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ABSTRACT

In this paper, we examine the increase in the relative wages of skilled workers in Mexico during the 1980s. We argue that rising wage inequality in Mexico is linked to capital inflows from abroad. The effect of these capital inflows, which correspond to an increase in outsourcing by multinationals from the United States and other Northern countries, is to shift production in Mexico towards relatively skill-intensive goods thereby increasing the relative demand for skilled labor. We study the impact of foreign direct investment (FDI) on the share of skilled labor in total wages in Mexico using state-level data on two-digit industries from the *Industrial Census* for the period 1975 to 1988. We measure the state-level growth in FDI using data on the regional activities of foreign-owned assembly plants. We find that growth in FDI is positively correlated with the relative demand for skilled labor. In the regions where FDI has been most concentrated, growth in FDI can account for over 50 percent of the increase in the skilled labor share of total wages that occurred during the late 1980s.

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1. Introduction

During the 1980s, the United States experienced a dramatic increase in wage inequality, as the wages of more-skilled workers increased relative to those of less-skilled workers (Bound and Johnson, 1992; Katz and Murphy, 1992; Juhn, Murphy, and Pierce, 1993). While there is general agreement that the relative-wage changes are due to an increase in the relative demand for skilled labor, economists are sharply divided over the source of the demand shift. Two explanations have dominated the debate. One is that the advent of computers and related technologies have caused firms to switch towards production techniques that are biased in favor of skilled workers (Davis Haltiwanger, 1991; Lawrence and Slaughter, 1993; Berman, Bound, and Griliches, 1994); the other is that an increase in import competition from low-wage countries has shifted resources towards industries which use skilled labor relatively intensively (Leamer 1993, 1994; Borjas and Ramey, 1994; Wood, 1994).

The literature has so far only considered the experiences of the United States and a few other advanced economies. This is surprising, given that both skill-biased technical change and increased foreign competition have global implications. In particular, little attention has been devoted to wage movements in the low-wage trading partners of the United States.[1] The evidence that does exist for recent periods suggests that these countries have experienced a similar rise in wage inequality. Feliciano (1993) finds that in Mexico a rise in the returns to education has contributed to an increase in the relative wage of skilled workers; over the period 1986-1990, the wages of manufacturing workers in the 90th wage percentile increased by 16

[1] Davis (1992) provides evidence on wage inequality in four middle-income countries, Brazil, Columbia, South Korea, and Venezuela. While he finds that all countries except Brazil show declines in wage inequality, he has data after 1986 for only one country (Columbia). Given that the largest increases in wage inequality in the United States and elsewhere occurred in the late 1980s, Davis' data do not permit a direct comparison.

percent relative to those in the 10th wage percentile. Robbins (1994) finds a similar pattern in Chile, where over the period 1980-1990 the wages of university graduates increased by 56.4 percent relative to those of high school graduates. We shall also report an increase in wage inequality for Mexico.

We argue that the rise in wage inequality across dissimilar countries is consistent with a third explanation: that capital flows from North to South, and a corresponding rise in outsourcing by Northern multinationals, have contributed to a worldwide increase in the relative demand for skilled labor. In a recent paper (Feenstra and Hanson, 1995), we develop a model which shows that capital flows from North to South, or more generally, any increase in the Southern capital stock relative to that in the North, can increase the relative wage of skilled labor in both regions. In our model, the output of each industry is produced using many inputs, each of which differ in their requirements of skilled and unskilled labor. If factor prices are not equalized between countries, then under plausible conditions the North specializes in inputs which are relatively intensive in skilled labor and the South specializes in inputs which are relatively intensive in unskilled labor. A flow of capital from North to South, which we identify as outsourcing by Northern firms, shifts an increasing portion of input production to the South. These activities outsourced to the South are, from the North's perspective, ones that use relatively large amounts of unskilled labor, but, from the South's perspective, are ones for which the reverse is true. The result is an increase in the relative demand for skilled labor in both countries, which, in turn, causes the relative wage of skilled labor to rise in both regions.

While the capital accumulation-outsourcing hypothesis has captured much attention in the popular press, it has been largely dismissed in the academic literature. Berman, Bound, and

Griliches (1994) claim that U.S. materials imports, which they use to measure foreign outsourcing, are too small to have impacted U.S. wages. Lawrence (1994) argues that the fact that U.S. multinationals have increased the relative employment of non-production workers abroad provides further support for the hypothesis that this shift is due to biased technological change. In our previous work, we take issue with the narrow definition of outsourcing these authors use, but we also feel that an equally important point has been ignored: from the perspective of the South foreign direct investment (FDI) represents a huge inflow of resources. In Mexico, FDI equaled 13.7 percent of total fixed investment in 1987 and 9.6 percent in 1989; and in China, FDI totaled 3.7 percent of gross domestic investment in 1988 and 7.9 percent in 1991. Foreign activities of this magnitude are sufficient to have had a major impact on recipient-country labor markets.

In this paper, we apply our model of trade and investment to study the effect of FDI on the relative demand for skilled labor in Mexico. Figure 1 shows the relative wages and employment of skilled and unskilled workers in Mexico for the period 1965-1988.[2] Since 1985, the wages of skilled workers have increased dramatically relative to those of unskilled workers. Mexico's recent policy reforms and its proximity to the United States make the country a particularly interesting case. In the early 1980s, the government dramatically relaxed restrictions on foreign investment. The result was a sudden infusion of foreign capital. A large share of FDI has gone into the creation of in-bond foreign assembly plants, known as *maquiladoras*, which are concentrated in the Mexico-U.S. border region. The FDI boom, then, has resulted in a region-

[2] We use non-production workers to identify skilled labor and production workers to identify unskilled labor. While there are well-known problems with this classification (Leamer, 1994), there is evidence which suggests that in practice it is successful in tracking employment by skill category (Berman, Bound, and Griliches, 1994; Sachs and Shatz, 1994).

specific shock to labor demand. The suddenness of the policy change and the subsequent regional concentration of FDI create a natural experiment of sorts, in which we can sharply identify the effects of foreign investment on relative labor demand. In contrast, if FDI were spread evenly across regions within a country, its effects on labor demand would be indistinguishable from those of other macro shocks.

We shall study the impact of FDI using state-level data on two-digit industries from the Mexico *Industrial Census* for the period 1975 to 1988. We measure the state-level growth in FDI using data on the regional activities of maquiladoras. To preview the results, we find that growth in FDI is positively correlated with the relative demand for skilled labor. In the regions where FDI was most concentrated, growth in FDI can account for over 50 percent of the increase in the share of skilled labor in total wages that occurred during the late 1980s. This is consistent with the hypothesis that outsourcing by multinationals has been a significant factor in the increase in the relative demand for skilled labor in Mexico, and we expect this hypothesis holds for other countries, as well.

2. Theory

A. Foreign Investment and Relative Wages

To motivate the empirical approach we take in the following section, we briefly outline the model in Feenstra and Hanson (1995). Consider a world economy with two countries, North and South, where each country i has fixed endowments of capital (K_i), skilled labor (H_i), and unskilled labor (L_i). For country i, let r_i be the return to capital, q_i be the wage to skilled labor, and w_i be the wage to unskilled labor. We assume initially that there is no international factor

mobility and that relative factor endowments are such that $r_S > r_N$ and $q_S/w_S > q_N/w_N$.[3]

There is a single final good, Y, which is assembled from a continuum of intermediate inputs, indexed by $z \in [0,1]$. Each unit of z requires $a_H(z)$ units of skilled labor and $a_L(z)$ units of unskilled labor, where the inputs are arranged such that $a_H(z)/a_L(z)$ is increasing in z. Each input is produced according to the production function,

$$x(z) = [\min\{\frac{L(z)}{a_L(z)}, \frac{H(z)}{a_H(z)}\}]^{\theta}[K(z)]^{1-\theta} \qquad (1.1)$$

where $L(z)$, $H(z)$, and $K(z)$ are the amounts of unskilled labor, skilled labor, and capital, respectively, used in the production of input z. The final good Y is then costlessly assembled according to the Cobb-Douglas function,

$$\ln Y = \int_0^1 \alpha(z) \ln x(z)\, dz \qquad (1.2)$$

where $\int \alpha(z)dz = 1$.

