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The Effects of Trade Liberalization and Technological Progress on Mexico's Wage Inequality, 1988-2000[1]

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Abstract

During the last years, there has been a rapid increase in wage inequality between skilled and unskilled workers in Mexico. This increment in the wage gap has coincided with both a period of rapid technological change and with the process of trade liberalization in Mexico that began in 1985. Such an increase in the wage gap has also taken place in several other countries and the academic literature has suggested two main candidates as explanatory factors of such trend: trade liberalization (or globalization) and skill-biased technological progress. Using a model developed by Leamer (1998) we separate out the effects of globalization and technological progress on the real wage evolution of skilled and unskilled workers in Mexico's manufacturing industry. Our main finding is that technological progress has played a major role in the increase in wage inequality in Mexico between 1988 and 2000. We also find that trade liberalization pressed for a decrease in the wage gap in the period 1988-1994, but such effect was offset by the relatively large negative impact of technological progress on the real wage of unskilled workers.

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I. Introduction

The effect of trade liberalization on wage inequality is a topic that has attracted the attention of many economists during the last decade. However, there is not yet a consensus about the true responsibility of trade openness over the increasing inequality in different countries. The purpose of this paper is to analyze the impacts of Mexico's trade liberalization on the wage gap between skilled and unskilled workers.

For the United States case, where income inequality between skilled and unskilled workers has been continuously rising on the past thirty years, we can distinguish three points of view. One of them points out that the increasing inequality is consequence of the trade openness of the U.S. with developing countries.[2] Using as framework the HO model, this view affirms that given that the U.S. is a country with relative abundance of skilled labor and developing countries like Mexico are abundant in unskilled labor, trade caused the relative price of unskilled labor intensive goods to diminish, and through the Stolper-Samuelson theorem, this provoked the increase in the wage gap.

The second point of view states that U.S. trade with developing countries is still very small, so that it is very unlikely that this could be the principal cause of the great increase in wage inequality.[3] Many economists that support this view have found in technological progress a very plausible explanation for the changes in the distribution of income. They suggest that skill biased technological progress has shifted to the right the demand for skilled labor, rising the relative wage of these workers.

A third point of view found in the trade of intermediate inputs with developing countries and the use of computers, the principal factors that have caused the increase in the wage gap.[4] Feenstra and Hanson (1996) call "outsourcing" to the action taken by some firms of sending to other countries some part of the production process. They affirm that the U.S.,

[2] Leamer (1998) and Wood (1995).

[3] Krugman (2000) and Lawrence and Slaughter (1993).

[4] Feenstra and Hanson (1995).

being a skilled abundant country, is sending less-skilled production processes abroad, causing an increase in the relative demand for skilled labor. As we know, this will cause an increase in the wage gap.

For Latin America, there have been some studies that try to explain the relation between trade liberalization and wage inequality. Wood (1997) shows that since the mid-eighties, when Latin-American countries started to open their trade, began to rise the wage gap between skilled and unskilled workers.

For the Chilean case, Beyer, Rojas and Vergara (1999) found that trade liberalization caused a rise in inequality. According to their work, this conclusion is evidence against the HO model, which predicts through the Stolper-Samuelson theorem a decrease in the wage gap for a country like Chile, relatively abundant in unskilled labor.

For Mexico, Epelbaum and Cragg (1997) found that in the period from 1987 to 1993, the wage inequality increased as a consequence of a rise in the demand for skilled labor. They affirm that this shift in the demand was provoked by skill biased technological change. On the other side, Robertson (2001) concludes that trade liberalization has been the principal cause of the changes in the wage gap in the period from 1987 to 1999. He argues that after GATT and before NAFTA, the wage gap rose due to the decrease in the relative price of unskilled labor intensive goods. Robertson considers that this price decline was obtained because with GATT, Mexico opened its frontiers to countries with relative abundance of unskilled labor. Besides, Robertson points out that after NAFTA wage inequality have begun to diminish, as consequence of Mexico's openness with countries with relative abundance of skilled labor (U.S. and Canada).

In this paper we will analyze the evolution of the wage gap between skilled and unskilled workers during the period going from 1988 to 2000. Using "price regressions"[5] we will estimate the effects of technological progress and trade liberalization on real wages of

[5] This methodology has been used before by Baldwing and Cain (2000), Krueger (1997) and Leamer (1998).

skilled and unskilled workers. With this, we pretend to give a clear idea of the magnitude of the responsibility of each of these factors on the wage gap.

In part II we give a brief description of the changes in Mexico's trade policy since the mid-eighties and we present some insights about the evolution of the wage gap between skilled and unskilled workers in our period of study. In part III we estimate our price regressions, using the equations obtained by Leamer (1998) to separate the effects of technological progress and trade liberalization on real wages of skilled and unskilled workers.

II. Trade liberalization and changes in wage inequality

Since the beginnings of the forties, Mexico began a growth strategy of "industrialization by imports substitution (IIS)". This strategy consisted in protecting the industrial sector of the country through trade barriers. By this way, Mexican government was looking to promote the creation of new industries and the development of the already existing.

The IIS strategy reached its best times on the sixties, with the so called "Mexican Miracle". However, in the mid-seventies this strategy began to collapse but it was until 1982, with the oil-crisis, when finally the government decided to drop it.

In 1985 Mexico began a strong period of trade liberalization. After a considerable decrease in trade barriers, Mexico decided to enter to the General Agreement on Tariffs and Trade (GATT) in July of 1986. To complete the structural change initiated in 1985, Mexico decided in 1990 to start negotiating with the U.S. and Canada a free trade agreement. In January 1, 1994 came into effect the North America Free Trade Agreement (NAFTA).

