Effects of manufacturing dynamics on returns to education in the North of Mexico

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Resumen

En este trabajo se examina la valoración en el mercado de trabajo de la escolarización de los trabajadores, centrándose en las regiones del norte del país. La industria manufacturera es estudiada en particular ya que una gran parte de la actividad económica se encuentra en el norte en relación con el resto de regiones del país. El cambio en la industria manufacturera se ha visto afectado por las crisis internacionales, los acuerdos comerciales y la entrada de fuertes competidores con una oferta de mano de obra poco calificada, tales como los países asiáticos. Los resultados de la estimación por cuantiles muestran que el mercado laboral valora menos los años adicionales de educación adquiridos por los trabajadores durante el período de 1988 a 2011. Muestran además que los trabajadores de la parte más baja de la distribución son los que parecen ser los más afectados en términos de inversión en educación por la disminución de la actividad manufacturera en la región norte.

Palabras clave: manufactura, retornos a la educación, regresión por cuantiles, regiones del norte

Abstract

This paper examines the pattern of the labor market appraisal of workers' schooling, focusing on the Northern regions of the country. The manufacturing industry is studied in particular since a large part of the economic activity is located in the North, relative to the rest of the country's regions. The change in the manufacturing industry has been affected by international shocks, trade agreement regulations and the entrance of stronger competitors with a supply of low-skill workers, such as Asian countries. Quantile estimation results show that the labor market valued less the additional years of education acquired by workers over the period from 1988 to 2011. Results show that workers at the lowest part of the distribution are the ones who seem to be most affected in terms of education investment by the decline of manufacturing activity in the Northern region.

Keywords: manufacturing, returns to education, quantile regression, Northern regions

1. Introduction

The intention of this paper is to estimate the pattern of the returns to education over time in the northern regions. The technique used makes it possible to account for the heterogeneity of the conditional wage distribution. The study will divide the northern part of the country into two regions: North-Border (NB) and North-Center (NC). The results show that the evolution of the returns has followed a downward trend particularly after 1997 that could be related to the decline in manufacturing production in these regions.

The Mexican economy has followed a regional localization or concentration of some productive activities in certain regions more than others. The manufacturing industry is one of the most dynamic export

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industries, since it represented 35 percent of Mexican exports[2] before the North-American Free-Trade Agreement (NAFTA) and, since then, reached 87.4 percent of the total exports[3] in 2000 compared to 9.2% in oil exports, for example. Recent official reports reveal that manufacturing exports account for 80% of the total exports[4] in 2011, while oil exports comprise around 16% of the total exports.

The start of trade liberalization in the 1980s, the consolidation of NAFTA in 1994, growing foreign direct investment,[5] expansions and recessions of the economy, and globalization have underlined the complexity of the manufacturing industry. Approximately 58% of manufacturing workers were concentrated in the northern regions during the period analyzed (1988-2011). However, there was a change in the predominant economic activity in the northern regions since information from employment surveys reveals that employees were mainly working in firms related to manufacturing activity during the first 12 years. This changed after 2001 when the major economic activities of the firms became social, public and professional services. The reduction in the manufacturing activity was most remarkable in the states closer to the U.S. border.

The organization of the paper is as follows: section 2 presents a brief explanation of the papers related to the returns to education and changing demographics in the U.S. and Mexico; section 3 offers a descriptive analysis of the data used; section 4 describes the econometric methodology used and the empirical strategy; section 5 presents the results of the study and section 6 the conclusions.

2. Literature Review

Changes in wage structure in the United States have been widely documented. They have been related to factors such as rising levels of education and changing demographics over the past decades. Welch (1970) was among the pioneers who explained why a rising average in education was not accompanied by a decline in the rates of returns to education that took place in the United States during 1940-1960. He pointed out that growth in demand must have occurred to prevent the decline and proposed three main changes to explain this phenomenon: changing the composition of industrial activity, non-neutralities in production and rising quality of schooling. However, with the empirical evidence he could not explain the stability of the relative wage of high school graduates, unlike the growth in demand for college graduates, which was, as he claimed, the result of increasingly complex production processes that required more skill.

Likewise, others have emphasized that the driving force of the relative wage changes were on the demand side. Some studies found that the wage structure changes between 1963 and 1987 were the result of a growth in the demand for more educated workers. Using a supply and demand framework, Katz and Murphy (1992) measured changes in the allocation of labor between industries and occupations and found that they favored college graduates and women. Murphy and Welch (1992) made a distinction by age and schooling and observed that returns to schooling increased[6] over 1987-1971 and decreased between 1971 and 1979. They deduced a stable demand, however, in the 1980s when a dramatic rise was identified that was not consistent with a stable demand; the school-related wage differentials were larger compared to those of previous years. Similarly, Juhn, Murphy and Pierce (1993) linked the increase in wage inequality to increasing returns to skill, which was driven by an increase in the demand for skill.

2 López-Acevedo (2003).

3 National Institute of Statistics and Geography (INEGI).

4 INEGI: http://www.inegi.org.mx/inegi/contenidos/espanol/prensa/comunicados/balcom.asp

5 Mainly from the United States and a smaller proportion from Europe and Asia.

6 Due to the arrival of the baby boom cohorts into the labor market.

Peracchi (2006) presented a large review of papers that studied the evolution of the educational wage premium over time for several countries. He mentioned that the educational wage premium may have been stable in Ireland and Norway because of a large increase in the supply of workers with secondary and tertiary education, although this effect could have caused a decline in Austria, Canada and Spain. In Germany and Italy, mainly institutional conditions such as wage bargaining rules or employment protection laws could offset the influence of the market forces, although these institutional conditions seemed to affect the other countries mentioned as well.

