] \tilde{\psi}_t(z', \ell) dz' d\ell - N_{e,t} c_e}_{\text{aggregate profits}} \tag{72}$$

10. trade is balanced, i.e. every period t the exchange rate k_t adjusts so that total domestic expenditures on imported varieties (expressed in domestic currency) equals total export revenues,

$$D_{h,t} \tau_{a,t}^{-\sigma} (\tau_{c,t} k_t)^{1-\sigma} = k_t D_{f,t} \tau_{c,t}^{-1} \tag{73}$$

11. government budget is balanced, i.e. unemployment benefits plus lump-sum rebates matches revenues collected from firing costs, tariffs and payroll taxes

$$T_t + b_t^u L_{u,t} = \underbrace{c_{f,t} \int_{z \in \mathcal{Z}} \int_{\ell \in \mathcal{L}} \mathbf{1}_t^f(z', \ell)(\ell - L_t(z', \ell)) \tilde{\psi}_t(z', \ell) dz' d\ell}_{\text{firing cost revenues}} + \underbrace{D_{h,t} \tau_{a,t}^{-\sigma} (\tau_{c,t} k_t)^{1-\sigma} (\tau_{a,t} - 1)}_{\text{tariff revenue}} \tag{74}$$

B.2. Stationary Recursive Competitive Equilibrium

A Stationary Recursive Competitive Equilibrium is a Recursive Competitive Equilibrium where

1. value functions and policy functions are time-invariant;

2. the probability distributions of firms over the state space (z, ℓ) at the end and the interim stage of the period, $\psi(z, \ell)$ and $\widetilde{\psi}(z, \ell)$ are time-invariant, i.e. they replicate themselves through the Markov processes on z, the policy functions and the productivity draws upon entry;

3. the measure of active firms in the industrial sector is time-invariant, the exit rate is constant and the measure of exiting firms resembles that of entrants,

$$N_e = \mu^{exit} N_h$$

4. the vacancy filling rate for firm and the probability of finding industrial jobs for workers are time-invariant;

5. the number of workers flowing into industrial jobs matches the number of industrial jobs that are destroyed,

$$\widetilde{\phi}U = \delta N_h \int_{\ell\in\mathcal{L}}\int_{z\in\mathcal{Z}} \ell\psi(z,\ell)dzd\ell + (1-\delta)N_h \int_{\ell\in\mathcal{L}}\int_{z\in\mathcal{Z}} (1-\mathbf{1}^o(z,\ell))\ell\psi(z,\ell)dzd\ell + N_h \int_{\ell\in\mathcal{L}}\int_{z'\in\mathcal{Z}} \mathbf{1}^f(z',\ell)[\ell - L(z',\ell)]\widetilde{\psi}(z',\ell)dz'd\ell$$

6. the measures over workers over services and industrial employment are constant over time

7. aggregate price indexes, aggregate income and profits, wages, interest rate and exchange rate are constant over time

B.3. Numerical Solution Algorithm

To characterize the dynamics of this economy outside the stationary equilibria, I assume the following timing. At time $t = 0$ the economy is in a stationary equilibrium with limited openness to trade. At $t = 1$ a trade reform is implemented. Workers cannot forecast the date of the reform, which takes the form of unexpected shock. I assume by the time $T > 1$ the transition towards the new steady state is complete. In the quantitative exercise (based on yearly time periods) I will impose $T = 100$. From period T onward, the economy converges to a new stationary equilibrium with a larger trade exposure. The trade shock consists of an exogenous and unexpected once-and-for-all increase in the revenue premium from exporting, $d_{f,t}, \forall t \geq 1$, led by either a drop in the iceberg costs, $\tau_{c,t}$ or by a drop the tariffs on imports, $\tau_{a,t}$, or both. Let $\{c_{f,t}, \underline{w}_t, b_t^u\}_{t=0}^T$ be an exogenous sequence of labor market policies. To solve for the full transition I assume the interest rate is exogenous and does not react to changes in home-policies, i.e. $r_t = r$, $\forall t = 0, 1, ...T$. The numerical strategy I adopt is therefore the following.

1. I first solve for the initial and the final stationary equilibria. (See Appendix 4 in Cosar, Guner and Tybout (2016)). To do so, I discretize the state space using a log-spaced grid of 300 points for employment of industrial firms, ℓ and a grid of 50 equally-distanced points for productivity, z.[49] Once solved, I store equilibrium allocations and prices. In particular, I store:

[49] In steady state, workers value functions are homogeneous of degree one with respect to aggregate home price. This allows me to solve them in nominal terms and deflated them after convergence is achieved.

- the stationary probability distributions of firms over the state space (z, ℓ) at the end and the interim stage of the initial equilibrium, $\psi_0(z,\ell), \widetilde{\psi}_0(z,\ell)$, and the final equilibrium $\psi_T(z,\ell), \widetilde{\psi}_T(z,\ell)$
- the initial mass of operative firms, $N_{h,0}$
- the final steady-state value functions for the firms, $\tilde{V}_T(z,\ell)$ and $V_T(z,\ell)$, and the final steady-state value of being employed in the industrial sector at the beginning of period T for the workers, $J^e_T(z,\ell)$
- the final aggregate home price indexes, equal to $\gamma^{-\gamma}(1-\gamma)^{1-\gamma}P_T^{\gamma}$, where P_t is the aggregate home price index for the bundle of industrial goods in the final steady state.

