Changes in Returns to Education in Latin America: The Role of Demand and Supply of Skills

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This version: December 2006

Using micro data for the urban areas of five Latin American countries we document trends in men's returns to education over the 1980s and 1990s, and estimate the role of supply and demand factors in explaining the changes in skill premia. Building on Card and Lemieux (2001a), we propose a model of demand for skills with three production inputs. The model allows the elasticity of substitution between the different educational inputs to be different using a nested CES function. We show that an unprecedented rise in the supply of workers with secondary school depressed their wages relative to workers with primary education throughout the continent. This supply shift was compounded by a generalized shift in the demand for workers with tertiary education. As a result, and despite adverse supply shocks, tertiary workers saw their wage premium increase.

JEL codes: J23, J24, O15

Key words: demand for skills, supply of skills, returns to education.

* We thank Daron Acemoglu, Harold Alderman, Orazio Attanasio, Indermit Gill, William Maloney, Nina Pavcnik, Guillermo Perry, Michael Walton and participants at seminars at Princeton University, the Inter-American Development Bank, the World Bank, the LAMES Conference held in Sao Paulo on July 25-27 2002, and the LACEA Conference held in Madrid on October 11-13, 2002 for useful comments. Paula Giovagnoli provided excellent research assistance. Marco Manacorda gratefully acknowledges financial support from the Nuffield Foundation (New Career Development Fellowship in the Social Sciences) and ESRC (grant no. 000-22-0131). All remaining errors are our own. Corresponding author: Marco Manacorda, CEP, LSE, Houghton Street, London WC2A 2AE, UK, ph. +44-207-9556647, fax +44-207-9557595, email: m.manacorda@lse.ac.uk.
1. Introduction

This paper uses micro data from five of the six largest Latin American economies to study the role of demand and supply of skills in shaping the returns to education over the 1980s and 1990s. Building on the model originally developed by Card and Lemieux (2001a), we show that an unprecedented rise in the supply of workers with secondary school education generally depressed their wages relative to workers with primary school only. This supply shift against secondary workers was compounded by a shift in the demand for university-educated workers, who saw their wage premium increase in spite of increases in their relative supply. Shifts in demand and supply of skills to the overall detriment of secondary school workers go a long way towards explaining trends in the wage structure in Latin America over the last two decades.

The rising wage premium for skilled workers since (at least) the 1980s is a well-documented fact in many OECD countries. In the United States, for example, Katz and Autor (1999) estimate that the real wages of high school drop-outs, the least skilled workers, fell over the 1963-1995 period (by about -4.5 percent), while the real wages of college graduates rose sharply (by about 22.4 percent). Considerable controversy exists about the extent to which the increase in the wages of skilled workers can be explained by acceleration in the demand for skill (for example, Katz and Murphy 1992; Katz and Autor 1999) or a deceleration in their relative supply (Card and Lemieux, 2001a). Authors who have emphasized the role of relative demand have analyzed the determinants of such demand changes, including the computer revolution, Heckscher-Ohlin effects of trade, or outsourcing (Wood 1994; Feenstra and Hanson 1996; Autor, Katz, and Krueger 1998; Berman, Bound, and Machin 1998; Machin and Van Reenen 1998). Those instead who believe that changes in the wage structure can largely be explained by changes in relative supply have concentrated on the deceleration in the supply of college graduates among the baby boom cohort (Card and Lemieux, 2001a, 2001b). At present, the literature is split between those who see changes in wage inequality as a largely episodic phenomenon occurring in the early 1980s (for example, Card and DiNardo, 2002), and those who see steady, and perhaps
increasing growth in demand for skilled workers, at least at the top of the distribution (for example, Katz, Autor and Kearney 2005).

The literature on changes in the wage distribution in the US has prompted a considerable amount of research documenting trends and possible determinants elsewhere in the world. A number of multi-country studies (Berman, Bound, and Machin 1998; Berman and Machin 2000a and 2000b) point to an increase in both employment and wages of skilled workers in middle and high income countries, suggesting a generalized net demand shift in their favor.

As far as Latin America goes, the existing literature has largely focused on understanding demand-side shifts in favor of skilled workers, especially those prompted by trade reforms. Many countries in the region have seen substantial increases in import penetration and Foreign Direct Investment (FDI). Trade could decrease the demand for skilled workers through Heckscher-Ohlin effects, but both trade and FDI could result in increases in the demand for skill if they stimulate companies in developing countries to adopt new technologies that are skill-biased. Behrman, Birdsall, and Szekely (2001) and Inter-American Development Bank (2002) document an increase in the wages of college graduates relative to secondary school graduates in Latin America, and argue that some of the observed changes can be explained by trade reforms. There are also a number of studies that consider the evolution of relative wages within a given country in the region. Papers based on household survey data for Colombia (Attanasio, Goldberg, and Pavcnik 2004) and Brazil (Pavcnik, Blom, Goldberg, and Schady 2004) both attribute an important role to skill-biased technological change transferred through trade. Other papers investigate the role played by technology: for example papers based on firm-level data for Chile (Pavcnik 2002) and Colombia (Kugler 2002) suggest a complementary relationship between skill-upgrading and adoption of new technology by firms. In a

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1 An important additional factor in explain changes in the wage distribution in the US is given by labor market institutions. In particular, the erosion of the real value of the minimum wage during the 1980s and its partial restoration over the 1990s is considered responsible for changes in the wage structure at the bottom of the US wage distribution (Lee 1999).
2 Blau and Khan (1996) though suggest that most of the differences in the level of inequality between the US and other developed countries is attributable to labor market institutions, namely minimum wages and centralized wage bargaining.
recent review paper on the effect of globalization on wage inequality in Latin America (and India) Goldberg and Pavcnik (2006) conclude (p. 54) that "the particular mechanisms through which globalization affected inequality are country-, time- and case-specific".

While this literature concentrates on the demand-side determinants of changes in the wage structure in Latin America, the supply of workers with different skill levels is also likely to be important. Technological progress has been accompanied by a rise in the demand for skills since at least the beginning of last century (see for example Acemoglu 2002). However, such an increase in the demand for skills does not necessarily lead to an increase in the returns to skills. The experience of early twentieth century America suggests that even in the face of skill-biased technological change favoring high–school workers, their wages deteriorated at least up to the onset of World War I, due to a rapid concurrent increase in their supply (Katz and Goldin 1999; Goldin 2001).

