1-1-2009

Vertical Integration and Wage Inequality in Mexico in the NAFTA Era

Maximilian Sirianni
Macalester College

Honors Project

Macalester College

Spring 2009

Title: Vertical Integration and Wage Inequality in Mexico in the NAFTA Era

Author: Maximilian Sirianni

PERMISSION TO DEPOSIT HONORS PROJECTS

Please read this document carefully before signing. If you have questions about any of these permissions, please contact Janet Sietmann (x6545) in the Library.

Title of Honors Project: Vertical Integration and Wage Inequality in Mexico

Author's Name: (Last name, first name) Sirianni, Max

The library provides access to your Honors Project in several ways:

- The library makes each Honors Project available to members of the Macalester College community and the general public on site during regular library hours.
- Using the latest technology, we make preservation copies of each Honors Project in both digital and microfilm formats.
- Every Honors Project is cataloged and recorded in CLICnet (library consortium OPAC) and in OCLC, the largest bibliographic database in the world.
- **To better serve the scholarly community,** a digital copy of your Honors Project will be made available via the Digital Commons @ Macalester (digitalcommons.macalester.edu).

The DigitalCommons@Macalester is our web based, open access compliant institutional repository for digital content produced by Macalester faculty, students, and staff. It is a **permanent** archive. By placing your projects in the Digital Commons, all materials are searchable via Google Scholar and other search engines. Materials that are located in the Digital Commons are freely accessible to the world; however, your copyright protects against unauthorized use of the content. Although you have certain rights and privileges with your copyright, there are also responsibilities. Please review the following statements and identify that you have read them by signing below. Some departments may choose to protect the work of their Honors students because of continuing research. In these cases the project is still posted on the repository, but content can only be accessed by individuals who are located on campus.

The original signed copy of this form will be bound with the print copy of the Honors Project. The microfilm copy will also include a copy of this form. Notice that this form exists will be included in the Digital Commons version.

I have read the above statement and **agree** to make my Honors Project available to the Macalester College community and to the larger scholarly community in our permanent digital archive the DigitalCommons@Macalester or its successor technology.

Signed [signature]

OR

I do not want my Honors Project available to the larger scholarly community. I want my Honors Project available only in the library, **NOT** for interlibrary loan purposes, and **NOT** through the Macalester College Digital Commons or its successor technology.

Signed ______________________

NOTICE OF ORIGINAL WORK AND USE OF COPYRIGHT PROTECTED MATERIALS:

If your work includes images that are not original works by you, you must include permissions from original content provider or the images will not be included in the electronic copy. If your work includes discs with music, data sets, or other accompanying material that is not original work by you, the same copyright stipulations apply. If your work includes interviews, you must include a statement that you have the permission from the interviewees to make their interviews public.

BY SIGNING THIS FORM, I ACKNOWLEDGE THAT ALL WORK CONTAINED IN THIS PAPER IS ORIGINAL WORK BY ME OR INCLUDES APPROPRIATE CITATIONS AND/OR PERMISSIONS WHEN CITING OR INCLUDING EXCERPTS OF WORK(S) BY OTHERS.

All students must sign here.

Signature: [signature] **Date:** 5/4/09

Printed Name: Max Sirianni

G:/libstaff/sigitalassetsmanagement/digitalcommons/forms/dchonorspermission2009.doc

MACALESTER COLLEGE

Vertical Integration and Wage Inequality in Mexico in the NAFTA Era

Max Sirianni

Advisor Raymond Robertson
Department of Economics
Honors Thesis
May 4, 2009

The effect of international outsourcing on Mexican manufacturing wages and wage inequality in the 1994-2003 period is an understudied phenomenon. The rising and falling of wage inequality in Mexico in the past twenty-five years remains unresolved by trade economists so far. The "mandated wage" approach is used to isolate the changes in factor prices that have occurred as a result of imported intermediate inputs and technology changes in Mexico. This measure of vertical integration is associated with rising wage inequality during the peso crisis and falling inequality thereafter. This paper finds a large and significant relationship between returns to skilled workers and outsourcing.

Acknowledgements

This project would not have been possible without the generous help of many people. First of all I would like to thank my advisor, Professor Raymond Robertson, for his continuous support and advice throughout the process. I would also like to thank my thesis committee readers, Professor Paul Dosh, Professor Amy Damon, and Professor David Blaney for insightful questions and criticisms. The other honors seminar students, Cyrus Butler, Todd Copenhaver, Ben Galick, Jayant Gokhale, Colin Hottman, Xi Luo, Vivian Liu, Nick Marchio, Lilla Nemeth, Isra Salim, Cael Warren, and Keaton White, gave great feedback and made us feel that we were never alone in this process. I am grateful to the 2009 Carroll Round participants and Professor Rod Ludema of Georgetown University in pariticular for some crucial comments for improving the paper. Finally I would like to thank my friends and family, without which none of this would be possible.

1. Introduction

The opening of borders in trade, investment, and migration between the United States and Mexico in recent decades has been subject of great debate. The deepening of this economic relationship coincided with an apparent increase in inequality within both countries. This surprising observation contradicted the expectations of trade theory and trade economists who predicted a fall in inequality in labor-abundant developing countries. Mexico has been on a long course of trade liberalization, beginning in the 1970s. It completed its accession into GATT in 1986, and NAFTA was ratified in 1994. Meanwhile, from the mid-1980s, through the middle of the 1990s, inequality rose within Mexico. In recent years, however, the trend has reversed and inequality has fallen. This fall in inequality since the mid 1990s has also confounded many, since so many explanations have been developed to link increased trade and higher inequality. A few particular aspects of the trade debate, intra-industry trade or outsourcing, as well as technology, seem to be playing a significant role. This paper evaluates the influence of outsourcing and technology transfers on wages and wage inequality in Mexico. Outsourcing favors skilled labors overall, although this pattern has not been constant over time.

Many economists have explored the theoretical implications of the recent global rise in international outsourcing[1]. Some authors have focused on developing a model for fragmentation of goods (Deardorff, 2001; Chung and Deardorff 2008) and services production (Jones and Kierzkowski, 2000). In this framework the standard 2x2x2 trade model is expanded to break up or fragment the production of one good into two tasks.

[1] For an overview of the literature of North-South trade, skill-biased technological change, offshoring, and inequality see Chusseau (2008).

One is completed in the home country and the other is performed abroad, or offshored. The model has been developed further to conceptualize offshoring as task-trading across countries (Grossman and Rossi-Hamberg, 2006). This model predicts an increase in low-skilled wages through increased productivity and international best practice. It also predicts a reduction in low-skill wages because of lower final goods costs. Their study implies lower demand for the low-skill jobs that are moving abroad. All of these theoretical models predict an increase to inequality in the skill-intensive country.

The complex interplay of workers, goods, and intermediates in many of these models makes the results of trade extremely difficult to observe or estimate empirically. In addition, many of the distribution effects of these models remain ambiguous, since the outcomes depend on subtle differences in factor endowments among countries and factor intensities among goods. Still, there is some mixed empirical evidence about the relationship between offshoring and inequality. Eggers and Eggers (2001) examine the intermediate goods trade between Western and Eastern European countries. They find that offshoring improves low-skilled labor's productivity by increasing value added per worker in the European Union overall. On the other hand, Feenstra and Hanson (1999, 2001) provide several different specifications to test the effect of outsourcing on wage inequality in the United States. They find conclusively that the rise in outsourcing has disproportionately benefitted skilled workers. Feenstra and Hanson utilize a two-stage mandated wage approach that isolates the effects of outsourcing and technology on wages. This approach is particularly useful for this paper because it allows the factor price effects of technology and outsourcing to be explicitly measured.

