The Impact of Trade Margins on the Skill Premium: Evidence from Mexico*

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Abstract

This paper formulates a static applied general equilibrium model of a small open economy and then calibrates it to the Mexican input-output matrix for 1987. We use the calibrated model to quantify how much of the dramatic rise in the skill premium over the period 1987-1994, following the liberalization of the trade policy in Mexico, can be accounted for by the change in the extensive margin of trade or trade variety. Our numerical experiments show that the increase in the extensive margin of Mexican manufactured trade with the U.S. can account for up to approximately 12 percent of the actual increase in skill premium in Mexico from 1987 to 1994.

Keywords: Trade liberalization, Trade variety, Skill premium, Applied general equilibrium, Mexico

JEL Classifications: F12, F16

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1 Introduction

Mexico started to liberalize its trade policy in 1985 as it prepared to join the General Agreement on Tariffs and Trade (GATT) in 1986. As a result, trade barriers were substantially reduced in Mexico. The maximum tariff rate fell drastically from 100 percent in 1985 to 20 percent in 1988, and the (production-weighted) average tariff rate fell from 23.5 percent to 11 percent (Tornell and Esquivel, 1997). This trade liberalization was associated with a dramatic increase in the relative wage of high-skilled to low-skilled workers—the skill premium—in Mexico as shown in Figure 1.[1] Further, it was also associated with an increase in the extensive margin of trade, or trade variety, between Mexico and the U.S. (e.g., see Table 3 in Kehoe and Ruhl, 2013). These two facts suggest that the increased extensive margin of Mexican trade with the U.S. might have contributed to the increased skill premium following the trade liberalization in Mexico.

In fact, extending Ethier's (1982) model of variety trade in intermediate goods, Kurokawa (2006, 2011) has shown that an increase in the extensive margin of trade can be a factor for an increase in the skill premium.[2] While many studies have quantitatively or empirically examined the effect of trade on the skill premium, no studies have quantified how much of the increase in skill premium is accounted for by the increase in the extensive margin of trade.[3] This paper fills this void by formulating a static applied general equilibrium (GE) model of a small open economy and calibrating it to Mexican data for 1987 to quantify how much of the dramatic increase in the skill premium over the period 1987-1994, following the trade liberalization in Mexico, can be accounted for by the increase in the extensive margin of Mexican manufactured trade with the U.S.[4] The choice of the year 1987 is due to data

[1] The data for the Mexican skill premium is from the *Encuesta Industrial Mensual* (EIM) [Mexican Monthly Industrial Survey] conducted by the *Instituto Nacional de Estadística Geografía e Informática* (INEGI). Here, we use non-production and production workers as an index for high-skilled and low-skilled workers (Berman et al., 1994; Robertson, 2004). We calculate the Mexican relative wage by first calculating the monthly income per person of non-production relative to production labor. The annual average is then produced by averaging this monthly relative wage. Note that since the value data are available only from 1987, the data before 1987 are constructed by using the index data corresponding to the value data as suggested by Timothy Kehoe.

[2] Ethier's (1982) model is an intermediate-good version of Krugman's (1979) model of variety trade in final goods. It shows that the increased variety of intermediate goods translates into the higher productivity of final goods.

[3] Although Kurokawa (2006, 2011) has provided several numerical examples to show that the variety-skill complementarity mechanism can be potentially important, it does not undertake a comprehensive quantitative analysis since its purpose is to use a simple model to highlight the existence of such a mechanism. Recently, based on Kurokawa (2006, 2011), Foster-McGregor and Stehrer (2014) also test the effects of changes in trade variety on the skill premium, particularly high- versus medium- versus low-skilled wages, in the Central and Eastern European Countries (CEECs) using regressions.

[4] Here, applied GE analysis is defined to be the numerical implementation of GE models calibrated to data whose source is usually an input-output matrix: An applied GE model is a computer representation of a national economy or a group of national economies, each of which consists of consumers, producers, and possibly a government. The model's people make many of the same sorts of transactions as do their counterparts in the world (Kehoe and Kehoe, 1994; Kehoe and Prescott, 1995). For example, Kehoe et al. (1984) use a static applied GE model for the Mexican economy like this paper. Kehoe et al. (1988) and Kehoe et al. (1995) use it for the Spanish economy.

constraint. Fortunately, however, this is not a serious limitation because Mexico acceded to the GATT in 1986 and signed a framework agreement on trade and investment with the U.S. in 1987.

We consider a small open economy with three sectors—primaries, manufactures, and services. While primaries and services are produced under constant returns and perfect competition, manufactures are differentiated goods produced under increasing returns and monopolistic competition. The production of each good uses high- and low-skilled workers, primaries, services, and a variety of manufactures. The technology in each sector displays the variety-skill complementarity: an increase in the variety of manufactured goods raises the marginal products of both high- and low-skilled labor; however, the former rises disproportionately more than the latter if the varieties and high-skilled workers are complements (if more productive firms demand more high-skilled workers).[5] Primaries and manufactures are traded goods, while services are non-traded. An increase in the variety of manufactured goods thus comes from an increase in the numbers of imported varieties and/or domestically produced exported varieties. A representative consumer with homothetic preferences consumes these primaries, manufactures, and services.

We calibrate our theoretical model to the Mexican input-output matrix for 1987. There are two important features of this matrix that our model allows us to capture. First, it is possible in the model to account for the fact that much of output is services that are non-traded. Second, the model can be calibrated to allow for the fact that trade is not balanced in the data. In this calibrated model, we conduct numerical experiments to see how much of the increase in Mexican skill premium, following trade liberalization, can be accounted for by the increase in the extensive margin of Mexican manufactured trade with the U.S.

The increase in the extensive margin of trade is measured by the increase in the number of traded goods. In this paper, we define traded/non-traded goods in two alternative ways. The first way uses Kehoe and Ruhl's (2013) definition of traded/non-traded goods. They define non-traded goods by the "least traded goods", the set of goods with the least trade that accounts for only 10 percent of trade. In the first case, the goods that are not included in the list of least traded goods (non-traded goods) are counted as traded goods.

Kehoe and Ruhl's (2013) method for measuring non-traded goods is different from fixed-cutoff methods used in the few previous studies of the extensive margin. Hummels and Klenow (2005) and Broda and Weinstein (2006), for example, classify a good as not traded if the value of trade is zero, and Evenett and Venables (2002) classify a good as not traded if its yearly value of trade is less than or equal to 50,000 1985 U.S. dollars, regardless of

[5]Kurokawa (2006, 2011) formalizes the hypothesis of variety-skill complementarity. Dinopoulos et al. (2009) also link variety trade to wage inequality. Their model, however, modifies the standard one-sector variety-trade model by introducing quasi-homothetic preferences for varieties and non-homothetic technology in the production of each variety, thus relating an increase in the output of each variety—not an increase in the number of variety—to an increase in the relative demand for high-skilled labor by each variety (output-skill complementarity).

the country to be studied.[6] In Kehoe and Ruhl's definition of a non-traded good, on the other hand, goods with very small but non-zero amounts of trade can also be considered, and the actual dollar value of the 10 percent cutoff can differ across countries. Thus non-traded goods in a country are determined based on the relative importance of goods in the country's trade.[7]

Our second way of defining traded/non-traded goods uses a fixed cutoff value like Hummels and Klenow (2005), Broda and Weinstein (2006), and Evenett and Venables (2002). We use the U.S. dollar value of the marginally non-traded good at 10 percent cutoff for 1987 as the fixed cutoff. Then, the goods whose yearly trade value in 1987 U.S. dollar is more than the fixed cutoff value are counted as traded goods in our second case.

