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On the Skill Premium Hypothesis in Mexico: An Analysis by Scientific Area

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ABSTRACT

This work estimates the short-run relationship between the ratio of the number of college-educated workers and high-school-educated workers with the ratio of their respective incomes. The analysis is by scientific area of the Mexican states along 2005-2010. It is demonstrated that the skill premium hypothesis is fulfilled: increases in the relative supply of skills reduce the skill premium for the assessed scientific areas. Estimates of the elasticity of substitution are stronger in Social Sciences than Engineering and Medicine. Tested against the skilled biased technical change (SBTC) hypothesis, this finding suggests that demand for skilled workers has not kept up with supply. On the other hand, empirical results reinforce the explanation of the persistence of low professional salaries. Economic policy recommendation claims a major connection among human capital and labor market by linking, for example, the higher education and production systems through the most direct stimulus.

Keywords: Skill Premium, GMM-Dynamic Panel, Wages, Education.

Sobre la hipótesis del premio a la educación en México: Un análisis por área científica

RESUMEN

Este trabajo estima la relación de corto plazo entre el ratio de trabajadores de educación universitaria y secundaria con el ratio de sus respectivos ingresos. El análisis es por área científica de los estados mexicanos durante 2005-2010. Se demuestra que se cumple la hipótesis del premio a la educación: incrementos en la oferta relativa de los educados reduce el premio a la educación en las áreas científicas consideradas. Estimaciones de la elasticidad de sustitución son más fuertes en el área de Ciencias Sociales que en Ingeniería y Medicina. Contrastada con la hipótesis del cambio técnico sesgado hacia la educación, este hallazgo sugiere que la demanda de trabajadores educados no se ha mantenido con la oferta. Por otro lado, los resultados empíricos refuerzan la explicación sobre la persistencia de salarios profesionales bajos. La recomendación de política económica clama por una mayor conexión entre capital humano y mercado laboral vinculando, por ejemplo, la educación superior y los sistemas de producción a través de estímulos más directos.

Palabras clave: Premio a la educación, panel dinámico-GMM, salarios, educación.

Clasificación JEL: O3, J31, E24

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1. INTRODUCTION

The skill premium is defined as the ratio of skilled labor wage (workers holding college degrees) to unskilled labor wage (workers holding high school diplomas). From the theory it has been established and documented a relationship between technology and the skill premium; a relationship that is confirmed by the well-documented connection between education and improved productivity (Becker, 1975). This fact is mainly but not exclusively, due to the rise in wage differentials and the invention of the personal computer in the 1980s (Katz, 2000), as well as, the observation that college students tend to use computers most often at work (Krueger, 1993), thereby allowing for "… an agreement that during the 80's, the growing demand for high skilled workers caused a growing unequal distribution of income" (Johnson, 1997). This hypothesis, known as skill-biased technical change (Acemoglu, 1998, 2002; Card and DiNardo, 2002; among others), has set the pace for decades in explaining wage differentials between high and low-skilled workers. In particular, Acemoglu (1998) notes that there was a low demand for college graduates in the U.S. in the 1970s, which grew as technology increasingly became complementary to skilled labor. Later, Acemoglu (2002) claims the skill premium, as a result, of the technical change, which was biased in favor of skilled workers. Given that skilled and unskilled workers are gross substitutes, an increase in skilled labor efficiency led to an increase in the relative wages of skilled workers.

The study of the skill premium, or in general the skilled labor, is quite important nowadays because an augment of professionals has been increasing since some decades ago and, as a consequence, the economies are insufficiently prepared to absorb the demand for skilled workers. It can experience serious difficulties to keep the necessary levels of growing, such as was predicted by some studies (see, for example, Sánchez, Renobales and Rasines, 1994), moreover, general education and major training also are the main forces determining earnings (Blazquez and Ramos, 2008).

Several research articles include investment-specific technological change through capital–skill complementarity (see Krusell *et al.*, 2000), skill-biased technological change induced by international trade (Acemoglu, 2003) and skill-biased technological change associated with the computer revolution (Autor, Katz and Krueger, 1998). Katz and Murphy (1992) attribute the fluctuations in the relative supply of skilled labor to the demographic change. They also argue that the accelerated skill-biased technological change in the 1980s contributed to the rise in the college wage premium by increasing the relative demand for skilled labor in the U.S. economy.

The topic of skill premium and, most generally, the skilled workers, have been researched from several perspectives. Coulombe and Tremblay (2009) compare the skill intensity and schooling of international immigrant to Canada

with interprovincial migration in the study of the provincial income disparities, whereas Nifo and Vecchione (2014) assess the role of the institutions in decisions of skilled migration in Italy. Velde and Xenogiani (2007) study the effects of foreign direct investment (FDI) on skill inequality among a panel of countries and they find that FDI enhances the development of skills. Mello (2008) investigates the substitutability between skilled and unskilled workers in a set of countries. He finds that substitutability is higher in economies with high levels of capital, output and a high proportion of skilled workers. Further, he highlights that college education is the most plausible cutoff for skilled labor[1]. Südekum (2008) tests the convergence hypothesis among levels of high-skilled workers and their rates of growth for the Germany regions, whereas Dohse and Ott (2014) analyze the impact of heterogeneous individual skills and the aggregate skill distribution on growth and convergence towards the world technology frontier. Using a similar methodology to this work, Srour, Taymaz and Vivarelli (2013) find an increasing employment gap between skilled and unskilled workers in the Turkish manufacturing sector. In a structure of intergenerational educational mobility, Ben-Halima, Chusseau and Hellier (2014) demonstrate that skill premium is declining in the French region with the lowest educational level, whereas an increase in the skill premium of higher education degrees is happening. Açikgöz and Jaymak (2014) observe that the skill premium explains about 40% of the decline in the unionization rate in the U.S. economy. He highlights that labor unions compress the wages between skilled and unskilled workers and therefore a rising skill premium encourages skilled workers to withdraw from the union.

Previous investigations on the Mexican case have reported an augment of the gap between skilled and unskilled workers. Cragg and Epelbaum (1996) document that the Mexican economy became more skill-intensive and, as a consequence, the wage dispersion grown since it undertook the trade reform. Cañonero and Werner (2002) say that in the short-run the wage differential can be explained by the degree of substitutability between capital and low-skilled workers who will provoke increasing in demand for high-skilled workers and the skill premium. Montes Rojas (2006) also reports an increment in skill premium and he concludes that the North American Trade Agreement (NAFTA) favors unskilled labor. An augmentation of the skill premium in Mexico is also found by Mollick (2008), although his study only covers the maquiladora industry. Caselli (2014) estimates a rise in real skilled wages and a fall in the real wages of unskilled workers of the Mexican manufacturing sector between 1984 and 1990. Finally, Benita (2014) document's wage gap increments between younger and older workers with the same education level after the economic crisis of 2008, whereas Campos-Vazquez, Lopez-Calva and Lustig

[1] A benchmark also defined in this work.

(2016) indicate a declination of the wage gap among older and younger workers between 2000 and 2014.

This work affronts a recent problem in Mexico: the rapid increasing of professionals who results from the demographic bonus and whose supply remains unemployed and/or with a low salary. This observation suggests a declination on the skill premium of some professions, in line with the tendency to increase the income inequalities (see, for instance, Carrion-i-Silvestre and German-Soto, 2009 and 2010 and Campos-Vázquez, Esquivel and Lustig, 2012). So, our main concern is to demonstrate if the skill premium hypothesis is fulfilled: increments in the relative supply of skills reduce the skill premium at the level of scientific areas.

Although this paper is not the first to analyze the skill premium in Mexico, it is distinguished from the previous literature because it proposes original evidence by scientific area using panel data from the Mexican state's level. In addition, the methodological approach sustained in system-GMM techniques has not been applied to aboard this hypothesis. Therefore, this look on the skill premium in Mexico would be of great interest.

