Explaining Rates of Return to Schooling in Three South American Countries

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ABSTRACT

This paper investigates rates of return to schooling in three South American countries, Argentina, Brazil, and Chile. I look at overlapping time periods during which each country has liberalized its trade policies. Examining wage differentials by level of education, I find that trade reform is associated with higher returns to university education in all three countries, as a result of rising demand for skilled labor. I also estimate internal rates of return to schooling that account for the costs as well as the benefits of education at different education levels. My results suggest that private and social economic returns have been low in these countries relative to those in other countries. The most striking finding is the very low rates of return to primary education in Argentina. This finding may reflect internal inefficiencies in the Argentine primary education system. My results indicate that, in general, labor demand has been weak or the quality of education has been poor. Rates of return in these countries do not generally conform to the predictions of theory and international evidence by falling over time.

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1. INTRODUCTION

In this paper I investigate rates of return to schooling in three South American countries: Argentina, Brazil, and Chile. I attempt to answer three questions: What is the effect of trade liberalization on the wages of workers with different levels of education? How large are the private and social returns to schooling, and how do the returns for primary, secondary, and university education compare? Are the patterns and trends in the returns to education consistent with the predictions of theory and international evidence? I chose to look at Argentina, Brazil, and Chile because during the time periods studied each country liberalized its trade policies; income inequality is high in each country, making the potential effect of trade liberalization on relative wages particularly relevant for equity considerations; and in two of the countries, Argentina and Brazil, data on social rates of return to education are not available since the 1980s and a time series of returns has never been estimated.

Standard trade theory predicts that trade liberalization will raise the relative wages of unskilled workers, increasing the returns to primary education. However, recent studies in Latin America suggest that the opening of trade has increased the returns to university education and thereby raised income inequality. After examining the economies and education systems of the three countries in Section 2, in Section 3 I develop a conceptual framework to explain the determinants of rates of return and present estimates of wage differentials by education level. I find that in each country rising labor demand increased returns to university education one to three years following trade liberalization, but in Brazil the increase in demand appears temporary. In Argentina and

Chile, demand for high school graduates also rose. These findings are consistent with hypotheses about trade reform that focus on the role of skill-biased technology.

Given rising enrollment rates, theory and international evidence predict that rates of return will decrease over time. Rates of return do not generally fall in Argentina, Brazil, or Chile, suggesting that labor demand has been increasing or the quality of education has been improving.

In Section 4, I extend the analysis by calculating a time series of private and social internal returns to schooling, which reflect the costs of education in addition to the benefits. Private and social returns are the standard means to assess the productivity of an investment in education for the individual and the state, respectively. My results indicate that private and social returns at certain education levels in these countries have been lower than international averages. Most striking, the private and socials return to primary education in Argentina appear extremely low, well below the expected return on alternative investments such as physical capital. My findings in these countries suggest that labor demand has been weak or the quality of education has been poor. The finding in Argentina may reflect internal inefficiencies in the Argentine primary education system that cause poor quality of education. Low private rates of return imply that incentives for workers to attend school have been low, although not enough to prevent enrollment from rising. I conclude in Section 5 and discuss some policy implications.

2. ECONOMIES AND EDUCATION SYSTEMS

2.1 Economies

Table 1 presents some indicators of the economies and education systems in each country, over the time periods of study. Appendix Figure B1 shows trends in GDP per capita. The time period studied for Chile, 1960-1985, differs substantially from those studied for Argentina and Brazil: 1975-1998 and 1981-1999, respectively. I chose these years because they were used in the estimates of returns to education that I modify in Sections 3 and 4.

Table 1. Development and Education Indicators During Time Periods of Studies: Argentina, Brazil, Chile

All Monetary Units: 1995 US$

Indicators	Argentina		Brazil		Chile	
	1975	1998	1981	1999	1960	1985
Economy						
GDP per Capita:	7310	8686	3980	4507	1968	2577
GDP (Billions):	190	306	495	748	15	31
Population (Millions):	26	35	124	166	8	12
Gini Coefficient:	0.34[2]	0.44[7]	0.59[3]	0.62[6]	0.41[1]	0.47[5]
Education						
Primary Enroll (% Gross):	106.1	119.7	97.8[4]	148.5	104.3[1]	105.0
Secondary Enroll (% Gross):	53.8	89.0	33.5[4]	107.5	37.4[1]	66.9
University Enroll (% Gross):	26.6	46.3	11.2[4]	17.9	9.1[1]	15.6

Source: World Bank (WDI), except Gini coefficients from de Janvry and Sadoulet (2000).
[1]1970 [2]Average of 1970 and 1980 [3]1979 [4]1980 [5]1987 [6]1993 [7]1994.

Argentina, Brazil, and Chile also differ during the relevant time periods with respect to their size and wealth. Brazil's population and GDP have been 15 and 30 times those of Chile, respectively. Argentina falls in the middle, with a population of about 3 times the size of Chile's and a GDP about 40% that of Brazil. Argentina, Brazil, and Chile's GDPs per capita (1995 US$) in the last year each country was studied were: $8686 (1998), $4486 (1999), and $2577 (1985), respectively.

Income growth in all three countries was very low over the periods studied: GDP per capita grew by 0.7% per year in both Argentina and Brazil and 1.1% per year in Chile.[1] Income inequality is high in all three countries, represented in Table 1 by Gini coefficients.[2] Brazil, with a Gini coefficient of 0.62 in 1999, is known to have one of the highest rates of income inequality in the world.

Decades of import substitution policies had left all three economies closed and inefficient by the 1970s, but each country concentrated widespread and substantial trade liberalization into a small number of years. In Brazil, the vast majority of trade reform occurred from 1990-1993 (Arbache, Dickerson, & Green, 2004).[3] Trade reform was also pursued from 1990-1993 in Argentina. Argentina sharply lowered barriers to trade from 1976-1982, but then largely reversed the reforms in 1983 during a period of recession, inflation, and overvaluation (Robbins, 1996). In Chile, the important period of trade liberalization was 1975-1979.[4] Table 2 shows average tariffs in each country before and after the important periods of trade reform. The fall in tariffs is illustrative of the reductions in non-tariff barriers that occurred simultaneously.

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[1] Chile has made miraculous economic progress since 1985. The economy today is substantially more developed than it was during the time period considered here.

[2] Gini coefficients reflect the inequality of income distribution, measured here in terms of household income per capita, on a scale of 0 to 1 in which 0 is minimum inequality and 1 is maximum inequality.

[3] Some modest reduction in tariffs were introduced in 1988 but did not significantly affect domestic industries because of continued reliance on non-tariff barriers (Kume, 2000, as cited in Pavcnik et al., 2002; Hay, 2001, as cited in Pavcnik et al., 2002; Arbache et al. 2004). In addition, the average tariff climbed slightly between 1995 and 1998 (Pavcnik et al., 2002).

