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Foreign direct investment and relative wages: Evidence from Mexico's maquiladoras

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Abstract

In this paper, we examine the increase in relative wages for skilled workers in Mexico during the 1980s. Rising wage inequality in Mexico is linked to foreign capital inflows. We study the impact of foreign direct investment (FDI) on the skilled labor share of wages in Mexico over 1975–1988. We measure FDI using regional data on foreign assembly plants. Growth in FDI is positively correlated with the relative demand for skilled labor. In regions where FDI has concentrated, growth in FDI can account for over 50 percent of the increase in the skilled labor wage share that occurred in the late 1980s. ©1997 Elsevier Science B.V.

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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 (Juhn et al., 1992)). 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

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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 and Haltiwanger, 1991; Lawrence and Slaughter, 1993; Berman, Bound, and Griliches (Berman et al., 1994)); the other is that an increase in import competition from low-wage countries has shifted resources towards industries that use skilled labor relatively intensively (Leamer, 1993, 1994; Borjas and Ramey, 1995; 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. There is evidence 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 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, 1996), 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 that are relatively intensive in skilled labor and the South specializes in inputs that 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. The 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 regions, 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 (Berman et al., 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 that 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. Fig. 1 shows the relative wages and employment of skilled and unskilled workers in Mexico for the period 1965–1988.[1] 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 relaxed restrictions on foreign investment. The result was a sudden infusion of foreign capital. A large share of FDI in manufacturing has gone into the creation of in-bond foreign assembly plants,

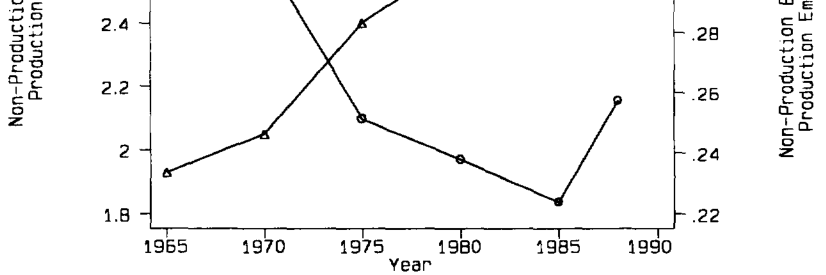

Fig. 1. Relative wages and employment in Mexican manufacturing.

[1]We use non-production workers to identify skilled labor and production workers to identify unskilled labor. While there are problems with this classification (Leamer, 1994), there is evidence that in practice it successfully tracks employment and wages by skill category (Berman, Bound, and Griliches (Berman et al., 1994); Sachs and Shatz, 1994).

known as maquiladoras, which are concentrated in the Mexico–U.S. border region. The FDI boom, then, has resulted in a region-specific shock to labor demand. Maquiladoras import most of their intermediate inputs from abroad and export virtually all of their output.[2] Their primary source for inputs and primary destination market for outputs is the United States. 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. Given that maquiladoras are primarily the result of outsourcing by U.S. multinationals, their activities are an appropriate measure of foreign investment for the hypothesis that we test. 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.

2. Theory

2.1. 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 (1996). Consider a world economy with two countries, North and South, where each country i has given 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 $z \in [0, 1]$. Inputs vary in terms of the relative amounts of skilled and unskilled labor used in production. Each unit of z requires $a_H(z)$ units of skilled labor and $a_L(z)$ units of unskilled labor, where the inputs are

[2] Until 1988, maquiladoras were required by law to export all output.

[3] The factor-price assumptions are consistent with U.S. and Mexican wage data (Feenstra and Hanson, 1996).

arranged such that $a_{\mathrm{H}}(z)/a_{\mathrm{L}}(z)$ is increasing in z. Each input is produced according to the production function,

$$x(z) = \left[\min \left\{ \frac{L(z)}{a_{\mathrm{L}}(z)}, \frac{H(z)}{a_{\mathrm{H}}(z)} \right\} \right]^{\theta} [K(z)]^{1-\theta} \tag{1}$$

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,

$$\ln Y = \int_0^1 \alpha(z) \ln x(z)\, \mathrm{d}z \tag{2}$$

where $\int \alpha(z)\, \mathrm{d}z = 1$.