Methodologically, our proposal is as follows. Firstly, a simple theoretical model to explain the factors that affect the skill premium is developed. Second, a Blundell-Bond estimator is applied to check whether the skill premium hypothesis holds using panel data from Mexico's states on employment of the main scientific areas. Delimited by information, the technology is considered as given and so the empirical model of the skill premium only is a function of the relative supply of human capital. The results confirm the hypothesis of skill premium and suggest that demand for skilled workers has not kept up with supply.

The remainder of the paper is organized as follows. Section 2 motivates the paper approaching the economic and educational situation in Mexico. Section 3 presents the theoretical hypothesis on the relationship between the skill premium and the changes in the relative supply of skilled labor. Empirical results with an econometric procedure are introduced in the section 4, while the section 5 discusses some economic policy implications and details some of the main conclusions.

2. MOTIVATION: ECONOMY AND EDUCATION OF THE MEXICAN STATES

The aim of this section is to offer a description of the Mexican economy and its institutional education system. The approach is from both the demand and supply skilled labor. In this vein, Montes Rojas (2006) explains the evolution of the skill premium in Mexico in a simple relative demand and supply framework using the Katz and Murphy (1992) method, where the factors are, for instance,

the number of skilled workplaces mainly located in manufacturing industry, labor market regulations, migration flows and education system, among others.

2.1. The Mexican state's economy: labor demand factors

Appendix B reports the number of professionals working in Mexico, by scientific area, and its absolute rate of growth between 2005 and 2010. These figures are the professionals exerting in the labor market, so it could be an indicator of the labor demand and its evolution. Along this period, the increments were substantial: 1.6 times for Social Sciences, almost 4 times for Engineering and 6.6 times for Medicine. On the contrary, the average income registered negatives rates of growth along this same period: -23% for Social Sciences, -22.5% for Engineering and -37% for Medicine. This behavior is explained by several factors as trade liberalization, heterogeneity in both industries and state economies. Esquivel and Rodriguez-Lopez (2003) shows that the real average wage of non-production workers in Mexico's manufacturing industry was 2.25 times larger than the real average wage of production workers in 1988. This ratio was monotonically increased between 1988 and 1996, when it was about 2.9. Throughout 1988-2000 period the wage gap between skilled and unskilled workers increased by about 27% in the country.

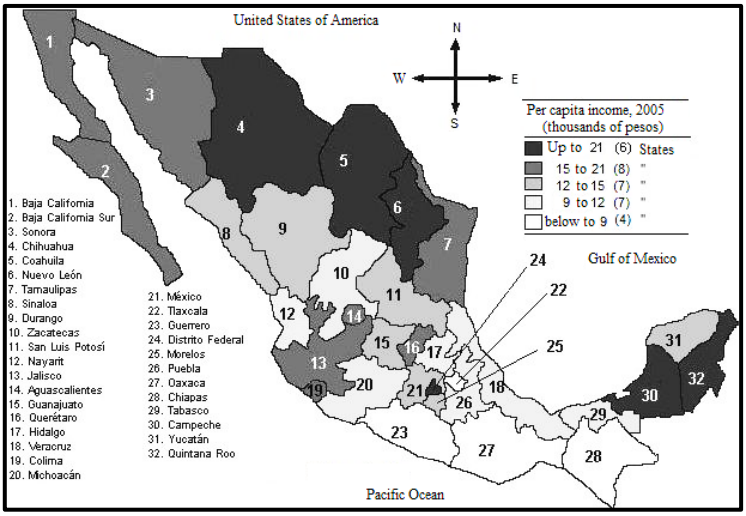
However, it is important to stress that Mexico began the 1980s with the necessity to improve its economic structure. The aftermath of its greatest crisis was the signature of the NAFTA, which began in 1994. Recall that the Stolper-Samuelson theorem affirms that it is more likely to explain the wage differential because of the trade openness will provoke a strong demand for the abundant factor, which is the low-skill work (Esquivel and Rodriguez-Lopez, 2003).

NAFTA has not reached the Southern states of Mexico because of their low economic development that has turned into obstacles for the development as insufficient infrastructure, restricted telecommunication access and social instability. While the Northern states had greater contact and trade with the Southern states of the U.S., the Southern states were conditioned on the federal state's budget, with limited production activities almost entirely focused on the primary sector, resulting in a differentiated development path for each state (see Figure 1).

The Northern states of Mexico benefited more than the Southern states because of their location. It made possible to recognize to the agglomeration economies, that came from the spatial concentration of economic activities (Marshall, 1920), as a result of NAFTA. On the other hand, the New Economic Geography considers the market size, the transport costs and the scale economies are the main determinants of economic concentration (Krugman and Livas Elizondo, 1996) and those could explain the wage and employment differentials among regions: where the population has more scholarly it is possible to make

more benefits from NAFTA and faster grow (Garduño, 2014). Thus, the trade agreement could lead some regions to its economic growth and to explain the wage differentials between qualifying and non-qualifying workers.

Figure 1
The Mexican states system and its income distribution



Source: Own elaboration.

Business operations in some specific industries, such as the automobile industry and auto-parts, electronics and computing, fabrics and confection were settled in the country. The automobile and auto-parts firms mainly chose the Northern entities, with a few exceptions, like Puebla, which has become one of the most important automobile producers with the Volkswagen Company. This state also developed a fairly strong higher education sector, which resulted in the birth of many private colleges.

Along the trade reforms (starting with the General Agreement on Tariffs and Trade, GATT, in 1986), the regional employment in Mexico, wage and per capita GDP changed the optimal location choice of the manufacturing firms, promoting the breakup of Mexico City's manufacturing belt and a displacement of the economic activity towards the border with the U.S. (Hanson, 2003; Meardon, 2003). Indeed, a strong increase in the relative wage of skilled workers was observed by Chiquiar (2008). He pointed out the NAFTA broke down the gradual decline in the skilled-unskilled wage gap that was observed up to 1985. Considering that Mexico has a relative abundance of unskilled labor it seems to be inconsistent with the Stolper-Samuelson Theorem.

The new scenario gave the opportunity for the country to decentralize and specialize in many regions. Jalisco state (in the west of the country) became one of the most important regions in the production of electronic and computer goods. Before NAFTA, it was focused on the production of goods for domestic consumption, such as cooking utensils, clothing and footwear (Brito, 1999; Woo, 2001). On the other coast, Veracruz specializes in logistics activities and international trade while also participates in the oil production.

Other states, like Baja California Sur, Yucatán, Quintana Roo and Distrito Federal are specialized in tourism or services, taking advantage of their natural resources, cultural tradition and the public and private investment in infrastructure. States like Tabasco, Campeche and others remain more focused on the internal market and oil production.

On the other hand, Robertson (2000, 2004) provides evidence that, precisely after NAFTA started to operate, the increasing trend in the skill premium stopped and, in fact, this premium started to fall again. Montes Rojas (2006) shows that the evolution of skill premium is highly correlated with demand shocks to which the two phases of increasing and decreasing of the skill premium can be associated with pre and post-NAFTA. Moreover, the demographic bonus has been increasing in the last decade and it will not stop until 2030 (CONAPO, 2008), has been differently affecting the education demand and augmenting the regional disparities, the labor market and the skill premium.

Additionally, we can say about the Mexican manufacturing sector, which is its main economic sector[2], that it is almost controlled by the big enterprises who contribute 77% of that sector with less than 1% of the establishments for 2008 (INEGI, 2009:24) and they represent the most technologically advanced part of the economy. It means that the other enterprises, mainly MSMEs[3], almost only hire not skill workers, because of their productive framework.

