Leaving NAFTA:
Implications for Inequality

Collin Rabe

Andrea Waddle*

February 15, 2018

Abstract

We explore the impact that the renegotiation of NAFTA would have on both high- and low-skilled workers in the United States. We build a multi-country general equilibrium trade model with vertically integrated supply chains and trade in both intermediate goods and the technologies necessary to produce them. The technologies used to produce intermediate goods are assumed to be non-rivalrous and skill-augmenting. We find the freer trade generally increases inequality through increased investment in the skill-augmenting technology, but a reduction in trade with Mexico does little to offset the existing inequality in the United States.

Preliminary and Incomplete

*University of Richmond. Contact information: crabe@richmond.edu, awaddle@richmond.edu.

1 Introduction

The North American Free Trade Agreement (NAFTA) became the subject of much focus and concern in the 2016 Presidential campaign. Then Presidential-candidate Trump made claims that NAFTA was a deal that "hurt American workers" and made illusions to the idea that economic inequality had increased a result of the increased trade with Mexico that followed the signing of the 1994 deal with Canada and Mexico. He further suggested that renegotiating the deal would serve to reverse some of these losses experienced by American workers. In this paper, we explore these claims, examining the reversal of the NAFTA in a multi-country general equilibrium trade model in order to assess the extent to which high- and low-skilled workers will be impacted by a re-negotiation of the trade deal. We build upon Waddle (2017) in order to explore several policy alternatives and their impacts on employment and relative wages of high- and low-skilled workers. We find that, although re-negotiating NAFTA would reduce trade with Mexico, it does little to reverse inequality in the United States. These results depend crucially on our assumed policy alternatives. In particular, our results depend on our assumptions about tariffs between the United States and Canada in the post-NAFTA era, as well as our assumptions about the U.S.'s tariffs with the rest of the developing world, including China.

A key component of the model is the use of a non-rivalrous technology in the production of intermediate goods. Because this technology is assumed to be non-rivalrous and necessary to the production of the traded intermediate good, increased trade which results from decreased tariffs will cause an increase in investment in this technology. The logic is as follows: a non-rivalrous technology, such as a blueprint, can be used by multiple users at once without reducing its useful. Therefore, when they are more users of that blueprint, its effective productivity increases and therefore, the incentive to invest in that technology is increased. This causes an increase in the overall stock of these technologies, or ideas. We assume that technologies are skill-augmenting and serve as substitutes for unskilled workers. There is a large literature that argues that recent technological advances are complementary with high-skilled workers, while replacing low-skilled ones. We take this as given and explore the interaction of trade with this observation. We build on the model in Waddle (2017) and consider a world with five countries: the United States, Canada, Mexico, other advanced countries, and other developing countries. We want to capture the idea that there are countries which could substitute for either Mexico (a developing country) or Canada (an advanced economy) in the production chain of any American country.

Contribution to Related Literature

There is a large body of literature dealing with the rise of the skill premium in the United States, and a somewhat smaller literature on the rise of the skill premium in Mexico. Studies such as Feenstra and Hanson (1996), Feenstra and Hanson (1997), and Grossman and Rossi-Hansberg (2008) have shown that increasing imports of intermediate goods from less-developed countries can increase skill premia in advanced economies. For a useful summary of articles that have explored the behavior of the skill premium of developing countries as they open to trade, see Goldberg and Pavcnik (2007).

The papers that are most closely related to our own are Feenstra and Hanson's 1996 empirical and theoretical work on the importance of foreign direct investment (FDI) in Mexico, Acemolgu's 2009 theoretical exploration of linkages between trade and technological upgrading, and Burstein and Vogel's 2017 quantitative analysis of a particular mechanism linking trade and technology. Empirically, the Feenstra and Hanson show that regions with a higher proportion of inward FDI from the United States have greater increases in the relative demand for skilled labor. Furthermore, they build a theoretical model which rationalizes this prediction; capital is complementary with skilled labor, and as capital flows from the United States to Mexico via foreign direct investment, demand for skilled labor rises in Mexico. The Mexican subsidiary of the multinational in Mexico produces a less-skilled intermediate which is then substituted for less-skilled workers in the United States. Thus, the relative demand for unskilled workers falls in the United States as well. We see our paper as a complement to their work. At the aggregate level, flows of foreign direct investment between Mexico and the United States did not rise substantially until the mid-1990s. Moreover, the majority of growth in both maquiladora[1] establishments and employment came after the North American Free Trade Agreement (NAFTA) (GAO, 2005), and, as such, post-dates the observed growth in the skill premium in Mexico. We focus on the transfer of technology through non-ownership channels precisely because trade increases substantially before NAFTA but direct investment does not. We provide evidence that supply chains are an important channel through which technology is transferred. The mechanism proposed in their paper is also similar to what we propose. However, in their setup, the investment channel that we describe is not present. This is because the type of capital they consider is physical capital, which can be only used in one location at a time. We, instead, consider technology capital which can be used in multiple locations at once. Therefore, once a firm has more than one location in which to use its technology, it has an increased incentive to invest in it. This is the primary driver of the increase of the skill premium in the United States in our model, whereas in the Feenstra and Hanson model, the increase in the skill premium in the United States is primarily driven by Stolper-Samuelson effects.

[1] manufacturing plants in the free trade zone

We contribute to the emerging literature on the interaction between trade, technology, and inequality. Our work complements papers such as Acemoglu (2009), Acemoglu, Gancia, and Zilibotti (2012), and Burstein and Vogel (2017), which all address the idea that trade and technological innovation are linked. Acemoglu (2009) and Acemoglu, Gancia, and Zilibotti (2012) both build theoretical models in which globalization, in the form of trade or offshoring, can induce skill-biased technical change through increasing the price of skill-intensive goods and, hence, the profitability of investing in the technologies that are needed in order to produce these goods. The logic which supports the increase in skill-biased technology in these papers is the same as the one that We present here: trade makes it such that investing in these technologies is more profitable. Moreover, the driver of the increasing skill premia in less developed countries in these models is the same as the one considered here: technologies that are more skill-biased are adopted by the less developed countries. Our paper adds to these two by proposing a mechanism by which these technologies may be adopted by firm in the less developed countries and, in doing so, provides a way to understand why skill premia in less developed countries do not follow identical patterns following trade liberalizations with advanced countries. Burstein and Vogel (2017) build a quantitative multi-country model in which trade induces reallocation within economies towards more productive and skill-intensive firms. This model is able to generate increasing skill premia in all countries following a reduction in tariffs. Our model differs from the one considered by Burstein and Vogel in that a firm's productivity is determined by their stock of technology capital used for production in our model while it is the result of an exogenous draw in theirs. Both models feature endogenous increases in productivity, as in their model, firms with lower productivity draws are forced to shut down following a trade liberalization due to increased foreign competition. However, in our model, final goods producers must choose to invest in this technology in order for its stock to increase. This choice lends itself to consider the case of vertically integrated supply chains, while the set up in Burstein and Vogel (2017) does not lend itself as readily to considering how parts producers interact with the final goods producer for which they are part of the supply chain.