2. I impose a path of foreign expenditure of domestic products, $d_{f,t}, \forall t = 1 : T-1$, so to match the observed the revenue premium of exporters

3. I guess a path along the periods $t = 1 : T-1$ for the following variables:

   - probability of filling a vacancy, $\{\phi_t\}_{t=1}^{T-1}$, which determines a sequence of workers probability of finding a job, $\{\widetilde{\phi}_t\}_{t=1}^{T-1}$, through equation 8
   - domestic sales, $\{D_{h,t}\}_{t=1}^{T-1}$
   - wages of industrial workers at hiring, firing and inactive firms, $\{w_t^{\mathrm{h}}(z,\ell), w_t^{\mathrm{f}}(z,\ell)\}_{t=1}^{T-1}$
   - measures of entrant firms, $\{N_{e,t}\}_{t=1}^{T-1}$
   - aggregate home price index for industrial goods, $\{P_t\}_{t=1}^{T-1}$

   I will update these guesses until convergence so to be consistent with a number of equilibrium conditions. In the specific, along the transition path:

   - guesses for domestic sales, $\{D_{h,t}\}_{t=1}^{T-1}$, are updated until convergence *period by period backward*, so to ensure that the firm entry condition holds at any t
   - guesses for industrial wages, $\{w_t^{\mathrm{h}}(z,\ell), w_t^{\mathrm{f}}(z,\ell)\}_{t=1}^{T-1}$, are updated until convergence *period by period backward*, using the closed form solutions available
   - guesses for the measures of entrant firms, $\{N_{e,t}\}_{t=1}^{T-1}$, are updated until convergence *period by period forward*, so to ensure that supply and demand are equal in the service sector at any period t
   - guesses for the probability of filling a vacancy, $\{\phi_t\}_{t=1}^{T-1}$, are updated *after simulating forward*, to ensure equilibrium in the labor market of the industrial sector in any period t. New guesses are used to solve the problem backward again, until convergence.

4. Given the steady state value function at time T for the firm and the guesses of the above variables, I solve recursively the problem of the firm at time $T-1$:

$$V_{T-1}(z,\ell) = \max\left\{0, \frac{1-\delta}{1+r}\mathbf{E}_{z'|z}\max_{\{\ell'\}}[\pi_{T-1}(z',\ell,\ell') - c_o + V_T(z',\ell')]\right\}$$

where:

$$\pi_{T-1}(z',\ell,\ell') = R_{T-1}(z',\ell') - w^{\mathrm{h}}_{T-1}(z',\ell')\ell' - C^h_{T-1}(\ell,\ell')$$

if $\ell' > \ell$, or

$$R_{T-1}(z',\ell') - w^{\mathrm{f}}_{T-1}(z',\ell')\ell' - c_{f,T-1}(\ell-\ell')$$

if $\ell' \leq \ell$. I store firms value function at time $T-1$, $V_{T-1}(z,\ell)$ and the associated policy functions for optimal employment, $\ell' = L'_{T-1}(z,\ell)$, the optimal exit decision, $\mathbf{1}^o_{T-1}(z,\ell)$ and exporting decision, $\mathbf{1}^x_{T-1}(z',\ell')$.

5. Using the solution of the firm problem, I compute the expected value of entry at time $T-1$:

$$V^e_{T-1} = \int_{z\in\mathcal{Z}} \max_{\{\ell'\}}[\pi_{T-1}(z,1,\ell') - c_o + V_T(z,\ell')]\psi_e(z)dz$$

where $\psi_e(z)$ is the ergodic distribution of productivity z, constant over time. To obtain domestic sales arising in equilibrium, I compare V^e_{T-1} with the cost of entry, $c_e\phi_t^{-\lambda_1}$. If $V^e_{T-1} > c_e\phi_t^{-\lambda_1}$, I decrease domestic sales $D_{h,T-1}$, otherwise I increase them. Therefore, I repeat this until convergence and I store the converged value, $D^*_{h,T-1}$

6. Using the final steady state value of being employed, $J^e_T(z',\ell')$, the final steady state value of being unemployed J^u_T, and exploiting the equilibrium condition $J^u_t = J^s_t = J^o_t \quad \forall t = 0,1,...T$, I update the wages for firing firms in the industrial sector so to ensure the participation constraint in the bargaining problem is not violated, i.e. such the interim value of a match is equal to the outside option of being unemployed

$$w^{\mathrm{f}}_{T-1}(z',\ell') = b + b^u_t + \frac{P_{T-1}}{P_T}J^o_T - \frac{P_{T-1}}{P_T}J^e_T(z',\ell')$$

where we express the continuation value for workers in terms of current aggregate price. Thus I repeat this until convergence and I store the converged value for the firing wage, $w^{\mathrm{f}*}_{T-1}(z',\ell')$.

