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**SKILL PREMIUM IN CHILE: STUDYING THE SKILL
BIAS TECHNICAL CHANGE HYPOTHESIS IN THE
SOUTH**

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SKILL PREMIUM IN CHILE: STUDYING THE SKILL BIAS TECHNICAL CHANGE HYPOTHESIS IN THE SOUTH

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Resumen

La evolución de la diferencia entre los sueldos que reciben los trabajadores calificados y no-calificados es interesante de analizar desde, al menos, dos perspectivas: (i) esta variable mide de modo grueso la desigualdad salarial entre trabajadores de diferentes niveles de calificación y (ii) esta variable entrega información sobre las características del proceso de desarrollo de un país. Este trabajo presenta un estudio empírico de la evolución de las diferencias salariales entre trabajadores calificados y no calificados en Chile durante los últimos 40 años. Las diferencias salariales presentan algunas fluctuaciones durante los 1960s y 1970s y aumentan significativamente durante los 1980s, para finalmente estabilizarse en los 1990s. Una descomposición simple sugiere que detrás de evolución se observa un fuerte aumento en la demanda relativa por trabajo calificado en los 1980s y 1990s, y un significativo aumento de la oferta relativa de trabajo en los 1990s. Estos resultados se explican en el contexto de un modelo de cambio tecnológico endógeno (Acemoglu, 2003a) donde las tecnologías son producidas en países desarrollados (como Estados Unidos) y adoptadas por países en desarrollo (como Chile). Este trabajo presenta evidencia macroeconómica de series de tiempo y microeconómica sectorial para Chile que confirma la principal predicción teórica del modelo: una correlación positiva entre los patrones de cambio tecnológico en Chile y en los Estados Unidos.

Abstract

The evolution of the skill premium (i.e., the wage differential between skilled and unskilled workers) in an economy has interest from at least two perspectives: the evolution of the skill premium is a rough measure of inequality among workers of different qualifications and provides information on the characteristics of the development process of the economy. In this paper, I investigate empirically the evolution of the skill premium in Chile over the last 40 years. After some fluctuations in the 1960s and 1970s, the skill premium increased in the 1980s and has remained roughly constant since then. A simple accounting framework suggests that this evolution is an outcome of a significant increase in relative demand for skilled workers in the 1980s and 1990s and a sizeable increase in the relative supply in the 1990s. Next, I explain the evolution of the relative demand for skilled labor in Chile in the context of the Acemoglu (2003a) model of endogenous technological choice where new technologies are produced in developed countries (like the US) and adopted in developing economies (like Chile). Macro evidence and sectoral evidence confirm the main theoretical prediction of the model: patterns of skill upgrading in Chile have followed the evolution of the same variable in the US.

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1 INTRODUCTION

The evolution of the skill premium (i.e., the wage differential between skilled and unskilled workers) in an economy has interest from at least two perspectives. First, the skill premium is a rough measure of inequality among workers of different qualifications. Second, the evolution of the skill premium provides information on the characteristics of the development process of the economy.

A large body of the literature has analyzed the evolution of the skill premium in developed and developing economies. In the case of developed economies, the literature tends to emphasize the role of skill-biased technical (SBTC) change as a driving force of the evolution of the skill premium (e.g. see Acemoglu, 2002a). In the case of developing economies, the emphasis is more related to the effect of reforms such as trade openness on wage differentials, albeit the results are not uncontroversial (e.g., see Attanasio et al., 2004). Some papers have tried to relate both literatures. Theoretically, in a context where only developed countries produce new technologies, Acemoglu (2003a) shows that the skill premium in developing economies –which adopt new technologies created in developed countries–should be correlated with the skill premium in developed economies, controlling for the relative supply of skilled and unskilled workers in developing countries. Interestingly, Berman et al. (1998) and Berman and Machin (2000) report positive correlations between measures of skill upgrading in high and middle income countries for the manufacturing sector in the 1970s and 1980s.¹

In this paper, I extend this line of research in three dimensions: (i) I explicitly study the correlation between the wage premium and skill upgrading in a developed country (the US) and a developing country (Chile) using macro time series, (ii) I extend the analysis to include sectors outside manufacturing and data from 1960 to 2000, and to use a unique panel data set which allows me to control for time and sector specific effects, and (iii) I study empirically the implication of the Acemoglu (2003a) model that trade openness in the US should affect skill upgrading both in the US and in Chile.

Chile is a particularly interesting case of study because it corresponds to a small open economy that has undergone a significant change in its economic structure over the last 40 years. Starting in the mid 1970s, a process of economic liberalization has been implemented. At the same time, I estimate in this paper that the skill premium has increased significantly from about 82 log points in the 1960s to an average of 120 and 123 log points in the 1980s and 1990s, respectively. In turn, the relative supply of skilled

¹While most correlations in Berman and Machin (2000) are positive the correlations are statistically significant only for about 10% of the countries.

workers has increased significantly over the last forty years. The ratio of college graduate equivalents to high-school graduate equivalents (my basic measure of the relative supply of skilled workers) has increased from 0.14 in the 1960s to 0.21 and 0.31 over the 1980s and the 1990s, respectively. This suggests that the relative demand for skilled workers has increased significantly in the latter period.

The finding that changes in the relative demand for skilled labor are important leaves open the question of what factors explain the recent evolution of the skill premium in the Chilean economy. In this paper, I provide macro and sectoral evidence of a close relationship between patterns of skill upgrading in the US and Chile. As predicted by a simple model of skill upgrading along the lines of Acemoglu (2003a), macro time-series regressions imply that a proxy for the relative demand for skilled labor in Chile is significantly correlated with skill premium and trade openness in the US, after controlling for the traditional determinants presented in the literature. In turn, the sectoral evidence presents the same conclusion: skill upgrading in Chile is correlated with skill upgrading in the US, after controlling for sector and time effects. The sectoral evidence also suggests that this effect is relatively stronger in the tradable sectors especially in the period of economic liberalization (post 1975). The data I use do not provide a clear answer of what component of liberalization explains this correlation: including proxies for trade openness and FDI penetration does not capture the change in the correlation in the period after 1975. Further research using more detailed data and more countries should address this point.

The related empirical literature includes several studies for Chile and other developing countries. For the case of Chile,² Robbins (1994a) argues that the increase in the relative demand for skilled workers is related to trade openness and, in particular, to technology transfers from abroad, which is also emphasized by Pavcnik (2000) and Sánchez-Páramo and Schady (2002). The idea being that a more open economy creates incentives for firms to adapt new technologies, which are skill-biased. The basic finding of this literature is a correlation between variables such as imports of capital goods or the FDI stock and skill upgrading (typically measured as the share of the wage bill that goes to skilled labor) at the micro level.

Some evidence, however, contradicts these explanations. First, Robbins (1994a) focuses the analysis on the 1975-1990 period, but the big increase in the relative demand for skilled workers takes place only since the mid 1980s, while trade openness increases significantly in the 1970s. Second, the evidence on the role of technology transfer has

²Recent papers for other Latin American countries include Bustos (2005) and Galiani and Sanguinetti (2003) for Argentina, Attanasio et al. (2004) for Colombia, and Pavcnik et al. (2004) for Brazil.

no clear causal interpretation. It may well be the case that some sectors have a higher demand for skilled workers and for equipment capital because of a third (omitted) variable. Recent evidence in Fuentes and Gilchrist (2004) and Pavcnik (2003) shows that the correlation between skill upgrading and proxies for technology transfers disappears after controlling for plant fixed effects. Putting it differently, *within-firm* variation does not support the claim that measures of technology adoption from abroad are per se correlated with changes in the relative demand for skilled workers.

An alternative hypothesis is that the relative bias of technology adopted from abroad is what determines the relative demand for skilled labor in Chile.³ I study this hypothesis in this paper. In particular, I study the correlation of measures of skill upgrading in the US and Chile. I find suggestive support for the idea that skill upgrading in Chile is correlated with skill upgrading in the US. Since I also show that openness *in the US* is correlated with the wage premium in Chile, I interpret this result as supportive evidence of a simplified version of the Acemoglu (2003a) model. A more general interpretation of my results is the existence of *pervasive* skill biased technical change *à la* Berman et al. (1998)—i.e., the fact that there is skill biased technical change in all the countries at the same time. However, the theories of pervasive SBTC have the limitation that they take SBTC as exogenous, while the model in Acemoglu (2003a) explains *why* there may be pervasive SBTC. Finally, even though a literal interpretation of my results is about correlation between skill upgrading in the US and Chile, I interpret my results as a correlation between skill upgrading in developed countries and Chile. The basic evidence supporting this idea is three-fold: (i) a high correlation between skill upgrading at the sectoral level in all high income countries, as documented in Berman et al. (1998), (ii) a high share of the domestic supply of non-transportation machinery and equipment comes from developed countries—I document that about 85% of the supply of non-transportation machinery and equipment in Chile is imported (using data from the Chilean output-input matrix for 1996), and (iii) most imports of non-transportation machinery and equipment (and data-processing machines) come from the US (the most important exporter country to Chile in each year and category) and OECD countries (using data from Feenstra et al., 2005). In other words, Chile seems to be using technologies that mostly come from a group of developed countries that are producing skill-biased technologies.

The paper is organized as follows. Section 2 presents a group of stylized facts related to the evolution of the skill premium in Chile. Section 3 presents a simplified version

³Technical changes do not have to be skill-biased: Goldin and Katz (1998) and James and Skinner (1985) present some evidence that technical change was skill-replacing during the nineteenth century.

of the theoretical model in Acemoglu (2003a) to motivate the main empirical tests of this paper. Section 4 presents macro time series evidence. Section 5 presents sectoral evidence from 1960 to 2000. Section 6 documents that non-transportation machinery and equipment in Chile tend to be imported from the US and the OECD and Section 7 briefly concludes.

2 STYLIZED FACTS

2.1 TIME-SERIES EVIDENCE: A CES FRAMEWORK (KATZ AND MURPHY, 1992 AND KRUSELL ET AL., 2000)

To organize the discussion on the determinants of the skill premium in Chile I present a simple framework that allows me to compose the skill premium between its demand and supply components (this approach was popularized by Katz and Murphy, 1992). I start from a nested CES production function that includes three inputs: skilled and unskilled labor and physical capital.