More generally, we contribute to a literature that examines the trade linkages between developing and developed countries and how these impact technological adoption and therefore the skill premium.Bustos (2011), the author analyzes firm-level panel data covering the period of Argentinian trade liberalization with Brazil and documents that there is a steep increase in the demand for skill in Argentina following said liberalization, which is driven primarily by skill-upgrading within firms. She further finds that exporters engage in upgrading activities more quickly than non-exporters and that this skill-upgrading is accompanied by investments in new technologies. She then presents a modified Meltiz model that can rationalize these observations through a mechanism that is similar but distinct from the one that we consider here. In Bustos' model, there is a fixed cost to exporting, as well as a fixed cost to operating a technology that is both more productive and more skill intensive than the alternative. The fixed cost set-up causes there to be a cut-off level of productivity above which firms will choose to both export and use the better, more skill intensive technology. Thus, the main driver of skill-grading in this model operates through the standard Melitz logic: a reduction in tariffs causes the per-unit profit of exported goods to increase, thus reducing the cut-off level of productivity needed to export and upgrade to the better technology. Therefore, more firms export and operate this advanced technology after the trade liberalization. There is a similar observation as a result of trade liberalization in our model; however, our model differs both in terms of the key assumption and the implications for the impact of a trade liberalization. First, the key assumption in our model is that there is a stock of technology, which grows through investments made by the final goods producer and is rented to the intermediate goods producer that will produce a part for the owner of that particular technology. The producer of an intermediate variety, i.e. a part used to produce the final good, is allowed to produce for the final goods producer in each country but must operate the technology from the country of the final goods producer in order to do so. A trade liberalization impacts the intermediate goods producer by making the part that they produce less expensive for the foreign final goods producer, thus inducing them to produce more parts for the foreign final goods producer. Because they are forced to use the technology of the foreign goods producer in order to produce a part for this supply chain, the domestic firm will become more skill-intensive if the foreign technology is skill augmenting and there is a larger stock of technology capital in the foreign country. This, in turn, will cause the domestic skill premium to increase. Moreover, because the technology capital that we consider is non-rivalrous, the fact that the foreign final goods producer's technology is now being used more intensively means that there is a greater return to investing in that technology, thus causing them to increase investment and therefore the stock of this skill-augmenting technology. The adoption of foreign technologies thus induces an increase in skill intensity in both countries. The asymmetry of the two countries is one of the primary drivers of the greater increase in the skill premium in the less skill-abundant country; the stock of technology capital in the skill-abundant country is much larger and, therefore, when the skill-scarce country begins to produce for the supply chain of the skill-abundant one, the skill premium in the skill-scarce country will increase dramatically. This asymmetric response will not occur in the framework proposed by Bustos and so, while her model can generate increasing skill premia in both countries, it is ill-equipped to explain why Mexico's skill premium increased by so much *more* than that of the United States.This paper is also related to the literature that has explored the impact of globalization on Mexican labor markets. A number of studies (for example, see Esquivel and Rodriguez-Lopez, 2003; Harrison and Hanson, 1999; and Robertson, 2004) explore this question using the Stolper-Samuelson theorem as their basis, and find the correlation between changes in output prices and wages at the industry level to be very low. The conclusion from this strand of literature was that skill-biased technological change, and not trade, was responsible for the observed increase in the skill premium. Verhoogen (2008) explores both overall increase in inequality and the between-plant inequality in Mexico and hypothesizes that exporting opportunities increase wage dispersion across plants due to quality upgrading. Riano (2009) builds a model in which SBTC is embodied in capital equipment and measures the effect of increasing imports of capital equipment upon the skill premium in Mexico. The idea in his paper is similar to what we model here, but importantly, the capital that is traded in our model is technology capital or "ideas." The non-rivalrous nature of technology capital creates an environment such that even as the capital begins to be used in Mexico, firms in the United States have an incentive to invest more in it. In fact, it is *because* the ideas are being used in an additional location that their marginal product increases. Ripoll (2005) builds a model in which the skill premium in the developing country responds non-monotonically to trade liberalization and depends heavily on the initial conditions in the economy. Trefler and Zhu (2005) show that those countries with the largest increase in skill premia following a trade liberalization are those which export relatively more skill-intensive goods, and they build a model akin to Feenstra and Hanson (1996), but allowing the "South" to catch up to the technology of the "North" instead of receiving FDI flows. They do not propose a mechanism for how this catch-up occurs. Burstein, Cravino, and Vogel (2013) and Parro (2013) each propose capital-embodied technology as an avenue by which skill-biased technological change crosses borders. We contribute to this literature by proposing an alternative way that this technology is accumulated and then transmitted from one country to the next, and We provide evidence of our hypothesis.

The paper is organized as follows: In Section 2, we provide brief background information on the North American Free Trade Area; in Section 3, we provide a summary of changes in inequality and evidence for the importance of trade linkages for the skill premium: Section 4 contains our model and its theoretical analysis; Section 5 provides an analysis of the model and describes its theoretical predictions; Section 6 presents a quantitative exercise; and Section 7 concludes.

2 History of NAFTA and U.S. Trade

This section briefly describes the policies that were implemented in the United States as a result of the trade negotiations that began in the mid-1800s. The North American Free Trade Agreement (NAFTA) was proposed in the late 1980s with a central goal of reducing trade costs, increasing business investments, and helping North American countries be more competitive on the global scale. Ronald Regan was the first U.S. President to propose a common market between the countries, in part to remain competitive with the development of a European common market and in part in response to increased manufacutring competition coming from Japan. President George H.W. Bush began negotiation of the free trade agreement with Canada, but this was quickly replaced by negotiations on a trilateral agreement between the U.S., Mexico, and Canada that began in 1991. In 1992, George H.W. Bush, Meixcan President Carlos Salinas de Gortari, and Canadian Prime Minister Brian Mulroney signed the trilateral agreement. In 1993, the legislatures of the three countries ratified it and in December of 1993, President Bill Clinton signed it into law. It entered into force on January 1, 1994.

Several important trade liberalizations between the countries precede NAFTA. In the 1980's, Mexico joined the General Agreement on Trade and Tariffs (GATT) and embarked on a large-scale unilateral trade liberalization whereby tariffs on U.S. goods dropped from an average ad-velorum tariff of 25% in 1986 to an average ad-velorum tariff of 10% in 1989. Moreover, Mexico moved to substantially reform their system of restrictive import quotas. Similarly, in 1989, Canada and the United States signed a free trade agreement which eliminated tariffs, reduced many non-tariff barriers, and implemented a mechanism to arbitrate trade disputes. NAFTA built upon the Canadian-U.S. agreement and augmented it with provisions dealing with intellectual property, environmental protections, and established teh CANAMEX Corridor for road transport between Canada and Mexico. Additionally, it granted the signatories Most Favored Nation (MFN) status, eliminated barriers to trade, facilitated cross-border movement of goods and services, and had as its stated goals the promotion of fair competition and increasing investment opportunities. Changes in tariffs and other industry protections were phased in, with the slowest implementation being in agricultural products.

