The rise of the maquiladoras: Labor market consequences of offshoring in developing countries

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Abstract

Labor markets of many emerging countries like Mexico are characterized by a high degree of informality. Conventional wisdom sees informal sector jobs as “bad jobs” due to lower wages. Hence one of the main policy objectives of the Mexican maquiladora program was to attract foreign direct investment to increase employment especially for low-skilled workers. We present a simple heterogeneous firm model with imperfect labor markets which captures the salient features of the Mexican economy. Specifically, we model the differences between manufacturing and maquila plants, their reliance on intermediate inputs and unskilled labor, as well as the predominance of foreign ownership and the existence of an informal labor market for low-skilled workers. We calibrate key parameters with observed stylized facts of the Mexican economy. Counterfactually shutting down the informal sector in our model decreases Mexican welfare. As low-skilled workers use their informal sector employment as a threat to bargain higher wages in the formal manufacturing and maquila sectors, shutting down the informal sector destroys this exit option and allows foreign-owned firms to extract higher profits, decreasing factor income and hence Mexican welfare.

JEL codes: F12, F14, F16, F23, O24
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1 Introduction

Beginning in the mid-1980s, all over Latin America governments began shying away from import-substitution as an industrialization policy and in turn tried to attract foreign direct investment and moved to export promoting policies for their manufacturing industries. One of the front runners of this policy change was Mexico. Beginning in 1984, it began reducing restrictions on foreign direct investment and, by the end of 1993, basically lifted all restrictions on foreign direct investment.\(^1\) The creation of the North American Free Trade Agreement (NAFTA) in 1994 further strengthened this trend by a spectacular expansion of predominantly US-owned input-processing plants known as *maquiladoras* or *maquilas* which took advantage of low labor costs and low transportation costs to sell in the US market. From 1980 to 1998, more than 60% of all FDI flows into Mexico came from the US, see Graham and Wada (2000). In the same line, Waldkirch (2010) reports that investment in *maquilas* as percentage of total inbound FDI flows has risen from 8% in 1994 to 20% in 2005. Policy makers stressed the importance of the *maquila* sector for increasing exports, creating job opportunities for Mexican workers and ultimately promote growth and an increase in welfare. Further jobs were expected as *maquilas* would ultimately use inputs not only from US-suppliers but also from domestic manufacturing firms. This export-oriented growth model was also seen as a way for Mexico to get access to foreign currency, thus allowing imports of foreign consumer and capital goods. Finally, hopes amongst Mexican politicians were high that the increase in labor demand brought about by the influx of foreign capital would create industrial sector jobs and reduce poverty, see Villarreal (2010). Poverty is especially rampant in the informal sector which represents a substantial fraction of the labor force not only in Mexico but also across the Latin American continent, e.g. about 30% in Mexico.\(^2\) Informal sector jobs are mainly characterized by low productivity and hence low wages, lack access to social security systems like e.g. the pension system and are less stable than formal sector employment. *Maquilas* were thus seen as a golden bullet to increase the overall productivity of the Mexican economy by replacing “bad” informal sector jobs by “good” formal sector jobs in the *maquila* sector driven by its export-led growth, see e.g. Martin (2000).

However, informal sector employment remained high. Irrespective of different definitions of informality, the hoped for general decline in informal jobs did not materialize in Mexico.

Understanding the determinants of informal sector employment, its link to for-

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1See Kehoe (1995) for an account of the Mexican *apertura*, i.e. its opening up to trade and foreign investments.

2For a survey on levels of informality throughout Latin America, see Gasparini and Tornarolli (2009).
eign direct investment and the *maquila* phenomenon and its larger welfare implications are of major interest for policy makers not only in Mexico but also in other developing and emerging economies in Latin America and beyond.\(^3\) However, empirical studies evaluating the impact of the rise of the *maquila* sector are scarce. The few existing studies offer mixed results at best. Whereas Graham and Wada (2000) stress positive effects on wages, they also note that inequality between high-skilled and low-skilled workers may have increased due to trade liberalization and the increased importance of *maquila* production. Waldkirch, Nunnenkamp, and Bremont (2009) find only modest positive employment effects of FDI inflows in non-*maquila* manufacturing sectors for blue-collar workers but none for white-collar workers. Paus and Gallagher (2008) stress the fact that most of the potential of FDI could not translate into overall positive effects for Mexican employment as MNEs procured the necessary inputs from US and other international suppliers whereas input producers from the domestic manufacturing sector where forced out of business by increasing competition from abroad.

One reason for the mixed conclusions about the *maquila*-employment nexus is that most studies either focus on informal or formal sector employment or the expansion of foreign direct investment separately. The *maquila* phenomenon is mostly viewed in terms of the invested foreign capital in Mexico without taking into account its broader implications for the Mexican labor market. To the best of our knowledge, the implications of *maquilas* for informal sector employment have not been investigated so far. Hence most studies are oblivious to the linkages between increased foreign activity, trade and the informal sector.

To evaluate these complex interrelations, a unifying theoretical framework is needed. So far, theoretical models of the informal sector tend to neglect the impact of the export-oriented policies implemented throughout Latin America. This paper advances the literature by presenting a calibrated model which is specifically designed to capture the salient features of the Mexican economy like foreign ownership of low-skilled labor intensive *maquila* plants and the profit repatriation which is linked to it, the heavy reliance on US intermediates as well as US export markets and, most crucially, the presence of an informal sector. Our model allows to evaluate the welfare implications of an increase of the *maquila* sector. Our simulations indicate that a rise of the *maquila* sector may actually be detrimental to Mexican welfare, even though the informal sector may decrease. Counterfactually shutting down the informal sector, we find that welfare is lower than in the economy with the possibility of informal employment. The intuition for this result is that taking away the possibility for workers to work in the informal sector hurts their bargaining power. As workers cannot opt out from working in the formal sector, wages in the formal part of the economy will be lower. If workers can use informality as a threat in their wage bargaining process, less

\(^3\)For a comparative world-wide survey of informality, see Jüttling and de Laiglesia (2009).
profits will get siphoned off to foreign owners and hence more income is retained in the home country for domestic consumption. This directly increases welfare. To the best of our knowledge, this mechanism has not been discussed in the literature so far. In addition, this paper is the first in presenting a unified treatment of the \textit{maquila} phenomenon and informality using a heterogeneous firm model in the vein of Melitz (2003). In a well-intentioned effort to focus on the implications of informal labor markets, most of the literature has modeled the production side of the economy as populated by homogeneous firms which operate on perfectly competitive markets. However, empirical studies using firm-level data have highlighted the vast differences which exist across firms in terms of productivity, see e.g. Bernard and Jensen (1999) and Bernard and Jensen (2004). Furthermore, resource reallocations induced by trade liberalization and \textit{maquila} promoting policies occur not only across sectors as stressed by standard homogeneous firm trade models of the Heckscher-Ohlin type but also within industries from less productive firms to more productive ones, see Pavcnik (2002).

Crucially, firm-level adjustment processes work through the labor market and hence are important determinants for evaluating the labor market implications of the rise of the \textit{maquila} sector. Standard homogeneous firm models are also intimately linked to perfect competition and hence the absence of firm profits. In heterogeneous firm models, fixed costs of entering export markets naturally give rise to operating profits. Therefore, foreign ownership of \textit{maquila} plants can be cast quite naturally as profit repatriation. Finally, heterogeneous firm models allow a wider evaluation of policy instruments like \textit{maquila} promoting policies and reduction of red tape for foreign investment which are absent from standard trade models. For the first time in the literature, we merge the models of Bernard, Redding, and Schott (2007) and Felbermayr, Prat, and Schmerer (2010) to include the informal sector in a search and matching framework into a heterogeneous firm model of international trade and extend them to two sectors.

Informal sector jobs are often considered to be unequivocally “bad” jobs as workers only turn to the informal sector when they cannot find a formal sector job. In this view, informality is involuntary. On the other side, the possibility of picking up a job in the informal sector can be the outcome of a rational choice when a formal sector job is not attractive enough and can be used in a threat in the wage bargaining process. Hence, the existence of an informal sector can prop up formal sector wages. Our model will capture this Janus-faced nature of informality: Informal sector workers will earn lower wages than those in the formal sector but closing down the informal sector actually reduces welfare in Mexico and specifically hurts low-skilled workers.