Let $c(w_i,q_i,r_i;z)$ be the minimum cost of producing one unit of x, which is given by

$$c(w_i, q_i, r_i; z) = B[w_i a_L(z) + q_i a_H(z)]^{\theta} r_i^{1-\theta} \qquad (1.3)$$

with B a constant. We assume that for fixed factor prices $c(w_i,q_i,r_i;z)$ is continuous in z. Figure 2 shows the minimum cost locus for the North as C_NC_N and for the South as C_SC_S. The absolute slopes of the loci are indeterminant, but, given relative factor prices, we know that C_SC_S lies below C_NC_N for inputs that use a low ratio of skilled to unskilled labor and that the reverse holds

[3] These assumptions are consistent with U.S. and Mexican wage data (see Feenstra and Hanson, 1995).

for inputs that use a high ratio.[4] Let z^* be the cutoff intermediate input, at which the minimum cost loci are equated; it is implicitly defined by

$$c(w_S, q_S, r_S; z^*) = c(w_N, q_N, r_N; z^*) \qquad (1.4)$$

The critical value z^* defines the trading equilibrium: the South produces inputs that are relatively intensive in the use of unskilled labor, $z \in [0, z^*)$, and the North produces inputs that are relatively intensive in the use of skilled labor, $z \in [z^*, 1]$.

We permit labor to be mobile between skill categories, such as may result from education or training opportunities that allow unskilled workers to become skilled workers. This implies the supply of each type of labor is responsive to the relative wage; specifically, $L_i'(q_i/w_i) \leq 0$ and $H_i'(q_i/w_i) \geq 0$. By Shephard's lemma, the demand for each factor is given by differentiating (1.3) with respect to its price. Labor market clearing requires that in the South

$$L_S(q_S/w_S) = \int_0^{z^*} B\theta \left[\frac{r_S}{w_S a_L(z) + q_S a_H(z)}\right]^{1-\theta} a_L(z) x_S(z)\, dz \qquad (1.5a)$$

and

$$H_S(q_S/w_S) = \int_0^{z^*} B\theta \left[\frac{r_S}{w_S a_L(z) + q_S a_H(z)}\right]^{1-\theta} a_H(z) x_S(z)\, dz \qquad (1.5b)$$

Full employment of capital in the South can be defined from the production function in (1.1), which implies that capital will receive share (1-θ) of national income,

$$r_S K_S = [w_S L_S + q_S H_S](1 - \theta)/\theta \qquad (1.6)$$

Since in equilibrium the price of an input equals its unit cost, the demand for an input produced

[4] We ignore the case where one locus lies entirely above another, since then there is no trade in inputs within this industry.

in the South is given by

$$x_S(z) = a(z)E/c_S(z), \qquad z \in [0, z^*) \qquad (1.7)$$

where E is total world expenditure on the final good Y. Conditions (1.4)-(1.6), along with the analogous full-employment conditions in the North, and world expenditure E equated to the sum of world factor payments define the world trading equilibrium.

To identify the effects of capital mobility on relative wages and employment, it is useful to define the relative demand for skilled and unskilled labor. Combining (1.6), (1.7), and (1.8), we define an expression for $D_S(q_S/w_S)$, the relative demand for skilled labor in the South,

$$D_S(q_S/w_S, z^*) = \frac{\int_0^{z^*} \left[\frac{a_H(z)\,a(z)\,E}{w_S a_L(z) + q_S a_H(z)}\right] dz}{\int_0^{z^*} \left[\frac{a_L(z)\,a(z)\,E}{w_S a_L(z) + q_S a_H(z)}\right] dz} \qquad (1.8)$$

An analogous condition, $D_N(q_N/w_N)$, defines relative labor demand in the North. Feenstra and Hanson (1995) show that the relative demand for skilled labor in both North and South is increasing in the critical value z^*. The intuition for the result is straightforward. An increase in z^* implies a shift in input production from North to South. In the South, the range of input production expands towards inputs that use a higher ratio of skilled to unskilled labor than previous activities. This causes an increase in average skill intensity, which, in turn, causes an increase in the relative demand for skilled labor. Conversely, the activities leaving the North use a lower ratio of skilled to unskilled labor than those remaining, which means the North also experiences an increase in the average skill intensity of production and an increase in the relative demand for skilled labor. It can also be shown that in both countries the relative demand for

skilled labor is decreasing in q_i/w_i.

Consider a movement of capital from North to South, which we interpret as an increase in outsourcing by Northern firms to the South. The immediate effect is to reduce r_S and raise r_N, from (1.6). At constant wages, C_SC_S shifts down and C_NC_N shifts up, as shown in Figure 2, causing z^* to increase. The movement of capital, of course, also changes wages in both countries, which affects the slopes of the minimum cost loci. Such feedback effects do not change the qualitative results shown in Figure 2: in general equilibrium, a capital flow from North to South raises z^*. Moreover, these results apply to any accumulation of capital in the South relative to the North.[5] From the results above, the increase in z^* implies that relative capital accumulation in the South causes an increase in the relative demand for skilled labor in both countries. We show this in Figure 3. The effect of capital accumulation on the relative wages of skilled workers is unambiguously positive; the effect on the relative employment of skilled labor is also positive, as long as the relative labor supply schedule is not vertical. Though wage inequality rises in both countries, it can be shown that it is still possible for workers in both countries to be better off, since the increase in Southern supply lowers its prices. It can also be shown that capital accumulation in the South causes the price-index of Northern inputs to increase relative to that of the Southern inputs.

B. An Empirical Model

To test the effects of foreign direct investment on relative wages and employment we develop a simple empirical model of labor demand. We study labor markets at the state and

[5] In Feenstra and Hanson (1995), we also show that these results apply to neutral technological progress in the South relative to the North.

industry level. Let total labor costs (or variable costs) for state i and industry j at time t be given by,

$$TVC_{ijt} = C(q_{ijt}, w_{ijt}, K_{ijt}, VA_{ijt}) \qquad (2.1)$$

where q_{ijt} is the wage paid to skilled labor, w_{ijt} is the wage paid to unskilled labor, K_{ijt} is the capital stock, and VA_{ijt} is value added. The restricted variable cost function approach is convenient, given we lack data on non-labor factor prices. It also permits direct comparison with the results from recent studies of relative labor demand in the U.S. (e.g., Berman, Bound, and Griliches, 1994). Applying Shephard's lemma to a translog approximation of (2.1) yields the following labor cost share equation (Brown and Christensen, 1981):

$$WSH_{ijt} = \beta_H + \beta_{VA}\ln(VA_{ijt}) + \delta_H\ln(q_{ijt}) + \delta_L\ln(w_{ijt}) + \beta_K\ln(K_{ijt}) + \eta_{ijt} \qquad (2.2)$$

where WSH_{ijt} is the share of skilled labor in total labor costs ($q_{ijt}H_{ijt}/(q_{ijt}H_{ijt} + w_{jt}L_{ijt})$ and η_{ijt} represents shocks to labor demand. Imposing the restriction that $C()$ is homogeneous degree one in input prices implies $\delta_H = -\delta_L \equiv \delta$. With two variable inputs, the analogous expression for the unskilled labor wage share is redundant and (2.2) represents the relative demand for skilled labor.