This paper uses micro data for five Latin American countries over the 1980s and 1990s to document trends in the returns to education, and estimate how the interplay between the demand and supply of skills shaped these returns. The countries we analyze—Argentina, Brazil, Chile, Colombia, and Mexico—are five of the six largest economies in the region, jointly accounting for 85 percent of GDP and 70 percent of population in 2000. Latin America is the most unequal region in the world. In the 1990s, the Gini coefficient, a widely-used measure of inequality, was between 15 and 19 points higher in Latin America than in North America and Western Europe (Deininger and Squire 1996; Milanovic 2002).

We document widespread erosion in the relative wages of those with intermediate levels of education (secondary school workers) relative to both high-skill (tertiary) and low-skill (primary) workers in Latin America over the last two decades. We formally attempt to assess the contribution of demand and supply changes in shaping these trends by building on the approach originally developed by Card and Lemieux (2001a) to analyze the evolution of the college-high school wage premium in the

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3 Total GDP is higher in Venezuela than in Chile.
US, UK and Canada. As in much of the literature, changes in demand are modeled parametrically as a linear trend, and changes in labor supply are taken to be exogenous. In contrast to Card and Lemieux, we derive an empirically identifiable model that includes three (as opposed to two) education labor inputs. The extension to three educational groups complicates the analysis, but provides a more thorough account of the changes in the wage structure that occurred in Latin America over this period. Wages of workers with secondary school education fell with respect to both those with tertiary and primary education, suggesting that secondary and primary school workers are not perfect substitutes in Latin America—unlike the evidence for the US, the UK, and Canada.

Our results show a generalized increase in the demand for skilled workers relative to unskilled workers. Despite adverse supply shocks in most countries, the tertiary-secondary school wage premia rose everywhere, suggesting a positive demand shift in favor of tertiary workers. Except in Mexico, secondary school workers also saw their relative wages deteriorate with respect to primary school workers. We attribute this trend to the mass movement of the population from primary to secondary school in most of these countries.

The rest of the paper proceeds as follows. In section 2, we briefly discuss our data sources and present descriptive evidence on the evolution of relative wages and the relative supply of workers with different amounts of education. In section 3 we lay out our basic model of wage determination. In this section we also discuss basic identification of the parameters of interest. Section 4 estimates the parameters of the production function and the trends in demand and supply for skills in the five countries under analysis. Section 5 concludes.

2. Data and basic trends

This section presents information on wages and labor supply for individuals with different levels of education. The data that are used are from labor force surveys for Argentina, Brazil, Chile, Colombia and Mexico. Because survey coverage varies across countries, the sample is limited to urban
areas only to ensure comparability. A detailed description of data sources and information on the criteria used to construct the sample are provided in the Data Appendix.

We construct wage and labor supply measures for three different education groups: primary (primary school), secondary (high school), and tertiary (college and above). Following Card and Lemieux (2001a) we use different samples to calculate each measure. Wage trends are based on a sample of full-time male employees, ages 27 to 57, who have exactly completed primary, secondary or tertiary education, while supply trends are based on a sample of both female and male workers with any level of education between incomplete primary and completed tertiary. For the purpose of this second calculation we attribute those with incomplete levels of education to the "nearest" education group, as described in the Data Appendix. On this basis, we obtain labor supply measures for primary-, secondary- and tertiary-educated worker "equivalents".

The wage premium is measured using relative returns to education. To calculate average returns, (log) weekly wages are regressed on age and age squared, education dummies for secondary and tertiary education, and year dummies. These estimates are reported in the first two rows of Table 1. (This and all the other data in the table refer to averages across the entire period of observation.) Returns to education are generally high, with each additional year of education being associated with a 10- to 20-percent increase in wages. There is, however, significant variation across countries. Workers with completed secondary education are paid between around 45 percent more than those with primary education in Argentina and Colombia, and 83 percent more in Brazil. Similarly, wages of tertiary-educated individuals are approximately 90 percent higher than those for workers with secondary education in Chile, but only 45 percent higher in Argentina and Mexico.

Table 1 reports averages for a number of labor supply measures, including total hours, total employment, total labor force and total population accounted for by individuals in each education group. The table also reports employment, unemployment and participation rates by education level. The patterns observed are fairly robust to the choice of supply measure. Workers with primary
education account for 50 to 60 percent of labor supply. An additional 25 to 30 percent of the labor supply has secondary school education, and the remaining 15 to 20 percent has tertiary education. The exception is Chile, where 50 percent of the labor supply has secondary education and only 30 percent has primary school education only. Employment and participation rates increase with education, while unemployment rates are highest among those with primary school and lowest for those with tertiary education.

We next examine changes in relative wages and labor supply over time. Figure 1 plots the returns to tertiary education relative to secondary, and to secondary education relative to primary, by country, during the 1980-2000 period. Returns are estimated from earnings regressions and standardized to zero at the beginning of the period. Relative returns to tertiary education increase and relative returns to secondary education decrease almost monotonically in all countries—the one exception being the increase in the return to secondary education relative to primary in Mexico. Put differently, wage differences widened at the top of the distribution and narrowed at the bottom. The magnitude of these changes, however, varies across countries. The annual increase in the relative return to tertiary education is lowest in Argentina (around 0.8 percentage points) and highest in Chile (2.1 percentage points). Similarly, the decline in the relative return to secondary education is largest in Chile (-2.7 percentage points) and smallest in Colombia (-0.8 percentage points). Note that each series appears to be the mirror image of the other, suggesting that the return to tertiary education relative to primary has remained roughly constant over time. In other words, workers with secondary education seem to have lost ground relative to both those with tertiary and primary education during this period in all countries but Mexico.

Figure 2 plots the labor supply of workers with tertiary education relative to those with secondary, and workers with secondary education relative to those with primary. We here measure labor supply as the percentage of the total population with different education levels, and standardize all series to zero at the beginning of the period. The relative supply of secondary workers increases in
all countries, with annual growth rates ranging from 3 percentage points in Mexico to about 5 percentage points for Chile and Colombia. These changes reflect widespread public efforts to increase secondary school enrollment. In contrast, the relative supply of tertiary workers varies significantly across countries. In most countries, relative supply was roughly constant during the 1980s; in the 1990s it grew in Argentina and Chile, declined slightly in Brazil and remained stable in Colombia. Mexico is the only country in the sample where the supply of workers with tertiary education increased faster than that of workers with secondary education throughout the entire period.