The remainder of the paper is structured as follows: Section 2 reviews the literature, section 3 presents key stylized facts of the Mexican informal sector and the \textit{maquila} industry. Section 4 presents our theoretical model. Comparative statics
from model simulations are presented in section 5. Section 7 shows results from policy experiments under varying different assumptions on preferences and the production structure to check the robustness of our results. Finally, section 8 concludes.

2 Literature review

There exists a body of theoretical literature which analyzes the conditions for detrimental effects of foreign direct investment, dating back in spirit at least to Bhagwhati's (1958) case of immiserizing growth for a small open economy in a perfectly competitive framework with no frictions on the labor market. Growth is assumed to happen exogenously by moving out the production possibility frontier.

Chandra and Khan (1993) analyze the welfare effects of foreign direct investment in a Harris and Todaro (1970) type economy. Workers have the choice between employment in the rural sector or in the urban center. There, they can either be employed in the formal or informal sector which is a residual part of the economy where workers subsist on low wages, absence of social security benefits and general dire conditions while they are queing for “good” formal sector jobs. This view on informality argues that above-market clearing wages, too strict labor regulation and red tape force workers into informal work. In this view, the bigger the informal sector, the lower the general welfare of the society.

Chandra and Khan (1993) endogenize the size of the informal sector using a variant of the Heckscher-Ohlin model where the output produced in the informal sector is internationally traded. They demonstrate that an influx of capital can be immiserizing for a small open economy in the presence of an informal sector. In their model, however, no explanation is offered as to why wages should not be equalized in the formal and informal sector by underbidding in the absence of any labor market rigidities as the informal sector is in essence just a label attributed to an otherwise standard sector.

Marjit, Ghosh, and Biswas (2007) present a theoretical model of homogeneous firms employing both formal and informal workers where firms have the possibility to bribe government officials to get away with employing informal workers. In this setup, trade liberalization leads to an increase in informality. The mechanisms in their model are complementary to ours as we abstract from the public sector.

Satchi and Temple (2009) present a calibrated model of the Mexican economy with search and matching frictions in the urban labor market where workers have the possibility of self-employment in the informal sector. However, the model does not include a foreign-owned maquila sector and no self-selection of more productive firms into exporting as our model does.
Ulyssea (2010) presents a model where an intermediate good can be used in the production of a final consumption good that can either be produced in the formal or informal sector. Homogeneous firms face vacancy costs to post both formal and informal jobs, where the latter jobs are less costly. The model completely abstracts from trade and hence the maquila sector is not accounted for.

A recent strand of the trade literature has incorporated labor market rigidities in heterogeneous trade models, see e.g. Helpman and Itskhoki (2010), Felbermayr et al. (2010), Egger and Kreickemeier (2009) and Larch and Lechthaler (2009). Helpman and Itskhoki (2010) present a two country model with two sectors, a differentiated heterogeneous firm sector and a homogeneous firm sector and labor market frictions modeled in a search and matching framework. Felbermayr et al. (2010) analyse the implications of search and matching frictions in a single sector model of heterogeneous firms. Egger and Kreickemeier (2009) use fair wages to generate unemployment in a single sector Melitz-type model. Larch and Lechthaler (2009) analyse search and matching in a multi-sector model without an homogenous goods outside sector. However, all of these papers do not consider the specific structure of the maquila phenomenon with its heavy reliance on imported intermediate inputs and foreign ownership. Furthermore, none of the papers compares welfare differences when labor market rigidities are abolished.

Hence, our paper is the first to address the linkages between the informal sector and the export-processing plants phenomenon in a single theoretical framework, complementing the recent literature concerned with the impact of globalization on domestic labor markets.

3 Stylized facts on the Mexican economy

3.1 The rise of the maquila sector

The beginning of the maquila phenomenon dates back to the 1960ies when the Programa de Industrialización de la Frontera Norte (Industrialization Program for the Northern Border) was put into place to promote the creation of export-processing plants in the Northern part of Mexico. To create a maquila factory, US companies have to get a permission from the Secretaría de Economía (Secretary of Economy), see INEGI (2007). Hence Mexico underwent a structural shift towards a more foreign-oriented manufacturing sector. Between 1994 and 2000, maquila-related inflows of FDI doubled from 8.4 to 17% of annual inflows, see Waldkirch (2010). During the 1990s, maquila production experienced a major expansion, both in terms of output produced as well as in terms of employment. Figure 1 shows the increase of the value added in the maquila sector from 1990 to
2004. During this period, value added has more than doubled. Accordingly, also the number of employees has increased substantially, from 450,000 to 1,115,000 persons in total. In 1990, this figure represented 1.5% of the labor force. The maquila phenomenon became more and more important for the Mexican economy. Whereas in 1990, only 6% of the total value added in the manufacturing sector came from maquiladoras, this share rose to 25% in 2004, see the middle panel in figure 2. At the same time, maquiladoras account for about over 50% of Mexican total exports (ADD SOURCE/GRAPH). Not only have maquiladoras proven to be an important source of foreign currency, they also gained importance in terms of jobs. Its employment share in manufacturing more than doubled from 15% of all manufacturing employees in 1990 to 35% in 2004, see the right panel in the same figure. This rise of the maquiladoras mainly came at the expense of standard manufacturing firms, as the overall share of manufacturing in GDP remained more or less stable at about 18% during the same time period, see left panel. During the 1990s, the maquila industry also increased its reliance on intermediate inputs. Whereas expenses for intermediate goods made up about 80% of total production costs in 1990, this share has seen a steady increase to over 92% in 2004, see figure 3.

Another key feature of the maquila mode of production is that most plants are foreign owned. Hence, profits generated in the sector are moved abroad. Ramirez (2006) presents evidence that overall remittances of profits and dividends from Mexico more than doubled from 1990 to 2000 (from US$2.3 to $5.2 billion). Finally, the relative wage of white collar workers compared to blue collar workers in Mexican maquilas rose during the 1990s which is commonly linked to skill-biased technological change in the presence of complementarities between skilled labor and capital, see Mollick (2008). With our model presented in section 4, we offer a distinct explanation for the rise in the skill-premium via the increase in the maquila sector.

3.2 Informality and the Mexican labor market

The literature on jobs in the informal sector uses heterogeneous definitions of which job characteristics constitute an informal job. This reflects partly that definitions of informality have evolved over the last decades. Earlier studies stress informality as a concept referring to a specific sector of the economy. This productive definition focuses on characteristics of the single establishment. Enterprises belong to the informal sector when they operate “with scarce or even

\footnote{More recent data are not available as the Mexican statistical office INEGI discontinued its survey of maquila plants, \textit{Estadística de la Industria Maquiladora de exportación} (EIM) in 2006. Since 2007, maquila plants are incorporated in the survey \textit{Industria Manufacturera, Maquiladora y de servicios de Exportación} (IMMEX), hence the data do not allow to discriminate between maquila and standard manufacturing plants after 2006.}
no capital, using primitive technologies and unskilled labor, and then with low productivity \(^5\) as in the ILO (1993) definition of the informal sector. More recently, emphasis has moved away from enterprise centered definitions towards informal employment, recognizing the fact that informal employment can arise both in formal as well as informal establishments. For example, formal businesses may subcontract informal workers to cut labor costs as a response to increasing competition. \(^5\) This *legalistic* definition of informality \(^6\) comprises employees and self-employed which do not have access to social security benefits like e.g. the pension system, but also workers who do not have a written work contract. As data on informality are often scarce, proxies like the share of self-employed in the labor force are also used to measure informality. Obviously, this measure includes freelancing professions like e.g. doctors which are normally not considered to be informal workers. Hence, depending on one’s definition, informality can refer to very heterogeneous economic conditions. \(^7\)

Recent studies on stylized features of the informal sector in Mexico are scarce. Martin (2000) presents evidence on trends in unemployment and informal employment rates for Mexico for the 1990s. Using INEGI’s definition of the informal sector, one can see that the hoped-for reduction in the informal sector employment rate by the increase of *maquila* activity did not materialize. As indicated by figure 4, there is no discernible trend in the informal sector employment rate, at least not for the last decade. Informal sector employment fluctuated around an average value of just below 28% of the economically active population. Gasparini and Tornarolli (2009) corroborate this finding using micro-level household data and using different definitions of informality.