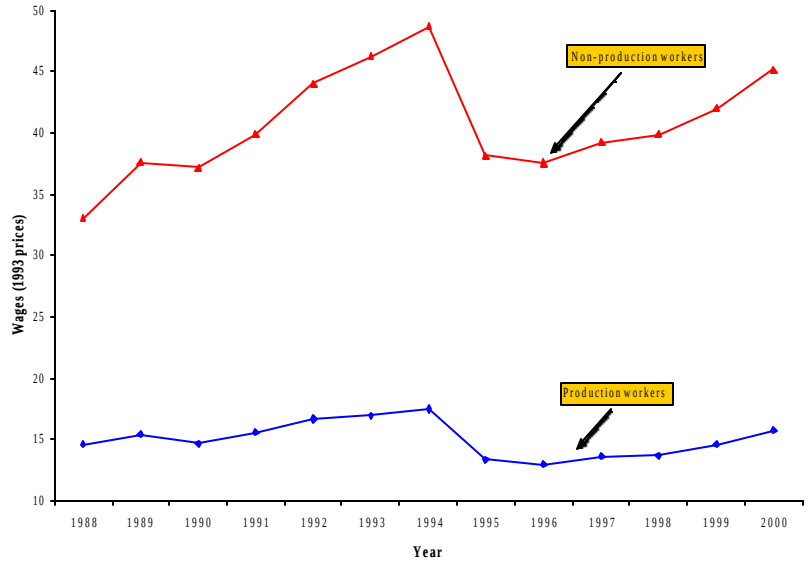
Taking into account the precedents of the Mexican trade liberalization, we will make an analysis of the evolution of the wage gap between skilled and unskilled workers in the manufacturing industry from 1988 to 2000. Besides, we study the link between real wages and technological progress in this period.

II.1 Evolution of the wage gap between skilled and unskilled workers

To separate the skilled workers from the unskilled, we are going to use as an approximation the division made by INEGI of non-production and production workers. Non-production workers are our approximation for skilled workers and production workers are our unskilled workers. However, in the following part we will make some comments about the disadvantages of using this approximation to measure the level of skill of the workers.

Now we are going to make a short analysis of the evolution of the wage gap in the manufacturing industry in our period of study. Figure 1 shows the evolution of real average wages of non-production and production workers.

Figure 1. Real average wages in the manufacturing industry

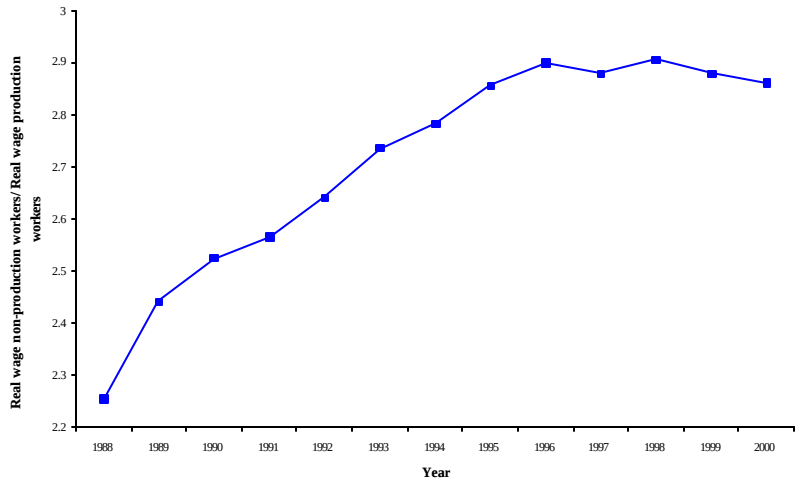


Source: National Accounts System, INEGI.

As we can notice, from 1988 to 1994 the real average wages of both kinds of workers showed an increasing trend, though the trend is more pronounced for non-production workers. In 1995 there was an important decrease in real wages, due mainly to the economic crisis initiated at the end of 1994. In 1997 the real average wages of production and non-production workers started to recover.

In Figure 1 we cannot see clearly the evolution of the wage gap. To have a first approximation for the changes in wage inequality in Mexico, in Figure 2 we use as a measure of inequality the real average wage of non-production workers divided by the real average wage of production workers.

Figure 2. Wage inequality in the manufacturing industry



Source: National Accounts System, INEGI.

As we can observe in this figure, the real average wage of non-production workers was 2.25 times larger than the real average wage of production workers in 1988 and 2.90 times larger in 1996. From 1996 to 2000 the wage gap has been practically constant with two consecutive slight decreases in the last two years. During the period, the increase in wage inequality between non-production and production workers on the manufacturing industry was about 27 percent, with an increasing trend until 1996 and almost constant after this year.

It is clear that the great increase in wage inequality occurred from 1988 to 1996 overlaps with the Mexican trade liberalization. According to a paper by Robertson (2001), wage inequality in Mexico rose after GATT and began to diminish after NAFTA. Robertson asserts that with GATT, Mexico opened its frontiers to countries that, just as Mexico, have relative abundance of unskilled labor. According to Robertson, trade caused in Mexico an

increase in the relative price of skill-intensive goods; therefore, through the Stolper-Samuelson effect, there was a rise in wage inequality. Furthermore, Robertson points out that with NAFTA the opposite situation happened. With NAFTA Mexico opened its frontiers to countries with relative abundance of skilled labor, then the relative price of skill-intensive goods began to diminish and with the wage gap started to diminish.

It is important to indicate that in Robertson's paper it is difficult to see that the wage gap might have begun to diminish after NAFTA. Moreover, as we can see in Figure 2, from 1994 to 1996 there are still increases in wage inequality. Since 1996 there are some small decreases in inequality, but not yet a clear diminishing trend.

One of the problems to analyze properly the effects of trade and technological progress on the wage gap after NAFTA is that the first years of the agreement are overlapped with the severe economic crisis that faced the country since the endings of 1994. Due to this, it is particularly difficult to separate the effects on wages from globalization and technological progress from the effects provoked by the crisis. Even in 2000, as we can observe in Figure 1, the real average wages for production and non-production workers were still far below the 1994 levels.

We already saw how Mexico's trade openness has coincided with increases in wage inequality between skilled and unskilled workers. Now we are going to analyze the existing relationship between technological progress and real wages, and its final effect on the wage gap. In the following section we are going to develop this point, studying evidence for Mexico from 1988 to 2000.

II.2 Real wages and technological progress

For this section we are going to use annual growth rates of productivity and real average wages of non-production and production workers from 1988 to 2000. These data were obtained for the 49 branches of the manufacturing industry, from the National Accounts System of Mexico published by INEGI.