To determine the pattern of trade in inputs between the North and South, we examine how unit production costs vary across inputs in the two countries. Let $c(w_i, q_i, r_i; z)$ be the minimum cost of producing one unit of x in country i, which is given by

$$c(w_i, q_i, r_i; z) = B[w_i a_{\mathrm{L}}(z) + q_i a_{\mathrm{H}}(z)]^{\theta} r_i^{1-\theta} \tag{3}$$

with B a constant. We assume that for fixed factor prices $c(w_i, q_i, r_i; z)$ is continuous in z. Fig. 2 shows the minimum cost locus for the North as $C_{\mathrm{N}}C_{\mathrm{N}}$ and for the South as $C_{\mathrm{S}}C_{\mathrm{S}}$. The absolute slopes of the loci are indeterminant, but, given relative factor prices, we know that $C_{\mathrm{S}}C_{\mathrm{S}}$ lies below $C_{\mathrm{N}}C_{\mathrm{N}}$ for inputs that use a low ratio of skilled to unskilled labor and that the reverse holds for inputs that use a high ratio.[4] That is, the South has a comparative advantage in relatively

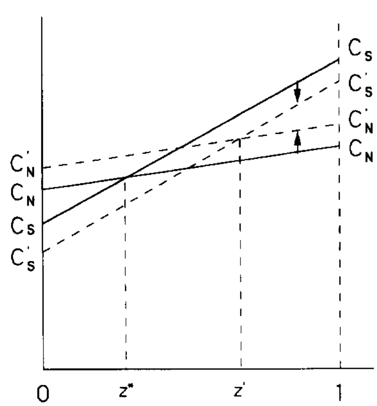

Fig. 2. Outsourcing from North to South.

[4]We ignore the case where one locus lies entirely above another, as there is no trade in inputs.

non-skill-intensive inputs. Let z^* be the cutoff intermediate input, at which the minimum cost loci are equated; it is implicitly defined by

$$c(w_S, q_S, r_S; z^*) = c(w_N, q_N, r_N; z^*) \tag{4}$$

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, $z \in (z^*, 1]$.

For the outcome in Fig. 2 to be an equilibrium, factor markets in both countries must clear. 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 that the supply of each type of labor is responsive to the relative wage; we assume, in particular, that $\partial L_i(q_i/w_i, V_i)/\partial(q_i/w_i) \leq 0$ and $\partial H_i(q_i/w_i, V_i)/\partial(q_i/w_i) \geq 0$, where V_i is a vector of exogenous variables that condition labor supply. By Shephard's lemma, the demand for each factor is given by differentiating (3) with respect to its price. Labor market clearing requires that in the South

$$L_S(q_S/w_S, V_S) = \int_0^{z^*} B\theta \left[\frac{r_S}{w_S a_L(z) + q_S a_H(z)}\right]^{1-\theta} a_L(z) x_S(z)\, dz \tag{5}$$

and

$$H_S(q_S/w_S, V_S) = \int_0^{z^*} B\theta \left[\frac{r_S}{w_S a_L(z) + q_S a_H(z)}\right]^{1-\theta} a_H(z) x_S(z)\, dz \tag{6}$$

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

$$r_S K_S = [w_S L_S + q_S H_S](1-\theta)/\theta \tag{7}$$

Conditions (4)–(7), 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. Thus, factor prices and the critical value z^* are determined as functions of the exogenous variables, K_i and V_i (i=N, S). We make the determination of z^* explicit by

$$z^* = F(K_S, K_N, V_S, V_N) \tag{8}$$

We discuss some of the properties of the function $F()$ below.

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

(5)–(7), we define an expression for $D_S(q_S/w_S)$, the relative demand for skilled labor in the South,[5]

$$D_S(q_S/w_S, z^*) \equiv \frac{\int_0^{z^*} \left[\frac{a_H(z)\alpha(z)E}{w_S a_L(z) + q_s a_H(z)} \right] dz}{\int_0^{z^*} \left[\frac{a_L(z)\alpha(z)E}{w_S a_L(z) + q_s a_H(z)} \right] dz} \tag{9}$$

An analogous condition, $D_N(q_N/w_N)$, defines relative labor demand in the North. Feenstra and Hanson (1996) show that the relative demand for skilled labor in both the North and the 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 relatively high ratio of skilled to unskilled labor. This causes an increase in average skill intensity, which, in turn, causes an increase in the relative demand for skilled labor. The activities that leave the North, on the other hand, use a low ratio of skilled to unskilled labor relative to those that remain, which implies that 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. From (7), the immediate effect is to reduce r_S and raise r_N. At constant wages, C_SC_S shifts down and C_NC_N shifts up, as shown in Fig. 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 Fig. 2: in general equilibrium, a capital flow from North to South raises z^*. This implies that in Eq. (8) the function $F(K_S, K_N, V_S, V_n)$, which defines z^*, is increasing in the ratio, K_S/K_N. The fact that z^* increases implies that relative capital accumulation in the South causes an increase in the relative demand for skilled labor in both countries.[6] We show this in Fig. 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

[5]We also make use of the demand for inputs produced in the South, given by $x_s(z) = \alpha(z)E/c_s(z)$, $z \in [0, z^*)$.

[6]In Feenstra and Hanson (1996), we also show that these results apply to neutral technological progress in the South relative to the North.