To control for region and industry-specific factors that affect the level of labor demand, we reexpress (2.2) in first-differenced form,

$$\Delta WSH_{ijt} = \beta_{VA}\Delta\ln(VA_{ijt}) + \delta\Delta\ln(q_{ijt}/w_{ijt}) + \beta_K\Delta\ln(K_{ijt}) + \Delta\eta_{ijt} \qquad (2.3)$$

where we impose homogeneity on the cost function. From the model we outline in the last section, FDI represents an observable shock to state-industry labor demand. The regressor, K_{ijt}, represents the total capital stock in state-industry ij, which we can write as the sum of the domestic capital stock, K^D_{ijt}, and the foreign capital stock, K^F_{ijt}. To identify the effects of foreign

capital accumulation on relative labor demand, we reexpress $\Delta ln(K_{ijt})$ as

$$\Delta \ln(K_{ijt}) = \Delta \ln(K^{D}_{ijt}) + \Delta \ln(1 + (K^{F}_{ijt} / K^{D}_{ijt})) \qquad (2.4)$$

Separating domestic and foreign capital in this way will allow us to estimate different coefficients on the two variables. Substituting (2.4) into (2.3), we arrive at the estimating equation,

$$\Delta WSH_{ijt} = \phi_1 \Delta \ln(VA_{ijt}) + \phi_2 \Delta \ln(K^{D}_{ijt}) + \phi_3 \Delta \ln\left(1 + \frac{K^{F}_{ijt}}{K^{D}_{ijt}}\right) + \phi_4 \Delta \ln\left(\frac{WA^{H}_{ijt}}{WA^{L}_{ijt}}\right) + \phi_5 \Delta \ln(RPOP_{it}) + \epsilon_{ijt} \qquad (2.5)$$

Regional labor demand may also be a function of location-specific factors, such as transportation infrastructure or proximity to consumer markets. These factors are unobserved to the econometrician and hence represent state-industry-specific fixed effects. As long as these factors are constant over time, they are eliminated by first differencing.

One issue for estimation is that state-industry relative wages are simultaneously determined with the skilled-labor wage share. To avoid simultaneity bias, we take a reduced-form approach, in which case we estimate the total effect of FDI on the skilled wage share, including its effects on relative wages. As shown in (2.5), we replace q_{ijt}/w_{ijt} with the relative alternative wage for skilled and unskilled workers in state-industry ij, $WA^{H}_{ijt}/WA^{L}_{ijt}$, where H indexes skilled workers and L indexes unskilled workers, and the population density, inhabitants per square kilometer, in state i relative to the national population density, $RPOP_{it}$. Both variables reflect labor supply. Relative population density captures inter-state differences in housing prices, which affect the willingness of labor to work in a location for a given nominal wage.

3. Relative Wages and Employment in Mexico

We study relative labor demand in a panel of nine two-digit (ISIC) industries in Mexico's 32 states over the period 1975 to 1988. Wage and employment data are available at five-year intervals from the Mexico *Industrial Census*. This provides three sets of observations on the change in the skilled labor share of total wages, 1975-1980, 1980-1985, and 1985-1988. During this period, Mexico dramatically reformed its trade policy and its regulations regarding foreign investment. To provide context for the empirical analysis that follows, we first briefly describe recent changes in Mexico's policy environment.

A. Trade and Investment Policy

Between 1950 and 1980, the Mexican government progressively tightened restrictions on foreign ownership and raised barriers to trade, as part of a conscious policy to promote the creation of a domestically-owned manufacturing base (Whiting, 1992). The government restricted trade through import tariffs, import-license requirements, and export controls; it regulated foreign ownership by subjecting foreign investment activities to official approval and by imposing a 49 percent ownership cap on foreign holdings in individual firms.[6] Restrictions on foreign investment reached their peak in the 1970s, when the government engaged in a concerted effort to 'Mexicanize' industry by pressuring foreign owners to sell their holdings to Mexican nationals.

Mexico liberalized its trade and investment policies in the 1980s, partly in response to a balance of payments crisis. In 1983, the government began to relax the foreign ownership cap and expedite the approval of foreign investment projects; the foreign investment law was formally

[6] In practice, the government applied the 49 percent cap on a case by case basis, which caused de facto restrictions on foreign investment to vary widely across presidential administrations.

changed in 1989 (Peres, 1992). The government also eliminated many regulations governing maquiladoras (Wilson, 1992). All along, these plants had been exempt from foreign ownership limitations and allowed to import inputs duty free, but the bureaucratic steps necessary to obtain these benefits were burdensome.[7] The 1983 reform streamlined the process of obtaining legal recognition as a maquiladora. In 1985, the government began to liberalize trade and announced plans to join the General Agreement on Trade and Tariffs (GATT). At the initiation of reform, the national weighted-average tariff was 23.5 percent, import-license requirements covered 92.2 percent of national production, and there were export controls on 85 percent of non-oil exports. By 1987, the government had reduced import-license coverage to 25.4 percent of production, cut the average tariff to 11.8 percent, with a 20 percent maximum rate, and abolished export controls.

Following the reforms, there was a dramatic increase in FDI in Mexico. Figure 4 shows that between 1983 and 1989 FDI in Mexico increased from $478 million to $3,635 million; the share of FDI in total investment increased from 1.42 percent to 9.68 percent.[8] A major destination for FDI was the creation of maquiladoras. Figure 5 shows that between 1983 and 1990 employment in maquiladoras increased from 150,867 workers to 460,293 workers, as the

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[7] The significance of the maquiladora designation is that it allows a plant that engages in export production to avoid paying value-added taxes on domestic inputs and import duties on imported inputs (the plant posts a bond with the government equal to the value of the import duty, which is returned to it once the plant exports the output made from the inputs -- hence the term "in-bond"). A primary motivation for the maquiladora regime is to take advantage of Item 807 of the Tariff Schedule of the United States, which exempts firms that engage in off-shore assembly of U.S. manufactured components from paying import duties on the value of the product in excess of the value-added abroad. To qualify for the 807 exemption, a firm must have a U.S. base of operations. This requirement has given rise to the twin-plant arrangement, in which a plant on the U.S. side of the border supplies an assembly plant on the Mexican side with U.S. manufactured inputs and then imports the final output.

[8] Our measure of FDI is from the National Commission on Foreign Investment, which collects data from foreign firms on new investments and reinvestments from retained earnings (*La Economia Mexicana en Cifras, 1990*). This measure does not include real estate purchases or other asset acquisitions unrelated to investment in plant and equipment; hence, it is preferable to the standard measure of FDI obtained from the balance of payments.

share of maquiladora workers in national manufacturing employment increased from 4.90 percent to 18.96 percent. The majority of assembly plants are located in states along the Mexico-U.S. border; in 1990, the border region contained 90.25 percent of total assembly employment and 87.84 percent of total assembly plants. Most maquiladoras assemble one of four product types: apparel, auto parts, domestic appliances, and electronics. Apparel is in ISIC 32 (textiles and apparel) and the other three products are in ISIC 38 (metal products) and 39 (other industries). In 1990, 63.34 percent of total assembly employment was in one of these three industries.

B. Variable Definition

The unit of observation at which we study relative labor demand is the state-industry. We measure the employment of skilled (unskilled) workers as the average annual employment of non-production (production) workers, and the wage paid to skilled (unskilled) labor as the average annual wage of non-production (production) workers. The skilled labor wage share is then measured as non-production wages as a share of total wages.

We measure the alternative wage for skilled labor -- appearing as WA^H in (2.5) -- as the average annual state wage in professional services and the alternative wage for unskilled labor -- appearing as WA^L in (2.5) -- as the average annual state wage in food services. Given data limitations, we measure value added and the change in the domestic capital stock at the national industry level, using data from Mexico's *System of National Accounts*. We use fixed capital investment to measure changes in the domestic capital stock. This measure overstates investment, as it does not account for depreciation, but no other industry-level measure of capital is available. Investment data are unavailable before 1980 and are not available at all for two industries, food

products (ISIC 31) and paper and printing (ISIC 34).