As we can see in many papers in the literature, the usual measure for technological progress is total factor productivity (TFP). In this case, we will use the measure of labor productivity by INEGI as our approximation for technological progress.

To analyze the existing relationship between productivity and wages we will use some scatter graphics. In the x-axis is measured the annualized growth rate of productivity for each branch of the manufacturing industry and on the y-axis we have the corresponding annualized growth rate of the real average wage. In Table 1 is presented the description of each branch of the manufacturing industry.

Table 1. Description of the manufacturing industry branches

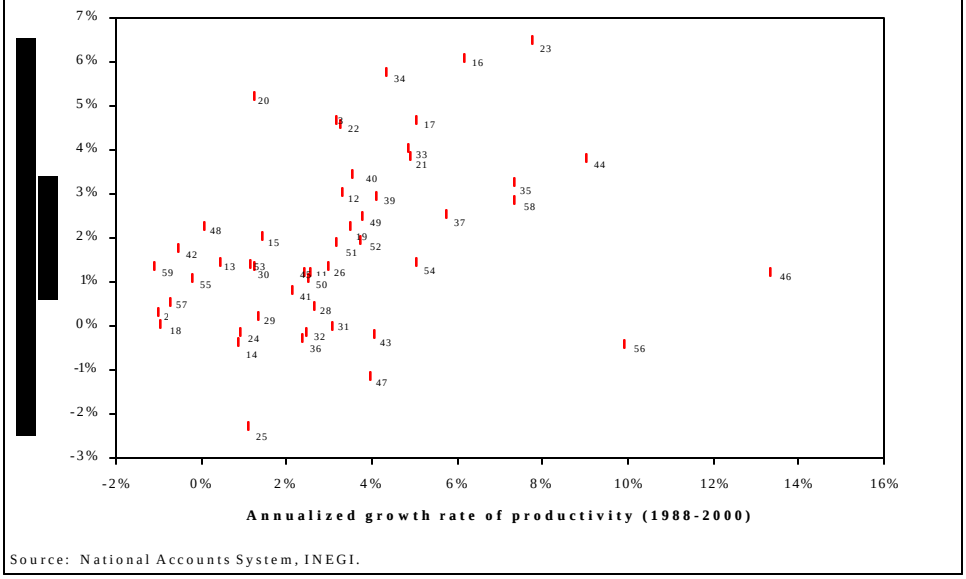
Branch	Description	Branch	Description
11	Meat and dairy product	**36**	Fertilizers
12	Preserved fruits and vegetables	**37**	Synthetic resins and chemical fibers
13	Wheat milling	**38**	Pharmaceutical products
14	Corn milling	**39**	Soaps, detergents and cosmetics
15	Coffee milling	**40**	Other chemical products
16	Sugar	**41**	Rubber products
17	Fats and oils	**42**	Plastics products
18	Food for animals	**43**	Glass and glass products
19	Other food products	**44**	Cement, hydraulic
20	Alcoholic beverages	**45**	Miscellaneous nonmetallic mineral products
21	Malt beverages	**46**	Basic industries of iron and steel
22	Soft drinks	**47**	Basic industries of nonferrous metals
23	Tobacco	**48**	Metal appliances
24	Soft fiber textiles	**49**	Structural metal products
25	Hard fiber textiles	**50**	Other metal products, but machinery
26	Other textile industries	**51**	Machinery and non-electric equipment
27	Apparel	**52**	Machinery and electric equipment
28	Leather and footwear	**53**	Electronic household appliances
29	Wood products	**54**	Electronic apparatus and equipment
30	Other wood products	**55**	Electric apparatus and equipment
31	Paper and allied products	**56**	Motor vehicles
32	Printing and publishing	**57**	Car bodies, motors, parts and accesories for motor vehicles
33	Petroleoum and allied products		
34	Basic petrochemicals	**58**	Transportation equipment and material
35	Basic chemicals	**59**	Other manufacturing industries

Source: National Accounts System,INEGI.

First we analyze the relation between the growth of productivity and the growth of real average wages without making distinctions between non-production and production

workers. This experiment is useful for providing an idea of which has been the impact of technological progress on the average worker wage. In Figure 3 we show this experiment.

Figure 3. Relation between productivity and wages

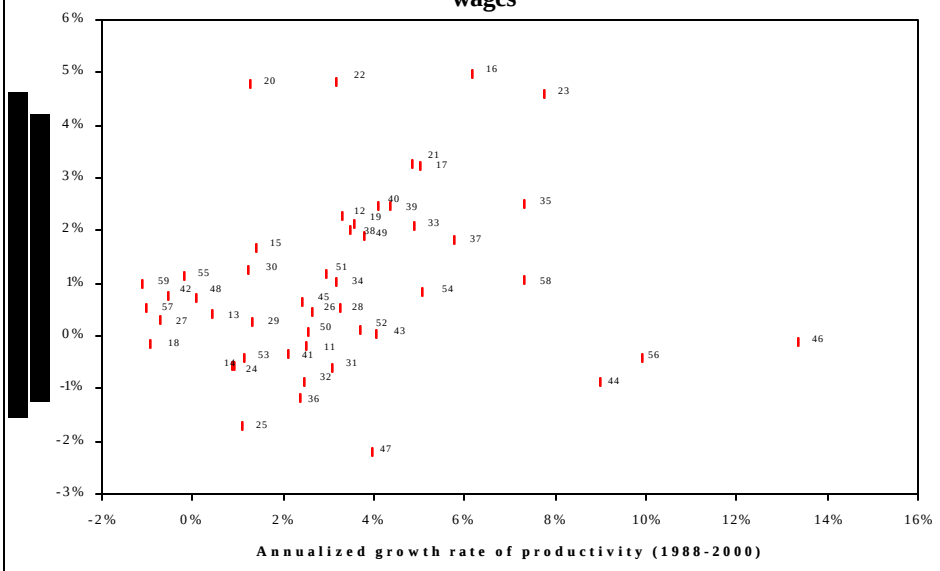


Source: National Accounts System, INEGI.

