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Trade and labour market institutions: A tale of two liberalizations

Alessandro Ruggieri

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Alessandro Ruggieri*
University of Nottingham

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Abstract

In this paper I study how labor market institutions at the time of a trade reform determine the dynamic response of unemployment. I first document that for a large group of developing countries (1) unemployment increases on average following a trade reform, (2) there are significant cross-country differences in unemployment response, and (3) cross-country variation in the labor market institutions in place at the time of the reform can account for the observed unemployment changes. I interpret this evidence through the lens of a model of international trade, featuring heterogeneous firms, endogenous industry dynamics and search and matching frictions and a dual labor market. I estimate the model to match the pre-liberalization firm dynamics in Colombia and Mexico, two countries that differed by the labor regulations in place at the time of trade liberalization, and I characterize numerically the full transition path towards the new steady state. I show that the dynamic response of unemployment to a reduction in trade costs is non-linear across different combinations of labor market institutions in place at the time of the reform. Consistent with the cross-country evidence, the response is stronger and more persistent when the firing costs are lower and the statutory minimum wage and unemployment benefits are larger. These three institutions account for up to 46 percent of the average unemployment response in the case of Mexico, and up to 41 percent in the case of Colombia.

Keywords: Trade reform, labor market institutions, unemployment, transitional dynamics, gains from trade
JEL Classification: E24, F12, F16, L11

*Contact: School of Economics, Sir Clive Granger Building, University of Nottingham, University Park, NG7 2RD, Nottingham, aruggierimail@gmail.com. I am indebted to my advisor, Nezih Guner, and I am grateful to Jim Tybout and Chris Busch for their help and suggestions. I would also like to thank Paula Bustos, Jordi Caballe, Lorenzo Caliendo, Russell Cooper, Rafael Dix-Carneiro, Swati Dhringa, Andres Erosa, Marcela Eslava, Pablo Fajgelbaum, Giammario Impullitti, Tim Kehoe, Samuel Kortum, Omar Licandro, Tim Lee, Alejandro Riano, Raul Santaeulalia, Jaume Ventura, Neil Wallace and Steve Yeaple for their comments along different stages of the paper, and the department of Economics at Penn State University and CEMFI for the hospitality offered during the final stage of this project. I also thank the seminar audiences at the UAB Macro Club, the Yale International Trade Lunch, the Macro Workshop at TSE, the Enter Seminars at UC3M and ULB, the 2018 RES PhD Meeting, the 2018 SAEe Meeting, the 2018 ESW Meeting, the 2018 NEUDC conference, the 2018 Mid-West International Trade Conference, the 2018 Enter Jamboree, the 2017 Vigo Macro Workshop and the 2017 UAB-UPF PhD Jamboree. I acknowledge financial support from the La Caixa-Severo Ochoa Program for Centers of Excellence in R&D of the Spanish Ministry of Economy and Competitiveness. The usual disclaimers apply.

1 Introduction

Over the past 40 years, most developing countries have embarked on programs of trade liberalization.[1] Despite the well-known benefits of product market integration, a large literature has documented that trade reforms can create adverse effects on labor markets, and a key concern has been the higher unemployment that often follows.[2] Countries, however, differ significantly in how they fare with respect to unemployment after a trade reform.[3]

In this paper I study whether labor market institutions in place at the time of a trade liberalization are responsible for the post-reform dynamics of unemployment. Labor institutions in place at the eve of a trade reform vary greatly among countries.[4] Some countries adopt free-trade policies with flexible labor market institutions, while others do so with more rigid ones. Is the 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? Which one is the most relevant? What are the channels they operate? To address these questions, I develop and estimate a structural model of firm dynamics with a rich institutional environment, and I show that regulations in the labor market are key determinants of the transitional dynamics after a trade liberalization episode.

To illustrate how labor market institutions shape the response to a trade opening, I provide aggregate evidence from an event study analysis. In particular, I track the dynamics of unemployment rate within a panel of 40 developing countries who experienced a trade reform in the last 30 years. On average, the unemployment rate increases shortly after a trade liberalization and it stays higher within at least 10 years after the reform. Employment protection legislation (EPL, henceforth), minimum wage regulation and unemployment insurance (UI, henceforth) in place induce heterogeneous responses of unemployment to a fall in trade costs, and the cross-country variation in these three labor market institutions can account for the observed unemployment responses.

To interpret these findings and quantify the causal effects of regulations in the labor market, I develop a two-sector structural equilibrium model of a small open economy with endogenous firm dynamics. Unlike most of the works in the trade literature, the focus of this paper is on the transitional dynamics triggered by a reduction in trade costs, within a framework characterized by a rich institutional setting in a frictional labor market. I discipline the model using firm level data from the Colombian and the Mexican manufacturing sector and I solve for the full transition path that results from lowering variable trade barriers towards the new steady state. I show that the response of unemployment after a trade reform is consistent with the empirical evidence: a counter-factual analysis indicates that the labor market institutions at the time of trade opening can explain up to 46 (41) percent of the response of unemployment in Mexico (Colombia).

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

[2] 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).

[3] On the effect of trade openness on unemployment in developing countries, see, for instance, Revenga (1997) for the case of Mexico, Currie and Harrison (1997) for Morocco, Goldberg and Pavcnik (2004) for Colombia, Kpodar (2007), Nicita (2008) for Madagascar, Balat and Porto (2007) for Zambia, Hasan et al. (2012) for India and Menezes-Filho and Muendler (2011), Dix-Carneiro (2014) and Dix-Carneiro and Kovak (2017) for Brazil.

[4] See Freeman (2010) for a discussion about differences in labor market institutions across developing countries.

The model combines endogenous firm dynamics with costly employment adjustment and 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 and engaging in international trade.

Industrial firms enter and exit the industry, driven by profit considerations and exogenous bankruptcy shocks, and they expand and shrink their size, subject to idiosyncratic productivity shocks. To hire workers, firms are subject to search and matching frictions and convex adjustment costs, which prevent immediate employment adjustment in response to a change in revenues. Moreover, firms must comply with three major labor market institutions: (1) firing restrictions, modeled as a tax on employment reduction; (2) a statutory minimum wage, modeled as a legal minimum contribution each employer is forced to provide to employees; (3) unemployment insurance, modeled as a government lump-sum payment accruing to workers who separate from their employers, and financed with taxes on firms' payroll.

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 stage of life-cycle, 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, unemployment rate and income inequality. 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 and unemployment benefits induce an *amplification effect*, increasing the cost of labor and making the domestic firms respond to foreign competition with larger worker displacement.

In a 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.[5] 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,

[5] 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.

firms contributions for worker dismissal in Colombia were roughly equivalent to one average real monthly 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.

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 the Method of Simulated Moments to estimate 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 and the rates of employment growth among firms of different sizes, although they are not part of the estimation targets. Finally, I use the estimated model to study a general equilibrium transition path in response to a trade liberalization reform under counterfactual labor market institutions.

As a first analysis, I implement a once-and-for-all reduction of both tariffs and non-tariff barriers (NTB, henceforth), and I solve for the full transition path towards the new steady state, while keeping 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 and income inequality.

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. 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. First, low-productivity incumbents react on impact. High firing costs hamper job destruction, low minimum wage or low unemployment insurance foster greater wage cuts. Greater job destruction contributes to increase unemployment, particularly in the short run. Second, high-productivity firms expand slowly. Search and matching frictions and convex adjustment costs prevent exporting firms to jump immediately to the new optimal size, with the effect of keeping, at the aggregate level, unemployment duration of displaced workers higher along the transition path. It follows that, as in Bellon (2016), unemployment and employment share of manufacturing overshoot in the short-run. Third, 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. Fourth, lower minimum wage and lower UI induce temporary survival of low-productivity incumbents, thereby reducing firm selection. At the aggregate level, lower selection slows down the adjustment process, with the effect of crowding out higher-productivity entrants, hence depressing average firm growth in the tradable sector. Finally, 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.

As a second analysis, I quantify the role played by each institution. To do so, I use the model to perform a difference-in-difference type of analysis. 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 open to trade with a reduction of both tariffs and NTB and I measure the average increase in unemployment along the transition to the new equilibrium. Therefore, 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, the stricter the minimum wage policy, and the larger the coverage of unemployment insurance. This pattern resembles the cross-country evidence of the event study of liberalization. I find that the *wage rigidity* induced by the statutory minimum wage and the unemployment benefits is the most important cause of unemployment response to a trade shock: taken separately, these two institutions quantitatively account for approximately one half of the unemployment response generated by a reduction in trade costs. The *employment rigidity* induced by the employment protection legislation has the opposite effect: larger firing costs have a negative effect on unemployment response and much lower magnitude, accounting for less than one fifth.

As a final analysis, I evaluate the welfare properties of several labor market reforms, simultaneously implemented with a trade reform. To do so, I focus on the transitional dynamics of per-capita real income and real income inequality after a fall in trade costs under different labor market regimes. I use Atkinson (1970)′s formulation of social welfare function to compute the consumption-equivalent *cost of inequality*, defined as the percentage change in all agents′ consumption or disposable income that would make the entire economy indifferent between a trade reform with and without changes in income inequality.[6]

The simulations indicate that a reduction in trade costs under the observed labor market institutions (1) improved aggregate real income more in Colombia (9.03%) than Mexico (3.70%), at a cost of (2) a significant consumption-equivalent loss from larger income inequality in both countries, with a greater loss in Colombia (6.00%) than Mexico (0.57%). On the other hand, while tariff reductions and globalization shocks would increase both aggregate real income and income inequality by themselves, the impact of greater product market integration is reinforced when the employment protection legislation is less stringent and the statutory minimum wage is stricter, and it would be milder with more generous benefits to 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 rate and highlights the role of labor market institutions. Section 3 outlines the structural model, defines a notion of equilibrium along the transition path from autarcky to 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 estimation strategy. Section 7 explores the quantitative implication of the model and numerically characterize the transitional dynamics after a trade reform under the different labor market policies.

[6]See Antràs et al. (2017).

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 literature. 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.[7] 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 along the entire transition path between different steady states, through ongoing productivity shocks, endogenous firm entry and exit, and endogenous job creation and destruction.

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.[8] 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. Both models yield comparable prediction about unemployment: they both show that falling trade costs can generate a short-run increase in unemployment. 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 the lowering of variable trade costs.

This paper speaks eventually about the effects of labor market institutions on unemployment.

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

[8]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 intersectoral job turnover using the US Census of Manufacturing.

To this regard, this paper can be viewed as complementary of 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. Extensive studies have focused on the effects of regulations on labor market performance of low and middle-income countries, exploiting for instance, the waves of reforms that have characterized many Latin American and Caribbean (LAC) countries during the 1980's and the 1990's.[9] This paper extends the analysis by studying the effect of labor market institutions on the labor market performance of an economy subject to large structural shock, that is, a trade liberalization. On this matter, this paper is close to Veracierto (2008), who studies the effect of firing costs on an economy that is subject to business cycle technological shocks, and to Anderton et al. (2015) and di Mauro and Ronchi (2016) who analyze the effects of labor market institutions on firms adjustment to the great recession. The focus of this paper is on trade reforms, which, as opposed to a business cycle shock, induce asymmetric responses between high-productivity firms - which benefit from larger demand from foreign markets - and low-productivity firms - which are harmed from larger import penetration. 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 nominal rigidity on both quantity and wages.

Finally, this model contributes to the recent theoretical labor-search literature that incorporate a notion of firm size, including Elsby and Michaels (2013), Acemoglu and Hawkins (2014), and Kaas and Kircher (2015), and speaks more generally about the interaction between labor market and product market regulations, giving particular emphasis on the consequences of increased import competition on firm and employment dynamics, and to this regard it is close to Koeniger and Prat (2007), Felbermayr and Prat (2011) and Felbermayr et al. (2011).

2 Aggregate evidence

Between the mid-'70s and the mid-'90s, various developing countries liberalized their trading regimes, dismantling trade barriers and lowering import tariffs.[10] This wave of trade reforms was particularly intense in Latin American and the Caribbean (LAC, henceforth) countries, where,

[9] For a comprehensive review of the literature, with particular focus on the effect of EPL and minimum wages policies on employment, turnover rates and wage distribution between demographic groups, see Heckman and Pages (2004). For a discussion about labor market institutions and unemployment in continental European economies, see Nickell and Layard (1999).

[10] Wacziarg and Wallack (2004) report that more than 70% of the countries in the world were open up to international trade by the end of the 1990s, a share representing almost 50% of the world population.

as a result of unilateral trade opening policies, the regional average tariffs on imports fell from 45% to 13% and non-tariff restrictions and permits went to cover from 34% of total imports to no more than 11%.[11] As a consequence, trade flows significantly expanded, increasing import penetration of intermediate inputs and final manufactured goods and exposing these countries to foreign competition.[12]

In this section, I focus on a subset of countries who embraced a process of trade liberalization during the last 40 years and I report aggregate evidence on the response of the unemployment rate to a liberalization episode. In particular, I track the dynamics of unemployment within 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).[13] 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 to identify differences in employment protection regulation. Finally, to measure the unemployment benefit legislation I use the average gross replacement rates within one year of dismissal, weighted by the total benefit coverage. 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 are taken from the World Development Indicators (henceforth the WDI) provided by the World Bank merged with the Penn World Table version 9.0.[14]

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.

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. Figures 1 report (a) the unconditional cross-sectional average import penetration and (b) the unconditional cross-sectional average import tariffs applied on all products, for each period around the date of

[11] Data on trade barriers are taken from the IADB, Integration and Trade Division, and are reported in Lora (1997). For the same period, Haltiwanger et al. (2004) document a marked reduction in the standard deviation of average 2-digit sector tariffs in all countries of the region.

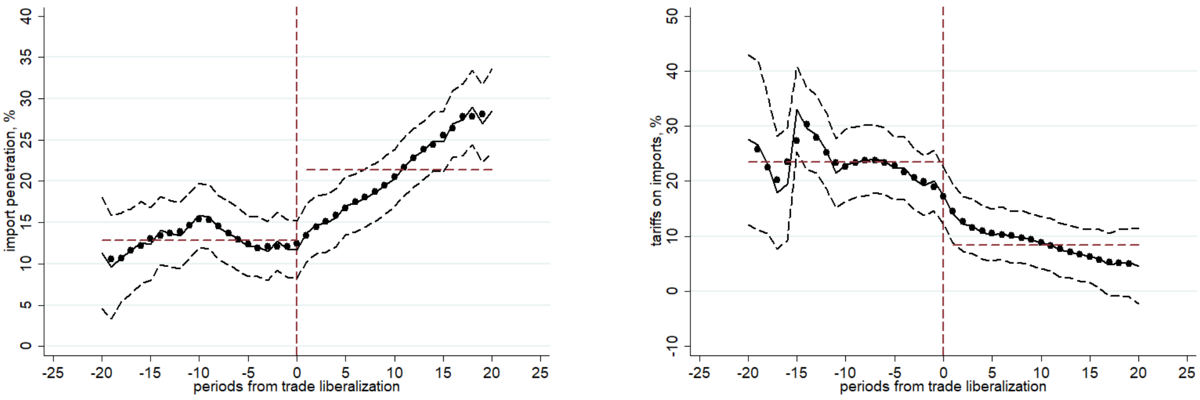
[12] From 1985, total imports of goods and services (over GDP) in LAC countries increased at a annual rate of 2.5%. Further evidence on trade openness and drop in tariffs are available at the WITS dataset from the World Bank. See http://wits.worldbank.org.

[13] 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

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

Figure 1: **Trade reforms**

(a) Import dynamics (b) Tariffs dynamics



Note: Import penetration is constructed as total imports divided by GDP minus net export. Tariffs on imports are weighted average tariffs applied on all imported products. Each dot is the OLS estimate of year fixed effects in a regression with the dependent variable and year dummy variables. The continuous lines are three-years moving averages of the year fixed effects. The dashed lines are 95 percent confidence intervals constructed using robust standard errors. Source: ILO-stat, WBI, Furceri et al. (2018) and author′s calculations.

reform, within a time-window of 30 years. Tariffs are on average 15 percentage points lower after a liberalization episode, and the share of imported goods in domestic output is twice as large as before. Moreover, both tariffs and imports fluctuate around the pre-reform average while trending roughly at he time indicated by the liberalization date.

2.1 Trade reform and unemployment

The first hypothesis I investigate in this paper is whether unemployment rate has been relatively higher after a trade reform. Figure 2-a reports the unconditional cross-sectional average unemployment rate, each period around the date of liberalization. After a trade opening, the unemployment rate increases about two percentage points (from 6 to 8 percent of the active labor force).

To provide more detailed evidence, I estimate the following cross-country equation,

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

where unemp_{it} is the 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 unemp_{it} occurred after the trade reform. Finally, X_{it} is a vector of controls, including population growth, real GDP per capita and its square, real GDP per capita

Table 1: **Trade Liberalization and Unemployment**

	unemp_{it}			
VARIABLES	(1.1)	(1.2)	(1.3)	(1.4)
Liberalization dummy				
$\mathbf{1}_{\{t\geq t_i^*\}}$	2.111	2.111	1.916	1.914
	[0.759]***	[0.683]**	[0.647]**	[0.679]**
R-squared	0.099	0.164	0.518	0.599
Observations	1004	1004	1004	998
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.*

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 to capture country-specific episodes of economic and financial distress, I include three dummy variables for the occurrence of banking, currency, and sovereign debt crises, constructed using the crisis dates reported in Laeven and Valencia (2013).[15] If the average response of unemployment to a trade reform were positive, then the estimates for α should be significantly greater than zero.

Table 1 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: the coefficient α is always positive and statistically significant at 5% percent level. Conditional on the full set of observables, the unemployment rate is roughly 1.9 percentage points higher after a trade liberalization.[16]

Table 2: **Labor Market Institutions**

	Min/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
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. AN refers to the months of advance notice, SP refers to level of severance payment: both are expressed as a multiple of average real monthly wage. UI benefits refers to the average gross replacement ratio after one year of dismissal, UI coverage refers to the share of unemployed workers entitled to benefits after dismissal: both are expressed in percentage. Source: FRdB Labor Institution v.1 database and authors′ calculation.