Figure 1 plots the 1980-2000 data on the skill premium in Mexican manufacturing industries. As can be seen, the Mexican skill premium was drastically increasing after Mexico joined the GATT in 1986, and it became stable (with a slight decrease) after the North American Free Trade Agreement (NAFTA) was enacted in 1994.[8] Since our interest is in the impact on the rising skill premium, our numerical experiments will focus on the period 1987-1994, when the skill premium was drastically increasing.[9] Specifically, we assess how much of the increase in Mexican skill premium can be accounted for by the increase in the extensive margin of Mexican manufactured trade with the U.S. over that period.

Our numerical experiments show that in the calibrated model, if the numbers of imported varieties and domestically produced exported varieties increase according to the data, the skill premium can increase by up to approximately 4 percent in the first case, where the number of traded goods is counted by the number of goods that are not included in the least traded goods. It can increase by up to approximately 5 percent in the second case, where the number of traded goods is counted by the number of goods whose yearly trade value in 1987 U.S. dollar is more than the fixed cutoff value. On the other hand, the data show that Mexican skill premium increased from 2.021 to 2.899 over 1987-1994, which is a 43.4 percent increase. Thus the results indicate that the increase in the extensive margin of Mexican manufactured trade with the U.S. can account for up to approximately 12 percent of the actual change in Mexican skill premium over 1987-1994, which is shown in the second

[6] According to Kehoe and Ruhl (2013), there is no absolute concept of zero in trade statistics. For example, export shipments from the U.S. (import shipments to the U.S.) are, in general, required to be reported only if the value of the shipment is greater than 2,500 U.S. dollars (2,000 U.S. dollars). A good could have trade with a number of shipments smaller than this limit and be reported as having zero trade. The minimum reporting level tends to vary across countries.

[7] This country-variant method by Kehoe and Ruhl has been widely used. Mukerji (2009) and Sandrey and van Seventer (2004), for example, use the method to measure the extensive margin of trade as does our paper.

[8] Esquivel and Rodríguez-López (2003) also show the same movements of Mexican wages. Robertson (2004), using the Mexican Industrial Census data, argues that the Mexican skill premium declined from 1994 to 1998.

[9] Note that the variety-skill complementarity can be also compatible with the 1994-2000 data in that the skill premium did not show an increasing trend when trade variety did not show an increasing trend during the period 1994-2000.

case. We, therefore, illustrate that the extensive margin of manufactured trade is possibly a channel significantly contributing to the increase in wage inequality in Mexico following trade liberalization.[10]

It is worth noting that one of the most salient characteristics of the Mexican economy is *maquiladoras*. This export-processing sector imports intermediate inputs and then assembles them into final goods in a similar way as modeled in this paper. In fact, our results are compatible with the observations in *maquiladoras* emphasized by Feenstra and Hanson (1997): both the imports from the U.S. and the demand for high-skilled workers increased in *maquiladoras*.[11] It is also worth emphasizing that the key mechanism driving our results is the assumption of variety-skill complementarity. If the variety of intermediate goods is interpreted as the variety of tasks as in task-based models (e.g., Mitchell, 2005; Grossman and Rossi-Hansberg, 2008; Acemoglu and Autor, 2010), this assumption can mean that an increase in task variety increases the relative demand for higher-skilled workers, which is compatible with the data on Stanford business school alumni and Denmark's registry data. Using data on Stanford business school alumni, Lazear (2005, 2012) empirically confirmed that leaders (who would be high-skilled workers) are generalists who are competent in many skills. Using Denmark's registry data, Frederiksen and Kato (2011) empirically confirmed that broadening the scope of human capital by becoming a generalist is advantageous for career success.

Of course, there are several studies that quantitatively or empirically examine the changes in the skill premium following trade liberalization. One set of studies use a calibrated model (e.g., Atolia, 2007; Riaño, 2009; Burstein and Vogel, 2010; Burstein et al., 2013; Cho and Díaz, 2013; Waddle, 2015). Another set of studies use regressions (e.g., Borjas and Ramey, 1994; Cragg and Epelbaum, 1996; Feenstra and Hanson, 1996; Revenga, 1997; Hanson and Harrison, 1999; Harrigan and Balaban, 1999; Feliciano, 2001; Robertson, 2004; Zhu and Trefler, 2005; Verhoogen, 2008).[12]

In this line of studies, our paper makes the following contributions to the literature.

[10] It should be noted that here we look at Mexican trade with the U.S. alone. Our results, however, would be little changed even if Mexican trade with other trade partners of Mexico is also included. This is because Mexico's principal trade partner is by far the U.S., which in 1994 supplied 69 percent of Mexico's imports and attracted 85 percent of its exports. In 1994, Japan provided 6 percent of Mexico's imports, Germany 4 percent, Canada 2 percent, and France 2 percent. Canada was the second largest destination for Mexican products, accounting for 2 percent of exports. Outside the NAFTA, no individual country absorbed more than 2 percent of total Mexican exports.

[11] Of course, low-skilled workers would be used more intensively than high-skilled workers in *maquiladoras*, but it is still possible that the demand for high-skilled workers increases more than that for low-skilled workers. In fact, our experiments successfully capture both features. Note also that Amiti and Cameron (2012) show evidence for Indonesia that reducing input tariffs reduces the skill premium within firms that import their intermediate inputs.

[12] There are also many studies that quantitatively or empirically test the effect of skill-biased technological change on the skill premium. One set uses a calibrated model (e.g., Krusell et al., 2000); another uses regressions (e.g., Berman et al., 1994; Berman et al., 1998). There are also studies that test the relative effect of trade liberalization versus technological change within a unified framework. One set uses a calibrated model (e.g., Parro, 2013); another uses regressions (e.g., Feenstra and Hanson, 1999; Esquivel and Rodríguez-López, 2003).

First, while applied GE models have been used in trade studies, in particular, for analyses of the impact of the NAFTA (e.g., Robinson et al., 1993; Taylor et al., 1999; Kehoe, 2005; Francois and Shiells, 1994), to the best of our knowledge our paper is a first application to the analysis of trade and wage inequality.[13] Second, our paper makes a contribution to the extensive margin of trade literature. While the extensive margin of trade has recently been proven useful in understanding firm-level export patterns (Melitz, 2003), our paper now quantifies the possible importance of the extensive margin of trade in understanding the increase in skill premium.