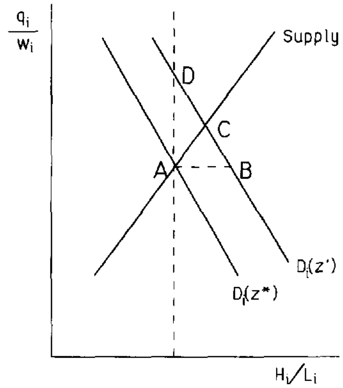

Fig. 3. Outsourcing and relative labor demand.

to be better off, since the increase in Southern supply lowers the prices of its inputs. 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.

2.2. *An empirical model*

To test the effects of foreign direct investment on skilled wages and employment, we examine the case of Mexico, which has received large capital inflows from the United States and, to a lesser extent, other Northern countries. As a dependent variable, we use the skilled-labor share of total wages to measure relative labor demand, since it incorporates the effects of both relative wages and relative employment.[7] From Eqs. (8,9), and the equilibrium depicted in Fig. 3, the skilled-labor share of total wages in Mexico, WSH_t, can be expressed as a function of U.S. and Mexican capital stocks and exogenous factors that affect U.S. and Mexican labor supply:

$$WSH_t = G(K_t, V_t; K_t^{US}, V_t^{US}) \tag{10}$$

where K_t is the Mexican capital stock, V_t is a vector of variables that condition Mexican labor supply, and US indexes U.S. values. To implement Eq. (10) empirically, we need to specify the exogenous factors, V_t and V_{USt}, and the observations over which (10) will be estimated.

Using national-level data to estimate (10) would provide us with too few observations. Instead, we disaggregate Mexican manufacturing by region and industry. We estimate the skilled labor share of total wages at the state and industry

[7]In Fig. 3, for instance, if relative labor supply curve is vertical, then an increase in z^* will leave relative employment unaffected but will raise the skilled labor share of total wages.

level as a function of the capital stock and labor-supply conditions at the state level. In this specification, we allow the skilled-labor wage share to vary across industries, as will be the case if industries use different technologies, and we treat the supply of capital as fixed at the region level. Treating the regional supply of capital as exogenous is more plausible than treating the region–industry supply of capital as exogenous.

The regional analysis goes somewhat beyond our theoretical model. In Fig. 2, for example, there would be separate cost loci for each region of the South. Nominal wages would not be equalized in such a setting, as long as there existed regionally non-traded goods, such as housing, whose supply depends on regionally fixed factors of production. We extend the theoretical model to a regional setting by assuming that the functional form of $G()$ in (10) is the same across regions and industries, after making the standard correction for fixed industry and region effects. We ignore, however, cross-sectional variation in U.S. (Northern) variables. One rationale for doing so is that, to the extent that such factors only vary over time, we can control for their presence by including fixed time effects in the estimation.[8]

We assume that Eq. (10), expressed in first differences, can be written as

$$\Delta WSH_{ijt} = \phi_1 + \phi_2 \, \Delta \ln(K_{it}) + \phi_3 \, \Delta \ln(WA^{\mathrm{H}}_{it}) + \phi_4 \, \Delta \ln(WA^{\mathrm{L}}_{it}) + \epsilon_{ijt} \qquad (11)$$

where i indexes the state, j indexes the industry, t indexes the year, K_{it} is the total manufacturing capital stock in state i, and ϵ_{ijt} is an i.i.d. random error term. The sources of the disturbance in Eq. (11) include unobserved shocks to technology or non-labor factor prices that affect the relative demand for skilled labor. First differencing eliminates from (11) time-invariant factors that cause the skilled-labor wage share to vary across states and industries. We include two regressors that condition relative labor supply in state i, the alternative wage for skilled workers in state i, WA^{H}_{it} (where H indexes skilled labor), and the alternative wage for unskilled workers in state i, WA^{L}_{it} (where L indexes unskilled labor). The alternative wage variables control for the non-manufacturing labor-market opportunities of skilled and unskilled labor in state i. There are, of course, other variables that in principle affect labor supply, but data limitations prevent us from considering such factors.

2.3. Estimation issues

The main obstacle to the estimation of (13) is that we do not have a direct measure of the total capital stock. Instead, we express K_{it}, the total capital stock in state i, as the sum of the domestic capital stock, K^{D}_{it}, and the foreign capital stock, K^{F}_{it}. In log first differences,

[8]If the U.S. factors that influence Mexican wages vary across time and industries, our specification in incomplete.

$$\Delta \ln(K_{it}) = \Delta \ln(K_{it}^{\mathrm{D}}) + \Delta \ln\left(1 + \frac{K_{it}^{\mathrm{F}}}{K_{it}^{\mathrm{D}}}\right)$$