In the empirical evidence of the wage structure in Mexico in the 1990s, there is a consensus that changes were driven mainly by demand side factors, such as trade liberalization and market-oriented reforms implemented at the beginning of the 1990s. Cragg and Epelbaum (1996) estimated general skill intensification in all sectors for the first half of the 1990s. Carrillo (2007) argues that even though manufacturing plants performed more complex production processes, at the end of 2000 external conditions changed ever since the U.S. recession. NAFTA regulations also impacted change regarding taxation, since the maquiladoras were considered national plants that increased tariff uncertainty.

The Mexican manufacturing industry is heterogeneous and the general notion of being an economic activity with unskilled assembly-line workers with low wages may be flawed. The evolution of the manufacturing industry has not being homogeneous. A report by the US General Accounting Office[7] describes three main types of manufacturing plants in Mexico: first manufacturing generation, where tasks consisted of simple assembly with minimum technological requirements; the second generation was established in the 1980s with advanced manufacturing; and the third generation in the 1990s when manufacturing incorporated research and development tasks, including integral coordination with the main chains.

Giuliani, Pietrobelli and Rabellotti (2005) define upgrading as innovating to increase value added. They characterize manufacturing upgrading in four types: 1) process upgrading that involves introducing new technology into the production process; 2) product upgrading that requires moving to more refined lines; 3) functional upgrading that takes on new tasks considering higher value-added activities such as design and marketing; and 4) intersectoral upgrading that means moving to more profitable sectors. In their study, Giuliani et al. (2005) found that the majority of the Mexican traditional manufacturing clusters -included in their sample in 2002 and 2003- showed process and product upgrading, and a low proportion showed functional upgrading, but none of them showed intersectoral upgrading. Therefore, as they mention, it is the degree of knowledge and complexity that influences the capacity of firms to upgrade.

3. Descriptive analysis

In order to consider labor characteristics of workers for a wider period of time, this study based the estimations on the information provided by the Urban National Employment Survey (ENEU) from 1988 to 2004, and the National Employment and Occupation Survey (ENOE) from 2005 to 2011. Although the information is available as quarterly data, only the third quarter data is used to analyze the trend over time of the returns to education. The reason for using the third quarter is to have an indicator of the respondents' permanent income: during the first two quarters workers could get extra income in the form of profit sharing and/or productivity bonuses, and in the last quarter they could receive a Christmas bonus.

The sample is composed of full-time, full-year workers (FTFY) who are employees that work at least 20 hours and no more than 72 hours per week and throughout the whole year. The study is based on male workers only who are not studying at the time of the survey. Also, the estimation will consider employees aged between 20 and 55 years old.

7 International Trade (2003), United States General Accounting Office.

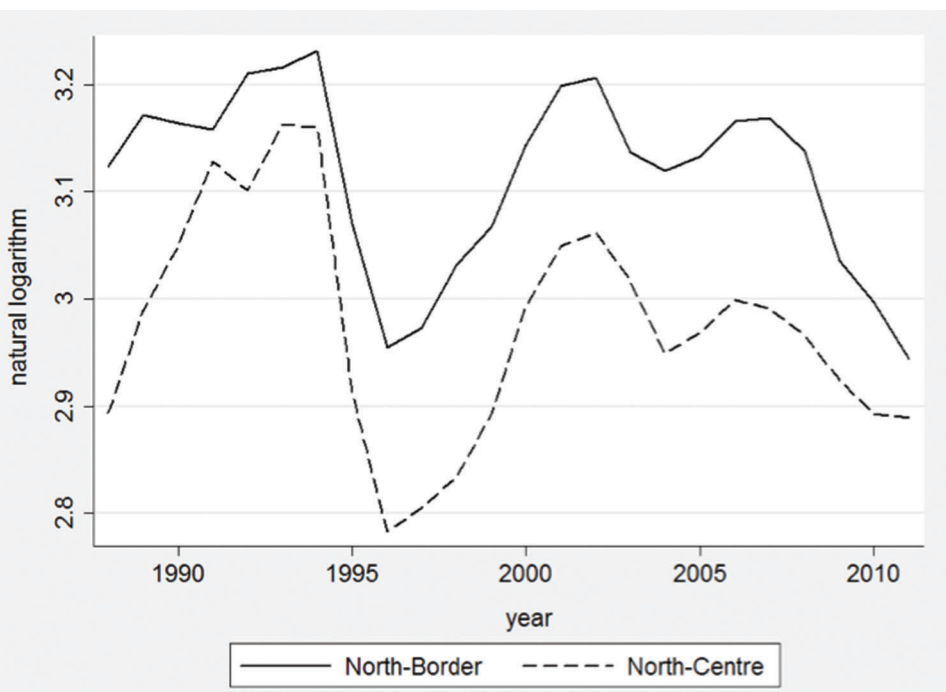
The empirical strategy of the paper is to focus on the northern parts of the country, which are divided into two regions according to INEGI´s geographical classification[8]: North-Border and North-Centre. The North-Border consists of states neighboring the U.S. border that include Nuevo León, Chihuahua, Tamaulipas, Coahuila, Sonora, and Baja California Norte. The states located in the North-Centre are Aguascalientes, Durango, San Luis Potosí, Zacatecas, Querétaro, and Guanajuato, most of which are considered to be a traditional source of U.S. migrants.

Figure 1 shows the evolution of the real wage per hour- expressed as a natural logarithm- of FTFY employees in these two regions. The reductions in wages were notable during the economic crises that took place in the country in 1995, 2001 and 2008. On average, during the period considered, hourly wages were higher in the North-Border than in the in North-Centre at $28.5 Mexican pesos and $24.4 Mexican pesos respectively.