There is no comprehensive measure of foreign direct investment in Mexico at the state or industry level. We obtain a state-level measure of foreign investment by exploiting the fact that much FDI in Mexico has taken the form of investments in maquiladoras. Annual state-level data on the number of assembly plants are available for the period 1975-1988. We measure the ratio of the foreign capital stock to the domestic capital stock (K^F_{ijt}/K^D_{ijt}) as the ratio of the number of maquiladoras in a state to the number of manufacturing establishments in a state.

An issue for estimation is whether FDI should be treated as an endogenous variable. At the national level, inflows of foreign capital are determined by international differences in the return to capital, which are clearly exogenous to local labor markets. The allocation of FDI across states within a country, however, may be a function of local factor market conditions. We address the issue by taking an instrumental variables approach to estimating (2.5).

The importance of imported inputs in foreign assembly suggests several instruments for (K^F_{ijt}/K^D_{ijt}). Assembly plants do not produce any raw materials. Rather, they obtain inputs from foreign parent firms, most of which are located in the United States, and ship final goods back to the parent firm for distribution abroad. The importance of inter-firm, cross-border trade suggests that transport costs are a major consideration in the maquiladora location decision. We use transport costs as an instrument for FDI. Since the major market for maquiladoras is the United States, we measure transport costs as distance from a Mexican state capital to the nearest U.S. border crossing. Proximity to large domestic markets, all else equal, is likely to discourage export activity. Since Mexico City is the country's largest market, we also use distance from a state's capital to Mexico City as an instrument. The in-bond provision governing assembly

activities (see note 7) suggests that maquiladoras are a more desirable vehicle for foreign investment the higher are tariffs on imported inputs. As a third instrument, we use the industry-weighted average tariff on imported inputs (measured at the state level).

C. Relative Wages and Employment in Mexico

Table 1 reports summary statistics for the logarithmic annual rates of change in the three subperiods. The means for the change in the non-production wage share reproduce the findings in Figure 1; the non-production wage share began to rise after 1975, with the most rapid increase occurring during the late 1980s. During much of the period the non-production wage share was rising, output growth was slow or nonexistent and domestic investment was falling. There was, however, a dramatic increase in maquiladora activities. Between 1985 and 1988, the number of maquiladoras in Mexico increased at an average annual rate of 17.84 percent and assembly employment grew at an average annual rate of 18.52 percent.

Assembly activity, as we have shown, is highly concentrated in the Mexico-U.S. border region. In the early phases on the maquiladora program, government policy confined assembly plants to designated zones, most of which were located in border states. Even with the lifting of the restriction in 1971, assembly plants have continued to locate in the border. This is consistent with our reasoning about the importance of transport costs in maquiladora activities.

The model outlined in section 2 predicts that the relative demand for skilled labor will be positively correlated with foreign investment. Given the regional concentration of maquiladora activity, we expect the border region, all else equal, to have experienced the largest increase in relative labor demand. Table 2 shows relative wages and the non-production wage share by

region for the period 1975-1988. We divide Mexico into five regions running north to south: the Border contains states that border the United States; the North contains the next tier of states; the Center contains states surrounding Mexico City; Mexico City contains the two states the capital occupies; and the South contains all states south of the capital. Consistent with the predictions of the model, over the period 1985-1988 the border region had the largest increase in relative wages and in the non-production wage share. Further, in both 1985 and 1988 the border had the highest relative wages and the second highest non-production wage share.[9]

The wage figures in Table 2 do not control for regional differences in industry composition. It may be that industries which use a relatively high ratio of skilled to unskilled labor have concentrated in the border, for whatever reason. To control for such effects, we calculate the regional average wage differential and the regional average wage share differential. The regional average wage differential is defined as the weighted sum of the log difference between the state-industry relative wage and the national industry average relative wage, where weights are the state-industry share of the regional wage bill. The regional average wage share differential is defined as the weighted sum of the difference between the state-industry non-production wage share and the national industry average non-production wage share, again using shares of the regional wage bill as weights. Table 3 reports the results. Controlling for industry, over the period 1985-1988 the border experienced the largest increase in the non-production wage share and the second largest increase in relative wages. In 1988, the industry-adjusted relative wage for the border region was 11.07 percent higher than relative wages in other regions.

One possibility is that the border's high relative wages for non-production labor reflect the

[9] The region with the highest non-production wage share is Mexico City. Mexico City has the country's highest concentration of non-maquiladora foreign-owned plants (Aitken, Hanson, and Harrison, 1994).

tendency of maquiladoras to hire a disproportionately large share of female production workers. Maquiladoras have earned a reputation in the popular press as "sweat shops" that employ teenage girls and pay extremely low wages. While the majority of production workers in maquiladoras are female, the female share of employment has been declining over time, from 77.3 percent of production workers in 1980 to 63.1 percent in 1988. Even with the decline in the female share of production workers, the relative wage of non-production workers in assembly plants has risen, from 2.26 in 1980 to 3.01 in 1988. This suggests that the gender composition of the maquiladora labor force is not responsible for the relative-wage increases on the border.

Still, it is worth comparing wage levels in maquiladoras and general manufacturing plants. To control for variation in nominal wages across regions, we limit the comparison to plants in the border region. We also control for the fact that maquiladoras are concentrated in certain industries. Table 4 reports the ratio of average maquiladora wages to average manufacturing wages by skill type and the ratio of the average maquiladora non-production wage share to the average manufacturing non-production wage share. We calculate these ratios for two samples of border industries: all manufacturing industries and the three two-digit industries in which maquiladoras are concentrated. While maquiladoras on average pay production workers lower wages when compared to all manufacturing industries, they actually pay higher wages in recent years when compared to similar manufacturing industries. The relative demand for skilled labor is higher in maquiladoras than in general manufacturing plants. In 1988, the non-production wage share in maquiladoras was 5.0 percent larger than that in all manufacturing industries and 2.2 percent larger than that in similar manufacturing industries.

4. Empirical Results

We report OLS and IV estimation results for equation (2.5). Observations are by state-industry for the periods 1975-1980, 1980-1985, and 1985-1988. The total number of observations is 768, rather than the potential 864 (3x9x32), since three industries (chemicals, iron and steel, and other industries) have zero production in certain states in all years.[10]

In Table 5 we report OLS results of equation (2.5) without industry, year, or time dummies. The coefficient on the maquiladora variable (ΔlnMAQ) is positive and significant in all regressions. This is consistent with the hypothesis that FDI is associated with an increase in the relative demand for skilled labor, leading to an increase in its wage share. In the first three columns, which exclude domestic investment, the magnitude of the maquiladora coefficient ranges from 1.96 to 2.19. The economic effect of FDI implied by these estimates is substantial. Since maquiladora activities are concentrated in the border, it is appropriate to consider the implied importance of the growth in assembly activities for that region alone. Over the period 1985-1988, the total change in the non-production wage share for the border region was 0.0557.[11] Multiplying the smallest estimated maquiladora coefficient times the log change in the maquiladora variable for the border (1.962*0.0148) implies that FDI can account for an estimated 52.3 percent of the increase in the region's non-production wage share.

In the last column of Table 5, we include investment, which substantially reduces the

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[10] Alternative wage measures are unavailable for Baja California in certain years, which further reduces the sample size.

[11] This value for the change in the non-production wage share excludes Baja California, since data availability prevent the inclusion of industries for that state in the estimation (see note 10). The value for the change in the non-production wage share obtained from Table 1, which is calculated using the entire sample of state-industries, is slightly lower.

sample size, given we have no observations on the variable before 1980 or for two of the two-digit industries. The coefficient on maquiladora activities is again positive and significant, and its value increases to 4.73. The larger coefficient estimate reflects, in part, the fact that the increase in the non-production wage share has been larger outside of the two industries excluded from the regression (food products and wood and paper products).