We have a direct measure of K_{it}^{D}, but not of K_{it}^{F}. Given this, we shall proxy for $K_{it}^{\mathrm{F}}/K_{it}^{\mathrm{D}}$ by using the ratio of foreign manufacturing establishments to domestic manufacturing establishments in state *i*, $E_{it}^{\mathrm{F}}/E_{it}^{\mathrm{D}}$. The estimating equation becomes,

$$\Delta WSH_{ijt} = \beta_1 + \beta_2\, \Delta \ln(K_{it}^{\mathrm{D}}) + \beta_3\, \Delta \ln\left(1 + \frac{E_{it}^{\mathrm{F}}}{E_{it}^{\mathrm{D}}}\right) + \beta_4\, \Delta \ln(WA_{it}^{\mathrm{H}}) + \beta_5\, \Delta \ln(WA_{it}^{\mathrm{L}}) + \eta_{ijt} \tag{12}$$

To the extent that the variable $\Delta \ln(1+E_{it}^{\mathrm{F}}/E_{it}^{\mathrm{D}})$ measures $\Delta \ln(1+K_{it}^{\mathrm{F}}/K_{it}^{\mathrm{D}})$ with error, the regressor will be negatively correlated with the error term, η_{ijt}. In the presence of measurement error, OLS estimates of β_3 will be biased toward zero. To correct for measurement error, we take an instrumental variables (IV) approach to estimating Eq. (12). Since the domestic capital stock itself may be measured with error, we instrument for both $\Delta \ln(K_{it}^{\mathrm{D}})$ and $\Delta \ln(1+E_{it}^{\mathrm{F}}/E_{it}^{\mathrm{D}})$.

It is worth noting that under certain conditions, measurement error in (12) will not cause severe problems. If capital per establishment in foreign manufacturing plants relative to that in domestic manufacturing plants is constant across time and states, we can define this ratio as α:

$$\alpha \equiv \frac{K_{it}^{\mathrm{F}}/E_{it}^{\mathrm{F}}}{K_{it}^{\mathrm{D}}/E_{it}^{\mathrm{D}}}$$

Making use of this ratio, the relationship between the true variable, $\ln(1+K_{it}^{\mathrm{F}}/K_{it}^{\mathrm{D}})$, and its proxied value is

$$\ln\left(1 + \frac{K_{it}^{\mathrm{F}}}{K_{it}^{\mathrm{D}}}\right) \approx \frac{K_{it}^{\mathrm{F}}}{K_{it}^{\mathrm{D}}} \approx \alpha\, \frac{E_{it}^{\mathrm{F}}}{E_{it}^{\mathrm{D}}} \approx \alpha \ln\left(1 + \frac{E_{it}^{\mathrm{F}}}{E_{it}^{\mathrm{D}}}\right) \tag{13}$$

The first approximation in Eq. (13) relies on $K_{it}^{\mathrm{F}}/K_{it}^{\mathrm{D}}$ being small in each state. There is no data to directly confirm this, but data on employment suggests that $K_{it}^{\mathrm{F}}/K_{it}^{\mathrm{D}}$ is not too large; the ratio of state employment in foreign manufacturing plants to state employment in domestic manufacturing plants ranges from 0 to 0.36. The second approximation in Eq. (13) simply relies on the constancy of α over time and across states. The third approximation in (13) relies on $E_{it}^{\mathrm{F}}/E_{it}^{\mathrm{D}}$ being small, which is confirmed in our data; the ratio ranges from 0 to 0.07. If the approximations in (13) hold reasonably well, then the proxy for $\ln(1+K_{it}^{\mathrm{F}}/K_{it}^{\mathrm{D}})$ will differ from the true value by a multiplicative constant. In this case, the only effects of measurement error are that the OLS estimates of β_3 and its standard error will be a fraction $1/\alpha$ of their true value. Even if the approximations in Eq.

(13) do not hold that well, our use of instrumental variables should in principle correct for measurement error caused by using a proxy.

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.

3.1. 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 (12)—as the average annual state wage in professional services and the alternative wage for unskilled labor-appearing as WA^{L} in (12)—as the average annual state wage in food services. Both variables are deflated by the national CPI. We measure the state domestic capital stock-appearing as K^{D} in (12)—as the real value of fixed assets in domestic state manufacturing establishments. Finally, we measure the ratio of foreign to domestic manufacturing establishments—appearing as E^{F}/E^{D} in (12)—as the ratio of the number of maquiladoras in a state to the number of domestic state manufacturing establishments. Maquiladoras account for a subset of foreign firms in any given state. Given that our model relates foreign capital inflows in the South to outsourcing by Northern multinationals, it is appropriate to restrict our definition of foreign firms to those that explicitly engage in outsourcing.

To estimate (14) using IV, we need to specify instrumental variables for the domestic and foreign capital stocks. A valid instrument is one that is correlated with the state capital stock and uncorrelated with unobserved shocks to the state-industry skilled labor share of total wages. Good instruments can be difficult to find, which is true in our case. The instruments we use, in addition to the exogenous explanatory variables, are total state manufacturing income, total state value added by domestic manufacturing plants, total state value added by maquiladoras, and a measure of unit transport costs for state manufacturing plants. All variables, except transport costs, are expressed in log first differences. We discuss each of the instruments in turn.