2.2 Trade reform and labor market institutions

Trade liberalizations were not followed by labor market reforms.[17] At the time of trade opening, the extent of labor market rigidity varies considerably across countries, most of the local labor markets were highly regulated and with limited active labor market policies.[18]

Table 2 reproduces this evidence for the countries in the sample. 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 employees averaged 6 months of real average wage, more than two times higher than those observed in France between the ′80s and ′90s, and almost three times higher than those in place in Italy during the same two decades. Unemployment insurance was limited in 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 in place. Finally, the statutory minimum wage averaged 37 percent (with a maximum

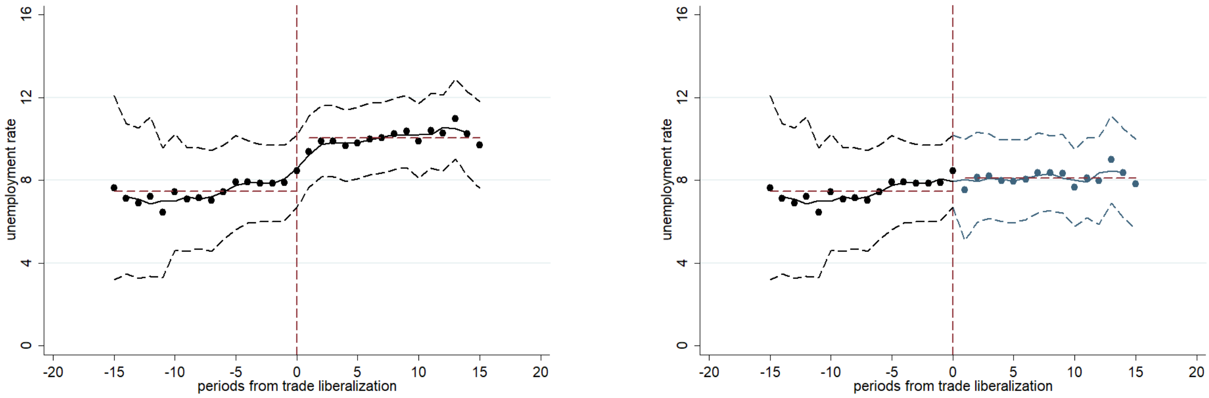
[15] Laeven and Valencia (2013) presents a comprehensive database on systemic banking crises during the period 1970–2011 for a panel of 141 countries, and complement it with dates for sovereign debt and currency crises during the same period. See https://www.imf.org/en/Publications/WP/Issues/2018/09/14/Systemic-Banking-Crises-Revisited-46232

[16] The liberalization dates used in the main specification are based on what Wacziarg and Welch (2003) labeled *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 Appendix A.

[17] 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.

[18] Freeman (2007) documents 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.

Figure 2: **Unemployment Dynamics**



Note: Each dot is the OLS estimate of year fixed effects in a regression with the dependent variable and year dummy variables. The continuous lines are three-years moving averages of the year fixed effects. The dashed lines are 95 percent confidence intervals constructed using robust standard errors. Source: ILO-stat, WBI and author′s calculations.

of 70 percent) of real average wage at the time of the reform; nevertheless, some countries had no minimum wage legislation in place.

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. That is, can the dynamics of unemployment documented in section 2.1 be explained by the labor market institutions in place at the time of reform? Figure 2-b reports the un-weighted cross-sectional average for the unemployment rate, each period around the date of trade liberalization, after filtering out the effect of minimum wage, employment protection and unemployment benefits. Conditional on the legislation in place, there is no significant difference in the unemployment rate before and after trade openings anymore, suggesting that the labor market institutions can account for a large share of cross-country variation in unemployment during free trade.

To confirm this fact, I extend the specification used in Kambourov (2009) and I estimate the following cross-country equation,

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

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

Table 3 reports the estimates of equation (2) for a number of different specifications. Labor market institutions explain the variation in unemployment rate observed after a trade reform: the coefficient α looses significance once the interaction terms are included. The p-value for the F-test of a joint positive effect of UI, minimum wage and EPL suggests that cross-sectional variation in labor market institutions significantly capture the differences in unemployment response to a

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

	unemp_{it}			
VARIABLES	(2.1)	(2.2)	(2.3)	(2.4)
Liberalization dummy				
$\mathbf{1}_{\{t \geq t_i^*\}}$	1.081	-0.719	3.498	-0.208
	[0.855]	[1.413]	[1.110]***	[1.408]
Liberalization dummy × UI				
$\mathbf{1}_{\{t \geq t_i^*\}}\text{ub}_i$	0.172			0.120
	[0.042]***			[0.050]**
Liberalization dummy × Minimum wage				
$\mathbf{1}_{\{t \geq t_i^*\}}\underline{\text{w}}_i$		5.544		6.191
		[3.162]*		[2.591]**
Liberalization dummy × EPL				
$\mathbf{1}_{\{t \geq t_i^*\}}\text{epl}_i$			-0.292	-0.254
			[0.104]***	[0.109]**
R-squared	0.621	0.609	0.611	0.632
Observations	907	901	972	775
Country FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Country trend	yes	yes	yes	yes
Controls	yes	yes	yes	yes
F-test p-value	0.998	0.925	0.987	0.997

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^*. epl_i, ub_i and $\underline{w}_i$ refers to employment legislation, unemployment benefits and minimum wage regulation 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. The p-value refers to the F-test for joint significance of labor market institutions, i.e. $H_0 : \mathbf{1}_{\{t \geq t_i^*\}} + \mathbf{1}_{\{t \geq t_i^*\}}ub_i + \mathbf{1}_{\{t \geq t_i^*\}}\underline{w}_i + \mathbf{1}_{\{t \geq t_i^*\}}epl_i > 0$. 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.*

trade liberalization across countries. Moreover, the estimates from the specification with full set of controls (column 5 in Table 3) predict the following unemployment response. The unemployment rate would be 0.619 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, a country with a larger unemployment benefit coverage by one percentage point is likely to experience an average increase in unemployment of 0.120 percentage points higher following a trade reform. And finally, one month more in the average firing costs predicts a 0.254 percentage points-lower unemployment rate in the aftermath of a trade reform.

The event study in this section indicates that labor market institutions are key to understand the response of unemployment post-trade liberalization. The analysis suggests three main facts. First, a trade reform is followed by a positive and significant average response of unemployment. Second, the dynamics of unemployment is tightly linked to the labor market institutions in place at the time of liberalization. Third, the unemployment response is higher the lower the costs of dismissing workers and the larger the minimum wage and the unemployment insurance in place. However, 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, the identification of a trade shock relies on the definition of liberalization date and it is subject to various limitation.[19]

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 and to disentangle the role of each labor market institution from the effect of other characteristics.

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 industrial sector and a fixed measure of firms producing service goods. Workers are homogeneous, risk neutral and live hand-to-mouth: they derive their utility from consumption and no savings technology is available to them. 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, financed with payroll taxes on industrial firms

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

[19] Harrison and Hanson (1999) have criticized the ability of the liberalization dates to correctly capture trade openness. The empirical analysis I conduct might suffer from well-established limitations (see Rodriguez and Rodrik (2000) for a critique) and should only be viewed as suggestive. Neverthless, in Appendix A I will try to address some limitations of the empirical strategy as a part of the robustness checks.

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 tradable sector good. In each period t, workers maximize their the expected discounted value of their utility stream, denoted by $\mathcal{U}_t$, and equal to

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

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:[20]

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

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, $L_{u,t}$.

[20]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).

3.3 Production

Firms in the service sector are homogeneous: they all produce the same service good using labor only.[21] Unemployed workers sustain themselves by home-producing $b < 1$ units of service goods. The total production of service sector is then equal to

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

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 service 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 Krugman (1980). 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

[21] 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).

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) to express gross revenues in terms of current period productivity, z, and employment values, ℓ, the net revenue function reads as follows,

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

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

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

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 $\tilde{V}^h_t(z',\ell)$ is the firm's value of expanding,

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

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

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

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

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

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

$$\pi_t(z',\ell') = R_t(z',\ell') - (1+\tau_{w,t})\max\{\underline{w}_t, w_t(z',\ell')\}\ell' \tag{22}$$

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 $t+1$.

Employment in industrial firms is characterized by four 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) the wage rate is negotiated through the *intra-firm bargaining* protocol proposed by Stole and Zwiebel (1996) and (2) the marginal revenue is *decreasing* in labor.[22] Second, the wage rate is subject to a the legal constraint imposed by the statutory minimum wage in force, $\underline{w}_t$. Third, employers are subject to a tax on payroll, $\tau_{w,t} \geq 0$, collected by the government and rebated back to unemployed workers through lump-sum transfers. Finally, changes in formal employment are subject to adjustment costs, $C_t(\ell,\ell')$, expressed in terms of service goods, and described by the following function,

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

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

[22]See section 3.8 for a description of the wage bargaining protocol.

cost with respect to the size of employment adjustment, and $\lambda_2 > 0$ governing the relative cost faced by small and large employers.[23] 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.[24] The ex-ante value of a firm with initial productivity z and employment, ℓ is thus equal to

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

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.

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).

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:

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

[23] 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).

[24] 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.

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

$$J_t^s = 1 + J_{t+1}^o, \tag{28}$$

while the value of searching for a job in the industry, J_t^u is equal to

$$J_t^u = \widetilde{\phi}_t \mathbf{E} J_t^{e,h} + (1 - \widetilde{\phi}_t)[b + b_t^u + J_{t+1}^o] \tag{29}$$

where $b_t^u \geq 0$ denotes transfers to unemployed, while $\mathbf{E} J_t^{e,h}$ is the expected value of a match with a firm operating in the industrial sector for a worker searching for a job, which depends on the distribution of hiring firms, through the vacancies they post, and on the value of the jobs they offer, through the wage they pay,

$$\mathbf{E} J_t^{e,h} = \int_{z' \in \mathcal{Z}} \int_{\ell \in \mathcal{L}} [\max\{\underline{w}_t, w_t(z', \ell')\} + J_{t+1}^e(z', \ell')] g_t(z', \ell) dz' d\ell \tag{30}$$

In equation (30), $J_{t+1}^e(z', \ell')$ stands for the continuation value of a worker employed in the industrial sector at beginning of period $t+1$ while $g_t(z', \ell)$ is the distribution of vacancies posted in the interim stage of the period by hiring firms with productivity z' and ℓ stock of employees.[25] By construction, the wages of *every* hiring firm are such that unemployed workers will always accept a job offer in the industrial sector whenever contacted, regardless the characteristic of the hiring firm.

Under risk neutrality, the supply of workers searching for a employment in the industrial sector depends on their expected 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 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 $J_t^s = J_t^u$, $\forall t$.[26] Using condition (27), it must be that J_t^s and J_t^u are all equal to

$$J_t^o = \frac{1}{1 + r_t}[1 + J_{t+1}^o] \tag{31}$$

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

[25] In equation (30) it is acknowledged that both ℓ' is functions of the state variables (z', ℓ), over which the expectation is taken.

[26] 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.

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.[27] 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

$$J_t^c(z', \ell) = p_t^f(z', \ell) J_t^u + \frac{(1 - p_t^f(z', \ell))}{1 + r_t} [\max\{\underline{w}_t, w_t(z', \ell')\} + J_{t+1}^e(z', \ell')] \tag{33}$$

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.

3.8 Wages

Wages for industrial employees are determined using the Stole and Zwiebel (1996) bargaining solution, which generalizes the standard Nash bargaining solution to a setting when marginal returns are diminishing. 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 become unemployed in the current period). This generates a surplus to split between firms and workers. At the time of determining wages, firms marginal surplus is equal to:

$$\Pi_t^{\text{firm}}(z', \ell') = \frac{\partial R_t(z', \ell')}{\partial \ell'} - (1 + \tau_{w,t}) \frac{\partial w_t(z', \ell') \ell'}{\partial \ell'} + \frac{\partial V_{t+1}(z', \ell')}{\partial \ell'} \tag{34}$$

while worker marginal surplus equal the difference between the interim value of being employed and the outside option at the time of bargaining, given by the home-production:

$$\Pi_t^{\text{worker}}(z', \ell') = w_t(z', \ell') + J_{t+1}^e(z', \ell') - (b + b_t^u + J_{t+1}^o) \tag{35}$$

[27] 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.

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

$$\begin{aligned} \max_{w_t} \quad & \left(\Pi_t^{\text{firm}}(z',\ell')\right)^{1-\beta} \left(\Pi_t^{\text{worker}}(z',\ell')\right)^{\beta} \\ \text{s.t.} \quad & \Pi_t^{\text{worker}}(z',\ell') \geq 0, \quad \textit{(participation constraints)} \end{aligned}$$

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

Consider now 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:

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

Substituting expressions (34) and (35) into (36), and assuming that the surplus continuation values are split the same way as current surpluses,[28] one obtains a first-order partial differential equation in wage, whose solution is a wage function for workers at a hiring firm:

$$w_t^{\text{h}}(z',\ell') = \frac{(1-\beta)}{1-\beta+\beta(1+\tau_{w,t})}(b+b_t^u) + \frac{\beta}{1-\beta+\alpha\Lambda\beta(1+\tau_{w,t})}\frac{\partial R_t(z',\ell')}{\partial \ell'} \tag{37}$$

where $\Lambda = \frac{\alpha(\sigma-1)}{\sigma-(1-\alpha)(\sigma-1)} > 0$. Equation (37) has a straightforward interpretation: workers at a hiring firm obtain a share of their marginal revenues, and the share increases (1) the larger the bargaining power of worker, β, (2) the lower the production elasticity of labor, α, and (3) the lower payroll tax, $\tau_{w,t}$.

Consider instead a firm firing workers. In this case, the existing matches do not generate anymore 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 point where optimality condition is re-established, i.e. up to a level where $\Pi_t^{\text{firm}}(z',\ell') = -c_{f,t} \leq 0$. The Nash splitting rule would then imply a negative total 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:

$$\Pi_t^{\text{worker}}(z',\ell') = 0 \tag{38}$$

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

$$w_t^{\text{f}}(z',\ell') = b + b_t^u + J_{t+1}^o - J_{t+1}^e(z',\ell') \tag{39}$$

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 $J_{t+1}^e(z',\ell')$.

[28]Same assumption is made, among the others, in Bertola and Garibaldi (2001) and Cosar et al. (2016).

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.[29] Given the domestic and the foreign price indexes, the total domestic demand for

[29]See Appendix B for a full derivation of $D_{h,t}$.

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

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

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. Following Melitz (2003), I assume that the industrial producers bear a fixed cost of exporting c_x, in terms of service good. 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 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

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

firing costs,

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

and taxes on firms$'$ payroll,

$$\tau_{w,t} \int_{z\in\mathcal{Z}} \int_{\ell\in\mathcal{L}} w_t(z', \ell')\psi_t(z', \ell') dz' d\ell' = \tau_{w,t} N_{h,t} \overline{w}_{f,t} \tag{58}$$

where $\overline{w}_{f,t}$ is the average wage paid in the economy to workers. Government revenues are returned to unemployed worker in form of unemployment benefit and, what left, to each worker in the form of lump-sum transfers.

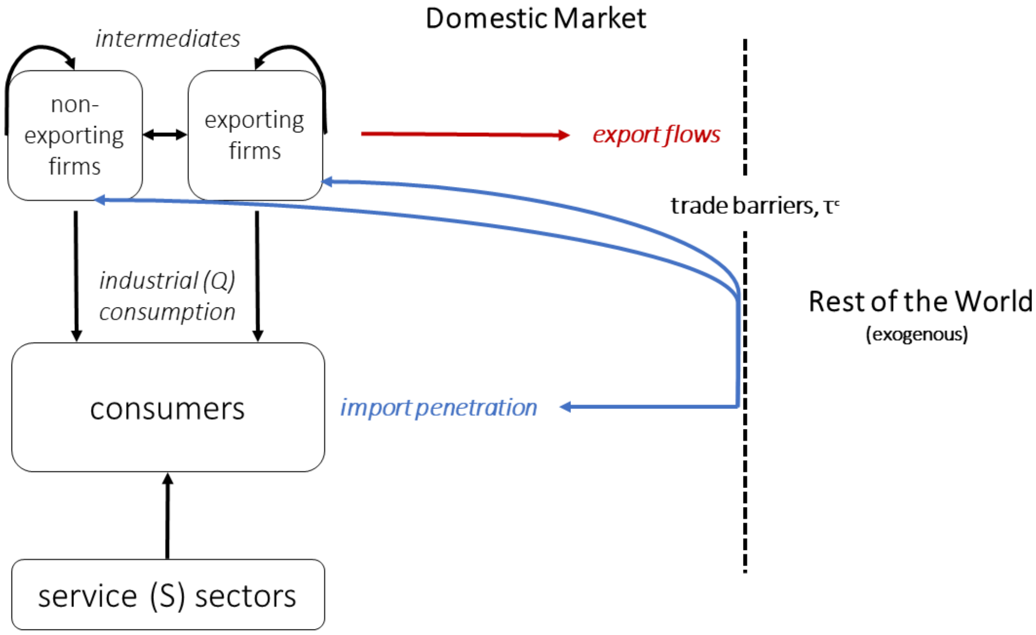
4.5 Recursive competitive equilibrium

The following six conditions characterize a Recursive Competitive Equilibrium for a small-open economy. First, incumbent firms in the industrial sector choose optimally the level of employment to solve the problem in equation (18) and take exit decision according to equations (25), whereas new firms enter the industry till condition (26) holds with equality. Second, the probability distributions of firms over the state space at the end and the interim stage of the period are consistent with the Markov processes on idiosyncratic productivity, the policy functions for employment, entry and exit, and the productivity draws upon entry. Third, industrial wages solve the bargaining problem between workers and the firm, as in equations (36) in the case of hiring firms and as in (38) in the case of firing firms. Fourth, workers optimally choose the sector in which they are working or seeking work, so that the equilibrium value of searching for a job in the industrial sector is equal to the value of working in the service sector. Fifth, the labor markets clear, that is, (1) the measure of workers who are employed in the industrial sector match the measure of industrial active jobs, (2) the sum of employment levels across sectors and the number of unemployed workers must be equal to the total labor force, normalized to one, and (3) the vacancy filling rate and the job finding rate are consistent with the measures of worker searching for industrial job in the interim state and the measure of vacancy posted by firms. Sixth, the market for service clears, and both trade and government budget are balanced. Government′s revenues come from tariffs on imports, firing costs and taxes of firms′ payroll, which used to finance unemployment benefits and eventually lump-sum transferred to consumers. Aggregate income is given by the sum total labor income (industrial and service sector wage payments plus value of home production), aggregate profits and government transfers, while aggregate expenditure in non-tradable services is divided between final good expenditure - given by a share $1 - \gamma$ of total income - and intermediate good expenditure, given by the sum of labor adjustment costs, operating costs, exporting costs and initial costs of set-up for firms. In Appendix C, I provide with a detailed discussion of the equilibrium conditions.

4.5.1 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 replicate themselves through the Markov processes on idiosyncratic productivity, the policy functions and the productivity draws upon entry, (3) the exit rate is constant and the measure of exiting firms resembles that of entrants; (4) the vacancy filling rate for firm and the probability of finding jobs for workers are time-invariant; (5) the number of workers flowing into industrial jobs matches the number of industrial jobs that are destroyed; (6) the measure of workers in the services, the measures of industrial workers, aggregate price indexes, aggregate income, profits and wages, interest rate and exchange rate are constant over time.

Figure 3: **Flows of goods**



4.6 Mechanisms

Trade openness and unemployment - 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 (Figure 3). 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 old and new exporting firms. Labor market institutions enter the picture by introducing *price* and *quantity rigidity*, which distorts the adjustments in labor demand after a trade shock, with effects on employment volatility, workers turnover and, ultimately, the unemployment rate.