7. Using the guesses for ϕ_{T-1} and the converged values for $D^*_{h,T-1}$ and $w^{\mathrm{f}*}_{T-1}(z',\ell')$, I update wages for hiring firms using the closed form solution of the bargaining problem:

$$w^{\mathrm{h}}_t(z',\ell') = (1-\beta)(b+b^u_t) + \frac{\beta}{1-\beta+\alpha_f\beta\Lambda}\frac{\partial R_t(z',\ell')}{\partial\ell'}$$

where $\Lambda = \frac{\alpha(\sigma-1)}{\sigma-(1-\alpha)(\sigma-1)}$. Thus I repeat until convergence and I store the converged value

for the hiring wage, $w_t^{\mathrm{h}*}(z', \ell')$. I construct the wage rate for inactive industrial firms as the maximum between the hiring and the firing wage, $w_t^{\mathrm{i}}(z', \ell') = \max\{w_t^{\mathrm{h}}(z', \ell'), w_{T-1}^{\mathrm{f}}(z', \ell')\}$. Finally, I construct the final wage rate imposing a legal statutory minimum wage, $\underline{w}_t$, i.e.

$$w_t(z', \ell') = \max\{\underline{w}_t, w_t^{\mathrm{h}}(z', \ell')\mathbf{1}_t^h(z', \ell) + w_t^{\mathrm{f}}(z', \ell')\mathbf{1}_t^f(z', \ell) + w_t^{\mathrm{i}}(z', \ell')(1 - \mathbf{1}_t^h(z', \ell) - \mathbf{1}_t^f(z', \ell))\}$$

8. Given the final steady state value function for workers and guesses for the above variables, I solve recursively the problem of the workers. I use the final steady state value of being employed for the worker, $J_T^e(z', \ell')$, and the converged value for wages of hiring firms, $w_{T-1}^{\mathrm{h}*}(z', L'_{T-1}(z, \ell))$ to compute the interim value of being employed in a hiring firms:

$$J_{T-1}^{e,h}(z', \ell) = w_{T-1}^{\mathrm{h}*}(z', L'_{T-1}(z, \ell)) + \frac{P_{T-1}}{P_T} J_T^e(z', L'_{T-1}(z, \ell))$$

9. Using the firms policy functions obtained above, and the wage scheduled constructed above, I compute the workers value of being employed at the beginning of period $T-1$:

$$J_{T-1}^e(z, \ell) = \frac{1}{1+r}\Bigg((\delta + (1-\delta)(1 - \mathbf{1}_{T-1}^o(z, \ell)) J_{T-1}^o + ... \\ ... \quad (1-\delta)\mathbf{1}_{T-1}^o(z, \ell)\mathbf{E}_{z'|z} \max\left\{ J_{T-1}^u, J_{T-1}^c(z', \ell) \right\} \Bigg)$$

where

$$J_{T-1}^c(z', \ell) = p_{T-1}^f(z', \ell)) J_{T-1}^o + \frac{(1 - p_{T-1}^f(z', \ell))}{1 + r_{T-1}} J_{T-1}^{e,h}(z', \ell) \tag{75}$$

and J_{T-1}^o is computed using equation 31 in the main text. I store all the converged values.

10. Therefore I solve *backward* for all the periods $t = T-1, ..., 1$ along the transition path, e.g. I repeat steps 3-8 for all the periods backward. Using the policy functions obtained before and the guesses for the mass of entrants, $\{N_{e,t}\}_{t=1}^{T-1}$, I simulate the economy for T periods *forward*, using $\psi_0(z, \ell), \widetilde{\psi}_0(z, \ell)$ as initial distributions for the end and the interim states.

11. I update guesses for the mass of entrants, $N_{e,t}$ as follow:

    - given $\psi_{t-1}(z, \ell), \widetilde{\psi}_{t-1}(z, \ell)$, the policy function for exit, $\mathbf{1}_t^o(z, \ell)$, the guessed mass of entrants, $N_{e,t}$, and the total mass of firms at time $t-1$, $N_{h,t-1}$, I compute $\psi_t(z, \ell), \widetilde{\psi}_t(z, \ell)$, the probability distributions over (z, ℓ) at the end and interim stage in period t.