The results on value added ($\Delta \ln VA$) in Table 5 indicate that the output elasticity of labor demand is higher for skilled labor than for unskilled labor. This result is consistent with other work on the demand for skilled and unskilled labor in developing countries (Roberts and Skoufias, 1994). Output growth provides an alternative explanation for the increase in the relative demand for skilled labor. It is apparent in Table 1, however, that output changes alone cannot account for the increase in the non-production wage share. During 1980-1985 and 1985-1988, when the non-production wage share increased most, output growth was minimal.

In Table 6 we report instrumental variables results for equation (2.5), in which we treat the change in maquiladora activities as endogenous. In addition to the other right-hand side variables in the regression, we include log distance to the nearest U.S. border crossing, log distance to Mexico City, and the log change in the industry weighted-average tariff on imported inputs as instruments.[12] For each regression we report the test statistic for a Hausman specification test. Given the instruments that are available, we find no evidence of endogeneity. In all regressions, we fail to reject the null hypothesis that the maquiladora variable is uncorrelated with the error term.

We also consider the possibility that there have been exogenous changes in relative labor

[12] Tariff measures are only available for 1980 and later years, which excludes the subperiod 1975-1980 from the sample.

demand, which vary systematically across industries, regions, or years. In Table 7 we report regression results in which we include industry, year, and region dummy variables in the estimation. The main change from Table 5 is that the coefficient on domestic investment is now statistically significant. The maquiladora variable remains positive and statistically significant, with coefficient estimates similar to those in the previous regressions. Consistent with our main hypothesis, capital accumulation, whether domestic or foreign, is associated with an increase in the relative demand for skilled labor.

The results on the time dummies stand in contrast to those for the United States. Berman, Bound, and Griliches (1994) find a significant increase in the non-production wage share over time, which they interpret as evidence of skill-biased technical change. We find no such temporal variation in the non-production wage share for Mexico, once other factors have been accounted for. It is also notable that none of the regional dummy variables are significant. This suggests that regional factors, such as possibilities for emigration to the United States, have played little role in the increase in relative demand for skilled labor.

Finally, in Table 8 we replace the change in the non-production wage share as the dependent variable with the log change in the relative wage of non-production workers and the log change in the relative employment of non-production workers. This allows us to determine whether the increase in the non-production wage share has been due to changes in the relative wages of skilled workers, changes in the relative employment of skilled workers, or both. The coefficient on the maquiladora variable is positive and significant in the two relative wage regressions, but it is statistically insignificant in the two relative employment regressions. It appears that the predominant effects of FDI have been on relative wages and not on relative

employment. Returning to Figure 3, this would be consistent with a situation where the relative labor supply schedule is vertical, or nearly so. In such a case, increases in the relative demand for skilled workers cause relative-wage changes, but not relative-employment changes.[13]

The regression results are consistent with the idea that the primary force behind the increase in the non-production wage share in Mexico has been foreign direct investment and the corresponding increase in activities by multinationals. The link between FDI and maquiladora activities creates a large regional component to the relative demand for skilled labor. Furthermore, there appears to be no cross-industry component to the relative labor demand shift; that is, the increase in the relative demand for skilled labor in Mexico is a *within-industry* phenomenon. To show this directly, we decompose the change in the non-production wage share, in a manner similar to that in Berman, Bound, and Griliches (1994). The non-production wage share in manufacturing can be written as the weighted sum,

$$WSH = \sum_i \gamma_i \, WSH_i$$

where i indexes the industry, WSH is the non-production wage share, and γ_i is national industry i's share of total wages. By taking first differences, we obtain,

$$\Delta WSH = \sum_i \overline{\gamma}_i \Delta WSH_i + \sum_i \Delta\gamma_i \overline{WSH}_i$$

where a bar represents the mean value for the period. The first expression is the change in the non-production wage share due to changes in the wage share within industries; the second

[13] While there was little change in the relative employment of non-production workers in the late 1980s, there was considerable change in the absolute employment of both non-production and production workers. Over the period 1985-1988 in the border region, for instance, employment of non-production workers increased by 7.1 percent and employment of production workers increased by 7.8 percent. The lack of relative employment changes may be attributable to lags in the process of production workers acquiring the necessary skills to become non-production workers.

expression is the change in the non-production wage share due to between industry shifts in employment. The results for the three sub-periods are presented in Table 9. Within industry changes in the wage share account for 92.1 percent of the total change in the non-production wage share over the period 1980-1985 and for 92.92 percent of the total change over the period 1985-1988. This is consistent with the model we outline in section 2, in which the increase in the relative demand for skilled labor occurs within industries.

5. Conclusion

The results we present in this paper suggest that, contrary to the prevailing view in the literature, foreign direct investment has important consequences for the relative wages and employment of skilled and unskilled workers. We find that in Mexico over the period 1975-1988, FDI is positively correlated with the relative demand for skilled labor and that it can explain a large portion of the increase in the skilled labor share of total wages. Foreign production activities in Mexico are primarily the result of outsourcing by U.S. multinationals. The implications of FDI for labor demand in the United States have been downplayed, due mainly to the belief that outsourcing accounts for a small share of U.S. materials purchases. Our findings cast doubt on this view. FDI into Mexico has been of a sufficient magnitude to have had substantial effects on the country's labor market. It is worthwhile, then, to reconsider the scale of outsourcing by U.S. multinationals and to further assess it effects on recipient countries.

In addition, the manner in which FDI has affected relative labor demand in Mexico suggests that the tendency in the literature to disassociate trade with within-industry labor demand shifts is unwarranted. The increase in the skilled labor share of total wages in Mexico, as in the

United States, has been almost entirely the result of within-industry changes in wage shares, rather than between-industry shifts in employment. Berman, Bound, and Griliches (1994) argue that such within-industry shifts are inconsistent with foreign outsourcing as an explanation for the increase in the relative demand for skilled labor, due presumably to Stolper-Samuelson-type arguments about how trade affects sectoral employment. Our findings provide evidence to the contrary. Within-industry labor demand shifts are perfectly consistent with increased outsourcing in particular, and with increased trade in general.

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Table 1: Average Annual Rates of Change in Mexican Variables, 1975-1988

Year	WSH	ΔWSH	ΔlnVA	ΔlnINVD	ΔlnMAQ
1975	0.372				
1980	0.375	0.058	6.377		0.150
1985	0.388	0.256	1.220	-7.987	0.143
1988	0.414	0.866	0.248	-1.067	0.840

Notes:

The sample is nine two-digit (ISIC) industries in Mexico's 32 states. WSH and ΔWSH are weighted averages, where weights are the state-industry share of the total wage bill.

Variables are defined as:

WSH	=	Non-production labor share of total wages.
ΔWSH	=	Average annual change in WSH x 100.
ΔlnVA	=	Average annual log change in national industry value added x 100.
ΔlnINVD	=	Average annual log change in national industry domestic investment x 100.
ΔlnMAQ	=	Average annual log change in (1 + maquiladora establishments/total manufacturing establishments) x 100.

Source: Authors' calculations based on data from the Mexico *Industrial Census*, various years.

Table 2: Relative Wages and Wage Shares By Region, 1975-1988

Region	Year	Non-Production Wage/ Production Wage		Non-Production Share of Total Wages	
		Level	% Change*	Level	Change**
Border	1975	2.104		0.342	
	1980	2.048	-0.537	0.365	0.477
	1985	2.073	0.245	0.373	0.154
	1988	2.517	6.464	0.415	1.398
North	1975	1.963		0.304	
	1980	1.964	0.011	0.335	0.632
	1985	1.813	-1.599	0.358	0.453
	1988	2.085	4.659	0.353	-0.178
Center	1975	1.838		0.313	
	1980	1.824	-0.156	0.330	0.329
	1985	1.719	-1.181	0.341	0.230
	1988	1.884	3.048	0.363	0.733
Mexico	1975	2.145		0.416	
City	1980	2.022	-1.185	0.410	-0.117
	1985	1.772	-2.634	0.435	0.482
	1988	2.137	6.237	0.466	1.055
South	1975	2.090		0.288	
	1980	1.518	-6.400	0.292	0.075
	1985	1.530	0.159	0.313	0.425
	1988	1.699	3.490	0.330	0.568

* % Change is the annual average log change between the current and preceding year x 100.