As can be seen in the Figure 1, the gap between regions was wider during recessions. The deepest drop occurred during the Mexican peso crisis in 1995 when wages were $28.8 and $23.9 for North-Border and North-Centre respectively. Also, it is evident that the highest real hourly wage obtained by FFTY employees was estimated, for the year 1994, at $32.5 and $30.4 for each region respectively. It is clear that the real hourly wages have decreased since the 2008 crisis, but not as much as in the crisis of 1995.

8 INEGI is the National Institute of Statistics and Geography in Mexico.

Figure 1. Evolution of average real hourly wages



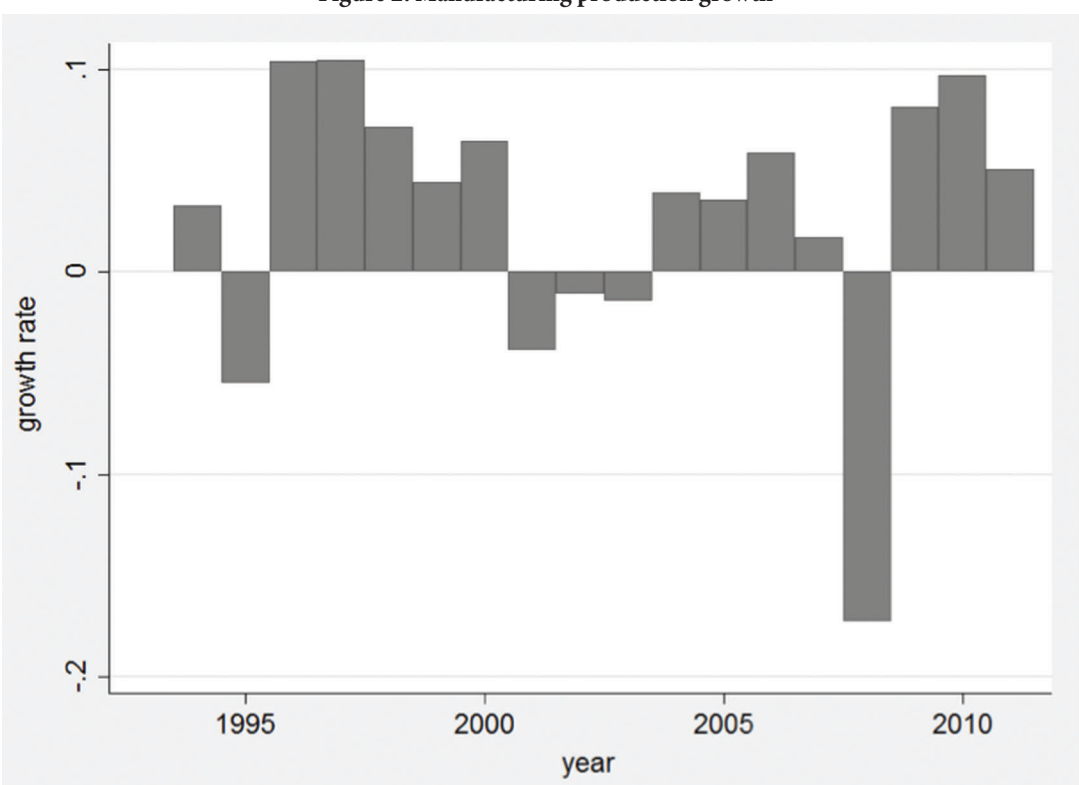
Note: Real hourly wages are in constant prices of 2002.
Source: Own calculations from ENEU-ENOE.

Information from ENEU-ENOE reveals that male manufacturing workers obtained the second highest hourly wage compared to other economic activities, even though they had a lower average level of schooling compared to social, public and personal service workers who obtained the highest wages and schooling. Moreover, manufacturing firms located in the northern regions, according to Lopez-Acevedo (2003), tend to be more productive and pay higher wages than in other regions. During the period from 1988 to 2011, 32.5% of the workers in North-Border region were employed in firms related to manufacturing activities, while 24.7% was calculated for the North-Center. Figures for other regions included the Centre 16.6%, Pacific 12%, states bordering the Gulf of Mexico 10.6%, and Mexico City 3.4%.

A question that emerges is how manufacturing production has evolved over time given the recurrent economic recessions. It is relevant to analyze the production growth from year to year. The volume index of manufacturing production, available since 1993, was obtained from the Sistema de Cuentas Nacionales (INEGI) for Mexico. The percentage change between adjacent years is then calculated. The resulting variable can be considered a measurement of the manufacturing production growth, which is shown in Figure 2.

Figure 2 shows a volatile growth in manufacturing production. Economic recessions are related to the negative growth calculated, for example the peso crisis in 1995 reduced manufacturing production by about 5.5%. Also, reductions calculated for the period 2001-2003 are smaller than reductions in the recessions of 1995 and 2008. The deepest negative drop is calculated in 2008 when the negative growth was approximately 17.3% with respect to the previous year. The international recessions had clearly affected

Figure 2. Manufacturing production growth



Source: Own calculation from Sistema de Cuentas Nacionales, INEGI.

manufacturing production in Mexico. The negative drop in manufacturing production observed during 2001-2003 is related to the evidence of Carrillo (2007) which estimates that 48% of the maquiladoras closed down to move to Asian countries, particularly China, Mexico´s main competitor in low-skill workers.

Table 1 presents the principal economic activities in the northern part of the country. It is evident that the economic activity in the region is concentrated into two main activities: Manufacturing and Social, Public and Professional Services (SPPS). Both activities represent around 60% of the region's total economic activity. There is also a notable dramatic change in the economic activity in the northern part of the country. Manufacturing represented the major economic activity up to 2000; however, the decline in manufacturing production has also affected the employment distribution between economic activities and since 2008 the main activity has been professional services.