The production function of the aggregate economy is:

$$Y = K^\alpha \left[\pi (A_h H)^{\frac{\sigma-1}{\sigma}} + (1-\pi) (A_l L)^{\frac{\sigma-1}{\sigma}} \right]^{(1-\alpha)\frac{\sigma}{\sigma-1}}, \quad (1)$$

where Y is aggregate output, K is physical capital, A_h is skilled labor augmenting technological change, H is skilled labor, A_l is unskilled labor augmenting technological change, L is unskilled labor, π is a technology parameter that can be interpreted as the share of work activities allocated to skilled labor, and σ is the elasticity of substitution between skilled and unskilled workers.⁴

Assuming that markets are competitive, then the wage of each factor is:

$$\begin{aligned} w_h &= \frac{\partial Y}{\partial H} = (1-\alpha) \pi K^\alpha A_h^{\frac{\sigma-1}{\sigma}} \left(\pi (A_h H)^{\frac{\sigma-1}{\sigma}} + (1-\pi) (A_l L)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{1-\alpha\sigma}{\sigma-1}} H^{\frac{-1}{\sigma}}, \\ w_l &= \frac{\partial Y}{\partial L} = (1-\alpha) (1-\pi) K^\alpha A_l^{\frac{\sigma-1}{\sigma}} \left(\pi (A_h H)^{\frac{\sigma-1}{\sigma}} + (1-\pi) (A_l L)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{1-\alpha\sigma}{\sigma-1}} L^{\frac{-1}{\sigma}}. \end{aligned}$$

The skill premium (ϖ) is defined as the relative price of skilled labor in terms of unskilled labor and is given by:

$$\varpi = \frac{w_h}{w_l} = \frac{\pi}{(1-\pi)} \left(\frac{A_h}{A_l} \right)^{\frac{\sigma-1}{\sigma}} \left(\frac{H}{L} \right)^{-\frac{1}{\sigma}}. \quad (2)$$

Finally, I take logs to (2):

$$\ln \varpi = \ln \frac{\pi}{(1-\pi)} + \left(\frac{\sigma-1}{\sigma} \right) \ln \frac{A_h}{A_l} - \frac{1}{\sigma} \ln \frac{H}{L}. \quad (3)$$

The three most important results of (3) are:

⁴A microfoundation for this aggregate production function is presented in Section 3.

- An increase in the relative supply obviously produces a decrease in the skill premium, provided that skilled and unskilled workers are not perfect substitutes.
- A rise in $\frac{A_h}{A_l}$ has ambiguous effects depending on the value of σ . The skill premium increases provided that $\sigma > 1$.⁵
- Physical capital has no effect on the skill premium because the capital increases the marginal productivity of skilled and unskilled labor in the same proportion.

I take expression (3) to the data. Data on the skill premium come from the Employment Survey of the University of Chile that spans the period from 1957 to 2002.⁶ This survey collects a representative sample of the Santiago Metropolitan Area (which represents about 39% of the Chilean population and 48% of the Chilean GDP). The University of Chile survey is the only source of microdata that covers a long period of time and has been widely used in studies of wage inequality in Chile (e.g. Robbins, 1994a and 1994b, Sánchez-Páramo and Schady, 2002) and has the additional advantage of providing reasonably comparable data on monthly earnings, hours worked, economic sectors, and educational categories. Robbins (1994b) argues that this sample is a good representation of the labor market in Chile, except for the agriculture and mining sectors.

I focus on the monthly earnings of full-time (working at least 35 hours) wage and salary workers aged 16 to 64 years. To compute an estimate of the skill premium I apply the methodology of Autor et al. (2005) to decompose the wage premium between predicted and residual wage inequality.⁷ I focus on male workers and run a regression of (log) earnings on dummies for eight education groups (no education, primary-school drop-out, primary-school graduate, high-school drop-out, high-school graduate, college drop-out, college graduate, and other education), and a cubic on experience for each education category for each year. It is worth noting that the estimated regressions are not meant to identify causal effects of the observables on wages—instead, the regressions are meant to be the best linear predictions of wages on observables, i.e. these regressions

⁵A Leontieff technology (i.e. $\sigma = 0, \alpha = 0$) is useful to understand the intuition of this result. In this case, an increase in $\frac{A_h}{A_l}$ "liberates" some skilled workers and, therefore, the skill premium decreases. Given that most empirical results suggest that $\sigma > 1$, improvements in $\frac{A_h}{A_l}$ in general increase the skill premium.

⁶Data on educational variables are missing for 1959, and 1963-1964.

⁷The basic motivation for this disaggregation is to study whether the increase in the demand for skilled labor is correlated with the evolution in the premium for (unobserved) abilities which are orthogonal to education, especially in the context of the US. In the case of Chile, the correlation between predicted and total (i.e., including residual wage premium) wage premium is 0.99 and residual inequality does not have a clear pattern. This basically implies that the behavior of wages can be explained using the observables described in the main text.

are meant to be used to *predict* wages on observables. Using the estimated regression I predict the wage for each observation for each year and define the log skill premium as the difference between the average log wage for the group of college graduates and high-school graduates using fixed-weighted averages of the 32 education \times experience sub-group means (using the average share of total hours worked for each sub-group from 1957 to 2002 as weights) to adjust for compositional changes within each group.⁸

I use the difference between college and high-school graduates as my main proxy for the difference between skilled and unskilled workers. There are some alternative measures of skilled and unskilled workers: college graduate equivalents and primary school graduate equivalents (used in Beyer et al, 1999), non-production and production workers (used in Berman et al., 1998 and Berman and Machin, 2000), for instance. My choice to use college graduate and high-school graduate equivalents to measure skilled and unskilled workers over these two alternative classifications is motivated by two facts:

1. The Chilean data suggest that the big increase in wages occurs for workers having more than 12 years of formal schooling (this result is also reported in Contreras, 2002). Putting it differently, this evidence implies that the correlation between the college-secondary wage premium and college-primary wage premium should be high. Indeed, the correlation between the college-secondary and the college-primary wage premium is 0.73 (0.83) in levels (first-differences) using data from 1957 to 2002.
2. The use of production and non-production workers as a proxy for skilled and unskilled workers in many papers is motivated by the lack of educational categories in most datasets more than by a direct preference for this classification of workers. The available evidence suggests that while using production and non-production workers identifies similar *trends* as using education categories (e.g. Feenstra and Hanson, 2001), the wage premium of non-production to production workers only corresponds to a small increase in the inequality between skilled and unskilled workers (e.g., Katz and Autor, 1999 for the US and Bustos, 2005 for Argentina). Therefore, I prefer a more direct proxy for skilled and unskilled workers.

The relative supply of skilled labor is defined as the ratio of hours worked by college graduate equivalents to high-school graduate equivalents. The supply of college graduate equivalents is the sum of hours worked by college graduates plus half the sum of hours worked by college drop-outs. The supply of high-school graduate equivalent workers is

⁸The four experience categories are 0-9, 10-19, 20-29, and 30+ years..

the sum of hours worked by high-school graduates, plus half the sum of hours worked by college and high-school drop-outs, plus 25% the sum of hours worked by primary-school graduates and by workers with other education, plus 12.5% the sum of hours worked by primary-school drop-outs. These weights roughly correspond to the average differences in returns to each group obtained in the above mentioned regressions.

Figure 1 shows the evolution of the skill premium in Chile from 1957 to 2000 (the skill premium is defined as the log difference between average wages of college graduates and high-school graduates). The skill premium presents a relatively volatile behavior before 1985. Initially, there is an increase in the skill premium in the mid 1960s, followed by a marked decrease at the same time of the first oil crisis and the collapse of the political and economic situation in Chile in the mid 1970s. Next, the skill premium returns to its previous level of the mid 1960s and starts a slow increase that seems to stabilize around the mid 1980s. My estimates of the evolution of the wage premium are roughly comparable to the estimates of the wage premium reported by Beyer et al. (1999) for 1960-1996 (see their Figure 1) and the estimates in Contreras (2002) for 1958-1996.⁹

The high level of the skill premium in Chile is a second factor that clearly emerges from Figure 1. The skill premium in Chile is about 110 log points on average over the 1965-2000 period, while the same variable for the US is about 50 log points over the same period. OECD (2004) reports skill premia of an average of 41 log points for a group of countries in the 1997-2002 period, with a maximum of 82 log points in the case of Hungary. IADB (2004) reports that the skill premium in Chile is high even in comparison to other Latin American countries. To compare the wage premium in Chile with that of a sample of countries, in Table 1 I present estimates of the wage premium in 79 countries, taken from Acemoglu (2003b), Banerjee and Duflo (2005), and Caselli and Coleman (2006). Chile is located in the percentile 87th (85th) [71th] of the distribution of the wage premium if I consider the complete sample of countries (I exclude Sub-Saharan countries) [I include only Latin American countries]. All in all, these results show that the wage premium is significantly high in Chile, even in comparison to the highly unequal Latin American countries.¹⁰

Figure 2 presents the evolution of the relative supply of skilled to unskilled labor

⁹The correlation between my indicator of the wage premium and the estimate of the same variable implicit in Contreras (2002) is 0.91. I construct the log of the wage difference between a college graduate and a high-school graduate as $5\beta_t$, where β_t is the estimate of the return of an additional year of education for college students for year t in a Mincerian regression, as reported in Contreras (2002).

¹⁰In order to make estimates comparable with other countries in Table 1, I use the average return to attending school –and not the marginal return of attending college– in Contreras (2002) to compute the wage premium for Chile. If I used the marginal return, the wage premium would be 1.07 for Chile.

during the same period. The relative supply increases slowly until around the early 1990s and takes off afterwards, after the big expansion of the higher education sector in the mid 1980s and the long period of high and positive economic growth.¹¹

Regarding the level of the relative supply of skilled workers, differences with the US are evident. While the relative supply was about 0.30 in the case of Chile in the 1990s, the same variable reached a value of about 1.10 for the US. Certainly, this low relative supply could explain the above mentioned differences in skill premium. Using the series on skill premium and relative supply in Chile and the US (from Autor et al. 2005), and equation (3), I construct an estimate of the share of the difference in skill premium between both countries that is explained by differences in their relative supplies. This is given by: $\frac{-\frac{1}{\sigma}(\ln \frac{H}{L} - \ln \frac{H}{L}_{US})}{\ln \varpi - \ln \varpi_{US}}$.

To implement this exercise, I need an estimate of σ . Most papers in the literature report estimates in the interval between 1 and 2 (see Ciccone and Peri, 2005 for a review of estimates for the US and other countries and Robbins (1996) for estimates for a group of small open economies). My estimates for Chile using cointegration techniques produce estimates of σ in the interval from 1.39 to 1.67.¹² Given these results and the similarity to results in other papers, I choose $\sigma = 1.50$, which is around the mean value of the available estimates and the preferred estimate in Ciccone and Peri (2005).

Results suggest that differences in the relative supply explain 113 and 117% of the differences in skill premium between Chile and the US in the 1965-2000 period and in the 1990s, respectively. In other words, only differences in the relative supply of skilled labor can explain completely the differences between Chile and the US in terms of skill premia. This is a very important result for the theory I present in this paper to explain the behavior of technology in Chile. My claim is that a model where technology is

¹¹A valid concern to the construction of the relative supply is that a big share of the increase in the relative supply during the 1990s is related to the creation of the so-called private universities. If graduates from these universities did not receive an education comparable to the education provided by the old universities, my estimates of the relative supply may be biased. To address this concern, I study whether cohort effects vary significantly for workers of the cohorts that enter the market after 1985, using a framework similar to Card and Lemieux (2001)—i.e. including year, cohort, and age effects. Results, available upon request, suggest that cohort effects are not significantly different for the youngest cohorts. Robbins (1994b) present similar results using a different methodology. In addition, results in Rappoport et al. (2004) suggest that differences in wages among traditional and private universities are not clearly significant, depending on the career and the geographic area.

¹²I estimate (3) using cointegration techniques because unit root tests suggest that the skill premium and the relative supply have a unit root. Estimates are obtained from a system of the skill premium and the relative supply as endogenous variables, dummies for 1972 and 1973 as exogenous variables, and assuming a linear trend in the data. The system is estimated using a vector error correction model including one lag. In this case the estimate of σ is 1.39 (with a t-test of 4.07) If I include the real minimum wage and unemployment in the equation, my estimated σ increases to 1.67 (with a t-test of 5.10). Detailed estimates are available upon request.

developed in the US and used in Chile explains the behavior of the relative bias of technology in Chile. In this model, the relative bias of the technology in Chile should be the same as in the US. This piece of evidence supports that claim.