Third, our paper is closely related to Atolia (2007), Riaño (2009), Burstein et al. (2013), Parro (2013), and Waddle (2015), who link an increase in imports of capital goods or technology to an increase in the skill premium through complementarity.[14] Particularly, like this paper, Riaño (2009) and Waddle (2015) focus on the increase in Mexican skill premium since the late 1980s. While our paper and these five papers are similar in that trade increases the skill premium by increasing the demand of an input that is complimentary to high-skilled workers[15], trade in capital goods or technology does not increase on the extensive margin in these papers while trade in manufactured goods does in our paper. Hence, our paper is complementary to these papers. Finally, as pointed out by Voigtländer (2014), previous empirical studies have ignored an intersectoral technology-skill complementarity. Our paper, however, indicates that technological change in the U.S. manufacturing sector that increases the number of varieties produced there can increase skill demand in the Mexican primary and service sectors through trade in manufactured intermediate varieties.[16]

The rest of this paper is organized as follows. In Section 2, we formulate our static applied GE model. Section 3 calibrates the model to the Mexican input-output matrix for 1987. Using the calibrated model, we present our numerical experiments in Section 4. Finally, Section 5 summarizes main results and mentions future research.

2 The Model

Consider a small-open economy with three types of goods, a primary good that is traded and homogeneous, a variety of manufactured goods that are traded and differentiated by

[13] Recently, Cho and Díaz (2013) also use an applied GE model to analyze the effect of trade integration on the decrease in Slovenian skill premium. See de Melo (1988) for a survey of applied GE models designed to quantify the implications of trade policy in developing countries.

[14] Unlike other papers, Atolia (2007) distinguishes the short-run and long-run effects and shows that trade liberalization could result in the *short-run* rise in skill premium in Latin America through capital-skill complementarity. See also Robbins (1996) for discussions on increased skill premium in Latin America.

[15] This mechanism was documented by Kurokawa (2006).

[16] This is also related to Keller's (2002a) model, which demonstrates that technology is transmitted to other industries internationally through trade in differentiated intermediate goods.

the firm that produces them, and a service good that is homogeneous and non-traded.[17,18] The varieties of manufactured goods are combined to produce a composite manufactured good. The endowment of high-skilled labor and low-skilled labor is H and L.

A representative consumer in the country solves the problem of maximizing

$$\beta_p \log c_p + \beta_m \log c_m + \beta_s \log c_s, \tag{1}$$

subject to[19]

$$\begin{aligned} q_p c_p + q_m c_m + q_s c_s &\leq w_H H + w_L L, \\ c_p, c_m, c_s &\geq 0. \end{aligned} \tag{2}$$

Here, c_p is the consumption of the primary good and q_p is its price; c_m is the consumption of the composite manufactured good and q_m is its price; c_s is the consumption of the service good and q_s is its price; and w_H and w_L are the wages for the high- and the low-skilled labor. The composite manufactured good is a CES aggregate of different varieties given by

$$c_m = \left(\int_{D^w} (c_{mz})^{\rho} dz \right)^{\frac{1}{\rho}}, \tag{3}$$

where parameter ρ, $\rho < 1$, governs the elasticity of substitution, $1/(1-\rho)$, between any two differentiated varieties in the interval $D^w = [0, n + n^*]$ where varieties 0 to n are produced in the country and n to $n+n^*$ are produced in the rest of the world. On the other hand, note that the elasticity of substitution between primaries, services, and composite manufactures is 1. One can show that q_m can be written as an exact consumption-based price index of the prices of individual varieties as follows:

$$q_m = \left[\int_D (q_{mz})^{-\frac{\rho}{1-\rho}} dz + \int_{D^w \setminus D} (q_{mz^*})^{-\frac{\rho}{1-\rho}} dz^* \right]^{-\frac{1-\rho}{\rho}}, \tag{4}$$

where $D = [0, n]$, $D^w \setminus D = [n, n + n^*]$, q_{mz} is the price of domestic variety $z \in D$, and q_{mz^*} the price of imported variety $z^* \in D^w \setminus D$.

Both the primary and the service good are produced according to constant returns

[17] It should be noted that by introducing primary and service goods in the present paper, we have generalized Kurokawa's (2006, 2011) numerical analysis that has only manufactured goods produced by high- and low-skilled labor. In addition, we have also allowed trade in final goods which is absent in Kurokawa's model.

[18] A three-sector model of economy is standard in the trade and open-economy macroeconomics literature. See Agenor and Montiel (2008) for its application to open-economy macroeconomics for developing countries and Buffie (2001) for its application to trade policy in developing countries. Finally, Atolia (2007) also uses a three-sector model to examine the effect of trade liberalization on wage inequality in Latin America.

[19] Note that as will be shown later, we consider the long-run economy where the profit of each firm becomes zero, and thus there is no profit in the consumer's budget.

production functions

$$y_i = \gamma_i \left[a_i \left\{ b_i (x_{m,i})^{\varepsilon} + (1-b_i)(H_i)^{\varepsilon} \right\}^{\frac{\mu}{\varepsilon}} + (1-a_i)(L_i)^{\mu} \right]^{\frac{\alpha_{i1}}{\mu}} (x_{p,i})^{\alpha_{i2}} (x_{s,i})^{\alpha_{i3}}, \qquad i = p, s, \tag{5}$$

where $0 < a_i,\ b_i < 1$, $\gamma_i > 0$, and $0 < \alpha_{ik} < 1$ are sector-specific parameters with $\alpha_{i1} + \alpha_{i2} + \alpha_{i3} = 1$ and $x_{h,i}$ refers to factor h used in sector i. The composite manufactured inputs are

$$x_{m,i} = \left(\int_{D^w} (x_{mz,i})^{\rho} dz \right)^{\frac{1}{\rho}}, \qquad i = p, s. \tag{6}$$

In contrast, the technology for producing manufactured goods exhibits increasing returns to scale because of the presence of fixed costs. Specifically, every manufacturing firm z, $z \in D$, has the production function

$$y_{mz} = \max \left\{ \gamma_m \left[\begin{array}{c} a_m \left\{ b_m (x_{m,mz})^{\varepsilon} + (1-b_m)(H_{mz})^{\varepsilon} \right\}^{\frac{\mu}{\varepsilon}} + \\ (1-a_m)(L_{mz})^{\mu} \end{array} \right]^{\frac{\alpha_{m1}}{\mu}} (x_{p,mz})^{\alpha_{m2}} (x_{s,mz})^{\alpha_{m3}} - F, 0 \right\}, \tag{7}$$

where as in other sectors $0 < a_m,\ b_m < 1$, $\gamma_m > 0$, $0 < \alpha_{mk} < 1$, and $\alpha_{m1} + \alpha_{m2} + \alpha_{m3} = 1$. Also,

$$x_{m,mz} = \left(\int_{D^w} \left(x_{mz',mz} \right)^{\rho} dz' \right)^{\frac{1}{\rho}}, \tag{8}$$

and $F > 0$ is the level of fixed costs in terms of output.