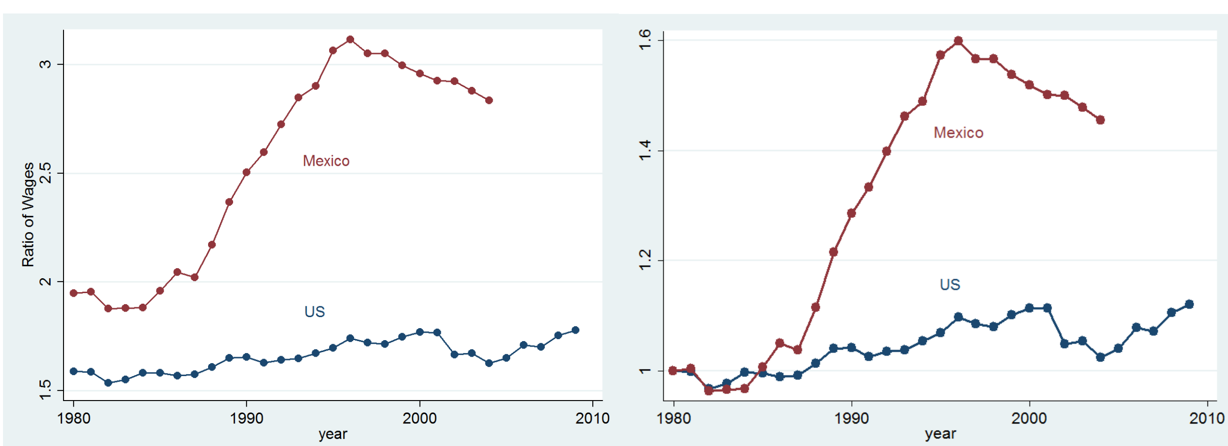
There is disagreement as to the size and scope of the effects of NAFTA. Opponents claim that it has destroyed manufacutring jobs and put downward pressure on the wages of the less skilled by encouraging multinational corporations to move production overseas. Proponents claim that it has reduced prices for consumers, boosted U.S. exports, and created jobs as a result. Economic data and analysis are mixed, with the most recent analyses finding limited impact on wages and employment at the local level (see, for example, Hakobyan and McLaren 2016). In what follows, we will initially take the level of inequality in 2008 as given and will then analyze the impact that rolling back the NAFTA provisions has upon that measure. We choose 2008 in order to avoid the impact of the financial crisis upon wage inequality.

3 Evidence on Skill Premia and Trade

In this section, we present first information on the patterns of skill premia for the United States and Mexico both preceding and following NAFTA. We then provide evidence of technological transfer through supply chains.

3.1 Skill Premia in Mexico and the United States

In what follows, we will use the term "skill premium" to mean the ratio of the wages of non-production workers to the wages of production workers, as is typical in the literature that examines the skill premium in developing countries. Amiti and Cameron (2011) use data that includes educational attainment and production/non-production status of workers in Indonesian manufacturing for several years and they show that the production/non-production breakdown is a good proxy for skill or educational attainment. Therefore, I will focus my analysis on this measure of the skill premium. In Mexico, the skill premium was stable with non-production wages being about twice as high as production wages during the late 1970s and early 1980s, but began to rise around 1986. It grew for the next decade and peaked with non-production wages being about 3.1 times higher than production wages in 1996. This can be seen in Figure 1a. The U.S. experienced similar timing in the rise of the same variable. Note that the college premium, measured as the ratio of college to non-college wages, began to rise earlier in the 1980s. The college premium is the measure which is frequently the concentration of papers dealing only with the United States, but we will concentrate on comparable measures of the skill premium in this paper. As can be seen in Figure 1a, the manufacturing skill premium in the United States also began to rise in the mid-1980s.



(a) Levels (b) Relative to 1980

Figure 1: Skill Premia in U.S. and Mexico

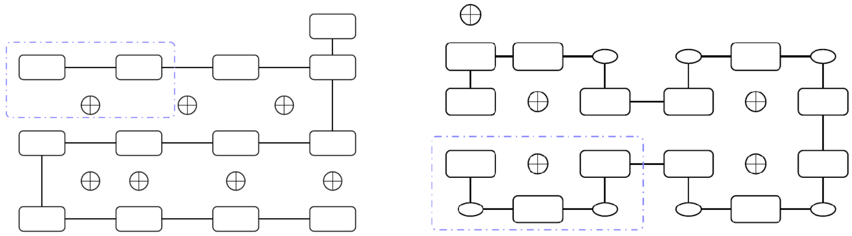
Inequality for the United States has been rising since the early to mid-1980s, with an increase after the inception of NAFTA. We will use the skill premium as our measure of inequality in order to examine whether the reversal of NAFTA will be able to decrease the observed inequality in the United States.

3.2 Evidence of Technology Transfer Due to Trade: A Case Study of an Auto Plant

As an example of the transfer of technology capital, we now turn to a case study of one company's vertical integration of its supply chain, including a plant in Northern Mexico, conducted by Shaiken and Herzenberg (1987). This particular plant was partially owned by an undisclosed American auto manufacturer to make engines and engine parts for cars that would be exported, in keeping with Mexican regulations that required that a large proportion of output from foreign owned plants be produced for export. The case study consists of interviews with both production and non-production workers and it directly compares the Mexican plant with its U.S. counterpart, in terms of production techniques, technology used, management practices, and quality and quantity of output. The Mexican plant was a brand new facility, which utilized some of the most advanced production technologies available at the time of its construction and it was built to compete with the most successful engine plants in the world.

The study finds that the Mexican plant was able to achieve efficiency that was comparable to that of the U.S. plant, due in large part to its utilization of technology capital that was the same across the two locations. The company invested significant resources in training the workers to operate state of the art machinery and to manage according to the company's best management practices. The case study details how supply chains served as a way to transfer blueprints for the production of parts, technology embedded in intermediate parts and in machines, best practices for efficient production, and organizational capital, such as worker training programs. These types of technology capital impacted production and non-production workers differentially. One place that this is evident is in the worker training programs implemented by the company. Non-production workers, such as technicians, had to require many skills that were not part of their previous skill-set. In order to do so, there were task certification programs, in-plant and on-the-job training programs and apprenticeships, and even trips to the tool suppliers in the United States, all to ensure that the technicians understood how to maintain the plant. Production workers also received training, but to a lesser extent.

Another example of the transfer of technology capital is the modification of the production line layout. Figure (2a) shows the standard layout for a production line, where each circle with a



(a) Standard (b) Modified

Figure 2: Production Line Layouts

cross in it represents a worker and each rounded solid box is a machine that needs to be operated. Figure (2b) displays the new layout used by the company. As can be seen by examining the areas enclosed with the dotted blue lines, in the standard layout each worker is in charge of two machines, whereas in the new layout, each worker is in charge of three machines. This changes the mix of workers necessary in the plant; because now each production worker is operating more machines, all else equal, fewer production workers are required. However, because this may lead to more breakdowns on the line, there are more technicians (non-production workers) required. This technology augments the skilled non-production workers and substitutes for the unskilled production workers. This case study serves to highlight the role of integrated supply chains in transferring skill-augmenting technology capital across borders.

4 The Model Environment

Our model economy features two countries, Mexico (denoted by M) and the United States (denoted by U), and I industries, indexed by i. In each country and industry, there is a tradeable final good produced by perfectly competitive firms. This final good is a CES aggregate of a continuum of varieties, some of which are produced domestically and some of which are imported and subject to a iceberg transportation cost. The final good can be used either for consumption or for investment in the stock of technology capital, which is used in production of the intermediate varieties. The production of these varieties requires skilled and unskilled labor, as well as the aforementioned technology capital. The producer of an individual variety is a monopolistic competitor and may produce that variety for a domestic final goods producer and for a foreign final goods producer at the same time, meaning that they may operate two different technologies within a single firm. We will refer to the operation of different technologies within a single variety as production lines within that variety or firm. Aggregate labor of each type is inelastically supplied and is immobile across countries, thought it is perfectly mobile across industries and production lines. We will allow certain parameters to vary across industries but the producers of varieties within an industry will be identical, due primarily to data constraints. We now provide details of the model environment.