Taken together, Figures 1 and 2 indicate that increases in the wage premium of workers with tertiary education occurred at a time when their relative supply was fairly stable or growing. (Brazil is an exception.) Increases in relative wages that coincide with increases in relative supply are highly suggestive of demand-side changes favoring the most skilled. On the other hand, the wage premium of workers with secondary education fell as their relative supply increased in all countries but Mexico. As a result it is unclear what effect, if any, demand-side changes may have had. Further analysis is necessary to isolate changes in relative demand from changes in relative supply. In the next section we present a theoretical framework that allows us to do this.

3. Model and empirical strategy

We develop a nested model that extends that in Card and Lemieux (2001a) to allow for the treatment of three education groups: primary, secondary and tertiary. Being able to identify changes in relative demand and supply for these groups is key for the purpose of our analysis since we observe a deterioration in the relative wages of secondary workers compared to both the tertiary and primary education groups in most countries in our sample. This differs from the experience of the US, UK and Canada, where the wages of secondary and primary workers moved roughly in parallel over the last two decades of the twentieth century (Card and Lemieux, 2001a; Card 2005).
In contrast with Card and Lemieux (2001a), we allow for primary and secondary workers to be only imperfect substitutes in production, and estimate the elasticity of substitution between these two labor inputs based on the data. This parameter is then used to compute the supply of "unskilled equivalent" labor, which combines primary and secondary workers. Similarly to Card and Lemieux (2001a), we estimate the elasticity of substitution between workers of different ages and use this to estimate changes in the demand and supply of skilled and unskilled labor. Finally, a composite measure of the trend in the supply of skilled and unskilled labor together with relative wages is used to derive an estimate of the shift in the demand for skills that occurred over this period.

3.1 Theoretical model

We assume that demand is a function of the marginal productivity of labor, supply is exogenously given, and wages are determined by the interaction of a downward sloping labor demand curve and a vertical labor supply curve. The representative firm produces under constant elasticity of substitution (CES) technology and uses two labor inputs with different skill levels. For simplicity, capital is maintained in the background. Then:

\[ Y_t = A_t (N_U t^\rho + \alpha_t N_S t^\rho) \]

where \( Y \) is total output, \( A \) is skilled-neutral technological change, \( N \) is employment, \( U \) denotes unskilled labor and \( S \) skilled labor, \( t \) is time, and \( \rho < 1 \) is a function of the elasticity of substitution between these two production inputs. Denote this elasticity of substitution by \( \sigma_E \), where \( \sigma_E = 1/(1 - \rho) \). The parameter \( \alpha_t \) is a measure of the relative productivity of skilled workers relative to unskilled workers at time \( t \). \( N_U t \) is normalized to be one—an innocuous transformation that defines the units of measurement of \( A_t \).

In constructing the employment measures for each skill group we allow for differences in productivity across workers with the same level of education but with different age, and define the
employment of each skill group as a productivity-weighted CES combination of all age groups of
individuals in that skill level. That is:

\[ N_{jt} = \left( \sum \beta_{ja} N_{ja} \right)^{\delta} / \delta \]

where \( j = S, U \)

where \( a \) denotes a generic age group and \( \delta \) is a function of the elasticity of substitution between
different age groups. This elasticity of substitution, \( \sigma_a \), where \( \sigma_a = 1/(1-\delta) \), is assumed to be the same
across skill groups and for any pair of age-specific inputs. \( \beta_{ja} \) is a measure of the relative productivity
of age-group \( a \) with skill level \( j \), which is taken to be time-invariant, thereby ruling out age-biased
demand changes. Further, we assume that \( \sum \beta_{ja} = 1 \). Once again, this is an innocuous normalization that
defines the units of measurement of \( N_{Ut} \) and \( N_{St} \).

So far the model is identical to Card and Lemieux (2001a). In contrast with Card and Lemieux,
however, the model allows for the age-specific supply of unskilled labor to be a CES combination of
the two bottom education groups, primary and secondary (respectively denoted by 1 and 2), while the
skilled group (S) represents workers with tertiary education (denoted by 3, so that \( S = 3 \) and \( N_{St} = N_{Sat} \)).
This implies:

\[ \text{(3)} \quad N_{Ut} = (\gamma_a N_{1at}^{\theta} + N_{2at}^{\theta})^{1/\theta} \]

where \( \gamma_a \) is a measure of the relative productivity of primary workers relative to secondary workers and
\( \sigma_U = 1/(1-\theta) \) is the elasticity of substitution between these two groups. Note that when \( \theta = 1 \), primary and
secondary education workers are perfect substitutes, with \( \gamma_a \) being the relative efficiency of a primary
worker relative to a secondary worker and \( N_{Ut} \) expressed in secondary workers "equivalent" units. This
is effectively the model used by Card and Lemieux (2001a).

Under the assumption that labor and product markets are perfectly competitive, (1) to (3) can be
manipulated to derive expressions for the wages of individuals of age \( a \) and education level \( e = 1, 2, 3 \) at time \( t \):
where $X_t = \rho \ln (A_t) + (1-\rho) \ln (Y_t)$, $n = \ln N$, $w = \ln W$ and $W$ denotes wages.

Equations (4) to (6) constitute the basis of our empirical analysis. They illustrate that (log) wages are a function of Total Factor Productivity, represented by $X_t$, demand shifts (the $\alpha$'s and $\beta$'s), and a series of labor supply terms. The first supply term captures the effect of overall changes in the supply of a given skill group, $n_{3t} (=n_{Ht})$ and $n_{Ut}$. The coefficient on this term is a transformation of the elasticity of substitution between unskilled ($U$) and skilled ($S$) workers, $\sigma_E$. The second supply term captures changes in the age composition of each skill group, $n_{ja1t}-n_{ja1t}$. The coefficient on this term is a transformation of the elasticity of substitution between workers of different ages within each skill group, $\sigma_A$. Finally, the third supply term, which only appears in (5) and (6), represents changes in the composition of the supply of unskilled ($U$) workers within each age-time cell, $n_{ear} - n_{Uat}$. The coefficient on this term is a transformation of the elasticity of substitution between primary and secondary workers, $\sigma_U$.