** Change is the annual average change between the current and preceding year x 100.

Source: Authors' calculations based on data from the Mexico *Industrial Census*, various years.

Table 3: Industry-Adjusted Relative Wages and Wage Shares By Region, 1975-1988

Region	Year	RLWGE	Change	WGESH	Change
Border	1975	-0.752		-2.941	
	1980	-1.054	-0.060	-1.357	0.317
	1985	10.305	2.272	-1.886	-0.106
	1988	11.071	0.255	-0.989	0.299
North	1975	-1.791		-4.518	
	1980	1.985	0.755	-3.219	0.260
	1985	2.895	0.182	-1.817	0.280
	1988	-2.845	-1.913	-4.460	-0.881
Center	1975	-15.450		-4.210	
	1980	-10.465	0.997	-4.324	-0.023
	1985	-7.442	0.605	-3.940	0.077
	1988	-11.706	-1.421	-4.055	-0.038
Mexico	1975	2.320		3.285	
City	1980	4.152	0.366	3.478	0.038
	1985	-2.414	-1.313	4.288	0.162
	1988	1.948	1.454	5.048	0.253
South	1975	3.216		-4.409	
	1980	-18.298	-4.303	-7.784	-0.675
	1985	-9.047	1.850	-7.407	0.075
	1988	-10.012	-0.322	-7.811	-0.134

Notes:

Figures are the regional weighted sums of variables defined below, where weights are the state-industry share of the regional wage bill (relative wage = non-production wage/production wage; non-production wage share = non-production wages/total wages).

RLWGE = [log (state-industry relative wage/national industry relative wage)] x 100

WGESH = [state-industry non-production wage share - national industry non-production wage share] x 100

Change is the annual average change between the current and preceding year.

Source: Authors' calculations based on data from the Mexico *Industrial Census*, various years.

Table 4: Wages and Wage Shares in Maquiladoras versus General Manufacturing Plants: Border States, 1975-1988

Average Maquiladora Level/Average Manufacturing Level

Year	Relative Non-Production Wage	Relative Production Wage	Relative Non-Production Wage Share
1975	0.949	0.836	0.892
1980	0.869	0.727	0.898
1985	1.045	0.816	1.086
1988	1.093	0.920	1.051

Average Maquiladora Level/Average Level for Selected Industries

Year	Relative Non-Production Wage	Relative Production Wage	Relative Non-Production Wage Share
1975	0.977	0.937	0.971
1980	0.961	0.845	1.020
1985	0.963	0.935	1.030
1988	0.976	1.013	1.022

Notes:

Wage levels and wage shares used to calculate ratios are for border states only.

Selected Industries are textiles and apparel (ISIC 32), metal products (ISIC 38), and other industries (ISIC 39).

Source: Authors' calculations based on data from the Mexico *Industrial Census*, various years.

Table 5: OLS Estimates for Change in Non-Production Wage Share
(standard errors in parentheses)

Variable	(1)	(2)	(3)	(4)
ΔlnMAQ	1.9624* (0.8727)	2.1620** (0.8726)	2.1978* (0.8755)	4.7314** (1.1484)
ΔlnKD				0.0004 (0.0007)
ΔlnVA		0.1029** (0.0390)	0.0995* (0.0401)	0.4257** (0.1173)
ΔlnRPOP			0.0795 (0.1040)	0.2979 (0.1746)
ΔlnALTWG			-0.0041 (0.0108)	-0.0018 (0.0153)
Adjusted R^2	0.005	0.013	0.011	0.066
Number of Observations	768	768	768	392

* (**) Indicates significance at the five (one) percent level.

Variable Definitions:

ΔWSH = Change in non-production wage share in state-industry.

ΔlnMAQ = Change in log (1 + number of maquiladoras in state/number of manufacturing establishments in state).

ΔlnKD = Log of cumulative national industry domestic investment.

ΔlnVA = Change in log national industry value added.

ΔlnRPOP = Change in log relative population density. (Relative population density = population per square km. in state/population per square km. in nation.)

ΔlnALTWG = Change in log relative alternative wage. (Alternative wage = average state wage in professional services/average state wage in food services.)

Time periods in sample: 1975-1980, 1980-1985, 1985-1988. All variables in annual averages.

Table 6: Instrumental Variables Estimates for Change in Non-Production Wage Share
(standard errors in parentheses)

Variable	(1)	(2)	(3)	(4)
ΔlnMAQ	2.5579 (2.0378)	4.0615* (2.0302)	5.3214* (2.0182)	6.4294** (2.3500)
ΔlnKD				0.0004 (0.0007)
ΔlnVA		0.4021** (0.0934)	0.3996** (0.0939)	0.4351** (0.1182)
ΔlnRPOP			0.2284 (0.1473)	0.3125 (0.1760)
ΔlnALTWG			-0.0168 (0.0132)	-0.0041 (0.0155)
Hausman Specification Test Statistic	0.137	-0.617	-1.290	-0.734
Adjusted R^2	0.011	0.039	0.033	0.060
Number of Observations	514	514	514	392

* (**) Indicates significance at the five (one) percent level.

Notes:

In addition to the other right-hand side variables in the regression, we include log distance to the nearest U.S. border crossing, log distance to Mexico City, and the log change in the industry weighted-average tariff on imported inputs as instruments.

The Hausman test statistic is for a t-test. The version of the Hausman test we use is to regress the suspect endogenous variable on all of the instruments, obtain the residuals from the regression, and include the residuals in the regression of interest. Under the null that the suspect variable is uncorrelated with the error term, the coefficient on the residuals is zero.

Table 7: OLS Estimates for Change in Non-Production Wage Share, With Industry, Region, Year, Dummies
(standard errors in parentheses)

Variable	(1)	(2)	(3)	(4)
ΔlnMAQ	2.0680*	2.0759*	2.0022*	3.8900**
	(0.9615)	(0.9612)	(0.9637)	(1.2657)
ΔlnKD				0.0304*
				(0.0121)
ΔlnVA		0.1347**	0.1331*	0.4432*
		(0.1074)	(0.1074)	(0.1729)
ΔlnRPOP			0.1356	0.4786*
			(0.1188)	(0.2211)
ΔlnALTWG			-0.0016	0.0027
			(0.0113)	(0.0158)
Year Dummies:				
1980-1985	-0.0004	0.0066	0.0067	
	(0.0032)	(0.0065)	(0.0065)	
1985-1988	-0.0055	0.0030	0.0031	-0.0040
	(0.0032)	(0.0076)	(0.0076)	(0.0047)
Regional Dummies:				
Border	0.0030	0.0030	0.0065	0.0140
	(0.0059)	(0.0059)	(0.0067)	(0.0114)
North	-0.0014	-0.0014	0.0019	0.0108
	(0.0058)	(0.0058)	(0.0064)	(0.0107)
Center	0.0018	0.0018	0.0049	0.0125
	(0.0054)	(0.0054)	(0.0060)	(0.0100)
South	-0.0037	-0.0037	-0.0009	-0.0031
	(0.0055)	(0.0055)	(0.0060)	(0.0099)
Adjusted R^2	0.036	0.019	0.019	0.097
Number of Observations	768	768	768	392

* (**) Indicates significance at the five (one) percent level. Industry dummies are not shown.