Using data on skill premia, the relative supply of skilled labor, and equation (3) is possible to construct an estimate of the relative demand for skilled labor as:

$$D\left(\frac{H}{L}\right) \equiv \ln \varpi + \frac{1}{\sigma} \ln \frac{H}{L}. \quad (4)$$

Figure 3 presents the evolution of the estimated demand in Chile from 1957 to 2000. Results confirm the presumption that the relative demand increased significantly in the 1980s and 1990s to explain a flat skill premium in the presence of a rising relative supply. There is also an increase in the mid 1970s and a subsequent slow increase of demand until the mid 1980s. A noteworthy aspect of the figure is that the big increase in relative demand observed in Chile seems to be more significant in the period starting in the mid-1980s. The liberalization period that starts in 1975 is accompanied by only a mild increase in the relative demand. Section 4 presents a detailed discussion of the factors behind the increase in demand using a time series approach.

Next, I extend the production function (1) to include both equipment capital (K_e) and capital structures (K_s) in the production function (closely following the derivations in Goldin and Katz, 1998 and Krusell et al. 2000).

$$Y = K_s^\alpha \left[\mu \left(\lambda (A_h H)^{\frac{\rho-1}{\rho}} + (1-\lambda) K_e^{\frac{\rho-1}{\rho}} \right)^{\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{\rho}{\rho-1}\right)} + (1-\mu) (A_l L)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma(1-\alpha)}{\sigma-1}}.$$

This extension is important because the Chilean economy has experienced a process of capital deepening in the last years. Several papers suggest that equipment capital is more complementary to skilled labor than to unskilled labor (e.g., Krusell et al. 2000). In this setup, the elasticity of substitution between unskilled and skilled labor is σ , which is the same value as the elasticity of substitution between equipment capital and unskilled labor. In turn, the elasticity of substitution between skilled labor and capital is ρ . To see the point more explicitly, following Krusell et al., 2000, after some algebraic manipulations, the skill premium is:

$$\varpi = \frac{w_h}{w_l} = \frac{\mu\lambda}{1-\mu} \left[(1-\lambda) \left(\frac{K_e}{A_h H} \right)^{\frac{\rho-1}{\rho}} + \lambda \right]^{\frac{\sigma-\rho}{\sigma(\rho-1)}} \left(\frac{A_h}{A_l} \right)^{\frac{\sigma-1}{\sigma}} \left(\frac{H}{L} \right)^{-\frac{1}{\sigma}}.$$

This expression implies that skill-capital complementarity requires $\sigma > \rho$. Log-

linearizing this expression, as in Krusel et al. (2000), yields:

$$\ln \varpi \cong \frac{w_h}{w_l} = (1 - \lambda) \frac{\sigma - \rho}{\sigma(\rho - 1)} \left(\frac{K_e}{A_h H} \right)^{\frac{\rho-1}{\rho}} + \frac{\sigma - 1}{\sigma} \ln \left(\frac{A_h}{A_l} \right) - \frac{1}{\sigma} \ln \left(\frac{H}{L} \right).$$

Therefore, in this case the relative demand for skilled labor is given by:

$$D \left(\frac{H}{L} \right) \equiv \ln \varpi + \frac{1}{\sigma} \ln \frac{H}{L} - (1 - \lambda) \frac{\sigma - \rho}{\sigma(\rho - 1)} \left(\frac{K_e}{A_h H} \right)^{\frac{\rho-1}{\rho}}. \quad (5)$$

This expression suggests two important points. The first point is that equipment capital deepening increases the skill premium as long as $\left(\frac{K_e}{A_h H} \right)$ increases. An empirical problem is having a good measure of the quality of equipment capital. Chumacero and Fuentes (2002) argue that available measures of the price of equipment capital in Chile are not good measures of its quality. To overcome this problem, I use two assumptions regarding the evolution of the quality of equipment capital: (i) the evolution of the quality of equipment capital in Chile is similar to the evolution of the same variable in the US and (ii) the evolution of the quality of equipment capital is similar to the evolution of A_h .

Figure 4 presents the evolution of $\left(\frac{K_e}{A_h H} \right)$ from 1957 to 2000. Strikingly, results suggest that the level of this variable is *not significantly higher* in the post-liberalization period and only starts increasing significantly over the 1990s. Putting it differently, in spite of the big increase in equipment capital, the supply of skilled labor also increased significantly, and, therefore, the ratio of both variables does not increase.¹³

The second point that is derived from (5) is that the effect of capital deepening on the skill premium is likely to be small. To see this, following Krusel et al. (2000), I take the time derivative of (5) and, after some algebraic manipulations, the growth rate of the relative demand is:

$$g_D \equiv \left(\frac{\sigma - 1}{\sigma} \right) (g_{A_h} - g_{A_l}) = g_\varpi + \frac{1}{\sigma} (g_H - g_L) - \theta (g_{K_e} - g_H - g_{A_h}). \quad (6)$$

where g denotes growth rate, and $\theta = (1 - \lambda) \frac{\sigma - \rho}{\sigma \rho} \left(\frac{K_e}{A_h H} \right)^{\frac{\rho-1}{\rho}}$. Using results in Krusel et al. (2000), estimates from Figure 4, and a value for the capital share of 1/3, I get that $\theta = 0.20$. Therefore, the relative contribution of equipment capital deepening to explain any increase in the demand is probably small, even if the figures in Figure 4 are underestimated.¹⁴

¹³Braun and Braun (1999) make a related point. They argue, contrary to the conventional wisdom, that the ratio of physical to human capital is relatively low in Chile.

¹⁴The result that equipment capital does not have a first order importance to explain the skill premium is also reported by Berman et al. (1994) and Acemoglu (2002).

Figure 5 presents the evolution of the growth rate of the skill premium using (6) to disentangle the contributions of relative supply, equipment capital deepening, and relative demand. The results suggest that the two major contributors are relative supply and demand. Capital deepening has a minor impact on the evolution of the skill premium. The big increase in the skill premium during the 1980s was an outcome of the combination of a strong demand with a relative slowdown in the growth rate of the relative supply. By contrast, the small increase in the 1990s was a consequence of an important expansion in the relative supply, which almost fully compensates for a strong demand.

In summary, the simple accounting framework presented in this section suggests that, from a macro perspective, both supply and demand play a significant role in explaining the evolution of the skill premium in Chile. The remainder of the paper focuses on explaining the evolution of the relative demand for skilled labor. An analysis of the evolution of the relative supply in Chile will be the focus of future research, probably using detailed microdata.

2.2 SECTORAL EVIDENCE: BETWEEN AND WITHIN SECTOR DECOMPOSITION

The sectoral composition of the demand for skilled labor adds another important stylized fact to understand the evolution of the skill premium in Chile. Subsection 2.1 suggests changes in the relative demand for skilled workers are significant especially in the 1980s and 1990s. It remains to be analyzed whether the increase in demand is a between or a within sector shift. This decomposition is particularly useful to disentangle several theories. For instance, an increase in the relative demand that is a consequence of intersectoral reallocation of workers would support theories that emphasize the reallocation of skilled labor toward sectors more intensive in skilled labor as suggested by Matsuyama (2005). By contrast, a within-sector increase in the relative demand would be consistent with theories that emphasize skill bias technical change.

To implement this decomposition, I focus on the evolution of the skilled labor share of the wage bill as a proxy for skill upgrading at the sectoral level.¹⁵ I decompose both components of skill upgrading according to Berman et al. 1994 and Autor et al. 1998:

$$\Delta(S_{jt}) = \sum_k (\Delta S_{kt} \gamma_{jk}) + \sum_k (\Delta \gamma_{jkt} S_k), \quad (7)$$

where S_{jt} is the group j (i.e., skilled and unskilled labor) share of the wage bill in

¹⁵This proxy is equal to the relative demand if $\sigma = 1$. See Autor et al. (1998) for a detailed discussion.

year t , S_{jkt} is the group j share of the wage bill of sector k in year t , $S_{kt} = \sum_j S_{jkt}$ is the sector k share of the wage bill in year t , $\gamma_{jkt} = \frac{S_{jkt}}{S_{kt}}$ is the group j share of the wage bill of sector k in year t , $\gamma_{jk} = \frac{\gamma_{jkt} + \gamma_{jkt-1}}{2}$, and $S_k = \frac{S_{kt} + S_{kt-1}}{2}$. Thus, the first term in the right-hand side of the equation captures the change in the skilled labor share of the wage bill related to reallocation of the demand for workers between sectors, and the second term reflects within-sector changes.

I implement this decomposition using data on 21 two-digit ISIC sectors from the Employment Survey of the University of Chile for 1960, 1970, 1980, 1990, and 2000. Appendix 1 describes the construction of the sectors and Table 2 presents annual changes in the skilled labor share of the wage bill.

The results confirm the macro evidence in that while skill upgrading in the 1960s and 1970s is roughly constant, this variable seems to increase significantly during the 1980s and the 1990s. More importantly, the within component of skill upgrading explains between 75 and 93% of skill upgrading for the economy. Results for the tradable sector suggest sizeable skill upgrading in the 1980s jointly with a small increase in the 1990s. In the tradable sectors, the within sector component also explains more than 90% of skill upgrading.^{16 17}

All these results suggest that within sector skill upgrading explains the major part of the increase in the relative demand observed in Chile during the 1980s and 1990s, while between sector changes are small.

3 MOTIVATING THEORY: A SIMPLE MODEL OF SKILL UPGRADING

I present a simplified version of the main results of the model in Acemoglu (2003a).¹⁸ The model basically analyses the balanced growth path (BGP) conditions of the evolution of a world where a developed country (the US) develops technologies and developing countries (like Chile) adopt technologies. The basic empirical implication of the model for this paper is that the bias of technology in the US affects the bias of technology in

¹⁶A valid concern about this decomposition is that I use only 2-digit sectors, so a lot of reallocation could be between 3- and 4-digit industries. I do not have more disaggregated sectors in the University of Chile dataset. If I use the ENIA survey that includes a 4-digit disaggregation of economic sectors (but only includes manufacturing plants from 1979 to 2001 and a rough proxy of skilled workers—e.g., non-production workers), I find that within sector reallocation explains 93 and 96% of skill upgrading in the 1980s and the 1990s, respectively. Still, the recent paper by Schott (2004) suggests that using very detailed information on reallocation between firms producing the same goods gives a more important role for the between-firm component.

¹⁷Wacziarg and Wallack (2004) and Caballero (2005) present evidence that inter-sectoral reallocation does not significantly increase after trade and other reforms that liberalize markets.

¹⁸I closely follow Acemoglu (2003a)'s notation and exposition.

a country like Chile. In addition, the model also predicts that trade openness in the US increases the skill premium in Chile.