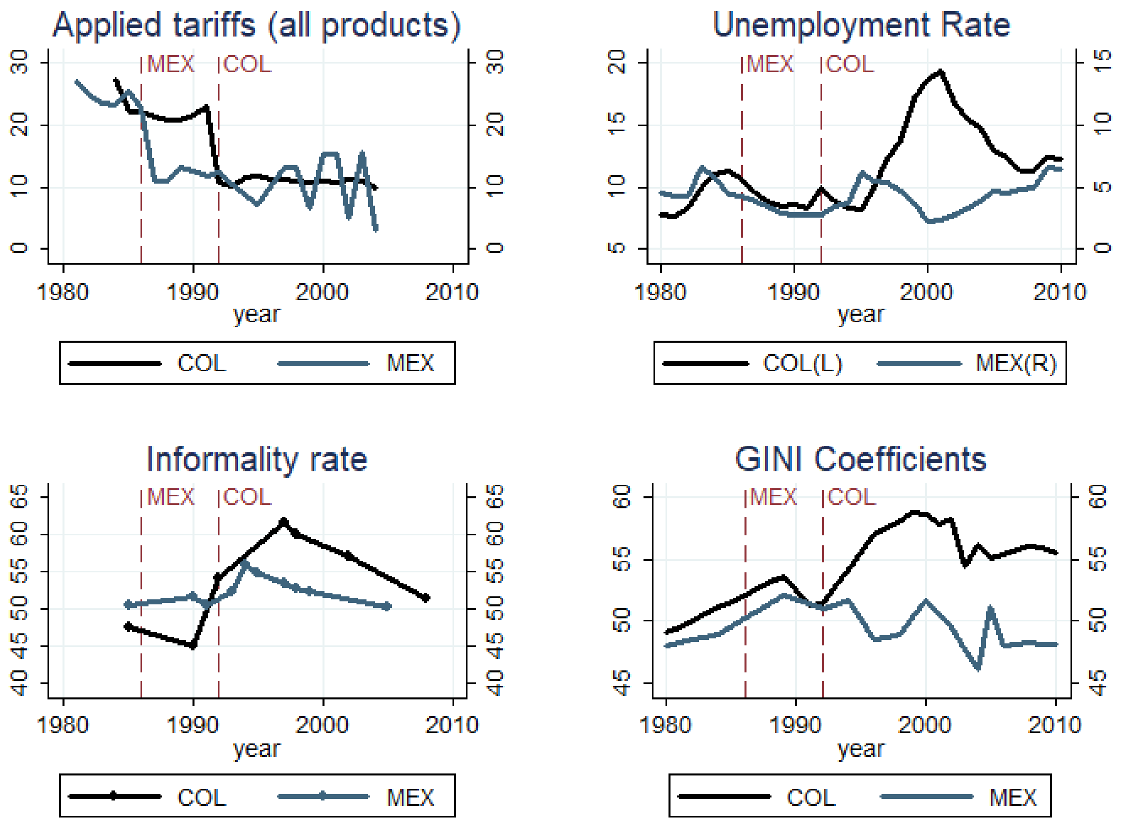
Effect of firing costs - In partial equilibrium, higher firing costs make firms employment less volatile by discouraging labor adjustments to fluctuations in revenues. To this extent, employment protection legislation introduces a *quantity rigidity*: as in Bertola and Caballero (1994), higher firing 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.

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. 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.

Effect of unemployment benefits - The unemployment insurance have less ambiguous effect on unemployment. Other things equal, larger benefits increases the cost of labor, by rising the outside option available to workers (equation 37). A larger cost of labor induces industrial firms to shed more workers in case of bad productivity shocks, triggering an increase in labor market tightness and a reduction in the the job finding rate. Furthermore, by shifting the wage distribution in the industrial jobs rightward, larger unemployment benefits increase 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. Finally, as in Hagedorn and Manovskii (2008), the unemployment insurance plays a central role in determining the elasticity of unemployment to changes in aggregate domestic and foreign expenditure: by reducing the match surplus, larger workers outside options make employers more sensitive to shocks to revenues, leading to larger employment adjustments as a response.

Non-tradable service sector - Finally, I turn to describe the consequence of a trade reform for the employment in the non-tradable sector. 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

Figure 4: **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.

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.

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., 2004). 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 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).

The trade openings in Colombia was followed by different patterns of unemployment, informality and income inequality compared to Mexico. Panel B in Figure 4 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 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 4).[30] In contrast, inequality did not increase in Mexico (it slightly decreased after 2000) and informal employment mirrored the evolution of the unemployment rate.[31]

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 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.[32]

[30] 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.

[31] 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.

[32] Source: Kugler (1999) for Colombia and Grandolini and Cerda (1998) - based on information provided by the Instituto Mexicano de Seguridad Social (IMSS)- for Mexico.

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	0.098	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).

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.[33] 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.[34] 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

[33]Source: Kambourov (2009) and IADB Report (1997) based on information from Ministries of Labour.

[34]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.

Table 5: **Calibration**

Panel A: External Parameters

Description	**Symbol**	**COLOMBIA Value**	**MEXICO Value**	**Source**
Discount rate (%)	r	10.63	6.46	IFS (2017) / Riaño (2011)
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) / Dornbush and Werner (1994)
Iceberg costs	τ_c-1	1.52		Anderson and van Wincoop (2001)
Payroll taxes	τ_w	0.16	0.18	Ayala (2013) / Kumler et al. (2015)
Firing costs/mean wage	$c_f/\overline{w}$	0.50	0.27	FRdB-IMF
Minimum/mean wage	$\underline{w}/\overline{w}$	0.54	0.33	FRdB-IMF / Bell (1997)
Unemployment benefit	b^u	0		FRdB-IMF

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

workers in 1987.[35] 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.

6.1 Parametrization

A number of parameters are taken from outside the model. Panel A in Table 5 describes them and their source. 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 10.63% in Colombia (IFS, 2017). I use information from the ECLAC-CEPAL database to compute the average share of service sector value added out of

[35] 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.

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.[36]

The remaining parameter matching moment from the data 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 and the average share 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 valuesfor d_f equal to 0.134 in Colombia and to 0.212 in Mexico.[37] 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). I take the payroll taxes for Colombia from Ayala (2013), who reports a value equal to 16% for the period 1980-1990, while for Mexico, I set the value equal to 18%, as documented by Kumler et al. (2015) for the same time period. Finally, I set the iceberg costs, τ_c to 1.52, as in Anderson and Van Wincoop (2001).

6.2 Estimation

This leaves a vector of 11 further *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 estimated using the method of simulated moments.[38] 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 estimator, $\hat{\vartheta}$ can be defined as the argument that minimize the following objective function,

$$\hat{\vartheta} = arg \min_{\vartheta \in \Theta} \quad \overline{m}(\vartheta)' \hat{\Sigma} \overline{m}(\vartheta) \tag{59}$$

[36]See the Appendix for details on the source and the construction of the external parameters.
[37]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.
[38]See, for instance, McFadden (1989), Pakes and Pollard (1989) and Gourieroux and Monfort (1996)

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 behavior 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, I choose $\hat{\Sigma}$ to be a bootstrapped estimate for the inverse of the variance-covariance matrix of the moment conditions, $[var(\overline{m})]^{-1}$. 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 (59).[39]

To construct the relevant moment conditions, I use information on Colombian manufacturing plants collected in the Annual Manufacturer Survey (*Encuesta Anual Manifacturera* - 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 contains information on Mexican manufacturing firms.[40] [41] 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.

6.2.1 Moment Selection and Identification

Table 6 reports the list of aggregate moments constructed from the data and used in the estimation algorithm. For both countries, I employ 20 moments, divided in three main groups. The first set of moments consists of means, variances and first-order auto-covariances for the log of employment, $\ln[l]$ and the log of gross revenues $\ln[g]$ (expressed, in both countries, in terms of thousands of 1977 LCU) and the mean for the export decision, $\mathbf{1}^x$, an indicator taking value one anytime a plant reports positive exports, zero otherwise.[42] The second group of moments includes the quintiles 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

[39]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 nonlinear. See Malhotra et al. (2011)

[40]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.

[41]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 over the sample periods, 1984-1986.

[42]For the case of the export indicator, the variance, $var[\mathbf{1}^x]$ is dropped from the list of moments because of redundancy, while the first-order auto-covariance, $cov[\mathbf{1}^x, \mathbf{1}^x_{-1}]$ is not included because information on exports in the Mexican dataset is not available during the first two years of the sample, hence it cannot be constructed.

Table 6: **Moment Selections**

	COLOMBIA		MEXICO	
Moments	**Data**	**Model**	**Data**	**Model**
Firm-level moments				
$\mathbf{E}[\ln l]$	3.619	3.740	3.303	3.239
$\text{var}[\ln l]$	1.134	1.443	1.497	1.516
$\text{cov}[\ln l, \ln l_{-1}]$	1.218	1.452	1.403	1.899
$\mathbf{E}[\ln g]$	5.430	4.676	4.559	5.106
$\text{var}[\ln g]$	1.674	1.760	1.746	1.955
$\text{cov}[\ln g, \ln g_{-1}]$	1.543	2.083	2.136	2.813
$\mathbf{E}[\mathbf{1}^x]$	11.89	11.20	21.56	21.16
Log-employment distribution				
20^{th} perctile	2.676	2.831	1.946	2.085
40^{th} perctile	3.178	3.343	2.944	2.643
60^{th} perctile	3.720	3.907	3.761	3.323
80^{th} perctile	4.450	4.622	4.625	4.325
Firm size distribution				
1-49 employees	70.81	70.22	82.66	81.92
50-99 employees	14.01	14.77	9.18	8.42
100-199 employees	7.90	9.17	4.55	5.56
200-499 employees	5.21	4.95	2.30	3.00
Aggregate moments				
Exit rate	12.04	13.05	11.01	13.14
Job turnover rate	16.54	15.41	16.08	17.43
Average wage	19.87	20.46	3.02	3.52
Labor share	45.01	46.41	34.10	35.72
Vacancy rate	2.27	2.17	1.51	1.50

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

average wage, the payment compensation share of revenues and the vacancy rate.[43]

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. Vacancy rate and

[43]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.

job turnover rate will be informative of the overall cost of hiring, c_h, and the exogenous firm hazard rate, δ: lower hiring costs will shrink the optimal inaction region for employment, inducing firms to post more vacancy on average, while larger hazard rate will increase the measure of job destroyed and, because of stationarity, reallocated to new employers. The moments describing the distribution of log employment will discipline the revenue elasticity of labor, α, 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. Finally, the average log revenues, the average wage and the labor compensation share will pin down the size of the domestic aggregate expenditure, D_h and the workers outside option b, since each of 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, together with a one standard deviation confidence intervals. The standard errors are constructed using the formula for the asymptotic variance-covariance matrix,

$$\text{var-cov}(\vartheta) = (D'\hat{\Sigma}D)^{-1}(D'\hat{\Sigma})\hat{\Omega}(\hat{\Sigma}D)(D'\hat{\Sigma}D)^{-1} \tag{60}$$

where $\hat{\Sigma}$ is the weighting matrix used in the estimation, D is the Jacobian matrix for the vector of moment conditions, with dimension $\dim[\vartheta] \times g$, and generic entry in position (i, j) equal to $D_{ij} = \partial\overline{m}_i(\vartheta)/\partial\vartheta_j$, whereas $\hat{\Omega}$ is a bootstrapped estimate for variance-covariance matrix of the moment conditions, $\Omega = \mathbf{E}[\overline{m}(\vartheta)\overline{m}(\vartheta)']$, with dimension $g \times g$.

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 10 and 13 percent. Moreover, since the sample moments are constructed using a large sample of plants, their sample variability is limited and the parameters are estimated with fine accuracy: the standard error are in general two order of magnitudes smaller than the point estimates, making each parameters statistically different than zero. On the other hand, larger sample variability in the Mexican survey due to the smaller number of firm-year observations in the dataset reflects into a sensibly larger estimation uncertainty compared to the Colombia estimates.

The model is able to match the firm size distribution and the log-employment distribution in each countries, and it correctly captures the share of exporters, the average wage, the labor share and the vacancy rate. However, it underestimates the magnitude of firm revenues for Colombia and it predicts slightly larger employer exit rates in both countries. Expressed in 2012 price level, the estimation predicts a per-period annual fixed cost of operating equal to 7.358 x $3,165.67$ USD= $23,292.99$ USD in Colombia and to 7.701 x $5,680.13$ USD = $43,742.68$ USD in Mexico; a per-period fixed cost of exporting equal to 102.360 x $3,165.67$ USD=$324,037.98$ USD in Colombia and to 68.181 x $5,680.13$ USD =$387,276.94$ USD in Mexico; and a sunk cost of setting up a business equal to 43.498 x $3,165.67$ USD = 137.700.31 USD in Colombia and to 68.412 x $5,680.13$ USD

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

		COLOMBIA	MEXICO
Description	**Symbol**	**Value**	**Value**
Fixed cost of operating	c_o	**7.358**	**7.701**
		[7.30, 7.42]	[7.29, 8.11]
Fixed cost of exporting	c_x	**102.360**	**68.181**
		[101.62, 103.10]	[64.00, 72.37]
Cost of entry ($= V^e$)	c_e	**43.498**	**68.412**
		[43.08, 43.90]	[65.20, 71.63]
Constant, hiring costs	c_h	**0.434**	**0.409**
		[0.43, 0.44]	[0.40, 0.42]
Convexity, hiring costs	λ_1	**3.303**	**2.265**
		[3.26, 3.35]	[2.20, 2.33]
Scale effect, hiring costs	λ_2	**0.238**	**0.125**
		[0.23, 0.24]	[0.11, 0.14]
Productivity persistency	ρ_z	**0.953**	**0.956**
		[0.95, 0.95]	[0.95, 0.96]
Innovation volatility	σ_z	**0.175**	**0.139**
		[0.17, 0.18]	[0.13, 0.14]
Employment elasticity	α	**0.278**	**0.132**
		[0.27, 0.28]	[0.13, 0.14]
Exogenous firm exit	δ	**0.036**	**0.012**
		[0.03, 0.04]	[0.01, 0.01]
Home production	b	**0.411**	**0.679**
		[0.41, 0.42]	[0.67, 0.69]
Objective Function, deviation		**0.10**	**0.13**

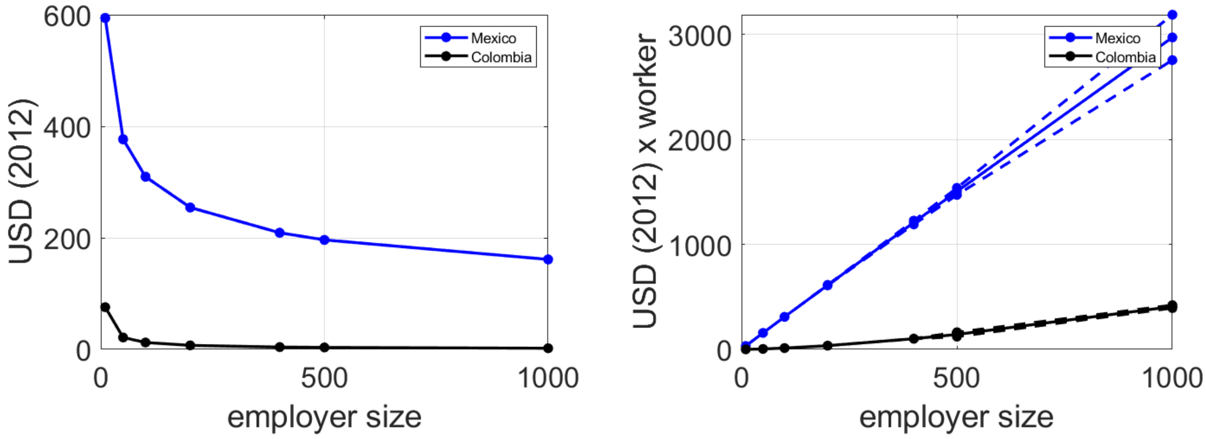
Note: This table reports the estimates for the structural parameters estimates using MSM, $\vartheta = \{c_o, c_x, c_e, c_h, \lambda_1, \lambda_2, \rho_z, \sigma_z, \alpha, \delta, b\}$, together with the confidence intervals of ± one standard error (in parenthesis).

$= 388,589.05$ USD in Mexico. The estimation also predicts large differences in the value of home production, b, between the two countries. In particular, unemployed workers in Colombia are able to ensure only 41 percent of the average wage in the service sector, corresponding to $1,300.48$ USD, whereas the return from home production in Mexico accounts for 68 percent of the average service wage, amounting to $3,855.10$ USD. These values are equivalent to roughly 40 and 59 percent of the per-capita income, respectively. On the other hand, home production is roughly 65 percent larger than the value of the statutory minimum wage in place in Mexico, whereas it is 54 percent lower in Colombia.

The estimates for the parameters of the vacancy cost functions imply a significantly larger and but less convex hiring costs in Mexico than Colombia. Panel A of Figure 5 displays the estimates for the cost of hiring a single worker as a function of the current workforce of the plant. While for a firm of ten employees this cost is estimated to be around 500 USD higher in Mexico than Colombia, for very large enterprises the difference drops to 200 USD. 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 $3,000$ USD per worker in a firm with a thousand employees, compared to Colombia, where the same figure is less than 500 USD.

Figure 5: **Hiring costs profile, 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. Standard errors are constructed using the delta method.

Since the estimates for the mean reversion of the productivity process, ρ_z, are not statistically different between the two countries (both equal to 0.95), 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 significantly larger in Colombia (0.175) than Mexico (0.139), with effect on the frequency of the employment adjustments. Finally, the estimation suggests that a share between 76 (Colombia) and 91 (Mexico) percent 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.

6.3 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 targeting them. Because of firms heterogeneity and 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. Because of the convexity in the employment adjustment costs, the model is able to replicate the patterns of job growth that declines over employer size and the greater stability observed in larger firms. 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 8: **Aggregate Implications**

	COLOMBIA		MEXICO	
	Data	**Model**	**Data**	**Model**
Relative market size to ROW	0.006	0.009	0.022	0.021
Employment share, manufacturing	0.355	0.323	0.260	0.194
Unemployment rate	0.098	0.072	0.049	0.046

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).

6.3.1 Aggregate implications

Table 8 reports a series of aggregate statistics. Although the model underestimates the share of employment in the manufacturing, it is able to reproduce the difference in the unemployment rate 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.[44] I find a value of 0.009 for Colombia and 0.021 for Mexico, remarkably close to the model outcome.

6.3.2 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 9 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.