The case of wages in Mexico is particularly interesting since the country has undergone several waves of trade liberalization and experienced varying patterns in wage distribution over the past few decades. There is a wealth of literature that attempts to explain patterns in wage inequality in Mexico after its initial liberalization in the 1980s. Some of the more interesting of the theories that account for increasing inequality include quality upgrading[2] (Verhoogen, 2008), changes in the demand and supply for skill[3] (López-Acevedo, 2006), and foreign direct investment (Feenstra and Hanson, 1997). FDI was initially thought to benefit low-skill maquiladora workers since low-skill US jobs were moving south, but the opposite effect was observed. The surprising explanation was that the classifications of skill in Mexico and in the US are quite different. In fact, there is much evidence that low-skilled US workers are quite similar to high-skilled Mexican ones.

One of the most widely discussed explanations of increased inequality is skill-biased technological change, which argues that the increased technology following trade has been complementary to skill and has substituted for unskilled labor. This hypothesis will be considered in the empirical section of this paper as an alternate explanation for wage patterns. Some (Esquivel and Rodriguez-Lopez, 2004) find strong evidence of this effect on inequality yet others (Robertson, 2004) find that skill-biased technological change cannot explain why inequality has fallen since NAFTA. Recent literature has shown strong evidence of Stolper-Samuelson effects and the expected reduction in inequality (Robertson, 2004; Chiquiar, 2008). These papers test for the expected

[2] More efficient firms develop better production processes to produce higher quality goods, which benefits skilled workers more than unskilled.
[3] Trade increased demand for skill but increases in educational attainment drove down prices of skill. This has translated to varying net effects over time.

movements in relative wages in response to liberalization and find trade as a clear explanation for lowered wage inequality within Mexico in recent years.

Alternate explanations may shed some light on inequality within Mexico. The past fifteen years have been characterized by great political instability, a monetary crisis, and of course, increased trade through NAFTA. The empirical literature suggests that outsourcing to Mexico has widened the wage gap within the United States (Feentra and Hanson, 2001). Export industries tend to be the most productive and the most integrated into the US's extremely productive supply-chain. The case of vertical specialization in Mexico is particularly interesting since wage inequality within Mexico seems strongly linked to the country's economic relationship with the United States.

The initial evidence suggests a relationship between outsourcing and relative wages. Figure 1 tracks movements in relative wages, outsourcing, and technology over the ten years since NAFTA. Outsourcing (measured as imported intermediates as a share of total inputs) seems to follow a very similar same pattern as relative wages. Both rise until about 1997 and decline in the rest of the period. Technology seems to be steadily rising although its value is more erratic than the other two. Preliminarily, these patterns suggest that outsourcing might be one of the driving forces behind wage inequality.

Similar papers (Robertson, 2004; Esquivel and Rodriguez-Lopez, 2004) have analyzed the question of trade liberalization, but the relationship between intermediate trade and relative wages in the developing country setting remains untested. This paper explores how this measure of offshoring has affected relative and absolute wages in Mexican manufacturing between 1994 and 2003. The rest of the paper will explore whether there is a significant relationship between outsourcing and wage in inequality within Mexico. Section 2 develops a simple theoretical explanation of such a relationship, why it might be non-neutral, and how it might be tested using the mandated wage approach. Section 3 provides a summary of statistics and explains the measures used. Section 4 derives a calculation of productivity that is used in the empirical method. Section 5 goes through in detail the empirical method, interprets the results, and provides some checks of robustness. Section 6 concludes.

2. Theory

This paper uses the mandated wage approach (Leamer, 1996; Feenstra and Hanson, 1999) to test the specific effects of intermediate imports and technology on factor prices. In particular, it allows us to test the ways that these variables affect factor prices beyond productivity by removing the effects of changes in goods prices. This paper assumes the perspective of the unskilled labor-abundant country, since its goal is explaining wage inequality within Mexico. The dependent variable of interest is not outsourcing in the sense of relocated jobs or the maquiladora sector. Instead I examine the increased trade in intermediates and its implications for wages and wage inequality. This section will explore what happens to skilled and unskilled wages when firms make technological progress and what effect this progress might have on inequality through changes in relative wages.. This progress can be interpreted as more high technology capital or importing higher value intermediate goods Outsourcing is measured here as the increased use of intermediate inputs from abroad.

This model is driven by a few key assumptions. The assumption most important to economic theory is that outsourcing may have direct and non-neutral effects on factor prices that are distinct from the ones predicted by the Heckscher-Ohlin model. This possibility will be depicted graphically in Figure 2 and Figure 3. I also assume that outsourcing and technology "shocks" are the same across all industries. The theoretical model assumes factors exhibit constant returns to scale and perfect competition such that p = MC for any given industry.

Figures 2 and 3 use basic iso-cost curves to show two different scenarios where changes in structural variables affect factor prices, following Feenstra and Hanson (1999). In both figures the iso-cost curves are depicted showing the demand for unskilled labor. The graph depicts two factors, skilled labor (H) and unskilled labor (L). These graphs also show two industries. Industry 1 is presumed to be skill-intensive and Industry 2 is labor-intensive. Thus these curves illustrate the zero profit condition, $p_i = c_i(w,s)$ in industries 1 and 2 for factors H and L and the implications for their prices, s and w respectively, where p_i is the total cost in industry i. Cost is a function of the prices of unskilled and skilled labor, w and s only.

Figure 2 shows neutral changes in outsourcing in industry 1, starting at point A. If the change taking place is neutral to levels of skill then the changes will be captured completely by the changes in product prices (Feenstra and Hanson, 1999). Holding goods prices constant, output of good y_1 will increase to point B as will factor price s causing factor price w to fall relatively and increasing inequality. Production of y_1 increases by the amount of the technological progress. As a result, goods prices will decrease proportional to the technological change so that changes in factor prices are completely offset. This will cause iso-cost to shift back to its initial equilibrium at A. There will therefore be no change in factor prices as long as goods prices may adjust. This conclusion illustrates that the determination of factor prices occurs independent of neutral progress in any given industry.[4]

Following Feenstra and Hanson (1999) I will also examine the case where changes in outsourcing are non-neutral. Figure 3 shows the effects of industrial progress that disproportionately benefits skill. The iso-cost curve in industry 1 rotates clockwise around its intersection with p_2 at point A, since the technological shift is relatively more complementary to skill. Just as in the previous case technological progress increases output of good y_1 proportionate to the decrease in p_1. The goods market is now in equilibrium.

The factor markets are no longer in equilibrium, however, since there has been an increase in relative demand for skill in industry 1, while industry 2 is unchanged. The factor markets are in disequilibrium because relative demand of skill has increased, but factor prices have not changed. Because of the increase in relative demand for skill the relative price of skill and the price of good y_1, the skill-intensive good, will both increase. The iso-cost curve for good 1 will shift outwards because of increased costs of skill. There is now relatively less demand for labor in labor-intensive industry 1 so it will decrease output and its iso-cost curve shifts inwards. This moves the new equilibrium to point C and brings the factor markets back into equilibrium. Unskilled wages decrease from w_0 to w_1 while skill rises from s_0 to s_1. The important fact to note is that in this simple model a progress "shock" has a further feedback effect on factor prices beyond the initial productivity changes. This will be vital to the empirical method below since it estimates these direct factor price effects.

[4] This assumption requires that the demand-side for these goods to have Cobb-Douglass preferences. For the formal derivation of this requirement see Krugman (2000).