[4] Average tariffs were increased slightly in the depression of 1982-1983, but then lowered again.

Table 2. Average Tariffs Before and After Periods of Trade Liberalization: Argentina, Brazil, Chile (Percent)

Country (Important Period of Trade Liberalization)	Average Tariff (Percent)	
	Beginning Year	Ending Year
Argentina (1990-1993)	100+	11
Brazil (1990-1993)	34	14
Chile (1975-1979)	44	10

Source: Argentina, from Robbins (1996); Brazil, from Pavcnik et al (2002); Chile, from Library of Congress (2003).

Despite certain caveats, Brazil is the best case study of the impacts of trade liberalization, as trade reform was the only major economic change taking place in that country besides general fluctuations in the economy and restrictive macroeconomic policies. Trade liberalization measures in that country predated other, less significant, reforms -- namely, privatization, deregulation of the labor market, and deregulation of international investment and banking -- by several years. In Chile and Argentina, however, trade liberalization accompanied other, lesser reforms. In both countries, reforms included privatizations and the introduction of more free market policies overall. In Chile, reforms also included suppression of trade unions, and in Argentina the government overvalued the domestic currency and stabilized the economic environment (Robbins, 1996; Green, Dickerson, & Arbache, 2001). Thus, isolating the impact of trade reform on returns to schooling is more difficult in Argentina and Chile than in Brazil.

Some additional considerations limit our ability to measure the effect of trade opening on rates of return in all three countries. The economic environment changed before, during, or after periods of trade reform in each country. Chile, Argentina, and Brazil fell into a recession or depression from 1982-1983, 1987-1990, and 1989-1992, respectively. Argentina suffered hyperinflation in 1989. Moreover, except during two

economic downturns, income growth was associated with trade opening. All changing variables, including trade reform, have lag effects, whose durations are unknown.

2.2 Education Systems

Table 3 shows the average duration of education levels among countries. Brazil has four education levels instead of three. Some researchers have interpreted Brazil's second education level as lower secondary, but I consider it upper primary, as eight years of education is mandatory in Brazil.

Table 3. Average Duration of Education Levels: Argentina, Brazil, Chile (Years)

Education Level	Average Duration (Years)		
	Argentina	Brazil	Chile
Primary	8	4	8
Upper Primary		4	
Secondary	5	3	4
University	5	5	5
Total	18	16	17

The bottom of Table 1 presents gross enrollment rates for each schooling level. Appendix Figures B2, B3, and B4 show trends in the enrollment rates.[5] Enrollment rates rose at the secondary and university levels in all three countries. Until the last years of the relevant periods, Argentina had much higher gross university enrollment rates than Chile and Brazil. Argentina had substantially higher gross secondary enrollment rates than Brazil. Brazilian enrollment rates are low by international standards, given that country's per capita income (Birdsall & Sabot, 1996). Notable, however, is the dramatic expansion of secondary enrollment in Brazil. Enrollment rates represent the flow of

[5] Gross enrollment rates represent the total number of students enrolled in the relevant level as a percentage of school-age population as defined by UNESCO.

educated labor; the stock of educated labor is determined by the proportion of workers in the population who have attained a given education level. Rising enrollment rates imply an increase in the stock of educated labor, which I will refer to as educational expansion, in every country at the secondary and university levels.

Over the relevant time periods, public tuition was free at all schooling levels in Argentina and Brazil, but a large percentage of universities in Chile charged tuition. Primary education is compulsory for all three countries. Private education is available at each level in the countries, and a significant share of university education is provided privately. All three countries are known to have experienced high grade repetition and low graduation rates during the relevant time periods (Tannen, 1991; Cossa, 1990), which suggests the average quality of education may be low in each country.[6]

Riveros (1990) provides estimates of government expenditure on education per student for Chile, and I estimate outlays for Brazil and Argentina for a number of years in which component data are available (Table 4; Appendix C). That in Brazil and Argentina spending on secondary and university levels fluctuate more than we would expect, brings into question the reliability of my estimates.[7] It is clear, however, that at the primary and secondary school levels, Chile spends less per student than Argentina and Brazil. At the university level, spending is comparable during the early years in each country, and then Brazil spends more than Argentina and Chile.

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[6] Repeaters are evidenced by gross enrollment ratios that exceed 100% in all three countries.

[7] Estimates by Riveros fluctuate less and appear more reliable. Riveros accounts for actual expenditure, as opposed to reported expenditure, which I use in my estimates. He distributes current investment levels across time in order to estimate per capita cost levels. It is reasonable to attribute some of the variation in estimates for Brazil and Argentina to the inclusion of multiyear investments in certain individual years.

Table 4. Government Education Expenditure Per Student by Schooling Level: Argentina, Brazil, Chile (1995 US$)

Years			Argentina			Brazil			Chile		
Arg	Bra	Chi	P	S	U	P	S	U	P	S	U
1975	1981	1960							227	431	2554
1976	1982	1961									
1977	1983	1962									
1978	1984	1963									
1979	1985	1964									
1980	1986	1965		859	2318	572	716	2943	124	359	3305
1981	1987	1966				750	934	3994			
1982	1988	1967									
1983	1989	1968							193	558	3012
1984	1990	1969									
1985	1991	1970		507	970						
1986	1992	1971									
1987	1993	1972							193	403	2531
1988	1994	1973									
1989	1995	1974									
1990	1996	1975				614	1485	5479			
1991	1997	1976				623	1364	5406	205	315	1763
1992	1998	1977				623	666	5133			
1993	1999	1978							249	376	2145
1994		1979			1662						
1995		1980									
1996		1981	694	1251							
1997		1982							260	387	2183
1998		1983	899	1154	1712						
		1984									
		1985							282	392	2194

P: primary education; S: secondary education; U: university education.
Monetary units are 1995 US$.
Source: for Argentina and Brazil, as explained in text; for Chile, modified from Riveros (1990).

3. WAGE DIFFERENTIALS BY EDUCATION LEVEL AND TRADE LIBERALIZATION

In this section, I investigate returns to schooling in terms of wage differentials by level of education. I develop a framework to explain the determinants of rates of return, then present theory and empirical evidence on the effects of trade liberalization on wage premiums. I discuss wage differentials and present estimates for Brazil, Argentina,

and Chile. Finally, I examine whether rates of return have fallen as theory predicts and analyze the effect of trade liberalization on the returns.