I use three important assumptions in the model. First, I assume that inventors in the US do not receive payments for technologies that are adopted in developing countries. In Acemoglu's model this assumption is related to the absence of intellectual property rights in developing countries, which make it unprofitable for inventors to develop technologies that are "appropriate" for developing countries. In the case of Chile, this assumption may appear as extreme because institutions in Chile are more developed than in most emerging countries. A (likely complementary) alternative assumption is that foreign inventors have to pay a fixed cost in order to start developing technologies abroad. In this case, small countries, like Chile, may not have enough size to make it profitable for frontier inventors to develop new technologies. In this case, only an improvement in intellectual property rights implemented by a (big) group of developing countries creates an incentive to invent technologies that are appropriated for developing countries.

The second assumption is that I solve the model considering the extreme case of a closed economy in the goods market. I do so basically to simplify the analysis. This assumption does not change the main implications of model (i.e., a correlation between skill premia in the US and Chile and the effect of openness in the US on the skill premium in Chile). The main implication of assuming a closed economy is that I allow the domestic relative supply of skilled labor to have a negative effect on the skill premium. The alternative polar case, complete trade openness, generates the prediction that the domestic relative supply of skilled labor has no impact on the skill premium (as long as the country is small, and technology adoption does not depend on the domestic relative supply of skilled labor). As previously stated, the significance of the domestic supply to understand the evolution of the skill premia in open economies is supported by the data. Robbins (1996) presents evidence that domestic relative supply has a negative and significant effect for a group of middle-income open economies. Moreover, the estimates for Chile I present in section 2.1 are not significantly different from other estimates of the elasticity of substitution between skilled and unskilled labor. Desjourneres et al. (1999) present simple generalizations of the basic open economy model that allow domestic supply to have an impact on the skill premium.

Finally, I assume, as do most papers in this literature, that domestic relative supply is exogenously given. Acemoglu (2003a, Appendix C) shows that the major conclusions of the model are robust to adding this factor. The main additional implication for the case of Chile is that an increase in the relative supply of skilled labor in the US, through

its effect on technology and the skill premium, encourages the accumulation of skills in Chile.

3.1 ENVIRONMENT

Consider an economy with $J + 1$ countries (J developing countries and the US).¹⁹ As previously defined, H and L are skilled and unskilled labor, respectively.

All consumers in all countries have identical linear preferences:

$$U(t) \equiv \int_t^{\infty} \exp(-r(\tau - t)) C(\tau) d\tau,$$

where $C(\tau)$ is consumption at time τ and r is the discount rate. Consumption is defined over a CES aggregate of skilled and unskilled intensive goods, C_h and C_l , respectively:

$$C^j = \left[\gamma (C_l^j)^{\frac{\epsilon-1}{\epsilon}} + (1-\gamma) (C_h^j)^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}}, \quad (8)$$

where ϵ is the elasticity of substitution between the two goods. Assuming the goods market is competitive, the relative price of both goods is:

$$p^j \equiv \frac{p_h^j}{p_l^j} = \frac{1-\gamma}{\gamma} \left(\frac{C_h^j}{C_l^j} \right)^{-\frac{1}{\epsilon}}.$$

Assuming a closed economy, we have that $C_s^j = Y_s^j$, for $s = h, l$, where Y_s is the production of the s -intensive good. Then,

$$p^j = \frac{1-\gamma}{\gamma} \left(\frac{Y_h^j}{Y_l^j} \right)^{-\frac{1}{\epsilon}}. \quad (9)$$

The production functions of each good in country j are:

$$Y_l^j = \int_0^1 \tilde{q}_l^j(i)^\beta x_l^j(i)^{1-\beta} (L^j)^\beta di, \text{ and } Y_h^j = \int_0^1 \tilde{q}_h^j(i)^\beta x_h^j(i)^{1-\beta} (H^j)^\beta di \quad (10)$$

where $x_s^j(i)$ and $\tilde{q}_s^j(i)$ are the quantity and the quality (productivity) of machine i used with workers s in country j , respectively. These production functions assume a continuum of different types of machines or intermediates used by unskilled labor and a different group of machines used by skilled labor and present constant returns to scale at the firm level. In contrast, the aggregate production possibilities set presents increasing returns to scale because the quality of technologies is determined endogenously.

¹⁹An alternative motivation is that there are J developing countries and a group of developed countries that use the same technology.

Therefore, the demand for machines is:

$$x_s^j(\tilde{q}_s^j(i)) = \left[\frac{(1-\beta)p_s^j}{\chi_s^j(\tilde{q}_s^j(i))} \right]^\beta \tilde{q}_s^j(i) S^j, \text{ with } s = h, l; \text{ and } S = H, L. \quad (11)$$

$\chi_s^j(\tilde{q}_s^j(i))$ is the rental price of machine i of quality $\tilde{q}_s^j(i)$ for skill type s in country j .

Firms in all countries can use domestic or foreign technologies, accordingly to the following rule:

$$\tilde{q}_h^j(i) = \begin{cases} q_h^j(i) \\ \theta^j q_h^{j'}(i) \text{ if } j \neq j' \end{cases}, \text{ with } \theta^j \leq 1,$$

where q_h^j is the most advanced technology developed in country j . This expression implies that countries can use domestic technologies or adopt foreign technologies. The important point is that foreign technologies may not be "appropriate" for the firms in country j (in the sense of Basu and Weil, 1998; Acemoglu and Zilibotti, 2001; and, Caselli and Coleman, 2006), and, therefore, the productivity of machines produced in country j' may be lower when used abroad.²⁰

Technical progress is related to R&D activities (Aghion and Howitt, 1998). Innovating over a machine of quality q creates a new vintage with quality λq ($\lambda > 1$). One unit of R&D spending (in terms of the final good) produces a flow rate of innovation $z\phi(z)$. R&D cost (also in terms of the final good) of innovating z over a machine of quality q is Bqz ($B = \beta(1-\beta)\lambda$), with $\phi'(z) < 0$ and $\phi(z)z$ is increasing in z .

The inventor of a new machine in the US becomes the monopolist of this technology. Given the demand functions in (11), the monopolist price is a constant markup over the marginal cost.²¹ To simplify the analysis, Acemoglu (2003a) assumes that machines fully depreciate after a year and the marginal cost of producing each machine is constant and equal to $(1-\beta)^2$. This implies that $\chi^U = (1-\beta)$. There is a monopolist in the developing country that can copy US technologies at a small cost ξ .

3.2 SKILL PREMIUM

Assuming that $(1-\beta)\theta^j q_s^U(i) > q_s^j(i)$ for all $s = h, l$ and j and i , firms in developing countries will use US technologies.²² This result implies that (1) $\tilde{q}_s^j(i) = \theta^j q_s^U(i)$, (2)

²⁰Various papers have presented evidence that developing countries tend to suffer from using inappropriate technologies (given their endowments)—e.g., Acemoglu and Zilibotti, 2001; Berman, 2000; Caselli and Coleman, 2006). For instance, Caselli and Coleman (2006) present estimates that the degree of inappropriateness of using US technologies decreases per-capita income (e.g. Chile would lose 20% of its GDP by using US technologies).

²¹Formally, this result requires that $\lambda > (1-\beta)^{\frac{(1-\beta)}{\beta}}$.

²²This assumption implies that it is more efficient to use US technologies even if the US monopolist sells the machine at the monopolist price and the domestic monopolist sells the machine at the marginal

the domestic monopolist will set χ^U (the monopolist price), and (3) there will be no R&D in developing countries in the future, so the developing country will always adopt US technologies.

Substituting χ^U in (11) and the demands in the production function, I get:

$$Y_s^j = (p_s^j)^{\frac{(1-\beta)}{\beta}} \tilde{Q}_s^j S^j, \text{ for } s = h, l; \text{ and } S = H, L; \quad (12)$$

where $\tilde{Q}_s^j = \int_0^1 \tilde{q}_s^j(i) di$, for $s = h, l$. Notice that (12) is equivalent to a linear technology, where the productivity of each unit of labor is proportional to the state of technology (\tilde{Q}_s^j) and to product prices.²³

Computing the marginal productivity of labor, using the fact that $\tilde{q}^j(i) = \theta^j q_s^U(i)$, the skill premium in this economy is:

$$\omega^j = (p^j)^{\frac{1}{\beta}} \frac{Q_h^U}{Q_l^U}.$$

Using (9), (10), and (12) implies that the relative price is:

$$p^j = \left[\left(\frac{1-\gamma}{\gamma} \right)^{-\varepsilon} \frac{Q_h^U H^j}{Q_l^U L^j} \right]^{-\frac{\beta}{1+\beta(\varepsilon-1)}}. \quad (13)$$

Therefore, the skill premium is:

$$\omega^j = \left[\left(\frac{1-\gamma}{\gamma} \right)^{-\varepsilon} \frac{H^j}{L^j} \right]^{-\frac{1}{1+\beta(\varepsilon-1)}} \left(\frac{Q_h^U}{Q_l^U} \right)^{\frac{\beta}{1+\beta(\varepsilon-1)}}. \quad (14)$$

This expression highlights the positive relationship between technological bias in the US and the skill premium in developing countries and the negative effect of the domestic relative supply on the skill premium.

3.3 EQUILIBRIUM SKILL BIAS

I determine the equilibrium skill bias of technology in the US to find a closed-form for the skill premium in the US. I will not present all the derivations to save space, but I use the following two results from Acemoglu (2003a):

$$(p^U)^{\frac{1}{\beta}} \frac{H^U}{L^U} = \Theta \left(\frac{z_h}{z_l} \right), \text{ with } \Theta' \left(\frac{z_h}{z_l} \right) > 0. \quad (15)$$

cost.

²³Expression (12) is equivalent to the aggregate production function (1), if $A_s^j = (p_s^j)^{\frac{(1-\beta)}{\beta}} \tilde{Q}_s^j$ and $\alpha = 0$.

$$\frac{Q_h^U}{Q_l^U} = \left(\frac{1-\gamma}{\gamma} \right)^\varepsilon \left(\frac{H^U}{L^U} \right)^{\beta(\varepsilon-1)}. \quad (16)$$

The first result is the basic prediction of the theory of induced technical change of Acemoglu (2002b). Relative research effort toward skilled labor increases if the relative price increases (the price effect) or the relative supply of skilled labor increases (the market size effect). Given that there is a relationship between both forces as highlighted by (13), the second expression presents the reduced-form relationship between the relative supply of labor in the US and the relative bias of technology. Notice that in this model the relative bias of technology in all the countries is completely determined in the US.

These expressions, jointly with the previous structure described in the model, lead to proposition 1 in Acemoglu (2003a):

$$\omega^U = \left(\frac{1-\gamma}{\gamma} \right)^\varepsilon \left(\frac{H^U}{L^U} \right)^{\beta(\varepsilon-1)-1}, \text{ and} \quad (17)$$

$$\omega^j = \left(\frac{1-\gamma}{\gamma} \right)^\varepsilon \left(\frac{H^U}{L^U} \right)^{\frac{(\beta(\varepsilon-1))^2}{\beta(\varepsilon-1)+1}} \left(\frac{H^j}{L^j} \right)^{-\frac{1}{\beta(\varepsilon-1)+1}}. \quad (18)$$

Finally, substituting (17) in (18) and taking logs I get:

$$\ln \omega^j = a \ln \left(\frac{1-\gamma}{\gamma} \right) + b \ln \left(\omega^U \right) + c \ln \left(\frac{H^j}{L^j} \right), \quad (19)$$

where $a = \frac{\beta(\varepsilon-1)-2}{\beta(\varepsilon-1)-1}$, $b = \frac{(\beta(\varepsilon-1))^2}{(\beta(\varepsilon-1))^2-1}$, and $c = -\frac{1}{\beta(\varepsilon-1)+1}$.