2.2. The Mexican states' educative context: labor supply factors

Data from the Organization for Economic Cooperation and Development (OECD) indicates that both the demographic and schooling effects imply relative changes in the labor supply and they tend to vary the returns to education. For example, Mexico achieved one of the highest enrollment rates of four-year-old children among OECD countries. Graduation rates at the upper secondary level increased by 14 percentage points between 2000 and 2010 and close to 100 percent of 5-14 years-olds participated in education (OECD, 2012). The proportion of 15-19 year-olds who are enrolled in education grew by 11 percentage points since 2000 (OECD, 2014), while attainment rates at higher

[2] It represents 45% of the national product (INEGI, 2009:24).

[3] Micro, small and medium enterprises.

levels of education have increased (5 percent in secondary level and 3 percentage points at the tertiary level) between 2000 and 2012 (OECD, 2014). Moreover, the share of education provided by public institutions is large in Mexico. However, the higher the level of education the larger the proportion of students enrolled in private institutions (OECD, 2014) with the largest proportion of students enrolled in private institutions for the tertiary level (OECD, 2014).

Populations with higher education reached larges increments. For example, population of 15 years-old or more with higher education represented the 13.6% in 2005, while this percentage was of 16.5% by 2010, an absolute augment of 3 percentage points. It could seem low, but when it is compared with the absolute increments in college level (of 0.6%) and high school (0.8%) for the same period, it results in a great increment.

Between 1992 and 2002 the annual rate of growth of students in higher education in Mexico was 5.3%, while postgraduate students grew at the rate of 10.8%. In addition, the percentage of postgraduate students in the private sector of Mexico was 22% in 1990 and this amount overcame the 40% by 2003. Other statistics indicate that number of students in higher education, as proportion of total population between 19 and 23 years-olds was 22% in 2005 and this figure rose to 31% by 2010.

An important factor in labor supply is the number of skilled workplaces by industry. In this vein, Meza (2003) analyzes changes in Mexico's manufacturing labor market between 1988 and 1998. Using indirect estimations of the trade liberalization effects and calculating the impact of the technological change on the relative employment and wage structure, she finds that changes in manufactures have been mostly driven by technological change rather than by trade liberalization. She also reports results suggesting that the increase in the Mexican exports has benefited low-skilled workers, as would be expected if we accept that Mexico is abundant on this factor.

However, to understand the type of labor supply, it is necessary to know how is structured the educational system in a country like Mexico. In this respect, two tendencies are observed in the last decades. On the one hand, the increasingly important participation of the private sector and, on the other hand, the search for an improvement in terms of the quality of higher education. Higher education institutions belonging to the private sector guarantee quality and high training in the labor market of the firms, but public institutions mainly generate and transfer new knowledge.[4]

With respect to the second tendency, the quality of the higher education started to improve when the Federal Government abandoned its passive role and

[4] According to the National Association of Universities and Institutions of Higher Education, ANUIES (2007).

took a more active participation, strengthening the systems of evaluation and professionalization (Tuirán and Muñoz, 2010: 374). However, like the economic performance, the educational one is differentiated among states and the dynamic of population has hardly affected it. The last Census of Population and Housing in Mexico (INEGI, 2011) helps to understand the behavior of the Mexican population. The population segment for over 15 years has increased its education level, which grew from a scholarly mean from 6.5 to 8.6 in only 10 years. At the state level, the best performance is for Distrito Federal, Nuevo León and Coahuila, with 10.1, 9.8 and 9.5 years, respectively. On the other hand, the worst performance is for the Southern states as Guerrero, Oaxaca and Chiapas, with 7.3, 6.9 and 6.7, respectively. The Southern states are also those with the highest level of illiteracy.[5] At the municipality level the results do not vary much. For example, in the top ten of municipalities, four of them belong to Distrito Federal and other two in the Nuevo León state. At the same time, one segment of a population with ages between 15 and 24, who is studying, has continuously increased. Indeed, in the last twenty years (1990 to 2010), there has been an increase of them from 30.2% to 40.4%. The change in the population structure -as identified by the National Population Council, CONAPO (2008: 2)- has affected the country's demographic profile, with impacts on social modernization and economic development as well as in social inequality, poverty and exclusion.

Speaking of educational specialization, it is well known that the number of people with a university education is just over 12.5 million, representing 11.4% of the total population. At the state level, the Distrito Federal and Estado de México account for 28% of the total, while 45% is constituted by only four states. This means a high concentration of education in the country. The situation with this population does not end here because the rapid increase in graduates generates other problems like unemployment, underemployment or the phenomenon of displacement between the less and the more prepared people with some effects on salaries. In this sense, the Labor Observatory of Mexico (FCCyT, 2012 and STPS, 2012) shows the most demanded careers (Management, Accounting and Law) that at the same time have the worst percentage of labor affinity, with 50%, 68% and 68%, respectively. Another point is brought up by the study of graduates undertaken by the Autonomous Metropolitan University (UAM), one of the most important universities in the country, which showed a decreasing in the job opportunities -as well as wages- for those graduating in Management, Accounting and Law, especially regarding recent graduates (UAM, 2008). Hernández Laos (2004) and Tenorio Martínez (2007) identified similar problems in the Mexican case in different periods.

[5] States like Chiapas, Guerrero, Oaxaca, Veracruz, Puebla, Hidalgo and Michoacán have a percentage between 10% and 18% (INEGI, 2011).

In this vein, Montes Rojas (2006) pointed out that workers with high school and college as a proportion of primary workers was increasing in Mexico along 1990-2003. He concluded that in terms of relative wages, the followed pattern by the labor supply had a positive impact on the incomes of the least skilled workers. The significant decline in the premium, after 1997, was the result of the relative supply increment.

In the last decades, the immigration rate grew almost twice, where women represented 45% of the total amount. In 1994 there were 6.5 million of Mexican people in the US, while in 2010 they raised 11.9 million, where the majority of the new immigrants were between 18 to 39 years-olds (BBVA_Bancomer-CONAPO, 2016:38).

The women incorporation at the labor market is growing and in 2008 they represented 38% of the completely occupied population in the country (INMUJERES, 2016), that it is another important demand market factor.

In addition, the specialization and diversification of the Mexican states could be conditioning the relative demand for skilled labor with important effects on the skill premium because it is also possible that a saturation phenomenon is arising in the professionals' labor market. In any case, the next skill premium model can be useful for shedding light on this issue.

3. THE MODEL

The main goal of this section has been just to motivate the short-run dynamic econometric exercise in which the skill premium was a function of the relative labor supply in the current time as well as in the past.

Accinelli and Sanchez-Carrera (2012) show the evolutionary dynamics between the skill premium and the relative supply of skilled labor. Their results indicate that for a large amount of the initial supply of skilled labor, greater than a certain threshold level denoted by $\mathrm{P} = \left(X^{H*}, X^{l*} \right)$, where the X's denote the fractions of skilled and unskilled, the economy converges in time to the path $t \to (1,1)$, *i.e.* with probability 1 the whole job is the qualified type. Furthermore, their results show that to overcome the poverty trap, the basin of attraction of low-level equilibrium should be reduced, *i.e.*:

1. The relationship between the cost of education and the skill premium should decrease, which happens if the skill premium increases.
2. The skill premium to educate must be greater than the cost of education. Therefore, when the supply of skilled labor is low, the skill premium or education award should be large enough to encourage or incentivize those with full labor potential to change their current behavior and join the club of skilled workers.

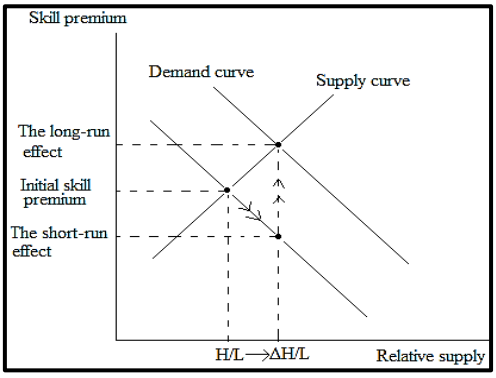
In what follows, we consider a short-run analysis. Such as is shown by Acemoglu (2002) in the short-run the substitution effect dominates the endogenous one. This perspective also suggests that a faster increase in the supply of skills, accelerates the demand for skills (Acemoglu 1998).