Industrial progress, both neutral and non-neutral, can be conceptualized in many ways. Technological change is perhaps the most common way of conceptualizing it and is often measured in use of high-technology capital or computer usage. The debate on skill-biased technological change relies on the idea that changes in technology can affect factor prices in a non-neutral way, exactly as discussed as above. Progress can be measured in other ways as well. Outsourcing, measured as the use of intermediate imports, will affect factor prices within an industry and may do so in a non-neutral way as well. This paper focuses on the effects of changes to these concepts of technology and outsourcing on relative factor prices.

3. Data

Ideally, outsourcing would be measured by examining and dissecting the fragmentation of production processes and materials across countries. Unfortunately, it is impossible to observe the full range of production activities at the firm or even industry level. The data available on Mexican manufacturing are aggregated to the industrial level. Thus outsourcing effects on factor prices can only be observed through changes to average factor intensities within industries. For example, if outsourcing raised the average skill-intensity in one industry, this effect will mimic that of skill-biased technological in that industry. It is for this reason that technology and outsourcing are observationally equivalent and that progress in both is theorized similarly, as explained above (Feenstra and Hanson, 1999).

Theory suggests that in order to empirically measure outsourcing effects on factor prices we need factor quantities, factor prices, goods prices, output data, and controlling input data. All of these data come from the Mexican National Institute of Statistics and Geography (INEGI in Spanish, http://www.inegi.org.mx/inegi/default.aspx). The annual data range from 1994-2003. Data come from the monthly industrial survey (EIM in Spanish) and the annual industrial survey (EIA). The variables taken from the monthly survey were summed to yearly values. All data use the 6 digit Mexican manufacturing code system (CMAP), which contain a total of 205 industries. There are therefore a total of 2050 potential observations, although variables with omitted observations are omitted from regressions and many variables are differenced, resulting in approximately 1620 usable observations. See Table 1 for summary statistics. Values are in real peso terms using data from the Mexican Consumer Price Index, with base year 1994.

Non-production and production workers are used to substitute for skilled and unskilled workers, respectively[5]. Wages for each type of worker are calculated at the hourly level by dividing total payments to each type of worker by total hours worked. Relative wage is equal to non-production hourly wage divided by production worker hourly wage. Capital costs are calculated by averaging ten year sums of changes in production machinery costs. Rental rates (the prices of capital) are calculated by dividing capital costs into total capital as calculated as the sum of investments made to production machinery over a ten year period. Energy and raw material costs are yearly costs paid for each.

Goods prices are calculated as the average of Paasche and Laspeyres indices, indexed to the year 1994. Goods prices are calculated using price data on a basket of goods (or single good if the industry produces only one) from each industry over time

[5] It is commonly recognized that these proxies for skill produce accurate results in Mexico. For a more detailed discussion of this issue see Robertson (2004).

using data from the Consumer Price Index, from the Bank of Mexico. The goods prices are unitized and organized by industry. There is a correlation of 0.69 between raw and deflated prices. The primary outsourcing measure is imported intermediates as a share of total intermediates (IITI)[6]. Technology is measure by dividing technology transfers and royalty costs by total capital. Total Factor Productivity[7] will be calculated using the method described in Section 4.

4. Prices, Productivity, and Factors of Production

Before moving on empirical section of the paper it is important to discuss the calculation of productivity, as it plays a vital role in the estimation of outsourcing and technology effects. Calculating productivity for Mexico is extremely difficult because of data limitations. Luckily, it is possible to derive a measure of effective total factor productivity (ETFP) using factor prices and goods prices by industry. This measure of ETFP will be used in the empirical method below to estimate the effect of outsourcing on factor prices.

An accurate measure of productivity is crucial to the final results since the mandated wage calculations are extremely sensitive to changes in TFP. Although this can

---

[6] For a discussion of different empirical measures of international outsourcing see Horgos (2007). He finds IITI to be the most theoretically consistent measure of outsourcing.

[7] This paper does not use an explicitly defined measure of TFP per se, but both the dual and primal TFP index can be calculated using Mexican manufacturing data. The dual measure is equal to the cost-shared weighted growth of primary factors minus changes value-added prices. The other commonly used measured is the primal measure of TFP which is defined as growth in value-added minus the weighted average growth of primary factors. For the United States Feenstra and Hanson (1999) find the expected correlation of 0.999 between these two measures. My measures generate a correlation of 0.35. The most likely explanation for this is noise in the Mexican data, although the gap between the two begs questions about competitiveness in Mexico. I use the effective TFP measure throughout the paper for its theoretical parsimony in relation to the method.

take many forms[8], it is generally contains changes in product prices as the dependent variable and changes in factor cost shares and total factor productivity as regressors. This produces the final results in many papers, but as Feenstra and Hanson (1999, 2001) argue, it produces an identity which gives actual instead of predicted change. Because of this it is necessary to endogenize prices into productivity and calculate the effect of our variables of interest on this, since as the theory above demonstrates, outsourcing and technology might be having a direct effect on factor prices. Before this can done, however, I must first calculate ETFP.

The method begins by describing the zero-profit[9] relationship between prices, productivity, and wages in each industry. There are assumed to be three productive factors: unskilled labor, skilled labor, and capital with prices w, s, and r, respectively. There are also certain structural variables (written with the vector z) that also determine prices in each industry. These structural variables are ideas, technologies, methods, practices, and outsourcing, all of which may change productivity and goods prices. The zero-profit conditions of prices, p_{it}, and costs, c_{it}, in industry i at time t can be expressed,

$$p_{it} = c_{it}(w_{it}, s_{it}, r_{it}, z_{it}) \tag{1}$$

Changes in goods prices are therefore determined by changes in the three factors used in production and some set of structural variables unique to each industry, including outsourcing. Although Mexico is probably a small country, the prices determined in

[8] For some of the most cited examples see Leamer (1998), Kruger (1997), Feenstra and Hanson (1999, 2001) and others.

[9] Mexican firms may not behave in a perfectly competitive manner, but evidence tends to show that markets essentially price in a competitive way. For a discussion of manufacturing competition in developing economies see Tybout (2000).

international manufacturing are probably determined this way. By definition, the industries of interest here are intertwined with, if not owned and operated by, their US counterparts. Because of this all prices, especially goods prices are determined in an international setting.

The zero-profit condition can be totally differentiated by industry to give us the first order conditions. This gives us a relationship between prices, productivity, and wages. Taking the first differences expresses changes in prices as a function of cost-share weighted factor prices and total factor productivity. In order to measure these changes I first express these relationships[10],

$$\Delta\, ln\, p_{it} = (\theta_{itW}\Delta ln\, w_{it} + \theta_{itS}\Delta ln\, s_{it} + \theta_{itr}\Delta ln\, r_{it}) - TFP_{it} + \varepsilon_{it} \qquad (2)$$

where p is the industry output price, θ is the factor-cost share, and w, s, and r are three factor prices, all in industry i at time t. Factors are weighted by their share of total costs for labor, skill, and capital, respectively. Factor cost shares of primary factors sum to unity. Equation (2) is can be considered a complete specification, since the difference between changes in prices and changes in factor costs should be attributed to technology, production practices, other changes in productivity, and nothing else so long as goods are competitively priced.