- I use the guess for ϕ_t to compute industrial vacancies at time t:

$$v_t(z', \ell) = \mathbf{1}_t^h(z', \ell) \frac{(L_t(z', \ell) - \ell)}{\phi_t}$$

- I use $\widetilde{\psi}_t(z, \ell)$ to compute the average number of vacancies $\bar{v}_t$ and the average industrial employment $\bar{\ell}_t$ in period t:

$$\bar{v}_t = \int_{\ell \in \mathcal{L}} \int_{z' \in \mathcal{Z}} v_t(z', \ell, L_t(z', \ell)) \widetilde{\psi}_t(z', \ell) dz' d\ell$$
$$\bar{\ell}_t = \int_{\ell \in \mathcal{L}} \int_{z' \in \mathcal{Z}} L_t(z', \ell) \widetilde{\psi}_t(z', \ell) dz' d\ell$$

- Using $\psi_t(z, \ell)$ and the exit policy function, $\mathbf{1}_t^o(z, \ell)$, I compute the exit rate at time t, μ_t^{exit}, using equation (65).
- Given the initial guess for the measure of entrant firm, $N_{e,t}$, the exit rate, μ_t^{exit}, and the previous period mass of firms, $N_{h,t-1}$, I compute the mass of operative firms at time t using equation (64).
- Given the initial guess for the measure of entrant firm, $N_{e,t}$, the mass of operative firms, $N_{e,t}$, and the guess for the job finding probability, $\widetilde{\psi}_t(z, \ell)$, I compute the distribution of vacancies in the interim stage, $g_t(z', \ell)$.
- Given $g_t(z', \ell)$, I use $J_{h,t}^e(z', \ell)$ to compute the expected value of a match in the interim stage, $\mathbf{E}_t J_{h,t}^e(z', \ell)$.
- Given $N_{h,t}, N_{e,t}, \bar{v}_t$, the guess for ϕ_t and $v_t^e = 1/\phi_t$ (equilibrium vacancies posted by entrant firms), I compute the unique measure of workers searching for a job in the industrial sector at time t, U_t from the following equation:

$$\phi_t = \frac{U_t}{[(N_{h,t}\bar{v}_t + N_{e,t}v_t^e)^\theta + U_t^\theta]^{\frac{1}{\theta}}}$$

- given U_t and $\widetilde{\phi}_t$, I compute the mass of unemployed workers who fail to find a job in the industrial sector, $L_{u,t} = (1 - \widetilde{\phi}_t)U_t$
- given $\bar{\ell}_t$, I compute the mass of workers who are employed in the service sector, $L_{s,t} = 1 - L_{u,t} - L_{q,t}$, where $L_{q,t} = \bar{\ell}_t N_{h,t}$
- with $N_{h,t}, N_{e,t}, L_{u,t}, L_{s,t}$ and $L_{q,t}$ I compute aggregate income I_t at time t, and I check if supply and demand are equal in the service sector. If not, I update the initial guess for $N_{e,t}$.
- I iterate until convergence and I store the converged value for entry rate, $N_{e,t}^*$.

- I compute $\{J_t^u\}_{t=1}^{T-1}$ through the following formula:

$$J_t^u = \widetilde{\phi}_t \mathbf{E} J_{h,t}^e + (1 - \widetilde{\phi}_t)\left(b + b_t^u + \frac{P_t}{P_{t+1}} J_{t+1}^o\right)$$

If $J_t^u > J_t^o$, I assign a lower value to new guess of the probability of filling a vacancy at time t, otherwise, I increase it. Thus I store the new path of guesses, $\{\phi_t\}_{t=1}^{T-1}$.

12. I update the sequence of prices $\{P_t\}_{t=1}^{T-1}$ using the definition in the main text and I use the new path of guesses for $\{\phi_t\}_{t=1}^{T-1}$ to solve again the recursive problem backward and I iterate until convergence.

13. Once convergence is achieved, I compute the aggregate export revenues using the firm policy functions and the equilibrium firm distribution and I use the equilibrium condition in the foreign market to back up the unique sequence of exchange rates, $\{k_t\}_{t=1}^{T-1}$ that ensures trade balance (total exports equal to total imports), for an exogenous values for the iceberg costs and the tariffs.

Appendix C. Details on Calibration

C.1. External Parameters

In the calibration exercise, a number of parameters are taken from external sources. Among those, the discount rate, r, the service share in output, γ and the average wage in the service sector used as numeraire, w_s are constructed as follows.

Interest Rate. The interest rate for Mexico is taken from Riaño (2011). It corresponds to the average real interest rate for the period 1982-2006 based *Certificados de la Tesoreria de la Federazione a 28 dias*, CETES bonds. The interest rate for Colombia is taken from Ruhl and Willis (2017). The IFS dataset reports a similar value for real average lending rate (10.63%) for the period 1986-2010.

Service Share. For both countries, the service share in output is taken from national accounts information available at http://estadisticas.cepal.org/cepalstat.

Average Service Wage. The average wage in the service sector is constructed as follow. I first construct an estimate for the average manufacturing wage of both countries in the pre-liberalization period. For Colombia, I take the nominal weekly wage in the manufacturing sector for the period 1984-1990 reported in Attanasio, Goldberg and Pavcnik (2002) and express it in annual term (assuming 48 working weeks a year). I convert this value from

national currency (pesos) into USD using the observed exchange rate (available at FRED dataset), and express it in real terms (2012 constant price) using the producer price index for all commodities (available at FRED). For Mexico, I take the nominal daily wage in the manufacturing sector for 1982 reported in Boltvinik (2000), "Nada que festejar", published in Jornada, available at http://www.jornada.unam.mx/2000/05/05/boltvinik.html and express it in annual term (assuming 264 working days a year). I convert this value from national currency (pesos) into USD using the exchange rate reported in Tailor (1995), "Peso's Plummeting Past", available at
http://timothytaylor.net/1995/031695.htm and express it in real terms (2012 constant price) using the producer price index for all commodities (available at FRED). Finally, I convert the average real wage in the manufacturing sector into average real wage in the service sector using a ratio between the two equal to 1.20:1 in Colombia (Cosar, Guner and Tybout, 2016) and to 1.03:1 (Marcouiller, Ruiz de Castilla and Woodruff, 1997) in Mexico.