Hence, Acemoglu (1998 and 2002) shows a model in which the direction of technological change is endogenous, which may explain why the demand for skilled workers (skilled or educated) has an effect on the skill premium, such that it first decreases and then sharply increases due to the increase in the relative supply of skilled workers. That is, when there are many skilled workers and endogenous technology is complementary to skills, then the market is very large and therefore the skill prize is large enough.

Accordingly, the impact of an increase in the relative supply of skilled or educated labor on the skill premium is primarily determined by two forces (see Figure 2):

1. A substitution effect (given in the short-run and analyzed in this paper) that makes the economy moves along the relative demand curve (negative slope) and the skill premium decreases.
2. A complementary (or directed) technological change effect that moves to the right of the relative demand curve for skilled workers, which is due to the increased supply of skilled workers, and leads to greater and faster updating or complementarity with endogenous technological change.

Figure 2
Changes in the relative supply of skilled labor and the relative demand curve



Source: Own elaboration from Acemoglu (2002).

That is, with regards to an increase in the relative supply of skilled labor, if the substitution effect dominates the directed technological effect -as might be the Mexican case-, then the skill premium falls -the short-run effect- and then increases -the long-run effect- but never above its initial level. In contrast, if the

directed technology effect is large enough, the model predicts that in the long-run the skill premium increases as a response to changes in the relative supply of skilled labor.

It is important to stress that the main purpose of the next simple model is to illustrate the mechanisms affecting the skill premium equation and then to guide our empirical analysis. With this purpose, we present a version of the Solow model - since it is skill neutral in technical change, which is assumed in our econometric model. Hence, let us consider a given number of firms in the economy where each firm has access to the following technology:

$$Y = BK^{\alpha}\left(A_L L\right)^{\beta}\left(A_H H\right)^{\gamma}, \tag{1}$$

where $\alpha+\beta+\gamma<1$, K denotes physical capital, $\beta>0$ is a constant technology parameter, A_L is the technology complementary to L, which denotes low-skilled workers, and A_H is the same technology, complementary to the high-skilled workers, H.

Workers are endowed with one unit of time per period, d_t, which is inelastically supplied to the labor market. Income of low-skilled workers, L, is given by $X_L = w_L + ra_L$. So, financial wealth evolves according to:

$$\dot{a}_L = X_L - C_L \text{ with } a_L(0) = a_{L0} \tag{2}$$

where C_L denotes the spending on consumption goods. Defining the saving rate:

$$S_L = \frac{X_L + \delta a_L - C_L}{X_L + \delta a_L}$$

then equation (2) may be expressed as:

$$\dot{a}_L = S_L\left(X_L + \delta a_L\right) - \delta a_L$$

Income of high-skilled workers, H, is given by $X_H = w_H + ra_H$. Thus, wealth evolves according to:

$$\dot{a}_L = X_H - C_H \text{ with } a_H(0) = a_{H0} \tag{3}$$

where C_H denotes the spending on consumption goods. Defining the saving rate:

$$S_H = \frac{X_H + \delta a_H - C_H}{X_H + \delta a_H}$$

then, equation (3) may be expressed as:

$$\dot{a}_H = S_H\left(X_H + \delta a_H\right) - \delta a_H$$

In equilibrium, the firms maximize profits, *i.e.* solve the following problem at each point in time:

$$\max_{K,L,H}\left\{K^{\alpha}\left(A_L L\right)^{\beta}\left(A_H H\right)^{\gamma}-\left(r+\delta\right)K-w_L L-w_H H\right\} \tag{4}$$

So, the first order conditions are:

$$\alpha\frac{Y}{K}=r+\delta,$$

$$\beta\frac{Y}{L}=w_L,$$

$$\delta\frac{Y}{H}=w_H.$$

Notice that capital market equilibrium requires that:

$$K=La_L+Ha_H.$$

Therefore, the skill premium is given by:

$$\omega=\frac{w_H}{w_L}=\frac{\gamma\dfrac{Y}{H}}{\beta\dfrac{Y}{L}}=\frac{\gamma}{\beta}\frac{L}{H}. \tag{5}$$

Equation (5) indicates that the skill premium is a function of the relative labor supply. Also, it highlights that skilled and unskilled labors display a high elasticity of substitution and therefore they are gross substitutes in production. In this case, a rapid increase in the supply of skills would first reduce the skill premium and second, following the increase in the relative supply of skills, there will be an initial decline in the skill premium (see Acemoglu, 2009, for a textbook discussion). By equation (5), our econometric modeling only considers that the skill premium is a function of both the last skill premium, ω_{t-1}, and the relative supply of skilled labor, at time *t, i.e.*:

$$\omega_t = f(\omega_{t-1},\ H_t/L_t) \tag{6}$$

where H_t/L_t is the relative supply of skilled labor - that is, workers with university education in relation to the total one. Thus, the econometric model is only determined by the expression (6).

4. EMPIRICAL SPECIFICATION AND ECONOMETRIC RESULTS

4.1. Specification of the empirical equation

As emphasized above, the econometric specification should consider that the skill premium was a function of the relative labor supply in the current time as well as in the past. Hence equation (6) can be defined by:

$$\omega_t = f(\omega_{t-1},\ H_t/L_t,\ H_{t-1}/L_{t-1}) \tag{7}$$

where the lagged dependent variable included in the right side of the equation (7), ω_{t-1}, has the aim to separate the inertias arising from the past skill premium values affecting the contemporaneous ones.

Naturally, an econometric challenge implied by (7) is the potential endogeneity due to the lagged term of the dependent variable (ω_{t-1}) in the role of the explicative variable (Arellano and Bond, 1991). In these cases, whichever is the estimator, it loses consistency. In order to correct for endogeneity, a generalized method of moments (GMM) in first differences was recommended by Arellano and Bond (1991), who demonstrated that the GMM estimator has a negligible finite sample bias. Later, Blundell and Bond (1998) demonstrated that regressions based on GMM in first differences have large finite sample bias and poor precision and they recommended using a linear GMM estimator known as system-GMM. The system-GMM was corroborated in empirical works by Blundell and Bond (2000) and Blundell, Bond and Windmeijer (2000). They conclude that the system-GMM estimator can overcome many of the failure to obtain consistent estimates in dynamic panel models. This procedure was improved by Bowsher (2002) and Windmeijer (2005), mainly in relation to the momentary conditions and the correct term of the standard errors, and it is heavily suggested by Bond and Windmeijer (2005) for studies of finite samples. One of its advantages is that it allows the elimination of the permanent and unobserved individual heterogeneity when the temporal dimension is small, in addition to the endogeneity problem.

With the end to obtain efficient estimations through GMM it will be necessary to include a set of instrumental variables to remove cross-section fixed effects. Blundell and Bond (1998) demonstrate that adding a mix of lagged differences of y_{it-1}, as instruments for equations in levels, and lagged levels of y_{it-1}, as instruments for equations in first differences, it is possible to correct the weak instruments problem that characterizes the first-difference GMM estimator. Their extended system-GMM estimator not only improves the precision, but also reduces the finite sample bias.