[10] Calculating equation 3 from 2:
$p = c(w,s,r,z)$
$TC = A^{\alpha}L^{\beta}K^{\gamma}S^{\delta}$
using the log-log form, $ln\, TC = \alpha\, ln\, A + \beta\, ln\, L + \gamma\, ln\, K + \delta ln\, S$,
Totally differentiating with respect to price, once again assuming perfect competition,
$ln\, MC = \partial ln\, A./\, \partial p + ln\, MPL + ln\, MPK + MPS$, where MP is marginal product,
$ln\, p = -TFP + ln\, w + ln\, r + ln\, k$
Taking the first differences in industry i at time t and weighing factors by cost shares,
$\Delta\, ln\, p_{it} = -TFP_{it} + \theta_{itW}\Delta ln\, w_{it} + \theta_{itS}\Delta ln\, s_{it} + \theta_{itr}\Delta ln\, r_{it}$

Feenstra and Hanson (1999, 2001) improve on these productivity measures by introducing changes in wages into the regression as a random error term (which will later be included with productivity) and relate goods prices to average factor prices and factor cost-shares. In this case the error term from equation (2) is equal can be expressed,

$$\varepsilon_{it} \equiv \theta_{itW} (\Delta ln\ w_{it} - \omega_{tW}) + \theta_{itS}(\Delta ln\ s_{it} - \omega_{tS}) + \theta_{itr} (\Delta r_{it} - \omega_{tR}) \quad (3)$$

This error term tells us the average deviation in industry i and time t of factor-price differences from their industrial mean levels. They are also calculated as first-differences to capture changes over time. Each term multiplied by the factor cost share θ is equal to level differences from industry means. Variables θ, w, s, and r are the same as in equation (2), but here industry average factor prices, ω, also are included.

Industry average factor price differentials are usually considered within stochastic error term in price regressions as in equation (2). These terms can in fact can be measured and reincorporated into the regression using available data to generate an even more accurate measure of TFP. With perfect competition, deviations in factor prices across industries may be attributed to some unobserved quality in the factors or industry-specific rents. Assuming that factors are mobile across industries I will assume that these differences are a result of differences in factor quality. The inclusion of (3) into the estimated specification allows measurement of these differences in factors across industries.

Feenstra and Hanson find that equation (3) can be used to generate an effective TFP measure that is an identity that is perfectly negatively correlated with goods price changes. Effective TFP is the best theoretical possible measure of total factor productivity. It is defined as,

$$ETFP \equiv TFP - \varepsilon_{it} \tag{4}$$

ETFP is simply a combination of the TFP measure and the error term calculated using factor changes and average industry factor prices. This new effective TFP can now be substituted into equation (2) using equation (4) above,

$$ETFP_{it} = \theta_{itL}\omega_{tL} + \theta_{itH}\,\omega_{tH} + \theta_{itK}\,\omega_{tK} - \Delta ln\,p_{it} \tag{5}$$

From this equation, an accurate measure of ETFP can be calculated. ETFP and prices should be perfectly negatively correlated if they match theoretical predictions. I would also expect a strong positive correlation between changes in factor prices and changes in goods prices. If factor and good prices are being determined in a competitive environment, then increased factor prices (because of increase in factor quality, increased MPL, etc.) would be expected to raise goods prices. Similarly, an increase in productivity would lower marginal costs of production and therefore lower goods prices.

The estimation of ETFP can be seen in Table 2. Regressions 1 and 2 evidence the definition of effective total factor productivity. In both the dependent variable is log change in prices for industry i at time t. Both regressions include ETFP, wage, skill, and capital as explanatory variables and all are extremely significant in both. Regression 1 contains a period dummy variable that separates the peso crisis period of instability of

1994-1997 from the 1998-2003 period. There is no explanatory significance of these regressions, but they demonstrate empirically the theoretical relationship in (5).

5. Empirical Approach

Following the initial ETFP calculation, the mandated wage method contains two steps. In the first stage the productivity measure is combined with price changes and regressed on outsourcing and technology. This generates coefficients on outsourcing and technology as they relate to prices and productivity. Endogenizing prices and productivity separates out price and productivity changes that are attributable to outsourcing and technology only. The second stage of the method is a linear decomposition of the structural variables and their generated coefficients to measure their influence on different factors. Outsourcing and technology are regressed on factor cost shares to give changes in factor prices predicted or mandated by each structural variable. All of the steps below follow closely Feenstra and Hanson (1999). The most significant difference is the estimation of Mexican instead of US manufacturing.

5.1 Endogenized Prices and Productivity

Now that we have estimated ETFP, we can "endogenize" prices and productivity to estimate how structural variables may affect them. The purpose of this exercise is to estimate how changes in certain structural variables, in this case technology transfers and outsourcing, affect goods prices and productivity. The reason for combining ETFP and goods prices is that, assuming perfect competition, this term should capture all variation in productivity. This allows a complete initial calculation of the estimated effect of structural variables on goods prices. After this estimation these effects can be decomposed by factor to examine the implications for wages and rental rates.

Equation (5) gives a pretty clear indication of how changes to productivity and factor cost-shares can affect factor prices. In this section I estimate the effect of changes to structural variables (technology and outsourcing) and product prices on total factor productivity. In section 5.2 I use the first stage results and the results from (5) to break down changes in factor prices that are attributable to outsourcing and technology. I begin with the first stage which describes the relationship between structural variables and productivity,

$$ETFP_{it} = \alpha\,\Delta z_{it} + e_{it} \tag{6}$$

ETFP is our measure of productivity from section 4 above, z_{it} is a vector of structural variables and α is a vector of coefficients on structural variables. e_{it} is a new "disturbance" term that includes all other shocks to productivity not captured in other variables[11]. Following Feenstra and Hanson (1999) I assume that changes in productivity are passed through to industry product prices because shocks are common across countries. These shocks are passed through industry in prices. Since the structured variables are affecting ETFP in ways unmeasured we must include them to accurately specify price changes,

[11] and is assumed to be orthogonal to the structural variables in z_{it} (Feenstra and Hanson, 1999).

$$\Delta ln\, p_{it} = \lambda ETFP_{it} + \beta\, \Delta z_{it} + v_{it} \qquad (7)$$

In equation (7) λ is the "pass-through" coefficient (which is expected ≤0), β is a vector of structural variable coefficients, and v_{it} is an error term. This pass-through coefficient shows the indirect effect of changes in productivity on goods prices. This estimation also assumes that the structural variables have a direct effect on price changes that goes beyond our measure of productivity that is captured by the coefficient β on the structural variables.

The idea that technology or outsourcing can affect factor prices through changes in goods prices is somewhat disputed. Technology may affect productivity by improving capital machinery and it may also lead to more efficient production practices. Outsourcing may improve measured productivity as well. When tasks are outsourced to Mexico they generally use parts or materials imported from abroad to complete the new production task. As shown above, when tasks are brought into Mexico and firms begin importing more and more goods from abroad there are clear-cut mechanisms for changing returns to factors. As explained in the theory above and demonstrated in Figure 3 either structural variable has the potential to affect factor prices directly. This would be evident empirically if the coefficient on ETFP, λ, is approximately equal to -1 as in the first set of regressions and if β is significant. We want to be especially vigilant of the significance of β since this term captures the direct effects of outsourcing and technology that are not captured in our ETFP measure.

Since outsourcing and technology can impact productivity and prices directly, I can now combine (6) and (7) from above to create an equation that expresses all possible elements of productivity that might produce a change in prices discussed so far,

$$\Delta ln\, p_{it} + ETFP_{it} = \gamma\, \Delta z_{it} + \eta_{it} \qquad (8)$$

where $\gamma_t = (1+\lambda)\alpha+\beta$ and $\eta_{it} = (1+\lambda)e_{it} + v_{it}$. Equation (8) is simply the sum of (6) and (7). The coefficient on the structural variable, z_{it}, now contains the some amount of the "pass through" effects that are captured in λ. η_{it} contains random error terms ε_{it} and v_{it}. Since λ is expected to be equal to -1, we cautiously interpret η_{it} as the random error term and γ_t to be equal to β. The regression can be broken down by k structural variables and regressed to estimate the change in TFP and product prices as a result of each variable. In this case $\gamma_k\, \Delta z_k$ is the k^{th} structural coefficient-variable term. This is the first stage of the two-stage regression.