In this table is seen the positive relation between the growth of productivity and the growth of real average wages. This shows that improvements in technology for a given branch in the manufacturing industry were reflected in better wages for its workers. The branches 46 and 56 are far from the group of dots and can be considered as outliers. Branch 46, "Basic industries of iron and steel", faced important reductions in the international price of steel. Then, even that it is the industry with the highest growth in productivity, the low prices of steel did not allow better wages. On the other hand, branch 56, "Motor vehicles", is an industry that has grown considerably in Mexico during the last decade because of its cheap labor. Probably without this advantage, this industry would never have gotten the progress observed.

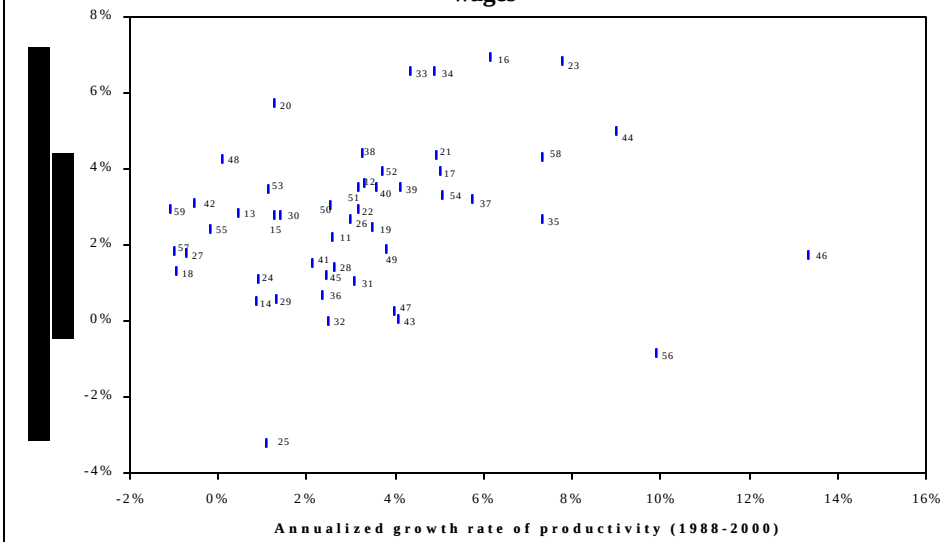
Now, let us divide the workforce in production and non-production workers. In Figures 4 and 5 we show the scatter graphs, which indicate the relation between the growth of productivity for each branch and the growth of real average wages for each type of worker.

Figure 4. Relation between productivity and production workers' wages



Source: National Accounts System, INEGI.

Figure 5. Relation between productivity and non-production workers' wages



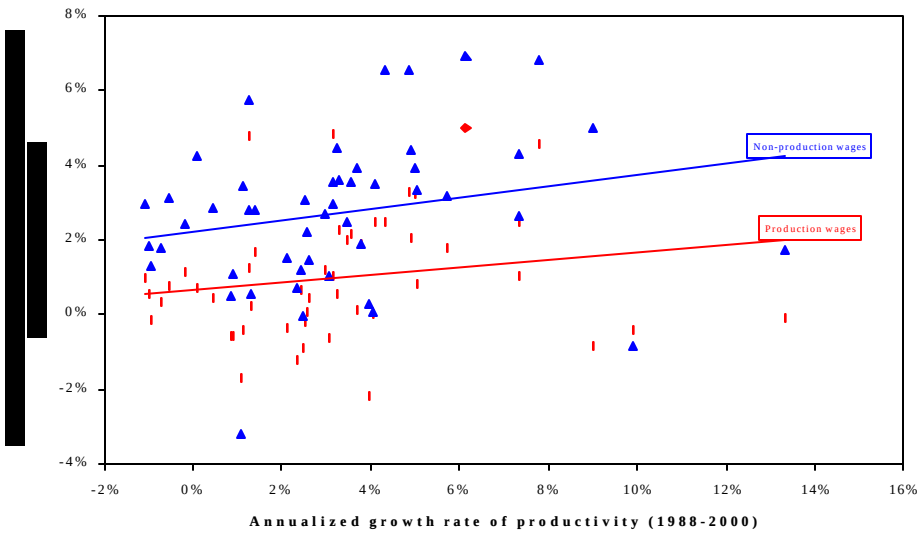
Source: National Accounts System, INEGI.

In both charts we can observe a positive relation between the variables. This shows that during the period, technological progress may have had a positive impact in real terms

for both production and non-production workers. However, this not shows anything about the evolution of the wage gap.

By looking only at Figures 4 and 5 we can not say anything about the responsibility of technological progress on the increase in the wage gap between skilled and unskilled workers in the period 1988 to 2000. For that reason, in Figure 6 we do a simple experiment to have an idea of the technological progress' effect.

Figure 6. Productivity and real average wages



Source: National Accounts System, INEGI.

If we take a look to the different slopes of the trend lines for each type of worker we can note a slightly steeper slope for non-production workers. This might suggest that even though technological progress could have had a positive relation with real average wages of both types of workers, this relation was greater with non-production workers' wages. Therefore, this evidence may support the hypothesis that technological progress contributed to increase the wage inequality between skilled and unskilled workers.

III. Empirical estimates of the effects of technological progress and trade on wages

In this part of the paper we are going to estimate "price regressions" for Mexico to separate the effects of technological progress and trade liberalization on wages. As mentioned before, this methodology has been used before for the United States' case by Baldwin and Cain (2000), Krueger (1997) and Leamer (1998). For the Mexican case, similar regressions were estimated by Robertson (2001).

The price regressions are derived from the basic Heckscher-Ohlin model, being the Stolper-Samuelson theorem the building block and the zero profit condition the principal assumption. From these regressions we can obtain the "mandated" changes in real wages due to technological progress and globalization. From this time, we will use the terms globalization and trade liberalization indistinctly.

The base equations we will use are those derived by Leamer (1998). He found the following equation to estimate the mandated changes in factors' prices due to technological progress:

$$(1-\lambda)\hat{TFP}_i = \theta_i' \hat{w}(t) \qquad (1)$$

where as named by Leamer, λ is the "rate of technological pass-through" to product prices; $\hat{TFP}_i$ is the total factor productivity growth in sector i; θ_i is the vector of factors' shares in the price of good i (good produced by sector i) and $\hat{w}(t)$ is the vector of mandated changes in factors' prices due to technological progress.