3.1 Conceptual Framework

Relative wages can be explained through a standard supply-demand model for different skill levels (Pessino, 1995, for example). Assuming imperfect substitution among labor types and that labor is a normal good, an increase in supply of more educated workers relative to demand will decrease their relative wage, leading to a fall in the return to schooling for these workers. Because enrollment rates represent the flow of educated labor, which is small compared to the stock of skilled labor, increases in enrollment rates imply small decreases in relative wages.[8] On the demand side, policy and macroeconomic changes affect the wages of workers and the proportion of unemployed by education level. A multitude of potentially interrelated factors may cause the demand for workers by education level to shift. Among these factors are changes in income, inflation, protection, technology, sectoral structure, investment, and productivity. In contrast to changes in enrollment rates, which have only small effects on the total supply of educated workers in the short run, changes in demand could have large effects over the short and medium terms. It also seems reasonable that a sustained macroeconomic change, such as globalization, may put long term pressure on relative wages.[9]

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[8] Other supply side factors that may influence relative wages but fall outside the scope of this study include age, gender, and geographic region.

[9] There may be a self-controlling limit to the impacts of labor demand on rates of return. As rates of return grew higher, we might expect the larger incentives to invest in education to drive up enrollment rates, to the extent that educational expansion is based on popular demand rather than government choices. As supply expanded, returns would eventually fall.

Demand for graduates of different education levels is also influenced by the quality of education. Behrman and Birdsall (1983) and Andres (2003) find that the returns to schooling in Brazil and Argentina, respectively, rise with school quality. Changes in average school quality should have small effects on wage premiums in the short run. Average education quality is presumably influenced by the level of investment in education in terms of government outlays per student and tuition.

Given rising enrollment rates, we should expect returns to education to fall gradually, with policy changes and macroeconomic shocks associated with labor demand accounting for most of the short term variance. If returns do not decline over time, demand side factors are at play. This explanation is consistent with observations from other countries (Murphy, Riddle, & Romer, 1998, for example), including Brazil.[10]

3.2 Trade Liberalization: Theory and Empirical Evidence

A separate body of research deals with the effect of trade liberalization on wage premiums. The standard theorem, developed by Stolper and Samuelson and based on the Hecksher-Ohlin model, suggests that trade liberalization raises the price of developing countries' abundant factor, unskilled labor, relative to the price of skilled, or educated, labor. Early trade reform in the East Asian newly-industrialized economies was associated with an increase in the returns to primary school, a finding consistent with standard trade theory (Arbache et al., 2004).

However, recent empirical studies, concentrated almost exclusively in Latin America, suggest a positive relationship between trade reform and the relative returns to

[10] Blom et al. (2001), using evidence from Brazil, suggest that, to the extent that returns change slowly and persistently, structural mechanisms associated with labor supply are most likely the major determinant of rates of return.

skilled workers. Robbins (1996) surveys findings that the returns to skilled labor grew after trade liberalization in Argentina, Uruguay, Malaysia, and the Philippines. Robbins (1994) examines the structure of wages in Chile and finds that the returns to skilled labor grew following trade reform. Robbins and Gindling (1999) investigate relative wages in Costa Rica and find that the skill premium rose after trade reform. Hanson and Harrison (1999) examine relative wages and employment in Mexico and find an increase in skilled workers' relative wages following the opening of trade. Several researchers find an increase in returns to university education following trade reform in Brazil (Green et al., 2001; Blom, Holm-Nielson, & Verner, 2001; Pavcnik et al., 2002; Machado & Moreira, 2000; Ferreira & Barros, 1999; Barros & Ramos, 1996).

Researchers have offered preliminary hypotheses to explain this unexpected widening of the wage distribution, arguing that trade reform increases the demand for skilled workers by stimulating capital inflows and bringing technology. In one argument, demand for skilled workers rises because capital is directly complementary with skilled labor. In another argument, which Robbins (1996) has named the "Skill-Enhancing-Trade Hypothesis," foreign direct investment and increased imports bring technology, which is assumed to be skill-biased, to developing countries (Arbache et al., 2004; Berman, Bound, & Machin, 1998). Others have suggested that trade reform may bring only temporary increases in the skill premium. Pissarides (1997) theorizes that the transfer of technology involves skilled labor, so even if transferred technology is skill-neutral, demand for skilled labor will rise temporarily after trade reform. Goldin and Katz (1998) argue that demand for educated labor rises initially but declines as other workers learn to use the transferred technology. Another hypothesis that suggests

temporary increases in the skill premium is that elasticity of supply of skilled labor is greater in the long than in the short run, but elasticity of supply of unskilled labor is high in both cases (Arbache et al., 2004).

3.3 Measuring Wage Differentials and Returns to Education

Earnings differentials associated with additional schooling are typically estimated through an econometric earnings function (Mincer, 1974), in which the dependent variable is the logarithm of wages and the explanatory variables are years of schooling, years of labor market experience, and its square.[11] The coefficient on years of schooling represents the average wage gains to one additional year of schooling, regardless of the educational level referred to by the year of schooling. By converting the continuous years of schooling variable into a series of dummy variables that indicate if a person has completed different education levels, one obtains Mincer coefficients that represent wage gains to schooling at different educational levels.

Mincer coefficients assume that educational categories adequately specify skill levels in the labor market. This assumption is crude when categories are specified only be three levels that do not account for alternatives to traditional schooling such as vocational schools, nonformal education, and on-the-job training. Moreover, the Mincerian model does not incorporate school quality and may therefore cause upward biases in the estimated wage differentials by education level (Behrman & Birdsall, 1983).

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[11] The standard proxy for labor market experience, used when there is a lack of information on job experience, is age minus years of schooling minus six. In the Mincerian model, the initial conditions affect the intercept and slope of the future educational profile. The method assumes stability of the economic environment. See Heckman, Lockman, and Todd (2003) for criticism of this assumption.

Wage differentials should be measured after taxes to accurately reflect income. In practice, however, calculations made for developing countries usually measure earnings before taxes, as tax data can be difficult to obtain and personal income taxes are generally less important than they are in developed countries (Perkins, 2001).

Wage premiums are representative of an average typical outcome of each schooling level, but this interpretation does not reflect differences found through disaggregating wage differentials by industry, occupational category, sex, or within educational groups.[12]

One can present wage gains from education in terms of gross and marginal returns to education by schooling level.[13] I calculate gross returns as the ratio of earnings at a given level of education to the earnings of the average person that did not complete primary school. Marginal returns are the ratio of earnings associated with a given education level to the earnings associated with the preceding level. Notice that when calculated in this way gross and marginal returns to primary education are equal.

Because of their nature as relative ratios, gross and marginal returns for a given education level depend on the wages associated with lower levels. If wages of secondary school graduates fall but wages of university graduates stay constant, the marginal return to university education will rise. Comparing gross to marginal returns highlights which component of a relative ratio is causing the change in that ratio.

3.4 Estimates for Brazil, Argentina, and Chile

My estimates of wage differentials are based on Mincer coefficients by education level provided by Green et al. (2001), for Brazil; by Cossa (2000), for Argentina; and by Riveros (1990), for Chile (Appendixes D, E, and F). These studies are highly regarded and are consistent with other estimates, despite the use of different datasets and

[12] For example, Blom et al. (2001) show that returns to schooling within education groups differ considerably across the wage distribution in Brazil. Cossa (2000) computes separate rates of return in Argentina by sex and finds that males have higher opportunity costs and rates of return than females at all education levels.