Thus, in each sector, production requires primaries, services, and a composite good as inputs. The composite input is produced by combining the manufactured good, high-skilled labor, and low-skilled labor with a nested-CES technology, where substitution parameters ε and μ are the same across all sectors. The nested-CES specification allows us to introduce variety-skill complementarity in production in the most natural and parsimonious manner. This is achieved by setting $\varepsilon < \mu$ which makes the varieties of manufactured goods relatively more complementary to high-skilled labor than to low-skilled one.[20]

First, we solve the consumer's problem. Then the demand by the consumer in the country for the domestic variety $z \in D$ and the foreign variety $z^* \in D^w \backslash D$ is:

$$c_{mz} = \left(\frac{q_{mz}}{q_m} \right)^{-\frac{1}{1-\rho}} \frac{\beta_m (w_H H + w_L L)}{q_m}, \qquad z \in D, \tag{9}$$

$$c_{mz^*} = \left(\frac{q_{mz^*}}{q_m} \right)^{-\frac{1}{1-\rho}} \frac{\beta_m (w_H H + w_L L)}{q_m}, \qquad z^* \in D^w \backslash D. \tag{10}$$

[20] Note again that Kurokawa (2006, 2011) formalizes the hypothesis of variety-skill complementarity. The number of inputs plays a related role in the O-ring model of Kremer (1993), which shows that higher skill workers will use more complex technologies that incorporate more inputs. Blanchard and Kremer (1997) define the index of complexity that relates the increased number of inputs to more complexity in production processes.

Thus the demand by the consumer in the country for a variety varies with price with elasticity $-1/(1-\rho)$. Following the standard practice in the small open economy literature with imperfect competition (e.g., Venables, 1982; Sen et al., 1997; Chakraborty, 2001; Ghosh and Sen, 2012), we assume that the price and the number of foreign varieties are exogenously given. Deriving the demands for the primary and service goods and the composite manufactured good is standard and has been relegated to the Supplementary Appendix.

Next, we solve firm z's problem. Let $\tilde{c}_{mz}(q_m, w_H, w_L, q_p, q_s; y_{mz}+F)$ be the solution to the cost minimization problem for manufacturing firm z. As the manufacturing sector produces output using a nested-CES technology with primaries, services, and a composite input made from manufactured good, high-skilled labor, and low-skilled labor as inputs, the cost function can be written in terms of the sub-cost functions as follows:

$$\tilde{c}_{mz}\left(q_m, w_H, w_L, q_p, q_s; y_{mz}+F\right) = \frac{1}{\gamma_m}\left(\frac{\tilde{c}_{A,m}}{\alpha_{m1}}\right)^{\alpha_{m1}}\left(\frac{q_p}{\alpha_{m2}}\right)^{\alpha_{m2}}\left(\frac{q_s}{\alpha_{m3}}\right)^{\alpha_{m3}}\begin{bmatrix} y_{mz} \\ +F \end{bmatrix}, \quad (11)$$

where $z \in D = [0, n]$ and the sub-cost functions are

$$\tilde{c}_{A,m}\left(q_m, w_H, w_L\right) = \left[a_m^{\frac{1}{1-\mu}}\tilde{c}_{B,m}\left(q_m, w_H\right)^{-\frac{\mu}{1-\mu}} + \left(1-a_m\right)^{\frac{1}{1-\mu}}\left(w_L\right)^{-\frac{\mu}{1-\mu}}\right]^{-\frac{1-\mu}{\mu}}, \quad (12)$$

$$\tilde{c}_{B,m}\left(q_m, w_H\right) = \left[b_m^{\frac{1}{1-\varepsilon}}\left(q_m\right)^{-\frac{\varepsilon}{1-\varepsilon}} + \left(1-b_m\right)^{\frac{1}{1-\varepsilon}}\left(w_H\right)^{-\frac{\varepsilon}{1-\varepsilon}}\right]^{-\frac{1-\varepsilon}{\varepsilon}}. \quad (13)$$

Thus we can write $\tilde{c}_{mz}(.)$ as a linear function of $y_{mz}+F$:

$$\tilde{c}_{mz}\left(q_m, w_H, w_L, q_p, q_s; y_{mz}+F\right) = G\left(y_{mz}+F\right), \qquad z \in D, \quad (14)$$

where $G > 0$ is independent of firm's choices. The profit maximization for domestic firm $z \in D$ implies the mark-up pricing rule:

$$q_{mz} = \frac{G}{\rho}, \qquad z \in D. \quad (15)$$

Further, by the zero profit condition for this q_{mz}:

$$\pi_{mz} = \frac{G}{\rho}y_{mz} - G\left(y_{mz}+F\right) = 0, \quad (16)$$

we obtain

$$y_{mz} = \frac{\rho}{1-\rho}F, \qquad z \in D. \quad (17)$$

Solving the problems for the primary and service sectors and deriving the input demands using Shephard's lemma are standard and have been relegated to the Supplementary Appendix. The definition of an equilibrium for this small open economy is also shown in the Supplementary Appendix.

3 Calibration of the Model

We calibrate the model to the input-output matrix for Mexico for the year 1987 to test the ability of the model to account for the rise in skill premium in Mexico over the period 1987-1994. The choice of 1987 comes from data constraint on the break-up of the cost share of labor between low- and high-skilled labor. However, this is not a serious limitation since Mexico acceded to the GATT in 1986 and signed a framework agreement on trade and investment with the U.S. in 1987.

3.1 Data

The input-output matrix for Mexico for 1987 is given in the Data Appendix. This matrix contains the information on the factor costs in each sector ($X_{h,i}$) where h stands for the factor and i stands for sector; the value of output for each sector, Y_i; the value of consumption of each good, C_i; the value of net exports, exports, and imports for each sector, NX_i, EX_i, and IM_i. Note that the break-up of the cost share of labor between low-skilled and high-skilled labor for each sector is constructed from data provided by the EIM and also the *Encuesta Nacional de Empleo Urbano* (ENEU) [National Urban Employment Survey] conducted by the INEGI. All of the steps to construct this input-output matrix and the sources of the data are shown in the Data Appendix.