Final Goods Producers

In each industry and each country, there are perfectly competitive producers of a non-tradeable final good which seek to maximize the infinite sum of discounted dividends. The final good in country k and industry i is denoted Y_{ki} and is composed of a CES aggregation of intermediate varieties $y_{kji}(\omega)$, where the variety is denoted by ω and the country of origin for that particular variety is indexed by j. The final goods producer owns and invests in a stock of technology capital, Z_{ki}, which it rents to the producers of the intermediate varieties of which its final good is composed. It earns returns $r_{kki}$and $r_{kji}$from renting its technology capital to domestic and foreign producers of intermediate varieties, respectively. To economize on notation, we will suppress the time subscript. These final goods producers in country $k \in \{U, M\}$ and industry i solve the following problem:

$$max \sum_{t=0}^{\infty} P_{ki} D_{ki} \tag{1}$$

s.t.

$$\begin{aligned} D_{ki} &= Y_{ki} - I_{ki} + Z_{ki}\left(r_{kki} + r_{kji}\right) - \int_{\Omega_i} p_{kji}(\omega) y_{kji}(\omega) d\omega && (2) \\ I_{ki} &= Z_{ki}^{'} - (1-\delta) Z_{ki} && (3) \\ Y_{ki} &= \left[\int_{\Omega_i} y_{kji}^{d}(\omega)^{\rho} d\omega\right]^{1/\rho} && (4) \end{aligned}$$

where $\frac{1}{1-\rho}$is the elasticity of substitution between varieties within each sector. A variety ω is country specific and final producer will purchase varieties from both countries, substituting towards more domestic varieties if the cost of foreign intermediates is higher.

Technology Capital: Investment and Rental

The technology capital that we consider, Z_{ki}, can be thought of as a stock of ideas, blueprints, or production techniques and, as such, is non-rivalrous in nature. These production techniques are the ones that are necessary in order to make an intermediate part for the final product so when the final goods producer begins to purchase more intermediates from foreign producers, the foreign producer will have to rent more of this technology capital in order to produce these parts. This causes the rate of return on technology capital to increase for the final goods producer, thus inducing them to increase investment in it. Moreover, the rental of technology capital in order to produce the appropriate part for the foreign final goods producer is the channel by which this technology capital will be transferred across borders.

We assume that this technology is high skill augmenting and low skill saving. This assumption is based on the large literature that shows that technological advancements since the early 1980s have favored high skill workers. We extend this observation to technology capital, assuming that production techniques have changed the mix of high and low skill workers. The extent to which this is true in the model will depend on parameter values, which will be discussed in detail in what follows.

Production of Varieties

The intermediate goods producer that produces intermediate variety ω for industry i in country k can produce both for the domestic market (k) and for the foreign market (j). He chooses output for the domestic market ($y_{kki}(\omega)$), output for the foreign market ($y_{jki}(\omega)$), skilled labor to produce for the domestic market ($h_{kki}(\omega)$), skilled labor to produce for the foreign market ($h_{jki}(\omega)$), unskilled labor to produce for the domestic market ($l_{kki}(\omega)$), unskilled labor to produce for the foreign market ($l_{jki}(\omega)$), and amount of domestic and foreign technology (Z_{ki},Z_{ji}) to maximize profits, taking the inverse demand function, wages (w_k^H, w_k^L), and the rental rates for technology (r_{jki}, r_{kki}) as given. The first subscript refers to the country for which the intermediate variety is produced and the second refers to the country in which production takes place. The producer of the intermediate good must use the technology of the supply chain that they are supplying in order to produce the variety for that firm.

$$\max \sum_{j\in\{U,M\}} \frac{p_{jki}(\omega)}{\tau_{jki}} y_{jki}(\omega) - w_k^H h_{jki}(\omega) - w_k^L l_{jki}(\omega) - Z_{ji} r_{jki} \tau_{jki}^z \tag{5}$$

s.t.

$$y_{jki}(\omega) = A_k \left[\theta_i \left(Z_{ji}^{\alpha} h_{jki}^{1-\alpha}(\omega) \right)^{\frac{\sigma-1}{\sigma}} + (1-\theta_i)\, l_{jki}(\omega)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \qquad \forall j \in \{U,M\} \tag{6}$$

$$y_{jki}(\omega) = \left(\frac{p_{jki}(\omega)}{P_{ji}} \right)^{\frac{1}{\rho-1}} Y_{ji} \qquad \forall j \in \{U,M\} \tag{7}$$

where $\sigma > 0$ is the elasticity of substitution between high and low skilled labor. The skill-intensity of production will be jointly governed by $\alpha \in (0,1)$ and $\theta_i \in (0,1)$, as will be discussed in more detail below. $A_k \geq 0$ is the level of country-specific total factor productivity (TFP) and P_{ji} is the cost of the final good produced in industry i in country j, the country for whose supply chain the intermediate variety is being produced. There are two wedges on the production, τ_{jki} and τ^z_{jk}, which are both equal to one if the variety is produced for the domestic final goods producer ($j = k$) and greater than one otherwise ($j \neq k$). The first of these is an iceberg trade cost on goods and the second can be thought of as an implicit tax on the use of foreign technology. This implicit tax is a stand-in for imperfect intellectual property protection. As detailed in Section 2, part of the liberalization between the United States and Mexico was the adoption of stricter protection of intellectual property by Mexican firms; τ^z_{jk} is included in order to capture this feature.

Aggregation and Market Clearing

Final output in each industry i and each country k must equal domestic demand for consumption and investment from that industry

$$Y_{ki} = c_{ki} + I_{ki} \qquad \forall i \in I, \quad k \in U,M \tag{8}$$

and total output for each variety ω must in each industry i must equal its world demand

$$y_{kki}(\omega) + y_{jki}(\omega) = y^d_{kki}(\omega) + \tau_{jki} y^d_{kji}(\omega). \tag{9}$$

Labor market clearing in each country requires that the labor used to produce all varieties in country k for the domestic production line and for the foreign production line across all industries i is equal to the aggregate inelastic supply of high and low skilled labor respectively

$$H_k = \sum_{i \in I} \int_{\Omega_i} \left(h_{kki}(\omega) + h_{jki}(\omega) \right) d\omega \tag{10}$$

$$L_k = \sum_{i \in I} \int_{\Omega_i} \left(l_{kki}(\omega) + l_{jki}(\omega) \right) d\omega. \tag{11}$$

Recall that a firm producing variety ω may produce both for the domestic production line ($y_{kki}(\omega)$) and for the foreign one ($y_{jki}(\omega)$).