[13] The conventional term 'return' is misleading in these cases because the calculation does not account for education costs.

methodologies.[14] Data for each country is taken from yearly cross-sectional household surveys. Each survey is well reputed regarding sample design quality and data compatibility over time.

Differences among studies prevent a close comparison of the patterns in returns across countries. The explanatory variables differ somewhat among studies. Namely, Green et al. and Riveros control for work experience, but Cossa does not. In Brazil, the survey is nationally representative, but in Argentina and Chile the surveys represent Greater Buenos Aires and Greater Santiago and are therefore only representative of metropolitan workers. Tannen (1991) finds that geographic differences in rates of return by schooling levels in Brazil were not substantial in 1980, and meta-analysis suggests rates of return are similar for urban and rural workers in Brazil. Whether these findings have applicability to the other countries, however, is unclear. In Brazil and Chile, the surveys exclude the unemployed. I correct for unemployment in Chile,[15] but lack of time series data prevents me from doing so in Brazil. The effect of this selectivity bias on wage differentials is unclear.

For Brazil, I modify estimates of wage differentials by education level (see Appendix D) provided by Green et al. In order to obtain wage premiums in Argentina, I use Mincer coefficients provided by Cossa and my own rough estimate of income for primary graduates, Y_a (see Appendix E), to calculate wages for secondary school graduates and university graduates, such that:

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[14] Other existing estimates are: for Brazil, Tannen (1991), Barros and Ramos (1996), Ferreira and Barros (1999), and Blom et al. (2001); for Argentina, Pessino (1993), Pessino (1995), and Andres (2003), although none of these studies disaggregate returns by education level; and for Chile, Corbo and Stelcner (1983), Uthoff (as cited in Riveros, 1990), and Beyer (2000). Wage differentials are comparable for every country with the exception of Beyer's less precise estimates for university education in Chile.

[15] Riveros corrects for unemployment in estimating internal rates of return in Chile, but not for wage differentials. I adjust wage differentials to compensate for unemployment at each education level using the same unemployment rates that Riveros uses in his adjustment to internal rates of return.

(1), $Y_b = \left(Y_a(1+M_s)^m\right)$

where Y_b = the earnings of a secondary school graduate; and M_s = the average of the male and female Mincer coefficients, which I weight by sex, for secondary education.

3.5 Marginal and Gross Returns for Brazil, Argentina, and Chile

Appendix Tables A1, A2, and A3 present marginal and gross returns to education. I do not calculate gross returns for Chile because Riveros (1990) does not include data on the income of those with no formal education. Figures 1-5, in which the relevant periods of trade liberalization are highlighted, depict the trends.

Contrary to the predictions of educational expansion, marginal and gross returns do not generally fall in Brazil, Argentina, and Chile. In Brazil, although gross returns fall at all levels and marginal returns fall for primary education, marginal returns for secondary and university education stay fairly constant until 1992, and then university returns rise. In Argentina, marginal and gross returns to primary and secondary education stay more or less constant. Marginal and gross returns to university education increase over the period studied. In Chile, marginal returns to secondary and university education, which are the only returns available, stay relatively constant, except that returns to university education rise after 1972. Given rising enrollment rates in all three countries, at the education levels for which returns do not fall over time, labor demand must be increasing or the quality of education improving.

In all three countries, marginal returns to university education increase starting one to three years after the beginning of trade liberalization: by 3% per year in Brazil (1992-1999); by 3% per year in Argentina (1992-1998); and by 8% per year in Chile (1976-1985).

However, the sustained periods of constant or rising returns prior to trade liberalization, as well as the observed periods of heavy fluctuation in the returns, make it difficult to clearly attribute the rising marginal returns that follow trade liberalization to the effect of trade reform.