As shown in the matrix, much of output is services that are non-traded, and trade is not balanced in the data. We can also see that the gross value added in each sector equals its factor payments

$$Y_i = \sum_h X_{h,i}, \qquad i = p, m, s, \tag{18}$$

and that the total use of each good equals its net supply

$$\sum_k X_{i,k} + C_i = Y_i + IM_i - EX_i \qquad i = p, m, s. \tag{19}$$

3.2 Calibration

We begin our calibration by choosing the values of the three substitution parameters in the model, ρ, μ, and ε. The parameter ρ governs the elasticity of substitution, $1/(1-\rho)$, among varieties. Recall that the elasticity of substitution between the primaries, the services, and the manufactures is already set to 1. We set $\rho = 19/29$, which means that the elasticity of substitution among varieties, $1/(1-\rho)$, is 2.9. This is in accordance with evidence on the elasticity of substitution across varieties of intermediate goods estimated by Klenow and Rodríguez-Clare (1997).[21]

Parameters ε and μ set the elasticity of substitution between the varieties and high-skilled labor and between the varieties and low-skilled labor, respectively. Due to the

[21] Klenow and Rodríguez-Clare's (1997) estimate, though based on Costa Rican data, is in line with estimates of substitutability in the trade and industrial organization literatures (see Feenstra, 1995).

uncertainty about these elasticities, we set ε and μ as free parameters. Here, as a benchmark case, we choose the elasticity of substitution for high-skilled labor to be 1/2 and for low-skilled labor to be 2. This implies $\varepsilon = -1$ and $\mu = 1/2$. In Section 4.2, we will do an extensive sensitivity analysis for a variety of values of ε and μ and report the range for skill premium rather than a point estimate. Therefore, the choice of benchmark values of these two substitution parameters does not affect the results that we report.

We next calibrate most of the model's parameters to match the input-output matrix for Mexico for 1987. We begin this calibration by setting

$$E = C_p + C_m + C_s. \tag{20}$$

From (2), we have that the consumption expenditure equals the wage income. However, with an eye on calibration to data wherein a country may not have the balanced current account, we allow for net exports (NX) and let E to be given by

$$E = w_H H + w_L L - NX. \tag{21}$$

Accordingly, in the consumer's budget constraint (2) and the demand for each individual variety $(9) - (10)$, $w_H H + w_L L$ is now replaced by $w_H H + w_L L - NX$.

Further, given that there are productivity parameters in the production functions, we can normalize all domestic goods prices to 1, i.e., we set

$$q_p = q_m = q_s = 1. \tag{22}$$

We normalize low-skilled wage to 1 and then calibtare high-skilled wage by using data from the EIM and the ENEU (see the Data Appendix for this calibration). Thus, we set

$$w_L = 1, w_H = 6.18. \tag{23}$$

The calculation of $\beta's$ is straightforward in our case

$$\beta_i = \frac{C_i}{E}, \qquad i = p, s, m. \tag{24}$$

Thus we calibrate values of $\beta's$ by targeting consumption shares of different goods from the input-output matrix in the Data Appendix.

For factor h, define the cost share of that factor in sector i as $\theta_{h,i}$ and denote by $\mathbf{w}_h$ the price of factor $h = p, s, m, L, H$.[22] Then, from the demand functions derived in the Supplementary Appendix, we get

$$\theta_{h,i}\left(q_m, w_H, w_L, q_p, q_s\right) = \frac{\mathbf{w}_h x_{h,i}\left(q_m, w_H, w_L, q_p, q_s\right)}{\tilde{c}_i\left(q_m, w_H, w_L, q_p, q_s\right)}. \tag{25}$$

[22] For example, $\mathbf{w}_m = q_m$, $\mathbf{w}_p = q_p$, and $\mathbf{w}_s = q_s$.

We use these equations and cost shares from the input-output matrix to calibrate the production function parameters $b_i's$ and $a_i's$. In particular, $b_i's$ can be solved from the following equations

$$\frac{\theta_{m,i}}{\theta_{H,i}} = \frac{X_{m,i}}{X_{H,i}}, \qquad i = p, s, mz. \tag{26}$$

Each of these equations has only one unknown, b_i. Note that here we are using the fact that

$$\frac{X_{m,mz}}{X_{H,mz}} = \frac{X_{m,m}}{X_{H,m}}. \tag{27}$$

Similarly, $a_i's$ solve the following equations

$$\frac{\theta_{m,i} + \theta_{H,i}}{\theta_{L,i}} = \frac{X_{m,i} + X_{H,i}}{X_{L,i}}, \qquad i = p, s, mz. \tag{28}$$

The $\alpha_i's$ are easy to calculate as well. α_{i1} is equal to the sum of the cost shares of manufactures, high-skilled and low-skilled labor in each sector. α_{i2} and α_{i3} are the cost share of primaries and the cost share of services in each sector, respectively. Thus, using the input-output matrix, we have

$$\alpha_{i1} = \frac{X_{m,i} + X_{H,i} + X_{L,i}}{Y_i}, \qquad i = p, s, mz, \tag{29}$$

$$\alpha_{i2} = \frac{X_{p,i}}{Y_i}, \qquad i = p, s, mz, \tag{30}$$

$$\alpha_{i3} = \frac{X_{s,i}}{Y_i}, \qquad i = p, s, mz. \tag{31}$$

With $q_p = q_s = 1$, it is easy to calibrate γ_p and γ_s by using the production functions in (5) in which the only remaining unknown is γ_i. Furthermore, the supply of low-skilled and high-skilled labor is calibrated by the factor payments of each labor. Thus, L and H solve the following equations, with $w_L = 1$ and $w_H = 6.18$,

$$w_L L = \textstyle\sum_{i=p,m,s} X_{L,i}, \tag{32}$$

$$w_H H = \textstyle\sum_{i=p,m,s} X_{H,i}. \tag{33}$$

3.2.1 Remaining Calibration

To complete the calibration, we still need to find values for the exogenous variables and parameters for manufactured varieties. For this we begin by imposing symmetry in the manufacturing sector so that the price of all domestic varieties and hence their quantities produced as well as domestically used are all the same. Similarly, the price and quantities used of the imported varieties are the same as well. Let n be the number of domestically produced exported varieties and n^* be the number of imported varieties. Further, let x_{mz} be the quantity of a representative domestic variety that is domestically used and similarly define x_{mz^*}.

Then x_{mz} can be expressed as

$$x_{mz} = \frac{Y_m - EX_m}{nq_{mz}}. \tag{34}$$

Similarly,

$$x_{mz^*} = \frac{IM_m}{n^* q_{mz^*}}. \tag{35}$$

Since varieties are aggregated using a CES aggregator, it is easy to see from (9) – (10) that the relative demand for the domestic and foreign varieties is

$$\frac{x_{mz}}{x_{mz^*}} = \left(\frac{q_{mz}}{q_{mz^*}}\right)^{-\frac{1}{1-\rho}}. \tag{36}$$

Further, we can write the price index of the manufactured good

$$q_m = \left[nq_{mz}^{-\frac{\rho}{1-\rho}} + n^* q_{mz^*}^{-\frac{\rho}{1-\rho}}\right]^{-\frac{1-\rho}{\rho}}, \tag{37}$$

which can be simplified using (34) – (36). For this, we use (34) – (36) to obtain

$$\frac{nq_{mz}x_{mz}}{n^* q_{mz^*} x_{mz^*}} = \frac{n}{n^*}\left(\frac{q_{mz}}{q_{mz^*}}\right)^{-\frac{\rho}{1-\rho}} = \frac{Y_m - EX_m}{IM_m}, \tag{38}$$

which can be used to write (37) as

$$\begin{aligned} q_m &= (n^*)^{-\frac{1-\rho}{\rho}} q_{mz^*} \left[\left\{\frac{n}{n^*}\left(\frac{q_{mz}}{q_{mz^*}}\right)^{-\frac{\rho}{1-\rho}}\right\} + 1\right]^{-\frac{1-\rho}{\rho}} \\ &= (n^*)^{-\frac{1-\rho}{\rho}} q_{mz^*} \left[\frac{Y_m - EX_m}{IM_m} + 1\right]^{-\frac{1-\rho}{\rho}}. \end{aligned} \tag{39}$$