Leamer gets the effect of globalization on wages as the difference between the actual change in wages and the change due to technological progress. In this way, he gets the following equation for the effect of globalization on wages:

$$\hat{p}_i + \lambda \hat{TFP}_i = \theta_i' \hat{w}(g) + \gamma_i' \hat{p} \qquad (2)$$

where $\hat{p}_i$ is good i's price growth, g_i is the vector of materials inputs' shares in good i's price, $\hat{p}$ is the vector of prices and $\hat{w}(g)$ is the vector of mandated changes in factors' prices due to globalization. Given that equation (2) is obtained as the residual, $\hat{w}(g)$ might be including mandated changes in wages due to factors other than globalization, besides the rate of inflation. Then, when analyzing the results we have to be very careful in subtracting the inflation rate and take into account any other factors that could have led to changes in real wages.

We will estimate equations (1) and (2) for the entire period, 1988 to 2000, then we will separate the period in two, 1988 to 1994 and 1994 to 2000. This will serve us to have a clearer idea of the mandated wage changes by globalization and technological progress after GATT and before NAFTA, and the mandated changes after NAFTA.

To make these estimates we use annual data from the National Accounts System of Mexico published by INEGI. The data we need for each branch of the manufacturing industry are: shares of the factors of production and materials inputs, annual growth of productivity, annual growth of the prices of the materials inputs and the annual growth of the price of the average good produced by each branch.

In equations (1) and (2), l is the rate at which technological progress is passed to product prices. For example, a rate of 0 means that technological progress in a country does not affect product prices and a rate of 1 implies that the changes in technological progress cause a decrease in product prices in the same proportion. Then, a pass-through rate of 0 could be the case of a small country that takes prices as given. In the next part of this section we will analyze the relationship between technological change (productivity) and prices in Mexico to find the best approximation for the value of l.

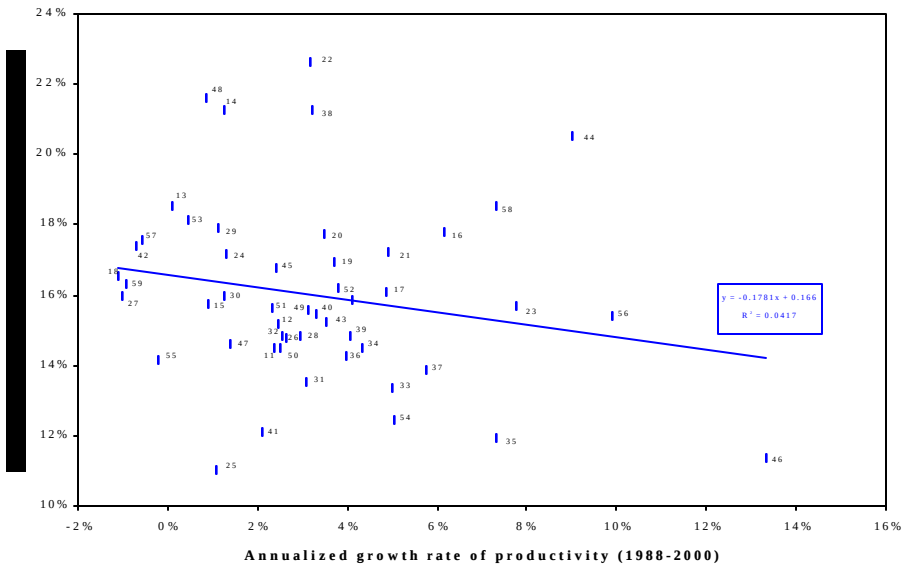
III.1 Prices and productivity

In Leamer's model, one of the assumptions of the model is to set up a constant pass-through rate (l) for all the sectors. In our case this means that we have to assume the same

l for every branch of the manufacturing industry. According to this model, technological progress may cause a decrease in costs and therefore a decrease in product prices. However, this depends on the size of the economy and on whether the technological progress is "local" or "global".

For our case, we will assume that Mexico is a small country and that technological progress is completely "local". To verify if this assumption is or not realistic, we analyze the relation between the growth of productivity and the growth of prices. If we observe a high negative correlation between the two variables then the assumption would not be realistic. This would mean that Mexico is an influential economy on international prices and that technological progress is mainly "global". If we do not find any relationship between the two variables or if we find a weak correlation, the assumption would be good for the Mexican reality. To know in which case we are, we will make a scatter graph with the annualized growth rate of productivity for each branch in the x-axis and its corresponding annualized growth rate of product prices in the y-axis. This graph is showed in Figure 7.

Figure 7. Relation between productivity and prices



Source: National Accounts System, INEGI.

Figure 7 shows the negative relationship between the growth of productivity and the growth of prices in our period of study. The R^2 of the linear regression shown in the Figure indicates that the changes in productivity only explain about 4 percent of the changes in prices. The slope of the trend line, which could be an approximate of the negative of the λ prevailing in this period for the branches of the manufacturing industry, is -0.18. It is important to mention that if we exclude branch 46 from the sample, the R^2 changes to 0 and the slope of the trend line changes to -0.08.

With this information we now can affirm that the assumption that Mexico is a small country and that technological progress is mainly "local" is well fitted to the Mexican reality. Therefore, the pass-thorough rate (l) in the Mexican manufacturing industry is close to zero.

III.2 Empirical estimates

In the previous part we saw that the assumption of a pass-through rate equal to zero is reasonable for the Mexican case. We will also assume that the "mandated" changes in the prices of the factors are the same for all the branches of the manufacturing industry. Then, to make our regressions we build a panel in which we include cross section and time series data.

We split our period of study, 1988 to 2000, into six sub periods to avoid any problem caused by annual data and to capture long-run effects. Our six sub periods are: 1988 to 1990, 1990 to 1992, 1992 to 1994, 1994 to 1996, 1996 to 1998 and 1998 to 2000. This way, we create a panel for the entire period of six observations for each branch. Therefore, having 49 branches in the manufacturing industry, the panel for the period of 1988 to 2000 has 294 observations. When we separate the total period in two, from 1988 to 1994 and from 1994 to 2000, we have two panels with 147 observations each.