Total state manufacturing income is a measure of the size of the local market. Domestic and foreign producers are, all else equal, likely to locate their manufacturing operations in regions with large consumer markets, in which case the capital stock will be positively correlated with market size. State value added is correlated with the state capital stock, given that capital is an input in production. If it is the case, however, that skill intensity varies with the level of output, then value added should be included as an explanatory variable in the regression. While this is not a prediction of our theoretical model, it is consistent with other models of labor demand. We estimate specifications using total state manufacturing value added either solely as an instrument or as an additional explanatory variable. Unit transport costs to the United States are likely to be important in the maquiladora location decision, since maquiladoras obtain most of their non-labor inputs from parent firms in the United States and export their output to the United States. We measure transport costs to the United States as log distance from the state capital to the nearest Mexico–U.S. border crossing. Given Mexico City is the country's largest internal market, we use log distance from the state capital to Mexico City as an additional instrument.

3.2. Trade and investment policy

During the 1980s, Mexico dramatically reformed its trade policy and its regulations on foreign investment. The policy changes were followed by large inflows of foreign direct investment. This sequence of events provides an ideal experiment in which to study the impact of capital inflows on the skilled labor wage share. To provide context for the empirical analysis, we briefly describe the changes in Mexican trade and investment policy.

Prior to 1982, the Mexican government maintained tight restrictions on foreign ownership and high barriers to trade, as part of a conscious policy to promote the creation of a domestically-owned manufacturing base (Whiting, 1992). The government regulated foreign ownership by subjecting foreign investment to official approval and maintaining a 49 percent ownership cap on foreign holdings in individual firms, and it restricted foreign trade through import tariffs, import-license requirements, and controls on exports.

In 1983, the Mexican government moved to relax the foreign ownership cap, expedite the approval of foreign investment projects, and eliminate many regulations governing maquiladoras (Wilson, 1992). These reforms were induced in part by a severe balance of payments crisis. Since the inception of the program in the 1960s, maquiladoras have been exempt from foreign ownership limitations and free from paying value-added taxes on domestic inputs and import duties on imported inputs, under the provision that they export all of their output. A 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"). Initially, the bureaucratic steps necessary to obtain these benefits were burdensome. The 1983 reform substantially simplified the process of obtaining legal recognition as a maquiladora. One motivation for the maquiladora regime is to take advantage of Item 807 of the Tariff Schedule of the United States, which exempts U.S. firms that import goods assembled from U.S.-made components from paying import duties on the value of U.S. content in the good. In 1988, 98.5% of intermediate inputs used by maquiladoras were imported from abroad.

In 1985, the government began to liberalize trade and announced plans to join the General Agreement on Trade and Tariffs (GATT). Prior to 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, and abolished export controls.

It was in 1983, after the change in Mexican government regulations on maquiladoras, that the boom in FDI began. Fig. 4 shows that between 1983 and 1989 FDI in Mexico increased from $478 million to $3,635 million; the share of FDI in total fixed investment increased from 1.42 percent to 9.68 percent.[9] Much

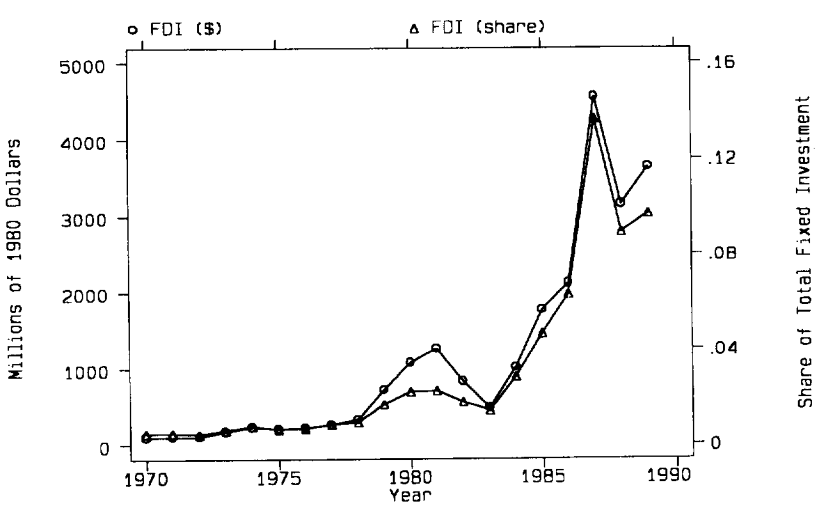

Fig. 4. Foreign direct investment in Mexico.

[9]This 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 Economía Mexicana en Cifras, 1990). It 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. Fig. 4 shows total FDI in Mexico, including investment in firms that engage in production for the domestic market.