3.2 Empirical strategy.

The main objective of the proposed empirical strategy is to obtain estimates of $\alpha_t$ that capture differences in relative productivity and hence relative demand between skilled and unskilled workers. This is our estimate of skill-biased technological change. The variables of interest, in turn, are a function of the parameters included in (4) to (6) above: $\sigma_E$, $\sigma_U$, $\sigma_A$ the $\beta$'s and $\gamma_a$. To estimate these parameters we follow the strategy proposed in Card and Lemieux (2001a), appropriately modified to account for the fact that our production function is modeled as a nested CES process with three
production inputs. The need to fully identify all parameters obliges us to proceed backward.

Specifically:

**Step 1** – The first step produces estimates of the elasticity of substitution between primary and secondary workers, $\sigma_U$, and the efficiency of primary workers relative to secondary workers $\gamma_a$, which can be used to construct $N_{Uat}$. Subtracting $w_{2at}$ from $w_{1at}$ using (5) and (6) one obtains:

$$w_{1at} - w_{2at} = d_a - 1/\sigma_U (n_{1at} - n_{2at})$$  \hspace{1cm} (7)

where the $d_a$'s are unrestricted age dummies to account for log relative productivity of primary to secondary workers ($ln\gamma_a$). In practice, log wage differentials between primary and secondary workers by age and time are regressed on their relative labor supply plus age dummies to obtain estimates of $\gamma_a$ and $\sigma_U$. Finally, we complete this step by taking these estimates back to (3) to compute $N_{Uat}$.

**Step 2** – The second step produces estimates of the elasticity of substitution between age groups, $\sigma_A$, and of all age-specific productivity measures, $\beta_{ja}$, that can be used to construct $N_{jt}$ ($j=S,U$). From (4) to (6) and after some manipulation, we obtain:

$$w_{eat} - w_{3at} = d_t + d_{ea} - 1/\sigma_A (n_{Uat} - n_{3at}) - 1/\sigma_U (n_{eat} - n_{Uat})$$  \hspace{1cm} (8)

where $d_{ea}$ represent unrestricted age-education effects and $d_t$ represent unrestricted time effects. In particular $d_{2a} = ln\beta_{3a} - ln\beta_{2a}$, $d_{1a} = d_{2a} + ln\gamma_a$ and $d_t = -ln\alpha_t - (1/\sigma_E - 1/\sigma_A)(n_{Ut} - n_{3t})$.

This exercise produces an estimate for $\sigma_A$ (plus a new estimate of $\sigma_U$) which can then be plugged back into (5) and (6) to obtain:

$$w_{3at} + 1/\sigma_A n_{3at} = d_{3t} + ln\beta_{3a}$$  \hspace{1cm} (9)

$$w_{2at} + 1/\sigma_A n_{Uat} + 1/\sigma_U (n_{2at} - n_{Uat}) = d_{Ut} + ln\beta_{Ua}$$  \hspace{1cm} (10)

$$w_{1at} + 1/\sigma_A n_{Uat} + 1/\sigma_U (n_{1at} - n_{Uat}) - ln\gamma_a = d_{Ut} + ln\beta_{Ua}$$  \hspace{1cm} (11)

where the left-hand side of the equation represents (log) wages corrected for labor supply, $d_{3t} = X_t + ln\alpha_t - (1/\sigma_E - 1/\sigma_A) n_{3t}$ and $d_{Ut} = X_t - (1/\sigma_E - 1/\sigma_A) n_{Ut}$. In practice, the adjusted (log) wages are regressed on skill ($j=S, U$) dummies interacted with age dummies to produce the estimated age effects $\beta_{ja}$.
Finally, we complete this step by taking these estimates back to (2) together with $\sigma_A$ to construct $N_{St}$ and $N_{Ut}$.

**Step 3** – The third and final step produces an estimate of the elasticity of substitution between skilled and unskilled workers, $\sigma_E$. From (4) to (6) and assuming that the relative demand for skilled versus unskilled workers follows a linear trend over time (i.e. $\ln \alpha_t = f_0 + f_1 t$), we obtain:

\[
(12) \quad w_{eat} - w_{3et} = f_0 + f_1 t + d_e - 1/\sigma_E (n_{Ut} - n_{3t}) - 1/\sigma_A (n_{Ut} - n_{3t}) - 1/\sigma_U (n_{Ut} - n_{3t}) - 1/\sigma_A (n_{Ut} - n_{3t}) - 1/\sigma_U (n_{Ut} - n_{3t})
\]

where the left-hand side of the equation represents (log) wage differentials of secondary and primary workers relative to tertiary (skilled) workers, and the coefficient $f_1$ captures skill-biased technological change. The coefficient on the first labor supply term provides an estimate of $\sigma_E$. The coefficients on the other terms provide new estimates of $\sigma_A$ and $\sigma_U$.

4. Results

In this section we implement the empirical strategy described in section 3 using the wage and labor supply data described in section 2. We present both regression results and graphs that illustrate the different sources of variation in the data.

Individuals are grouped into three-year birth cohorts. The technical appendix describes in detail how wage and supply differentials are computed based on the micro data and how the aggregation into cells is performed. To improve the precision of the estimates, data from all five countries are pooled together, restricting $\sigma_E$, $\sigma_A$ and $\sigma_U$ (but not the $\gamma$'s, the $\beta_{ja}$'s and $f_1$) to be the same across all countries. We consider four labor supply measures: total population, labor force employment and hours worked. Hours worked and employment are commonly used in the literature for developed countries (Katz and

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4 We closely follow Card and Lemieux (2001a) to compute these differentials. In order to calculate labor supply we pool men and women. Results (available upon request) that use males only are very similar but slightly less precise. Using information on both female and male workers to construct supply measures is legitimate if male and women are substitutes in the production function—i.e. an increase in female labor supply has the same impact on wages of male workers as a similar increase in male labor supply.
Murphy, 1992; Card and Lemieux, 2001a). These measures are adequate if labor supply is exogenous, so that the labor supply curve is completely inelastic with respect to wages. However, in countries with high unemployment, including some of the countries in our sample, this assumption may not be realistic. Under these circumstances, labor force participation, or even total population if participation is endogenously determined, can be better measures of labor supply.5

**Step 1** – From equation (7), wage differentials between primary and secondary education workers by age and time \((w_{1at} - w_{2at})\) depend on unrestricted age dummies plus the measure of their relative supply \((n_{1at} - n_{2at})\); the coefficient on this last variable is the inverse of the elasticity of substitution between primary and secondary workers, \(\sigma_U\). The age dummies provide a measure of the relative efficiency of primary versus secondary workers. Since there is strong evidence in the data of a dramatic change in the wage structure in Mexico following the implementation of NAFTA, this and the following regressions include unrestricted year-age-education interaction dummies for Mexico post 1993.6

Results are presented in Table 2. To account for the fact that relative wages by cell are computed on samples of different sizes, and hence vary in their precision, all regressions are weighted by the inverse of the sampling variance of the dependent variable (see the Data Appendix). Estimates of \(\sigma_U\) are remarkably similar across specifications. The coefficient on (log) relative labor supply is negative and statistically significant, approximately -0.350 (s.e. 0.024). This implies that the estimated value of the elasticity of substitution between primary and secondary workers is 2.29 (=1/0.350).