6.3.3 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.[45] To shed light on the relationship between firm-level wages and export status, I run the following firm-level regression,

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

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

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

Table 9: **Exporters shares and wage premia**

	COLOMBIA		MEXICO	
	Data	**Model**	**Data**	**Model**
	Exporters shares			
Revenue share of exporters	0.521	0.646	0.860	0.834
Employment share of exporters	0.360	0.441	0.631	0.698
	Exporters wage-premium: $\ln w_{it} = \beta_1 \mathbf{1}^x_{it} + \epsilon_{it}$			
β_1	0.416	0.646	0.314	0.499
	[0.001]***	[0.002]***	[0.023]***	[0.001]***
R^2	0.088	0.035	0.025	0.213
	Size-wage relationship: $\ln w_{it} = \beta_1 \log l_{it} + \epsilon_{it}$			
β_1	0.215	0.050	0.114	0.088
	[0.000]***	[0.001]***	[0.000]***	[0.000]***
R^2	0.283	0.035	0.090	0.214

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

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 9 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 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 (37) 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 9 reports the OLS estimates for the

Table 10: **Wage Dispersion**

	COLOMBIA		MEXICO	
	Data	**Model**	**Data**	**Model**
Firms				
St.Dev. log wage	0.461	0.392	0.456	0.288
Max-Mean log wage	8.261	2.755	5.457	2.167
Workers				
St.Dev. log wage	0.800	0.717	0.760	0.373

Note: The standard deviation of worker-level log wage is taken from Attanasio, Goldberg, and Pavcnik (2004) for Colombia (Source: Colombian National Household Survey - DANE) and J Airola and C Juhn (2005) for Mexico (Source: Mexican Household Income and Expenditure Survey - ENIGH).

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.

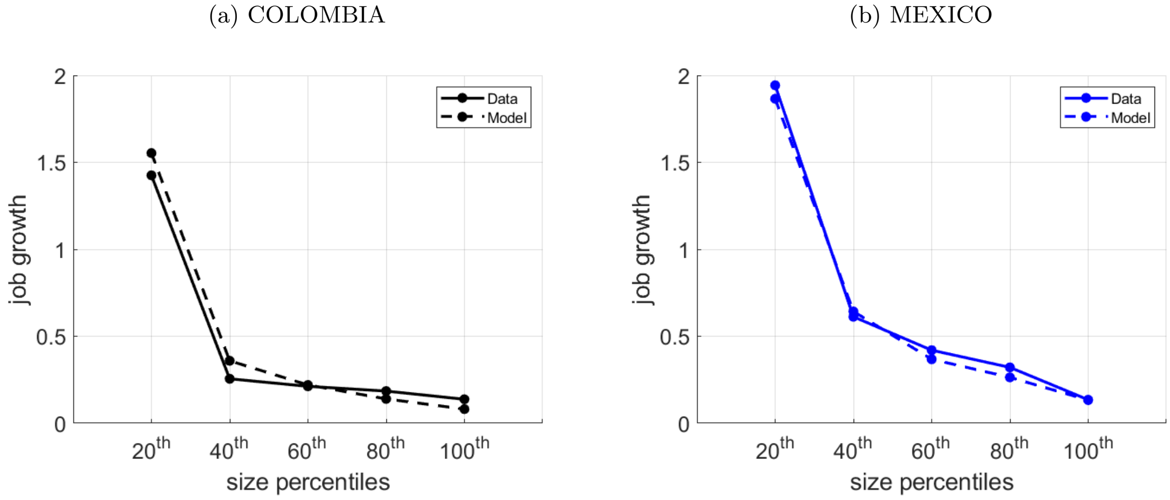
Wage Dispersion. To analyze the degree of wage dispersion that the model can generate, I consider the cross-plant standard deviation of log average wages, the max-mean firm-level wage ratio, and the standard deviation of worker-level log wages. A simulated version of the model predicts a standard deviation of firm-level log wages equal to 0.392 for the case of Colombia, against an observed value of 0.461, and equal to 0.288 for the case of Mexico, against the observed value of 0.456. Overall, the model can account for between 63 and 85 percent of the overall firm-level log-wage dispersion in Mexico and Colombia, respectively, and it can account for slightly more than one third of the mean-max wage ratio in both countries. On the other hand, the model under-predicts the unconditional dispersion of worker-level log wages, consistent with other search models that do not incorporate on-the-job search (Hornstein et al., 2011), or with firm-level models that abstracts from workers heterogeneity, which typically explains around a third of the empirical wage dispersion (Mortensen, 2005).

6.3.4 Cross-sectional implication for employment

Employment growth distribution. The model speaks also about firm stability over size and differential job growth. In Figure 6, I report the actual and the simulated rates of job growth ranked by size quintiles, for both Colombia and Mexico.[46] The model also does a remarkable job of reproducing the decline of job growth rates across employer size quintiles, and matches remarkably well the magnitudes observed in both countries. The convexity of the adjustment costs, λ_1, implies that those firms that would like to adjust employment by a greater amount (i.e. large firms) find it increasingly costly to post vacancies. Thus, the pace at which they hire slows down and job growth is reduced. This effect is in turn reinforced by a positive scale effect, λ_2, which makes the cost of

[46]The growth rate is constructed using only the sample of expanding firms. This is the case because, in the model, the linearity of the firing costs makes only the upward adjustment of employment be function of the current employer size.

Figure 6: **Job growth by firm size**



Note: This figure reports the model-based average growth rate of employment by firm-size quintiles and the empirical counterparts for Colombia (black line) and Mexico (blue line).

expanding the workforce increasing in firm size.

7 Trade reforms

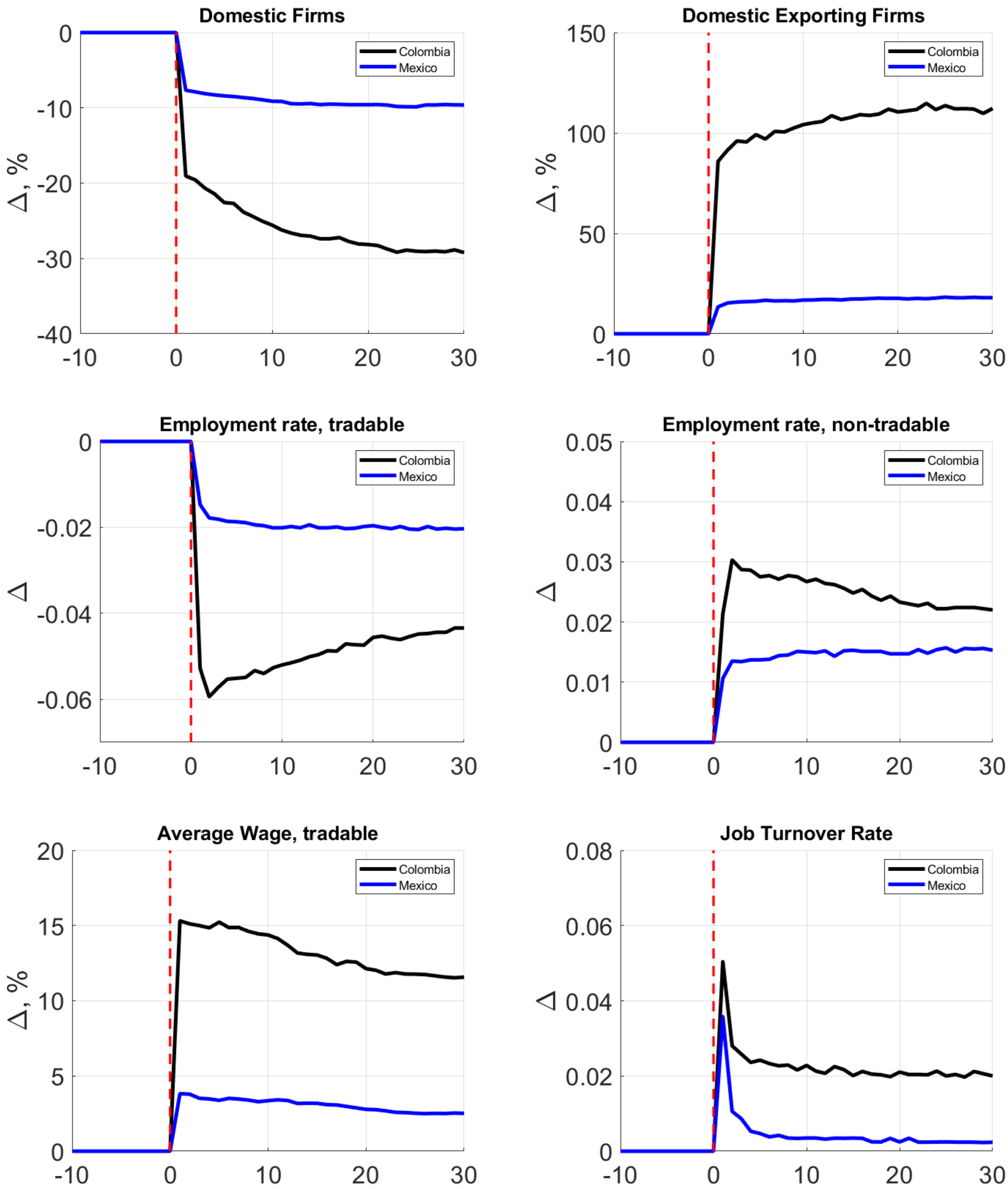
In this section I use the model to explore the quantitative implications of a trade liberalization. The goal of this exercise is to determine (1) the ability of the model to replicate the dynamic response of unemployment, sectoral employment and job volatility to a drop in trade costs, and (2) the ability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

Starting from an autarkic stationary equilibrium, I shock the economy with a once-and-for-all reduction of trade barriers, causing a proportional increase in the value of foreign absorption. The magnitude of the drop in tariffs is chosen so to mimic the the reduction observed after the trade liberalization, while the drop in iceberg costs is modeled to match the increase in the aggregate revenue share of exports (Table 4). Therefore, I track unemployment rate and other aggregates along the transition to the new steady state. Along the transition path, I keep the interest rate fixed at the autarkic level, $r_t = r_0, \forall t \geq 1$.[47]

Figure 7 reports the transitional dynamics for the measure of domestic firms in the tradable sector, the measure of exporters, the employment shares across sectors, the average wage and the job reallocation rate within the tradable sector after an unexpected and permanent fall in trade costs in Colombia (black line) and Mexico (blue line). Figure 8 displays the impulse response of the unemployment rate after the same trade liberalization.

[47]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.

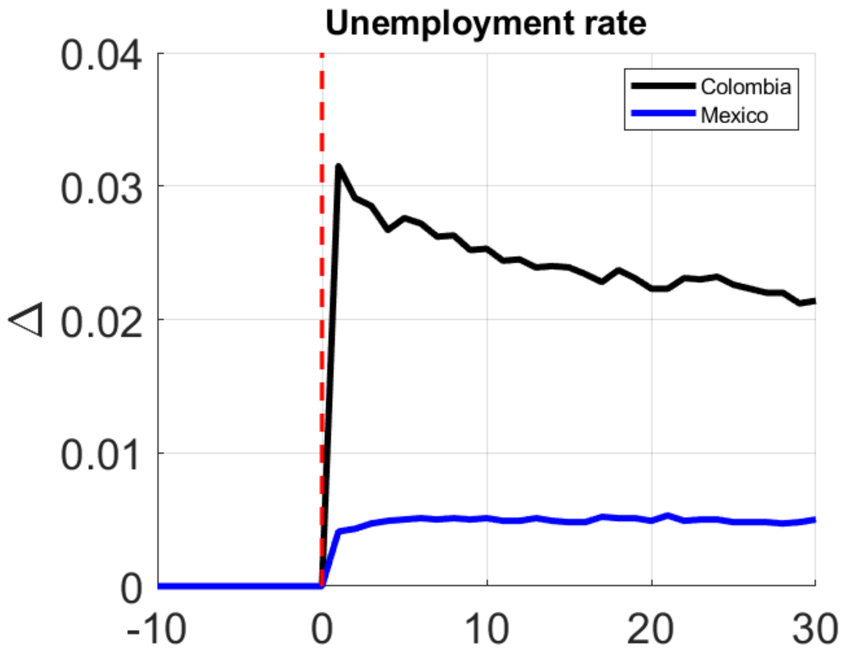
Figure 7: **Transitional dynamics after a trade reform**



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

A fall in trade costs reduces the number of domestic firms and the impact response undershoots the long-run values. The share of exporters increases in impact in both countries, and expand further along the transition in Colombia. Employment is driven out of the tradable sector,

Figure 8: **Trade reform and unemployment rate**



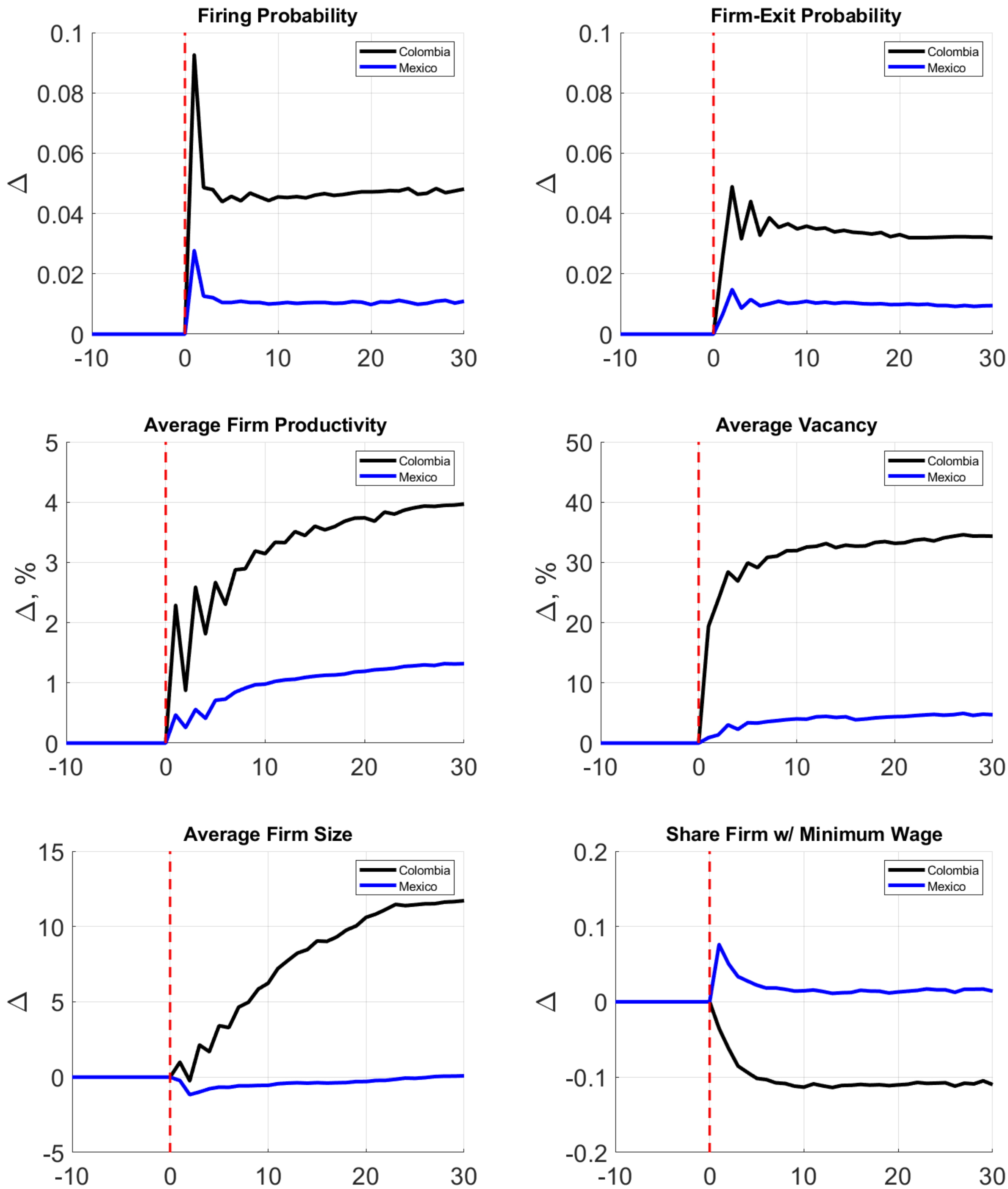
Note: This figure displays the unemployment rate along the transition path following a trade liberalization in Colombia (black line) and Mexico (blue line).

which shrinks on impact in both countries. This drop overshoot the long-run value in Colombia, where exporters slowly expand along the transition. Finally, the simulation-based dynamics of the unemployment rate closely resembles the observed dynamics in Colombia and Mexico. The model predicts that unemployment rate increases by three percentage points in Colombia, whereas it marginally responds in Mexico, rising only by 0.5 percentage points. Furthermore, unemployment in Colombia responds non monotonically along the transition: it jumps in the short-run by 3 percentage points, and it only partially re-absorbed (by roughly one third) in the long run.

To explore the mechanisms behind the impulse response and the role played by the labor market institutions, Figure 9 reports the evolution in the firing probabilities, due to either firm closing or individual dismissal, of tradable firms, the average productivity in the tradable sector, the average measure of vacancy posted, the average size (measured in terms of number of employees) and the share of firms paying the minimum wage along the transition towards the new steady state.

First, a 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. Second, low employment protection and high minimum wage amplify this margin of adjustments in Colombia, where the workers probability of being fired rises on impact four times more as in Mexico. At the same time, vacancy posting grows substantially more in Colombia, because of lower hiring costs and greater firm selection. Third, higher employment protection and lower minimum wage trigger large wage cuts instead of employment adjustments. The share of employers paying the minimum

Figure 9: **Firm adjustments 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).

wage increases by fifteen percent in Mexico, whereas it drops in Colombia, where larger firm growth translate into larger wage growth along the transition.

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

7.1 The role of labor market institutions

To isolate the contribution of each labor market institutions, I conduct a difference-in-difference analysis using the structure of the estimated model. The goal of this exercise is to determine to which extent the labor market institutions in place at the time of a trade liberalization affect the dynamics of unemployment afterward.

Let $L_u(t, \mathrm{z}_i|\mathrm{z}_{-i}, \vartheta)$ be the unemployment rate observed in period $t \in \{pre, post\}$ - meaning either before or after a trade liberalization is implemented - when a particular labor market regulation $\mathrm{z}_i \in \{\underline{z}_i, \overline{z}_i\}$ is in place, and conditional on the remaining policies z_{-i}, equal to the values reported in Table 5, and the structural parameters ϑ, equal to the estimates reported in Table 7. Hence, the difference-in-difference

$$\underbrace{L_u(t = post, \mathrm{z}_i = \overline{z}_i|\mathrm{z}_{-i}, \vartheta) - L_u(t = pre, \mathrm{z}_i = \overline{z}_i|\mathrm{z}_{-i}, \vartheta)}_{\Delta L_u(\mathrm{z}_i=\overline{z}_i)}$$
$$-\underbrace{\left(L_u(t = post, \mathrm{z} = \underline{z}_i|\mathrm{z}_{-i}, \vartheta) - L_u(t = pre, \mathrm{z}_i = \underline{z}_i|\mathrm{z}_{-i}, \vartheta)\right)}_{\Delta L_u(\mathrm{z}_i=\underline{z}_i)} = \hat{\beta}$$

identifies the effect of a discrete change in a labor market policy on the response of unemployment to a trade reform.