Table 1. Economic activities in the north

	Manufacturing	Professional Services	Total
1988-1994	33.43	26.22	59.65
1995-2000	34.01	28.09	62.10
2001-2007	28.32	28.51	56.83
2008-2011	24.82	37.14	61.96

Source: Own calculations.

Using macro information allows the examination of the national context related to the manufacturing sector and provides the background to understand the economic cycles that have been experienced in the manufacturing sector. Using micro data obtained from the surveys will make it possible to study the effect on the labor market of the northern region where most of the manufacturing production is concentrated. Also, it is relevant to study how the labor market has rewarded workers' education over time, measured as the returns to education.

4. Empirical Strategy

The empirical specification to estimate the returns to education follows Mincer (1974), which in turn is based on the theoretical model proposed by Becker (1967). Becker developed a simple model of optimal schooling that relates schooling and average earnings over a lifecycle. Individual heterogeneity in the optimal schooling choice arises from differences in costs or tastes of schooling and differences in the economic benefits of schooling. Therefore, the coefficient of interest relates education and wages and is interpreted as the individual´s best estimate of her/his additional earnings per year of education.

The literature related to the estimation of the returns to schooling is vast. However, there is still an open question of how to account for the unobserved ability effect on education and wages. The most common technique used to deal with the endogeneity is the Instrumental Variable Approach. Nonetheless, studies by Griliches (1977), Angrist and Krueger (1991), Ashenfelter and Krueger (1994) and Card (1999), among others, have found that returns to schooling using instrumental variables were as big as or even greater than the corresponding OLS estimates and they claim this fact as evidence of a small ability bias in the OLS estimates.

The purpose of the study is to obtain a broader view of the relationship between wages and schooling in the northern regions. The technique applied does not make any assumptions regarding causality since the analysis requires comparing particular sections of the conditional wage distribution over time.

The applied technique is Quantile Regression Estimation proposed by Koenker and Bassett (1978). This approach will estimate the local effect that education has upon wages at any point of the distribution and thus accounting for existent unobserved heterogeneity, but not affecting the temporal comparison of returns to schooling. By using quantile regression, the return to schooling for those in the upper ten percent, lower ten percent, upper and lower quarter and the median can be calculated. This will complete the inter-quantile analysis.

Basically, quantile regression solves the following problem:

$$min_b \frac{1}{n}\{\sum_{i:y_i \geq x'_i b} \tau|y_i - x'_i b| + \sum_{i:y_i < x'_i b}(1-\tau)|y_i - x'_i b|\} . \quad [1]$$

The resulting coefficient $\beta(\tau)$ is the return to schooling of the quantile τ. It is called conditional quantile estimator because the quantile of the conditional distribution of the wage variable is expressed as a function of the observed covariates.

In order to estimate the returns to education for northern regions, a model following Mincer (1974) and Murphy and Welch (1990) is used for the earnings equation specification applying both OLS and quantile estimation techniques. The unit of measurement is the individual, i, working in the region, r, at any time, t, the equation to estimate is:

$$\ln(\text{wage})_{irt} = \alpha_{rt} + g(age)_{irt} + \beta_{rt} educ_{irt} + \gamma_{rt} marital_{irt} + \delta_{rt} ins_{irt} + f(act)_{irt} + \varepsilon_{irt} \quad [2]$$

Where *r=North-Border, North-Centre* and *t=1988, 1989,..., 2011.*

The variable $ln(wage)_{irt}$ is the natural logarithm of the real hourly wage in constant prices of 2002. Murphy and Welch (1990) argued that the quadratic functional form in experience proposed by Mincer (1974) does not provide a reasonable approximation to actual earnings profiles since it overstates earnings at the initial and mid-career and understates actual earnings at retirement; to reduce estimated profile bias they propose a quartic polynomial in age or experience since initial earnings are overstated between 1% to 6% versus 14% to 20% for the quadratic specification.[9] Following Murphy and Welch (1990), a fourth order polynomial on age is defined as:

$$g(age) = \vartheta_{1rt} age_{irt} + \vartheta_{2rt} age^2_{irt} + \vartheta_{3rt} age^3_{irt} + \vartheta_{4rt} age^4_{irt} . \quad [3]$$

The variable $educ_{irt}$ is the years of schooling attained by workers; $marital_{irt}$ represents dummy variables to account for single and married men; ins_{irt} is a vector of three dummy variables indicating whether workers have access to IMSS, ISSTE medical services or do not have a health care provider. Finally, variable $f(act)_{irt}$ represents dummy variables for 9 economic activities, ind_{irt}, leaving agriculture as the reference in the constant:

$$f(act)_{irt} = \sum_a \theta_{art} ind_{airt} \quad [4]$$

Where *a=1,2,..., 9.*

9 According to Murphy and Welch (1990), a cubic specification overstates initial earnings by 5% or 9%.

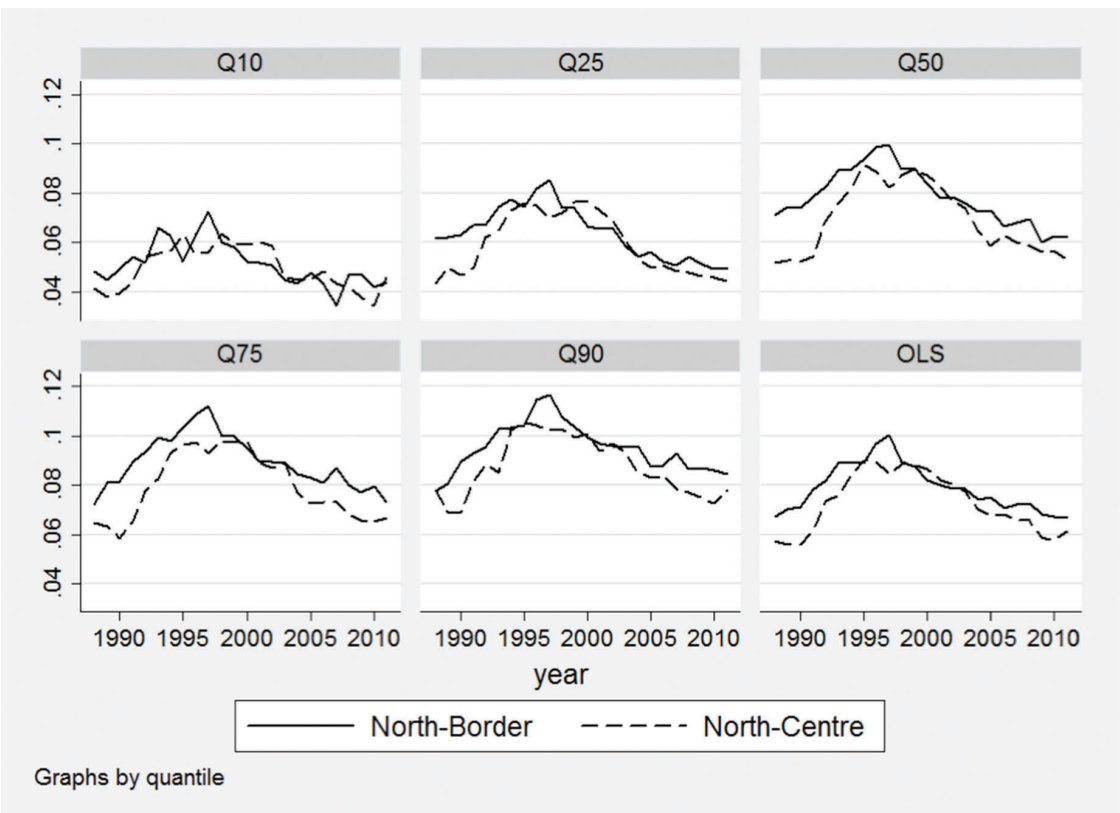
The one-digit 9 industries are defined using the Economic Activity codification provided by the ENEU-ENOE survey: Agriculture (1), mining (2), manufacturing (3), construction (4), electricity, gas and water (5), commerce, restaurants and hotels (6), transport, storage and communications (7), financial services and property rental (8), and social, public and personal services (9). The reason for including industry dummies is to control for possible wage and education heterogeneity inter-industry over time.

5. Results

The objective of estimating returns to education for each region is to find differences across regions in the evolution of returns to schooling. Specifically, it is important to identify whether the declining manufacturing productivity has affected the labor market. Possible regional effects due to trade liberalization and other factors affecting the local labor market will be accounted for, and other economic activities carried out in these regions will also be taken into consideration.

In order to observe the evolution of the returns to schooling, the estimated coefficients of the returns to education are presented in Figure 3. Since the total number of estimated coefficients is 288 and the number of years is 24, there are 5 quantile estimators, an OLS estimator, and two regions.

Figure 3. Regional evolution of the returns to education



Note: Estimated coefficients significant at 95% confidence level obtained from equations (2), (3) and (4).
Source: Own calculations from ENEU-ENOE 1988-2011.

Figure 3 shows that returns to schooling are remarkably well below 10 percent in both regions for the median and lower quantiles, but this is not the case for men working in the North-Border in the upper quantiles, Q 75 and Q 90. In the period when NAFTA started in 1994, larger increases in the men's returns to education were estimated in North-Centre, considerably different from North-Border. However, at the end of the period in 2008, the reductions were deeper in North-Centre compared to North-Border, especially in the upper quantiles.

Since NAFTA, most of the maquiladoras moved from the interior to the border regions, which is consistent with the greater men´s returns to education. Also, international shocks, especially the United States recession in 2001 and 2008, could have affected the performance of the manufacturing industry. An estimated 95% of manufacturing exports are sent to the United States. In addition, the increasing competition with other developing economies, such as Asian countries, could attract manufacturing firms to move to other countries, substituting low-paid Mexican workers with an even cheaper labor force. Lusting (2001) claimed that Mexico has offered relatively high protection to unskilled labor intensive industries, so when barriers were removed, these sectors were affected most.

In general, the concave trend is evident in both regions and is consistent with the estimation for all regions presented in Caamal-Olvera (2010). Also, returns to education in the North-Border are above the men's returns obtained in the North-Centre. Another difference between North-Border and North-Centre is that in the latter region 5 out of the 6 states are considered to be a traditional source of U.S. migrants: Aguascalientes, Durango, Guanajuato, Zacatecas, and San Luis Potosí.