I use two different measures of outsourcing and technology to check for the robustness of my results. The first measure, IITI, is equal to the imported intermediates as a share of all inputs to production. The second measure, IIGO, is defined as imported intermediates as a share total gross output. The two measures of outsourcing have a correlation of 0.97, not surprisingly and so produce almost identical results. IITI will be used as the default[12]. The first measure of technology, technology 1, is calculated by dividing technology transfers and royalty costs by total capital. The second measure,

[12] For a discussion of different empirical measures of international outsourcing see Horgos (2007). He finds IITI to be the most theoretically consistent measure of outsourcing.

technology 2, estimates it as technology transfers per total workers. These two measures have a correlation of 0.8281.

For this regression I will assume that there are only two structural variables, outsourcing (z_O) and technology (z_A).Results for the first stage of the mandated wage regression, equation (8) are shown in Table 3. The dependent variable in all regressions is equal to changes in indexed prices plus ETFP. Regressions (1), (3), and (4) use the primary measure of outsourcing, IITI, and the first measure of technology, tech transfers per total capital. Regression (2) contains the alternative measures IIGO for outsourcing and technology transfers per worker. The coefficients of the explanatory variables can be interpreted as the effect of these structural variables on goods prices and productivity.

The coefficients of the structural variables are significant at the 5% level for most of the variables. This suggests that the structural variables are affecting and possibly causing non-neutral-shifts in factor prices. The important result is that the estimation of γ is significant in most specifications. This can be interpreted as revealing that β in equation (8) is nonzero and therefore technological progress in technology and outsourcing produces non-neutral changes. The next section will use the second stage estimation to estimate the effect of both structural variables on factor prices.

5.2 Outsourcing, Technology, and Wages

In the second stage price and productivity changes are combined and regressed on factor cost-shares. The linear decomposition of factor price effects allows me to isolate the effects of individual structural variables. This reveals the wage change predicted (or "mandated") by the structural factors. The second-stage regression equations for technology (A) and outsourcing (O) appear as,

$$\gamma_{tA}\,\Delta z_{itA} = \theta_{itLA} + \theta_{itHA} + \theta_{itKA} + \mu_{it} \tag{9a}$$

$$\gamma_{tO}\,\Delta z_{itO} = \theta_{itLO} + \theta_{itHO} + \theta_{itKO} + \mu_{i} \tag{9b}$$

Once again, θ represents factor cost sharess in industry i at time t. This variable can be interpreted as changes in primary factor prices that occurred because of changes in prices and productivity only. In these decomposed regressions we are able to estimate the changes in factor prices for all factors that result from technology and outsourcing separately.

Before moving to the results it is worth briefly discussing the dependent variables. See Table 4 for a detailed summary of the dependent variables. All structural variables are measured in annual changes. The dependent variable in all regressions is the structural variable times its coefficient as generated in the first stage, presented in Table 3 and summarized in Table 4. The results of the second stage are presented in Table 5. The coefficients can be interpreted as changes in the factor prices because of the structural variables. The constant gives the effect of the structural variable that is taking place for all factors. Once again, results in the second regression are not explaining much variation.

There are several important estimation issues that must be addressed. The construction of the dependent variable in (9a) and (9b) uses the coefficients generated by equation (8). For any given structural variable, these same coefficients demonstrate the effect of the structural variable on productivity and are present in the characteristics of that industry. This creates unwanted covariance between the error term and the dependent variable. Unfortunately, there is little that can be done to alter this and therefore the standard errors must be interpreted with great caution.

The coefficients can be interpreted as changes in the factor prices as a result of the presence of the structural variables. These coefficients give the linear decomposition of the productivity effects of the structural variables. Regressions (1), (5), and (6) include the IITI measure of outsourcing. Regressions (5) and (6) estimate effects for 1994-1997 and 1998-2003, respectively. Regression (2) contains the alternate measure of outsourcing, IIGO. Finally, regressions (3) and (4) estimate technology transfers. Tech transfers 1 is measured as technology transfers per total capital and tech transfers 2 is measured as transfers per worker.

Interestingly, in every regression the effect of the structural variables on skilled-workers is large and significant. Both measures of outsourcing, IITI and IIGO seem to be benefiting all workers, but skilled workers disproportionately. Outsourcing appears to be having a negative effect on returns to capital. Technology also seems to be having little effect on the wages of unskilled workers and appears complementary to skill. This in itself is an interesting result. Depending on the measure used the effect of technology on capital is clear. Finally, breaking up the regressions by period changes the results drastically. The 1994-1997 period, that of the tequila crisis, is the only one in which skilled labor falls as a result of outsourcing. During the later, 1998-2003 period, outsourcing appears to be benefiting all factors, although skill slightly more than others. These results therefore suggest a decrease in inequality in the first period and an increase in the second.

5.3 Alternative Specification

The results of the specification tested in sections 5.1 and 5.2 suggest that outsourcing and technology appeared to be lowering productivity in Mexican manufacturing. One possible explanation for this counterintuitive result is that the assumption of perfect competition made earlier was false. If this was indeed the case for Mexican industry, then prices would not correspond to marginal costs. The observed apparent fall in productivity could therefore be explained as increased competition driving down price markups in manufacturing. This explanation of increasing competition is quite plausible considering the sharp degree of liberalization in the 1994-2003 period. This explanation, however, invalidates the cost based measure of total factor productivity in section 4. Instead, a quantity-output based of TFP would be expected to correct for this problem.

To test for this alternative hypothesis, I recalculate the regressions using an output based measure of productivity. The results suggest that this explanation may indeed be valid. The results, presented in Table 6, show a reversal in signs. Technology and outsourcing have a positive coefficient in every specification. Although technology is mostly insignificant, outsourcing holds significance at the 5% level in almost every specification. The overall result is the expected increase in productivity because of technology and outsourcing.

I then proceed to calculate stage two in exactly the same manner as in section 5.2. Surprisingly this generated another sign reversal. Once again, the significance of the coefficients on low-skill wages and capital rents are low, but the coefficient on skill remains significant at the 1% level to almost every specification. This provides further evidence for a strong relationship between outsourcing and skilled labor in Mexico. The interpretation of these coefficients is difficult, since they seemingly contradict theory so strongly. They suggest a negative relationship between productivity shifts caused by outsourcing and changes in factor prices. Once again examining the relationship by period suggests a reversal of inequality between the two periods. In the 1994-1997 period I observe increased inequality and in the 1998-2003 period the opposite occurs. Referring back to Figure 1, this matches up quite closely with overall patterns in relative wages, and tentatively suggests that indeed outsourcing might be decreasing inequality in recent years.

6. Conclusion

The purpose of this paper was to isolate the effect of vertical integration and technology on wages in Mexico's manufacturing sector for the era following the NAFTA agreement. It is theoretically possible that outsourcing can affect factor prices in a non-neutral way similar to technology. In fact, empirically both outsourcing and technology transfers are having direct and non-neutral effects on factor prices. Although the effect of this measure of technology remains ambiguous, the effect of outsourcing seems to depend on period. Its effect seems to be an increase to inequality in the period immediately following the peso crisis of 1994. In the subsequent period up to 2003 outsourcing seems to be decreasing inequality, as this paper initially predicted. There also appears to be a strong and consistent relationship between this measure of outsourcing and skilled labor. This warrants further study using an expanded time period, but is suggestive that the relationship between vertical integration as measured here and inequality is significant.

References

Antràs, Pol, Garciano, Luis, and Rossi-Hamberg, Estbean, 2006. Offshoring in a Knowledge Economy. The Quarterly Journal of Economics 121(1): 31-77.