Equilibrium

An equilibrium of the world economy is a set of prices P_{ki}, $p_{kji}(\omega)$; wages w_k^H, w_k^L; rental rates for technology capital r_{kji}; demand for labor $h_{jki}(\omega), l_{jki}(\omega)$; quantities demanded $y_{kji}^d(\omega)$; demand for consumption and investment c_{ki}, I_{ki}; and quantities produced $Y_{ki}, y_{jki}(\omega)$ that satisfy, in each country: dividend maximization by the final goods producer (Equations (1) through (4)); profit maximization by the intermediate goods producers (Equations (5) through (7)); utility maximization by the consumer (Equations (17) and (18) in the Appendix); and goods, labor, and bond market clearing conditions (Equations (8) through (11) and Equation (19) in the Appendix).

5 Skill Premium

The skill premium in Country k in this model can be expressed as

$$\frac{w_k^H}{w_k^L} = (1-\alpha)\frac{\theta_i}{1-\theta_i}\left(\frac{Z_{ji}}{h_{jki}}\right)^{\alpha\frac{\sigma-1}{\sigma}}\left(\frac{h_{jki}}{l_{jki}}\right)^{\frac{-1}{\sigma}} \tag{12}$$

where we denote by h_{jki} and l_{jki} the equilibrium choices for high and low skilled labor that are made by all firms in industry i producing in country k for the supply chain of country j. Recall that producers of all varieties ω in a particular industry are identical so their equilibrium choices will be the same; therefore, we suppress the notation indicating the variety. Because labor is perfectly mobile across all industries, wages will equalize across industries and this equation will hold for every industry i. In the expression above, we can think of the term $\left(\frac{Z_{ji}}{h_{jki}}\right)^{\alpha\frac{\sigma-1}{\sigma}}$ as representing the relative demand for high-skill labor and $\left(\frac{h_{jki}}{l_{jki}}\right)^{\frac{-1}{\sigma}}$ as representing the relative supply of labor in industry i. The demand will be affected by the amount of technology being utilized in a given country and industry and the supply will be subject to the normal Stolper-Samuelson forces.

In what follows, for simplicity, we will consider only two industries $i \in \{1,2\}$ with Industry 1 being relatively high-skill intensive and Industry 2 being relatively low-skill intensive ($\theta_1 > \theta_2$). The results and logic will extend to the multi-industry case.

Standard H-O

Suppose for the moment that $\alpha = 0$. In this case, technology capital is not used at all in production and the expression for the skill premium simplifies to

$$\frac{w_k^H}{w_k^L} = \frac{\theta_i}{1-\theta_i}\left(\frac{h_{jki}}{l_{jki}}\right)^{\frac{-1}{\sigma}} \tag{13}$$

which is equivalent to the skill premium in the standard H-O model and the logic from the 2x2x2 H-O model follows. Mexico is relatively abundant in low-skill labor while the United States is relatively abundant in high-skill labor. Therefore, absent any role for technology, i.e. $\alpha = 0$, when countries are in autarky, the relative wages are completely determined by the aggregate supply of factors in the country and the skill premium will be higher in Mexico. Once the countries open to trade, because it's relatively less expensive to make the low-skill intensive good in Mexico, the low-skill abundant country, Mexico will move towards specializing in producing goods from Industry 2. Likewise, the United States will move towards specializing in the production of goods for Industry 1 since it is less expensive to produce that good in the United States than in Mexico. If both countries were to completely specialize in the producing their respective goods, meaning that the entire labor force would be dedicated to production in that industry, the skill premia in the United States and Mexico would become

$$\frac{w_U^H}{w_U^L} = \frac{\theta_1}{1-\theta_1}\left(\frac{H_U}{L_U}\right)^{\frac{-1}{\sigma}} \tag{14}$$

$$\frac{w_M^H}{w_M^L} = \frac{\theta_2}{1-\theta_2}\left(\frac{H_M}{L_M}\right)^{\frac{-1}{\sigma}} \tag{15}$$

Because there would have been some portion of the labor force producing for each industry in autarky in order to satisfy demand for both goods, the movement to specialization drives the skill premium down in the United States and up in Mexico. [2] This is true even in the case of incomplete specialization, as the result is driven by the facts that $\theta_1 > \theta_2$ and that a greater proportion of the labor force being dedicated to the high-skill intensive industry in the United States and a greater proportion of the labor force working in the low-skill intensive industry in Mexico after trade liberalization.

[2] See appendix for details.

Role of Technology Capital

Now, if $\alpha > 0$, technology capital will be a necessary part of the production process, the skill premium will be expressed as in Equation (12), and the relative demand for labor will therefore be affected by technology capital. In order to understand how the skill premium is impacted by a trade liberalization, first note that if $\sigma > 1$ and Z_{ji} increases following liberalization, then the skill premium will increase, all else equal. Therefore, an increase in technology capital may offset or completely overturn the pressure on the skill premium that arises due to labor reallocation across industries. Moreover, the increased availability of more productive technology due to a decrease in trade barriers will decrease the incentive for labor to reallocate across industries.

There are two forces that may cause technology capital in the world to increase. The first is what we refer to as the "adoption channel" whereby Mexican producers upgrade to using the more skill-intensive technology of the U.S. final goods producers in order to produce for their supply chain. This occurs as the tariff on the intermediate good produced for the U.S. (τ_{jki}) falls or the distortion to the use of the U.S. technology capital (τ^z_{jki}) falls. A reduction in either distortion results in the Mexican intermediate goods producer shifting towards producing more for the U.S. final goods producer than they did per-liberalization.

The second force is what we refer to as the "investment channel," which is the increase in investment in technology capital by the final goods producer that will occur as a result of an increase in the rental rate for that technology. As barriers to trade fall, the technology of the United States will begin to be used more intensively in Mexico as discussed above. This increases the return to investing in that technology for the American final goods producers. All else equal, these producers will increase investment in their technology capital. This is a secondary driver of increased technology in Mexico and the primary driver of increased technology in the United States. We will explore each of these pieces through some simple comparative statics. We will provide the intuition in what follows, while details can be found the the appendix.

Adoption Channel

In order to see how the adoption channel operates, suppose for the moment that there is only one industry, i, so high and low skilled laborers are fully employed therein and there is no reallocative pressure from the H-O mechanism discussed above. Changes both to the tariff, τ_{jki}, and to the distortion to the use of foreign technology capital, τ^z_{jki}, will contribute to the adoption channel. Suppose first that there is a reduction in the tariff on the good and consider the problem of the final goods producer in the United States (Equations 1 through 4). Because the intermediate goods producers are monopolistic competitors, they will charge a constant mark-up over marginal cost,

$c(w_k^H, w_k^H, r_{kki}, r_{jki})$:

$$p_{jki} = \rho \tau_{jki} c(w_k^H, w_k^H, r_{kki}, r_{jki})$$

When the tariff falls, all else equal, the effective price paid by the final goods producer for the Mexican intermediate will also fall, therefore increasing the amount that the U.S. final goods producer demands from the Mexican intermediate firm. In order to meet this demand, the Mexican intermediate goods producer must rent more of the U.S. technology capital, Z_{Ui}, and allocate more labor to producing for the U.S. production line, which is more skill intensive ($Z_{Ui} > Z_{Mi}$) since the autarkic levels of technology capital will be determined by the skill level in country. This reallocation towards producing for the U.S. final good will, therefore, increase the skill premium in Mexico.