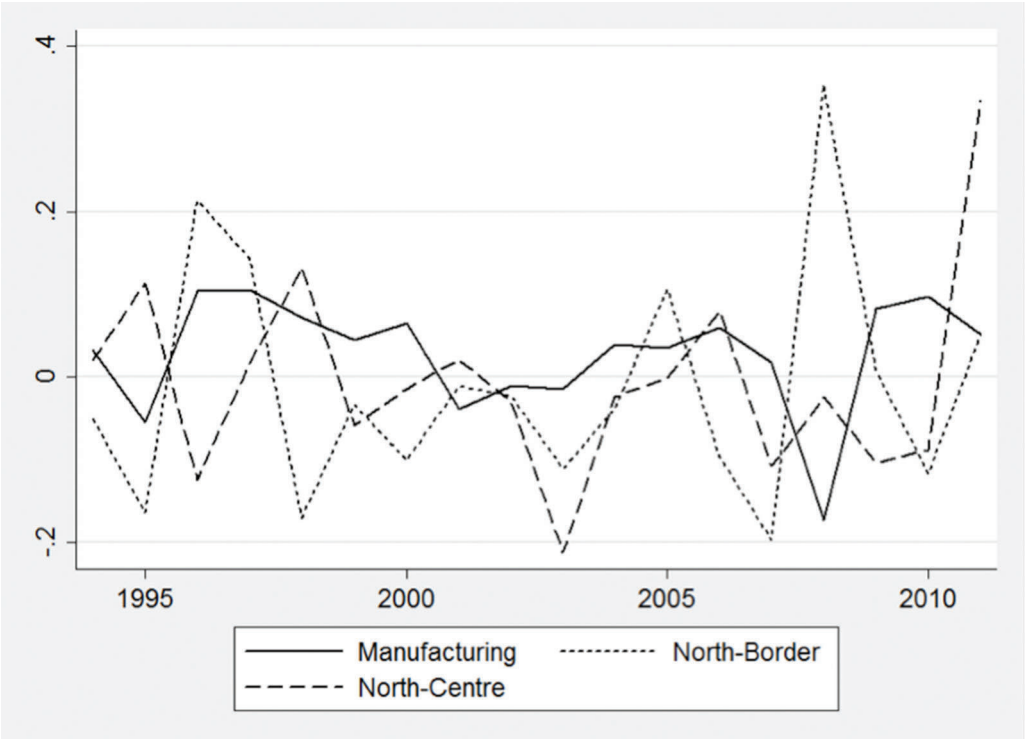
The estimated coefficients of the returns to education for each region are shown in the Appendix, Tables A1 and A2, respectively. Overall, the highest return to education was reached in 1997, whereas the lowest return is usually at the end of the period. The upper quantiles obtained larger returns in comparison to the lower ones; this could be seen as a positive correlation between unobserved ability and education, according to Arias, Hallock and Sosa-Escudero (2001).

In the North-Border region, return to education obtained in the lowest quantile Q10 is in the range of 0.0347 estimated for the year 2007 to 0.0725 estimated in 1997. This is comparable to the return that was estimated in 1988 for the top25. For workers in the top10 of the conditional wage distribution working in the North-Border region, results show that labor market values an additional year of schooling 14.4% more than in the North-Centre at the peak of the trend; however at the end of the period the evidence shows that the return to an extra year of education is only 8.7% greater. More variability is found when the lowest quantiles of both regions are compared, since the maximum return obtained in the North-Centre is not reached in 1997 as it is in the North-Border. In particular, the estimated coefficients for that year show that additional schooling can increase wages 29.2% more in the North-Border than in the North-Center. On the contrary, by the end of the period in 2008, results show that an extra year of education increases wages in the North-Centre 4.5% more than in the North-Border.

Trade liberalization was deemed to be a crucial option to create jobs for unskilled workers and macro information showed that manufacturing production was more dynamic after the implementation of NAFTA, despite the Mexican peso crisis of 1995. Results showed that real hourly wages were higher in the northern regions, especially in the states close to the U.S. border. However, the deteriorating manufacturing pace has been affected by international shocks, trade agreement regulations and the entrance of stronger competitors in the supply of low-skill workers, such as Asian countries.

Figure 4 shows how manufacturing growth evolves like the growth in returns to education in the lowest part of the distribution (upper part of the distribution (Q90) is shown in Figure A1 in the Appendix). Although the pace of the two variables -manufacturing growth and returns to education growth- seems to

Figure 4. Manufacturing and Returns to Education Growth: Quantile 10



Source: Own calculation, growth rates of manufacturing are calculated from Cuentas Nacionales, INEGI, and returns to education growth estimated from tables A1 and A2.

evolve in a similar manner in some periods of time, it does not provide a strong enough case to argue that manufacturing is the cause of the reduction of the returns to education. However, it does clearly show that manufacturing dynamics is correlated to the growth in the premium that the market gives to education.

In summary, this study examined the returns for acquiring additional education in different segments of the conditional wage distribution, which is controlled by socio-demographic and industry characteristics for two targeted regions in the northern part of Mexico. From the regional aspect, results show that the labor market rewards additional schooling in the North-Border more than in North-Center region. An examination between quantiles shows that upper quantiles obtained larger wage increases than the lower ones, which is related to the interaction between unobserved ability and education. Another important result is the similar growth evolution of the manufacturing activity and the returns to education. Although the decline of manufacturing might not be the only cause of the diminishing trend of the returns to education, it provides evidence of the relationship between them.

Table 2 shows a formal way to compare returns to education and manufacturing-related variables. To estimate the correlation between the two variables, it is convenient to use Kendall's tau coefficient since it represents the probabilities' difference of concordance (positive sign) or discordance (negative sign) between the two variables (Kendall and Gibbons, 1990). The coefficient will be used to compare over time the correlation of the returns to education –for the lowest, median and top quantiles[10]- versus manufacturing growth, total production and the percentage of workers that are employed in the manufacturing sector for each region analyzed.

10 Quantiles 25 and 75 show the same pattern as the quantiles shown.

According to Kendall's tau coefficient there is a positive association between returns to education and manufacturing growth in the North-Border, with probabilities between 9.8% and 13.73%, larger for lower quantiles. In the North-Center, there is a disassociation in the lower quantiles between returns to education and manufacturing growth and only positive in the top quantile. This means that workers in the North-Border and workers with higher wages in the North-Center obtained an increase in the return of their education when there was a positive growth in the manufacturing industry. However, the null hypothesis of independence between the two variables cannot be rejected, and then the probabilities are not significant.