C.2. Data Description

The Colombian data is obtained from the Annual Manufactuer Survey (*Encuesta Anual Manufacturera*, EAM) run by the National Administrative Department of Statistics (*Departamento Administrativo Nacional de Estadistica*, DANE) and covers the universe of manufacturing plants with more than 10 employees, along the period 1981-1991. The Mexican data is obtained from the Annual Industrial Survey (*Encuesta Industrial Anual*, EIA) run by the Mexican National Institute of Statistics, Geography and Information (*Institudo Nacional de Estadistica, Geografia e Informacion*, INEGI), and covers a sample of 3200 firms for the period 1984-1987. Although the Mexican data reports firm-level data, I use the term "plant" to describe a unit of observation. In both data, firms are required to report the number of formal employees, which is used as measure of size in the estimation. The data provide with further information about annual domestic and foreign sales, employment compensation (inclusive of salaries and other benefits), and cost of material and other intermediate inputs. Total sales is constructed by summing domestic and foreign sales plus the change in inventories. Nominal variables are cleaned and deflated as in Roberts and Tybout (1996).[50] Each firm-year observation is classified as exporter if the firm exports a positive share of their output. For Mexico, information on exports is available starting from 1986, and entry and exit of firms cannot be observed.

C.3. Calibration Algorithm

To calibrate the model, I assume the economy is in steady state. Thereafter, I can drop the time index, t. During the estimation, I treat the aggregate domestic expenditure, D_h,

[50]See the section "Appendix: Data Preparation" in Clerides, Lach and Tybout (1998) for a comprehensive description of the data cleaning.

as a parameter to estimate. This is not the case when I compute the equilibrium of the model (see section on solution algorithm), in which case D_h is endogenously determined by the free entry condition. Moreover, since no unemployment benefits were available in either countries during the '80s, b^u is set equal to zero (see Table 5 in the main text). Given these assumptions, the estimation algorithm goes as follow.

1. I propose a guess for the following parameters: $\vartheta_0 = \{c_o^0, c_x^0, c_h^0, \lambda_1^0, \lambda_2^0, \rho_z^0, \sigma_z^0, \alpha^0, \delta^0, b^0, D_h^0\}$. Notice that no guess for the entry cost, c_e, is proposed.

2. Given the guess, I solve for the equilibrium. To do so,

   2.1. I guess a value for job finding probability in the industrial labor market, ϕ.

      i. I guess the wage schedule for industrial workers, $w(z, \ell)$.

         A. I solve the dynamic problem of the firms, given by equation (18) of the main text. I store value functions and policy functions.

         B. I compute the firm entry value, V^e using equation (26) in the main text, and I set the entry cost, $c_e = V^e$.

         C. If $c_e < 0$, I discard the initial parameter guess, and I go back to step 1.

      ii. If $c_e > 0$, I update the wage equation. To do so, I first solve the dynamic problem of the workers, given by equation (32) in the main text and I store the value functions and policy functions. Therefore, I use workers' value function, firms' policy functions and the solution to the bargaining problem to construct a new wage schedule. I go back to step 2.1.i till convergence. I store the wage function.

   2.2. If convergence is achieved, I update the job filling probability. To do so, I construct the stationary probability distributions of firms over the state space (z, ℓ) at the end and the interim stage of the period, $\psi(z', \ell)$, and $\psi(z', \ell')$. I use them to construct the distribution of vacancies for industrial jobs at interim stage of the period, $g(z', \ell)$, and, in turn, to compute the expected value of being employed in the industrial sector, $\mathbf{E}J^{e,h}$ (equation 30 in the main text) and the value of searching for an industrial job, J^u (equation 28 in the main text). Therefore, I use the no-arbitrage condition between sectors to obtain a new guess for ϕ, as in step 11 of the solution algorithm. I go back to step 2.1 till convergence. I store the job filling rate.

3. Once convergence is achieved and an equilibrium for the economy is found, I use the equilibrium policy functions, wage schedule and job filling rate to simulate a large pool of firms for a large number of periods. I discard the first T periods of the simulation to remove the dependence from the initial conditions, and I use the remaining periods to

construct the vector of firm-level simulated moments, $m(\vartheta_0)$, listed in Table 6 in the main text.