To have a complete perspective of the effects of trade liberalization and technological progress on the real prices of the factors of production, we obtain estimates for four

different ways of dividing the labor force. In the first experiment we use as independent variables the shares of only two factors: labor and capital. In the second experiment we separate the labor factor in production and non-production workers. Then, after considering the possible problems of the division of labor in production and non-production workers, we make a third experiment separating the labor force in low and high-wage production and non-production workers. Finally, we divide the labor force in low and high-wage workers.

In Table 2 we present the results for the first experiment. We obtain the "mandated" changes in the real wage of the average worker in Mexico without making distinctions of skill level. To get the "mandated" changes in the real prices of the factors due to globalization, we must subtract the rate of inflation to the coefficients obtained from equation (2). As we mentioned before, we should be aware that the estimated coefficients of equation (2) may include other factors different than globalization.

Table 2. Estimates with factors: labor and capital

	Equation (2), $l = 0$			Equation (1)		
	1988-2000	**1988-1994**	**1994-2000**	**1988-2000**	**1988-1994**	**1994-2000**
Labor	0.2550	0.0360	0.4982	0.0855	0.1286	0.0330
	(0.0377)	(0.0242)	(0.0577)	(0.0314)	(0.0254)	(0.0102)
Capital	0.1260	0.1785	0.0624	0.0689	0.0273	0.0695
	(0.0190)	(0.0139)	(0.0283)	(0.0151)	(0.0083)	(0.0065)
Mean dependent variable	0.0722	0.0809	0.0880	0.0468	0.0633	0.0595
S.D. dependent variable	0.0541	0.0534	0.0670	0.0629	0.0777	0.1011
S.E. of regression	0.0478	0.0370	0.0513	0.0592	0.0731	0.0480
Observations	294	147	147	294	147	147
"Mandated" annual growth in real wages due to changes in prices not related with technological progress: Estimated coefficientes (Eq. 2) - Inflation rate						
Labor	0.0691	-0.1204	0.2820			
Capital	-0.0599	0.0221	-0.1538			
"Mandated" annual growth in real wages due to technological progress						
Labor	0.0855	0.1286	0.0330			
Capital	0.0689	0.0273	0.0695			
Total "mandated" annual growth in real wages						
Labor	0.1546	0.0081	0.3151			
Capital	0.0090	0.0493	-0.0843			
Share of "globalization" in the total effect						
Labor	44.68%	48.37%	89.52%			
Capital	46.51%	44.72%	68.88%			

Note: Standard erros in parentheses.

For the whole period, 1988 to 2000, globalization had a positive effect on the real wage of the average worker in the economy, while it negatively affected the real payment to capital. On the other hand, technological progress had a positive effect for both labor and capital. The total effect for the period is an annual increase in the real wage of the average worker of around 15 percent and an almost zero percent annual change for the real payment to capital. As we can observe, the effect of technological progress was more important than the effect of globalization for both factors.

These first results agree with what would have been predicted by the Stolper-Samuelson theorem. As a country with relative abundance of labor, the Mexican trade liberalization caused an increase in the relative price of labor intensive goods, raising with this the real wage of the average worker and reducing the real payment to the factor that is not used intensively, capital.

Now we separate the total period in two. For the period from 1988 to 1994, we can observe that globalization acted against the real wage of the average worker and slightly in favor of the real payment to capital. In contrast, technological progress acted in favor of labor and slightly in favor of capital. At the end, the positive effect of technological progress is almost of the same magnitude that the negative effect of globalization, therefore the real wage had a "mandated" annual growth of nearly zero percent. Meanwhile, for capital both effects are reinforced and the "mandated" annual growth of its real payment was around 5 percent. Therefore, in the period from 1988 to 1994 the real wage of the average worker stayed practically without change and the payment to capital registered a little annual increase. In this period, the effect of technological progress dominated the effect of globalization.

From 1994 to 2000, globalization benefited the average worker while negatively affecting capital. The effect of technological progress was somewhat discreet in favor of both. The final effect is a very large positive "mandated" change in the average worker's real wage and a negative "mandated" change for the real payment to capital. In this period, unlike the

period 1988-1994, the globalization effect dominated the effect of technological progress in both factors.

To examine the effects of globalization and technology on the wage gap between skilled and unskilled workers we now divide the labor factor. In the following experiment we divide the workforce in production and non-production workers, considering production workers as an approximation for the unskilled and non-production workers as the skilled. Beginning with this experiment we will stop mentioning the effects of globalization and technological progress on the real payment to capital. This is to focus the discussion on the wage gap between skilled and unskilled workers, besides that in every subsequent experiment the results for capital are, as it should be, almost the same that in the first experiment. In Table 3 we show the results for this exercise.

Table 3. Estimates with factors: production workers, non-production workers and capital

	Equation (2), $l = 0$			Equation (1)		
	1988-2000	1988-1994	1994-2000	1988-2000	1988-1994	1994-2000
Production workers	0.1410	0.0970	0.3627	-0.0706	0.2556	-0.3155
	(0.0676)	(0.0557)	(0.0939)	(0.0567)	(0.0211)	(0.0309)
Non-production workers	0.4118	-0.1466	0.6943	0.2956	-0.1641	0.4298
	(0.0826)	(0.0637)	(0.1199)	(0.0695)	(0.0567)	(0.0321)
Capital	0.1223	0.1578	0.0527	0.0608	0.0960	0.0785
	(0.0191)	(0.0169)	(0.0286)	(0.0146)	(0.0097)	(0.0045)
Mean dependent variable	0.0727	0.0883	0.0880	0.0473	0.1043	0.0946
S.D. dependent variable	0.0552	0.0788	0.0673	0.0633	0.3299	0.2814
S.E. of regression	0.0477	0.0386	0.0510	0.0588	0.0712	0.0467
Observations	294	147	147	294	147	147
"Mandated" annual growth in real wages due to changes in prices not related with technological progress: Estimated coefficientes (Eq. 2) - Inflation rate						
Production workers	-0.0449	-0.0594	0.1465			
Non-production workers	0.2259	-0.3030	0.4781			
Capital	-0.0636	0.0014	-0.1634			
"Mandated" annual growth in real wages due to technological progress						
Production workers	-0.0706	0.2556	-0.3155			
Non-production workers	0.2956	-0.1641	0.4298			
Capital	0.0608	0.0960	0.0785			
Total "mandated" annual growth in real wages						
Production workers	-0.1155	0.1962	-0.1689			
Non-production workers	0.5215	-0.4671	0.9079			
Capital	-0.0028	0.0975	-0.0849			
Share of "globalization" in the total effect						
Production workers	38.89%	18.86%	31.72%			
Non-production workers	43.32%	64.87%	52.66%			
Capital	51.14%	1.47%	67.54%			

Note: Standard erros in parentheses.