Table 2. Kendall's tau coefficient

Quantile	Returns to schooling:	Manufacturing growth	Manufacturing production	% workers in manufacturing
Q10	NB	0.1373	-0.5848***	0.3841***
	NC	-0.0588	-0.3275**	0.3116**
Q50	NB	0.0327	-0.5497***	0.3841***
	NC	-0.0458	-0.4444***	0.2319
Q90	NB	0.098	-0.5146***	0.2609*
	NC	0.0327	-0.3626**	0.2101

Source: Own calculations from tables 1, A1 and A2. NB: North-Border, NC: North-Center.
*Note: ***, **, * Kendall's tau coefficient significant at 99%, 95% and 90% respectively.*

A negative association in returns to education and manufacturing production is statistically significant. The probability that manufacturing production and returns to education are discordant is in the range of 52% to 58% in the North-Border and clearly the disassociation is more severe in the lower quantiles. In the North-Center, the discordant relationship ranges from 32% to 44% and probabilities are significantly smaller than in the North-Border where the manufacturing activity is more intense, although the disassociation is more intense in the higher quantiles. The negative relationship implies that high manufacturing production does not necessarily imply larger returns to education – and vice versa- over the period considered.

Trade theory analysis requires comparing prices and wages. However, it is not feasible to obtain definite conclusions regarding the effect of NAFTA over the returns to education since the information is obtained from household surveys. Nevertheless, the results are consistent with Robertson (2004), when using the information available regarding manufacturing. His results suggest that relative price of skill-intensive goods went down when Mexico opened to trade with relatively skill-abundant countries, such as the United States and Canada. More particularly, Robertson (2004) argues that before NAFTA an increase in the relative wage of skilled workers was preceded by an increase in the relative price of skill-intensive goods (consistent with the Stolper-Samuelson theorem) and as a consequence the skill-industries expanded.

The results provided in this paper are consistent with previous studies which estimated that returns to skill in Mexico have been declining after NAFTA (Robertson, 2004; Hazarika and Otero, 2008). They argue that demand for skill reversed after NAFTA since Mexico's partners -in the free-trade agreement- were skill-abundant countries. This is consistent with the positive association between the percentage of workers employed in the manufacturing sector (a proxy of the labor market employment) and returns to education shown in the last column of Table 2. Previous evidence of shifting from the manufacturing to the professional services sector was presented, which is associated with lower labor demand and falling returns to education. The probability of this association is larger for lower quantiles in the North-Border and North-Center states.

Trade theory assumes perfect mobility in the labor market. However, this assumption does not (at least not between Mexico and either of the other two countries) hold in the countries that signed NAFTA. In fact, a limitation of this paper is the unknown migrant status of the respondents from the survey ENEU-ENOE. Even if the results show a robust declining trend over time in the return to education, it is possible that migration patterns are playing an important role and could be a source of bias in the estimation if they are ignored. This, however, is outside the scope of this paper.

6. Concluding remarks

This paper examines the pattern of the labor market appraisal of workers' schooling, focusing the analysis on the northern regions of the country. The manufacturing industry is studied in particular since a large part of the economic activity is located in the north relative to the rest of other regions. The change in the main economic activity from Manufacturing to Social, Public and Professional Services, activities that require more skilled workers, is relevant. In general, quantile estimation results show that the labor market has valued less the additional years of education acquired by workers. The gap in returns to schooling between the North-Border and North-Centre was reduced for workers in the top part of the conditional wage distribution. In fact, for the workers at the top of the distribution in the North-Border, a 27% reduction in the return to education was measured from 1997 to 2011. However, comparing workers in the lowest part of the distribution, a reduction of 39% was calculated. In the North-Centre the reductions were 23% for the top and 27% for the lowest quantile respectively. Therefore, workers at the lowest part of the distribution are the ones who seem to be more affected in terms of education investment by the decline of manufacturing activity in both regions.

Given the increased international competition, Mexico must take advantage of the increase in the highly educated workforce. Results showed that having additional years of education is an investment with lower returns compared to the returns that workers obtained 20 years ago. This result means that education is reducing the potential to enhance wages.

The cause of lower returns to education appears to be related to the reduction in manufacturing activity in the north and the possible migration from other parts of the country to this area. Therefore, a public policy recommendation is to improve the incentives that federal and local governments provide to firms to increase competitiveness, research and development in order to make use of the skilled labor force that has been accumulating during the last decades.

Also, a rising investment in research and development could attract manufacturing firms that engage in some form of high technology, enabling them to employ highly educated workers. These types of firms would be able to compete with countries like India that has attracted firms because of its skilled workers who are relatively cheaper than in developed countries. A better coordination is also required between firms and universities to understand which careers and studies are in demand, particularly in the North.