To see the second way in which the adoption channel might be activated, consider the intermediate goods producer's problem in Mexico (Equations 5 through 7) and suppose that there is a reduction in the distortion to foreign technology capital. The intermediate goods producer is effectively paying a tax on his use of foreign technology capital, Z_{Ui}. As the distortion on that technology capital falls, it becomes less costly for him to produce for the foreign final goods producer. Therefore, all else equal, he will reallocate resources toward that production line. This will again cause the producer to adopt more U.S. technology capital, thus affecting the skill premium as before.

Investment Channel

In order to understand the investment channel, consider the expression for the rental rate for the U.S. technology (Z_{Ui}) being used in Mexico by an intermediate goods producer for Industry i

$$r_{jki} = \rho \theta_i \alpha \quad \frac{p_{jki}(\omega)}{\tau} A_j \left[\theta_i \left(Z_{ki}^{\alpha} h_{jki}^{1-\alpha} \right)^{\frac{\sigma-1}{\sigma}} + (1-\theta_i) l_{jki}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{\sigma-1}} Z_{ki}^{\frac{\alpha(\sigma-1)}{\sigma}-1} h_{jki}^{\frac{(1-\alpha)(\sigma-1)}{\sigma}} \tag{16}$$

where

$$\tau = \tau_{jki}^{z} \tau_{jki}$$

As can be seen in Equation (16), the tariff on the good and the tax on technology capital serve to reduce the return to renting technology across borders. Therefore, as either of these distortions decrease, the return to investing in the technology capital increases, thus increasing the U.S. final goods producer's investment. The key assumption here is that the technology capital is non-rivalrous and so the total return to investing in it is equal to the sum of the return in each country. All else equal, the domestic return will be unaffected by the reduction of the trade distortions, while the foreign return will increase. This means that the total return increases, incentivizing the final goods producer to increase the stock of technology capital.

6 Quantitative Exercise

We now turn to a simple quantiative exercise to assess the impact of an increase in tariffs on key observations for the U.S. and Mexico. In this exercise, we assume only two countries: the U.S. and Mexico, and assume that relations with Canada will remain the same. The use of only two countries is not innocuous, as in equilibrium there may be substantial shifting between low-skill trade partners for U.S. producers. In particular, one can imagine that if the U.S. decreases trade with Mexico, it may then rely more heavily on China in order to produce intermediate parts. Furthermore, we assume only two industries in this exercise for simplicity. This assumption does not affect the analysis greatly, though it does simplify computation substantially.

6.1 Parameterization

We now parameterize the model in order to quantify the impact that a change in tariffs will have upon the skill premia. Table 1 details the fixed parameter values chosen, as well as the source for these parameter selections.

Some of these parameters deserve discussion. In particular, we calculate the relative total factor productivity (TFP) in Mexico (A_M) to be 0.25. Note that we normalize TFP in the United States to be 1. We then calculate the relative value added per worker in the manufacturing sector in Mexico in 2008. We choose the manufacturing sector instead of the overall economy because our skill premium data pertains to the manufacturing sector only. For the relative supply of high-skilled workers, we use the household surveys that are available for both countries. The data analog to high-skilled workers are non-production employees. Since these are defined to be managers and technicians, we look at individuals with some college. This includes individuals with technical training. We do not want to rely on the ratio of non-production to production employees in manufacturing because this is an equilibrium outcome which is reflective of the skill intensity of manufacturing. While both countries have similar ratios of non-production to production employ-

Parameter	Value	Source
β	0.96	Annual return on risk-free bonds
ρ	0.63	Trade literature
δ_j	0.08	McGrattan & Prescott
A_M	0.25	Relative value-added per worker in 2008
H_U	0.28	CPS - Fraction of Population with Some College 2008
H_M	0.09	ENOE - Fraction of Population with Some College 2008
L_U	0.72	CPS - Fraction of Population with No College 2008
L_M	0.91	ENOE - Fraction of Population with No College 2008

Table 1: Fixed Parameter Values

ees in manufacturing, the ratio of college to non-college individuals differs substantially across the two. We utilize this difference in order to rationalize the large observed difference in initial skill premia. The rate of time discounting (β) and the substitutibility of intermediate goods (ρ) are taken directly from the literature. The model unit of time is one year. Although changing these parameters would affect the initial calibration, they do not impact the qualitative results in terms of *changes* in skill premia. Moreover, the initial calibration is not particularly sensitive to these parameter choices. As in McGrattan and Prescott (2009), δ is not separately identified from α; the parameters jointly determine the return to technology capital. For the rest of the parameters, we follow Waddle (2017), setting the parameter values equal to those chosen to match the pre-NAFTA period.

Parameter	Value	Interpretation
$\frac{\theta_1}{\theta_2}$	1.10	Relative Skill Intensity of the Sectors
α	0.15	Technology Capital's Share
σ	1.64	Elasticity of Substitution between H & L

Table 2: Calibrated Parameters

The most important parameters for the results are technology capital's share of income (α) and the elasticity of substitution between high- and low-skill labor (σ). Also important is the ratio of the factor share parameters in the production function $\left(\frac{\theta_1}{\theta_2}\right)$ which determines how relatively skill intensive each sector is. In order to pin these parameters down, we match three moments in the data: (1) the ratio of royalties to payroll in Mexico in 2008; (2) the Mexican skill premium in 2008;

and (3) the U.S. skill premium in 2008, following Waddle (2017). We matches the parameters via the general method of moments (GMM).

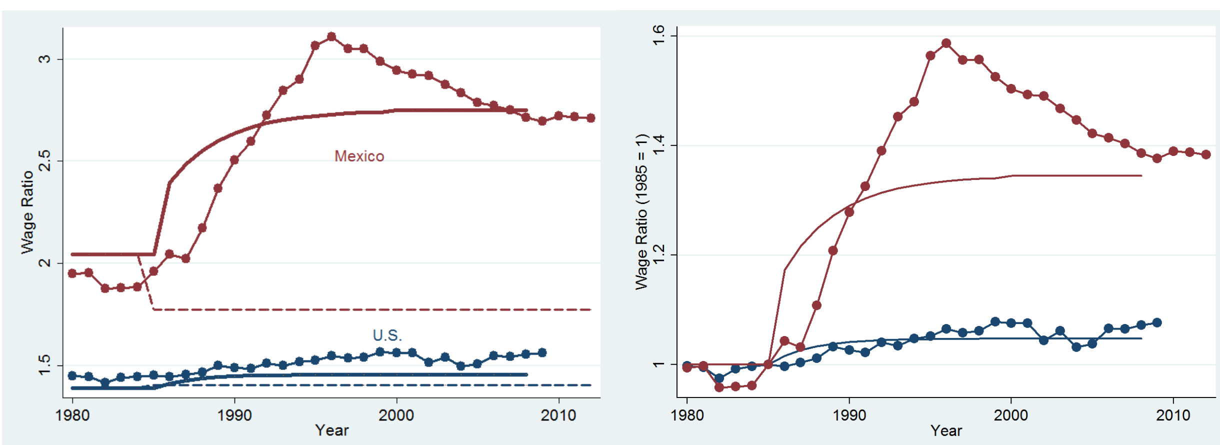
Moment	Data	Model
Ratio of Royalties to Payroll - Mexico 2008	0.07	0.07
Skill Premium - Mexico 2008	2.83	3.01
Skill Premium - U.S. 2008	1.77	1.58