Figure 3 shows that the model fits the data remarkably well. The figure plots the residuals of log wage differentials \((w_{1at} - w_{2at})\) from a regression on country-age interaction dummies on the vertical axis, and the residuals of log relative supply \((n_{1at} - n_{2at})\) from a comparable regression on country-age

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5 In which case, though, the estimated coefficients, despite being consistent, are a combination of labor supply and labor demand parameters.

6 Results are essentially unchanged if we exclude Mexico from the sample. Indeed the additional controls for Mexico post 1993 imply that Mexico does not really contribute to the identification of the regression parameters.
interaction dummies on the horizontal axis. Labor supply in this figure is defined in terms of hours, as in column (4) of Table 2. The figure also includes the GLS regression line. Each graph refers to a separate country, while the last graph pools observations from all countries. There is clear evidence of a negative relationship between the relative wages of primary and secondary workers and their relative employment across all countries; results do not appear to be driven by specific observations or countries.

**Step 2** – The estimated values of $\sigma_U$ and the $\gamma_a$'s are next used to obtain estimates of $N_{Uat}$ based on equation (3). This consists of estimating equation (8) to obtain the elasticity of substitution between different age groups, $\sigma_a$, plus new estimates of $\sigma_U$. For this purpose, the log wage of secondary and primary workers relative to tertiary workers ($\log(w_{at} - w_{3at})$) is regressed on unrestricted country-time interaction dummies; country-age-education interaction dummies; the supply of unskilled relative to skilled (i.e. tertiary) workers, by age and time, ($n_{Uat} - n_{3at}$), which are computed using the estimated $\sigma_U$ and $\gamma_a$ from step 1; and the relative labor supply of each unskilled labor input relative to the overall supply of unskilled workers ($n_{ear} - n_{Uat}$). The coefficient on the first labor supply term provides an estimate of $\sigma_a$, while the coefficient on the second supply term provides a new estimate of $\sigma_U$. Results are reported in Table 3, again for the four different labor supply measures. The first row reports the estimate of $-1/\sigma_a$ and the second row the estimate of $-1/\sigma_U$. We find evidence that the age-specific labor inputs are perfect substitutes. The coefficient in row 1 of Table 3 is either zero or very small in magnitude (when hours are used). In any case, the estimates are not significant at conventional levels. In contrast to what has been found in the US, UK and Canada (where this elasticity is estimated to be on the order of 5), it appears that different age inputs are close to being perfect substitutes in production in Latin America.

This can also be seen in Figure 4, which summarizes the regression-adjusted correlation between wages by age and time of primary and secondary workers relative to skilled workers. These
are obtained as residuals from regressions of relative wages and relative employment \((w_{ear}, w_{3at}, \text{and } n_{ear}, n_{3at})\) on country-year interaction dummies and country-age-education interaction dummies. The figure clearly shows that relative wages remain essentially constant as relative supply varies.

Estimates of the coefficient \(1/\sigma_U\) in row 2 of Table 3 are similar to the ones found in Table 2, providing an internal consistency check. We use these estimated coefficients to obtain estimates of the \(\beta_{ja}\) based on equations (9) to (11) (regressions not reported). These estimated values and the elasticity of substitution \(\sigma_d\) are then used to compute \(N_{jt}\), based on equation (2).

**Step 3** – Finally, we turn to the estimation of equation (12) to obtain the elasticity of substitution between skilled \((S)\) and unskilled \((U)\) workers, \(\sigma_E\), and a measure of skill-biased technological change, \(\ln \alpha_t\). Results are presented in Table 4. The first row reports the coefficient on the log relative labor supply of skilled versus unskilled workers, \(-1/\sigma_E\). Unlike the previous steps, the magnitude of the estimated coefficient is somewhat sensitive to the choice of labor supply measure, although the sign remains unaltered. The coefficient varies between -0.194 (s.e. 0.121) for labor force participation and -0.390 (s.e. 0.108) for hours worked. As a result, the estimated elasticity of substitution between skilled and unskilled workers ranges from 2.56 (=1/0.390) to 5.15 (=1/0.194). The value found when supply is defined in terms of hours is very similar to existing estimates for the elasticity of substitution between skilled (tertiary) versus unskilled (secondary and below) workers in the US. Estimates of the elasticity of substitution across age groups, \(\sigma_{A}\), and the elasticity of substitution between primary and secondary workers, \(\sigma_E\), are similar in Tables 2 and 3, suggesting that the proposed empirical strategy is internally consistent.

The lower part of Table 4 presents the coefficients for the country-specific linear trends, which estimate the demand for skilled workers relative to unskilled workers \((-f_{jt})\). The coefficients again vary across specifications. When population is used as a measure of labor supply we find evidence of an increase in the demand for skilled workers relative to unskilled workers in all countries analyzed.
Coefficients vary in magnitude across countries—in particular, they are higher in Mexico (0.035) than in Brazil, Argentina and Colombia (where they range from 0.004 to 0.008). The estimate for Chile (0.017) is similar to that in Card and Lemieux (2001a) for the US, Canada, and the UK. Overall we find a clear indication of a rise in demand for skilled workers. When other measures of labor supply are used in columns 2 to 4, results remain essentially unchanged, although for Brazil they are no longer significant.  