Table 8: OLS Estimates for Change in Relative Non-Production Wage and Change in Relative Non-Production Employment
(standard errors in parentheses)

Variable	ΔlnRLWG	ΔlnRLWG	ΔlnRLEMP	ΔlnRLEMP
ΔlnMAQ	14.9426*	9.8224*	-2.1319	-2.6539
	(4.0719)	(4.4974)	(4.5834)	(5.0672)
ΔlnKD	-0.0003	0.0234	-0.0003	0.0699
	(0.0024)	(0.0407)	(0.0028)	(0.0459)
ΔlnVA	0.1806	0.5291	1.0734*	0.4322
	(0.3958)	(0.5914)	(0.4455)	(0.6664)
ΔlnRPOP	-0.3627	-0.7064	1.1269	2.1868*
	(0.5903)	(0.7553)	(0.6645)	(0.8510)
ΔlnALTWG	0.0164	-0.0353	0.0522	0.1062
	(0.0513)	(0.0530)	(0.0576)	(0.0597)
Year Dummies:				
1985-1988		0.0030		-0.0531
		(0.0076)		(0.0176)
Regional Dummies:				
Border		-0.0211		0.0876*
		(0.0383)		(0.0431)
North		-0.0297		0.0556
		(0.0365)		(0.0411)
Center		-0.0274		0.0627
		(0.0338)		(0.0381)
South		-0.0400		0.0283
		(0.0335)		(0.0378)
Adjusted R^2	0.027	0.051	0.017	0.041
Number of Observations	383	383	383	383

* (**) Indicates significance at the five (one) percent level. Industry dummies are not shown.

ΔlnRLWG = Change in log average non-production wage/average production wage.
ΔlnRLEMP = Change in log non-production employment/production employment.

Table 9: Decomposition of Changes in the Non-Production Wage Share, 1975-1988

Year	WSH	ΔWSH	Portion of ΔWSH due to: Between-Industry Employment Shifts	Within-Industry Wage Changes
1975	0.372			
1980	0.375	0.292	0.342	-0.050
1985	0.388	1.279	0.101	1.178
1988	0.414	2.597	0.184	2.413

Variable definitions:

WSH	=	Non-production labor share of total wages.
ΔWSH	=	Change in WSH between current and preceding period x 100.

Source: Authors' calculations based on data from the Mexico *Industrial Census*, various years.