Figure 1. Marginal Returns to Education by Education Level: Brazil

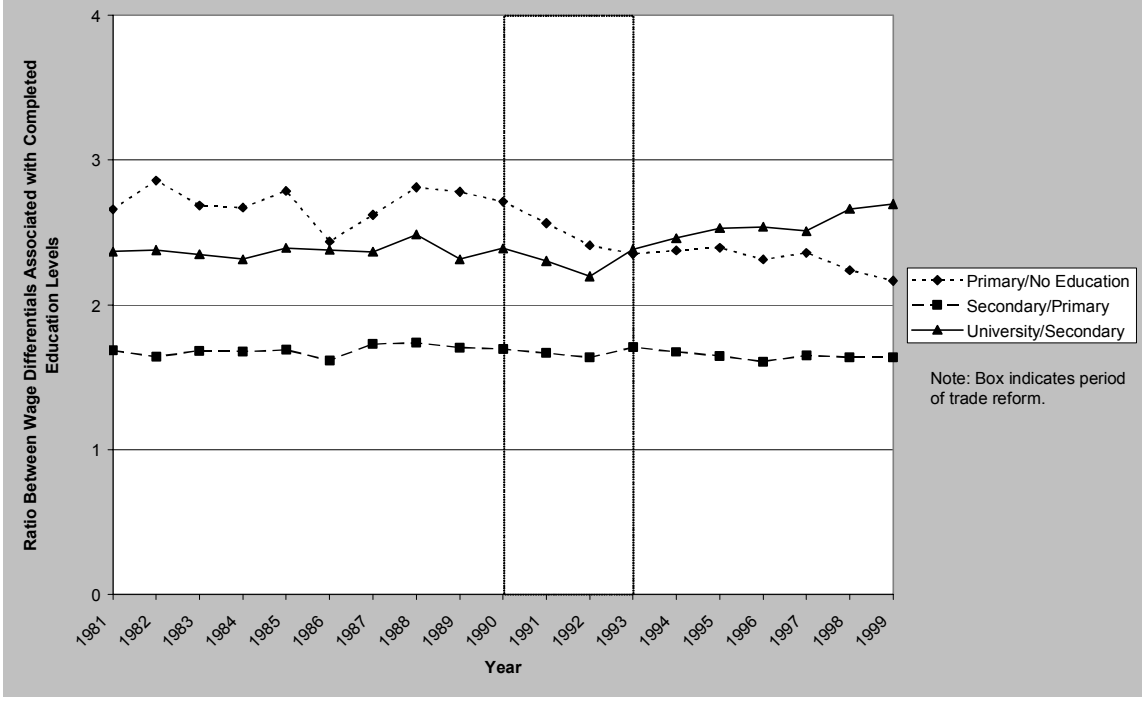


Figure 2. Gross Returns to Education by Education Level: Brazil

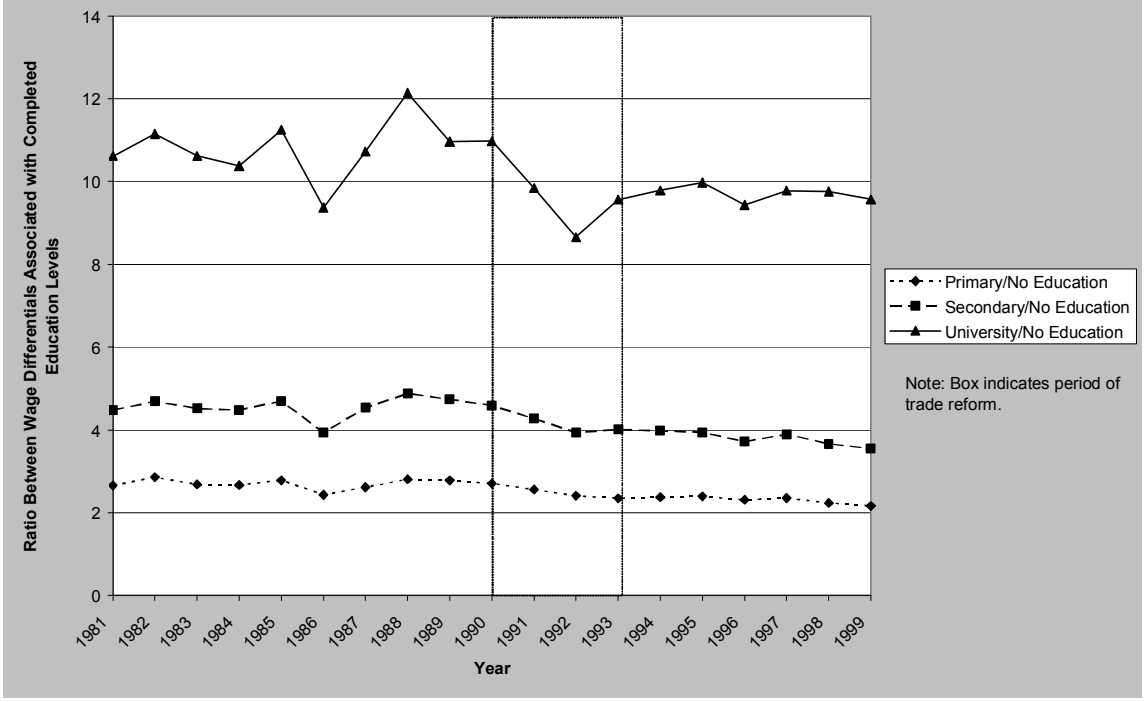


Figure 3. Marginal Returns to Education by Education Level: Argentina

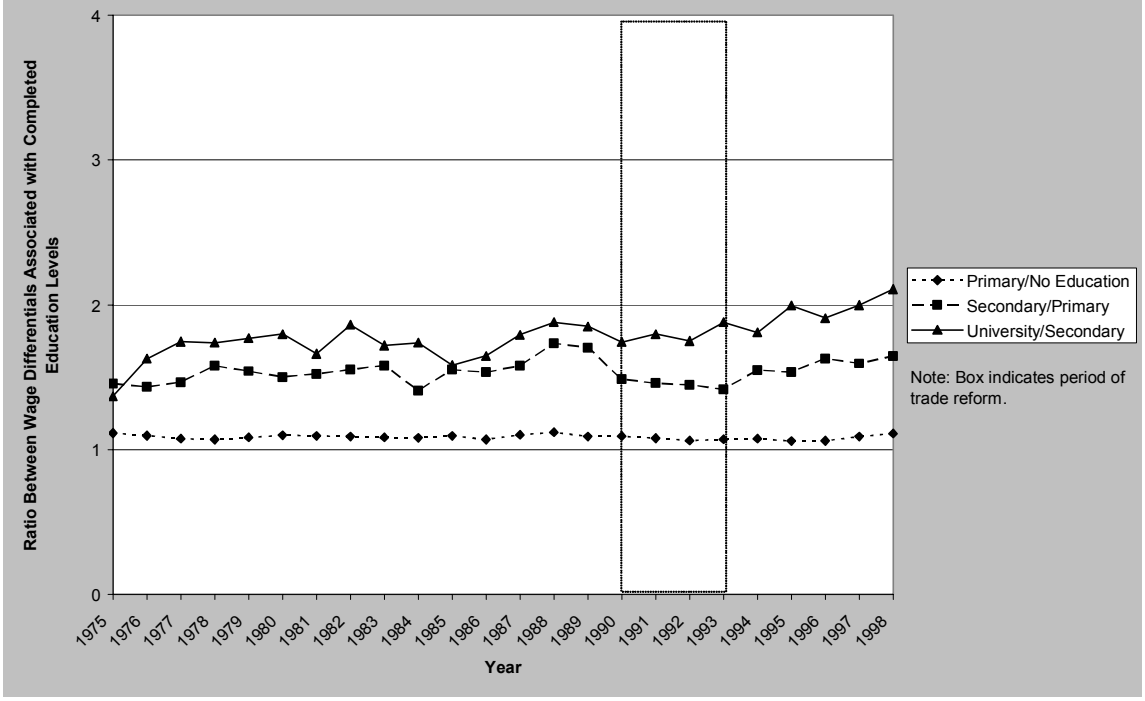
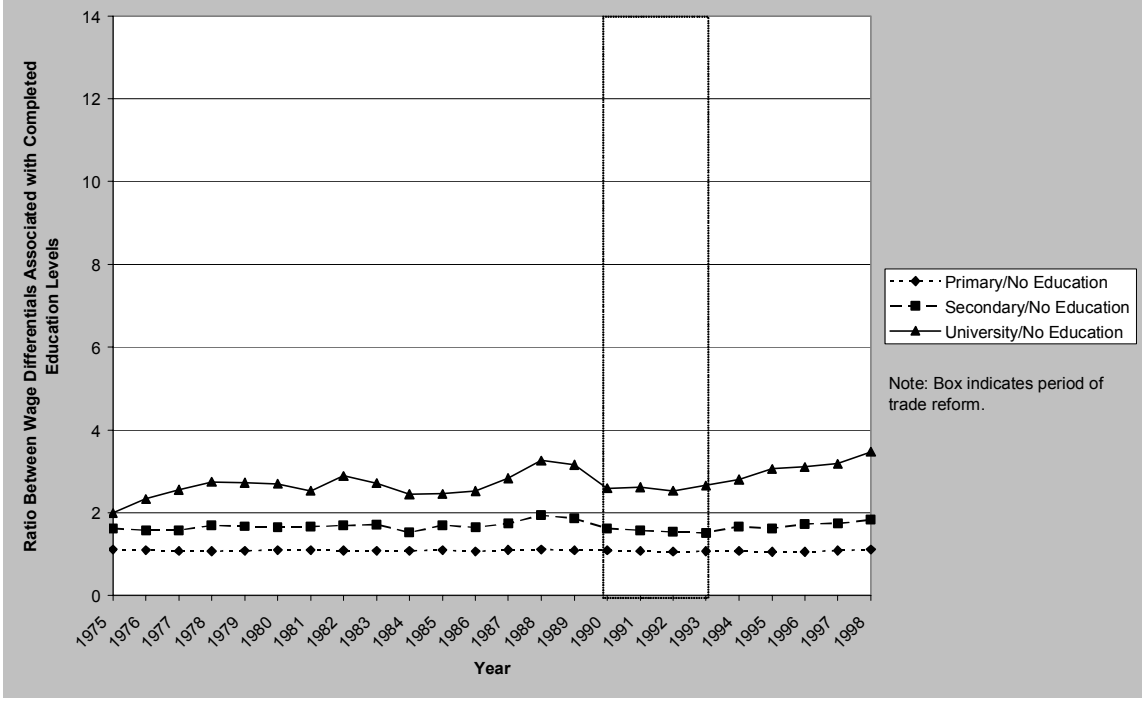
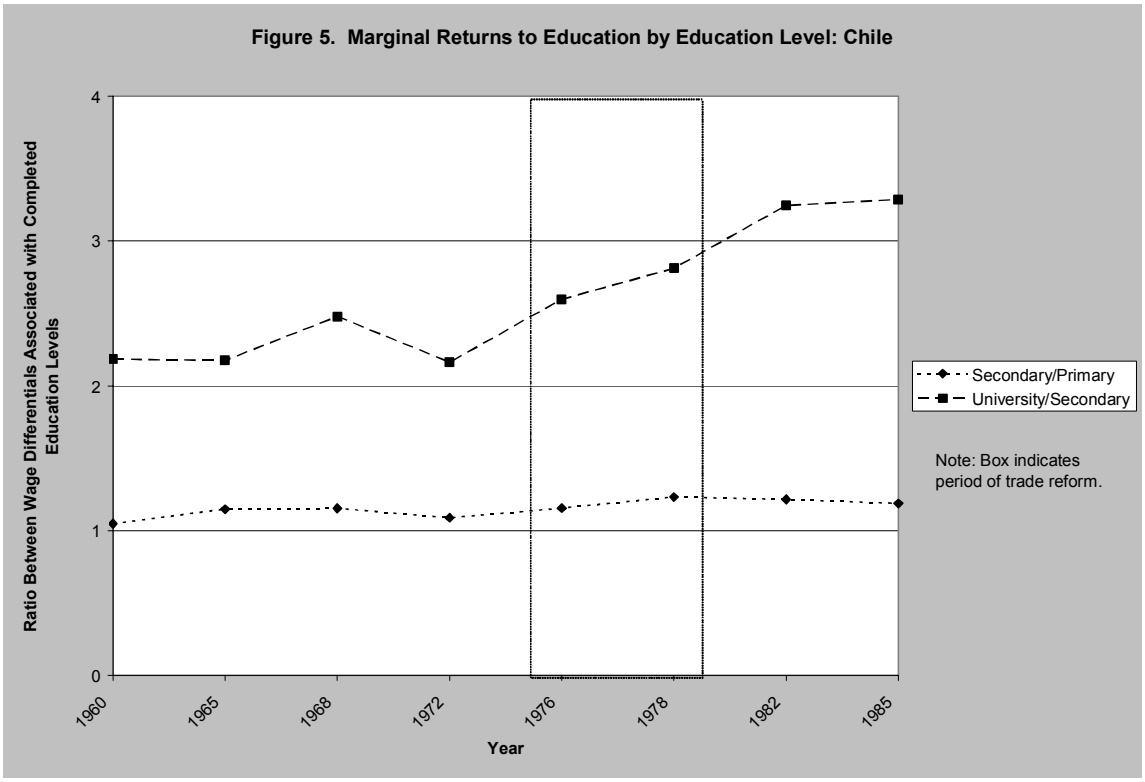