Figure 5, finally, shows the time-series correlation between relative wages and relative labor supply of unskilled to skilled workers. To obtain these series we regressed relative wages of skilled to unskilled workers by age and time \((w_{at}-w_{3at})\) on a country-specific linear time trend, \(t\), country-age-education interaction dummies, the supply of unskilled workers by age and time relative to skilled workers, standardized to the overall relative supply by time \((n_{Uat}-n_{3at})\), and the relative labor supply of primary and secondary workers relative to the overall supply of unskilled labor \((n_{sat}-n_{Uat})\) (see equation (12)). The residuals from these regression are averaged across age groups using the same weights used in the regressions; these average residuals are plotted on the vertical axis. We proceed in a comparable fashion for the relative supply of unskilled to skilled workers \((n_{Uat}-n_{3at})\); these residuals are then plotted on the horizontal axis. The sample is split into three sub-periods 1981-1986 (denoted by 83), 1987-1993 (denoted by 90) and 1994-1999 (denoted by 97).

Figure 5 shows a negative correlation between wages and the supply of skilled to unskilled workers. (The figure is based on hours of work as a measure of labor supply.) Broadly speaking, observations for the early 80s and late 80s-early 90s are located around the origin or to southeast of it, while observations for the late 90s are to the northwest of it. This suggests that the growth in the

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7 Some caution should be exercised in drawing conclusions for Mexico. Although here we find the strongest rise in demand for skills, data on Mexico on their own are unlikely to warrant identification of the model since relative supply by education varies linearly over time, with no possibility of identifying this separately from changes in demand. Effectively in our analysis we have used estimates of the elasticity of substitution between different education groups largely coming from the other countries to identify the trends in demand that occurred in Mexico.
relative supply of skilled versus unskilled labor tended to accelerate in the late 1990s while relative wages tended to decelerate.\textsuperscript{8}

5. Conclusion

In this paper we use micro data from the urban areas of five Latin American countries over the 1980s and 1990s to document trends in men's returns to education, and to estimate the magnitude of demand and supply shifts that affected the wages of three broad educational groups, corresponding to workers with primary school, secondary school, and tertiary education. The analysis is based on a nested CES model with three educational inputs. This model allows for different elasticities of substitution across educational groups, takes into account the fact that workers of different age are potentially imperfect substitutes in production, and allows for a trend in the relative productivity of skilled versus unskilled workers.

In contrast with results for the US, UK and Canada, we find that primary and secondary workers are only imperfect substitutes in production in Latin America. We estimate the elasticity of substitution between these two labor inputs to be on the order of 3. This explains why, as the share of workers with secondary education rose, their relative wages deteriorated sharply relative to those of workers with primary education only. We also find an infinitely high degree of substitution between workers of different ages (within each skill group) in Latin America.

We build on these estimates to assess the role played by changes in the demand and supply of skills in shaping returns to education in Latin America. Our estimates of the elasticity of substitution between skilled and unskilled workers in Latin America range between 2.5 and 5, depending on the measure of labor supply used. In a similar fashion to findings for the US, UK, and Canada, our results suggest a generalized increase in the demand for skilled workers. This was only partly compensated by an increase in relative supply, so that skill premia increased throughout the continent.

\textsuperscript{8} Recall that the regressions condition on a linear time trend, so only variations around this trend can be identified.
Like much of the literature on changes in the wage structure in the US, the paper remains agnostic on a number of issues that certainly deserve further consideration. We do not investigate the determinants of the demand changes that occurred in Latin America, and in particular we do not attempt to understand whether these demand changes were driven by skill-biased technological change, trade penetration, FDI flows, or other factors. Similarly, we ignore the role of institutions. Both of these might have played a role in shaping the observed returns to education, and deserve further research. Despite these caveats, our analysis shows that shifts in demand and supply of skills to the overall detriment of secondary school workers go a long way in explaining trends in the wage structure in Latin America over the last two decades.
References


---------- 2000b. "Skill-Biased Technology Transfer: Evidence of Factor Biased Technological Change in Developing Countries." Boston University and London School of Economics.


Hanson, Gordon H. and Ann Harrison. 1999. "Trade Liberalization and Wage Inequality in Mexico."


Pavcnik, Nina and Pinelopi Goldberg. 2005 "Distributional Effects of Trade Liberalization in Developing Countries, mimeo, Department of Economics, Dartmouth College.
Data Appendix

The Data used in this paper come from the individual records of five roughly consistent national household surveys. Data refer to urban areas only. Data for Argentina are based on the Enceusta Continua de Hogares (ECH) and refer only to Greater Buenos Aires, since information for provinces other than Buenos Aires is not available in the 1980s. Each year we include both the March and October survey in order to maintain a reasonable sample size. Data for Brazil are based on the Pesquisa Nacional De Amostra de Domicilios (PNAD). We restrict the sample to areas classified as "metropolitan" in the survey. Chilean data are based on the Encuesta de Ocupación y Desocupación de la Universidad de Chile (EOD), and only refer to Santiago. Data for Colombia are based on the Encuesta Nacional de Hogares (ENH), while those for Mexico are based on the Encuesta Nacional de Empleo Urbano (ENEU). For Mexico we limit the sample to municipalities that are sampled each year throughout the survey period. For both Colombia and Mexico we append data from the different rounds of a survey within a year, treating multiple surveys as a single survey. Because the Mexican data have a component of rotating panel, whereby a new sample enters each quarter and stays in the sample for five consecutive quarters, we restrict the sample for our analysis to observations in the third quarter of each year and exclude individuals who have remained in the sample for more than four waves.

As a first step, for each country we have identified the years of education necessary to achieve exactly completed primary school, completed secondary school and completed tertiary education. In order to maintain reasonable sample sizes, tertiary education includes all formal post-secondary schooling, regardless of whether this was acquired in university or technical schools. Table A1 reports this information.

As a second step, and in a manner similar to Card and Lemieux (2001a), we construct two samples for each country: a wage sample and a labor supply sample. The wage sample includes exclusively male full-time (at least 20 hours of work a week) employees, aged 26-56 with exactly
completed levels of education (primary school, secondary school, tertiary). We restrict the sample to all workers who are salaried employees, i.e. all wage and salary earners, regardless of whether they are in the formal or informal sectors. For all individuals in this wage sample, we construct a consistent measure of weekly wages, obtained as monthly labor income in the main job divided by usual weekly hours of work. We drop from this sample individuals with wages below the 1st percentile or above the 99th percentile of the year-specific wage distribution, those with missing wages, and those with missing years of education.