Informal sector employment is mainly a phenomenon affecting unskilled workers. On average, 57% of all informal sector workers only have primary education or no formal education at all. Only 14% of informal sector employment represents individuals with an university degree, see the right panel in figure 4. Finally, informal jobs tend to pay lower wages on average. Using a wage regression approach and a productive definition of informality, Gasparini and Tornarolli (2009) show that workers without secondary education have a 30% lower hourly wage than their formal sector co-workers.

\(^6\) For the terms *productive* and *legalistic* definition of informality, see Gasparini and Tornarolli (2009).
\(^7\) For a detailed overview of informality definitions see Jütting and de Laiglesia (2009).
4 The model

We treat Mexico as a small open economy, and think of the US as the rest of world, abstracting from all other trade partners. This is not unduly restrictive, as 80% of all Mexican exports are shipped to the US.\textsuperscript{8} Thus, we only model Mexico explicitly and take the prices of final goods as well as of the imported intermediate goods as given.

We model Mexico as a small open economy consisting of two sectors, \textit{maquila}, \( j = 1 \), and non-\textit{maquila} manufacturing, \( j = 2 \), both populated by firms that are heterogeneous with respect to their productivity.\textsuperscript{9} There are two types of labor, skilled, and unskilled, which are inelastically supplied by households, and we assume that Mexico is abundant in unskilled labor. Although workers of both types can move freely between sectors, we assume that the labor market for low-skilled workers is subject to search-and-matching frictions as in Pissarides (2000). Firms pay a fixed cost to post vacancies for low-skill workers, and the filling rate of these vacancies depends on the aggregate tightness of the labor market. Individuals that do not get matched with firms in either of the two sectors earn an income in the informal sector. The labor market for skilled workers on the the other hand, is assumed to be perfectly competitive.

4.1 Consumption

Mexican households only consume goods produced in the manufacturing sector, which means that \textit{maquila} output is exported in its entirety. The representative consumer’s utility takes the CES form,

\[
U = C_2, \quad C_2 = M^\frac{1}{\sigma} \left[ \int_{\omega \in \Omega_2} [q_{2d}(\omega)]^{\frac{\sigma - 1}{\sigma}} d\omega + \int_{\omega^{'} \in \Omega_{2f}} [q_{2f}(\omega^{'})]^{\frac{\sigma - 1}{\sigma}} d\omega^{'} \right]^{\frac{\sigma}{\sigma - 1}},
\]

where \( C_2 \) is a composite good from all different varieties produced in the manufacturing sector in Mexico, \( \Omega_2 \), and varieties imported from abroad, \( \Omega_{2f} \), \( \sigma > 1 \) is the elasticity of substitution and \( M \) denotes the total mass of varieties available in the domestic economy (including imported varieties). We follow Felbermayr et al. (2010) and Larch and Lechthaler (2009) and normalize utility by \( M^\frac{1}{\sigma} \) in order to ensure that the size of the informal sector does not depend on the size of the economy.

\textsuperscript{8}In 1991, 79.4% of all exports were shipped to the US; in 2009, 80.5%, see INEGI (2010).

\textsuperscript{9}We will refer to the non-\textit{maquila} manufacturing as manufacturing sector for short hereafter.
Taking into account the existence of ‘iceberg’ transportation costs $\tau_2 \geq 1$ for imported varieties, the price index corresponding to the composite $C_2$ is given by:

$$P_2 = M_2^{-\frac{1}{\sigma}} \left[ \int_{\omega \in \Omega_2} [p_{2d}(\omega)]^{1-\sigma} d\omega + \int_{\omega' \in \Omega_2} [\tau_2p_{2f}(\omega')]^{1-\sigma} d\omega' \right]^{\frac{1}{1-\sigma}}. \quad (4.2)$$

Inverse demand for domestic and foreign varieties from sector 2 is given by:

$$p_{2d}(\omega) = \left( \frac{Y}{M_2} \right)^{\frac{1}{\sigma}} P_2^{\frac{\sigma-1}{\sigma}} q_{2d}(\omega)^{-\frac{1}{\sigma}}, \quad (4.3)$$

$$p_{2f}(\omega) = \left( \frac{\tau_2Y}{M_2} \right)^{\frac{1}{\sigma}} P_2^{\frac{\sigma-1}{\sigma}} q_{2f}(\omega)^{-\frac{1}{\sigma}},$$

where $Y$ denotes total expenditure in Mexico.

4.2 Production

Firms in both sectors are heterogeneous with respect to their idiosyncratic productivity, $\varphi$. Since each firm produces a unique variety, we index firm-level variables by $\varphi$. The production side of our model follows closely Larch and Lechthaler (2009) and their extension of Felbermayr et al. (2010) into a two-sector, two-factor model.

Manufacturing Plants

Firms differ in their productivity $\varphi$ which can be used as a firm index as in Melitz (2003). There is an unbounded mass of potential entrants in the domestic manufacturing sector. To enter, producers pay a sunk cost $f_{e2}$. All fixed costs in the model, which include the fixed costs of entry, operation, exporting (only in sector 2) and vacancy posting are denominated in terms of units of the manufacturing good. Note that this implies that not all output produced can be used for consumption.\(^{10}\) Note also that this is contrary to Melitz (2003) where fixed costs are paid in terms of units of labor. This is not a viable option in our case as we will assume that there is bargaining between workers and employers. When plant setup costs are effectively created by labor input, the bargaining power of low-skilled workers would increase as they could prevent production from taking place altogether. Therefore, we could not resort to wage bargaining where every worker is treated as the marginal worker.\(^{11}\) After incurring this cost, firms draw their productivity (which remains constant over time) from a Pareto distribution with pdf $g(\varphi) = ak^a\varphi^{-(a+1)}$ for $\varphi \geq k$.\(^{12}\) Firms that choose to operate need to

\(^{10}\)See Egger and Kreickemeier (2009) for a similar assumption.

\(^{11}\)For wage bargaining when workers are complements, see e.g. Horn and Wolinsky (1988).

\(^{12}\)We also restrict $a > \sigma - 1$ to ensure that the variance of the sales distribution is finite.
pay a fixed cost $f_2$ per period.

Production in manufacturing combines low-skilled $l$ and high-skilled labor, $s$ in a Cobb-Douglas form,

$$q_2(\varphi) = \varphi(s_2)^{\beta_2}(l_2)^{1-\beta_2}.$$ \hfill (4.4)

Firms sell their output domestically but can also incur an additional fixed cost $f_{x2}$ to serve the foreign market through exports. We borrow the notion of a small open economy in a monopolistic competition environment from Flam and Helpman (1987), and the extension to a heterogeneous-firms environment proposed by Demidova and Rodríguez-Clare (2009). This assumption implies that, despite the fact that firms located in Mexico (both maquiladoras and manufacturing firms) face a downward-sloping demand schedule for their exports in the foreign market, their pricing decision does not affect the respective price index abroad. We also take as given the mass of foreign manufacturing firms and the subset of them exporting to Mexico, but foreign expenditure in Mexican manufacturing goods, $Y^F_2$, is endogenous.\footnote{In both Flam and Helpman (1987) and Demidova and Rodríguez-Clare (2009) an endogenous variable that clears the balanced trade condition is needed. In Flam and Helpman (1987) firms from the small economy do not affect the expenditure level in the differentiated good abroad but can influence the price index. In Demidova and Rodríguez-Clare (2009), the price index and expenditure abroad are unaffected by Home firms but the share of foreign firms exporting to the small economy is endogenous. The choice of which variable to adjust to achieve equilibrium in the balance of payments is immaterial for our results.} Thus, inverse demand for Mexican manufacturing exports abroad is given by,