Figure 4. Gross Returns to Education by Education Level: Argentina





3.6 Trade Liberalization in Brazil

In Brazil, most of the trade liberalization occurred during the period 1990-1993. Gross and marginal returns to all education levels fell during Brazil's recession, from 1988-1992. After the recession, the gross return to university education increased, then stayed relatively constant from 1995-1999. This observation suggests a lag period of two or three years associated with the effect of trade reform on the relative wage of skilled workers. The gross returns to secondary education continued their decline after the recession while the gross return to primary education stayed fairly constant.

Comparing trends in gross returns, we can infer that from 1992-1995, rising marginal returns to university education were the result of rising wages at the university level. Given the observed rising enrollment rates, the college wage premium increased

relative to others because demand grew faster than supply, not because of a supply shift. However, from 1995-1999, rising marginal returns to university education overall were the result of decreasing wages at the secondary level. An explanation for the fall in wages, noted by Green et al. (2001), is the marked increase in the rate of growth in enrollment at that level after 1993. Previous studies have not distinguished these two separate effects of trade liberalization by time period.

The gross returns to primary education decreased in Brazil over the entire period studied. Returns did not fall at a marked faster or slower pace following trade reform, leaving the effect of trade liberalization on the relative wages of primary graduates ambiguous.

A caveat to measuring the effect of trade liberalization on rates of return in Brazil is that rising gross returns to university education could be a result of the economic recovery that followed the recession rather than trade reform. Moreover, returns to education do not reflect the impact of trade liberalization on the proportion of unemployed by education level, as wage differentials estimated for Brazil do not account for unemployment.

3.7 Trade Liberalization in Argentina

During the first two years of trade reform in Argentina, 1990-1992, marginal and gross returns stayed relatively constant at the university level and fell at the secondary level. From 1992-1998, gross returns at the university and secondary levels increased gradually by 5% and 3% per year, respectively. These findings once again

imply a two to three year lag associated with the impact of trade reform on relative wages.

Rising enrollment rates occurred at both education levels after 1994, implying that increasing returns after 1994 were the result of demand growing faster than supply. Gross enrollment at both levels fell slightly from 1990 to 1994. Thus, between 1992 and 1994, slower growth in supply may have helped secondary and university returns rise.

Returns to primary education stayed more or less constant over the entire relevant period. The impact of trade liberalization on the wages of low skilled workers in unclear, but probably not strongly negative.

Argentina also pursued trade liberalization from 1976-1982, a longer time span, during another period of major economic change. During this episode, trade reform was also associated with an increase in the marginal and gross returns to university education. Then when the reforms were largely reversed in 1983, returns to university education fell. Despite the observed association between trade reform and rising returns to higher skill levels during two distinct periods, in Argentina the impact of trade reform on wages is uncertain because other important economic changes occurred at the same time that trade was liberalized. Pessino (1995) analyzes returns to education over the period 1986-1993 and attributes rising demand for skilled labor until 1993 to the effect of hyperinflation.