Figure 1: Relative Wages and Employment in Mexican Manufacturing

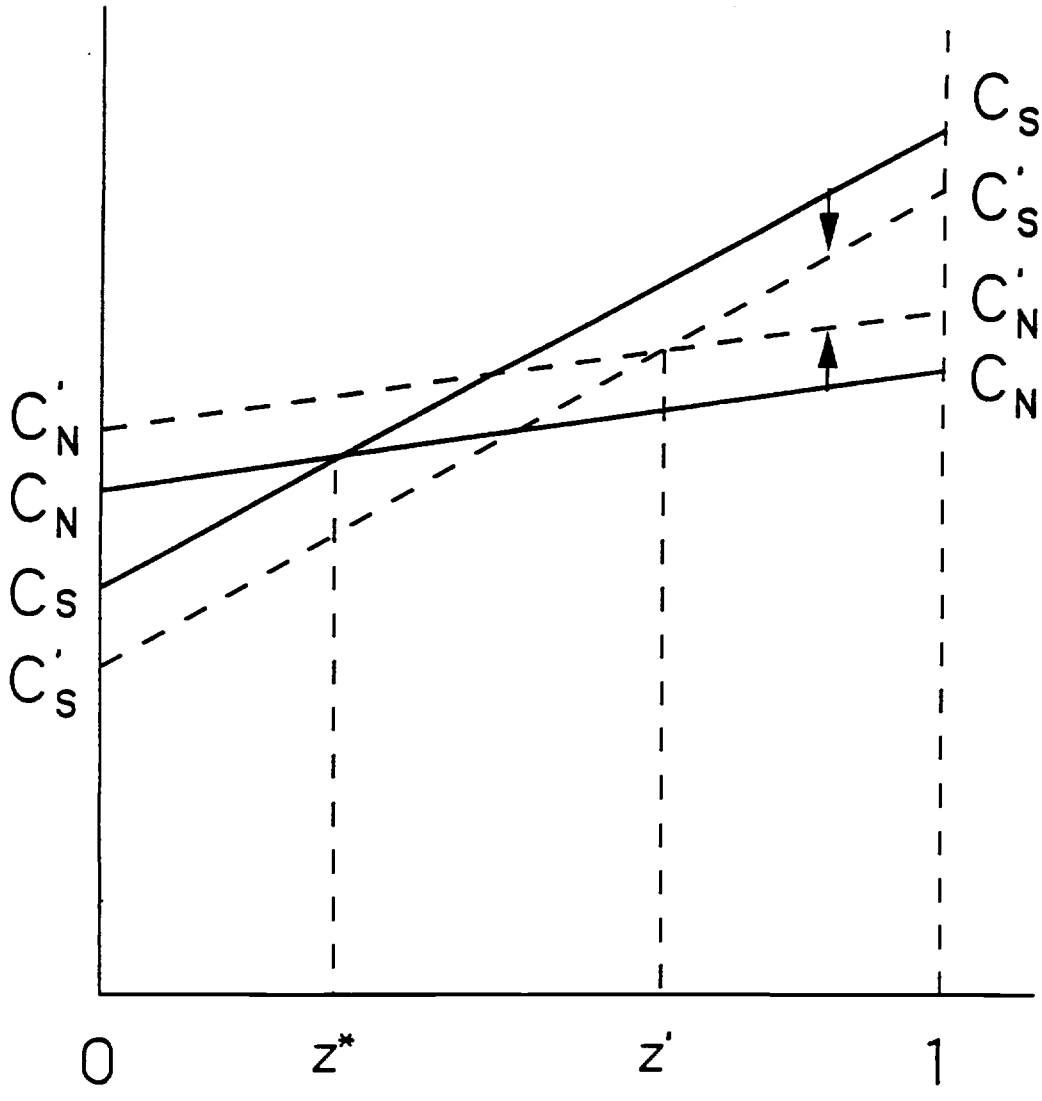

Figure 2

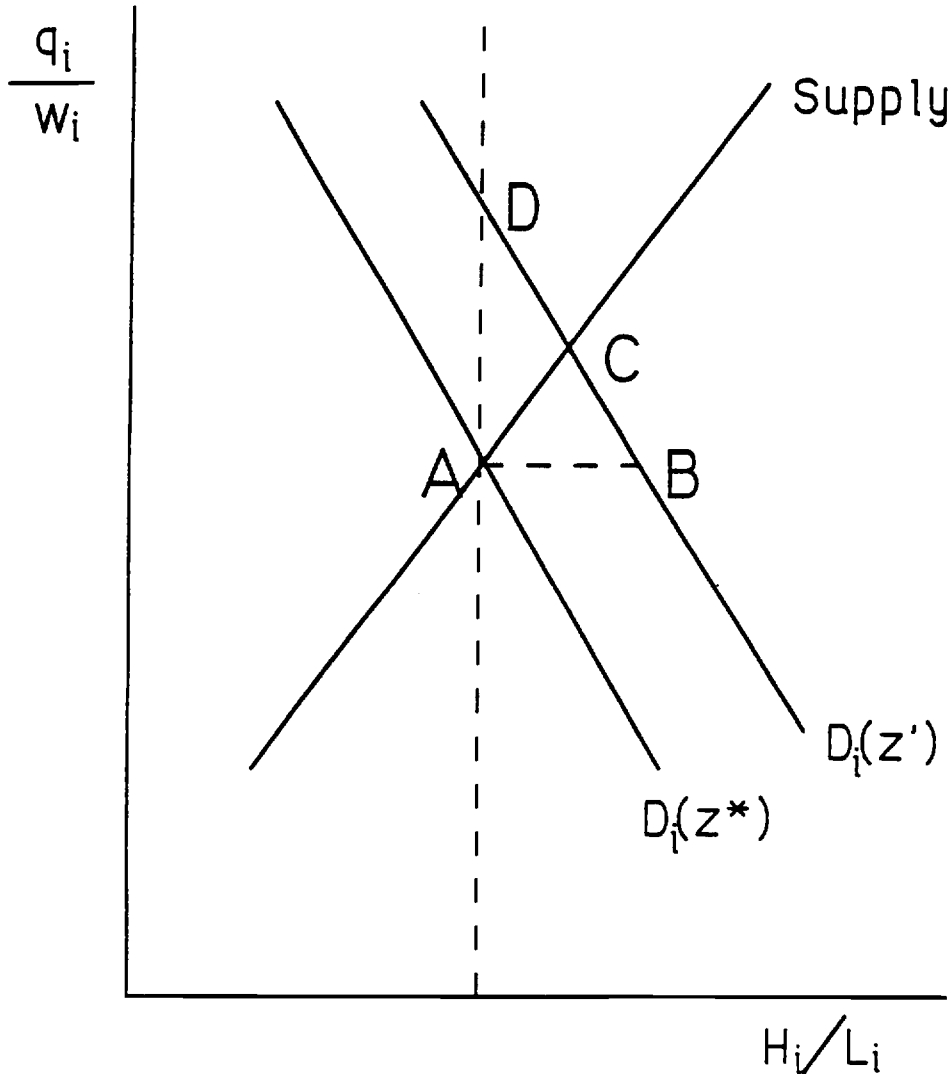

Figure 3

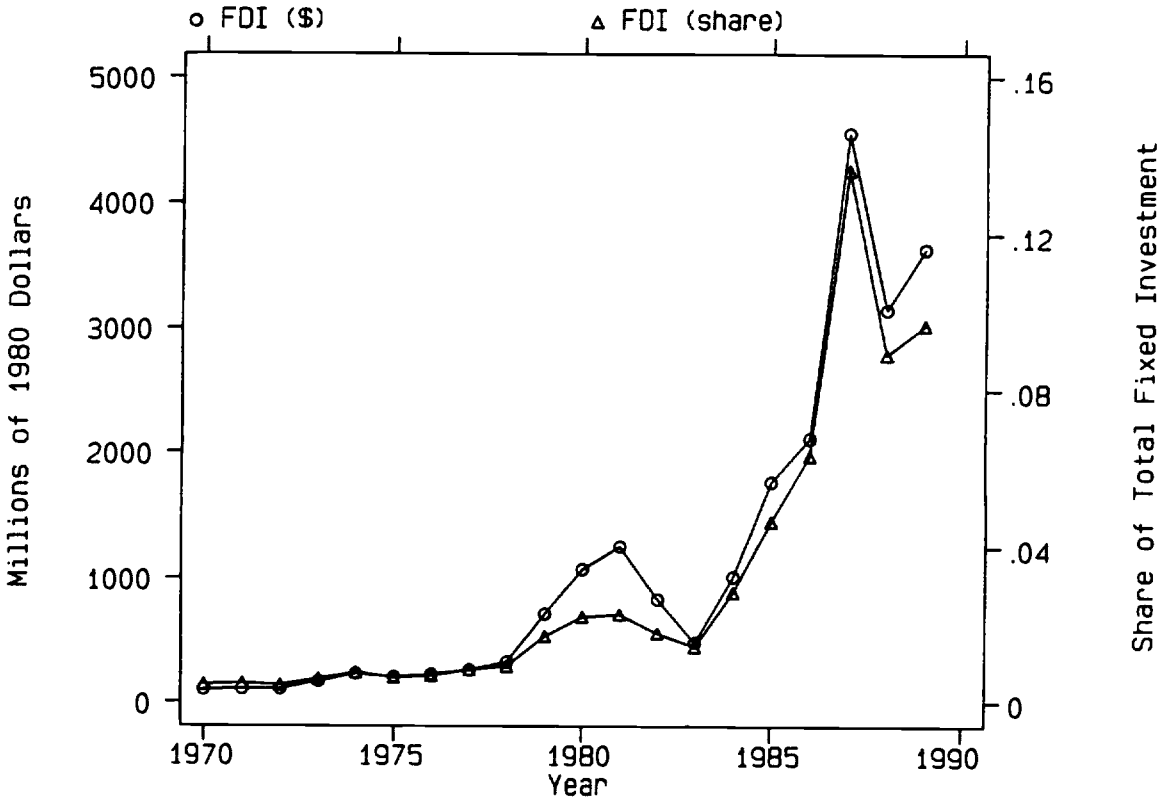

Figure 4: Foreign Direct Investment in Mexico

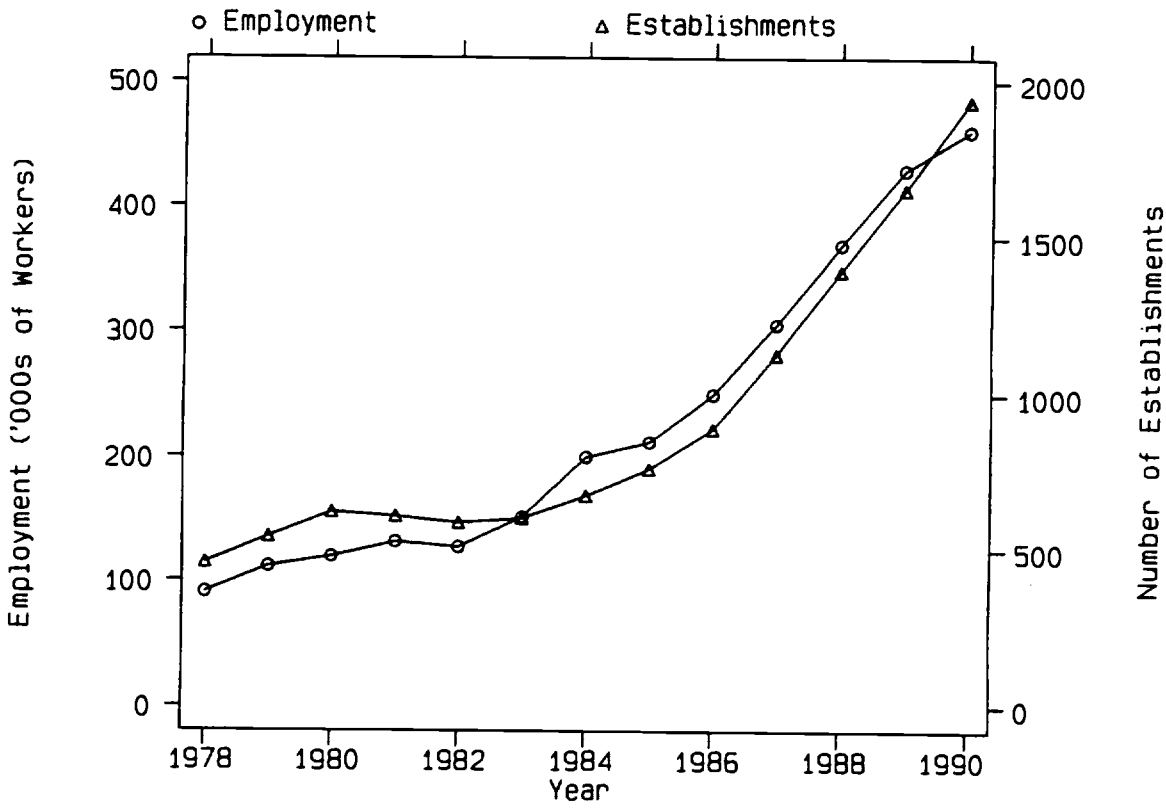

Figure 5: Maquiladora Activity in Mexico