$$p_{2x}(\varphi) = A_{2x}(r_{2x}Y^F_2)\frac{1}{\sigma} q_{2x}(\varphi)^{-\frac{1}{\sigma}},$$ \hfill (4.5)

where $A_{2x} \equiv \left[\left(P^F_2\right)^{\sigma-1}/M^F_2\right]^{1/\sigma}$, is a parameter that encompasses the manufacturing price index as well as the total mass of firms selling manufacturing goods abroad and is taken as given by Mexican manufacturing firms. Total revenue for a Mexican manufacturing firm is given by:

$$r_2(\varphi) = r_{2d}(\varphi)+\I_x(\varphi)r_{2x}(\varphi) = \left(\frac{Y}{M_2}\right)^{\frac{1}{\sigma}} P_2^{\frac{\sigma-1}{\sigma}} q_{2d}(\varphi)^{\frac{\sigma-1}{\sigma}} + \I_x(\varphi)A_{2x}(r_{2x}Y^F_2)\frac{1}{\sigma} q_{2x}(\varphi)^{\frac{\sigma-1}{\sigma}}.$$ \hfill (4.6)

where $\I_x(\varphi)$ is an indicator function that takes the value one if a manufacturing firm with productivity $\varphi$ exports and zero otherwise.

**Maquiladora Plants**

We model *maquiladoras* in a similar fashion to manufacturing firms, thus in this section we just highlight the differences between the two sectors, namely that (i) maquila plants are foreign-owned, (ii) export all their output and (iii) use foreign manufacturing goods as intermediate inputs for production.
A foreign investor pays a sunk entry cost in Mexico (denominated in units of the Mexican manufacturing good) to set up a maquiladora plant.\footnote{The fixed costs associated with the operation of the plant and vacancy posting for low-skill workers are also incurred in Mexico and are denominated in units of the Mexican manufacturing good.} Productivity draws for maquiladoras are drawn from the same Pareto distribution as that for Mexican manufacturing firms. Since maquila output is only used abroad, maquiladoras export all their output. This implies that there are no fixed costs associated with exporting in this sector. Unlike Mexican-owned plants in the manufacturing sector, profits derived from the operation of maquila plants are repatriated abroad.\footnote{The Mexican government can potentially tax a share $\eta$ of these profits and redistribute them in a lump-sum fashion to Mexican households.}

Finally, we assume that maquiladoras use foreign manufacturing goods as intermediate inputs, denoted by $i$, for production along with skilled and unskilled labor. Thus, production of maquila output for a plant with productivity $\varphi$ takes the form,

$$q_1(\varphi) = \varphi(s_1)^{\beta_1 s}(l_1)^{\beta_1 l}(i_1)^{1-\beta_1 s-\beta_1 l}. \quad (4.7)$$

Since maquiladoras are on average less skill-intensive than manufacturing firms, we assume that $\beta_{1s} < \beta_{2s}$.

Inverse demand for maquila output abroad is given by,

$$p_{1x}(\varphi) = A_{1x}\left(\frac{q_{1x}(\varphi)}{\tau_1}\right)^{-\frac{1}{\sigma}}, \quad (4.8)$$

where we have defined the foreign price index for maquila goods, $P^F_1$, as the numéraire, and $A_{1x} \equiv [Y^F_1/M^F_1]^{1/\sigma}$, is a foreign demand shifter that maquiladora plants take as given and has a similar interpretation to $A_{2x}$ defined above. Total revenues for a maquiladora plant with productivity $\varphi$ are given by:

$$r_1(\varphi) = r_{1x}(\varphi) = A_{1x}\left(\frac{q_{1x}(\varphi)}{\tau_1}\right)^{\frac{\sigma+1}{\sigma}}. \quad (4.9)$$

### 4.3 Labor Market

We assume that the labor market for skilled workers is perfectly competitive. However, the labor market for low-skill workers is subject to search and matching frictions. More specifically, and following Satchi and Temple (2009), we redefine the unemployment state as informal self-employment. Thus, unskilled individuals that are unable to get matched with a plant in the formal sector (either a manufacturing or maquila plant) are considered informal workers. These individuals earn income $bw_l$, with $b \in (0, 1)$, financed by lump-sum transfers from employed individuals, so we can interpret $1 - b$ as the formality wage premium for low-skilled workers.
Firms need to post vacancies \( v \) to be filled by low-skill individuals, which requires them to pay a fixed cost \( c \) per vacancy. As is common in the search and matching literature, we assume that the matching technology exhibits constant returns to scale, and takes a Cobb-Douglas form,

\[
m(\theta) = \overline{m} \theta^{-\gamma}, \quad \gamma \in (0, 1).
\] (4.10)

where \( \theta \equiv v/u \) is the vacancy-informality ratio, and the parameter \( \overline{m} \) determines the overall efficiency of the matching process in the economy. Thus, the probability that a vacancy is filled is given by \( m(\theta) \), which is decreasing in \( \theta \), and the probability that a low-skilled individual in the informal sector finds a job in a formal plant is \( \theta m(\theta) \), which is increasing in \( \theta \).

In order to reduce the number of parameters to be calibrated in the next section, we follow Keuschnigg and Ribi (2009) and consider a simplified one-shot version of the search and matching basic framework. The only difference with respect to the textbook model as presented in Pissarides (2000) is that we assume that the entire population of unskilled workers gets matched with firms in one period.\(^{16}\)

The optimal labor demand decision for a manufacturing firm solves the following program:

\[
\pi_2(\phi) = \max_{l_2, s_2} \left\{ r_2(\phi) - w_1 l_2 - w_s s_2 - c P_2 \left( \frac{l_2}{m(\theta)} \right) - f_2 P_2 - f_x \mathbb{I}_x(\phi) \right\},
\] (4.11)

subject to equation (4.6) and \( q_2(\phi) = q_{2d}(\phi) + \mathbb{I}_x(\phi) q_{2x}(\phi) \), where we have also made use of the fact that a manufacturing plant wishing to hire \( l_2 \) unskilled workers needs to post \( l_2/m(\theta) \) vacancies.\(^{17}\)

The solution to program (4.11) yields two policy rules, one for skilled labor demand, which is the usual condition that the marginal revenue product of skilled labor has to be equal to the skilled wage, \( w_s \), and a second one for low-skilled employment that reads:

\[
\frac{\partial r_2(\phi)}{\partial l} = w_1 + \frac{\partial w_1}{\partial l_2} + \frac{c P_2}{m(\theta)}.
\] (4.12)

This equation means that the optimal demand for low-skilled labor equals its marginal revenue product to the expected marginal cost of hiring an unskilled worker, which consists of three terms identified by Felbermayr et al. (2010): (i)\(^{18}\)

---

\(^{16}\)This setting allows us to avoid choosing parameter values for the exogenous rate of match destruction and the exogenous failure rate of firms which would appear in the benchmark search and matching model. The results of the model carry through when we study the steady state of a model with exogenous job destruction and exogenous plant exit.

\(^{17}\)The labor demand program for maquila plants is almost identical to equation (4.11), with the only difference being that maquiladoras need to choose how much foreign intermediate inputs to use for production.
the wage paid to the marginal worker, (ii) a monopsony effect that the firm internalizes as the hiring of a new worker affects the wage bargaining for inframarginal workers and (iii) expected recruitment costs.

**Wages**

As Felbermayr et al. (2010) and Larch and Lechthaler (2009) who in turn follow Stole and Zwiebel (1996) we assume that unskilled workers bargain individually with their employers about their wage and are treated as the marginal worker. Total surplus of a worker-employer match is split according to a generalized Nash Bargaining solution:

\[
(1 - \mu)[E(\varphi) - U] = \mu \frac{\partial \pi_j(\varphi)}{\partial \theta}, \quad j = 1, 2.
\]

(4.13)

where \(E(\varphi)\) denotes the value of an unskilled worker employed at a plant with productivity \(\varphi\), \(U\) is the value of a worker in the informal sector, and \(\mu \in (0, 1)\) measures the bargaining power of a worker.