Chiquiar, Daniel, 2008. Globalization, regional wage differentials, and the Stolper-= Samuelson Theorem: Evidence from Mexico. Journal of International Economics 74: 70-93.

Chung, Chul and Deardorff, Alan, 2008. Specialization, Fragmentation, and Factor Intensities: Evidence from Chilean Plant-Level Data. The Journal of Developing Areas 41(2): 91-109.

Chusseau, Nathalie, 2008."Explaining Rising Inequality: Skill-Biased Technical Change and North-South Trade. Journal of Economic Surveys 22(3): 409-457.

Deardorff, Alan, 2001. Fragmentation in Simple Trade Models. North American Journal of Economics and Finance 12(2): 121-137.

Egger, Hartmut and Egger, Petter, 2006. International Outsourcing and the Productivity of Low-Skilled Labor in the EU. Economic Inquiry 44(1): 98-108.

Esquivel, Geraro and Rodríguez-López, José Antonio. 2003. Technology, trade, and wage inequality in Mexico before and after NAFTA. Journal of Development Economics 72: 543-565.

Feenstra, Robert C. and Hanson, Gordon H, 1997. Foreign direct investment and relative wages: Evidence from Mexico's maquiladoras. Journal of International Economics 42 : 371-393.

Feenstra, Robert C. and Hanson, Gordon H, 1999. The Impact of Outsourcing and High-Technology Capital on Wages: Estimates For The United States, 1979–1990. The Quarterly Journal of Economics 114(3): 907-940.

Feenstra, Robert C. and Hanson, Gordon H, 2001. Global Production Sharing and Rising Inequality: A Survey of Trade and Wages. NBER Working Paper No. 8371.

Grossman, Gene M. and Rossi-Hansberg, Esteban, 2006. Trading Tasks: A Simple Theory of Offshoring. NBER Working Paper No. 12721.

Hanson, Gordon H. and Harrison, Ann, 1999. Trade Liberalization and Wage Inequality in Mexico. Industrial and Labor Relations Review 52: 271-288.

Horgos, Daniel. 2007. Labor Market Effects of International Outsourcing: How Measurement Matters. SOEPpapers on Multidisciplinary Panel Data Research. Working Paper Series No. 58

Jones, Ronald, (1963). The Structure of Simple General Equilibrium Models. Journal of Political Economy 73: 557-572.

Jones, Ronald, Kiezkowski, Henryk, 2001. A Framework for Fragmentation. In *Fragmentation: New Production Patterns in the World Economy,* ed. Arndy, Sven W. and Kierzkowski, Henryk, 17-34. USA: Oxford University Press.

Jones, Ronald, Kiezkowski, Henryk, and Lurong, Chen, 2005. What does evidence tell us about fragmentation and outsourcing? International Review of Economics and Finance, 14(3): 305-316.

Krugman, Paul, 2000. Technology, trade and factor prices. *Journal of International Economics.*50: 51-71.

Leamer, Edward E, 1996. In Search of Stolper-Samuelson Effects on U.S. Wages. NBER Working Paper Series No. 5427.

López-Acevedo, Gladys, 2006. Mexico: Two Decades of the Evolution of Education and Inequality. World Bank Policy Research Working Paper No. 3919.

Robertson, Raymond, 2004. Relative prices and wage inequality: evidence from Mexico. Journal of International Economics 64: 387-409.

Robertson, Raymond, 2007. Trade and Wages: Two Puzzles from Mexico. The World Economy 30(9): 1378-1398.

Robertson, Raymond, 2008. "Are Mexican, Canadian, and U.S. Workers Complements or Substitutes?" <macalester.edu/~robertson> mimeo.

Rojas, Gabriel Motes, 2004. Skill Premia in Mexico: demand and supply factors. Applied Economics Letters 12:917-924.

Shelburne, Robert C, 2004. Trade and Inequality: The Role of Vertical Specialization and Outsourcing. Global Economy Journal. 4(2).

Thompson, Henry, 2001. International Trade with Three Factors, Goods or Countries. Keio Economic Studies 38(1): 43-52.

Tybout, JR. 2000. Manufacturing Firms in Developing. Countries: How Well Do They Do, and Why? *Journal* of *Economic Literature*. Vol. XXXVIII:11–44.

Verhoogen, Eric A, 2008. Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector. Quarterly Journal of Economics 123: 489-.

Table 1: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Production Wage	2045	15.81	9.43	2.35	74.43
Non-production Wage	2045	46.40	29.19	3.13	341.28
Rental Rate	2050	2.66	4.79	0	86.10
Relative Wages	2045	3.00	.92	.91	7.54
Raw Material Costs	2050	2888690	1.09e+07	1682	1.98e+08
Energy Costs	2050	77275.20	201346.4	46	3158891
Nominal Indexed Prices	1800	66.79	30.44	10.54	232.51
Deflated Indexed Prices	1800	32.52	26.10	3.33	100
Output	2050	5705916	1.62e+07	0	2.78e+08
IITI	2050	.18	.16	0	.94
IIGO	2045	.15	.13	0	.85
Technology 1	2050	.06	.18	0	2.63
Technology 2	2045	8.37	25.25	0	478.72
Dual TFP	1611	24.65	13.85	2.39	86.62
Primal TFP	1824	.058	.12	-.71	.78
ETFP	1620	92.35	25.94	62.80	151.14

Notes: All values in pesos.

All data come from the Mexican National Institute of Statistics and Geography (INEGI in Spanish), range from 1994-2003, and are annual. Data come from the monthly industrial survey (EIM in Spanish) and the annual industrial survey (EIA). The variables taken from the monthly survey were summed to yearly values. All data use the 6 digit Mexican manufacturing code system (CMAP), which contain a total of 205 industries.

Table 2: ETFP Calculation

	(1)	(2)
Dependent Variable	Log Changes in Prices	Log Changes in Prices
ETFP	-1.000***	-1.000***
	(0.000)	(0.000)
Wage	1.000***	1.000***
	(0.000)	(0.000)
Skill	1.000***	1.000***
	(0.000)	(0.000)
Capital	1.000***	1.000***
	(0.000)	(0.000)
Period Dummy	2.12e-08*	.
	(2.43e-07)	
Constant	-7.54e-07	-7.64e-07
	(9.05e-07)	(8.79e-07)
Observations	1620	1620
R-squared	1.000	1.000

Notes: Robust standard errors in parentheses.
*** significant at 1% level, **significant at 5% level, *significant at 10% level

Regressions 1 and 2 evidence the definition of effective total factor productivity. In both the dependent variable is log change in prices for industry i at time t. Both regressions include ETFP, wage, skill, and capital as explanatory variables and all are extremely significant in both. Regression 1 contains a period dummy variable that separates the peso crisis period of instability of 1994-1997 from the 1998-2003 period.

Table 3: First Stage Results

	(1)	(2)	(3)	(4)
ΔOutsourcing IITI	-34.155** (17.150)	.	19.169*** (6.605)	-25.656 (28.846)
ΔOutsourcing IIGO	.	-44.613** (21.083)	.	.
ΔTechnology transfers (per total capital)	-33.663** (15.437)	.	7.086 (8.349)	-28.554*** (8.851)
ΔTechnology transfers (per worker)	.	-0.104 (0.066)	.	.
Constant	92.449*** (0.695)	92.341*** (0.697)	72.606*** (0.326)	101.935*** (0.808)
Observations	1620	1620	540	1080
R-squared	0.011	0.005	0.017	0.010
Period	1994-2003	1994-2003	1994-1997	1998-2003

Notes: Robust standard errors in parentheses.
*** significant at 1% level, **significant at 5% level, *significant at 10% level

The dependent variable in all regressions is equal to log changes in indexed prices plus ETFP. Regressions (1), (3), and (4) use the primary measure of outsourcing, IITI, and the first measure of technology, tech transfers per total capital. Regression (2) contains the alternative measures IIGO for outsourcing and technology transfers per worker. The coefficients of the independent variables can be interpreted as the effect of these structural variables on goods prices and productivity.