Table 3: Target Moments

Table 2 shows the parameter values resulting from our calibration exercise and Table 3 displays the targeted moments in the data and the model's fit with them. As Table 3 shows, the model hits the target moments. The estimated elasticity of substitution between high- and low-skill labor is in keeping with estimates from the literature, though it is on the high side of the acceptable range. We assume that the elasticity of substitution is the same across countries. Likewise, we assume that technology's share of income is the same across countries. We do this for two reasons. The first is that we have data on royalty payments only for Mexican manufacturing. Because royalty payments over payroll is the obvious data analog to technology's share of income, we want to match this moment precisely in order to discipline α. In the absence of royalty data, we have no way of pinning down this parameter. The second reason is that these two parameters (α, σ) are the parameters to which our model results are most sensitive. We do not want the difference in production functions to be driving the results. The model has difficulty in matching both the initial skill premium in Mexico and the initial skill premium in the United States. This is in part because of our choice to keep the parameters governing these two data points the same across countries. In the data, the skill premium in the United States is higher than one might expect, given the large proportion of the population that is considered "skilled." In Mexico, the opposite is true – the skill premium is lower than one might expect in 2008, given the derth of skilled workers in that country. Therefore, holding the parameters the same across the two countries creates a difficulty for the model to match both moments. However, we will take the baseline as given and calculate the percent change in the skill premia in both countries relative to their baseline.

6.2 Quantitative Results

First, we explore what happened when the U.S. and Mexico opened to one another, for comparison, replicating the results in Waddle (2017) and using the calibration therein. Figure 3a shows the fit of the skill premium in the model relative to the data and its transition path from the steady state in which the U.S. and Mexico were totoally closed to one another to the totally free-trade equilibrium. The red lines correspond to Mexico and the blue lines correspond to the United States. Consider first the output for Mexico. The line with circular markers denotes the data and the solid line corresponds to my baseline model. Notice that, while the baseline model features a smooth transition between the autarkic steady state and the free trade steady state, the initial jump in the skill premium in the first period is pronounced. This is due to the fact that there is no cost to the producers of the intermediate goods for switching from producing for the Mexican supply chain, which uses the Mexican technology capital, $Z_{M,y}$, to producing for the American supply chain, which uses the U.S. technology, $Z_{U,y}$. Because the more advanced technology becomes immediately adopted, there is a large initial jump in the skill premium. This is the adoption channel at play. The rest of the increase in the skill premium is driven by the investment channel. As the U.S. invests more and more into the stock of U.S. technology capital, $Z_{U,y}$, Mexican firms continue to adopt this technology. This additional adoption would not happen, however, if the U.S. were not investing additional resources into $Z_{U,y}$. For contrast, I have also included the results for the world without technology capital (setting $\alpha = 0$ but keeping all other parameter values fixed at the calibrated values), which is the basic H-O model. This is represented by the red dashed line for Mexico. Notice that in the absence of technology capital, the skill premium falls immediately. This is because there are no dynamics in the basic H-O model and so the model transitions immediately to the new steady state, where Mexican firms specialize entirely in the production of the unskilled-intensive good, or the good produced in Sector X. The new steady state in the H-O world features a falling skill premium in Mexico, just as standard trade theory predicts.



(a) Levels (b) Relative to 1985

Figure 3: Data vs. Model - Skill Premia

Now, we turn our attention to the results for the United States, which are denoted by the blue lines. Again, the line with circular markers is the data, the solid line is the result of the baseline model, and the dashed line is the result of the basic H-O analog using the calibrated parameter values from the baseline model. We can see in Figure 3a that my baseline model also increases the skill premium in the United State by more than the H-O analog. This is precisely because of the investment channel. In the basic H-O setup, there is an immediate jump in the skill premium due to specialization. Because firms can switch immediately to production of the good in which they have the comparative advantage and there is no dynamic accumulation of any sort of capital (technology or otherwise), the transition from one steady state to the next is immediate. In the model with technology capital, however, there is a slower transition to the new steady state, while the stock of technology capital is being accumulated to its new steady state level. As the Mexican firms adopt more and more of the U.S. technology capital, the return to investing in this technology capital continues to increase. Therefore, the U.S. final goods producer will continue to invest in additional technology capital until the marginal return on that investment is maximized, which occurs once all of the Mexican firms that will switch to producing for the American supply chain have completed their transition. We see this as a gradual transition from the initial closed economy steady state to the one in which supply chains are integrated across countries.

Our calibration was conducted assuming free trade between the United States and Mexico. We now conduct an experiment in which bilateral tariffs increase by 10%. Table 4 shows the results of this experiment. As can be seen, the change in tariffs effects the skill premium very little: the skill premium decreases by 1 percent in Mexico and by 0.5 percent in the United States. This is because an increase in tariffs does not impact the investment decision of firms very much and the skill premium is largely determined by the stock of technology capital used in production. Part of the liberalization that accompanied NAFTA was the implementation of IP protection laws that allowed U.S. final goods producers to use their technology in Mexico without fear that it would be illegally used without royalties being paid. Increasing tariffs does not serve to increase the wedge on use of foreign technology capital. Recall from the intermediate goods producers' problem that there were two wedges on the production of goods for the foreign final goods producer: a tariff on intermediate goods and a distortion to the use of foreign capital. For the purposes of this exercise, we have assumed that the latter wedge does not change when NAFTA is repealed in the model. Therefore, the decision of the final goods producer to invest in the technology capital is not changed by much and so they continue to invest in their non-rivalrous technology. Because the skill premium is largely determined by this factor, there is little impact on the skill premium overall.

	Closed		%Δ
	Data	Model	Model
Mexico	2.83	3.01	1
U.S.	1.77	1.58	0.5

Table 4: Results - Increase Tariffs by 10%

7 Conclusion

In this paper, we explore the impact that increasing tariffs to their pre-NAFTA levels would have upon skill premia in the United States and in Mexico. We show theoretically that, while tariffs have an impact on the investment decision of the final goods producer, they are only part of the story in determining the overall investment in technology capital. A modest increase in tariffs from 0% to 10% produces very little change in the decision making of the final goods producer in our quantitative exercise. Therefore, there is little change in inequality resulting from this policy change. It is possible that if we were to take into account additional countries, these results would be further weakened. In particular, if China were to improve its intellectual property laws in order to increase U.S. production therein, we would expect to see the skilll premium continuing to rise in the United States. Likewise, further opening between the U.S. and other advanced countries might produce similar results. We find that, although trade has an impact on the level of technology maintained by a final goods producer, that technology itself is primarily responsible for changes in the skill premium. Moreover, similar to what has been found in the extant trade literature, modest changes in tariffs produce only small changes in production and investment activities. Therefore, we should not expect that withdrawing from NAFTA will reverse the steady increase in wage inequality that has characterized the last 30 years. Withdrawing from the world economy will not increase employment and wages of lower skilled workers sufficiently to justify the deleterious effects of this poilcy.

References

(2005): "INTERNATIONAL TRADE: Mexico's Maquiladora Decline Affects U.S.- Mexico Border Communities and Trade; Recovery Depends in Part on Mexico's Actions," Discussion paper, United States General Accounting Office.

ACEMOGLU, D. (2002a): "Directed Technical Change," *Review of Economic Studies*, 69, 781–810.

——— (2002b): "Technology and the Labor Market," *Journal of Economic Literature*, 40, 772.

——— (2009): "Patterns of Skill Premia," *Review of Economic Studies*, 70, 199–230.