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Appendix

Table A1. North-Border returns to education

Year	Q10	Q25	Q50	Q75	Q90	OLS
1988	0.0481947	0.0615237	0.0709218	0.0722257	0.0775326	0.0671066
1989	0.0447181	0.061916	0.0743347	0.08121	0.0806816	0.070117
1990	0.0495331	0.0630551	0.073896	0.0814876	0.0894949	0.0714847
1991	0.0543503	0.067336	0.0783534	0.0893293	0.0928159	0.0780503
1992	0.0519188	0.0671885	0.083000	0.0935542	0.0956076	0.0819473
1993	0.0659525	0.0745271	0.0892541	0.0996853	0.1030842	0.088994
1994	0.0625529	0.0773417	0.0896149	0.0981931	0.103286	0.0897185
1995	0.0522872	0.0744057	0.093572	0.1033733	0.1045464	0.088949
1996	0.0634563	0.0820417	0.0986187	0.1087355	0.114833	0.0969871
1997	0.0725109	0.0856396	0.099514	0.1123876	0.1169742	0.100381
1998	0.0601804	0.0740871	0.0897516	0.1001294	0.1076709	0.0893328
1999	0.0581851	0.0737812	0.0899889	0.0998414	0.1037811	0.0878064
2000	0.0523163	0.0665209	0.0840299	0.0951313	0.0994978	0.082255
2001	0.0517383	0.0654929	0.0779531	0.0894402	0.0971884	0.0799516
2002	0.050564	0.0653806	0.0784075	0.0897642	0.0958936	0.0789097
2003	0.0449349	0.058679	0.0760715	0.0891354	0.0957231	0.0784446
2004	0.0432592	0.0540287	0.0727415	0.0845108	0.0953526	0.0742922
2005	0.0478531	0.0562189	0.0730476	0.0832871	0.0876794	0.0753368
2006	0.0432297	0.0524161	0.066665	0.0811957	0.0879687	0.0707013
2007	0.0346819	0.0509296	0.0679554	0.0869668	0.092945	0.0724063
2008	0.0469375	0.0541735	0.0695382	0.0799408	0.0865683	0.0726028
2009	0.0473051	0.0514846	0.0603292	0.0770376	0.0872434	0.0681417
2010	0.0417556	0.0493978	0.062552	0.079814	0.0861019	0.0672595
2011	0.043867	0.0491527	0.0620711	0.0734007	0.0848438	0.0669791

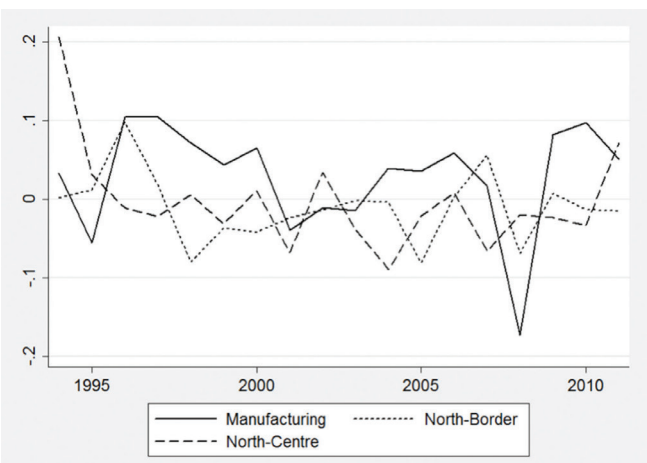
Source: Own calculations from ENEU-ENOE. The estimated coefficients are obtained from equations (2), (3) and (4). Coefficients significant at 95% confidence level.

Table A2. North-Centre returns to education

Year	Q10	Q25	Q50	Q75	Q90	OLS
1988	0.0411798	0.043224	0.0515583	0.0649377	0.0780733	0.0574433
1989	0.0380722	0.0501077	0.0527221	0.0634256	0.0694571	0.05609
1990	0.0395887	0.0466262	0.0523654	0.0586028	0.0687265	0.0561178
1991	0.0443253	0.0495462	0.0542313	0.0653096	0.0810784	0.0618898
1992	0.0538599	0.061981	0.0691056	0.0779051	0.0885149	0.0739468
1993	0.0555576	0.0653272	0.0758306	0.0828717	0.0849172	0.0756535
1994	0.0567029	0.0732149	0.0823437	0.093039	0.1024339	0.0843508
1995	0.063119	0.0758352	0.0915869	0.0966542	0.1056271	0.0900869
1996	0.055275	0.0747879	0.0886401	0.0975291	0.104477	0.0897131
1997	0.0561957	0.0698774	0.082245	0.0930947	0.1022335	0.0846669
1998	0.063607	0.0722561	0.0872197	0.0981277	0.1028424	0.0887965
1999	0.0598866	0.0766125	0.0898441	0.0975615	0.0996699	0.0879679
2000	0.0590155	0.0766757	0.087375	0.0973999	0.1007946	0.0867189
2001	0.0602686	0.0731832	0.0824491	0.0890533	0.093968	0.0823198
2002	0.0584951	0.0688117	0.0768438	0.0870149	0.0971632	0.0805588
2003	0.046038	0.0609212	0.0741684	0.0890915	0.0934425	0.0774651
2004	0.0449453	0.0534521	0.0644952	0.077338	0.0851376	0.0703019
2005	0.0448924	0.0495548	0.0587323	0.0725134	0.083336	0.0675283
2006	0.0484642	0.0507845	0.0631706	0.0733558	0.0840493	0.0682946
2007	0.0432358	0.0483177	0.0602428	0.0731875	0.078534	0.0660653
2008	0.0421838	0.0480283	0.0584619	0.0682177	0.0770348	0.0656658
2009	0.0377917	0.0464387	0.0561991	0.0659984	0.0752397	0.0589351
2010	0.0344646	0.0460469	0.0564884	0.0650222	0.0727684	0.057831
2011	0.0459694	0.0442389	0.0533551	0.0666987	0.0780079	0.0612754

Source: Own calculations from ENEU-ENOE. The estimated coefficients are obtained from equations (2), (3) and (4). Coefficients significant at 95% confidence level.

Figure A1. Manufacturing and returns to education growth over time: Quantile 90



Source: Own calculations from Cuentas Nacionales and ENEU-ENOE.