Equation (1) is the basic specification for the empirical analysis in the next section, using macro time series. Two basic results can be derived from (19):

- A positive relationship between the skill premium in the US and in countries that use technologies developed in the US. Moreover, b is expected to be greater than 1.
- A negative impact of the domestic relative supply on the skill premium.²⁴

²⁴Equation (18) suggests the alternative empirical implication that the relative supply in the US should be positively correlated with the wage premium in Chile. Unfortunately, the relative supply of skilled labor in the US is empirically hard to distinguish from a deterministic trend, so time series exercises using this variable are hard to interpret.

3.4 TRADE OPENNESS IN THE US

This theory also presents the additional implication that periods of trade openness in the US create additional incentives to produce skill-biased technologies. The basic intuition of this result comes from expression (15). If $\frac{H^U}{L^U} > \frac{H^j}{L^j}$ for all countries j , then periods of trade openness in the US increase the relative price of skilled-intensive goods in the US on impact. This creates an incentive to increase the relative effort in developing new machines to be used in the production of skilled-intensive goods. Thus, in the new steady-state equilibrium, there is an increase in the degree of bias of the new technologies.²⁵

The main implication for the analysis of the skill premium in Chile is a predicted correlation between skill premium in Chile and trade openness in the US.

4 TIME SERIES EVIDENCE

This section takes a macro time-series approach to study the determinants of changes in the relative demand for skilled labor documented in section 2, using the main theoretical predictions of equation (19): a positive correlation between the skill premium in Chile and the US. In addition, I also test whether an increase in trade openness in the US should increase the skill premium in Chile, which is a more demanding test of the model in Acemoglu (2003a).

The model outlined in section 3 is highly stylized. Therefore, I extend the model to include other (potentially competing) determinants of the relative demand for skilled labor in the empirical analysis. I include a group of determinants that have been studied in other papers in the main estimating equations of this section. The other variables are:

- A proxy for the relative price of goods intensive in unskilled labor to capture potential Stolper-Samuelson effects. In particular, I use a wholesale price index of textile goods in Chile as a proxy for the relative price of unskilled-labor intensive goods (Beyer et al., 1999).²⁶
- Proxies for policy reforms (Behrman et al., 1997). Namely, I use a structural

²⁵This theory also predicts that along the BGP the relative price of skill-intensive goods remains constant in the US. This result is supported by the empirical literature. See Acemoglu (2003a) for more details.

²⁶Notice that the model of section 3 suggests that including the relative price of skill-intensive goods and the relative labor supply is redundant. In a more general model, however, both variables could be included.

reform index and the subindices of trade and financial liberalization constructed by Morley et al. (1999) and Lora (2001).²⁷

- The evolution of (the log of) real minimum wage to control for labor market regulations (Autor et al., 2005). I use and extend data from Bravo and Contreras (1999).
- Finally, the output gap to capture the potential effect of short-run fluctuations on the skill premium (Autor et al., 2005). I use the Hodrik-Prescott filter to construct my measure of output gap.²⁸

I focus on analyzing the relative demand for skilled labor. I use the estimated demand from equation (4), i.e., without including equipment capital, because of the problems related with equipment capital measurement. I choose $\sigma = 1.5$ (results using other estimates of σ in the interval between 1 and 2 produce similar results).

My basic estimating equation is:

$$D_t = \alpha_1 + \alpha_2 t + \alpha_3 cycle_t + \alpha_4 \log(w_{\min t}) + \alpha_5 SR_t + \alpha_6 \log(p_t) + \alpha_7 \log(\varpi_t^{US}) + \varrho_t, \quad (20)$$

where D is the relative demand obtained from (4) at time t , $cycle$ is the output gap, w_{\min} is the real minimum wage, SR is an index of structural reforms, p is an index of the relative price of unskilled goods, ϖ^{US} is the skill premium in the US (I use the estimates reported in Autor et al., 2005), and ϱ is an error term.

I estimate equation (20) using both levels and first differences because of the known limitations of unit root tests.²⁹ In this case, for instance, Phillips-Perron tests are inconclusive because they suggest that D has either a unit root or is stationary around a deterministic trend.

The results of estimating equation (20) are presented in column (1) of tables 3 and 4. All the estimated coefficients are in line with the previous literature, but the only coefficient that is statistically significant at the conventional levels is the skill premium in the US.³⁰ Notice that the fact that both level and first-difference equations report very

²⁷My procedure to construct a structural reform index that covers the complete period in my sample is as follows. First, I extend the Morley et al. (1999) index to cover the 1996-1999 period using the Lora (2001) index. Second, I extend the combined index to cover the 1960-1969 and 2000-2002 periods. To do that, I run a regression of the combined index on trade openness and financial depth. I use the predicted coefficients and observed variables to extend the index. Data on trade openness and financial depth come from Diaz et al. (2005).

²⁸Using the unemployment rate instead of output gap produces similar results.

²⁹In the case of first-difference equations I include an $MA(1)$ to control for potential over-differentiation of the series if the true process is $I(0)$.

³⁰Results do not change significantly if I replace the structural reforms index by indices of trade and financial liberalization.

similar results suggesting that spurious correlation between the skill premium in the US and the relative demand in Chile is not driving the results. An additional way of testing whether results could be driven by spurious correlation is using Granger-causality tests. I can not reject the hypothesis that the relative demand in Chile does not Granger-cause the relative skill premium in the US (p-value=0.47), *but* I reject the hypothesis that the skill premium in the US does not Granger-cause the relative demand in Chile (p-value=0.03).

The estimated coefficient of the skill premium in the US is positive and significant and implies that a 1% increase in the skill premium in the US increases the relative demand in Chile by between 2.1 and 2.4%. This is consistent with the prediction of equation (19) that this elasticity should be bigger than one. More importantly, I cannot reject that the magnitude is equal to the value predicted by equation (19) (with p-values of 0.17 and 0.14 for first-difference and level estimates, respectively), given the available estimates of $\beta(\varepsilon - 1) - 1$ for the US. The coefficient $\beta(\varepsilon - 1) - 1$ captures the long-run relationship between the relative supply and the skill premium in the US (see equation 17). I find an estimate for this variable of 0.15 for the US (Acemoglu, 2003a reports an estimate of 0.13).

I test the second implication of the model in section 3: the level of trade openness in the US should positively affect the relative demand for skilled labor in Chile. In columns (3) of Tables 3 and 4, I replace the skill premium by a proxy of trade openness in the US—the ratio of the sum of real exports and imports to GDP. Results support this theoretical prediction: an increase in trade openness in the US increases the skill premium in Chile. As discussed in section 3, the intuition of this result is that in periods of trade opening in the US, the price of skill intensive goods increases, which creates an incentive to produce technologies that are biased towards skilled labor.

Finally, for completeness I present estimates including both the wage premium in the US and trade openness in the US in columns (3) of Tables 3 and 4—notice that in the model, the wage premium in the US is determined by trade openness in the US so these estimates have no clear theoretical interpretation. Both variables are positive and (marginally) significant.³¹

³¹Other (non-reported) exercises include substituting total wages for predicted wages, including equipment imports, including dummies for 1972-1973, including measures of strikes, including alternative indices of institutions (such as democracy), and including interactions of the skill premium in the US and the supply of skills in Chile. Results were not significant. The last exercise is interesting because a model where technology adoption depends on skill intensity in Chile would suggest a higher correlation of demand and supply for skills as the economy becomes more skill intensive. The evidence does not support this view.

The time series evidence suggests that the relative demand for skilled workers in Chile responds to the behavior of skill upgrading in the US. These effects are not only statistically significant, but also economically relevant. The skill premium in the US increased about 25 log points between 1980 and 2000. The estimated elasticity implies an effect of between 50 and 60 log points on the relative demand in Chile, which increased about 80 log points over the same period. Similarly, trade openness in the US increased about 80 log points over the last 20 years, and the estimated effect on the relative demand in Chile is above 100 log points.³²

The timing of the evolution of the relative demand for skilled labor in Chile also supports the empirical results in this section. As Figure 6 shows, the big increase in the relative demand in the mid 1980s occurs at the same time as the increase in the relative wage in the US and the period of major trade openness in the US. As previously discussed, the 1980s was the period when skill upgrading was stronger in Chile. The next section analyzes in more detail this set of results by using sectoral data from 1960 to 2000 to analyze whether skill upgrading in Chile is related to skill upgrading in the US at the sectoral level.

5 SECTORAL EVIDENCE

The model in section 3 predicts a positive correlation between skill upgrading in the US and skill upgrading in Chile because the relative bias of technologies is determined in the US, where machines are produced. I test this prediction using sectoral data on the share of the wage bill of skilled labor in Chile and the US from 1960 to 2000, as a proxy for skill upgrading. I use 20 two-digit sectors that are consistent across time and across countries. The University of Chile Employment Survey provides the sectoral classification in Chile at the two-digit level. I follow Robbins (1994b) in the definition of sectors and in the exclusion of public employees and the agriculture and mining sectors. For the US, I use the 1% Census Public Use Micro Samples of the decennial censuses of 1960, 1970, 1980, 1990, and 2000 provided by the Integrated Public Use Microdata Series (IPUMS) of the University of Minnesota to construct wage bill shares for each sector. I follow Autor et al. (1998) and extend their methodology to the 2000 census, using information from the Census Bureau. This methodology produces 142 four-digit

³²As a comparison, if I use the point estimates in Tables 3 and 4 for the other variables, the improvement in the structural reform index and the drop in the relative price labor-intensive goods from 1980 to 2000 explain an increase in the relative demand of about 5 and 30 log points, respectively. Obviously, the confidence intervals around these values are huge, given that the point estimates are not statistically significant.

sectors in the US that are consistent from 1960 to 2000. Next, I aggregate these US four-digit sectors to have two-digit sectors that are consistent with the Chilean data.

In addition, I use a second proxy for skill upgrading in the US: an index of computer use at the sectoral level, from Autor et al., 1998. Several papers use this as a proxy for technological changes that increase the demand for skilled workers (e.g., Autor et al., 1998, Berman and Machin, 2000). In this sense, computer use can be thought of as a more primitive determinant of changes in the relative demand for skilled workers in the US. Therefore, I can test the theoretical prediction that skill upgrading in the US is correlated with skill upgrading in Chile using a more direct measure of a skill-biased technology at the sectoral level. The data on computer use are not available for 1960 and 1970.³³

The basic estimating equation is:

$$S_{jt} = \beta_1 + \beta_2 S_{jt}^{US} + D_j + D_t + v_{jt}, \quad (21)$$

where S_{jt}^{US} is skilled labor share in the US (recall that S_{jt} is the skilled labor share in Chile), D_j are sector fixed effects, D_t are year dummies, and v_{jt} is an error term. This regression allows me to identify the effect of skill upgrading in the US from *within-sector* variation and after controlling for time effects. This is important because not including these time and sector fixed effects may generate spurious estimates if there are sectoral differences in skill intensity or time effects that are common to both countries. As previously discussed, in some regressions I substitute a proxy for computer use at the sector level in the US for S_{jt}^{US} .