4. I use simulated moments, $m(\vartheta_0)$ and the respective sample statistics $\overline{m}$, to evaluate the fit of the model under the initial guess. To do so, I compute the objective function in equation (58) at ϑ_0, i.e. $\overline{m}(\vartheta_0)'\hat{\Sigma}\overline{m}(\vartheta_0)$, where $\overline{m}(\vartheta_0) = m(\vartheta_0) - \overline{m}$, whereas $\hat{\Sigma}$ is an identity matrix. I store $\overline{m}(\vartheta_0)'\hat{\Sigma}\overline{m}(\vartheta_0)$ and I go back to step 1.

I search and select new guesses over the parametric space Θ using a genetic algorithm.

C.4. Calibration Validation

In this section, I validate the identification of the parameters by discussing a number of additional statistics the model is able to generate without being targeted. Because of firms heterogeneity, search and matching frictions in the labor market, the model can reproduce wage dispersion observed in the data, where differences in wage payments across employers are linked to differences in size, idiosyncratic productivity and export status. Moreover, the model generates enough vacancy posting to correctly reproduce the observed manufacturing share of employment and enough job turnover to induce a rate of equilibrium unemployment which is aligned with the data.

Table 10: **Aggregate Implications**

	COLOMBIA		**MEXICO**	
	Data	**Model**	**Data**	**Model**
Relative market size to ROW	0.006	0.009	0.022	0.019
Employment share, manufacturing	0.381	0.355	0.283	0.260

Note: The manufacturing share of employment is taken from Attanasio et al (2005) for Colombia (source: National Household Survey - *Encuesta Nacional de Hogares*, ENH) and from Fairris and Levine (2004) for Mexico (source: National Survey of Household Income and Expenditure - *Encuesta Nacional de Ingresos y Gastos de los Hogares*, ENIGH).

Aggregate implications Table 10 reports a series of aggregate statistics. Though slightly underestimated, the model is able to reproduce the difference in the the share of employment in the manufacturing observed between Colombia and Mexico. Moreover, the model generates predictions for the size of the aggregate domestic expenditure in tradable goods relative to the demand from the rest of the world, $\frac{D_h}{k^\sigma D_f}$. A plausible empirical counterpart to this measure is the average real GDP in Colombia relative to the sum of its trade partners′s GDP during the pre-reform period.[51] I find a value of 0.006 for Colombia and 0.022 for Mexico, remarkably close to the model outcome.

[51]To compute this ratio we use data from the WBI tables of the World Bank.

Table 11: **Exporters shares and wage premia**

	COLOMBIA		MEXICO	
	Data	**Model**	**Data**	**Model**
Exporters shares				
Revenue share of exporters	0.634	0.521	0.834	0.860
Employment share of exporters	0.441	0.360	0.699	0.631
Exporters wage-premium: $\ln w_{it} = \beta_1 \mathbf{1}^x_{it} + \epsilon_{it}$				
β_1	0.646	0.416	0.499	0.314
	[0.002]***	[0.005]***	[0.001]***	[0.023]***
R^2	0.270	0.088	0.502	0.025
Size-wage relationship: $\ln w_{it} = \beta_1 \log l_{it} + \epsilon_{it}$				
β_1	0.051	0.215	0.088	0.114
	[0.001]***	[0.001]***	[0.000]***	[0.000]***
R^2	0.034	0.283	0.213	0.090

Note: For Colombia, both regressions are run using 152,580 observations. For Mexico, I use 9,657 observations. Standard errors are bootstrapped over 3000 repetitions with replacement. *** p<0.01, ** p<0.05, * p<0.1

Role of Exporters In the data, a large share of aggregate firm revenues and aggregate employment in the manufacturing sector is concentrated on exporting firms. Exporting firms account for one third (Colombia) and two third (Mexico) of the total aggregate employment in manufacturing, and one half (Colombia) and four fifth (Mexico) of the economy-wise employers revenues. Table 11 reports the aggregate employment share and the aggregate revenue share for exporters obtained using simulated data, and compare them to the observed values. The model is able to reproduce and match the degree of concentration in both countries.

Cross-sectional implication for wages *Export-Wage premium.* Exporters pay higher wages. Bernard et al. (1995) estimate a value for the unconditional export wage premium roughly equal to 20 percent, and values between 7 percent and 11 percent after controlling for plant specific characteristics.[52] To shed light on the relationship between firm-level wages and export status, I run the following firm-level regression,

$$\ln w_{it} = \beta_1 \mathbf{1}^x_{it} + \epsilon_{it}$$

where β_1 denotes the wage premium paid by exporting firms. I estimate this equation using simulated data and I compare the estimates with the actual data. Table 11 reports the results. The model generates a wage premia for exporting firms of the same order of those observed in the data, though the magnitude is slightly over-predicted. The tendency to

[52]These values refers to a cross-section of US manufacturing plants for the period 1967-1986.

Table 12: **Wage Dispersion**

	COLOMBIA		MEXICO	
	Data	**Model**	**Data**	**Model**
Firms				
St.Dev. log wage	0.369	0.461	0.484	0.456
Workers				
St.Dev. log wage	0.624	0.800	0.652	0.930

Note: The standard deviation of worker-level log wage is taken from Attanasio et al. (2004b) for Colombia (Source: Colombian National Household Survey - DANE) and Airola and Juhn (2008) for Mexico (Source: Mexican Household Income and Expenditure Survey - ENIGH).

overstate exporter premia reflects the fact that in this model the only source of heterogeneity comes from idiosyncratic productivity and size, making all firms above a certain productivity threshold be exporters.