To obtain $\hat{\beta}$, I use the following strategy. First, for a chosen value of each labor market policy, I compute the new steady-state keeping the trade costs unchanged. This allows me to obtain several counter-factual stationary equilibria for the same country, i.e. a different equilibrium for each selected combination of employment protection legislation, minimum wage and unemployment benefits, while keeping everything else fixed.[48]

Second, I apply the same trade liberalization to each counterfactual initial equilibrium, and I simulate the transitional dynamics towards the new steady state. 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.

Table 11 reports the response of unemployment across alternative initial institutions at different horizons. In particular, I report the short-run response of unemployment after one year from the liberalization ($t = 1$), the long-run response of unemployment ($t \to \infty$) obtained by comparing steady-state, and the average response of unemployment rate along the transition from high to low trade costs.

For both country, the first column of Table 11 displays the response of unemployment under the

[48] Computing the new stationary equilibrium under counterfactual labor market regulations is necessary to ensure that the parallel trend assumption is satisfied.

Table 11: **Unemployment Response and Labor Market Institutions**

Effect of Employment Protection Legislation

	COLOMBIA			MEXICO		
	status-quo	counterfactual 1		status-quo	counterfactual 1	
	$c_f = 0.50$	$c_f = 0.08$	$\hat{\beta}_1$	$c_f = 0.27$	$c_f = 0.08$	$\hat{\beta}_1$
horizon						
t=1	+2.77	+3.16	+0.39	+0.41	+0.80	+0.39
$t \to \infty$	+1.76	+1.88	+0.12	+0.50	+0.52	+0.02
average	+2.06	+2.34	+0.28	+0.49	+0.58	+0.09

Effect of Statutory Minimum Wage

	COLOMBIA			MEXICO		
	status-quo	counterfactual 2		status-quo	counterfactual 2	
	$\underline{w} = 0.54$	$\underline{w} = 0.33$	$\hat{\beta}_2$	$\underline{w} = 0.33$	$\underline{w} = 0.54$	$\hat{\beta}_2$
horizon						
t=1	+2.77	+1.93	-0.84	+0.41	+1.39	+0.98
$t \to \infty$	+1.76	+1.39	-0.37	+0.50	+0.62	+0.12
average	+2.06	+1.47	-0.59	+0.49	+0.71	+0.22

Effect of Unemployment Benefits

	COLOMBIA			MEXICO		
	status-quo	counterfactual 3		status-quo	counterfactual 3	
	$b^u = 0.00$	$b^u = 0.05$	$\hat{\beta}_3$	$b^u = 0.00$	$b^u = 0.05$	$\hat{\beta}_3$
horizon						
t=1	+2.77	+4.88	+2.11	+0.41	+1.50	+1.09
$t \to \infty$	+1.76	+2.50	+0.74	+0.50	+0.77	+0.27
average	+2.06	+2.97	+0.91	+0.49	+0.90	+0.41

Note: This table reports the model-based response of unemployment rate to a trade shock (ΔL_u), expressed in percentage points, under counterfactual labor market institutions, for different horizons. c_f refers to the amount of firing costs, $\underline{w}$ to the statutory minimum wage in place, b^u to the unemployment benefits. All the institutions are expressed as a fraction of the average wage. $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$ refer to the model-based estimates of the treatment effects.

institutions observed in the *status-quo*, i.e. in the steady state before the liberalization. The second column reports the response of unemployment under an alternative policy, keeping everything else fixed. Finally, in the third column I report the treatment effects $\hat{\beta}$.

The dynamics of unemployment is function of the initial conditions: the average response is larger the higher the minimum wage, the lower the firing costs, and the more generous the unemployment benefits. The estimates in Table 11 relate directly to the aggregate evidence reported in Section 2.2. Notice that a model-based trade reform implemented under a one-month lower firing costs (i.e. 0.083 percentage points lower) generates an increase in unemployment rate equal to

$$\frac{\hat{\beta}_1}{100 \times (0.50 - 0.083)} \times 8.3 \quad \text{percentage points}$$

for the case of Colombia, where the firing costs in the *status-quo* eqiulibrium were 50 percent the average real wage, and to

$$\frac{\hat{\beta}_1}{100 \times (0.27 - 0.083)} \times 8.3 \quad \text{percentage points}$$

for the case of Mexico, where the firing costs in the *status-quo* equilibrium were 27 percent the average real wage. The treatment effect is equal to 0.056 percentage points in Colombia and 0.039 percentage points in Mexico. Empirically, the same effect, constructed using the estimates from Table 3, amounts to 0.254 percentage points.

Second, a model-based trade reform implemented under a ten percent higher minimum wage generates an increase of unemployment rate of

$$\frac{\hat{\beta}_2}{100 \times (0.54 - 0.33)} \times 10 \quad \text{percentage points}$$

The average effect is equal to 0.281 percentage points in Colombia and 0.104 percentage points in Mexico. Empirically, the same effect is estimated to 0.619 percentage points.

Finally, a model-based trade reform implemented with a one percent larger benefits generates an increase in unemployment rate of

$$\frac{\hat{\beta}_3}{100 \times (0.05 - 0.00)} \times 1 \quad \text{percentage points}$$

This value amounts to 0.181 percentage points in Colombia and 0.082 percentage points in Mexico. Empirically, the same effect is equal to 0.120 percentage points.

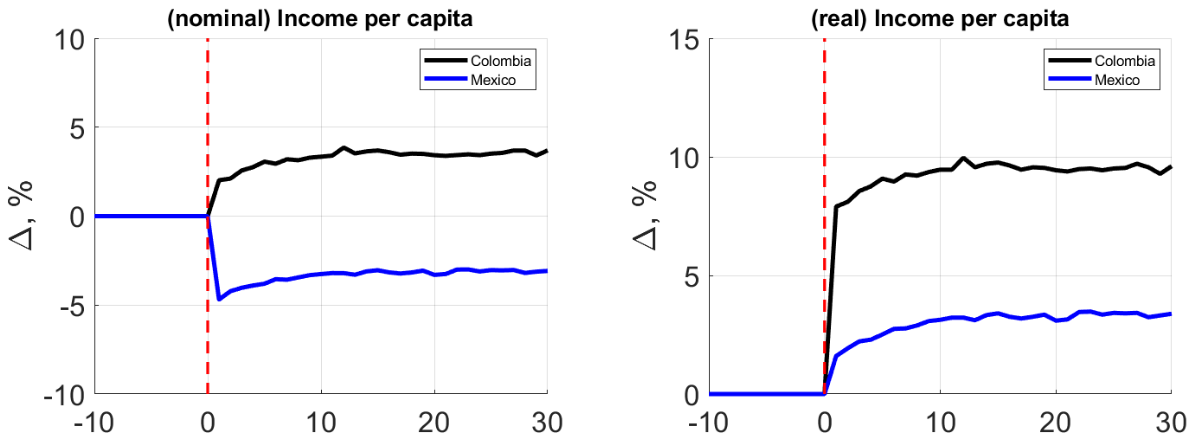
Everything else equal, the labor market institutions account separately between 12.11 and 40.46 percent of the average increase in unemployment rate after a trade reform in Colombia, and between 15.78 and 45.52 percent for the case of Mexico. The *price rigidity* introduced by the statutory minimum wage and the unemployment benefits is a fundamental cause of larger unemployment response to a trade shock: these two institutions quantitatively account for the largest share of the unemployment response generated by a reduction in trade costs. The *quantity rigidity* introduced by the employment protection legislation has the opposite effect: larger firing costs have a negative effect on unemployment response and much lower magnitude, accounting for between 12 and 15 percent.

Both price and quantity rigidity have much larger effect in the short-run. The treatment effects at time ($t = 1$) are between 3 times (for the case of Colombia) and 10 times (for Mexico) larger than treatment effects evaluated at the steady-state ($t \to \infty$). To this extent, simple steady-state comparisons would largely understate the role played by the labor market policies in place.

7.2 Gains from trade and income inequality

Trade reforms trigger aggregate gains. Despite the ambiguous effect to nominal income, a model-based reduction in trade costs predicts a significant growth in real income per-capita. Figure 10 reports the impulse response of nominal income per capital, I_t, and real income per-capita, defined

Figure 10: **Income Gains from Trade**



Note: This figure displays nominal and real income per capital along the transition path following a trade liberalization in Colombia (black line) and Mexico (blue line).

as $Y_t = I_t/P_t^{-\gamma}$, to a trade reform implemented in Colombia and Mexico.

As in Itskhoki and Helpman (2015), the gains from trade are largely due to the reduction in the price of tradable goods. This is particularly the case in Mexico, where nominal income drops by 5% on impact, and remains negative in the long run. This result is partly due to the reduction in the number of varieties ($N_{h,t}$) available to consumers, as production becomes concentrated at fewer firms.

Nevertheless, trade reform improved aggregate real income in both countries. To measure the gains from trade, I employ two different measures. The first is the *immediate* gains from trade, $\lambda^{immediate}$ which measures the income gains one period after a trade reform is implemented. This measure is defined by the solution of the following equation,

$$Y_0 \left(1 + \lambda^{immediate}\right) = Y_1$$

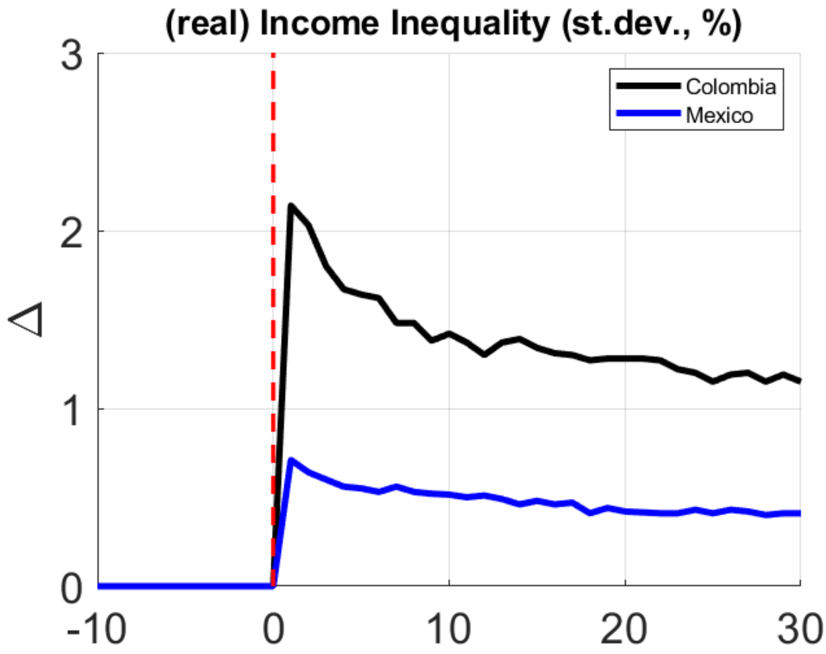
where Y_0 and Y_1 denote, respectively, the real income per-capita in the initial steady state and one period after a trade reform. The second measure is the *dynamic* gain from trade, $\lambda^{dynamic}$, defined by the solution of following equation

$$\sum_{t=1}^{\infty} \frac{1}{(1+r_t)^{t-1}} Y_0 \left(1 + \lambda^{dynamic}\right) = \sum_{t=1}^{\infty} \frac{1}{(1+r_t)^{t-1}} Y_t$$

where Y_t denotes real income per-capita at any period t after a trade reform.

Under the observed labor market policies, the immediate gains from trade are 7.91% in Colombia and by 1.80% in Mexico. Moreover, despite the model does not admit investment and capital accumulation, yet it generates dynamic gains that are larger then the immediate gains, and amount to 9.03% in Colombia and to 3.19% in Mexico.

Figure 11: **Trade and Income Inequality**



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

Gains from trade are realized with at a cost of larger inequality in real income. Figure 11 reports the standard deviation of real income across individuals, for each period along the transition following a trade reform. Notice that income inequality increases on impact and overshoots the the long-run value. This is consistent with the aggregate evidence reported in Bellon (2016), who documents a hump-shaped dynamics of income inequality following a trade reform in a panel of developing countries. Moreover, income inequality increase significantly more in Colombia than Mexico. This is consistent with the aggregate evidence discussed in section 5.

To evaluate the benefits of trade reform accounting for the social cost of income inequality, I posit the existence of a social welfare function that maps the vector of agents' income level into a single real number. Let φ_t be a density function of individual income at time t. Then, the social welfare function, W_t, is defined as

$$W_t = \int_0^1 u(Y_{i,t})\varphi_t(Y_{i,t})di \tag{61}$$

where $Y_{i,t}$ denotes real income of individual i,whereas u is a concave transformation of those income levels. In the specific, I follow Atkinson (1970) and I consider a constant-elasticity function,

$$u(Y_{i,t}) = \frac{Y_{i,t}^{1-\rho} - 1}{1 - \rho} \tag{62}$$

where $\rho \geq 0$ should be interpreted as reflecting a constant inequality aversion of the social planner. Antràs et al. (2017) show that (61) and (62) allow to express the social welfare as the product of aggregate real income Y_t and a correction term, Δ_t,

$$W_t = Y_t \times \Delta_t \tag{63}$$

where

$$\Delta_t = \frac{\left(\int_0^1 Y_{i,t}^{1-\rho}\varphi_t(Y_{i,t})di\right)^{\frac{1}{1-\rho}}}{Y_t}$$

The term Δ_t corresponds to one minus the Atkinson (1970) index of income inequality, and it is lower the higher is the level of inequality in the distribution of income, φ_t.[49] Using (63), the welfare gains between two consecutive periods, t and $t+1$, from a policy implemented from time $t+1$ onward, can be written as

$$\log\frac{W_{t+1}}{W_t} = \log\frac{Y_{t+1}}{Y_t} + \log\frac{\Delta_{t+1}}{\Delta_t} \tag{64}$$

The percent welfare gain in equation (64) is the sum of two distinct terms, that are the growth rate in aggregate real income, $\log\frac{Y_{t+1}}{Y_t}$ and the percent change in income equality, $\log\frac{\Delta_{t+1}}{\Delta_t}$. Notice that, when $\rho = 0$, $\Delta_t = 1$, and the welfare gain is simply equal to the income growth.

Table 12 reports the discounted gains from a trade reform jointly implemented with several counterfactual labor market reforms. In both countries, the discounted real income growth after a trade reforms is larger when employment protection is low and when the minimum wage is high. On the other hand, lower employment protection and larger minimum wage foster greater income inequality.

Under the observed policies, the consumption-equivalent cost of income inequality induced by a trade reform is equal to 6.00% in Colombia and 0.57% in Mexico, making the overall welfare gains from trade larger in the latter country.

A trade reform implemented with opposite labor market policies, that is, with high firing costs and low minimum wage, would get Colombia substantially lower dynamic gains, i.e. 7.76%, but a substantial decline in income inequality, i.e. 3.02% in consumption equivalent. On the other hand, if instead Mexico had implemented different labor market policy - that is, low firing costs and high minimum wage - the dynamic gain would 3.70%, with a consumption-equivalent cost of income inequality equal to 0.47%.

Finally, a more generous unemployment benefit would reduce income inequality while hampering income growth. Keeping the existing policies in place, if both countries had increased benefits to unemployment by 5% the the average wage, the dynamic gains would be 7.52 (2.30) percentage

[49] It can be shown that, while Δ_t is invariant to proportional changes of the income distribution (i.e., when all income levels are scaled by the same constant), it is reduced by mean-preserving spreads of the distribution of disposable individual income. And holding constant the distribution of individual income, φ_t, the higher is the degree of inequality aversion of the social planner, ρ, the lower is Δ_t. See Antràs et al. (2017).

Table 12: **Gains from trade (consumption equivalent, %)**

		Colombia	
c_f (*firing costs*)	0.08	0.50	0.08
$\underline{w}$ (*minimum wage*)	0.54	0.33	0.54
b^u (*unemployment benefits*)	0	0	0.05
Immediate gains	+7.91	+7.50	+6.77
Dynamic gains	+9.03	+7.76	+7.52
Ratio dynamic to immediate	+1.14	+1.03	+1.11
Loss from Inequality ($\rho = 2$)	+6.00	+3.02	+4.57
Welfare gain	+3.03	+4.73	+2.95

		Mexico	
c_f (*firing costs*)	0.08	0.27	0.27
$\underline{w}$ (*minimum wage*)	0.54	0.33	0.33
b^u (*unemployment benefits*)	0	0	0.05
Immediate gains	+2.15	+1.80	+1.35
Dynamic gains	+3.70	+3.46	+2.41
Ratio dynamic to immediate	+1.72	+1.77	+1.70
Loss from Inequality ($\rho = 2$)	+0.57	+0.27	+0.11
Welfare gain	+3.13	+3.19	+2.30

Note: This table reports the discounted sum of welfare gains from a trade reform under observed (bold) and counterfactual labor market institutions for the cases of inequality neutrality and inequality aversion ($\rho = 2$). Firing costs, minimum wage and benefits are expressed as a fraction of the average wage.

points lower in Colombia (Mexico). On the other hand, the consumption-equivalent loss from the increase in income inequality would reduce by 1.43 (0.36) percentage points in Colombia (Mexico).

8 Conclusion

In this paper I investigate the hypothesis that the institutional features of the local labor markets determine the response to a trade liberalization. In particular, I use a structural model to characterize the dynamics of unemployment at the eve of 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 at the time of a trade shock determine the magnitude and the speed of how firms adjust employment in response to changes in the product markets, causing higher unemployment rate the lower firing costs, and the higher minimum wage legislation and unemployment benefits. 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, this paper contributes both 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 modeling transitional dynamics helps unveil the differences between short- and long-run response of aggregate income and income 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 dynamic response of unemployment, a channel the literature has not yet fully explored. I show that the *price rigidity* introduced by large statutory minimum wage and more generous unemployment benefits have a much larger effect on the unemployment response compared to the *quantity rigidity* introduced by the employment protection legislation. Moreover, I show that the impact is much larger in the short-run, and that steady-state comparison would underestimate the role of labor market institutions.

This analysis could be extended along several dimensions. Among the others, introducing ex-ante workers heterogeneity would allow the model to speak about the effect of trade liberalization on the unemployment rate across different skill-groups of workers, and about the role of labor market institutions in sorting workers between tradable and non-tradable sectors. Moreover, the model could be expanded with a more articulated informal sector, to better characterize economy-wide patterns of unemployment. I leave this analysis for future research.

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

Alessandro Ruggieri
University of Nottingham

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). [50]

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;

[50] 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.