As can be seen in the Appendix, following the same procedure as Felbermayr et al. (2010), i.e. combining the first-order conditions for low-skill employment by plants in both sectors together with the surplus-splitting rule (4.13) yields a set of two ‘job-creation’ conditions (one for each sector):

\[
w_l + \frac{cP_2}{m(\theta)} = \left[ \frac{\beta_{1l}(\sigma - 1)}{A_1} \varphi A_1 s_1(\varphi)^{\beta_{1s} l_1(\varphi)^{1-\beta_{1s}}}, \right.
\]

(4.14)

\[
w_l + \frac{cP_2}{m(\theta)} = \left[ \frac{(1 - \beta_{2s})(\sigma - 1)}{\sigma + \beta_{2s} \mu - \mu - \beta_{2s} \sigma \mu} \varphi P_{2d}(\varphi)^{\beta_{2s} l_2(\varphi)} \right] \left[ \frac{s_2(\varphi)}{l_2(\varphi)} \right].
\]

(4.15)

And the ‘wage curve’ is given by:

\[
w_l = \frac{\mu cP_2}{(1 - \mu)(1 - b)} \left[ \theta + \frac{1}{m(\theta)} \right],
\]

(4.16)

which jointly determine \(w_l\) and \(\theta\).

**4.4 Productivity Cutoffs and Entry**

As described in Section 4.2, industry evolution in our model follows closely Melitz (2003) and Bernard et al. (2007). Because \(r_j(\varphi)\) is a strictly increasing function of \(\varphi\), only plants with idiosyncratic productivity high enough to make non-negative profits will start production. Thus the usual productivity cutoff for production in sector \(j\), is defined implicitly by \(\pi_j(\varphi_j^*) = 0\). In the manufacturing sector, where plants need to incur a fixed cost to serve the foreign market, an export cutoff is similarly defined as \(\pi_{2x}(\varphi_{2x}^*) = 0\). In the calibration exercise, the fixed cost
of operation and exporting will be such that \( \varphi^*_2 < \varphi^*_{2x} \), so the model produces selection into exporting.

We follow Melitz (2003) and define the average productivity for maquiladoras and manufacturing firms as:

\[
\tilde{\varphi}_j \equiv \left[ \frac{1}{1 - G(\varphi^*_j)} \int_{\varphi^*_j}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi \right]^{\frac{1}{\sigma - 1}}, \quad j = 1, 2, \tag{4.17}
\]

and the average productivity for manufacturing exporters,

\[
\tilde{\varphi}_{2x} \equiv \left[ \frac{1}{1 - G(\varphi^*_2)} \int_{\varphi^*_2}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi \right]^{\frac{1}{\sigma - 1}}. \tag{4.18}
\]

Finally, let \( \chi_2 \equiv [1 - G(\varphi^*_2)]/[1 - G(\varphi^*_j)] \) denote the ex-ante probability that a manufacturing plant exports, conditional on successful entry. Using these definitions we can write the free-entry condition for plants in sector \( j \):

\[
[1 - G(\varphi^*_j)] \pi_j = f e_j P_2, \quad j = 1, 2. \tag{4.19}
\]

### 4.5 Aggregate Variables

The equilibrium share of informal workers in the labor force follows from the one-period equivalent of the Beveridge curve and is given by:

\[
u = \frac{1}{1 + \theta m(\theta)}. \tag{4.20}\]

The mass of firms operating in sector \( j \) in Mexico, \( M_{jd} \) (locally-owned manufacturing firms and foreign-owned maquiladoras\(^{19}\)) by is pinned down by the low-skill labor market equilibrium:

\[
M_{1d} = \frac{L_1}{l_1(\tilde{\varphi}_1)}, \tag{4.21}
\]

\[
M_{2d} = \frac{L_2}{l_{2d}(\tilde{\varphi}_2) + \chi_2 l_{2x}(\tilde{\varphi}_{2x})},
\]

with \( L_1 + L_2 = (1 - u) \bar{T} \), where \( L_j \) denotes total unskilled employment in sector \( j \) and \( \bar{T} \) is the total endowment of unskilled labor in the economy. Market clearing for skilled labor in turn, pins down the wage for skilled workers,

\[
M_{1d} s_1(\tilde{\varphi}_1) + M_{2d} [s_{2d}(\tilde{\varphi}_2) + \chi_2 s_{2x}(\tilde{\varphi}_{2x})] = \bar{F}, \tag{4.22}
\]

\(^{18}\)Note that for maquiladoras, \( \pi_1 = \pi_1(\tilde{\varphi}_1) \) and for manufacturing plants, \( \pi_2 = \pi_{2d}(\tilde{\varphi}_2) + \chi_2 \pi_{2x}(\tilde{\varphi}_{2x}) \).

\(^{19}\)Note that the total number of manufacturing varieties available for consumption in Mexico is \( M_2 = M_{2d} + \chi_2 M_{2F} \), where both \( \chi_2 \) and \( M_{2F} \) are exogenously fixed in the model.
whereas the wage for unskilled workers is determined by the combination of job
creation conditions for both sectors and the wage curve described in equations
(4.14) and (4.16).

Finally, the trade balance condition reads:

\[
\tau_2^{1-\sigma} \left( \frac{Y}{M_2} \right) \left( \frac{P_2}{P^F_2} \right)^{\sigma-1} + \tau_2 P^F_2 M_1 d_i(\tilde{\varphi}_1) + \chi_2 M_2 d_2(\tilde{\varphi}_2) = M_1 d_1(\tilde{\varphi}_1)
\]

(4.23)

That is, on the left-hand side, the total value of exports in both sectors has to
be equal to the sum of imports of foreign manufacturing goods used for domestic
consumption and as intermediate inputs in maquiladoras, plus aggregate profits
from maquila production which are repatriated to the rest of the world. Note
that aggregate profits in the manufacturing sector remain in the home economy
as it is domestically owned.

5 Calibration and policy experiments

5.1 Parameter values

We calibrate our model to key stylized facts in the data. Specifically, we choose
the parameter by minimizing the distance between observed moments in the
data and the corresponding moments in the model. An overview of the matched
moments as well as the identified parameters can be found in table 1. In addition
to the calibrated parameters, we exogenously fix a set of parameters by using
observed points in the data or use estimates from other researchers. For the
factor cost shares, we use data from the NIPA accounts. Specifically, we set
\( \beta_L^1 = 0.089, \beta_K^1 = 0.028, \beta_L^2 = 0.884, \beta_K^2 = 0.571, \) and
\( \beta^F = 0.429. \) We set the formality premium as in the data to \( 1-b = 0.29 \) (ADD SOURCE). The low-skilled
labor endowment of Mexico matches the total number of production workers in
total manufacturing employment.\(^{20}\) We closely follow Bernard et al. (2007) and
Felbermayr et al. (2010) and set the parameters of the Pareto distribution to
\( (k = 0.2, a = 3.4). \) Following Bernard, Eaton, Jensen, and Kortum (2004), we
set the elasticity of substitution \( \sigma = 3.8. \) In our baseline scenario, all profits
may be shifted abroad (\( \eta = 1. \)) We set the informal sector income to 50% of the
formal sector wage of unskilled workers. The elasticity of the matching function
is set to \( \gamma = 0.5 \) as in Petrongolo and Pissarides (2001). The productivity of the
matching function is set to \( \bar{m} = 7.6. \)

\(^{20}\) Hence our labor endowment accounts for 82.5% of the total labor force (ADD SOURCE).
The bargaining power of the worker is set to $\mu = 0.5$. Iceberg trade costs are all set to 1. Finally, we set the world price of manufacturing goods $P^F_2$ as the numeraire.

[Table 1 about here.]

5.2 Calibration results

Our model fits the matched moments very well as can be seen from table 1. The implied entry costs for maquiladoras are 3.3 times larger than for manufacturing firms. The implied exporter size premium in the manufacturing sector is 48.5% in our model is smaller than the observed one (62% in the actual data). Our model predicts that maquiladoras are on average 4% more productive than standard manufacturing firms serving only the domestic market. Also, manufacturing exporters are 25% more productive than maquiladoras. To validate our model, we can compare unmatched moments of the data to the moments implied by our calibrated parameters. As can be seen from table 2, our model predicts well the share of maquila production in total GDP. The informal sector share in GDP is a bit more off the mark but is still reasonably matched. Our model fails, however, to match the large employment share of maquila in total manufacturing employment.