Finally, we impose the normalization

$$n + n^* = 100, \tag{40}$$

and calibrate the ratio of export to import variety in Mexico

$$\frac{n}{n^*}, \tag{41}$$

using data on the ratio of the variety of manufactured exports to that of manufactured imports in Mexico in 1987, which is 91/149. As mentioned in the introduction, here we count the variety of traded goods in 1987 by the number of goods that are not included in what Kehoe and Ruhl (2013) call the least traded goods (non-traded goods).[23] The data is from the Standard International Trade Classification (revision 2) 4-digit manufacturing data provided by the OECD International Trade by Commodities Statistics.

It is possible to solve (15), $(34)-(36)$, and $(39)-(41)$ for calibrated values of q_{mz^*}, γ_m, and n^* and endogenous variables q_{mz}, n, x_{mz}, and x_{mz^*}. Finally, the value of n and the data on production of manufactures allow us to compute y_{mz}, the output of each variety, which then is used to calibrate the value of F using equation (17). In order to complete the calibration of the model, we check the calibration by ensuring that all markets actually clear. The resulting calibration of the model is summarized in Table 1. Table 2 lists the initial equilibrium values of the key variables.

4 Extensive Margin and the Skill Premium

We have calibrated the static applied GE model of a small open economy to the Mexican economy in 1987. As mentioned in the introduction, Mexico started the process of trade liberalization in 1985 and joined the GATT in 1986. This liberalization was followed by both an increase in the skill premium (see Figure 1) and the extensive margin of trade (see Table 3 in Kehoe and Ruhl, 2013) in Mexico. We, therefore, use our calibrated model to quantify how much of the increase in the skill premium over the period 1987-1994, following the trade liberalization in Mexico, can be accounted for by the change in the extensive margin of Mexican manufactured trade with the U.S. In order to do so, we begin by finding out the actual change in the extensive margin of Mexican manufactured trade with the U.S. in the period 1987-1994 and then study its effect on the Mexican skill premium. Note that as mentioned earlier, the choice of period 1987-1994 is partly due to data considerations, but primarily due to the fact that Mexico experienced a rapid and considerable increase in the skill premium during this period.

We measure the increase in the extensive margin of trade over 1987-1994, following trade liberalization, by the increase in the number of traded goods.[24] We define traded/non-traded goods in two alternative ways. The first way is using Kehoe and Ruhl's (2013) definition of traded/non-traded goods. They define non-traded goods by the least traded goods, the set of goods with the least trade that accounts for only 10 percent of trade. We can count the number of traded goods by counting the number of goods that are not included in the least traded goods (non-traded goods). Then, in the Mexican manufactured trade with the U.S. over the period 1987-1994, import variety increased from 149 to 193 (a 29.5 percent increase), and export variety increased from 91 to 99 (an 8.8 percent increase). The second way is using a fixed cutoff value, like Evenett and Venables (2002), etc. We use the U.S.

[23] See Kehoe and Ruhl (2013) for the detailed procedure used to measure the least traded goods.

[24] Keller (2002b) measures domestic and import variety by R&D expenditure data from the Analytical Business Enterprise Research and Development (which are available only from 2000 for Mexico). Klenow and Rodríguez-Clare (1997) measure import variety by the number of countries from which a given product is imported.

dollar value of the marginally non-traded good at 10 percent cutoff for 1987 as the fixed cutoff. We can now count the number of traded goods in 1987 and 1994 by counting the number of goods whose yearly trade value in 1987 U.S. dollar is more than this fixed cutoff value. Then, in the Mexican manufactured trade with the U.S over the same period, import variety increased from 149 to 234 (a 57.0 percent increase), and export variety increased from 91 to 98 (a 7.7 percent increase).

According to the above data, we change both import variety n^* and export variety n but keep constant both import and export quantity per variety. Specifically, we change the exogenous variable n^* as in the Mexican data from 1987 to 1994 and impose the constraint that the endogenous variable n also changes as in the data. We also impose the constraint that both import and export quantity per variety remain unchanged. Thus we can evaluate the pure effect of an increase in the extensive margin of trade over 1987-1994, following trade liberalization, while keeping the intensive margin constant.

Before presenting the results, here we briefly sketch the procedure for solving for the new equilibrium. Under the new value of n^* and the constraint that n also changes as in the data but both import and export quantity per variety remain unchanged, we solve zero profit conditions ($A.14$) for the primary and the service sectors; the profit maximization condition (15) for a representative domestic variety; the price index (37) for the domestic composite manufactured good, q_m; market clearing conditions $(32) - (33)$ for the two types of labor; the market clearing condition for the non-traded service good ($A.1$); and the net export constraint (21) for the new equilibrium values q'_{mz}, q'_s, q'_m, w'_H, w'_L, y'_p, y'_s, and E'. We keep net exports (the balance of trade) in the new equilibrium at the initial level.

4.1 Numerical Experiment - Extensive Margin and the Skill Premium

In this experiment, as mentioned above, we increase trade variety, both import variety n^* and export variety n, as in the Mexican data over 1987-1994, keeping constant both import and export quantity per variety. Thus it is anticipated that the increase in the availability of varieties, $n + n^*$, would raise the demand for the high-skilled labor relative to that of the low-skilled labor since the high-skilled labor is more strongly complementary to varieties than the low-skilled labor. This, in turn, will lead to the rise in the wage of the high-skilled labor relative to that of the low-skilled labor—the skill premium. In other words, the increase in the available number of varieties will lower the price of the composite manufactured input, which in turn will raise the skill premium through the variety-skill complementarity mechanism.

This indeed is the case as shown by the new equilibrium for the year 1994 in Table 2. In the first case, where the number of traded goods is counted by the number of non least traded goods, import variety n^* and export variety n increase by 29.5 percent and 8.8 percent as in the data, respectively. Then total trade variety $n + n^*$ increases by 21.7 percent. The price index of the composite manufactured good q_m falls from 1 to 0.9141. As a result, we can see that the nominal wage of the high-skilled labor w_H increases from 6.18 to 6.3237 and that of the low-skilled labor w_L decreases from 1 to 0.9921. Thus the skill premium w_H/w_L increases from 6.18 to 6.3743, which is a 3.14 percent increase. Note that the real wage of both types of labor increases; in fact, the real wage of the high-skilled labor w_H/q_m increases from 6.18 to 6.9180 and that of the low-skilled labor w_L/q_m also increases from 1 to 1.0853. In the second case, where the number of traded goods is counted by the number of goods whose yearly trade value in 1987 U.S. dollar is more than the fixed cutoff value, the increase in skill premium is larger. The skill premium w_H/w_L increases from 6.18 to 6.4606, which is a 4.54 percent increase.