The first column of Table 5 presents results of these estimates. The proxy for skill upgrading in the US is significantly correlated with skill upgrading in Chile, after controlling for sector and year dummies. This result gives additional support to the main prediction of the model: patterns of skill upgrading in the US are correlated with patterns of skill upgrading in Chile at the sectoral level. In addition, the effects are economically relevant. The implicit elasticity is about 0.83 (evaluated at the average values of the shares in the US and Chile). This elasticity predicts an increase of about 150% in the skilled-labor share of the wage bill in Chile, which is equal to 170% from 1960 to 2000. Putting it differently, the estimated elasticities imply that the evolution of skill upgrading in the US explains about 90% of the skill upgrading in Chile from 1960 to 2000.

³³A natural assumption is that computer use was 0 in 1960 and 1970. Most results in this paper are qualitatively similar if I use that assumption.

The next column of Table 5 presents results of studying whether the patterns of skill upgrading vary before and after the liberalization of the mid 1970s. I use a dummy that takes a value of one after 1975 and interact this dummy with skill upgrading in the US. Results suggest that the correlation does not change after the liberalization period if I include in my sample all the two-digit sectors. The next four columns of Table 5 present results of studying whether the effects are different for tradable and non-tradable sectors. The correlation between patterns of skill upgrading in the US and Chile is stronger in the tradable sector. This result may be explained in a model where firms operating in the tradable sector face stronger competitive pressures and the most efficient technologies are skill-biased, as suggested by the model in section 3.³⁴ Evidence regarding changes in the correlation over the post-liberalization period confirms this conjecture because, albeit not very precisely estimated, results suggest that skill upgrading in the tradable sectors is more important in the post-liberalization period.³⁵

The elasticities implicit in the estimates for the tradable and nontradable sectors imply that skill upgrading in the US explains about 103% and 60% of skill upgrading in Chile in the tradable and nontradable sector, respectively. This result is particularly remarkable because skill upgrading has been significantly higher in the tradable sector in the last 40 years, as reported in Table 2.

Table 6 presents the basic estimates of equation (21), but using computer use in the US at the sectoral level instead of the skilled labor share as a proxy for skill upgrading. In this case I cannot study the differential effects of computer use after and before the liberalization period because I do not have data for computer use in the US in 1960 and 1970. Results are mostly similar to results in Table 5, albeit more precisely estimated: skill upgrading in the US has a positive association with skill upgrading in Chile and the results seem to be more significant and more relevant for the tradable sector. For completeness, Table 7 presents the estimates including both the skilled labor share and computer use in the same regression—again, these regressions are not straightforward to interpret from a theoretical point of view. Results suggest that computer use in the US tends to be more correlated with skill upgrading than the wage bill.

It remains to be studied if some particular component of the liberalization process drives these results for the tradable sector. I focus on trade liberalization and FDI at the sectoral level, measuring trade liberalization using an index of implicit taxes at the

³⁴Data suggest that skill upgrading in the US in the tradable and nontradable sectors is roughly similar from 1960 to 2000.

³⁵Attanasio et al. (2004) report a related result for Colombia. They find that skill-biased technical change is more significant in the tradable sector after the Colombian liberalization of the early 1990s.

sectoral level (from Hachette, 1998) and measuring FDI at the sectoral level as (the log of) the stock of real FDI divided by employment in each sector.³⁶ Tables 8 and 9 present the results of these exercises. The interactions are not statistically significant. These results suggest that these two components of the liberalization process are not driving the differential results in the post 1975 period. Future research should analyze this phenomenon in more detail.

In summary, results in this section confirm time series results of section 4 and the predictions of the model of section 3. Patterns of skill upgrading in Chile are related to patterns of skill upgrading in the US at the sectoral level.³⁷

6 TECHNOLOGY IMPORTS TO CHILE

One of the main implications of the model developed in Section 3, which is implicit in the macro and sectoral analyses presented in the previous two sections, is that most technologies used in Chile come from developed countries, in particular from the US. In this section, I present descriptive evidence of (i) the share of the supply of non-transportation machinery and equipment that is imported and (ii) the main importers of machinery and equipment.

The input-output tables of Chile allow me to estimate the share of the domestic supply of machinery and equipment that is imported. Using the 1996 version of the tables (Banco Central of Chile, 2001), I estimate that about 85% of the non-transportation machinery and equipment is imported. In addition, using data on the exporter of non-transportation machinery and equipment imports to Chile from Feenstra et al., 2005, I estimate the share of imports of machinery and equipment that comes from the US and OECD (as a proxy for developed countries). I also present estimates for data-processing equipment, probably a more direct proxy of skill-biased technologies. Results in Table 10 confirm the basic assumption that most machinery and equipment come from developed countries. The US alone sends more than 50% of the non-transportation machinery and equipment imported to Chile, and OECD countries account for at least two-thirds of import share of machinery and equipment and data-processing machines.

As previously discussed, even though a literal interpretation of my results is about correlation between skill upgrading in the US and Chile, I interpret my results as a

³⁶My procedure to construct the stock of real FDI is as follows. I use annual flows of FDI, deflate the flows using the investment deflator, and use an annual depreciation rate of 10%. I have sectoral data on FDI only from 1974. To extend the series backwards I use total FDI flows from Diaz et al. (2005) and the sectoral shares observed in 1974-1975 to allocate the total flows to each sector.

³⁷Other (non-reported) exercises suggest that skill intensity of the sector does not explain differences. This result confirms the results using time series data.

correlation between skill upgrading in developed countries and Chile. The basic evidence supporting this idea come from the findings in Berman et al. (1998) of the existence of pervasive SBTC among developed countries, the evidence presented in this section, and the results in the previous sections.

7 CONCLUSIONS

This paper studies the evolution of the skill premium in Chile over the last 40 years. I use macro and sectoral evidence to analyze the behavior of the skill premium and to test implications of the skill-biased technical change hypothesis in a country that uses technologies developed abroad.

Macro evidence suggests that, after some fluctuations in the 1960s and 1970s, the skill premium increased in the 1980s and has remained roughly constant since then. Specifically, the skill premium has increased significantly from about 82 log points in the 1960s to an average of 120 and 123 log points in the 1980s and 1990s, respectively. I use a CES aggregate production function a la Katz and Murphy (1992) and Krusel et al. (2000) to decompose the evolution of skill premium into supply and demand factors. The relative supply of skilled workers has increased from 0.14 in the 1960s to 0.21 and 0.31 in the 1980s and the 1990s, respectively. Therefore, the relative demand for skilled workers increased significantly in the latter period.

Results using the CES framework also suggest that differences in the relative supply can completely explain the differences between Chile and the US in the level of the skill premium. This is a first piece of suggestive evidence supporting the theory I present to explain the technological bias in Chile. In my model, the relative bias of the technology in Chile should be the same as in the US (as representative of developed countries technologies). This piece of evidence supports that claim.

Next, I present sectoral evidence that supports the view that most of the skill upgrading in Chile over the last 40 years has taken place in all the sectors of the economy (i.e., within-sector skill upgrading). This result supports theories stressing skill-biased technical change to explain the evolution of the relative demand for skilled-labor and does not support theories explaining skill upgrading as a consequence of reallocation of labor demand between sectors.

I provide macro and sectoral evidence of a close relationship between patterns of skill upgrading in the US and Chile. As predicted by my model, macro time-series regressions imply that a proxy for the relative demand for skilled labor in Chile is significantly correlated with skill premium and trade openness in the US, after controlling for the

traditional determinants presented in the literature. Namely, my time series estimates imply that the evolution of the skill premium in the US can explain between 60 and 75% of the increase in relative demand in Chile from 1980 to 2000.

Results using sectoral data, in turn, present the same conclusion: skill upgrading in Chile is correlated with skill upgrading in the US, after controlling for sector and time effects. The sectoral evidence also suggests that this effect is relatively stronger in the tradable sectors, especially in the period of economic liberalization (post 1975). Namely, my estimates imply that skill upgrading in the US explains about 103% and 60% of skill upgrading in Chile in the tradable and nontradable sector, respectively. The data I use do not provide a clear answer of what component of liberalization explains this correlation: including proxies for trade openness and FDI penetration does not capture the change in the correlation in the period after 1975. Further research using more detailed data should address this point.

8 APPENDIX: CONSTRUCTION OF ECONOMIC SECTORS USING THE UNIVERSITY OF CHILE EMPLOYMENT SURVEY

The University of Chile survey allows me to construct 21 2-digit ISIC sectors that are comparable over the complete period. The detailed definitions of the sectors come from DECON(undated). Using this information, I follow Robbins (1994b) and exclude from my sample the agriculture, mining, and public administration and military sectors. Table A.1 presents the sectors included in the analysis.

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Figure 1: The Wage Premium in Chile