[Table 2 about here.]

6 Comparative statics results

In order to shed more light on the behavior of our model, we simulate it in order to understand the comparative statics of some key exogenous parameters. IN THE FINAL VERSION, COMPARATIVE STATICS WILL BE DONE WITH THE CALIBRATED MODEL. In order to obtain analytical results, we would have to simplify our model considerably which would preclude a comparison with the actual Mexican experience. Numerical solutions have gained importance for the analysis of international trade models in recent years, see e.g. Anderson and van Wincoop (2003), Bernard et al. (2004), Bernard et al. (2007), and Helpman and Itskhoki (2010).

For the simulations, we assume that the maquila sector is low-skilled labor intensive ($\beta^L_f = 0.3$, $\beta^K_f = 0.1$), whereas the standard manufacturing sector is high-skilled intensive ($\beta^K_2 = 0.6$). The entry fixed costs are set equal to $f_{ie} = 0.1$ in both sectors. Per period production fixed costs are equal to $f_i = 2$ in both sectors. The ratio of entry fixed costs to exporting fixed costs is 1.93. This implies that approximately 22% of all manufacturing firms export, which is in line with Bernard et al. (2004). Trade costs of the final maquila good are set
to $\tau_1 = 1.5$, for the final manufacturing good $\tau_2 = 1.2$, and for the intermediate good $\tau_I = 1.5$. The price for the intermediate good is set to $w_I = 1$, the relative price of the maquila good vs. the manufacturing good is set equal to 5. We set the informal sector income to 50% of the formal sector wage of unskilled workers. The elasticity of the matching function is set to $\gamma = 0.5$ as in Petrongolo and Pissarides (2001) who we also follow for the other matching parameters. The productivity of the matching function is set to $\bar{m} = 7.6$. The bargaining power of the worker is set to $\mu = 0.5$. Further details can be found in the appendix.

We analyze the effect of different policy changes on welfare:

1. rise in the relative price of the maquila good
2. fall in the profit tax in the maquila sector
3. reduction in the fixed exporting costs in the maquila sector
4. reduction of maquila/intermediate trade costs

Note that in our model, quantities consumed are strictly lower than quantities produced as fixed costs are paid in terms of the final manufacturing good. This implies that only wage income can be used for purchase of final consumption. As we assume homothetic preferences and given that the informal sector income is a lump sum transfer from formal sector workers, the appropriate welfare measure for Mexico in our model is given by

$$W = \frac{w_L L_e + w_K K}{P^H_2}. \quad (6.1)$$

### 6.1 A rise in demand for the maquila good

**Result 1.** A rise in the demand for the maquila good will decrease the informal sector and increase welfare in the home economy. Welfare will be unambiguously higher in an economy with an informal sector than in an economy where the informal sector is shut down.

[Figure 5 about here.]

[Figure 6 about here.]

As can be seen in figure 5, an exogenous rise in the demand for the final maquila good will increase the share of maquila exports of total exports, and decrease the relative wage. As the maquila sector is low-skilled labor-intensive, this result is as expected and moves along standard Stolper-Samuelson arguments. In addition, the informal sector decreases as more low-skilled labor vacancies are posted by maquila firms. Also domestic welfare increases. We then resimulate the model without any labor market rigidities, i.e. we shut down the informal sector.
sector and compare the factor incomes in both scenarios, see figure 6. All other
parameter settings remain equal. For all demand levels of the final maquila
good, welfare will be higher in the economy with an informal sector. A higher
demand of the maquila good increases relative demand for low-skilled workers as the
maquila sector is low-skilled intensive. This props up wages for low-skilled
workers. What is more, low-skilled workers have to be offered a higher wage. If
the wage paid in the formal sector is too low, workers will opt out of the bar-
gaining and start a business in the informal sector. This threat of the exit option
forces employers to pay more to their employees. This reduces profits. As the
increase in the maquila sector will also increase profits transferred abroad, the
threat of the exit option will leave more factor income in the domestic economy
and directly increase welfare. When the informal sector is shut down, workers
cannot use informal sector employment as a threat during the bargaining pro-
cess. In a perfectly competitive labor market, workers have no bargaining power
and are simply paid their marginal value product. This implies higher profits
for the foreign-owned companies. Hence, workers do not profit as much from
the increase in the final maquila good price as in the model economy with an
informal sector.

6.2 A reduction in the profit tax in the maquila sector
to be added

6.3 A fall in exporting fixed costs in the maquila sec-
tor

Result 2. A fall in the exporting fixed costs in the maquila sector will increase
the informal sector and decrease welfare in the home economy. Welfare will be
unambiguously higher in an economy with an informal sector than in an economy
where the informal sector is shut down.

The domestic government may create programs which specifically reduce the
exporting fixed costs in the maquila sector to attract multinational enterprises.
Programs may include simplified customs procedures, a general cut in red tape
or efforts to reduce corruption or increase general efficiency of government agen-
cies. As can be seen in figure 7, a reduction in exporting fixed costs in the
maquila sector decreases welfare. Shutting down the possibility of employment
in the informal sector, we again resimulate the model. Comparing both model
economies with the same parameter values, again welfare is higher across all con-
sidered values of exporting fixed costs in the economy with the informal sector.
A reduction in exporting fixed costs in the maquila sector increases the size of
the maquila sector and increases profits for multinational enterprises operating
there. As profits are going abroad, less income remains in the home economy, overall consumption is lower and hence domestic welfare. Again the possibility of employment in the informal sector is a credible threat of low-skilled workers and therefore preps up their wage. This keeps more profits in the domestic economy and directly leaves more income for domestic consumption directly increasing domestic welfare.

[Figure 7 about here.]

6.4 A differential fall in trade costs in the *maquila* sector

**Result 3.** A differential fall in trade costs for the final *maquila* good will decrease the informal sector and decrease welfare in the home economy. Welfare will be unambiguously higher in an economy with an informal sector than in an economy where the informal sector is shut down.

As can be seen in the left panel of figure 8, a differential fall in trade costs for shipping the final *maquila* good abroad decreases welfare in the home economy. A fall in iceberg trade costs implies that less output has to be produced to ship one unit to consumers in the foreign economy. At the same time, demand for the *maquila* good increases as its goods are cheaper for foreign consumers and the *maquila* sector expands. However, Mexican consumers do not profit from the fall in trade costs as they do not consume the good. What is more, the increase of the *maquila* sector comes at the expense of the standard manufacturing sector. The latter sector is domestically owned, whereas the *maquila* sector is foreign-owned. Hence, the expansion of the *maquila* sector increases the overall amount of profits sent out of the home economy directly decreasing available income for domestic consumption and hence decreasing overall welfare. Thus the home country over-specializes in the production of the *maquila* good. Note also that the fall in trade costs is accompanied by a decrease in the informal sector. Hence, two obvious measures of political success as an increase of multinationals in the *maquila* sector as well as the reduced informal sector would indicate an improvement of domestic welfare. Resimulating the model without the informal sector, we again find that welfare is lower across all considered trade cost values in the economy without the possibility of informal sector employment. The mechanism at work is again the exit option of low-skilled workers which retains more income for consumption in the home economy. The counter-factual fall in informal sector employment in our model simulations compared to the actual experience of Mexico can be rationalized by recognizing countervailing effects of trade liberalization on informality as indicated by Marjit et al. (2007). Their channel of higher corruption due to trade liberalization increases informal employment is
not present in our model. Empirically, it may well be that both effects exactly set off each other leading to the observed pattern of informality. Furthermore, the fall in the informal sector size is very small, contradicting the expected bigger effect of the expansion of *maquilas* on informal sector employment.

[Figure 8 about here.]

**Result 4.** Comparing two model economies with and without an informal sector, welfare will be higher in the economy with the informal sector across all comparative static exercises.