Table 4: Summary of Dependent Variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
$\gamma_{tO1}\ \Delta z_{itO1}$	1845	-0.0991	1.322	11.930	17.121
$\gamma_{tO1}\ \Delta z_{itO1a}$	1845	0.056	0.742	-9.609	6.695
$\gamma_{tO1}\ \Delta z_{itO1b}$	1845	-0.074	0.993	-8.961	12.861
$\gamma_{tO2}\ \Delta z_{itO2}$	1840	-0.097	1.513	-12.117	13.875
$\gamma_{tA1}\ \Delta z_{itA1}$	1845	-0.205	2.504	-71.707	27.632
$\gamma_{tA2}\ \Delta z_{itA2}$	1840	0.110	1.182	37.100	10.011

This table presents the summary statistics for the final regression. Each dependent variable is calculated by multiplying changes in the structural variable z, by its coefficient generated in section 5.1, γ. The first three rows show the primary measure of outsourcing, IITI. The second and third tows contain IITI for 1994-1997 and 1998-2003, respectively. The fourth row contains the alternate outsourcing measure, IIGO. The fifth and sixth rows contain information about Technology 1 and Technology 2.

Table 5: Second Stage Results

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	IITI	IIGO	Tech transfers 1	Tech transfers 2	IITI	IITI
Wage Share	0.843 (2.292)	3.768 (3.083)	1.326 (4.038)	-0.541 (2.387)	0.278 (8.871)	3.909* (2.104)
Skill Share	6.352*** (1.788)	5.598*** (1.915)	23.786*** (6.821)	6.480*** (1.813)	-12.513*** (4.074)	4.782** (1.920)
Capital Share	-11.343* (6.960)	-6.028 (7.733)	24.270*** (8.411)	2.948 (4.543)	8.568 (9.483)	5.992 (7.344)
Constant	-0.239 (0.368)	-0.548 (0.433)	-2.826*** (0.684)	-0.646** (0.274)	0.537 (0.777)	-0.846*** (0.302)
N	1845	1840	1845	1840	615	1230
R-squared	0.006	0.004	0.001	0.001	0.006	0.004
Period	1994-2003	1994-2003	1994-2003	1994-2003	1994-1997	1998-2003

Notes: Robust standard errors in parentheses.
*** significant at 1% level, **significant at 5% level, *significant at 10% level

The dependent variable in each regression is the structural variable times its coefficient as generated in the first stage. The coefficients can be interpreted as changes in the factor prices due to the presence of the structural variables. The coefficients on the independent variables give the linear decomposition of the productivity effects of the structural variables. Regressions (1), (5), and (6) include the IITI measure of outsourcing. Regressions (5) and (6) estimate effects for 1994-1997 and 1998-2003, respectively. Regression (2) contains the alternate measure of outsourcing, IIGO. Finally, regressions (3) and (4) estimate technology transfers. Tech transfers 1 is measured as technology transfers per total capital and tech transfers 2 is measured as transfers per worker.

Table 6: Alternate Specification-Stage 1

	(1)	(2)	(3)	(4)
ΔOutsourcing IITI	61.544*** (21.051)	.	44.393** (24.113)	0.975 (8.790)
ΔOutsourcing IIGO	.	42.151** (22.249)	.	.
ΔTechnology transfers (per total capital)	12.879* (7.884)	.	17.979 (26.417)	7.842** (3.506)
ΔTechnology transfers (per worker)	.	0.076 (0.053)	.	.
Constant	49.450*** (0.484)	49.531*** (0.485)	69.590*** (0.800)	39.424*** (0.215)
Observations	1611	1611	539	1072
R-squared	0.011	0.001	0.003	0.004
Period	1994-2003	1994-2003	1994-1997	1998-2003

Notes: Robust standard errors in parentheses.
*** significant at 1% level, **significant at 5% level, *significant at 10% level

The dependent variable in all regressions is equal to log changes in indexed prices plus the output measure of TFP. Regressions (1), (3), and (4) use the primary measure of outsourcing, IITI, and the first measure of technology, tech transfers per total capital. Regression (2) contains the alternative measures IIGO for outsourcing and technology transfers per worker. The coefficients of the independent variables can be interpreted as the effect of these structural variables on goods prices and productivity.

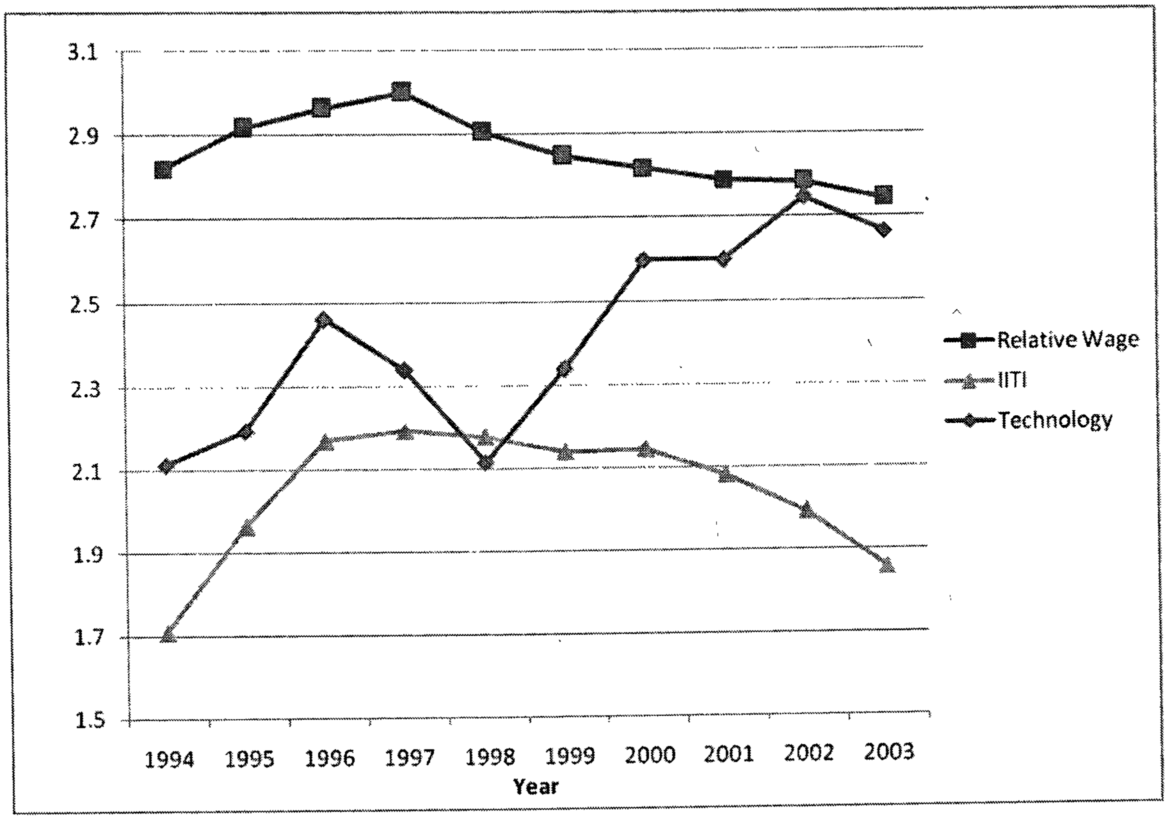
Table 7: Alternate Specification-Stage 2