Therefore, the econometric specification of empirical investigation arising from (7) is as follows:

$$\begin{aligned} \Delta\omega_{i,t} &= \alpha\Delta\omega_{i,t-1} + \beta_1\left(\Delta H_t/\Delta L_t\right) + \beta_2\left(\Delta H_{t-1}/\Delta L_{t-1}\right) + \Delta u_{i,t} \\ &\text{with } \Delta u_{i,t} = \Delta v_i + \Delta\varepsilon_{i,t} \end{aligned} \tag{8}$$

where, $\omega_{i,t}$ denotes the skill premium variable; (H_t/L_t) is the relative offer of qualified work; and the subscripts $i = (1,\ldots,N)$; $t = (1,\ldots,T)$ indicate the cross-

section units and the time periods, respectively. Moreover, v_i and $\varepsilon_{i,t}$ represent the unobservable effects (v_i) and the corresponding observable omitted factors ($\varepsilon_{i,t}$), with the aim to capture the cross-sectional differences in the constant term, as defined by Baltagi (2008), among others. According to Acemoglu (2002), from the estimated coefficients β_1 and β_2, it is possible to recover the elasticity of substitution among skilled and unskilled workers, which is defined by $\sigma = 1/\beta_i$.

4.2. Data description

The empirical evidence is based on data for the 32 federal entities (or states) of Mexico during the period 2005–2010, so we infer from the estimated sign whether truly exists a skill premium to educate. The next areas are considered: Social Sciences, Engineering and Medicine.[6]

Data comes from the Mexican Labor Observatory, which is under the Ministry of Labor and Social Welfare, called "*Panorama anual del observatorio laboral mexicano*" (STPS, 2012). The Social Science area includes careers like Business Administrator, Lawyer, Social Worker, Vocational Teaching, Preschooler, Elementary School, Middle and High School, Pedagogy, Educational Science, Communication Sciences, Customs and Foreign Trade, Tourism, Economics, Accounting and Finance. The Engineering area includes careers like Civil Engineering, Industrial Engineering, Computer Science and Information Engineering, Mechanical, Textile and Wood Engineering, Electrical and Electronic Engineering, Agronomy, Architecture, Chemistry and Chemical and Food Engineering. The medical area includes Medicine, Nursing, Optometry, Dentistry and Therapy.

The set of variables is also available for the activities defined as "not qualified" and they are treated as one unique variable. In addition, a variable of the job relative offer, as the ratio of qualified to unqualified employment, is added.

Appendix A of this work reports, in logarithmic terms, the main descriptive statistics about our database. It is possible to observe that there is a more asymmetry (skewness and kurtosis) in the database by profession that in the total one and also higher dispersion (standard deviation) in almost all variables, however, in terms of occupied persons (L) and relative offer labor (H/L) the dispersion is almost equal for all the samples. In addition, there are some negative values because the database contains some states that registered an inferior average income in some professions in relation to the general average

[6] Availability of information limits the empirical analysis only at these areas and period.

income. Relatively, they have a low demand for skilled workers. Moreover, it is appreciated that the mean of the skill premium (ω) is higher in the scientific professions of Engineering and Medicine than in the total sample and Social Sciences.

Also, Appendix B reports the number of professionals in Mexico by scientific area and its absolute rate of growth between 2005 and 2010. As is appreciated increments of professionals in each scientific area is huge in comparison to the total occupied (8.2%). This observation combined with the negative increment in the total column is indicative of the major professionalization of the labor in Mexico, that is, the skilled jobs are now more abundant, but how it will be the skill premium? The next estimates have something to say about it.

4.3. Estimates and analysis

Table 1 reports the results of the model with the equation (8). The Sargan test is reported in the bottom part of the Table 1, which assesses the consistency of the instruments used to estimate the regressions. Under the null hypothesis that the restrictions are valid, the corresponding p-values highlight that the set of instruments is adequate.[7]

Table 1 shows that the skill premium hypothesis holds for Mexico in the various scientific areas. All the estimated coefficients are significant at the 5% or less level of significance for the Social Sciences, Engineering and Medicine areas and they also present the right sign.

As expected from the theory, when the relative offer of qualified jobs is increasing, the skill premium tends to diminish, such as is observed from the negative sign of this variable in both contemporary and lagged values. That is to say, when skilled jobs are abundant, then the skill premium decreases, but when they are scarce, there is an increase. This explains the estimated negative relationship between the skill premium and the highly skilled work supply and empirically confirms the substitution effect given in the short-run, which was anticipated in the section 3 of this work when the theoretical model was developed. We are conscious that this is not the unique reason. In fact, there are other more reasons about the fall in the skill premium and the previous literature reviewing is a sample of it. For example, changes in the skill premium also can be due to rigidities in the labor market (Ruiz, 2001), scarce growth in wages (Campos-Vazquez, Lopez-Calva and Lustig, 2016), an increase in the demand for low skilled workers (Montes Rojas, 2006), as a consequence of new technology

[7] The number of cross-sections used to estimate the regressions was inferior to 32 in several scientific areas due to missing values in some states. The percentage of missing observations was of 6% in Social Sciences, 3% in Engineering and 12% in Medicine.

adoptions by firms (Riaño, 2009) or via changes in the domestic price of machinery and equipment (Caselli, 2014), among others. However, our database and model only allows evidence on the oversupply of skilled workers, so in that direction is the interpretation of the results.

Table 1
The skill premium results

Variable	Total	Social Sciences	Engineering	Medicine
$\Delta\omega_{t-1}$	0.7098***	-0.0848***	-0.3332***	-0.0387***
	(0.0487)	(0.0026)	(0.0019)	(0.0021)
$(\Delta H_t / \Delta L_t)$	-0.4840**	-2.8580***	-1.9273***	-6.3643***
	(0.2216)	(0.8279)	(0.2479)	(0.6150)
$(\Delta H_{t-1} / \Delta L_{t-1})$	-0.4253**	-1.3053**	-2.2953***	2.0577***
	(0.2084	(0.5615)	(0.3393)	(0.2609)
σ_t	2.07	0.35	0.52	0.16
σ_{t-1}	2.35	0.95	0.44	0.49
Average elasticity of (*H/L):*	2.21	0.65	0.48	0.33
Sargan test	20.693	22.032	23.882	20.652
p-value	[0.353]	[0.183]	[0.201]	[0.356]
Cross-sections (N)	32	30	31	28
Periods (T)	4	4	4	4

Notes: Estimations by one-step system of dynamic panel data in first differences (Blundell and Bond, 1998) suitable when the number of individuals is elevated and the time series is small. The instrumental variables are the levels an two lagged periods of the dependent and independent variables. Estimations are corrected by heteroscedasticity through the White method. Standard errors are reported in parentheses.

**** and ** indicate a statistically significant coefficient at 1% and 5%, respectively.*

Source: Own calculations.

The overall impact of an increase in the relative supply of skilled labor on the skill premium is larger for the total of professions - see the 'Total' column in Table 1. In the middle of the Table 1 the average elasticity is higher than two, indicating that the substitution effect among skilled labor and skill premiums for all professions is heavily strong. This result is comparable to the gap between skilled and unskilled workers reported for Turkish, a country of similar income level that Mexico, by Srour, Taymaz and Vivarelli (2013). Also, it may be in line with the relationship between education and work reported by Garrido (2012) for the Spanish case, where the author finds unfulfilled expectations among higher levels of employment and job quality with higher educational levels.

By scientific area this effect was relatively minor and differentiated. Social Sciences estimate an elasticity higher than one (0.35 + 0.95 = 1.30), unitary-elasticity (0.52 + 0.44 = 0.96) for Engineering and inelastic for Medicine (0.16+0.49 = 0.65). The average elasticity even follows this same order. According to these results the Social Sciences is the most saturate scientific area,

also it could mean that college and high-school-educated workers are easily substitutable by employers. Therefore, it is the area where the skill premium shows a big drop.