The effect on the skill premium of the increase in the extensive margin of manufactured trade with the U.S. seems to be small compared to the data. The data show that the Mexican skill premium increased from 2.021 to 2.899 during the period 1987-1994, which is a 43.4 percent increase. Thus, in the first case, the increase in the extensive margin of Mexican manufactured trade with the U.S. accounts for approximately 7.2 percent of the actual change in Mexican skill premium over 1987-1994. In the second case, it accounts for approximately 10.5 percent.

It should be noted that here we have looked at Mexican trade with the U.S. alone. Our results, however, would be little changed even if Mexican trade with other trade partners of Mexico is also included. This is because Mexico's principal trade partner is by far the U.S., which in 1994 supplied 69 percent of Mexico's imports and attracted 85 percent of its exports.

4.2 Sensitivity Analysis

The results obviously depend on the values of the two substitution parameters in the model, ε and μ. We thus do an extensive sensitivity analysis for a variety of values of ε and μ and report the range for skill premium rather than a point estimate.[25] Given the uncertainty about these elasticities, the sensitivity analysis can test the robustness of our quantitative results. It can also provide an estimate of the upper bound on the amount of rise in skill premium in Mexico that can be accounted for by the increase in the extensive margin of Mexican manufactured trade with the U.S. under the assumption of variety-skill complementarity.

Recall that the benchmark numerical experiment in Section 4.1 has set $\varepsilon = -1$ and $\mu = 1/2$. This means that the elasticity of substitution between the varieties and high-skilled labor, $1/(1-\varepsilon)$, is 1/2 and that between the varieties and low-skilled labor, $1/(1-\mu)$, is 2.

Here, we do our sensitivity analysis for two sets of value of ε and μ so that the two elasticities of substitution take extreme values. Table 3 reports the results of the numerical

[25] Harrison et al. (1993) argue that applied GE models should be routinely subject to systematic sensitivity analysis.

experiment in which $\varepsilon = -2$ and $\mu = 2/3$, that is, the elasticity of substitution between the varieties and high-skilled labor is 1/3 and that between the varieties and low-skilled labor is 3. The rise in skill premium is still small but is stronger (a 3.61 percent increase in the first case and a 4.95 percent increase in the second case) compared to the benchmark case (the 3.14 percent increase in the first case and the 4.54 percent increase in the second case). In the first case, we can now account for 8.3 percent of the actual rise in skill premium and, in the second case, for 11.4 percent.

In Table 4, we further increase the difference in the elasticities by letting $\varepsilon = -3$ and $\mu = 3/4$; the elasticity of substitution between the varieties and high-skilled labor is 1/4 and that between the varieties and low-skilled labor is 4. As we can see, the results indicate that the skill premium now increases slightly more (a 3.75 percent increase in the first case and a 5.02 percent increase in the second case). In the first case, we can now account for 8.6 percent of the actual rise in skill premium and, in the second case, for 11.6 percent.

Qualitatively, these results are as expected. A more negative value of ε (a smaller elasticity of substitution between the varieties and high-skilled labor) and a greater value of μ (a greater elasticity of substitution between the varieties and low-skilled labor) are accompanied by a larger increase in skill premium. Quantitatively, however, all of these increases do not make a significant difference in that they are 7.2-8.6 percent of the actual increase of 43.4 percent in the first case and they are 10.5-11.6 percent in the second case. In fact, it can be shown that in our numerical experiments, the upper bound for the increase in skill premium is approximately 12 percent of the actual increase of 43.4 percent, which is shown in the second case.

5 Conclusion

The main purpose of this paper has been to quantitatively evaluate the ability of the increase in trade variety to account for the rise in skill premium in Mexico over the period 1987-1994 following the liberalization of the trade policy in Mexico. The results of our numerical experiments indicate that the increase in the extensive margin of Mexican manufactured trade with the U.S. has the capability of accounting for up to approximately 12 percent of the change in Mexican skill premium during this period. Hence, we have illustrated that the increase in the extensive margin of manufactured trade with the U.S. can significantly contribute to the increase in Mexican skill premium following trade liberalization.

Here, it is noted that while it is possible that, in general, the increase in the extensive margin of trade could result from factors other than trade liberalization (e.g., technological change), Kehoe and Ruhl (2013) have shown that the extensive margin of trade responds largely to trade liberalization. Therefore, our experiments have likely captured the effect of the increase in the extensive margin of trade, largely arising from trade liberalization, on the skill premium in Mexico.

It may also be noted that while the increase in the extensive margin of manufactured trade is large, the rise in wage inequality in Mexico is modest in our experiments. A factor causing this modesty is that in our model, the marginal products of both high- and low-skilled labor rise due to the increased number of inputs, but the former rises disproportionately more than the latter.[26] Thus the relative demand for high- to low-skilled labor does not rise as much, thereby mitigating the rise in wage inequality.

Looking forward, we can say that this paper's methodology can be used to derive further quantitative implications. First, this paper has focused on the case where Mexico is a small open economy. We can also extend our model to a two-country model. Second, our model can be directly applied to countries other than Mexico. We can calibrate our model to the input-output data for other countries and then quantify the effect of the increase in the extensive margin of manufactured trade on skill premium in each of them.

Finally, it would also be interesting to extend our model to a heterogeneous firm trade model.[27] It may provide further insights on the rise in skill premium due to the heterogeneous use of increasing export and import varieties. In this framework, the additional varieties that are exported and imported on the extensive margin will be used in lesser quantities. However, for a given change in export and import volumes, it would imply a greater change in the number of varieties on the extensive margin. Therefore, the results of this paper will be further reinforced in a model with heterogeneous firms.

Data Appendix - Benchmark 1987 Mexican Data Set

Below is the input-output matrix for 1987 used to calibrate the model to the Mexican economy. All the numbers in the matrix are in millions of U.S. dollars. The steps following the matrix show the procedure for the construction of the input-output matrix and the sources of the data.

[26] Note, our numerical experiments have shown that the real wage of both types of labor increases.

[27] Verhoogen (2008) uses a heterogeneous firm trade model to analyze the Mexican skill premium. Eslava et al. (2012) is a Colombia version of Verhoogen (2008).

	Primaries	Manufactures	Services	Total
$X_{p,i}$	$2,712$	$13,485$	$1,533$	$17,730$
$X_{m,i}$	$2,836$	$23,704$	$15,939$	$42,479$
$X_{s,i}$	$1,190$	$8,355$	$14,874$	$24,419$
$X_{H,i}$	$13,324$	$17,100$	$48,893$	$79,317$
$X_{L,i}$	$6,563$	$20,074$	$32,596$	$59,233$
Y_i	$26,625$	$82,718$	$113,835$	$223,178$
C_i	$4,643$	$38,793$	$89,416$	$132,852$
NX_i	$4,252$	$1,446$	0	$5,698$
EX_i	$6,626$	$13,643$		
IM_i	$2,374$	$12,197$		

Step 1. Intermediate input and total production. Following Bergoeing and Kehoe (2003), this 1987 matrix is constructed from the *1980* input-output table provided by the INEGI.