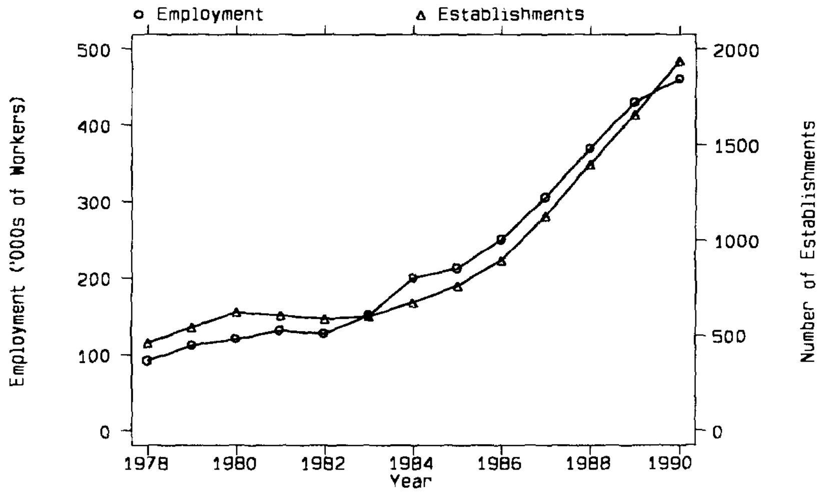

Fig. 5. Maquiladora activity in Mexico.

of the FDI has gone to create maquiladoras. Fig. 5 shows that between 1983 and 1990 employment in maquiladoras increased from 150,867 workers to 460,293 workers, as the share of maquiladora workers in national manufacturing employment increased from 4.9 percent to 19.0 percent. The majority of assembly plants are located in states along the Mexico–U.S. border; in 1990, the border region contained 90.3 percent of total assembly employment and 87.8 percent of total assembly plants. Initially, government policy confined assembly plants to designated zones located in border states. Even with the lifting of the restriction in 1971, maquiladoras have continued to locate at the border. Most maquiladoras assemble one of four product types: apparel, auto parts, domestic appliances, and electronics. In 1990, 63.34 percent of total assembly employment was in one of these industries.

3.3. Relative wages and employment in Mexico

If the outsourcing hypothesis is correct, FDI in Mexico will be positively correlated with the relative demand for skilled labor. Before presenting econometric results, we briefly describe national and regional patterns in the relative wage and non-production wage share of skilled labor. Table 1 reports the average annual rates of change in the regression variables over three subperiods. The means in the change in the non-production wage share reproduce the findings in Fig. 1: the non-production wage share began to rise after 1975, increasing most rapidly in the late 1980s. The dramatic increase in maquiladora activities corresponds with the rise in the non-production wage share. Between 1985 and

Table 1
Average annual rates of change in regression variables, 1975–1988

Year	*WSH*	ΔWSH	$\Delta \ln K^D$	$\Delta \ln(1+E^F/E^D)$
1975	0.372			
1980	0.375	0.058	10.504	0.150
1985	0.388	0.256	12.005	0.143
1988	0.414	0.866	−1.276	0.840

The sample is nine two-digit (ISIC) industries in Mexico's 32 states. *WSH* and ΔWSH are weighted by the industry average share of the manufacturing wage bill.
Variable are defined as:
WSH = Non-production labor share of total wages.
ΔWSH = Average annual change in WSH × 100.
$\Delta \ln K^D$ = Average annual log change in state manufacturing capital stock × 100.
$\Delta \ln(1+E^F/E^D)$ = Average annual log change in (1+ state maquiladora establishments/total state manufacturing establishments) × 100.
Source: Authors' calculations based on data from the Mexico *Industrial Census*, various years.

1988, the number of maquiladoras in Mexico increased at an average annual rate of 17.84 percent and maquiladora employment grew at an average annual rate of 18.52 percent.

Given the fact that maquiladora activity is concentrated in the Mexico–U.S. border region, the outsourcing hypothesis implies that the border region, all else equal, should 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: 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.[10]

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

[10]We find similar results when we control for differences in industry composition across regions. 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 (Aitken et al., forthcoming)).

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[a]	Level	Change[b]
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

[a] Change is the annual average log change between the current and preceding year × 100.
[b] Change is the annual average change between the current and preceding year × 100.
Source: Authors' calculations based on data from the Mexico *Industrial Census*, various years.

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, which 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 other manufacturing plants. To control for variation in nominal wages across regions and industries, we limit the comparison to plants located in the border region and in the industries in which maquiladoras are concentrated. Table 3 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. In 1988, production wages in maquiladoras were on average higher than production wages in general manufacturing plants, and non-production wages in maquiladoras were on average slightly below those in general manufacturing plants. In all years except 1975, the non-production wage share in maquiladoras was higher than that in similar manufacturing industries.

Table 3
Wages and wage shares in maquiladoras versus general manufacturing plants: Border States, 1975–1988

Year	Average maquiladora level/average manufacturing level for selected industries		
	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

Wage levels and wage shares used to calculate ratios are for border states only. Selected Industries are those in which maquiladoras are concentrated (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.