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;

5. No socialist economic system (SOC), as defined by Kornai (1992), is in place.[51]

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. See Appendix 1 in Wacziarg and Welch (2003) for further details on the data used to construct these five indicators. 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, unemployment benefit 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 unemployment benefits legislation is proxied by country-specific measure of unemployment insurance, constructed by multiplying the average gross replacement rate over 1 year after dismissal and unemployment benefits coverage, so to capture both extensive and intensive margin of the legislation. The gross replacement ratio is defined as levels of statutory

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

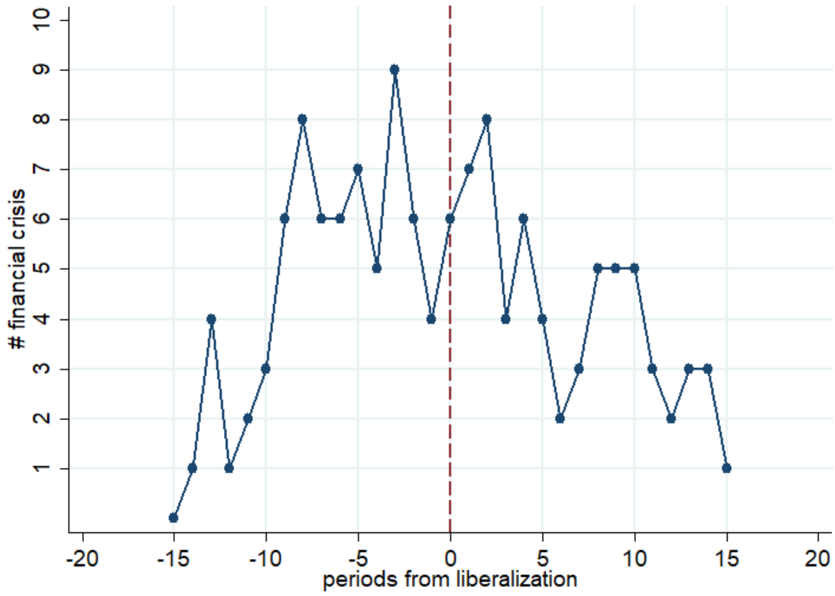
entitlements over the average wage, after the first year of unemployment, while the unemployment benefit coverage is constructed as the ratio of the number of UI benefit recipients to the number of unemployed.

- 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).

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

Figure 12: **Number of Financial Crisis**



Note: This figure reports the total number of episodes of banking, currency and sovereign debt crisis in the sample for each period before and after a trade liberalization.

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 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. Figure12 reports the total number of episodes of financial crisis (i.e. banking, currency and sovereign debt crisis) in the sample for each period around a trade liberalization.

A.2. Descriptive Statistics

In this section I report 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.

Table 13: **DESCRIPTIVE STATISTICS**

COUNTRY	LIBERALIZATION (DE-JURE)	(DE-FACTO)	UNEMPLOYMENT PRE	POST	IMPORT PENETRATION PRE	POST	MINIMUM 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.

A.3. Robustness and further aggregate evidence

In what follows I report a set of robustness checks and further aggregate evidence on the relation between trade regimes, labor market institutions and unemployment. The main results always go through: (1) unemployment is significantly higher after a trade reform, (2) the marginal effect of a trade reform on unemployment is significantly higher the greater the statutory minimum wage, the

Table 14: **Robustness check 1 - Sub-samples**

VARIABLES	(1.1)	(1.2)	(1.3)	(1.4)
		unemp$_{it}$		
		LAC countries		
Liberalization Dummy				
$\mathbf{1}_{\{t\geq t_i^*\}}$	3.149	2.793	3.324	0.168
	[1.500]*	[1.491]*	[1.403]**	[3.390]
Liberalization Dummy × UI				
$\mathbf{1}_{\{t\geq t_i^*\}}\text{ub}_i$				0.419
				[0.385]
Liberalization Dummy × Minimum wage				
$\mathbf{1}_{\{t\geq t_i^*\}}\underline{\text{w}}_i$				4.078
				[7.045]
Liberalization Dummy × EPL				
$\mathbf{1}_{\{t\geq t_i^*\}}\text{epl}_i$				-0.280
				[0.161]
Observation	466	466	463	453
R-squared	0.154	0.550	0.663	0.755
		non-LAC countries		
Liberalization Dummy				
$\mathbf{1}_{\{t\geq t_i^*\}}$	2.268	2.232	1.543	0.118
	[0.718]**	[0.683]***	[0.563]**	[1.328]
Liberalization Dummy × UI				
$\mathbf{1}_{\{t\geq t_i^*\}}\text{ub}_i$				0.044
				[0.065]
Liberalization Dummy × Minimum wage				
$\mathbf{1}_{\{t\geq t_i^*\}}\underline{\text{w}}_i$				8.159
				[3.555]**
Liberalization Dummy × EPL				
$\mathbf{1}_{\{t\geq t_i^*\}}\text{epl}_i$				-0.335
				[0.179]*
R-squared	0.381	0.562	0.636	0.686
Observations	538	538	535	411
Country FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Country trend	no	yes	yes	yes
Controls	no	no	yes	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. 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.. The estimation refers to the full sample. 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.*

greater the unemployment insurance and the lower the costs of worker dismissal in place at the time of openings, (3) cross-country variation in labor market institutions can explain the unemployment response after a trade liberalization.

Different sub-samples. The first robustness is about sample selection. In particular, I split the sample into LAC and non-LAC countries, and estimate equations (1)and (2) in the main text separately for the two sub-sample. Table 14 reports the OLS coefficients. Robust standard errors,

Table 15: **Robustness check 2.1 - De-facto liberalization**

VARIABLES	unemp$_{it}$ (1.1)	(1.2)	(1.3)
		Full-sample	
De-facto Liberalization			
$\mathbf{1}_{\{t \geq t_i^*\}}$	2.114	1.871	2.118
	[0.654]***	[0.664]***	[0.670]***
R-squared	0.164	0.518	0.603
Observations	1004	1004	998
		LAC countries	
De-facto Liberalization			
$\mathbf{1}_{\{t \geq t_i^*\}}$	2.467	2.291	3.218
	[1.365]*	[1.339]	[1.089]***
R-squared	0.141	0.554	0.662
Observations	466	466	463
		non-LAC countries	
De-facto Liberalization			
$\mathbf{1}_{\{t \geq t_i^*\}}$	2.385	2.222	1.747
	[0.732]***	[0.739]***	[0.622]***
R-squared	0.386	0.563	0.641
Observations	538	538	535
Country FE	yes	yes	yes
Year FE	yes	yes	yes
Country trend	no	yes	yes
Controls	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 **de-facto** trade 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.*

clustered at country level, are reported in parenthesis.

De-facto liberalization. The second robustness is about the date of trade reform. Following Wacziarg and Weich (2003), I construct a *de-facto* liberalization date, which combines the five criteria used in Sachs and Warner (1995) together with a sixth indicator, taking value one from the first year a country experience a five percent growth in trade openness (measured by the sum of total exports and imports over GDP), onward. Tables 15 and 16 display the OLS estimates of equations (1) and (2) in the main text using instead this new indicator. Robust standard errors, clustered at country level, are reported in parenthesis. Using *de-facto* liberalization dates does not alter the main results of the paper: (1) the unemployment rate increases on average following a trade reform, (2) the response of unemployment is larger the higher the minimum wage and the

Table 16: **Robustness check 2.2 - De-facto liberalization**

	unemp_{it}			
VARIABLES	(2.1)	(2.2)	(2.3)	(2.4)
De-facto Liberalization				
$\mathbf{1}_{\{t\geq t_i^*\}}$	1.001	-0.101	3.237	0.230
	[0.726]	[1.359]	[1.072]***	[1.812]
De-facto Liberalization × UI				
$\mathbf{1}_{\{t\geq t_i^*\}}\text{ub}_i$	0.219			0.154
	[0.043]***			[0.057]**
De-facto Liberalization × Minimum wage				
$\mathbf{1}_{\{t\geq t_i^*\}}\underline{\text{w}}_i$		5.975		5.293
		[3.302]*		[2.820]*
De-facto Liberalization × EPL				
$\mathbf{1}_{\{t\geq t_i^*\}}\text{epl}_i$			-0.267	-0.223
			[0.111]**	[0.125]*
R-squared	0.632	0.648	0.625	0.687
Observations	841	828	959	734
Country FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Country trend	yes	yes	yes	yes
Controls	yes	yes	yes	yes
F-test p-value	0.997	0.950	0.985	0.995

*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 **de-facto** trade liberalization, t_i^*. epl_i, ub_i and $\underline{w}_i$ refers to employment legislation, unemployment benefits and minimum wage regulation 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.. The p-value refers to the F-test for joint significance of labor market institutions, i.e. $H_0 : \mathbf{1}_{\{t\geq t_i^*\}} + \mathbf{1}_{\{t\geq t_i^*\}}ub_i + \mathbf{1}_{\{t\geq t_i^*\}}\underline{w}_i + \mathbf{1}_{\{t\geq t_i^*\}}epl_i > 0$. 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.*

unemployment benefits and the lower firing costs and (3) cross-country variation in these three institutions can explain the response of unemployment to a fall in trade costs.

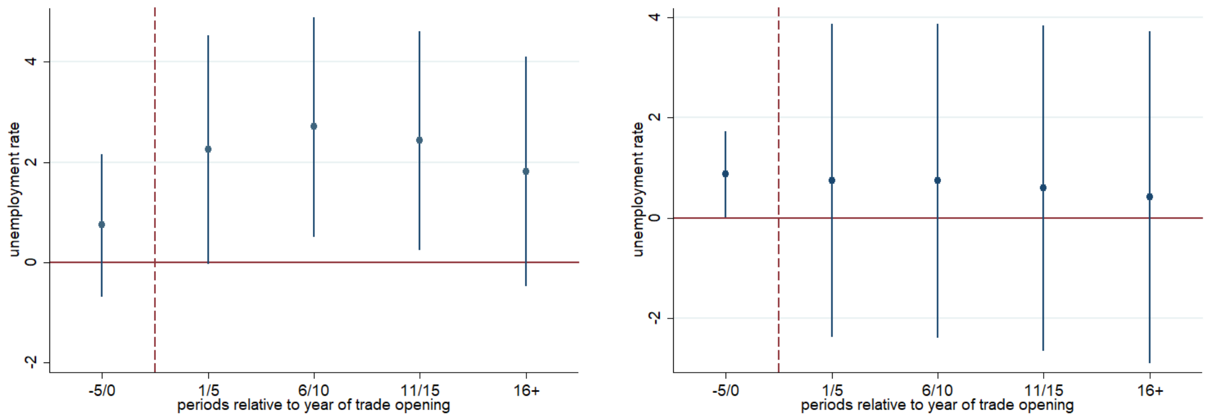
Dynamic response. Here I complement the main analysis by looking at the dynamic response of unemployment to a trade reform. To do so, I first estimate a dynamic version of equation (1) in the main text, i.e.

$$\text{unemp}_{it} = \sum_{j\in\{-5,0,5,10,15\}} \alpha_j \mathbf{1}_{\{t\in(t_i^*+j,t_i^*+j+5]\}} + \gamma_t + \upsilon_i + \eta_i(t-t_i^*) + \delta X_{it} + \epsilon_{it} \tag{65}$$

where t_i^* denotes the liberalization date of country i, whereas $\mathbf{1}_{\{t\in(t_i^*+j,t_i^*+j+5]\}}$ is a dummy variable that takes value one if for any period t between t_i^*+j and t_i^*+j+5. I fit five of these

Figure 13: **Lead and lagged effect of trade reform**

(a) Baseline (b) Controlling for labor market institutions



Note: This figure report the OLS estimates of lead and lagged effects of a trade reform on the unemployment rate for the baseline case (equation 65) and after controlling for labor market institutions (equation 66).

dummies into equation (65), covering any periods $t \in (t_i^* - 5, t_i^* + 20]$, and I set the time spanning between $t_i^* - 20$ and $t_i^* - 5$ as a baseline group. Second, I estimate a dynamic version of equation (2) in the main text, i.e.

$$\text{unemp}_{it} = \sum_{j \in \{-5,0,5,10,15\}} \alpha_j \mathbf{1}_{\{t \in (t_i^*+j, t_i^*+j+5]\}} + \beta \mathbf{1}_{\{t \geq t_i^*\}} \text{z}_i + \gamma_t + \upsilon_i + \eta_i (t - t_i^*) + \delta X_{it} + \epsilon_{it} \quad (66)$$

where the interaction terms $\mathbf{1}_{\{t \geq t_i^*\}} \text{z}_i$ are now included to capture cross-country differences in unemployment rate in periods of post-liberalization systematically associated to labor market institutions, z_i.

Figure 13 displays the time-varying marginal effects of a trade reform estimated in equation (65) and (66). In the baseline case (left panel), the coefficients on the trade reform leads are not statistically different than zero, showing little anticipatory response within each country close to embark in trade reform. From the year of adoption onward, the unemployment rate increases by more than two percentage points, reaching its peak between six and ten years after the reform, and declining afterwards. Once controlling for the cross-country variation in minimum wage, EPL and UI at the time of the trade reform, no significant effect on unemployment rate is detected anymore (right panel). Table 17 reports the OLS estimates for the interaction terms between the liberalization dates and the labor market institutions in equation 66.

Table 17: **Robustness check 3 - Dynamic response**

	unemp_{it}	
VARIABLES	(1.1)	(1.2)
Liberalization Dummy 1		
$\mathbf{1}_{\{t\in(t_i^*-5,t_i^*+j]\}}$	0.721	0.951
	[0.696]	[0.429]***
Liberalization Dummy 2		
$\mathbf{1}_{\{t\in(t_i^*,t_i^*+j+5]\}}$	2.253	0.952
	[1.111]***	[1.494]
Liberalization Dummy 3		
$\mathbf{1}_{\{t\in(t_i^*+5,t_i^*+j+10]\}}$	2.715	0.978
	[1.069]***	[1.502]
Liberalization Dummy 4		
$\mathbf{1}_{\{t\in(t_i^*+10,t_i^*+j+15]\}}$	2.411	0.780
	[1.069]***	[1.580]
Liberalization Dummy 5		
$\mathbf{1}_{\{t>t_i^*+15\}}$	1.803	0.625
	[1.124]	[1.594]
Liberalization Dummy × UI		
$\mathbf{1}_{\{t\geq t_i^*\}}\text{ub}_i$		0.116
		[0.049]***
Liberalization Dummy × Minimum wage		
$\mathbf{1}_{\{t\geq t_i^*\}}\underline{\text{w}}_i$		6.415
		[2.630]***
Liberalization Dummy × EPL		
$\mathbf{1}_{\{t\geq t_i^*\}}\text{epl}_i$		-0.292
		[0.103]***
R-squared	0.607	0.632
Observations	998	784
Country FE	yes	yes
Year FE	yes	yes
Country trend	yes	yes
Controls	yes	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 trade liberalization, t_i^*. epl_i, ub_i and $\underline{w}_i$ refers to employment legislation, unemployment benefits and minimum wage regulation 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.*

Appendix B. Details on the Model

B.1. Demand Functions and Firm Revenues

In this section I characterize the demand functions for each variety ω, the revenue functions of domestic firms and the revenue premium of domestic exporting firms. Given the CES structure, the inverse demand for a domestic variety ω at time t from a worker i with income I_i and from a firm j with gross revenues G_j is equal, respectively, to

$$q_{i,t}(\omega) = \gamma \left(\frac{p_t(\omega)}{P_t}\right)^{-\sigma} \frac{I_{i,t}}{P_t}$$

and

$$q_{j,t}(\omega) = (1-\alpha)\frac{\sigma-1}{\sigma} \left(\frac{p_t(\omega)}{P_t}\right)^{-\sigma} \frac{G_{j,t}}{P_t}$$

Combining demands and aggregating across workers and firms, we get,

$$q_t(\omega) = \int_0^1 q_{i,t}(\omega)di + \int_0^{N_{h,t}} q_{j,t}(\omega)dj \implies q_t(\omega) = p_t(\omega)^{-\sigma} D_{h,t}$$

where

$$D_{h,t} = P_t^{\sigma-1}\left[\gamma \int_0^1 I_{i,t}di + (1-\alpha)\frac{\sigma-1}{\sigma}\int_0^{N_{h,t}} G_{j,t}dj\right]$$

denotes the aggregate domestic expenditures. Similarly, the domestic inverse demand for a foreign variety ω^*, read

$$q_{i,t}(\omega^*) = \gamma \left(\frac{\tau_{a,t}\tau_{c,t}k_t p_t(\omega^*)}{P_t}\right)^{-\sigma} \frac{I_{i,t}}{P_t}$$

and

$$q_{j,t}(\omega^*) = (1-\alpha)\frac{\sigma-1}{\sigma} \left(\frac{\tau_{a,t}\tau_{c,t}k_t p_t(\omega^*)}{P_t}\right)^{-\sigma} \frac{G_{j,t}}{P_t}$$

which implies

$$\begin{aligned} q_t(\omega^*) = &\int_0^1 q_{i,t}(\omega^*)di + \int_0^{N_{h,t}} q_{j,t}(\omega^*)dj \\ &\implies q_t(\omega^*) = [\tau_{a,t}\tau_{c,t}k_t p_t(\omega^*)]^{-\sigma} D_{h,t} \end{aligned} \tag{67}$$

Finally, the foreign demand for domestically produced good ω is given by

$$q_t^*(\omega) = p_t^*(\omega)^{-\sigma} D_{f,t} \tag{68}$$

where $p_t^*(n)$ is the price of domestic variety ω in the foreign market while $D_{f,t}$ denotes the aggregate expenditures abroad denominated in foreign currency, net of any effects of foreign commercial policies, and treated as exogenous parameter.