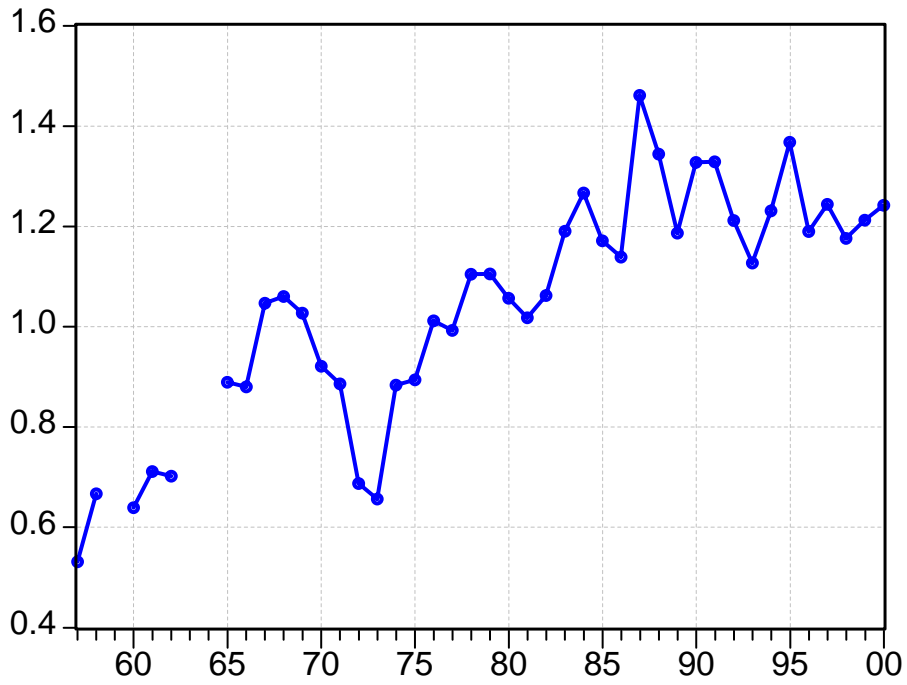


Figure 2: Relative Supply in Chile

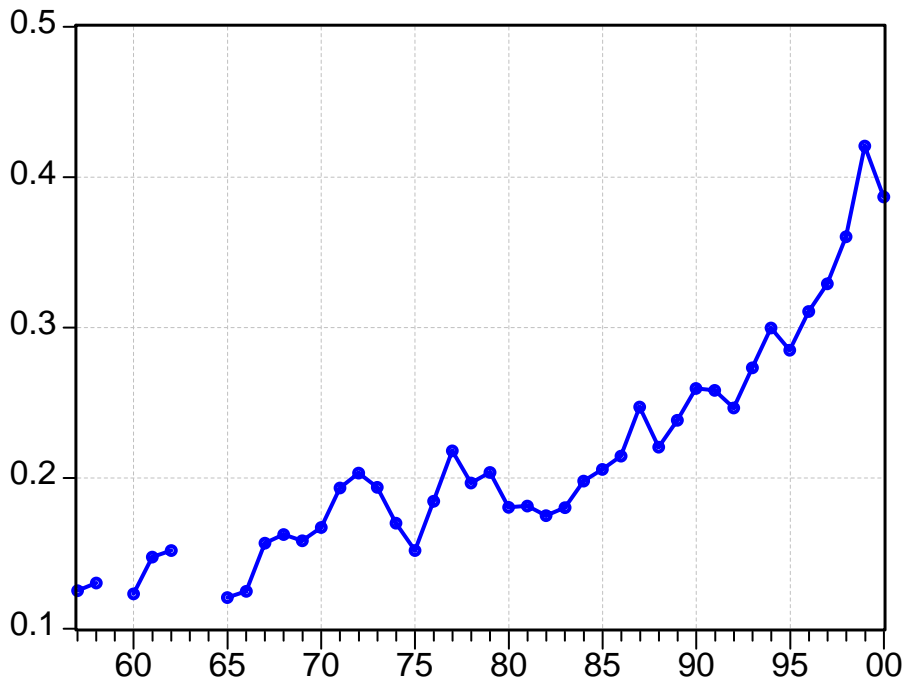


Figure 3: Relative Demand in Chile

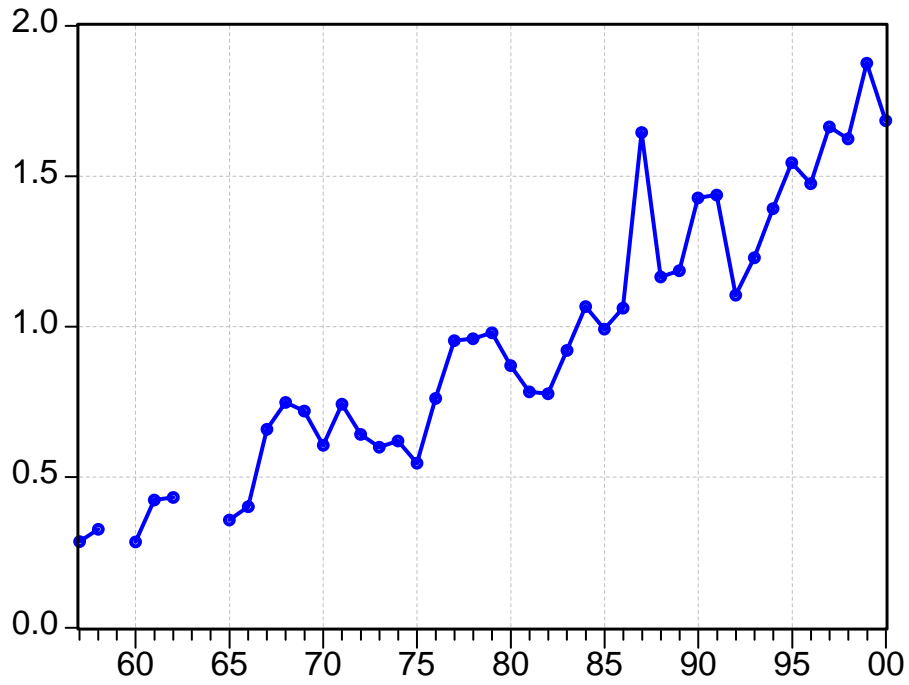


Figure 4: Equipment Capital per Skilled Labor

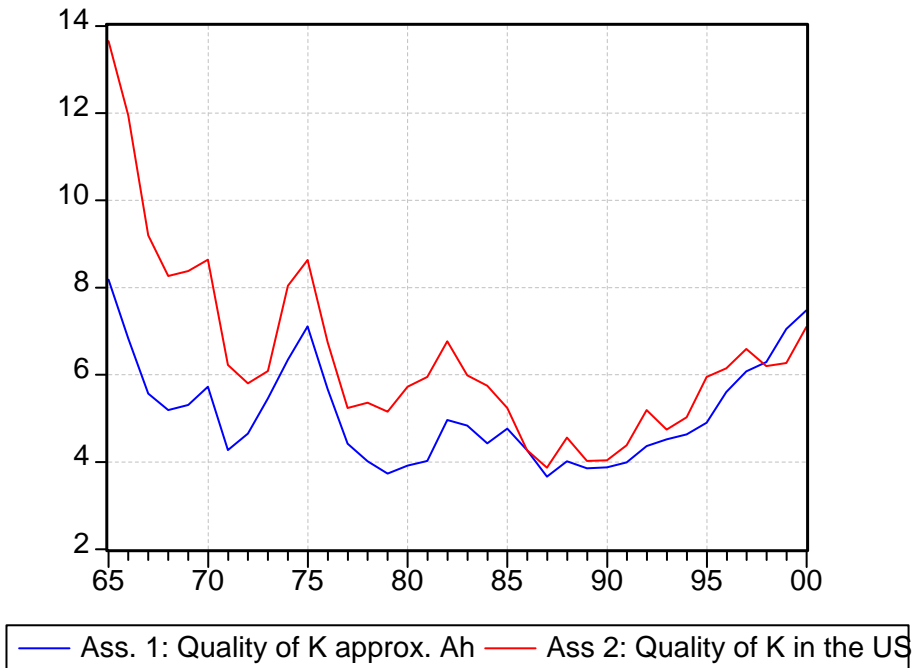
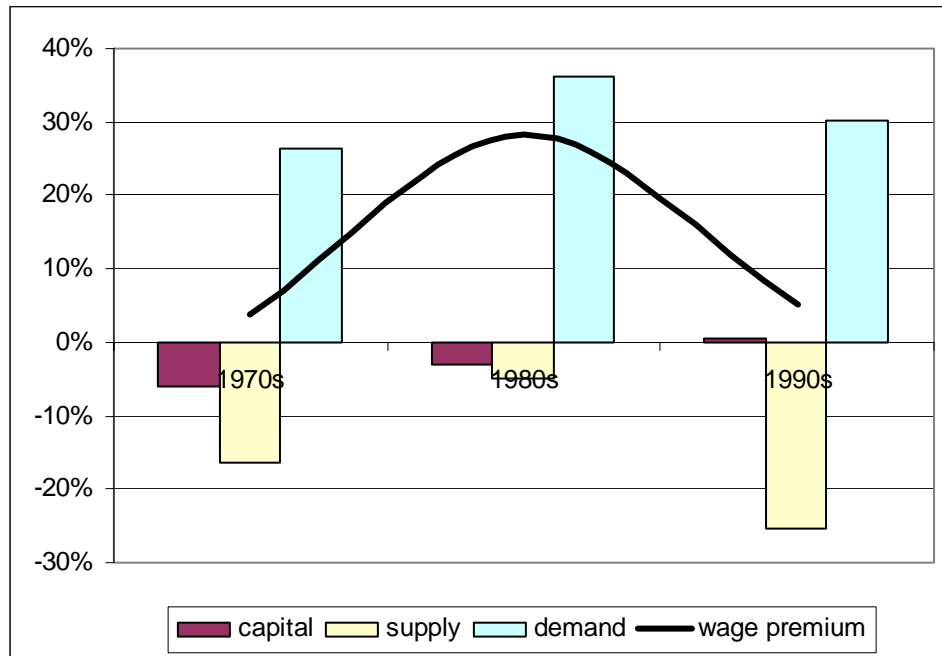


Figure 5: Decomposing Wage Premium Growth, by Decade

Panel A: Assumption 1: Quality of Capital equal to A_h



Panel B: Assumption 2: Quality of Capital in the US

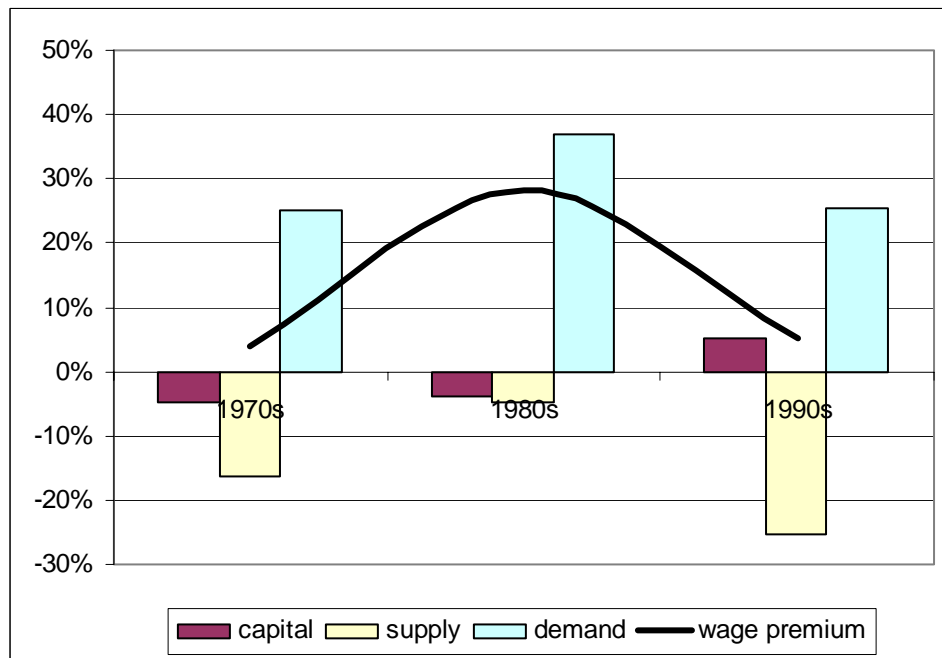


Figure 6: Skill Premium in Chile and the US

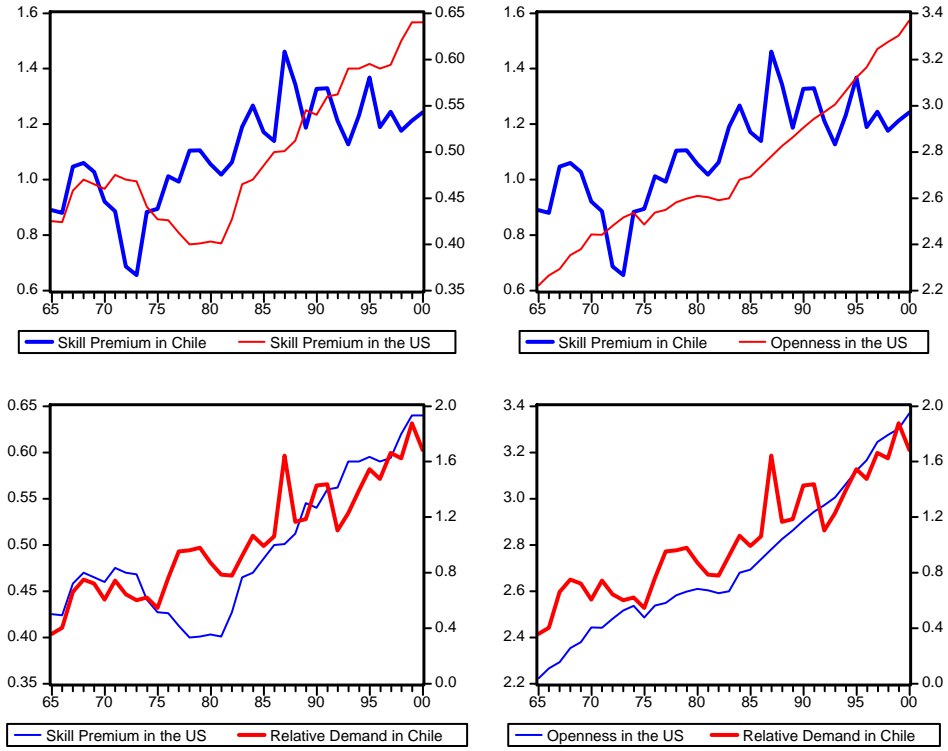


Table 1: College/High School Wage Premium (in log points)