### 7 Robustness checks

#### 7.1 Production in the informal sector

In our model, informal sector workers do not produce a final good. Instead, they rely on the lump sum transfer $bw_L$ from formal sector workers. In a variant of our model, we let informal sector workers produce varieties of the domestically consumed good by setting up informal sector firms as in Krugman (1979). Contrary to the formal manufacturing sector where firms can differ in their productivity, informal sector firms all have the same size and their output is not tradable as exporting would imply adhering to standards and formal sector procedures. There is an endogenous mass of informal sector firms $M_{inf}^2$ which employs all the unmatched workers. There are no profits in the informal sector as the mass of firms adjusts endogenously. This setup allows us to endogenize $1 - b$, the formal sector wage premium.

The production function of an informal sector firm is $q_{inf} = \frac{1}{\phi_{inf}} L$ once fixed costs are paid. $\phi_{inf}$ is an exogenous productivity parameter which is left unrestricted in the model. However, in a well-calibrated model, it should be lower than the average productivity in the standard manufacturing sector to reflect the lower productivity of the informal sector. The less productive the informal sector, the smaller it will become.

Profit-maximizing informal sector firms face a standard Dixit-Stiglitz demand function

$$q_{inf} = p_2^{\sigma - 1}(p_{inf}^2)^{-\sigma} \left( \frac{RS}{M^2_S + \chi_L M^L_S + M_{inf}^2} \right)^{1/\sigma} \quad (7.1)$$

and charge

$$p_{inf}^2 = \frac{\sigma}{\sigma - 1} b \phi_{inf}^2 w_L \quad (7.2)$$
the free entry condition is given by

\[ \frac{p_{2}^{inf} L_{2}^{inf} \phi^{inf}}{\sigma} = f_{2}^{inf} P_{2}^{S} \]  \hspace{1cm} (7.3)

The mass of firms is given by

\[ L_{2}^{inf} M_{2}^{inf} = u \bar{L} \]  \hspace{1cm} (7.4)

The remaining model equations essentially stay the same. The only difference is that \( M_{2}^{inf} \) is added in the price index calculation. As informal sector varieties are not traded, the balance of payment does not change.

### 7.2 Simulation of two country model

In order to check whether our results crucially hinge to the small open economy assumption, we simulate a two-country model. We stick to the assumption that Mexican low-skilled workers can end up in the informal sector whereas labor markets in the US are perfectly competitive and hence low-skilled workers in the US do not have the option of working in the informal sector. As in the small country case, welfare is higher if Mexican low-skilled workers may find a job in the informal sector.\(^{21}\)

### 7.3 Consumption of maquila good

In order to check the robustness of our results, we also simulate our models by allowing consumption of the maquila good also in the home economy. Hence, preferences are given by

\[ U^{H} = (C_{1}^{H})^{\alpha_{1}} (C_{2}^{H})^{\alpha_{2}} \]  \hspace{1cm} (7.5)

with \( \alpha_{1} + \alpha_{2} = 1. \)

DATA ON MEXICAN CONSUMPTION OF MAQUILA GOODS? to be added...

To see whether our results crucially hinge on the specific form of small country assumption we use, we simulate a two country version of our model where the small economy is characterized by an informal labor market whereas in the large economy, labor markets are perfectly competitive. RESULTS TO BE ADDED

\(^{21}\)Simulation code and results are available from the authors upon request.
8 Conclusion

This paper has investigated the relationship between the rise of the maquila sector in Mexico, its linkages to informal sector employment as well as its broader implications for Mexican welfare. Our simulations of a small open economy with heterogeneous firms and labor market rigidities for low-skilled workers indicate that a reduction in plant set up costs in the maquila sector like a reduction of red tape and other non-tariff barriers to trade and foreign direct investment lead to a decrease in general welfare. Most of the newly created jobs in the intermediate input processing plants sector replace standard manufacturing jobs without inducing a major decrease in informal sector employment. The decline in informality is accompanied by a general decline of welfare. Even though standard measures of political achievement like an increase in overall formal sector employment as well as an increase of foreign-owned plants seem to indicate a positive development of the model economy, welfare actually declines. This is due to XXX, WHAT HAPPENS TO RELATIVE WAGES (W/, W/O informal sector?). Hence, there arises a distributional conflict between high-skilled workers who prefer a stricter stance on informality whereas low-skilled workers prefer a two-tier labor market. Our results suggest that the presence of a large informal sector is not necessarily detrimental to general welfare in an economy, at least given the level of development and its general production and consumption structure. What is more, the reduction of informality creates a new distributional conflict between high-skilled and low-skilled workers which has been overlooked both in the theoretical literature as well as in policy discussions so far. The results also indicate that labor market rigidities may create intricate choices for policy makers as increasing formal sector employment and restricting access to informal jobs in order to increase tax revenues and payments to pension systems may well be detrimental to voters’ welfare. This highlights the importance of future research on informality to uncover its Janus-faced nature in order to enlighten policy choices faced by emerging economies.

References


A Parameter settings for model simulations

The calibration closely follows Bernard et al. (2007) and on the labor market side Felbermayr et al. (2010).

Parameters for exogenous large foreign country $F$:

- $M_1^F = 10.$
- $M_2^F = 10.$
- $X_1^F = 0.3.$
- $X_2^F = 0.3.$
- $A_1^F = 0.5.$
- $A_2^F = 0.5.$
- $B_1^F = 0.8.$
- $B_2^F = 0.8.$
- $p_1^F = 1.$
- $p_2^F = 1.$

General parameters:

- $N = 1$, denoted in the subsequent with superscript $H$ (for home country).
- $f_1^H = 0.1.$
- $f_2^H = 0.1.$
- $f_{1e}^H = 2.$
- $f_{2e}^H = 2.$
- $f_{1x}^H = f_1 \times 1.93.$
- $f_{2x}^H = f_2 \times 1.93.$
- $\delta = 0.11.$
- $\tau_1 = [1...0.05...1.6].$
- $\tau_2 = [1...0.05...1.6].$
- $\alpha = 0.5.$
- $\sigma = 3.8.$
- $\varsigma = 1 - 1/\sigma.$

Technological assumptions:

- Good 1 capital-intensive: $\beta_1 = 0.6.$
- Good 2 labor-intensive: $\beta_2 = 0.4.$

Assumption about the Pareto distribution:
• $\bar{k} = 0.2$.
• $c = 3.4$.
• $\gamma = c - \sigma + 1$.
• $\xi = c(k^{c-\gamma})/\gamma$.

Job Market parameter assumptions:
• $\bar{c}_l = 0.134$.
• $r = 0.04$.
• $\rho = 0.3$.
• $s = \rho + \delta - \rho\delta$.
• $\mu = 0.5$.
• $\bar{m} = 7.6$.
• $\gamma_m = 0.5$.
• $b = 0.4$.

Factor endowments are assumed as follows:
• $L^H = 1000$.
• $K^H = 1200$.