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	IITI	IIGO	Tech transfers 1	Tech transfers 2	IITI	IITI
Wage Share	-7.190* (5.545)	-10.789*** (3.423)	2.550 (2.223)	1.149 (2.099)	-22.287 (18.915)	-0.062 (0.104)
Skill Share	-18.986*** (5.368)	-8.249** (3.197)	-10.182*** (2.151756)	-5.757*** (1.960)	-16.825 (13.433)	-0.316*** (0.103)
Capital Share	-4.388*** (1.155)	-7.164*** (0.741)	-0.228 (0.463)	-0.413 (0.454)	-1.837 (3.419)	-0.069*** (0.021)
Constant	3.428*** (0.631)	4.066*** (0.421)	0.611** (0.253)	0.514** (0.258)	3.062* (2.008)	0.051*** (0.011)
N	1845	1840	1845	1840	615	1230
R-squared	0.006	0.009	0.000	0.000	0.003	0.010
Period	94-03	94-03	94-03	94-03	94-97	98-03

Notes: Robust standard errors in parentheses.
*** significant at 1% level, **significant at 5% level, *significant at 10% level

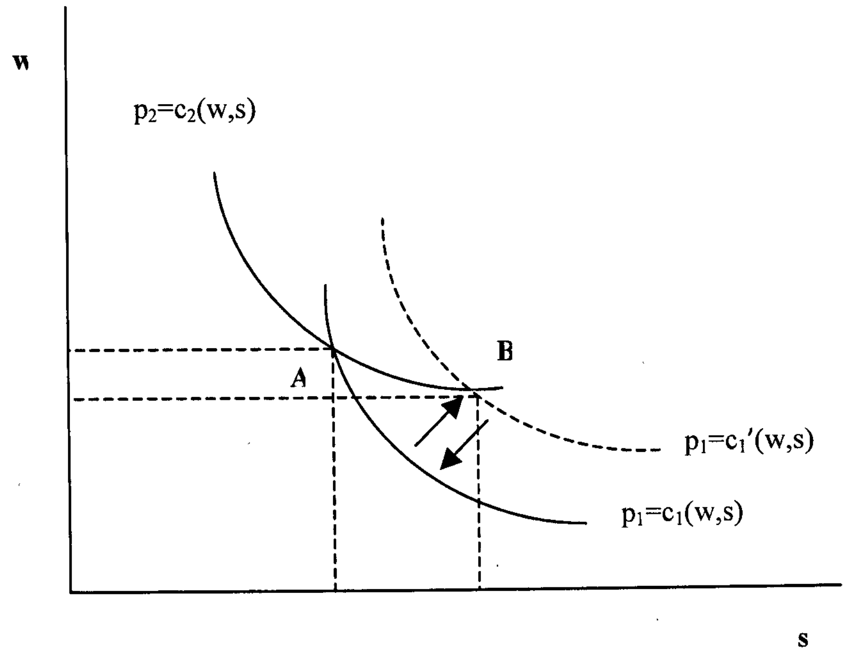
The dependent variable in each regression is the structural variable times its coefficient as generated in the first stage. The coefficients can be interpreted as changes in the factor prices due to the presence of the structural variables. The coefficients on the independent variables give the linear decomposition of the productivity effects of the structural variables. Regressions (1), (5), and (6) include the IITI measure of outsourcing. Regressions (5) and (6) estimate effects for 1994-1997 and 1998-2003, respectively. Regression (2) contains the alternate measure of outsourcing, IIGO. Finally, regressions (3) and (4) estimate technology transfers. Tech transfers 1 is measured as technology transfers per total capital and tech transfers 2 is measured as transfers per worker.

Figure 1 – Outsourcing, Technology, and Inequality Movements: 1994-2003



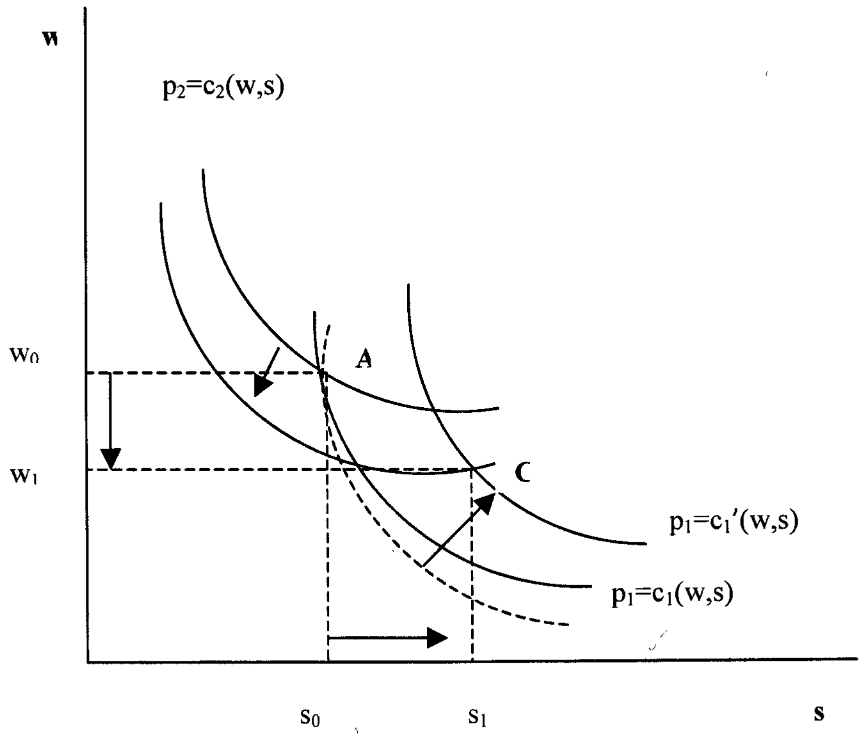
Notes: Relative wages are expressed as non-production wages over production wages. IITI is the imported intermediate share of total inputs and is used to measure outsourcing. Technology is measured as technology transfers per total workers. IITI and technology are scaled to fit the y-axis. All data come from the Mexican National Institute of Statistics and Geography (INEGI in Spanish).

Figure 2 – Neutral Technical Change



Notes: This curve depicts two industries with two factors: unskilled labor, whose price is written as w and skilled labor, whose price is written as s. Industry 1, which is skill-intensive, is depicted on the lower curve and industry 2, which is labor-intensive, is depicted on the higher curve. The graph depicts neutral technological progress in industry 1. In this industry technological progress shifts out the iso-cost curve to point B. This increase in output is countered by an equal decrease in prices (assuming Cobb-Douglas production functions) resulting in net changes to factor prices w or s. Factor prices remain unaffected by changes in good prices.

Figure 3 – Non-neutral Technical Change



Notes: This figure depicts two industries with two factors: unskilled labor, whose price is written as w and skilled labor, whose price is written as s. Industry 1, which is skill intensive is depicted on the lower curve and industry 2, which is labor intensive, is depicted on the higher curve. This graph shows non-neutral technological progress in industry 1. A change in technology rotates the iso-cost curve in industry 1 clockwise around its intersection with p_2 at A since the change is relatively more complementary to skill. Technological progress increases output of good y_1 and the goods market is in equilibrium. Because of the increase in relative demand for skill, factor markets are no longer in equilibrium. This causes the relative price of skill, s and price good y_1 to increase. The iso-cost curve for industry 1 shifts outwards because of increased skill costs. The iso-cost curve for industry 2 shifts inwards because relative demand for unskilled labor has fallen. This moves the new equilibrium to point C. Unskilled wages decrease from w_0 to w_1 while returns to skill rise from s_0 to s_1.