The elasticities of substitution are comparable with other previous studies on the Mexican case. For example, although with a different database and techniques, Benita (2014) reports elasticity around 1.7 between age groups, while between college-educated and high-school-educated workers his estimates are at three percent. Riaño (2009) estimates elasticities affecting the skill premium in the Mexican manufacturing sector between 2.5 and 4.2 percent. These results are in line with our estimates: 0.65 (in Medicine) and 4.42 (in the total of professions).

5. CONCLUDING REMARKS AND RECOMMENDATIONS OF ECONOMIC POLICY

In Mexico, the percentage of the population with a higher level of education has been steadily increasing, so the relative supply of skills has also grown. Therefore, skilled labor is actually more abundant, so the skill premium is declining in most of the scientific areas, in accordance with the skill-biased technological change hypothesis. In change, the Stolper-Samuelson theorem has not been fulfilled, negatively affecting the demand of the low skill workers and stressing the whole labor market.

Our research claims that an increasing trend of the ratio of wages -skilled to unskilled labor- calls for policies directed to promote education and training of lower-skilled workers. Previous research has focused on trade liberalization episodes. For example, Esquivel and Rodriguez-Lopez (2003) finds that trade liberalization would have led to a reduction in the wage gap in Mexico from 1988 to 1994, but it was offset by the large negative impact of technological progress on the real wage of unskilled workers. Hanson (2003) reports that returns to skill continued to rise and the wage regional differences continued to widen in Mexico during the 1990s. According to his results, the largest wage gains were observed in regions that are most exposed to international trade, foreign direct investment and/or opportunities for migration to the United States.

In this research, the estimated model found that an increase in the supply of skilled workers leads to a fall in the skill premium - which makes sense in a standard supply and demand model that increases in the supply of a good will reduce its price or demand. A similar result is highlighted by other studies, such as Benita (2014), who analyzes the college premium among younger and older workers in Mexico, and Campos-Vazquez, Lopez-Calva and Lustig (2016), who find that the average hourly wage of college-educated workers declined during 2000 and 2014. Villarreal (2010) and Campos-Vazquez, Lopez-Calva and Lustig (2016) consider that this decline in the skill premium has to see with the financial

crisis. Tested against the skilled biased technical change hypothesis the results suggest that demand for skilled workers has not kept up with supply (over supply store). Mollick and Ibarra-Salazar (2003) also reported findings in line with our results since they suggest that wage premium moves in tandem with the relative supply of skilled workers: as the relative supply of skilled workers rises, their relative wage falls as is predicted by the theory.

So, these findings are stronger when looking at specific areas. The substitution results suggest that the skill premium is more sensitive where high and low skilled workers are not good substitutes, where among all occupations there is more substitution between high and low skilled workers.

Hence, Mexico needs a more complete policy on human capital. Up to now, it seems that the economic policy has functioned with heterogeneous results. The educational achievements directed towards obtaining more quantity of professionals have not been accompanied by parallel policies to integrate them into the labor market and, as a consequence, notable asymmetries are rising. Actually, the share of science and technology is minor to 0.5% of the Mexican GDP (CONACyT, 2014), while the relative supply of skills has grown.

In addition, from the point of view of the implementation of an industrial economic policy, if it is possible to look at the determinants of the wage premium by economic sector, then the industrial policy could be focused by sector. This combination of factors makes important to study the major changes that are driving the Mexican manufacturing industry, for instance. It is well known that technical progress is considered to be the main source of long-term productivity growth within the framework of modern growth theories. Total factor productivity (TFP) measures the efficiency of technical progress, which is the portion of output not explained by the amount of inputs used in production. As such, its level is determined by how efficiently and intensely inputs like human capital and/or investment stocks in research and development (R&D) are utilized in the production. Notice that in this paper, we faced the question about the skill premium on human capital accumulation, but we have left the amount of investment in R&D, since the insufficiency of data makes difficult the identification of the contribution of investment to the growth of productivity.

In this vein, according to data from the Conference Board Total Economy Database (January 2012)[8], the growth rate of TFP exhibits a negative trend, in particular from 1990 to 1994, with an increase from 1996 to 2000. After that, it again starts with a negative trend, accentuating by 2006 and concluding with a growth rate of -6.23% in 2009 year (see Figure 3).

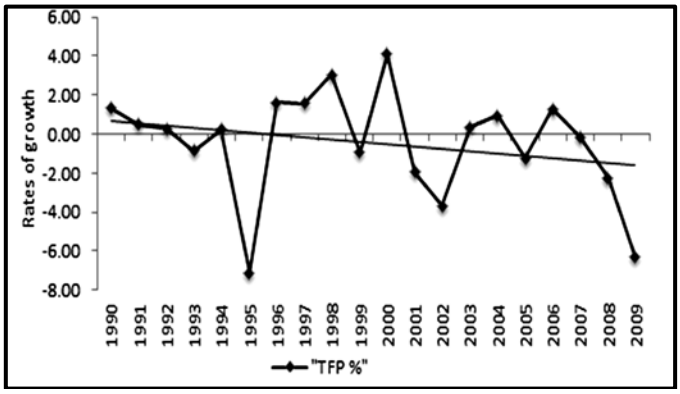
Mexico presents lower productivity levels than those of its main competitors, such as China, for example. The growth rate of the TFP in China has grown at a

[8] See: http://www.conference-board.org/data/economydatabase/.

higher rate than in Mexico (see Chiquiar and Ramos-Francia, 2008). If one takes into account that the rate of productivity growth tends to be lower than that achieved by its main competitors, then this is a significant challenge for the Mexican economy. The low rate of productivity growth, together with the relatively low skill premium, is part of the fundamental factors that Mexico has to radically change in order to achieve the sustained growth, *i.e.* complementarity between R&D and human capital. The Mexican economy should implement measures, for example, subsidizing investment in technology and/or education or improving the link between education and production systems.

The Mexican economic policy should consider the variety or diversity of regional productivity. In this regard, the econometric results also support the graphic analysis that suggests important asymmetries in the productive structure of the Mexican states and in-depth concentration of activities in some of them. Regionally, education and professionals are quite concentrated (see analysis of the section 2.2) and, as a result, the skill premium should also be regionally concentrated. In addition, some authors, as Hanson (2003), report that in Mexico during the 1990s, the returns to skill continued to rise and the regional differences in wages continued to widen.

Figure 3
TFP growth rates in Mexico, 1990-2009
(estimated as a Tornqvist index)



Source: Own elaboration from the Conference Board: Total Economy Database.

The empirical results conclude that the Social Sciences area is the most sensible to changes in the skill premium generated by an increment on skilled workers relative to the unskilled workers. These results highlight why some highly educated workers do not so easily gain access to the labor market, while when they do, then they face a low wage at the same time that other workers obtain higher wages. This asymmetry of treatment between workers in the

functioning of the Mexican labor market seems to be increasing. The supply of labor is determined by individual choices - everyone whose cost of education does not exceed the lifetime gains from working as high-skilled rather than low-skilled acquires education and becomes higher-skilled. In such a set-up, the relative technology must increase in the high-skilled sector in order to allow increments of the skill premium, thereby increasing the incentives to acquire education and educational attainment.

Therefore, this analysis indicates that we should incorporate the variable of technology in future research. We have mentioned that due to the paucity of data at the state level, technology was considered as given. However, no doubt, future research should show whether there is complementarity between the supply of human capital and the generation of new technology, which would make an increasing skill premium. Another interesting extension is to split the sample by states to investigate the skill premium among Northern states in comparison to Southern states, for example. Also, it is possible to test the convergence hypothesis applied to the relationship among levels and rates of growth of high-skilled workers, such as in Südekum (2008) for Germany regions.

BIBLIOGRAPHY REFERENCES

ACCINELLI, E. and SANCHEZ-CARRERA, E. J. (2012). "The Evolutionary Game of Poverty Traps". *The Manchester School*, 80(4), pp. 381-400.

ACEMOGLU, D. (1998). "Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality". *Quarterly Journal of Economics*, 113(4), pp. 1055-1090.