3.8 Trade Liberalization in Chile

In Chile, the important period of trade liberalization was 1975-1979. Marginal returns to university education increased gradually after 1972, except from 1982-1985,

during that country's depression.[16] Robbins (1994) extends the work of Riveros (1990) and finds that the college wage premium increased from 1975 until 1990. Gross returns are not available, but analyzing wage ratios presented in Riveros (1990) confirms that marginal returns to university education rose because of an increase in the wages of college graduates, rather than a decrease in the wages of secondary school graduates.[17] The marginal return to secondary education stayed more or less constant over the entire period studied.

Gross enrollment increased steadily at the secondary level over the period 1976-1985, and university enrollment increased generally but staggered somewhat, slipping in 1980. Thus, the rising returns to university education and steady returns to secondary education after trade liberalization were by and large the result of demand growing faster than supply. Riveros (1990) notes that enrollment rates at the university level were higher before 1972, while afterwards, the relatively lower increase in enrollment rates were associated with an increase in relative wages of university graduates. These observations suggest that a slower shift in the supply of university graduates helped increase the college wage premium.

I do not have an estimate of marginal or gross returns to primary education for Chile, but I present estimates of the internal rates of return at this level in Section 4. The private internal rates of return stopped falling and leveled off during the period of trade liberalization, leaving open the possibility that trade reform may have benefited primary school graduates.

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[16] Without analyzing marginal and gross wage differentials that account for unemployment, Riveros (1990) interprets a relative decline in the demand for skilled workers.

[17] In 1976, wages for secondary and university graduates fell by similar proportions.

In Chile, as in Argentina, the government pursued other reforms at the same time as it liberalized trade. Moreover, the returns for college graduates rose in the period immediately before and including the first year of trade reform, leaving the impact of trade liberalization on relative wages somewhat ambiguous.

3.9 Theoretical Explanations

My results show that in each country trade liberalization was associated with rising relative demand for university graduates. In Argentina and Chile, demand for high school graduates also rose. These findings are consistent with the hypotheses about trade reform that focus on the role of skill-biased technology. In Brazil and Argentina, researchers have suggested that capital imports and foreign direct investment induced technology transfers that were skill-biased relative to previous technology (Arbache et al., 2004; Blom et al., 2001; Pavcnik et al., 2002; Cossa, 2000). In Brazil trade reform increased demand for university graduates strongly at first, and then the effect tapered off, a finding consistent with the theory that suggests temporary increases in the skill premium.

The technology explanation may be less reasonable for Chile, which liberalized its trade policies before the era of information technology. During the 1970s, technology was more expensive than it was during the Brazilian and Argentine reforms of the 1990s. Robbins (1994) notes that trade reform increased export goods, whose marketing and distribution may have required skill intensive labor, or that trade may have increased inter-country knowledge transfers and thereby raised the productivity of education.

Pessino (1995) also offers an alternative explanation for Argentina.[18] Rising demand for skilled workers in each country can be explained by the role of skill-biased technology following trade liberalization, although other explanations are also plausible.

4. INTERNAL RATES OF RETURN

In this section, I investigate private and social internal rates of return. I discuss internal rates of return, calculate private and social returns for Brazil and Argentina, and explain patterns in the returns in light of international evidence.

4.1 Internal Rates of Return

While Mincerian returns reflect the benefits of investing in education, internal rates of return internalize the costs as well as the benefits. The internal rate of return is the discount rate that equates the discounted present value of the future earnings stream attached to a certain level of schooling with the costs of making the investment.

The benefits reflect the wage differentials estimated through Mincer equations. In the private return, the costs consist of the student's forgone earnings for each year of schooling plus tuition.[19] Both benefits and costs are discounted using a relevant rate of

[18] Pessino observes that in Argentina the relative price of capital goods versus labor fell drastically after massive increases in foreign capital induced by trade reform resulted in a lower real exchange rate and an implicit increase in dollar wages. She notes that lower capital goods prices may have implied a decrease in labor relative to physical capital demand. Given the heterogeneity of labor in terms of human capital, higher demand for physical capital entailed higher demand for more educated workers, assuming low elasticity of substitution for college graduates.

[19] Only two or three years of foregone earnings are typically used, since primary school children do not forego earnings for the full length of their schooling. Costs would ideally include educational fees and expenses, such as books, transportation outlays, and, at the university level, housing costs. In practice, these costs are typically assumed to equal the earnings a student would make working part-time or during the summer (Psacharopoulos, 1995).

interest, since they occur at different times. The formula to calculate the private internal rate of return for, say, secondary education is:

$$(2), \qquad \sum_{t=1}^{n} \frac{(Y_b - Y_a)_t}{(1+r)^t} = \sum_{t=1}^{m} (Y_a)_t (1+r)^t$$

where r = the discount rate, which is the private internal rate of return; Y_b-Y_a = the wage differential between a secondary school graduate and a primary school graduate; n = the number of working years; and m is the duration of secondary schooling in years. On the right side of the equation, Y_a is the student's foregone earnings. The private internal rate of return reflects the incentives that the average individual has to attend school.

Internal rates of return can also be calculated to reflect the social return and social costs. In order to incorporate the full resource cost of the investment, the formula for the social rate of return includes public-sector expenditures not reimbursed by tuition:

$$(3), \qquad \sum_{t=1}^{n} \frac{(Y_b - Y_a)_t}{(1+r)^t} = \sum_{t=1}^{m} (Y_a + C_s)_t (1+r)^t$$

where C_s = government expenditure per student at the secondary level. The difference between private and social returns represents the public subsidization of education.[20]

Despite a number of limitations to internal rates of return, they remain the standard tool for assessing education.[21] A major shortcoming is that returns do not

[20] Because income taxes are a cost to the individual but not to society as a whole, in calculating the social rate of return, gross earnings should be included instead of wages after taxes, which are ideally used in calculating the private rate of return. In practice, however, earnings before taxes are used for both private and social returns. When this is the case, the private return must be greater than the social return, since the costs are higher in the social return calculation than in the private measurement.

[21] One assumption is that in order for earnings to be a reliable indicator of social benefits, higher earnings must be attributed to higher productivity. This link is made by assuming that wages equal the marginal product of labor in a perfectly competitive labor market. However, this assumption might not always be valid (Psacharopoulos, 1995). A second assumption is that the relationship between education and earnings is causal. In the filter or screening hypothesis, the main role of education is to select those individuals who will do best in the labor market, not to train people. The model also assumes that individuals who leave the educational system work until the end of their productive life, and therefore leaves out migration. A fourth assumption is that the current earnings structure is an accurate guide to the future. Relative earnings

account for non-market benefits to education. The list of the potential externalities that are not reflected in estimates of market returns is extensive and involves, for example, the health status of the student and his family; the efficiency of choices made, including consumer, educational, and childbearing choices; and participation in criminal activities (Haveman & Wolfe, 2002). Some benefits are captured by individuals and if included in the rate of return calculation would increase both the private and social return; others involve public goods or spillover effects of schooling and would increase the social return even further. In addition, it is reasonable to assume that non-market returns are likely to be higher, the lower is the education level. Non-market effects are suspected to be high in developing countries (Riveros, 1990), and Haveman and Wolfe (1984) find that spillover effects may be as large as the market-based effects of schooling.[22] Since my estimates do not account for non-market returns, they should be considered floors rather than actual values, particularly for social returns and at lower education levels.