In the entire period we can notice that globalization worked in favor of non-production workers and slightly against production workers. Technological progress operated in the same way, with a higher value for the coefficient of non-production workers and a negative but not significant coefficient for production workers. The final effect points toward a considerable increase in wage inequality between non-production and production workers during the period from 1988 to 2000. According to these results, both effects (globalization and technology) forced the increase in the wage gap, though technological progress was somewhat more important.

The findings for the period from 1988 to 1994 are surprising. The effect of globalization was against both production and non-production workers, although it affected considerably

more the non-production labor. On the other hand, technological progress had a high positive impact on production workers' wages while negatively affecting non-production wages. Therefore, the final effect predicted is an increase in the real wage of production workers and a decrease in the real wage of non-production workers, that is, a decrease in the wage gap. Besides, we can notice that technological progress was by far the principal force in the "mandated" increase in the production workers' wage while globalization was the main cause of the "mandated" decrease in the wage of non-production workers. Even that the "mandated" changes in wages pointed toward a decrease in the wage gap, what we actually see in Figure 2 is a continuous increase in inequality between production and non-production workers. This fact leads us to believe that there were important forces playing in the Mexican case during the period 1988-1994 that are not considered in the model. These external forces, not globalization nor technological progress, are responsible for the observed increase in the wage gap during this period.

For the period 1994-2000 we can see that globalization improved the wages for both types of labor, though the impact was significantly higher for non-production workers. On the other hand, technological progress had a very strong effect against production workers' wages and an even stronger positive effect for the non-production wage. The final "mandated" changes predict a great increase in the wage gap, motivated mainly by the effect of technological progress.

The usefulness of the division of labor in production and non-production workers to indicate the skill level has been questioned by economists before. It is argued that there is a significant proportion of production workers who are skilled and equivalently, an important proportion of non-production workers who are unskilled. In Table 4 we try to illustrate this point for the manufacturing industry in Mexico.

Table 4. Average wages at current prices (in thousands)

	1988		2000	
	Production workers	**Non-production workers**	**Production workers**	**Non-production workers**
Mean	7.56	15.62	70.47	177.74
Median	6.37	14.17	57.41	170.60
Maximum	20.25	38.82	279.50	611.42
Minimum	3.39	4.72	24.48	38.79
Std. Dev.	3.70	7.05	42.89	98.21
Observations	49	49	49	49

Source: National Accounts System, INEGI.

In this table we present descriptive statistics of average wages for production and non-production workers for the years 1988 and 2000. As expected, the average wage of non-production workers is highly above the average wage of production workers in both years. However, in both years the minimal values of both categories are not as separate as we should expect and the maximum production wage is well above the mean of non-production wages. Therefore, this is an indication that production and non-production wages overlapped in a very important range. As a consequence, and under the assumption that skilled wages are almost perfectly separated from unskilled wages, the division of workers in production and non-production workers to indicate the skill level might not be the most appropriate.

As suggested by Leamer (1998), to solve this problem we linearly extrapolate wages under the assumption that each worker receives a wage according to her skill level. The skilled workers receive the higher wages and the unskilled receive the lower ones. Taking this into account, we first separate labor in production and non-production workers with low and high wages. In Table 5 we show the obtained results from this division of the labor force.

Table 5. Estimates with factors: low-wage and high wage production workers, low-wage and high-wage non-production workers and capital

	Equation (2), $l = 0$			Equation (1)		
	1988-2000	1988-1994	1994-2000	1988-2000	1988-1994	1994-2000
Low-wage production	0.1613	0.3535	0.5401	-0.2868	-0.1894	-0.3486
	(0.1560)	(0.1226)	(0.2075)	(0.1327)	(0.1330)	(0.1174)
High-wage production	0.0876	-0.1551	1.1168	0.3347	0.6598	-0.1696
	(0.1152)	(0.0800)	(0.2007)	(0.1253)	(0.1506)	(0.1059)
Low-wage non-production	0.5365	0.4224	0.5478	-0.2247	-0.7002	0.2683
	(0.4065)	(0.2679)	(0.4219)	(0.3113)	(0.2326)	(0.2817)
High-wage non-production	0.4265	-0.0214	0.7388	0.1641	-0.0097	0.4631
	(0.1039)	(0.0703)	(0.1355)	(0.1062)	(0.1255)	(0.0896)
Capital	0.1198	0.1655	0.1217	0.0719	0.0613	0.0624
	(0.0196)	(0.0123)	(0.0401)	(0.0149)	(0.0106)	(0.0107)
Mean dependent variable	0.0727	0.0905	0.0998	0.0475	0.0717	0.0509
S.D. dependent variable	0.0553	0.0823	0.0858	0.0640	0.0951	0.0638
S.E. of regression	0.0479	0.0371	0.0542	0.0581	0.0697	0.0454
Observations	294	147	147	294	147	147
"Mandated" annual growth in real wages due to changes in prices not related with technological progress: Estimated coefficientes (Eq. 2) - Inflation rate						
Low-wage production	-0.0246	0.1971	0.3240			
High-wage production	-0.0983	-0.3115	0.9007			
Low-wage non-production	0.3506	0.2660	0.3316			
High-wage non-production	0.2406	-0.1778	0.5227			
Capital	-0.0661	0.0091	-0.0945			
"Mandated" annual growth in real wages due to technological progress						
Low-wage production	-0.2868	-0.1894	-0.3486			
High-wage production	0.3347	0.6598	-0.1696			
Low-wage non-production	-0.2247	-0.7002	0.2683			
High-wage non-production	0.1641	-0.0097	0.4631			
Capital	0.0719	0.0613	0.0624			
Total "mandated" annual growth in real wages						
Low-wage production	-0.3115	0.0077	-0.0246			
High-wage production	0.2364	0.3483	0.7311			
Low-wage non-production	0.1259	-0.4342	0.6000			
High-wage non-production	0.4047	-0.1875	0.9858			
Capital	0.0058	0.0704	-0.0321			
Share of "globalization" in the total effect						
Low-wage production	7.91%	51.00%	48.17%			
High-wage production	22.70%	32.07%	84.16%			
Low-wage non-production	60.94%	27.53%	55.28%			
High-wage non-production	59.46%	94.83%	53.02%			
Capital	47.89%	12.90%	60.22%			

Note: Standard erros in parentheses.