ACEMOGLU, D. (2002). "Technical Change, Inequality and the Labor Market". *Journal of Economic Literature*, 40(1), pp. 7-72.

ACEMOGLU, D. (2003). "Patterns of Skill Premia". *The Review of Economic Studies*, 70(2), pp. 199-230.

ACEMOGLU, D. (2009). Introduction to Modern Economic Growth. New Jersey: Princeton University Press.

AÇIKGÖZ, Ö. T. and KAYMAK, B. (2014). "The Rising Skill Premium and Deunionization". *Journal of Monetary Economics*, 63, pp. 37-50.

ANUIES (2007). Consolidación y avance de la educación superior en México. Elementos de diagnóstico y propuestas, México: ANUIES.

ARELLANO, M. and BOND, S. (1991). "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations". *The Review of Economic Studies*. 58(3), pp. 277-297.

AUTOR, D. H.; KATZ, L. F. and KRUEGER, A. B. (1998). "Computing Inequality: Have Computers Changed the Labor Market?". *Quarterly Journal of Economics*, 113(4), pp. 1169-1213.

BALTAGI, B.H. (2008). *Econometric Analysis of Panel Data*. Chichester: John Wiley & Sons.

BBVA-BANCOMER_CONAPO (2014). Anuario de migración y remesas. México 2015, BBVA-Bancomer_CONAPO, México.

BECKER, G. (1975). Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education. New York: NBER and Columbia University Press.

BEN-HALIMA, B.; CHUSSEAU, N. and HELLIER, J. (2014). "Skill Premia and Intergenerational Education Mobility: The Frenc Case". *Economics of Education Review*, 39, pp. 50-64.

BENITA, F. (2014). "A Cohort Analysis of the College Premium in Mexico". *Latin American Journal of Economics*, 51(1), pp. 147-178.

BLAZQUEZ CUESTA, M. and RAMOS RODRIGO, J. (2008). "Recent Investments in Human Capital and its Effect on the Chances of Escaping from Low-paid Jobs: The Spanish Case". *Estudios de Economía Aplicada*, 26(2), pp. 161-180.

BLUNDELL, R. and BOND, S. (1998). "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models". *Journal of Econometrics*, 87(1), pp.115-143.

BLUNDELL, R. and BOND, S. (2000). "GMM Estimation with Persistent Panel Data: An Application to Production Functions". *Econometric Reviews*, 19(3), pp. 321-340.

BLUNDELL, R.; BOND, S. and WINDMEIJER, F. (2000). "Estimation in Dynamic Panel Data Models: Improving on the Performance of the Standard GMM Estimator". *Advances in Econometrics*, 15, pp. 53-91.

BOND, S. and WINDMEIJER, F. (2005). "Reliable Inference for GMM Estimators? Finite Sample Properties of Alternative Test Procedures in Linear Panel Data Models". *Econometric Reviews*, 24(1), pp. 1-38.

BOWSHER, C. G. (2002). "On Testing Overidentifying RestrITCions in Dynamic Panel Data Models". *Economics Letters.* 77(2), pp. 211-220.

BRITO, B. (1999). "Las regiones como impulsoras del crecimiento económico. El caso del estado de Jalisco". In Ruiz Durán, C. and Dussel Peters, E. (coords.) *Dinámica regional y competitividad industrial*, México: UNAM-Fundación Friedrich Ebert-Jus.

CAMPOS-VÁZQUEZ, R. M.; ESQUIVEL, G. and LUSTIG, N. (2012). "The Rise and Fall of Income Inequality in Mexico, 1989-2010". Working Paper Series ECINEQ, WP 2012-267.

CAMPOS-VAZQUEZ, R. M.; LOPEZ-CALVA, L. F. and LUSTIG, N. (2016). "Declining Wages for College-Educated Workers in Mexico". *Policy Research Working Paper*, 7546.

CAÑONERO, G. and WERNER, A. (2002). "Salarios relativos y liberación del comercio en México". *El Trimestre Económico*, 69(1), pp. 123-142.

CAPARRÓS RUIZ, A. and NAVARRO GÓMEZ, M. L. (2001). "¿Determina el salario mínimo seguir o no estudiando en España?". *Estudios de Economía Aplicada*, 17, pp. 107-124.

CARD, D. and DiNARDO, J. E. (2002). "Skill Biased Technological and Rising Wage Inequality: Some Problems and Puzzles". *NBER Working Paper* No. 8769.

CARRION-i-SILVESTRE, J. L. and GERMAN-SOTO, V. (2009). "Panel Data Stochastic Convergence Analysis of the Mexican Regions". *Empirical Economics*, 37(2), pp. 303-327.

CARRION-i-SILVESTRE; J. L. and GERMAN-SOTO, V. (2010). "Stochastic Convergence in the Industrial Sector of the Mexican States". *The Annals of Regional Science.* 45(3), pp. 547-570.

CASELLI, M. (2014). "Trade, Skill-Biased Technical Change and Wages in Mexican Manufacturing". *Applied Economics*, 46(3), pp. 336-348.

CHIQUIAR, D. (2005). "Why Mexico's Regional Income Convergence Broke Down". *Journal of Development Economics,* 77(1), pp. 257-275.

CHIQUIAR, D. (2008). "Globalization, regional wage differentials and the Stolper-Samuelson Theorem: Evidence from Mexico". *Journal of International Economics,* 74(1), pp. 70-93.

CHIQUIAR, D. and RAMOS-FRANCIA, M. (2008). "Determinantes de la ventaja comparativa y del desempeño de las exportaciones manufactureras mexicanas en el periodo 1996-2005". *Documento de Investigación 2008-01,* Banco de México, México.

CONACYT (2014). *Informe general del estado de la ciencia, la tecnología y la innovación, México 2013*, México: Conacyt.

CONSEJO NACIONAL DE POBLACIÓN (CONAPO) (2008). El informe de México: El cambio demográfico, el envejecimiento y la migración internacional en México. México: CONAPO.

COULOMBE, S. and Tremblay, J. F. (2009). "Migration and Skills Disparities across the Canadian Provinces". *Regional Studies*, 43(1), 5-18.

CRAGG, M. I. and EPELBAUM, M. (1996). "Why Has Wage Dispersion Growth in Mexico? Is it the Incidence of Reforms or the Growing Demand for Skills?". *Journal of Development Ecoomics*, 51(1), pp. 99-116.

DOHSE, D. and OTT, I. (2014). "Heterogenous Skills, Growth and Convergence". *Structural Change and Economic Dynamics*, 30, pp. 52-67.

ESQUIVEL, G. and RODRIGUEZ-LOPEZ (2003). "Technology, trade, and wage inequality in Mexico before and after NAFTA". *Journal of Development Economics*, 72(2), pp. 543-565.

FORO CONCULTIVO CIENTÍFICO Y TECNOLÓGICO (FCCyT) (2012). Estadísticas de los sistemas estatales de innovación, Vol. 1. México: FCCyT.

GARDUÑO, R. (2014). "La apertura comercial y su efecto en la distribución regional de México". *El Trimestre Económico*, 81(322), pp. 413-439.

GARRIDO MEDINA, L. (2012). "Estudios y trabajo de los españoles en la crisis de empleo". *Estudios de Economía Aplicada*, 30(1), pp. 29-58.

HANSON, G. (2003). "What Has Happened to Wages in Mexico Since NAFTA?". NBER Working Paper No. w9563.

HERNÁNDEZ LAOS, E. (2004). "Panorama del mercado laboral de profesionistas en México". *Economía UNAM*, 1(2), pp. 98-109.

INEGI (2009). Micro, pequeña, mediana y gran empresa. Estratificación de los establecimientos, Aguascalientes: INEGI.