	Middle East and North Africa		East Asia and Pacific		Developing Europe and Central Asia		Latin America and the Caribbean		High Income	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Kuwait	0.23		0.24		0.22		0.41		0.41	
Egypt	0.39		0.31		0.24		0.43		0.43	
Tunisia	0.40		0.35		0.27		0.47		0.47	
Iran	0.58		0.35		0.35		0.47		0.47	
Morocco	0.79		0.47		0.36		0.47		0.47	
Sub-Saharan Africa			0.49				0.49		0.49	
Mean	0.49		0.58				0.52		0.52	
Median	0.48		0.61				0.54		0.54	
Ethiopia	0.16		0.63				0.58		0.58	
Zimbabwe	0.28		0.66				0.59		0.59	
Uganda	0.30		0.68				0.61		0.61	
Cameroon	0.30		0.95				0.61		0.61	
Ghana	0.44						0.69		0.69	
South Asia										
Mean	0.47		0.53				0.69		0.69	
Median	0.48		0.51				0.70		0.70	
Burkina Faso	0.48		0.35				0.70		0.70	
South Africa	0.51						0.70		0.70	
Zambia	0.53		0.49				0.70		0.70	
Kenya	0.57		0.53				0.75		0.75	
Cote d'Ivoire	0.66		0.77				1.44		1.44	
Tanzania	0.69									
Botswana	0.96									
Sudan	0.47						0.69		0.69	
Burkina Faso	0.48						0.70		0.70	
South Africa	0.51						0.70		0.70	
Zambia	0.53						0.70		0.70	
Kenya	0.57						0.75		0.75	
Cote d'Ivoire	0.66						1.44		1.44	
Tanzania	0.69									
Botswana	0.96									
Italy									Italy	
Norway									Norway	
Netherlands									Netherlands	
Australia									Australia	
Israel									Israel	
UK									UK	
Germany									Germany	
Denmark									Denmark	
Canada									Canada	
Belgium									Belgium	
Austria									Austria	
Spain									Spain	
Finland									Finland	
Switzerland									Switzerland	
Greece									Greece	
Portugal									Portugal	
Sweden									Sweden	
France									France	
USA									USA	
Cyprus									Cyprus	
Japan									Japan	

Source: Author's calculations using data from Contreras (2002) for Chile; Autor et al. (2005) for the US; and Acemoglu (2003b), Banerjee and Duflo (2005), and Caselli and Coleman (2006) for other countries.

Table 2: Skill Upgrading in Chile, Sectoral Evidence

Panel A: All Sectors				
	Total (1)	Between (2)	Within (3)	Within Share (3)/(1)
1970-1961	0.58%	0.15%	0.44%	75.90%
1980-1970	0.65%	0.07%	0.58%	89.30%
1990-1980	1.34%	0.18%	1.17%	87.61%
2000-1990	0.84%	0.07%	0.77%	92.04%

Panel B: Tradable Sectors				
	Total (1)	Between (2)	Within (3)	Within Share (3)/(1)
1970-1961	0.13%	-0.01%	0.14%	108.85%
1980-1970	0.64%	0.06%	0.59%	91.81%
1990-1980	1.98%	0.11%	1.89%	95.50%
2000-1990	0.36%	0.00%	0.35%	99.56%

Panel C: Non-Tradable Sectors				
	Total (1)	Between (2)	Within (3)	Within Share (3)/(1)
1970-1961	0.75%	0.21%	0.56%	73.85%
1980-1970	0.56%	-0.02%	0.58%	103.68%
1990-1980	1.15%	0.24%	0.93%	81.00%
2000-1990	0.88%	-0.01%	0.89%	100.91%

Table 3: Times-Series Evidence: Estimation in Levels

Dependent Variable: Relative Demand			
Variable	(1)	(2)	(3)
Wage Premium in the US	2.0807 (0.8284)		1.8739 (0.7501)
		1.3312 (0.4210)	1.3527 (0.5696)
Openness in the US			
Output gap	0.6743 (0.4584)	0.4540 (0.5533)	0.5625 (0.4646)
Real Minimum Wage	-0.2943 (0.1994)	-0.3455 (0.1977)	-0.4986 (0.2203)
Structural Reforms	0.3712 (0.4646)	0.2432 (0.3304)	0.9408 (0.4005)
Price of unskilled goods	-0.2752 (0.1862)	-0.2542 (0.1462)	-0.3286 (0.1784)
Trend	0.0005 (0.0117)	0.0186 (0.8761)	-0.0510 (0.0227)
N	38	40	38
R ²	0.8534	0.8761	0.883
ADF-test	-4.6285	-4.6038	-5.6767

Notes: Newey-West HAC standard errors

Table 4: Times-Series Evidence: Estimation in First Differences

Dependent Variable: Relative Demand			
Variable	(1)	(2)	(3)
Wage Premium in the US	2.3966 (0.8769)		2.1424 (0.0620)
		1.5966 (0.4472)	1.3810 (0.5892)
Openness in the US			
Output gap	0.7211 (0.5601)	0.4383 (0.5496)	0.5383 (0.4427)
Real Minimum Wage	-0.3445 (0.2495)	-0.3884 (0.2130)	-0.5311 (0.2330)
Structural Reforms	0.4775 (0.3701)	0.3901 (0.3384)	1.0363 (0.4048)
Price of unskilled goods	-0.3172 (0.2070)	-0.2454 (0.2190)	-0.3649 (0.1788)
Trend	-0.0064 (0.0134)	-0.0336 (0.0165)	-0.0583 (0.0239)
N	38	40	37
R ²	0.2515	0.2931	0.4816

Notes: Newey-West HAC standard errors

Table 5: Sectoral Evidence, including the Wage Bill in the US

Dependent Variable: Skilled Labor Share of Wage Bill in Chile						
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Skilled Labor Share of Wage Bill in the US	1.5836 (0.7384)		2.1000 (1.9250)		1.2724 (0.7242)	
Skilled Labor Share of Wage Bill in the US*Pre-Liberalization		1.1189 (0.5007)		0.3243 (1.9248)		1.0100 (0.5288)
Skilled Labor Share of Wage Bill in the US*Liberalization		1.1285 (0.5270)		0.9849 (1.5635)		0.9606 (0.5489)
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	0.7796	0.7756	0.5776	0.5652	0.84600	0.8467
R ²	100	100	45	45	55	55
Sample	All sectors	All sectors	Tradable	Tradable	Non-Tradable	Non-Tradable

Robust standard errors clustered at the sector level.

Table 6: Sectoral Evidence, including Computer Use in the US

Dependent Variable: Skilled Labor Share of Wage Bill in Chile			
Variable	(1)	(2)	(3)
Computer Use in the US	1.3479 (0.6539)	2.0099 (0.8047)	0.9835 (0.8826)
Sector dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
N	0.8193	0.751	0.8578
R ²	60	27	33
Sample	All sectors	Tradable	Non-Tradable

Robust standard errors clustered at the sector level.

Table 7: Sectoral Evidence, including the Wage Bill and Computer Use in the US

Dependent Variable: Skilled Labor Share of Wage Bill in Chile			
Variable	(1)	(2)	(3)
Skilled Labor Share of Wage Bill in the US	0.2495 (1.1208)	-0.7107 (2.8712)	0.3097 (1.2187)
Computer Use in the US	1.3043 (0.7415)	2.1115 (0.8654)	0.9275 (0.9880)
Sector dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
N	0.8796	0.7534	0.8583
R ²	60	27	33
Sample	All sectors	Tradable	Non-Tradable

Robust standard errors clustered at the sector level.

Table 8: Sectoral Evidence: FDI and Tariffs, using the Wage Bill in the US

Dependent Variable: Skilled Labor Share of Wage Bill in Chile		
Variable	(1)	(2)
Skilled Labor Share of Wage Bill in the US	4.0523 (3.3289)	2.6613 (1.8817)
FDI	0.0065 (0.0125)	
Tariffs		-0.0008 (0.0005)
Skilled Labor Share of Wage Bill in the US * FDI	-0.1381 (0.1314)	
Skilled Labor Share of Wage Bill in the US * Tariffs		0.0035 (0.0023)
Sector dummies	Yes	Yes
Year dummies	Yes	Yes
N	0.6004	0.5986
R ²	45	45
Sample	Tradable	Tradable

Robust standard errors clustered at the sector level.

Table 9: Sectoral Evidence: FDI and Tariffs, using Computer Use in the US

Dependent Variable: Skilled Labor Share of Wage Bill in Chile		
Variable	(1)	(2)
Computer Use in the US	4.4443 (3.5583)	2.0257 (0.9706)
FDI	0.0315 (0.0597)	
Tariffs		-0.0148 (0.0615)
Computer Use in the US * FDI	-0.1657 (0.2320)	
Computer Use in the US* Tariffs		0.0078 (0.0537)
Sector dummies	Yes	Yes
Year dummies	Yes	Yes
N	0.7635	0.7544
R ²	33	33
Sample	Tradable	Tradable

Robust standard errors clustered at the sector level.

Table 10: Share of Developed Economies in Imports of Non-Transportation Machinery and Equipment

	US	OECD
1962		
Machinery and Equipment	50.01%	98.50%
Data Processing Machines	31.23%	99.26%
1970		
Machinery and Equipment	44.68%	94.33%
Data Processing Machines	24.12%	80.21%
1980		
Machinery and Equipment	38.23%	86.29%
Data Processing Machines	45.13%	91.58%
1990		
Machinery and Equipment	25.23%	83.27%
Data Processing Machines	46.97%	77.64%
2000		
Machinery and Equipment	38.79%	74.28%
Data Processing Machines	55.91%	67.56%

Sources: Author's calculations using Feenstra et al. (2005)

Table A1: Two-Digit Industries

Manufacture of food products, beverages, and tobacco products
Manufacture of textiles, dressing, and leather products
Manufacture of wood and wood products
Manufacture of paper and paper products, publishing and printing
Manufacture of chemicals and chemical products, plastics and rubber products, petroleum products
Manufacture of other non-metallic mineral products
Manufacture of basic metals
Manufacture of fabricated metal products, machinery and equipment
Other manufacturing industries
Construction
Wholesale and retail trade
Hotels and restaurants
Financial intermediation and real estate
Personal service activities
Education and health services
Sanitation services
Other community and social services
Transportation
Communications
Electricity, gas, steam and hot water supply
Collection, purification and distribution of water

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