ACEMOGLU, D., G. GANCIA, AND F. ZILIBOTTI (2012): "Offshoring and Directed Technological Change," *Working Paper*.

ALVAREZ, R., AND R. ROBERTSON (2004): "Exposure to Foreign Markets and Plant-Level Innovation: Evidence from Chile and Mexico," *Journal of International Trade and Economic Development*, 13(1), 57–87.

AMITI, M., AND L. CAMERON (2011): "Trade Liberalization and the Wage Skill Premium: Evidence from Indonesia," CEPR Discussion Papers 8382, C.E.P.R. Discussion Papers.

BARTELSMAN, E. J., AND W. GRAY (1996): "The NBER Manufacturing Productivity Database," Working Paper 205, National Bureau of Economic Research.

BERMAN, E., J. BOUND, AND S. MACHIN (2009): "Implications of Skill-Biased Technological Change: International Evidence," *The Quarterly Journal of Economics*, 113(4), 1245 – 1279.

BERMAN, E., AND S. MACHIN (2009): "Skill-Biased Technology Transfer: Evidence Factor Biased Technological Change in Developing Countries," *Leverhulme Centre for Research on Globalisation and Economic Policy (GEP), University of Nottingham.*

BERNARD, A. B., J. EATON, J. B. JENSEN, AND S. KORTUM (2003): "Plants and Productivity in International Trade," *American Economic Review*, 93(4), 1268–1290.

BURSTEIN, A., J. CRAVINO, AND J. VOGEL (2013): "Importing Skill-Biased Technology," *American Economic Journal: Macroeconomics*, 5(2), 32–71.

BURSTEIN, A., AND J. VOGEL (2017): "International Trade, Technology, and the Skill Premium," *Jounral of Political Economy*, 125(5), 1356 – 1412.

BUSTOS, P. (2011): "The Impact of Trade Liberalization on Skill Upgrading: Evidence from Argentina," *Working Paper*.

ESQUIVEL, G., AND J. A. RODRIGUEZ-LOPEZ (2003): "Technology, Trade, and Wage Inequality in Mexico Before and After NAFTA," *Journal of Development Economics*, 72.

ESQUIVEL, G., AND A. TORNELL (1995): "The Political Economy of Mexico's Entry into NAFTA," *NBER Working Paper 5322*.

FEENSTRA, R. C. (1996): "NBER Trade Database, Disk1: U.S. Imports, 1972-1994: Data and Concordances," *NBER Working Paper 5515*.

——— (1997): "NBER Trade Database, Disk 3: U.S. Exports, 1972-1994, with State Exports and Other U.S. Data," *NBER Working Paper 5990*.

FEENSTRA, R. C., AND G. H. HANSON (1996): "Globalization, Outsourcing, and Wage Inequality," *American Economic Review*, 86, 240–245.

——— (1997): "Foreign Direct Investment and Relative Wages: Evident from Mexico's Maquiladoras," *Journal of International Economics*, 42, 371–393.

GERVAIS, M., N. JAIMOVICH, H. E. SIU, AND Y. YEDID-LEVI (2015): "Technological Learning And Labor Market Dynamics," *International Economic Review*, 56, 27–53.

GOEL, M. (2012): "Does Offshoring Lift All Boats? The Role of Induced Technology Adoption and Innovation," *Working Paper*.

GOLDBERG, P., AND N. PAVCNIK (2007): "Distributional Effects of Globalization in Developing Countries," *NBER Working Paper 12885*.

GROSSMAN, G., AND E. ROSSI-HANSBERG (2008): "Trading Tasks: A Simple Theory of Offshoring," *American Economic Review*, 98(5), 1978–1997.

HAKOBYAN, S., AND J. MCLAREN (2016): "Looking for Local Labor Market Effects of NAFTA," *The Review of Economics and Statistics*, 98(4), 728 – 741.

HARRISON, A., AND G. HANSON (1999): "Who Gains from Trade Reform? Some Remaining Puzzles," *NBER Working paper 6915*.

KEHOE, T. J. (1995): "A Review of Mexico's Trade Policy from 1982 to 1994," *The World Economy*, 18, 135–151.

KUROKAWA, Y. (2011): "Variety-skill Complementarity: A Simple Resolution of the Trade-Wage Inequality Anomaly," *Economic Theory*, 46(2), 297–325.

MCGRATTAN, E., AND E. C. PRESCOTT (2009): "Openness, Technology Capital, and Development," *Journal of Economic Theory*, 144(6), 2454–2476.

PARRO, F. (2013): "Capital-Skill Complementarity and the Skill Premium in a Quantitative Model of Trade," *American Economic Journal: Macroeconomics*, 5(2), 72–117.

RIANO, A. (2009): "Trade, Technology Adoption and the Rise of the Skill Premium in Mexico," *Working Paper*.

RIPOLL, M. (2005): "Trade Liberalization and the Skill Premium in Developing Economies," *Journal of Monetary Economics*, 52(3).

ROBERTSON, R. (2004): "Relative Prices and Wage Inequality: Evidence from Mexico," *Journal of International Economics*, 64, 387–409.

SARAH FLOOD, MIRIAM KING, S. R., AND J. R. WARREN (2015): "Integrated Public Use Microdata Series, Current Population Survey: Version 4.0. [Machine-readable database]," Technical report, University of Minnesota.

SHAIKEN, H., AND S. HERZENBERG (1987): *Automation and global production: Automobile engine production in Mexico, the United States, and Canada*, vol. 26. Center for US-Mexican Studies, University of California, San Diego.

STEVEN RUGGLES, KATIE GENADEK, R. G. J. G., AND M. SOBEK (2015): "Integrated Public Use Microdata Series: Version 6.0 [Machine-readable database]," Technical report, University of Minnesota.

TENKATE, A. (1992): "Trade Liberalization and Economic Stabilization in Mexico: Lessons of Experience," *World Development*, 20(5), 659–672.

TREFLER, D., AND S. C. ZHU (2005): "Trade and Inequality in Developing Countries: A General Equilibrium Analysis," *Journal of International Economics*, 65(1), 21–48.

TYBOUT, J. R., AND M. D. WESTBROOK (1995): "Trade Liberalization and Dimensions of Efficiency Change in Mexican Manufacturing Industries," *Journal of International Economics*, 39, 53–78.

VERHOOGEN, E. (2008): "Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector," *Querterly Journal of Economics*, 123, 489–530.

WADDLE, A. (2017): "Trade, Technological Change, and the Skill Premium: The Case of Mexico," Working paper, University of Richmond.

Appendix

Additional Model Details

Households

Households in country k choose a consumption bundle $\{c\}_{i \in I}$ and bond holdings $(b_k^{'})$ to solve the following problem:

$$\max \sum_{t=0}^{\infty} \beta^t \sum_i log(c_{ki}) \tag{17}$$

s.t.

$$\sum_i P_{ki} c_{ki} + b_k^{'} = w_k^H H_k + w_k^L L_k + (1+r) b_k + \sum_i D_{ki} \tag{18}$$

In a given country, the households are identical and so in a closed economy, no bonds will be traded. Across countries, the endowment of high-skilled and low-skilled labor varies. In addition to the market clearing conditions laid out in the text, there will also be a bond market that must clear:

$$\sum_k b_k \quad = \quad 0 \tag{19}$$