The labor supply sample includes all individuals in the data aged 26-56. In order to obtain measures of labor supply for primary school, secondary school, and tertiary equivalents we proceed as follows. Workers with more than completed university (i.e. more than completed undergraduate, or college) education are included in the tertiary category with their supply re-weighted by their wage relative to exactly completed college graduates. For example, if those with more than a college degree earn 20 percent more than college graduates, on average, they count as 1.20 times a college worker. Similarly, workers with less than primary school are included in the primary school category with their labor supply weighted by their wage relative to primary school graduates. Workers with incomplete tertiary education are split between the secondary and tertiary categories on the basis of the distance between their wage and the wage of those with exactly completed college and exactly completed secondary. For example, if the difference in wages between those with some college and those with exactly secondary school is 30 percent of the difference in wages between those with exactly a college degree and those with exactly a secondary school degree, we attribute 30 percent of those with some college to the secondary school group and the residual 70 percent to the tertiary group. We proceed in a comparable fashion for secondary school dropouts, i.e. we split them between those with exactly completed secondary school and exactly completed primary school. The only exception is Chile, where secondary school dropouts earn less on average than those with exactly completed primary school. In
In this case, we assign these individuals entirely to the primary school group. In order to compute these weights we use average relative wages over the whole period of observation.

Information on the yearly size of the wage and supply sample is presented in the last two columns of table A1. The table shows wide variation across countries in sample sizes. The largest surveys are carried out in Brazil (with samples of about 60,000 observations per year), and Mexico (about 50,000); sample sizes are much smaller in Argentina and Chile (about 5,000 each). Colombia displays an intermediate sample size (about 28,000).

When we perform our regression analysis we group individuals into three-year X time X cohort cells. For each country the three-year cells are centered on the following mid points (where data are available): 1981, 1984, 1987, 1990, 1994, 1996, 1999. Similarly, we define three-year birth-cohort cells with midpoints ranging from 1927 to 1972. Age is defined as the difference between these new artificial year and cohort variables. In order to obtain log wage differentials by cell we regress individual log wages for each cell on two education dummies, corresponding to secondary and tertiary education, and a linear term in age. The differentials are the coefficients on these two education dummies. We use the standard errors of these estimated coefficients as a measure of their precision. In particular, when we run regressions we weight each sample by the reciprocal of the square of its standard error. In order to give the same weight to different countries we standardize these weights to the total sum of weights in each country.
Table 1
Wages and Labor Supply by Education

<table>
<thead>
<tr>
<th>Returns to education</th>
<th>Argentina</th>
<th>Brazil</th>
<th>Chile</th>
<th>Colombia</th>
<th>Mexico</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary-Primary</td>
<td>0.479</td>
<td>0.834</td>
<td>0.636</td>
<td>0.470</td>
<td>0.575</td>
</tr>
<tr>
<td>Tertiary-Secondary</td>
<td>0.448</td>
<td>0.837</td>
<td>0.896</td>
<td>0.701</td>
<td>0.474</td>
</tr>
<tr>
<td>% Hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.519</td>
<td>0.614</td>
<td>0.312</td>
<td>0.536</td>
<td>0.538</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.282</td>
<td>0.244</td>
<td>0.489</td>
<td>0.300</td>
<td>0.275</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.198</td>
<td>0.142</td>
<td>0.199</td>
<td>0.163</td>
<td>0.187</td>
</tr>
<tr>
<td>% Employment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.513</td>
<td>0.592</td>
<td>0.309</td>
<td>0.523</td>
<td>0.53</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.281</td>
<td>0.252</td>
<td>0.482</td>
<td>0.303</td>
<td>0.277</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.199</td>
<td>0.154</td>
<td>0.199</td>
<td>0.174</td>
<td>0.193</td>
</tr>
<tr>
<td>% Labor force</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.522</td>
<td>0.595</td>
<td>0.319</td>
<td>0.527</td>
<td>0.529</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.279</td>
<td>0.251</td>
<td>0.482</td>
<td>0.303</td>
<td>0.278</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.199</td>
<td>0.154</td>
<td>0.199</td>
<td>0.170</td>
<td>0.193</td>
</tr>
<tr>
<td>% Population</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.557</td>
<td>0.635</td>
<td>0.352</td>
<td>0.569</td>
<td>0.571</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.277</td>
<td>0.240</td>
<td>0.492</td>
<td>0.293</td>
<td>0.283</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.166</td>
<td>0.126</td>
<td>0.157</td>
<td>0.137</td>
<td>0.146</td>
</tr>
<tr>
<td>Employment to population rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.608</td>
<td>0.655</td>
<td>0.561</td>
<td>0.634</td>
<td>0.570</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.668</td>
<td>0.734</td>
<td>0.626</td>
<td>0.712</td>
<td>0.603</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.817</td>
<td>0.882</td>
<td>0.849</td>
<td>0.876</td>
<td>0.814</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.086</td>
<td>0.053</td>
<td>0.109</td>
<td>0.082</td>
<td>0.021</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.063</td>
<td>0.052</td>
<td>0.080</td>
<td>0.079</td>
<td>0.024</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.042</td>
<td>0.024</td>
<td>0.035</td>
<td>0.051</td>
<td>0.024</td>
</tr>
<tr>
<td>Participation rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.665</td>
<td>0.691</td>
<td>0.629</td>
<td>0.691</td>
<td>0.582</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.713</td>
<td>0.774</td>
<td>0.681</td>
<td>0.773</td>
<td>0.618</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.853</td>
<td>0.903</td>
<td>0.880</td>
<td>0.923</td>
<td>0.834</td>
</tr>
</tbody>
</table>

Notes. The table reports basic statistics on relative wages by education and the distribution of labor supply by education in the five countries under analysis. The first two rows report time averages of log wage differentials between workers with secondary school and primary school, and workers with tertiary education and secondary education, respectively. Coefficients are conditional on a quadratic in age and year dummies, and refer to male full-time employees with exactly completed primary, secondary or tertiary education. The following rows report the time averages of the distribution of hours, work, employment, labor force and population in terms of education equivalents (primary, secondary and tertiary). Data on supply are obtained pooling all individuals (males plus females) in the sample irrespective of whether they have exactly completed primary, secondary and tertiary education or not. For data sources and definitions see the Appendix.
Table 2
First Step Estimates
Dependent Variable: Relative Wages by age and time
Primary Relative to Secondary Workers