Employer Size-Wage Effect. Brown and Medoff (1989) noted that workers employed in larger firms are often paid higher wages. Inspection of the wage equation for hiring firms reveals there are two forces at play: on the one hand, the diminishing marginal product of labor in the model predicts a negative correlation between wages and employer size; on the other hand, larger employers will be those with higher idiosyncratic productivity z, and those participating in the foreign market, hence earning a revenue premium. The implications of the model for the employer size-wage effect depend on which of these forces dominates. To test if the model can also replicate the positive employer size-wage effect, I follow Schaal (2012) and I estimate the following firm-level regression,

$$\ln w_{it} = \beta_1 \ln l_{it} + \epsilon_{it}$$

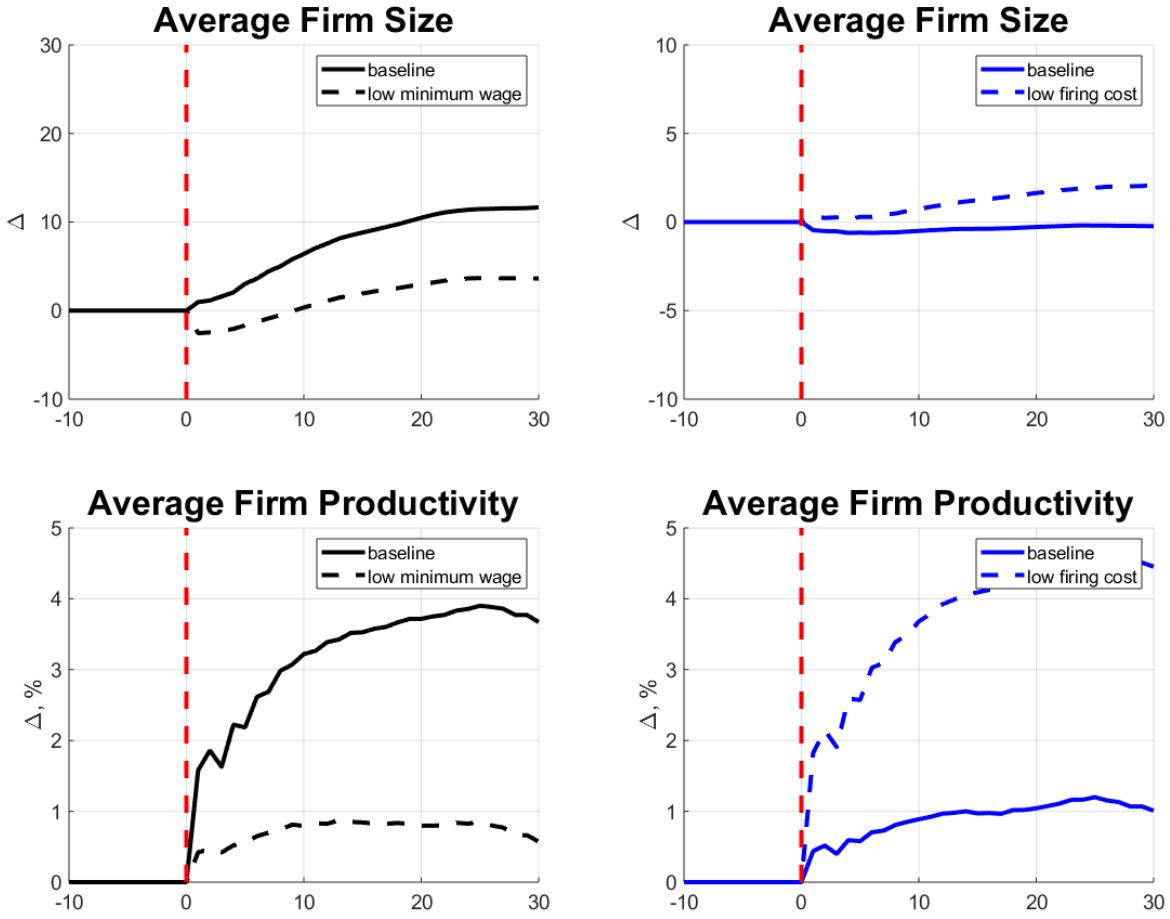
where β_1 denotes the wage elasticity of employer size. Notice that two major forces will be at play: on the one hand, decreasing marginal return from labor will induce a declining wage as the employer size increases. On the other hand, larger employers will be those with higher idiosyncratic productivity and a better likelihood of being exporters. The implication of the model for the wage-size relation depends on which force dominates the other. Table 11 reports the OLS estimates for the wage elasticity of size. The model generates a positive and significant wage elasticity of employer size, of magnitudes ranging between percent for Colombia and percent for Mexico, and in line with what we observe in the data.