As we can observe in this table, only half of the estimated coefficients for the labor factor have values significantly different from zero in both equations. Then, we can only get few conclusions from this experiment. For the period 1988 to 2000, we can assert that globalization had a strong positive effect on high-wage non-production workers. Besides,

technological progress acted in favor of high-wage production workers and against low-wage production workers. This few results point toward an increase in the wage gap due to both globalization and technology.

For the period from 1988 to 1994, the significant coefficients indicate that globalization affected positively the real wages of low-wage production workers, while deteriorating the payment to high-wage production workers. Contrary to this, technological progress had an important positive effect on high-wage production workers and a highly negative impact in low-wage non-production workers. These results may suggest that during the period 1988 to 1994, the effect of globalization pulled toward a reduction on the wage gap between skilled and unskilled workers, but this effect would have been undermined due to the high increase in the wage gap mandated by technological progress.

From 1994 to 2000, the significant coefficients of equation (2) indicate that globalization carried benefits for low-wage production, high-wage production and high-wage non-production workers. For production labor, the globalization effect was very much higher for the high-wage workers what may have caused an increase in the wage gap. On the other hand, technological progress acted in favor of high-wage non-production workers and against low-wage production workers. Then, just as globalization did, technological progress may have led to an increment in the wage gap during the period 1994-2000.

Even that we obtained some important insights from Table 5, the lack of statistical significance for half of its estimated coefficients oblige us to make one more experiment. In this last exercise we divide the labor factor in low-wage and high-wage workers. The principal feature of this experiment is that each category will now include production as well as non-production workers. As mentioned before, low-wage and high-wage workers are our new approximations for unskilled and skilled workers, respectively. The estimates of equations (1) and (2) for this experiment are presented in Table 6.

Table 6. Estimates with factors: low-wage workers, high-wage workers and capital

	Equation (2), $l = 0$			Equation (1)		
	1988-2000	1988-1994	1994-2000	1988-2000	1988-1994	1994-2000
Low-wage workers	0.2299	0.2590	0.3846	-0.1949	-0.2093	-0.2664
	(0.0760)	(0.0561)	(0.1094)	(0.0623)	(0.0887)	(0.0548)
High-wage workers	0.2678	-0.0639	0.5542	0.2260	0.2473	0.2116
	(0.0491)	(0.0296)	(0.0731)	(0.0370)	(0.0501)	(0.0353)
Capital	0.1258	0.1698	0.0616	0.0653	0.0702	0.0691
	(0.0190)	(0.0125)	(0.0283)	(0.0139)	(0.0205)	(0.0096)
Mean dependent variable	0.0723	0.0875	0.0882	0.0475	0.0587	0.0562
S.D. dependent variable	0.0543	0.0751	0.0673	0.0635	0.0748	0.0906
S.E. of regression	0.0479	0.0372	0.0514	0.0582	0.0659	0.0466
Observations	294	147	147	294	147	147
"Mandated" annual growth in real wages due to changes in prices not related with technological progress: Estimated coefficientes (Eq. 2) - Inflation rate						
Low-wage workers	0.0440	0.1026	0.1685			
High-wage workers	0.0819	-0.2203	0.3381			
Capital	-0.0601	0.0134	-0.1545			
"Mandated" annual growth in real wages due to technological progress						
Low-wage workers	-0.1949	-0.2093	-0.2664			
High-wage workers	0.2260	0.2473	0.2116			
Capital	0.0653	0.0702	0.0691			
Total "mandated" annual growth in real wages						
Low-wage workers	-0.1509	-0.1067	-0.0980			
High-wage workers	0.3079	0.0269	0.5497			
Capital	0.0053	0.0836	-0.0854			
Share of "globalization" in the total effect						
Low-wage workers	18.43%	32.89%	38.74%			
High-wage workers	26.60%	47.12%	61.50%			
Capital	47.91%	16.06%	69.09%			

Note: Standard erros in parentheses.

In this table all the estimated coefficients are statistically significant. From 1988 to 2000, we can notice that globalization acted in favor of both categories of workers, though it had a higher effect for high-wage workers. For the effect of technological progress, we can see that it had a highly positive impact for high-wage workers while it significantly damaged the low-wage workers. At the end, both effects pushed during the entire period for an increase in the wage gap between skilled and unskilled workers, though technological progress played by far the major role, as noted in the small share of globalization in the total effect.

In the period after GATT and before NAFTA (1988-1994), globalization had a positive impact on the real wages of low-wage workers while it adversely affected high-wage workers. Then, this result confirms that during this period, trade liberalization pressed for a decrease in the wage gap. However, during this same period technological progress behaved importantly against low-wage workers and highly in favor of high-wage workers. As a result, the effect of technological progress offset the effect of globalization for both types of workers, causing at the end an increase in the wage gap. Therefore, this result shows us that given that globalization worked for a reduction in inequality from 1988 to 1994, the actual observed increase in the wage gap between skilled and unskilled workers is almost certainly full responsibility of technological progress.

Finally, in the period after NAFTA (1994-2000), we observe that globalization improved high-wage as well as low-wage workers, but significantly more to the high-wage, contributing with this to the increase in wage inequality. As in the previous period, technological progress acted against low-wage workers and in favor of high-wage labor, increasing even more the wage gap.

IV. Conclusions

[To be written]

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