This is consistent with the hypothesis that skill intensity is higher in maquiladoras than in general manufacturing plants.

4. Empirical results

We report OLS and IV estimation results for Eq. (12). Observations are by state-industry for the periods 1975–1980, 1980–1985, and 1985–1988. The total number of observations is 746, rather than the potential 864 ($3\times9\times32$), since three industries (chemicals, iron and steel, and other industries) have zero production in certain states in all years.[11]

In Table 4 we report OLS results of Eq. (12), without year, industry, or region dummy variables. The coefficient on the maquiladora variable, $\Delta\ \ln(1+E^F/E^D)$, is positive and statistically significant at the five-percent level in all regressions. This is consistent with the hypothesis that an increase in FDI is associated with an increase in the relative demand for skilled labor, leading to an increase in its wage share. The coefficient on the change in the domestic capital stock, $\Delta\ \ln K^D$, is also positive, but it is statistically insignificant in all regressions. The inclusion of the alternative wage variables or state manufacturing value added as regressors makes little difference for the results on $\Delta\ \ln(1+E^F/E^D)$ and $\Delta\ \ln K^D$. That the coefficient on value added is positive is consistent with the hypothesis that the

[11] Alternative wage measures are unavailable for Baja California in certain years, which further reduces the sample size. We also drop the state of Tabasco from the estimation. Tabasco is an extreme outlier in terms of capital intensity, due mainly to the fact that the state is a major center for petroleum refining.

Table 4
OLS estimates for change in non-production wage share (*t*-statistics in parentheses)

Variable	(1)	(2)	(3)
$\Delta\ \ln(1+E^F/E^D)$	1.972	2.068	2.115
	(2.451)	(2.512)	(2.566)
$\Delta\ \ln K^D$	0.017	0.015	0.012
	(1.853)	(1.479)	(1.154)
$\Delta\ \ln VA$			0.008
			(1.108)
$\Delta\ \ln ALTWG1$	−0.005	−0.005	
	(−0.530)	(−0.523)	
$\Delta\ \ln ALTWG2$	0.005	0.003	
	(0.449)	(0.322)	
Adjusted R^2	0.010	0.007	0.008
Number of Observations	746	746	746

Variable Definitions:
ΔWSH = Change in state-industry non-production wage share (dependent variable).
$\Delta\ \ln(1+E^F/E^D)$ = Change in log (1+ number of maquiladoras in state/number of manufacturing establishments in state).
$\Delta\ \ln K^D$ = Change in log state manufacturing real fixed capital stock.
$\Delta\ \ln VA$ = Change in log state manufacturing real value added.
$\Delta\ \ln ALTWG1$ = Change in log average state real wage in professional services.
$\Delta\ \ln ALTWG2$ = Change in log average state real wage in food services.
Time periods in sample: 1975–1980, 1980–1985, 1985–1988. All variables are annual averages.

output elasticity of labor demand is higher for skilled labor than for unskilled labor, but the variable is statistically insignificant.

While the overall fit of the regression is rather poor, the economic effect of FDI implied by the coefficient estimates in Table 4 is substantial. The magnitude of the maquiladora coefficient ranges from 1.97 to 2.15. 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. Multiplying the smallest estimated maquiladora coefficient times the log change in the maquiladora variable for the border (1.972*0.0148) implies that FDI can account for 52.4 percent of the increase in the region's non-production wage share.

In Table 5 we report instrumental variables results for Eq. (12), in which we allow for measurement error in the change in the domestic capital stock and the change in maquiladora activities. In addition to the exogenous explanatory variables in the regression, we include the change in log state manufacturing income, the change in log state manufacturing value added, the change in log state maquiladora value added, log distance to the nearest U.S. border crossing, log distance to Mexico City, and region and year dummy variables as instruments. The main change from the previous results is that the coefficient estimates on the

Table 5
Instrumental variables estimates for change in non-production wage share (*t*-statistics in parentheses)

Variable	(1)	(2)	(3)
$\Delta\ \ln(1+E^F/E^D)$	2.476	2.515	2.565
	(2.483)	(2.446)	(2.491)
$\Delta\ \ln K^D$	0.031	0.030	0.026
	(2.508)	(2.103)	(1.694)
$\Delta\ \ln VA$			0.006
			(0.768)
$\Delta\ \ln ALTWG1$	−0.002	−0.002	
	(−0.141)	(−0.193)	
$\Delta\ \ln ALTWG2$	0.001	0.001	
	(0.118)	(0.078)	
Hausman specification test statistic κ^2 (15)	3.175	2.782	2.154
Adjusted R^2	0.006	0.004	0.005
Number of Observations	746	746	746