Wage Dispersion. To analyze the degree of wage dispersion that the model can generate, I consider the cross-plant standard deviation of log average wages. The model reproduces the observed wage dispersion remarkably well. A simulated version of the model predicts a standard deviation of firm-level log wages equal to 0.369 for the case of Colombia, against

an observed value of 0.461, and equal to 0.484 for the case of Mexico, against the observed value of 0.456.

Appendix D. Additional counterfactual results

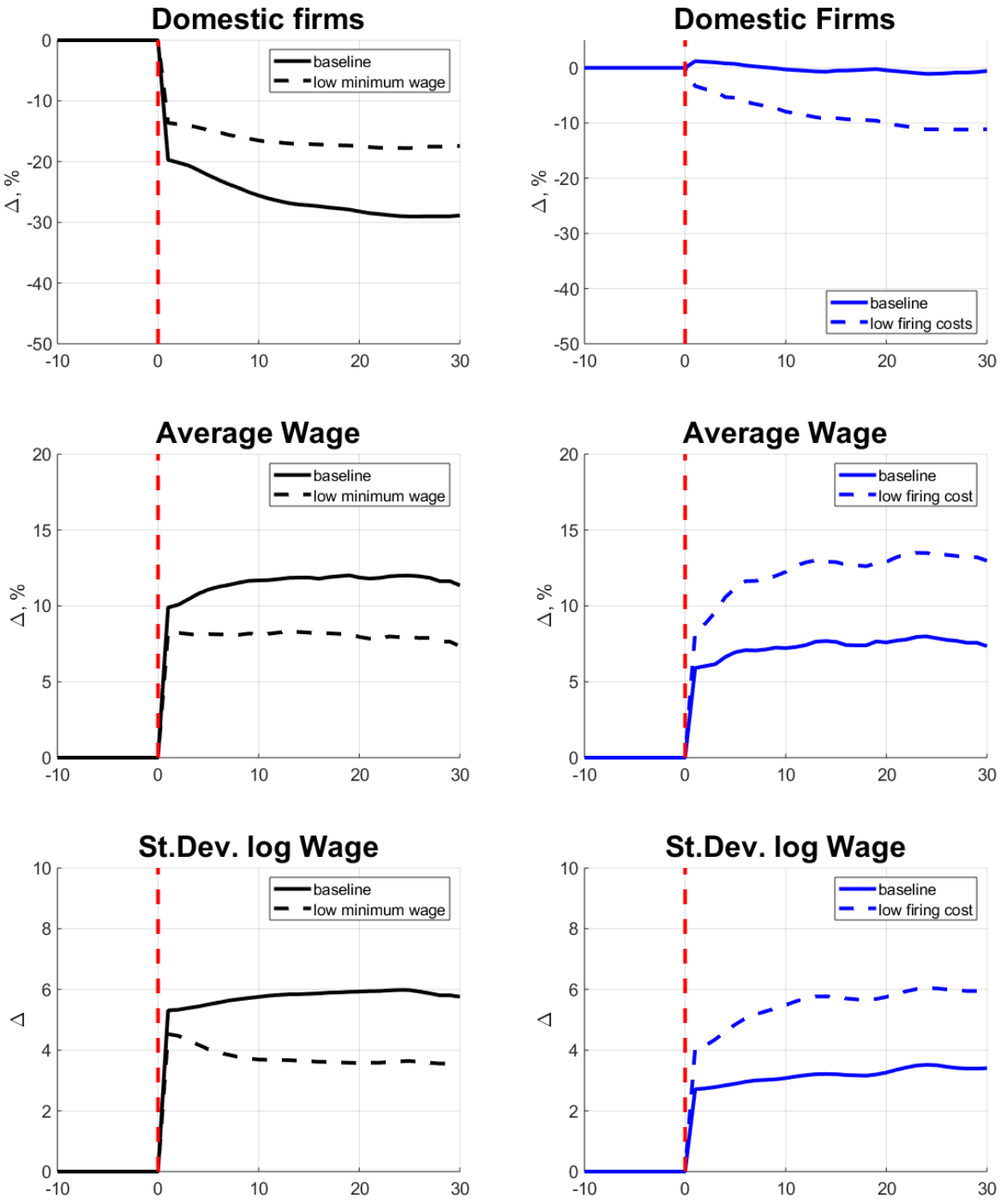
Figure 14: **Additional counterfactual outcomes**



Note: This figure displays the evolution of selected additional statistics along baseline and counterfactual transition path following a trade liberalization in Colombia (black line) and Mexico (blue line).

Figure 14 and 15 report the impulse response functions to a reduction in trade costs for a list of additional variables. Expanding firms recruit workers at a faster pace the less strict the EPL: lower firing costs increase the firms marginal surplus from hiring workers by reducing the expected costs of shedding them in the future. Lower minimum wage induce temporary survival of low-productivity incumbents, thereby reducing firm selection and lowering productivity gains.

Figure 15: **Additional counterfactual outcomes**



Note: This figure displays the evolution of selected additional statistics along baseline and counterfactual transition path following a trade liberalization in Colombia (black line) and Mexico (blue line).