Consider the problem of a domestic firm that produces q_t units of output which are sold in the home market. The gross revenues of this firm at time t are equal to

$$G_{h,t}(\omega) = p_t(\omega) q_t(\omega) \tag{69}$$

From the inverse demand in equation (67) we can solve for the price of variety ω charged in the home market, $p_t(\omega)$, i.e.

$$p_t(\omega) = \left(\frac{q_t(\omega)}{D_{h,t}}\right)^{-\frac{1}{\sigma}}$$

Substituting $p_t(n)$ into equation (69), we obtain the revenues of non-exporting domestic firms,

$$G_{h,t}(\omega) = D_{h,t}^{\frac{1}{\sigma}} q_t(\omega)^{\frac{\sigma-1}{\sigma}} \tag{70}$$

Consider now the problem of a firm located in the home country that produces q_t units of output which are then shipped to the foreign market in addition to the home market. The choice variables for the firm are the fraction is the fraction χ_t of total output allocated to either markets. Because of iceberg trade costs, $\tau_{c,t}$, only $\frac{1}{\tau_{c,t}} \chi_t q_t$ units are exported to the foreign market, where the quantity $\frac{\tau_{c,t}-1}{\tau_{c,t}} \chi_t q_t$ is lost in shipping the good abroad. The gross revenues of this firm at time t are equal to

$$G_{f,t}(\omega) = \max_{\chi_t} \quad p_t(\omega)(1-\chi_t) q_t(\omega) + k_t p_t^*(\omega) \frac{\chi_t q_t(\omega)}{\tau_{c,t}} \tag{71}$$

From the inverse demand in equation (68) we can solve for the price of variety ω charged in the foreign market, $p_t^*(\omega)$, i.e.

$$p_t^*(\omega) = \left(\frac{q_t(\omega)}{D_{f,t}}\right)^{-\frac{1}{\sigma}}$$

Substituting $p_t(\omega)$ and $p_t^*(\omega)$ into equation (71), we obtain the revenues of exporting domestic firms,

$$G_{f,t}(\omega) = \max_{\chi_t} \quad q_t(\omega)^{\frac{\sigma-1}{\sigma}} \left[(1-\chi_t)^{\frac{\sigma-1}{\sigma}} D_{h,t}^{\frac{1}{\sigma}} + k_t \left(\frac{\chi_t}{\tau_{c,t}}\right)^{\frac{\sigma-1}{\sigma}} D_{f,t}^{\frac{1}{\sigma}} \right] \tag{72}$$

The optimal output share allocated to the foreign market is the maximizer of the problem in equation (72), and it reads as

$$\chi_t = \frac{k_t^\sigma D_{f,t} \tau_{c,t}^{1-\sigma}}{D_{h,t} + k_t^\sigma D_{f,t} \tau_{c,t}^{1-\sigma}} \tag{73}$$

Substituting χ_t into equation (72), we can write the revenue function as follows,

$$G_{f,t}(\omega) = q_t(\omega)^{\frac{\sigma-1}{\sigma}} \left[D_{h,t} + k^\sigma \tau_{c,t}^{-(\sigma-1)} D_{f,t} \right]^{\frac{1}{\sigma}} = q_t(\omega)^{\frac{\sigma-1}{\sigma}} D_{h,t}^{\frac{1}{\sigma}} [1 + d_{f,t}]^{\frac{1}{\sigma}} \tag{74}$$

where $d_{f,t}$ is the revenue premium from exporting, equal to

$$d_{f,t} = k_t^\sigma \tau_{c,t}^{-(\sigma-1)} \frac{D_{f,t}}{D_{h,t}} \tag{75}$$

Finally, combining equations (73) and (72), I can write the optimal share of output allocated to the foreign market as

$$\chi_t = 1 - [1 + d_{f,t}]^{-\sigma} \tag{76}$$

B.2. Intermediate expenditure

Intermediate inputs are chosen every period so to maximize the net revenue function. This implies the following optimization problem for a generic firm,

$$R_t(z,\ell) = \max_m \quad G_t(q(z,m,\ell)) - P_t m \tag{77}$$

where $G_t(q(z,m,\ell))$ denotes the gross revenue function,

$$G_t(q(z,m,\ell)) = D_{h,t}^{\frac{1}{\sigma}}[1 + \mathbf{1}_t^x d_{f,t}]^{\frac{1}{\sigma}} q(z,m,\ell)^{\frac{\sigma-1}{\sigma}} - c_x \mathbf{1}_t^x \tag{78}$$

whereas $q(z,m,\ell)$ is the production function,

$$q(z,m,\ell) = z m^{1-\alpha} \ell^\alpha \tag{79}$$

Material expenditure satisfies the following first order condition,

$$P_t m_t = (1-\alpha)\frac{(\sigma-1)}{\sigma} G_t(q(z,m,\ell))$$

Solving for m_t and substituting into equation (77), yields the following expression for the net revenue function,

$$R_t(z,\ell) = \Delta_t(z,\ell)(z\ell^\alpha)^{\frac{\sigma-1}{\sigma-(1-\alpha)(\sigma-1)}} \tag{80}$$

where $\Delta_t(z,\ell)$ is equal to

$$\Delta_t(z,\ell) = \frac{1-(1-\alpha)\frac{(\sigma-1)}{\sigma}}{\left((1-\alpha)\frac{(\sigma-1)}{\sigma}\right)^{1-\frac{\sigma}{\sigma-(1-\alpha)(\sigma-1)}}} \left[\frac{D_{h,t} + \mathbf{1}_t^x(z,\ell) k^\sigma \tau_{c,t}^{-(\sigma-1)} D_{f,t}}{P_t^{-(1-\alpha)(\sigma-1)}}\right]^{\frac{1}{\sigma-(1-\alpha)(\sigma-1)}} \tag{81}$$

B.3. Firms optimal policies

Employment Policy. Standard optimization arguments lead to the two following first order conditions for hires and separation of an active firm at time t:

$$\frac{\partial \pi_t(z',\ell,\ell')}{\partial \ell'} + \frac{\partial V_{t+1}(z',\ell')}{\partial \ell'} = 0$$

$$\implies \frac{\partial R_t(z',\ell')}{\partial \ell'} + \frac{\partial V_{t+1}(z',\ell')}{\partial \ell'} = \frac{\partial w_t(z',\ell')\ell'}{\partial \ell'} + \mathbf{1}^h_t(z',\ell)\frac{\partial C^+_t(\ell,\ell')}{\partial \ell'} - \mathbf{1}^f_t(z',\ell)c_{f,t}$$

where $\mathbf{1}^h_t(z',\ell)$ and $\mathbf{1}^f_t(z',\ell)$ are two indicator functions taking value one if the firm is, respectively, hiring and firing and zero otherwise, $\frac{\partial R_t(z',\ell')}{\partial \ell'}$ denotes marginal revenues while $\frac{\partial V_{t+1}(z',\ell')}{\partial \ell'}$ captures the marginal effect of current employment decisions on the continuation value of the firm. This equation has a straightforward interpretation: firm will expand or contract up to the point where current and future marginal benefits from resizing is equal to the relative marginal costs, captured by the marginal effect on wage payments, $\left(\frac{\partial w_t(z',\ell')\ell'}{\partial \ell'}\right)$ plus the marginal costs of hiring new workers, $\left(\frac{\partial C^+_t(\ell,\ell')}{\partial \ell'}\right)$ or firing some of them $(c_{f,t})$. As in Cooper et al. (2007) and Elsby and Michaels (2013), the presence of adjustment costs make the optimal employment decisions of the firm be characterized by two reservation thresholds, $z^H(\ell)$ and $z^F(\ell)$, which are defined by the following two equations:

$$\frac{\partial R_t(z^H(\ell),\ell')}{\partial \ell'} - \frac{\partial w_t(z^H(\ell),\ell')\ell'}{\partial \ell'} + \frac{\partial V_{t+1}(z^H(\ell),\ell')}{\partial \ell'} = \frac{\partial C^+_t(\ell,\ell')}{\partial \ell'}$$

$$\frac{\partial R_t(z^F(\ell),\ell')}{\partial \ell'} - \frac{\partial w_t(z^F(\ell),\ell')\ell'}{\partial \ell'} + \frac{\partial V_{t+1}(z^F(\ell),\ell')}{\partial \ell'} = -c_{f,t}$$

The derivative of the continuation value of the marginal worker can be written as

$$\frac{\partial V_{t+1}(z',\ell')}{\partial \ell'} = \frac{1-\delta}{1+r_{t+1}}\mathbf{1}^o_{t+1}(z',\ell')\left(\frac{\partial \mathbf{E}_{z''|z'}\max_{\ell''}[\pi_{t+1}(z'',\ell',\ell'') + V_{t+1}(z'',\ell'')]}{\partial \ell'}\right)$$

which, by the envelope theorem, reads as

$$\begin{aligned}\frac{\partial V_{t+1}(z',\ell')}{\partial \ell'} &= \frac{1-\delta}{1+r_{t+1}}\mathbf{1}^o_{t+1}(z',\ell')\mathbf{E}_{z''|z'}\mathbf{1}^h_{t+1}(z'',\ell')\frac{\partial C^+_{t+1}(\ell',\ell'')}{\partial \ell'} - \frac{1-\delta}{1+r_{t+1}}\mathbf{1}^o_{t+1}(z',\ell')\mathbf{E}_{z''|z'}\mathbf{1}^f_{t+1}(z'',\ell')c_{f,t+1} \\ &+ \frac{1-\delta}{1+r_{t+1}}\mathbf{1}^o_{t+1}(z',\ell')\mathbf{E}_{z''|z'}(1-\mathbf{1}^h_{t+1}(z'',\ell'))(1-\mathbf{1}^f_{t+1}(z'',\ell'))\left[\frac{\partial \pi_{t+1}(z'',\ell',\ell')}{\partial \ell'} + \frac{\partial V_{t+2}(z'',\ell')}{\partial \ell'}\right]\end{aligned}$$

or equivalently

$$\frac{\partial V_{t+1}(z',\ell')}{\partial \ell'} = \begin{cases} -\frac{(1-\delta)}{1+r_{t+1}}\mathbf{1}^o_{t+1}(z',\ell')c_{f,t+1}, & \text{if} \quad z' < z^F(\ell) \\ \frac{(1-\delta)}{1+r_{t+1}}\mathbf{1}^o_{t+1}(z',\ell')\mathbf{E}_{z''|z}\left[\frac{\partial \pi_{t+1}(z'',\ell',\ell')}{\partial \ell'} + \frac{\partial V_{t+2}(z'',\ell')}{\partial \ell'}\right], & \text{if} \quad z' \in [z^H(\ell), z^H(\ell)] \\ \frac{(1-\delta)}{1+r_{t+1}}\mathbf{1}^o_{t+1}(z',\ell')\frac{\partial C^+_{t+1}(\ell',\ell'')}{\partial \ell'}, & \text{if} \quad z' > z^H(\ell) \end{cases}$$

Consider an incumbent firm entering the period with l employees and receiving an idiosyncratic productivity shock z'. The optimal employment level in the current period, $L_t(z',\ell)$, is thus characterized by the following policy function,

$$L_t(z',\ell) = \begin{cases} \ell^F(z') = \ell(z^F(\ell),\ell), & \text{if} \quad z' < z^F(\ell) \\ \ell, & \text{if} \quad z' \in [z^F(\ell), z^H(\ell)] \\ \ell^H(z') = \ell(z^H(\ell),\ell), & \text{if} \quad z' > z^H(\ell) \end{cases}$$

where $\ell^F(z')$ and $\ell^H(z')$ refer to the optimal employment level consistent with the optimality conditions,

$$\frac{\partial R_t(z',\ell')}{\partial \ell'}|_{\ell'=\ell^H} - \frac{\partial w_t(z',\ell')\ell'}{\partial \ell'}|_{\ell'=\ell^H} + \frac{\partial V_{t+1}(z',\ell')}{\partial \ell'}|_{\ell'=\ell^H} = \frac{\partial C^+_t(\ell,\ell')}{\partial \ell'}|_{\ell'=\ell^H} \tag{82}$$

$$\frac{\partial R_t(z',\ell')}{\partial \ell'}|_{\ell'=\ell^F} - \frac{\partial w_t(z',\ell')\ell'}{\partial \ell'}|_{\ell'=\ell^F} + \frac{\partial V_{t+1}(z',\ell')}{\partial \ell'}|_{\ell'=\ell^F} = -c_{f,t} \tag{83}$$

Therefore, if the idiosyncratic productivity z' is below the reservation threshold, $z^F(\ell)$, the firm will fire workers, pushing up the marginal benefits from employment till it is equal to marginal cost of dismissal. The opposite will happen if z' is above the reservation threshold, $z^H(\ell)$: the firm will hire workers, driving down the marginal return from employment till it is equal to the marginal cost of hiring. On the other hand, if z' lied between the two thresholds, the firm will be inactive, and will set current employment level equal to the previous one.

Export Policy. Each period t, incumbent firms decide whether to sell their product abroad or not. Export is a static decision, it entails the payment of a fixed costs, c_x, and grant a revenue premium, $d_{f,t}$. The presence of a fixed cost of exporting makes the optimal export participation decision, $\mathbf{1}^x_t(z',\ell')$ be characterized by a threshold productivity level, $z^x(l')$, which is implicitly defined as a solution the following equation,

$$R_{h,t}(z^x(\ell'),\ell') = R_{x,t}(z^x(\ell'),\ell') - c_x$$

so that

$$\mathbf{1}^x_t(z',\ell') = \begin{cases} 1, & \text{if} \quad z' \geq z^x(\ell') \\ 0, & \text{otherwise} \end{cases}$$

Exit Policy. At the beginning of each period t, firms who did not exit the industry for exogenous reasons decide whether to continue to operate or not. The presence of a fixed cost of operation, c^o, together with the autocorrelation of the idiosyncratic productivity process, makes the optimal exit decision be characterized by a threshold productivity level, $z^O(\ell)$, which is defined by the following equation

$$\mathbf{E}_{z'|z^O(\ell)}\left[\max_{\ell'}\left(\pi_t(z',\ell,\ell') + V_{t+1}(z',\ell')\right)\right] = 0$$

or, equivalently,

$$\mathbf{E}_{z'|z^O(\ell)}\left[\max_{\ell'}\left(R_t(z',\ell') - w_t(z',\ell')\ell' - C_t(\ell,\ell') + V_{t+1}(z',\ell')\right)\right] = c^o$$

Consider a firm entering the period with l employees and receiving an idiosyncratic productivity shock z'. The optimal exit strategy, $\mathbf{1}^o_t(z,\ell)$, is thus characterized by the following policy function:

$$\mathbf{1}^o_t(z,\ell) = \begin{cases} 1, & \text{if} \quad z \geq z^O(\ell) \\ 0, & \text{otherwise} \end{cases}$$

B.4. Wage Determination

Wages of industrial employees are determined using the Stole and Zwiebel (1996) bargaining solution, which generalizes the standard Nash bargaining solution to a setting when marginal returns are diminishing. Firms and workers meet and bargain simultaneously and on a one-to-one basis. Each worker is treated marginally by the firm. Failing to reach an agreement would imply a loss for the firm (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 remain unemployed in the current period). This generates a surplus to split between firms and workers. Consider a firm hiring workers. A solution for the wage paid to employees is implicitly defined by the following sharing rule,

$$\beta\Pi^{\text{firm}}_t(z',\ell') = (1-\beta)\Pi^{\text{worker}}_t(z',\ell') \tag{84}$$

where $\Pi_t^{\text{firm}}(z', \ell')$ is the firm marginal surplus, defined as,

$$\Pi_t^{\text{firm}}(z', \ell') = \frac{\partial R_t(z', \ell')}{\partial \ell'} - (1 + \tau_{w,t}) \frac{\partial w_t(z', \ell')\ell'}{\partial \ell'} + \frac{\partial V_{t+1}(z', \ell')}{\partial \ell'} \tag{85}$$

while $\Pi_t^{\text{worker}}(z', \ell',)$ is the worker marginal surplus equal to

$$\Pi_t^{\text{worker}}(z', \ell') = w_t(z', \ell') + J_{t+1}^e(z', \ell') - (b + b_t^u + J_{t+1}^o) \tag{86}$$

Substituting the surplus functions into the sharing rule, and assuming the continuation values are split using the same sharing rule, one obtains the following first-order partial differential equation,

$$w_t(z', \ell') = \frac{(1-\beta)}{1 + \tau_w \beta}(b + b_t^u) + \frac{\beta}{1 + \tau_w \beta} \left(\frac{\partial R_t(z', \ell')}{\partial \ell'} - (1 + \tau_w) \frac{\partial w_t(z', \ell')}{\partial \ell'} \ell' \right) \tag{87}$$

To solve this equation, I follow Cahuc et al (2007, Appendix B.2). Re-arranging the differential equation, we get

$$\frac{\partial w_t(z', \ell')}{\partial \ell'} + \frac{w_t(z', \ell')}{\tilde{\beta}(1 + \tau_w)\ell'} - \left[\frac{\partial R_t(z', \ell')}{\partial \ell'} - \frac{(1-\beta)}{1 + \tau_w \beta}(b + b_t^u) \right] \frac{1}{(1 + \tau_w)\ell'} = 0 \tag{88}$$

where $\tilde{\beta} = \frac{\beta}{1 - \beta \tau_w}$. Suppressing for easy of notation the dependence from z', equation (88) can be re-written in the following form:

$$\frac{\partial y(\ell')}{\partial \ell'} + p(\ell')y(\ell') + q(\ell') = 0 \tag{89}$$

where

$$\begin{aligned} y(\ell') &= w_t(z', \ell',) \\ p(\ell') &= \frac{1}{\tilde{\beta}(1 + \tau_w)\ell'} \\ q(\ell') &= -\left[\frac{\partial R_t(z', \ell')}{\partial \ell'} - \frac{(1-\beta)}{1 + \tau_w \beta}(b + b_t^u) \right] \frac{1}{(1 + \tau_w)\ell'} \end{aligned} \tag{90}$$

Plugging the expressions in (91) into the solution of (89), one can express wages as

$$w_t(z', \ell') = \frac{1}{1 + \tau_w} (\ell')^{-\frac{1}{\tilde{\beta}(1+\tau_w)}} \int_0^{\ell'} x^{\frac{1 - \tilde{\beta}(1+\tau_w)}{\tilde{\beta}(1+\tau_w)}} \frac{\partial R_t(z', x)}{\partial x} dx \tag{91}$$

Substituting the definition of marginal revenue function into (89) and integrating over employment yields the wage expression in the text

$$w_t(z', \ell') = \frac{(1-\beta)}{1 + \beta \tau_{w,t}}(b + b_t^u) + \frac{\beta}{1 - \beta + \alpha_f \beta \Lambda (1 + \tau_{w,t})} \frac{\partial R_t(z', \ell')}{\partial \ell} \tag{92}$$

with $\Lambda = \frac{\alpha(\sigma-1)}{\sigma - (1-\alpha)(\sigma-1)} > 0$. Notice that equation (92) generalizes the solution obtained in Cosar et al. (2016) for the case where firms payroll is subject to tax rate $\tau_w \geq 0$.