INEGI (2011). Censo de Población y Vivienda 2010. Aguascalientes: INEGI.

INMUJERES (2016). Online indicators, http://estadistica.inmujeres.gob.mx/formas/fichas_inm.php?modo=v&dirUrl=tooltipayudas.php%3FIDpag%3D6. [Accessed on April 8th, 2016.]

JOHNSON, G. E. (1997). "Changes in Earnings Inequality: The Role of Demand Shifts". *Journal of Economic Perspectives*, 11(2), pp. 41-54.

KATZ, L. F. (2000). "Technological Change, Computerization, and the Wage Structure". In Brynjolfsson E., Kahin B. (eds) Understanding the Digital Economy (pp. 217-244). Massachusetts: The MIT Press.

KATZ, L. F. and MURPHY, K. M. (1992). "Changes in Relative Wages, 1963-1987: Supply and Demand Factors". *Quarterly Journal of Economics*. 107(1), pp. 35-78.

KRUEGER, A. B. (1993). "How Computers have Changed the Wage Structure: Evidence from Microdata, 1984-1989". *Quarterly Journal of Economics*, 108(1), pp. 33-60.

KRUGMAN, P. and LIVAS ELIZONDO, R. (1996). "Trade Policy and the Third World Metropolis". *Journal of Development Economics*, 49(1), pp. 137-150.

KRUSELL, P.; OHANIAN, L. E.; RIOS-RULL, J. V. and VIOLANTE, G. L. (2000). "Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis". *Econometrica*, 68(5), pp. 1029-1053.

MARSHALL, A. (1920). Principles of Economics. London: Macmillan.

MEARDON, S. (2003). "Geography, Trade and Regional Disparities: The Case of the Missing Middle of Mexico". Inter-American Development Bank, Mimeo.

MELLO, M. (2008). "Skilled Labor, Unskilled Labor, and Economic Growth". *Economics Letters*, 100, pp. 428-431.

MEZA, L. (2003). "Apertura Comercial y Cambio Tecnológico. Efectos en el Mercado Laboral Mexicano". El Trimestre Económico, 70(3), pp. 457-505.

MOLLICK, A. and IBARRA-SALAZAR, J. (2013). "Productivity Effects on the Wage Premium of Mexican Maquiladoras". *Economic Development Quarterly,* 27(3), pp. 208-220.

MOLLICK, A. V. (2008). "The Rise of the Skill Premium in Mexican Maquiladoras". *Journal of Development Studies*, 44(9), pp. 1382-1404.

MONTES ROJAS, G. (2006). "Skill Premia in Mexico: Demand and Supply Factors". *Applied Economics Letters*, 13, pp. 917-924.

NIFO, A and VECCIONE, G. (2014). "Do Institutions Play a Role in Skilled Migration? The Case of Italy". *Regional Studies*, 48(10), pp. 1628-1649.

ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (OECD) (2012). Education at a Glance: OECD Indicators, Paris: OECD.

ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (OECD). (2014). Education at a Glance: OECD Indicators, Paris: OECD.

RIAÑO, A. (2009). "Trade, Technology Adoption and the Rise of the Skill Premium in Mexico". Working Paper, University of Nottingham.

ROBERTSON, R. (2000). "Trade Liberalization and Wage Inequality: Lessons from the Mexican Experience". *World Economy* 23(6), pp. 827-849.

ROBERTSON, R. (2004). "Relative Prices and Wage Inequality: Evidence From Mexico". *Journal of International Economics* 64(2), pp. 387-409.

SÁNCHEZ y SÁNCHEZ-AMAYA, M. I.; RENOBALES MOTA, I. and RASINES GARCÍA, L. A. (1994). "El camino hacia una demanda y oferta de trabajo más cualificada: Un reto permanente". *Estudios de Economía Aplicada*, 1, pp. 87-107.

SECRETARÍA DEL TRABAJO Y PREVISIÓN SOCIAL (STPS) (2012). Panorama anual del observatorio laboral mexicano, 2005 to 2012, México: STPS.

SROUR, I.; TAYMAZ, E. and VIVARELLI, M. (2013). "Skill-Biased Technological Change and Skill-Enhancing Trade in Turkey: Evidence from Longitudinal Microdata". IZA Discussion Paper Series, IZA DP No. 7320.

SÜDEKUM, J. (2008). "Convergence of the Skill Composition across German Regions". *Regional Science and Urban Economics*, 38, pp. 48-159.

TENORIO MARTÍNEZ, L. (2007). "El mercado de trabajo de profesionistas y la vinculación de los sectores educativo, productivo y gubernamental. Análisis y propuesta para México". *Redes. Revista de Estudios Sociales de la Ciencia*. 13(26), pp. 145-170.

TUIRÁN, R. and MUÑOZ, C. (2010). "La política de educación superior: trayectoria reciente y escenarios futuros". In Arnautt, R. and Giorguli, S. (coords): *Los grandes problemas de México VII. Educación*, México: El colegio de México.

UNIVERSIDAD AUTÓNOMA METROPOLITANA (UAM) (2008). Estudio de seguimiento de egresados. Generaciones 1998 y 2003, México: UAM.

VELDE, D. W. T. and XENOGIANI, T. (2007). "Foreign Direct Investment and International Skill Inequality". *Oxford Development Studies*, 35(1), pp. 83-104.

VILLARREAL, M. (2010). The Mexican economy after the global crisis. Mexico: UNT Libraries Government Documents Department.

WINDMEIJER, F. (2005). "A Finite Sample Correction for the Variance of Linear Efficient Two-Step GMM Estimators". *Journal of Econometrics.* 126(1), pp. 25-51.

WOO, G. (2001). "Hacia la integración de pequeñas y medianas empresas en la industria electrónica de Jalisco: dos casos de estudio". In Dussel Peters, E. (coord.), *Claroscuros. Integración exitosa de las pequeñas y medianas empresas en México*. México: CANACINTRA-CEPAL-Jus.

Appendix A

Database descriptive statistics
(variables in logarithms)

	ω	H	L	H/L	ω	H	L	H/L
	Total				**Social Sciences**			
Mean	0.75	11.86	13.73	0.86	0.76	10.59	13.69	0.77
Median	0.73	11.84	13.77	0.86	0.81	10.54	13.70	0.78
Maximum	1.14	13.87	15.57	0.92	1.59	12.87	15.57	0.85
Minimum	0.56	10.42	12.18	0.82	-5.74	8.41	12.18	0.68
Std. Dev.	0.10	0.80	0.76	0.02	0.65	0.86	0.76	0.03
Skewness	1.00	0.56	0.22	0.72	-8.24	0.36	0.24	-0.37
Kurtosis	4.45	3.00	2.69	3.89	77.14	3.12	2.74	3.59
	Engineering				**Medicine**			
Mean	0.87	9.11	13.71	0.66	0.87	8.51	13.72	0.62
Median	0.90	9.04	13.74	0.65	0.97	8.50	13.79	0.62
Maximum	2.51	11.87	15.57	0.83	1.56	11.19	15.57	0.80
Minimum	-7.13	6.80	12.18	0.54	-6.91	6.66	12.18	0.53
Std. Dev.	0.65	1.11	0.76	0.06	0.87	0.83	0.74	0.04
Skewness	-10.47	0.26	0.26	0.21	-7.94	0.09	0.14	0.79
Kurtosis	131.35	2.27	2.84	2.39	68.47	3.20	2.83	6.62

Source: Own estimates from database.

Appendix B

Number of professionals by scientific area in Mexico

Year	Total	Social Sciences	Engineering	Medicine	Occupied
2005	6,863,131	1,028,700	196,100	32,300	37,781,500
2010	5,938,300	2,678,100	977,100	245,600	40,879,100
Increment (%)	-13.48	160.34	398.27	660.37	8.20

Source: Own calculations from Mexican Labor Observatory.