In addition to the alternative wage variables, we include the change in log state manufacturing income, the change in the log state manufacturing value added, the change in log state maquiladora value added, log distance to the nearest U.S. border crossing, log distance to Mexico City, and region and year dummy variables as instruments.
Under the null hypothesis that $\Delta\ \ln(1+E^F/E^D)$ and $\Delta\ \ln K^D$ are uncorrelated with the error term, the Hausman specification test statistic is distributed as chi-square with degrees of freedom equal to the number of instruments (15). At a ten-percent level of significance, the critical value for κ^2 (15) is 22.31.

domestic capital stock and on maquiladora activities are both somewhat larger, and the domestic capital stock is now positive and statistically significant at the five-percent in two regressions. We do not find evidence of measurement error, however. For each regression we report the test statistic for a Hausman specification test. Under the null hypothesis that $\Delta\ \ln(1+E^F/E^D)$ and $\Delta\ \ln K^D$ are uncorrelated with the error term, the test statistic is distributed as chi-square, with degrees of freedom equal to the number of instruments. We fail to reject the null in all regressions.[12]

We also consider the possibility that there have been exogenous changes in relative labor demand, which vary systematically across industries, regions, or time. In Table 6 we report regression results in which we include year, region, and industry dummy variables in the estimation. The results are very similar to those in Table 5. In all regressions, the maquiladora variable is positive and statistically significant, and the domestic capital stock is positive and statistically insignificant. The results on the time dummies stand in contrast to those for the United States. Berman, Bound, and Griliches (Berman et al., 1994) find a significant increase in the non-production wage share over time, which they interpret as evidence of

[12]Alternatively, the specification test results may indicate that the instruments are of poor quality.

Table 6
OLS estimates for change in non-production wage share, with industry, region, year, dummies (t-statistics in parentheses)

Variable	(1)	(2)	(3)
Δ ln$(1+E^F/E^D)$	1.772	1.854	1.896
	(1.957)	(2.047)	(2.091)
Δ ln K^D	0.012	0.013	0.010
	(0.975)	(1.041)	(0.826)
Δ ln VA			0.007
			(0.968)
Δ ln $ALTWG1$		−0.020	−0.019
		(−1.454)	(−1.400)
Δ ln $ALTWG2$		−0.033	−0.033
		(−1.398)	(−1.392)
Year Dummies:			
1980–1985	0.0004	−0.076	−0.074
	(0.147)	(−1.747)	(−1.679)
1985–1988	−0.001	−0.007	−0.006
	(−0.288)	(−1.305)	(−1.257)
Regional Dummies:			
Border	0.003	0.003	0.003
	(0.473)	(0.542)	(0.491)
North	−0.001	−0.001	−0.001
	(−0.207)	(−0.024)	(−0.048)
Center	0.001	0.003	0.002
	(0.233)	(0.503)	(0.458)
South	−0.003	−0.001	−0.001
	(−0.288)	−(0.142)	(−0.204)
Adjusted R^2	0.012	0.014	0.013
Number of Observations	746	746	746

The regressions listed above also contain industry dummy variables. For expositional ease, coefficient estimates for these variables are not shown.

skill-biased technical change. We find no such temporal variation in the non-production wage share for Mexico, once we have accounted for other factors. 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.

Calculating the impact of the maquiladora variable on the non-production wage share in the border region, the regression results in Tables 5 and 6 also account for approximately one-half of the increase. It is important to note, however, that the specifications reported in Tables 4–6 account for only a small portion of the total variation in the change in the non-production wage share, as shown by the low R^2 values. Of course, the R^2's are much higher in the equivalent regressions that are run in levels, rather than first differences, with a full set of state-industry fixed effects included. We have also experimented with running the regressions in levels, including a limited set of controls on states and industries. The coefficient estimates in these regressions are very similar to those reported above. Without choosing which measure of the R^2 is most relevant, it is clear that there are factors that determine the non-production wage additional to those we have included.

Perhaps the most compelling additional explanation is that changes in Mexico's labor-market institutions have caused a shift away from unskilled labor. During the 1980s, the government aggressively pursued price and wage agreements with business and labor groups and deindexed the minimum wage as means to control inflation. The real value of the minimum wage fell steadily over the decade, and Mexico's major unions, which had enjoyed considerable political influence in the 1960s and 1970s, appeared much less able to dictate industry wage agreements. While the decline of union power could account for an overall decrease in the production labor share of total wages, there is little reason to believe it could account for the regional variation in relative-wage changes that we observe in Table 2. Mexico's unions are national organizations that negotiate labor contracts for entire industries. Such agreements generally do not allow for regional variation in contractual terms. Changing labor-market institutions, while not providing a complete explanation for the observed increase in the skilled labor share of total wages, are an important additional factor in Mexico's recent wage changes.

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 account for a large portion of the increase in the skilled labor share of total wages. A large fraction of new foreign manufacturing activities in Mexico are 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 large 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 largely the result of within-industry changes in wage shares, rather than between-industry shifts in employment. Berman, Bound, and Griliches (Berman et al., 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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