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure of Supply</td>
<td>Population</td>
<td>Labor Force</td>
<td>Employment</td>
<td>Hours</td>
</tr>
<tr>
<td>(-1/\sigma_u)</td>
<td>-0.350***</td>
<td>-0.352***</td>
<td>-0.350***</td>
<td>-0.325***</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.024)</td>
<td>(0.024)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Observations</td>
<td>248</td>
<td>248</td>
<td>248</td>
<td>248</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.84</td>
<td>0.83</td>
<td>0.83</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Notes: the table reports the GLS estimates of equation (7) in the text. The reported coefficient is the negative of the inverse of the elasticity of substitution between primary and secondary workers. Regressions are weighted by the inverse of the sampling variance of the dependent variable. *: significant at 10% level, **: significant at 5% level, ***: significant at 1% level. Each column refers to a different measure of labor supply as reported in the top row.
Table 3  
Second Step Estimates  
Dependent Variable: Relative Wages by age and time  
Primary and Secondary Workers Relative to Tertiary Workers

<table>
<thead>
<tr>
<th></th>
<th>Measure of Supply</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Population</td>
<td>Labor Force</td>
<td>Employment</td>
<td>Hours</td>
</tr>
<tr>
<td>(-1/\sigma_a)</td>
<td>-0.002</td>
<td>0.004</td>
<td>-0.006</td>
<td>-0.024</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.041)</td>
<td>(0.042)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>(-1/\sigma_u)</td>
<td>-0.367***</td>
<td>-0.369***</td>
<td>-0.366***</td>
<td>-0.342***</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.037)</td>
<td>(0.037)</td>
<td>(0.035)</td>
</tr>
</tbody>
</table>

Observations 496 496 496 496  
Adjusted R-squared 0.96 0.96 0.96 0.96

Notes: the table reports the GLS estimates of equation (8) in the text. The coefficient in the first row is the negative of the inverse of the elasticity of substitution between workers of different ages. The second row reports the same coefficient as in Table 2. See also notes to Table 2.
Table 4
Third Step Estimates
Dependent Variable: Relative Wages by age and time
Primary and Secondary Workers Relative to Tertiary Workers

<table>
<thead>
<tr>
<th>Measure of Supply</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>-0.222**</td>
<td>-0.194</td>
<td>-0.334***</td>
<td>-0.390***</td>
</tr>
<tr>
<td>Labor Force</td>
<td>(0.106)</td>
<td>(0.121)</td>
<td>(0.114)</td>
<td>(0.108)</td>
</tr>
<tr>
<td>Employment Hours</td>
<td>-0.061</td>
<td>-0.061</td>
<td>-0.056</td>
<td>-0.073</td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
<td>(0.045)</td>
<td>(0.046)</td>
<td>(0.046)</td>
</tr>
<tr>
<td>Tertiary Workers</td>
<td>-0.348***</td>
<td>-0.349***</td>
<td>-0.347***</td>
<td>-0.325***</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.042)</td>
<td>(0.041)</td>
<td>(0.039)</td>
</tr>
</tbody>
</table>

Trends in demand
Skilled - Unskilled

<table>
<thead>
<tr>
<th>Country</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>0.006*</td>
<td>0.004</td>
<td>0.006*</td>
<td>0.007**</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.004**</td>
<td>0.003</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Chile</td>
<td>0.017***</td>
<td>0.015***</td>
<td>0.017***</td>
<td>0.018***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Colombia</td>
<td>0.008***</td>
<td>0.007***</td>
<td>0.008***</td>
<td>0.008***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Mexico</td>
<td>0.035***</td>
<td>0.032**</td>
<td>0.037***</td>
<td>0.040***</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.013)</td>
</tr>
</tbody>
</table>

Observations 496 496 496 496
Adjusted R-squared 0.94 0.94 0.94 0.94

Notes: the table reports the GLS estimates of equation (12) in the text. The coefficient in the first row is the negative of the inverse of the elasticity of substitution between skilled and unskilled labor. The second and third row reports the same coefficients as in table 3. The following rows reports country-specific trends in the relative demand for skilled labor. See also notes to Table 2.
<table>
<thead>
<tr>
<th>Country</th>
<th>Source</th>
<th>Years of education corresponding to completed levels of education</th>
<th>Period</th>
<th>Average yearly sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Prim.</td>
<td>Sec.</td>
<td>Tert.</td>
</tr>
<tr>
<td>Argentina</td>
<td>Encuesta Continua de Hogares (Greater Buenos Aires)</td>
<td>7</td>
<td>12</td>
<td>15-18</td>
</tr>
<tr>
<td>Brazil</td>
<td>Pesquisa Nacional De Amostra de Domicilios</td>
<td>4</td>
<td>11</td>
<td>14-15</td>
</tr>
<tr>
<td>Chile</td>
<td>Encuesta de Ocupación y Desocupación de la Universidad de Chile</td>
<td>6</td>
<td>12</td>
<td>15-17</td>
</tr>
<tr>
<td>Colombia</td>
<td>Encuesta Nacional de Hogares</td>
<td>5</td>
<td>11</td>
<td>14-16</td>
</tr>
<tr>
<td>Mexico</td>
<td>Encuesta Nacional de Empleo Urbano</td>
<td>6</td>
<td>12</td>
<td>15-17</td>
</tr>
</tbody>
</table>

<sup>a</sup> Data are not available in 1991 and 1994.
<sup>b</sup> Data are not available in 1991.
Figure 1
The Evolution of Returns to Education in five Latin American Countries

Notes: the Figure reports the wage returns to tertiary versus secondary school workers (dashed line) and secondary versus primary school workers (solid line) by year, for male full-time employees in each country. The series are obtained from year-and country-specific regressions of log wages on a constant, a dummy equal one if the individual has at least completed secondary education, a dummy equal one if the individual has at least completed tertiary education, age and age squared. The series in the figure are the coefficients on the two educational dummies. All series are standardized to the first year of observation and are smoothed using a three year moving average.
Figure 2
The Evolution of Relative Labor Supply by Education in five Latin American Countries

Notes: the Figure reports the relative supply of workers with tertiary education versus secondary education (dashed line) and secondary education versus primary education (solid line) by time in each country. See text for details.
Notes: the Figure shows the fit of equation (7) in the text. See text for details.
Figure 4
Second Step Estimates
Regression-Adjusted Relative Wages and Relative Supply by Age and Time
Primary and Secondary Workers Relative to Tertiary Workers

Notes: the Figure shows the fit of equation (8) in the text. See text for details.
Figure 5
Third Step Estimates
Regression Adjusted Relative Wages and Relative Supply by Time
Unskilled Relative to Skilled Workers

Notes: the Figure shows the fit of equation (12) in the text. See text for details.