B.5. 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 labor market policies, $\{c_{f,t}, \underline{w}_t, b_t^u, \tau_{w,t}\}_{t=0}^{\infty}$, a path for the interest rate $\{r_t\}_{t=0}^{\infty}$, initial mass of operating firms $N_{h,-1}$, initial probability distributions of firms over the state space (z, ℓ) at the end and at the interim stage of the period, $\{\psi_{-1}(z, \ell), \widetilde{\psi}_{-1}(z, \ell)\}$, a transition density function of the Markov process for productivity shock z, $\Omega(z'|z)$ and its ergodic distribution, $\psi_e(z)$, a Recursive Competitive Equilibrium for this economy is characterized by a list of value functions for incumbent and potential entrant firms, $\{V_t(z, \ell), V_t^e\}_{t=0}^{\infty}$, and 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,

$$J_t^o = J_t^i = J_t^u = J_t^s \quad \forall t = 0, 1, ..., \tag{93}$$

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.

$$p_t^o(z, \ell) = \delta + (1 - \delta)(1 - \mathbf{1}_t^o(z, \ell)) \qquad p_t^f(z', \ell) = \mathbf{1}_t^f(z', \ell)\left(\frac{\ell - L_t(z', \ell)}{\ell}\right) \tag{94}$$

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:

$$\widetilde{\psi}_t(z',\ell)=\begin{cases}(1-\delta)\int_{z\in\mathcal{Z}}\Omega(z'|z)\psi_{t-1}(z,\ell)\mathbf{1}_t^o(z,\ell)dz, & \text{if} \quad \ell\neq 1\\ \frac{N_{e,t}}{N_{h,t-1}}\psi_e(z')+(1-\delta)\int_{z\in\mathcal{Z}}\Omega(z'|z)\psi_{t-1}(z,\ell)\mathbf{1}_t^o(z,\ell)dz, & \text{if} \quad \ell=1\end{cases} \tag{95}$$

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

$$\psi_t(z\prime,\ell')=\frac{\int_{\ell\in\mathcal{L}}\widetilde{\psi}_t(z',\ell)\mathbf{1}_{L_t(z',\ell)=\ell'}d\ell}{\int_{\ell\in\mathcal{L}}\int_{z''\in\mathcal{Z}}\widetilde{\psi}_t(z'',\ell)\mathbf{1}_{L_t(z'',\ell)=\ell'}dz''d\ell} \tag{96}$$

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:

$$N_{h,t}=(1-\delta)(1-\mu_t^{exit})N_{h,t-1}+N_{e,t} \tag{97}$$

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:

$$\mu_t^{exit}=\int_{\ell\in\mathcal{L}}\int_{z\in\mathcal{Z}}[1-\mathbf{1}_t^o(z,\ell)]\psi_{t-1}(z,\ell)dzd\ell \tag{98}$$

7. the wage of industrial employees, $w_t(z',\ell')$ is consistent with the bargaining protocols given in equations (36) and (38) 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:

   $$L_{q,t}=N_{h,t}\int_{\ell\in\mathcal{L}}\int_{z'\in\mathcal{Z}}L_t(z',\ell)\widetilde{\psi}_t(z',\ell)dz'd\ell \tag{99}$$

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

   $$L_{u,t}=(1-\widetilde{\phi}_t)U_t \tag{100}$$

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

$$\begin{aligned}\tilde{U}_t=\delta N_{h,t-1}\int_{\ell\in\mathcal{L}}\int_{z\in\mathcal{Z}}\ell\psi_{t-1}(z,\ell)dzd\ell+\\ (1-\delta)N_{h,t-1}\int_{\ell\in\mathcal{L}}\int_{z\in\mathcal{Z}}(1-\mathbf{1}_{t-1}^o(z,\ell))\ell\psi_{t-1}(z,\ell)dzd\ell+\\ N_{h,t}\int_{\ell\in\mathcal{L}}\int_{z\in\mathcal{Z}}\mathbf{1}_t^f(z',\ell)[\ell-L_t(z',\ell)]\widetilde{\psi}_t(z',\ell)dz'd\ell\end{aligned} \tag{101}$$

- 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,

$$v_t = N_{h,t} \int_{\ell \in \mathcal{L}} \int_{z' \in \mathbf{Z}} \mathbf{1}_t^h(z', \ell) \left(\frac{L_t(z', \ell) - \ell}{\phi_t} \right) \widetilde{\psi}_t(z', \ell) dz' d\ell \tag{102}$$

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,

$$bL_{u,t} + L_{s,t} = \underbrace{N_{h,t}[\overline{c} + c_o + \mu_x c_x] + N_{e,t} c_e}_{\text{intermediate demand}} + \underbrace{(1-\gamma) I_t}_{\text{final demand}} \tag{103}$$

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

$$\overline{c} = N_{h,t} \int_{z' \in \mathcal{Z}} \int_{\ell \in \mathcal{L}} \mathbf{1}_t^h(z', \ell) C_t^h(\ell, L_t(z', \ell)) \tilde{\psi}_t(z', \ell) dz' d\ell \tag{104}$$

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

$$\begin{aligned} I_t = & \underbrace{[b + b_t^u] L_{u,t} + L_{s,t} + \overline{w}_t N_{h,t}}_{\text{labor income}} + \underbrace{T_t}_{\text{lump-sum transfer}} + \\ & \underbrace{N_{h,t} \int_{z' \in \mathcal{Z}} \int_{\ell \in \mathcal{L}} [\pi_t(z', \ell, L_t(z', \ell)) - c_o] \tilde{\psi}_t(z', \ell) dz' d\ell - N_{e,t} c_e}_{\text{aggregate profits}} \end{aligned} \tag{105}$$

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,

$$D_{h,t} \tau_{a,t}^{-\sigma} (\tau_{c,t} k_t)^{1-\sigma} = k_t D_{f,t} \tau_{c,t}^{-1} \tag{106}$$

11. government budget is balanced, i.e. unemployment benefits plus lump-sum rebates matches

revenues collected from firing costs, tariffs and payroll taxes

$$
\begin{aligned}
T_t + b_t^u L_{u,t} = \\
\underbrace{\tau_w \overline{w}_t N_{h,t}}_{\text{payroll tax revenues}} \quad + \underbrace{c_{f,t} \int_{z\in\mathcal{Z}} \int_{\ell\in\mathcal{L}} \mathbf{1}_t^f(z',\ell)(\ell - L_t(z',\ell))\tilde{\psi}_t(z',\ell)dz'd\ell}_{\text{firing cost revenues}} + \\
\underbrace{D_{h,t}\tau_{a,t}^{-\sigma}(\tau_{c,t}k_t)^{1-\sigma}(\tau_{a,t}-1)}_{\text{tariff revenue}}
\end{aligned}
\tag{107}
$$

B.6. 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,

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

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.7. 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. Once solved, I store equilibrium allocations and prices. In particular, I store:
   - 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, $J_T^e(z, \ell)$
   - the initial and the final steady-state values for the equilibrium taxes on payroll, $\tau_{w,0}$ and $\tau_{w,T}$
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, $\{N_{e,t}\}_{t=1}^{T-1}$

- taxes on payroll, $\{\tau'_{w,t}\}_{t=1}^{T-1}$
  (only if $b_t^u > 0$, otherwise I fix $\tau_{w,t} = \tau_{w,0}$, $\forall t = 0, 1, ...$)

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.
- guesses for taxes on payroll, $\tau_{w,t}$, are updated *after simulating forward*, to ensure that unemployment benefits is fully self-financed and the government budget balances every period

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:

$$\pi_{T-1}(z',\ell,\ell') = R_{T-1}(z',\ell') - (1+\tau_{w,T-1})w_{T-1}^{\mathrm{h}}(z',\ell')\ell' - C_{T-1}^{h}(\ell,\ell')$$

if $\ell' > \ell$, or

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

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, $\mathbf{1}_{T-1}^{o}(z,\ell)$ and exporting decision, $\mathbf{1}_{T-1}^{x}(z',\ell')$.

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

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

where $\psi_e(z)$ is the ergodic distribution of productivity z, constant over time. To obtain domestic sales arising in equilibrium, I compare V_{T-1}^{e} with the cost of entry, $c_e\phi_t^{-\lambda_1}$. If $V_{T-1}^{e} > c_e\phi_t^{-\lambda_1}$, 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, $J_T^e(z', \ell')$, and exploiting the equilibrium condition $J_t^u = J_t^s = J_t^o = 1/r \quad \forall t = 0, 1, ...T$, 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
$$w_{T-1}^{\mathrm{f}}(z', \ell') = b + b_t^u + J_T^o - J_T^e(z', \ell')$$
Thus I repeat this until convergence and I store the converged value for the firing wage, $w_{T-1}^{\mathrm{f}*}(z', \ell')$.

7. Using the guesses for ϕ_{T-1} and the converged values for $D_{h,T-1}^*$ and $w_{T-1}^{\mathrm{f}*}(z', \ell')$, I update wages for hiring firms using the closed form solution of the bargaining problem:
$$w_t^{\mathrm{h}}(z', \ell') = \frac{(1-\beta)}{1+\beta\tau_{w,t}}(b + b_t^u) + \frac{\beta}{1-\beta+\alpha_f\beta\Lambda(1+\tau_{w,t})}\frac{\partial R_t(z', \ell')}{\partial \ell'}$$
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:
$$J_{T-1}^{e,h}(z', \ell) = w_{T-1}^{\mathrm{h}*}(z', L_{T-1}'(z, \ell)) + J_T^e(z', L_{T-1}'(z, \ell))$$

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

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, $\mathbf{1}^o_t(z,\ell)$, 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:

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

- 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, $\mathbf{1}^o_t(z,\ell)$, I compute the exit rate at time t, μ^{exit}_t, using equation (98).
- Given the initial guess for the measure of entrant firm, $N_{e,t}$, the exit rate, μ^{exit}_t, and the previous period mass of firms, $N_{h,t-1}$, I compute the mass of operative firms at time t using equation (97).
- 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 $J^e_{h,t}(z',\ell)$ to compute the expected value of a match in the interim stage, $\mathbf{E}_t J^e_{h,t}(z',\ell)$.
- Given $N_{h,t}, N_{e,t}, \bar{v}_t$, the guess for ϕ_t and $v^e_t = 1/\phi_t$ (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:

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

- 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, $N^*_{e,t}$.

- Finally, I compute J^u_t through the following formula:

$$J^u_t = \widetilde{\phi}_t \mathbf{E} J^e_{h,t} + (1 - \widetilde{\phi}_t)\left(b + b^u_t + \frac{1}{r}\right)$$

  If $J^u_t > 1/r$, 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, $\{\phi_t\}_{t=1}^{T-1}$.

- I update $\tau_{w,t}$ such that

$$\tau'_{w,t} N_{h,t} \overline{w}_{f,t} = b^u_t L_{u,t}$$

12. I use the new path of guesses for $\{\phi_t\}_{t=1}^{T-1}$ and $\{\tau_{w,t}\}_{t=1}^{T-1}$ 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 Estimation

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 the IFS dataset and it corresponds to real average lending rate, defined as the bank rate net of inflation that usually meets the short- and medium-term financing needs of the private sector, for the period 1986-2010. Ruhl and Willis (2017) report similar value, equal to 10.9% for the period 1980-2005.

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/1995/0316 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).[52] 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. Estimation Algorithm

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

To estimate the model, I assume the economy is in the autarkic steady state. Thereafter, I can drop the time index, t. During the estimation, I treat the aggregate domestic expenditure, D_h, 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, and the payroll tax, τ_w, is kept equal to the observed value (see Table 5 in the main text). This is not the case when I compute the equilibrium under the counterfactual scenario of a positive benefit, $b^u > 0$, in which case τ_w is endogenously determined to balance the government budget constraint. 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 given in equations (37) and (37) in the main text 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 29 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 (59) 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 a bootstrapped estimate for the inverse of the variance-covariance matrix of the moment conditions, $[var(\overline{m})]^{-1}$. 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.

Appendix D. Additional tables and figures

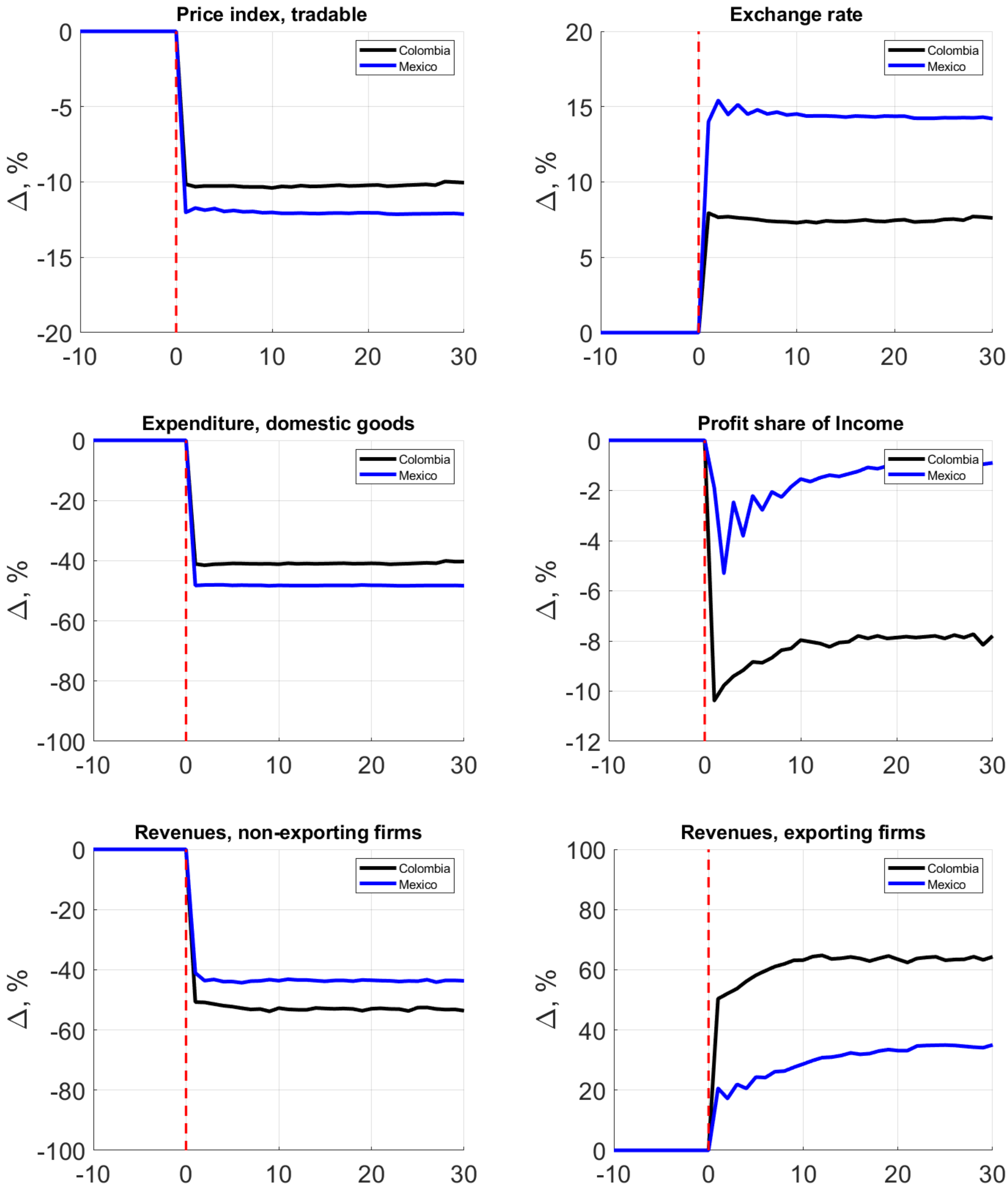
Table 18 reports a list of additional statistics for the baseline steady state. Figure 14 reports the impulse response functions to a reduction in trade costs for a list of additional statistics.

Table 18: **Additional statistics - Steady state**

		COLOMBIA	**MEXICO**
Variables	Symbols	Value	Value
Industrial price	P_t	5.5985	3.7730
Exchange rate	k_t	2.3528	1.3139
Domestic expenditure	$D_{h,t}$	4602.02	570.39
Profits/Income	Π_t/I_t	0.2988	0.1943
Avg. revenues, non exporters	$G_{h,t}$	73.84	148.16
Avg. revenues, exporter	$G_{f,t}$	24.38	148.93

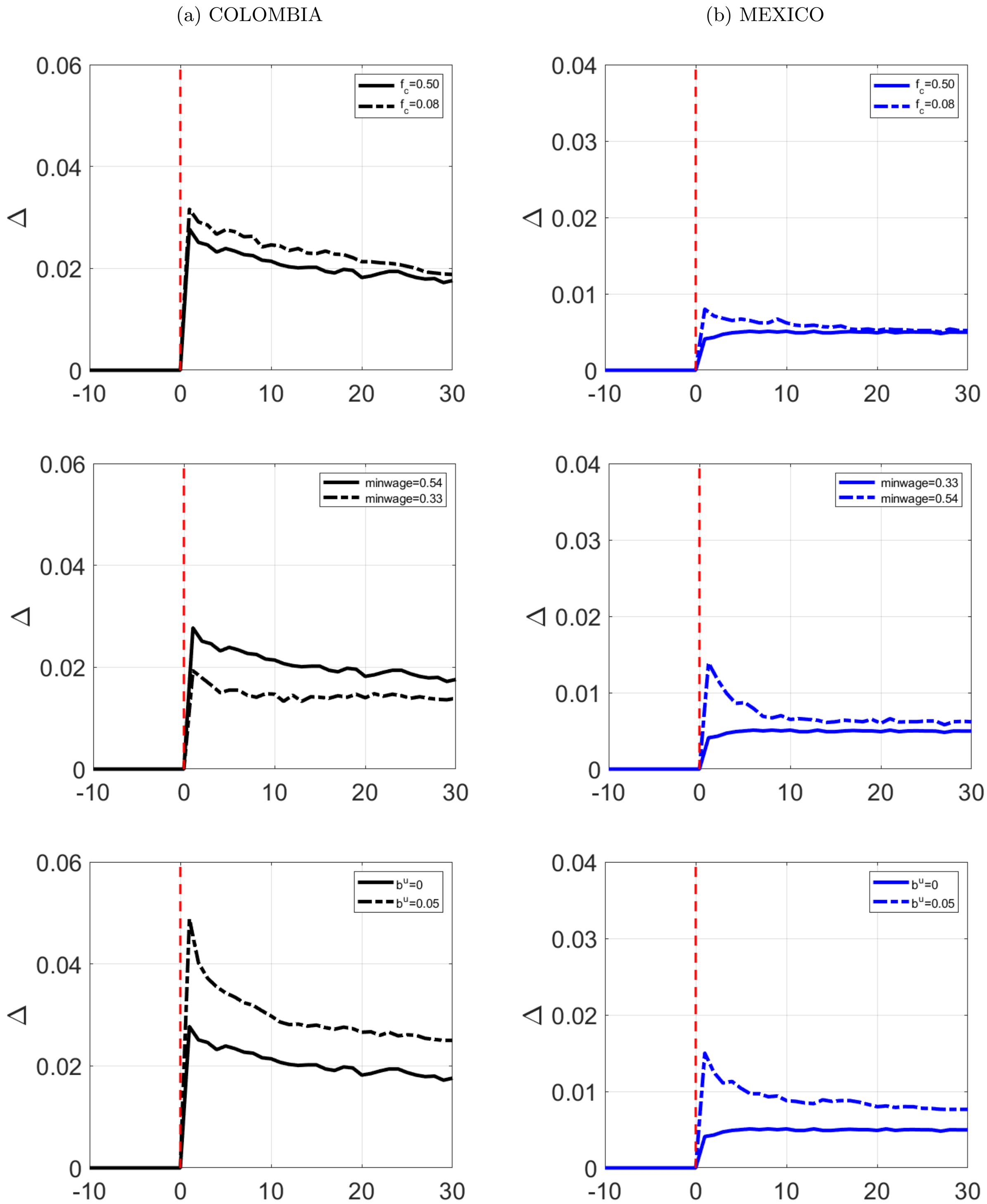
Note: This table reports a list of endogenous outcomes predicted by the model in the initial steady-state.

Figure 14: **Additional statistics - Transition**



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

Figure 15: **Counterfactual Unemployment Response to a Trade Reform**



Note: This figure reports the dynamic response of unemployment to a trade reform under counterfactual intial labor market institutions for Colombia (LHS) and Mexico (RHS). The response of unemployment under the "status-quo" institutions is reported in continuous line. The counterfactual response is in dashed line.