B Equations used for calibration

Productivity cutoffs, entry and exit:

$$\lambda^H_1 = 1 \quad (B.1)$$

$$\lambda^H_2 = \tau_2 \left( \frac{p^H_2}{p^H_2} \right) \left( \frac{(1-\tau)R^H_2}{M^H_2 + \chi_2^H \frac{M^F_2}{M^H_2}} \right)^{\frac{1}{\sigma-1}}.$$ 

$$\varphi^s_{1d} = \left( f^H_1 + f^H_{1x} (\lambda^H_1)^{-c} \right)^{\frac{1}{2}} \left( \frac{1}{f^H_{1x}} \right)^{\frac{1}{2}} \left( \frac{1+r}{r+\delta} \right) \left( \frac{c}{\gamma} - 1 \right) k^{c} \right)^{\frac{1}{2}}.$$ 

$$\varphi^s_{2d} = \left( f^H_2 + f^H_{2x} (\lambda^H_2)^{-c} \right)^{\frac{1}{2}} \left( \frac{1}{f^H_{2x}} \right)^{\frac{1}{2}} \left( \frac{1+r}{r+\delta} \right) \left( \frac{c}{\gamma} - 1 \right) k^{c} \right)^{\frac{1}{2}}.$$ 

$$\varphi^s_{1x} = \lambda^H_1 \varphi^s_{1d}.$$ 

$$\varphi^s_{2x} = \lambda^H_2 \varphi^s_{2d}.$$ 

$$\tilde{\varphi}_{1d} = \left( \frac{a}{\gamma} \right)^{\frac{1}{\sigma-1}} \varphi^H_{1d}.$$ 

$$\tilde{\varphi}_{2d} = \left( \frac{a}{\gamma} \right)^{\frac{1}{\sigma-1}} \varphi^H_{2d}.$$ 

$$\tilde{\varphi}_{1x} = \left( \frac{a}{\gamma} \right)^{\frac{1}{\sigma-1}} \varphi^H_{1x}.$$ 

$$\tilde{\varphi}_{2x} = \left( \frac{a}{\gamma} \right)^{\frac{1}{\sigma-1}} \varphi^H_{2x}.$$
• $B_2^H = \left(\frac{q}{\gamma}\right)^{\frac{1}{\gamma-1}} \varphi_{2x}$.

Prices and expenditure:

• \[
\left(\frac{1-\delta}{\tau+\delta}\right) p_H^1 \phi_1^H \left( L_{1d}^H \right)^{1-\beta_1} \left( K_{1d}^H \right)^{\beta_1} \left( 1 - \beta_1 \left( \frac{\sigma-1}{\sigma} \right) - (1 - \beta_1) \left( \frac{\sigma-1}{\sigma + \beta_1 \mu - \mu \beta_1 \sigma \mu} \right) \right) = \\
\left(\frac{\phi_1^H}{\varphi_1^H}\right)^{\sigma-1} \left(\frac{1+\tau}{\tau+\delta}\right) f_1^H \Phi_H^1.
\]

• \[
\left(\frac{1-\delta}{\tau+\delta}\right) p_H^2 \phi_2^H \left( L_{2d}^H \right)^{1-\beta_2} \left( K_{2d}^H \right)^{\beta_2} \left( 1 - \beta_2 \left( \frac{\sigma-1}{\sigma} \right) - (1 - \beta_2) \left( \frac{\sigma-1}{\sigma + \beta_2 \mu - \mu \beta_2 \sigma \mu} \right) \right) = \\
\left(\frac{\phi_2^H}{\varphi_2^H}\right)^{\sigma-1} \left(\frac{1+\tau}{\tau+\delta}\right) f_2^H \Phi_H^2.
\]

• $I_{1x}^H = L_{1d}^H$.

• $I_{2x}^H = \left(\frac{\phi_2^H}{B_{2x}^H}\right)^{\sigma-1} \tau_1 \left(\frac{1-\alpha R^F}{M_1^H + \chi_1^H M_1^F} \right) \left(\frac{p_H^F}{p_F^H}\right)^{\sigma-1} L_{2d}^H$.

• $K_{1x}^H = \left(\frac{\phi_2^H}{B_{2x}^H}\right)^{\sigma-1} \tau_1 \left(\frac{M_1^F + \chi_1^H M_1^F}{M_1^H + \chi_1^H M_1^F} \right) \left(\frac{p_H^F}{p_F^H}\right)^{\sigma-1} K_{1d}^H$.

• $K_{2x}^H = \left(\frac{\phi_2^H}{B_{2x}^H}\right)^{\sigma-1} \tau_2 \left(\frac{M_2^F + \chi_2^H M_2^F}{M_2^H + \chi_2^H M_2^F} \right) \left(\frac{p_H^F}{p_F^H}\right)^{\sigma-1} K_{2d}^H$.

• $M_1^H = \frac{L_{1d}^H}{\tau+\delta P_{1d}^H}$.

• $M_2^H = \frac{L_{1d}^H}{\tau+\delta P_{1d}^H}$.

Trade balance:

\[
0 = \left(\frac{\Phi_1^F}{B_1^F \Phi_1^F}\right)^{1-\sigma} \tau_1 \left(\frac{1-\alpha R^H}{M_1^H + \chi_1^H M_1^F} \right) \left(\frac{p_H^F}{p_F^H}\right)^{\sigma-1} \frac{R^H}{M_1^H + \chi_1^H M_1^F} \chi_1^H M_1^F \\
+ \left(\frac{\Phi_2^F}{B_2^F \Phi_2^F}\right)^{1-\sigma} \tau_2 \left(\frac{1-\alpha R^H}{M_2^H + \chi_2^H M_2^F} \right) \left(\frac{p_H^F}{p_F^H}\right)^{\sigma-1} \frac{R^H}{M_2^H + \chi_2^H M_2^F} \chi_2^H M_2^F \\
- \left(\frac{\Phi_1^F}{B_1^F \Phi_1^F}\right)^{1-\sigma} \tau_1 \left(\frac{1-\alpha R^F}{M_1^H + \chi_1^H M_1^F} \right) \left(\frac{p_F^F}{p_F^H}\right)^{\sigma-1} \frac{R^F}{M_1^H + \chi_1^H M_1^F} \chi_1^H M_1^H \\
- \left(\frac{\Phi_2^F}{B_2^F \Phi_2^F}\right)^{1-\sigma} \tau_2 \left(\frac{1-\alpha R^F}{M_2^H + \chi_2^H M_2^F} \right) \left(\frac{p_F^F}{p_F^H}\right)^{\sigma-1} \frac{R^F}{M_2^H + \chi_2^H M_2^F} \chi_2^H M_2^H \\
+ \eta \Pi^1 + \tau_1 w_1 (I_{1}^H + I_{2}^H)
\]

Hence, in the trade balance, entry fixed costs of maquilas enter the domestic economy and are balanced by the outflow of profits.

• $\theta = \frac{1-\delta}{c} \left[ \frac{(1-b)(1-\mu)}{\mu} w_L^H - \left( \frac{\tau+\delta}{1-\delta} \right) \frac{c}{m} \right]$. 

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Figure 1: Value of *maquila* production, 1990-2004

(source: INEGI)
Figure 2: Share of manufacturing output of total GDP, 1980-2006

source: INEGI Relative share of maquila output of total manufacturing output, 1990-2004
Figure 3: Share of intermediate input use in the *maquila* industry, 1990-2004

Source: INEGI
Figure 4: Informal sector employment share and educational attainment, 1987-2002

The left panel shows the share of informal workers of the population between age 25 and 60 using the ENEU (Encuesta Nacional de Empleo Urbano). The right panel shows the share of informal workers with different education levels.

Source: Binelli and Attanasio (2010)
Figure 5: Comparative statics of demand in the *maquila* sector

- Share of labor force
- Demand for maquila good in foreign informal sector
- Real factor income
- Welfare
Figure 6: Comparative statics of demand in the *maquila* sector
Figure 7: Comparative statics of exporting fixed costs in the maquila sector
Figure 8: Comparative statics of trade costs for the final maquila good
<table>
<thead>
<tr>
<th>parameter</th>
<th>statistic to match</th>
<th>data</th>
<th>model</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_{x2}$</td>
<td>share of exporters, mfg.</td>
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<td>0.389</td>
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<td>$f_2$</td>
<td>mean plant size, mfg.</td>
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<td>214</td>
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<td>$f_{e1}$</td>
<td>aggregate trade openness</td>
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<td>$f_1$</td>
<td>mean plant size, <em>maquila</em></td>
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<td>371</td>
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<tr>
<td>$p_1^F$</td>
<td>share of <em>maquila</em> exports in total exports</td>
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<td>$c$</td>
<td>yearly transition rate informal $\rightarrow$ formal</td>
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<td>0.210</td>
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<td>$\bar{m}$</td>
<td>share of informal workers</td>
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Table 1: Calibration Results
<table>
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<tr>
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<tbody>
<tr>
<td>maquila share of GDP</td>
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<td>informal sector share of GDP</td>
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<tr>
<td>maquila share of employment</td>
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<td>0.084</td>
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Table 2: Comparison of unmatched moments and data