Step 2. Labor compensation. $Y_i - X_{p,i} - X_{m,i} - X_{s,i}$ in each sector. The compensation is then distributed into $X_{H,i}$ and $X_{L,i}$ in each sector based on the 1987 data from the INEGI's EIM and ENEU. While the EIM has data on the *payment* share of non-production workers only in the manufacturing sector $X_{H,m}/(X_{H,m} + X_{L,m})$, the ENEU has data on the *employment* share of post-secondary workers in each sector $H_i/(H_i + L_i)$. First, we calibrate w_H/w_L so that the *payment* share of post-secondary workers in the manufacturing sector $w_H H_m/(w_H H_m + w_L L_m)$ (that is constructed from the calibrated w_H/w_L and the ENEU data) equals the EIM data on the *payment* share of non-production workers in the manufacturing sector, which is 0.46. The calibrated w_H/w_L is 6.18. Then, using this calibrated w_H/w_L and the ENEU data, we also construct the *payment* share of post-secondary workers in the primary and service sectors $w_H H_i/(w_H H_i + w_L L_i)$.

Step 3. Net exports to the U.S. of primaries and manufactures. Source: The International Trade Administration.

Step 4. Consumption. Get from $Y_i - C_i - X_{i,p} - X_{i,m} - X_{i,s} = NX_i$. This consumption C corresponds to consumption plus investment plus government spending plus net exports to the rest of the world except the U.S. in the national income accounts.

Notes

1. 1 peso = 1000 old pesos.
2. The nominal exchange rate in 1987 = 1.37818 MXP/USD. Source: The International Financial Statistics.

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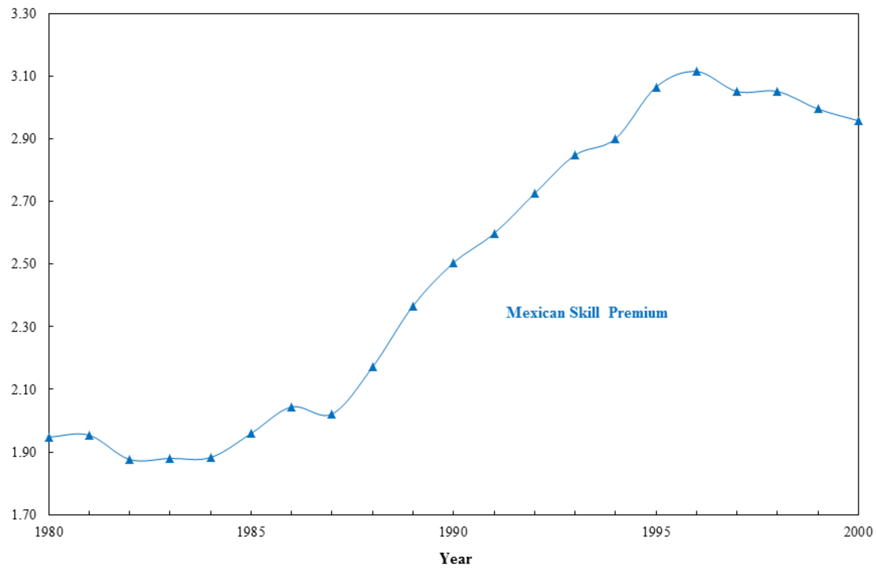

Figure 1: Mexican skill premium, 1980-2000

(a) Calibrated parameters		
Preference parameters		
$\beta_p = 0.035$	$\beta_s = 0.673$	$\beta_m = 0.292$
Technology: CES aggregator parameters		
$b_p = 0.219$	$b_s = 0.396$	$b_m = 0.922$
$a_p = 0.807$	$a_s = 0.783$	$a_m = 0.702$
Technology: productivity parameters		
$\gamma_p = 9.535$	$\gamma_s = 8.471$	$\gamma_m = 1.154$
Technology: cost shares		
$\alpha_{p1} = 0.853$	$\alpha_{p2} = 0.102$	$\alpha_{p3} = 0.045$
$\alpha_{s1} = 0.856$	$\alpha_{s2} = 0.013$	$\alpha_{s3} = 0.131$
$\alpha_{m1} = 0.736$	$\alpha_{m2} = 0.163$	$\alpha_{m3} = 0.101$
Endowments		
$L = 59,233$	$H = 12,834.5$	
Manufactured varieties		
$F = 155.555$		
$n^* = 62.083$	$q_{mz^*} = 23.834$	
(b) Free parameters		
$\varepsilon = -1$	(benchmark)	
$\mu = \frac{1}{2}$	(benchmark)	
$\rho = \frac{19}{29}$	(Klenow and Rodríguez-Clare, 1997)	

Table 1: The parameterization of the model.

$\varepsilon = -1, \mu = 1/2$	Initial equilibrium 1987	New equilibrium (1st case) 1994	New equilibrium (2nd case) 1994
n	37.917	41.250	40.833
n^*	62.083	80.417	97.500
q_m	1	0.9141	0.8899
w_H	6.18	6.3237	6.3754
w_L	1	0.9921	0.9868
w_H/w_L	6.18	6.3743	6.4606
w_H/q_m	6.18	6.9180	7.1642
w_L/q_m	1	1.0853	1.1089

Table 2: The results for the benchmark numerical experiment with epsilon = -1 and mu = (1/2).

$\varepsilon = -2, \mu = 2/3$	Initial equilibrium 1987	New equilibrium (1st case) 1994	New equilibrium (2nd case) 1994
n	37.917	41.250	40.833
n^*	62.083	80.417	97.500
q_m	1	0.9131	0.8887
w_H	6.18	6.3336	6.3839
w_L	1	0.9892	0.9843
w_H/w_L	6.18	6.4030	6.4857
w_H/q_m	6.18	6.9364	7.1834
w_L/q_m	1	1.0833	1.1076

Table 3: The results for the numerical experiment with epsilon = -2 and mu = (2/3).

$\varepsilon = -3, \mu = \frac{3}{4}$	Initial equilibrium 1987	New equilibrium (1st case) 1994	New equilibrium (2nd case) 1994
n	37.917	41.250	40.833
n^*	62.083	80.417	97.500
q_m	1	0.9128	0.8883
w_H	6.18	6.3366	6.3856
w_L	1	0.9883	0.9838
w_H/w_L	6.18	6.4117	6.4904
w_H/q_m	6.18	6.9419	7.1886
w_L/q_m	1	1.0827	1.1075

Table 4: The results for the numerical experiment with epsilon = -3 and mu = (3/4).