Researchers commonly compare the internal rate of return with the expected return on a comparable alternative investment, such as physical capital, which has historically averaged about 10% a year or slightly higher (Psacharopoulos, 1992; Tan, 1992). Taking into account potentially large non-market externalities, a private return below perhaps 6 percent and a social return below 5 percent should indicate clearly inefficient investments, in the sense that other investments would yield higher financial returns. A low private rate of return suggests that the average individual has few incentives to attend school. A low social rate of return implies that the provision of

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change considerably over time (Perkins, 2001). Finally, rates of return cannot include aspects like unobserved childhood family background.

[22] On the other hand, Venniker (2001) concludes that empirical evidence provides only weak and inconclusive support for externalities.

education is unproductive. Some researchers have suggested that governments should allocate resources in education according to the returns to education (Psacharopoulos, 2002, for example). However, researchers do not calculate rates of return at a given education level to reflect the expected earnings associated with the probability that a student will complete higher education levels. Moreover, although rates of return are important indicators of the incentives and productivity associated with an investment in education, low private and social returns are less significant at the primary education level, where full educational attainment has been a venerable goal in all three countries.

4.2 Conceptual Framework and International Evidence

Internal rates of return reflect wage differentials by education level and are thus determined by the same factors that determine wage differentials: the supply and demand of labor, as well as education quality. Internal rates of return have one additional determinant: cost of education, in terms of direct costs and expenditure per student. The effect of labor supply on internal returns to education is well documented. Psacharopolous has found a strong negative association between internal rates of return and economic development worldwide, and he attributes the association to educational expansion (Psacharopoulos & Patrinos, 2002). Table 5 presents estimates of private and social returns, mostly for the 1980s, by region and country type.[23] Later in the paper, I discuss additional patterns that are present in Table 5.

[23]Psacharopoulos has updated estimates for some countries and found that average returns to schooling have declined by 0.6% between approximately 1990 and 2002 (Psacharopoulos & Patrinos, 2002). In Table 5, note that private and social rate of return averages in high income and OECD countries fall between 8 and 13% at the secondary and university levels, meaning that the profitability of human and physical capital, at the margin, has approached equilibrium.

Table 5. Private and Social Internal Rates of Return by Region and Country Type (Percent)

Region/Country Type	Private Return			Social Return		
	P	S	U	P	S	U
Sub-Saharan Africa	41	27	28	24	18	11
Asia	39	19	20	20	13	12
Europe/Middle East/North Africa	17	16	22	16	11	11
Latin America/Caribbean	26	17	20	18	13	12
OECD Countries	22	12	12	14	10	9
World	29	18	20	18	13	11
Low-Income Countries	35	19	24	23	15	11
Lower-Middle-Income Countries	30	19	19	18	13	11
Upper-Middle-Income Countries	21	13	15	14	11	10
High-Income countries	..	13	8	..	10	8
World	31	18	19	20	14	11

P: primary; S: secondary; U: university
Most estimates were made in the 1980s. Data for "Asia" excludes OECD countries.
Source: Psacharopoulos (1994).

4.3 Calculations for Brazil, Argentina, and Chile

Riveros (1990) provides estimates for internal rates of return in Chile that are known to be first rate (see Appendix F). In Brazil, I calculate private and social rates of return by solving for r in the general model, after plugging in data on wages by education level (Y_a and Y_b) provided by Green et al. (2001), along with my estimates of government expenditure on education per student (see Appendix D).

For Argentina, I rewrite the model in terms of my estimate of primary graduate income, Y_a, the expenditure data I estimated in Section 1, and Cossa's Mincer coefficients, which I weight by sex, in order to solve for r (see Appendix E):[24]

[24] In calculating the private rate of return, I set expenditure per student = 0; in calculating the social return I set expenditure per student = its value for the corresponding year.

(4), Primary education:

$$\sum_{t=1}^{41}\frac{\left(Y_a - Y_a(1+M_p)^{-2}\right)}{(1+r)^t} = \sum_{t=1}^{2}\left(Y_a(1+M_p)^{-2} + C_p\right)(1+r)^t$$

$$\Rightarrow \sum_{t=1}^{41}\frac{Y_a\left(1 - (1+M_p)^{-2}\right)}{(1+r)^t} = \sum_{t=1}^{2}\left(Y_a(1+M_p)^{-2} + C_p\right)(1+r)^t$$

(5), Secondary education:

$$\sum_{t=1}^{41}\frac{\left(Y_a(1+M_s)^5 - Y_a\right)}{(1+r)^t} = \sum_{t=1}^{5}\left(Y_a + C_s\right)(1+r)^t$$

$$\Rightarrow \sum_{t=1}^{41}\frac{Y_a\left((1+M_s)^5 - 1\right)}{(1+r)^t} = \sum_{t=1}^{5}\left(Y_a + C_s\right)(1+r)^t$$

(6), University education:

$$\sum_{t=1}^{41}\frac{\left((1+M_u)^5\left(Y_a(1+M_s)^5\right) - \left(Y_a(1+M_s)^5\right)\right)}{(1+r)^t} = \sum_{t=1}^{5}\left(Y_a(1+M_s)^5 + C_u\right)(1+r)^t$$

$$\Rightarrow \sum_{t=1}^{41}\frac{\left(Y_a(1+M_s)^5\right)\left((1+M_u)^5 - 1\right)}{(1+r)^t} = \sum_{t=1}^{5}\left(Y_a(1+M_s)^5 + C_u\right)(1+r)^t$$

The private and social rates of returns I calculate for Brazil are consistent with other estimates, including the only other estimate of social rates of return, provided by Tannen (1991) for 1980, for men.[25] The private returns I calculate for Argentina are about a third smaller than those calculated by Cossa,[26] which are the only existing time series estimates of internal rates of return in Argentina. Kugler and Psacharopoulos (1989) provide private and social returns in Argentina for 1985 and Psacharopoulos and Ng (1992) do so

[25] Private returns have been estimated for 1970 (Behrman & Birdsall, 1983) and for 1960 (see Psacharopoulos, 1973).

[26] Cossa calculates his own private internal rates of return, separately for males and females, but not social returns. Ideally, one would plug both Cossa's Mincer coefficients, weighted by sex, and his estimated private rate of return into the model to allow either an inclusion of explicit costs, given an estimate of Y_a, or else a precise estimate of Y_a, assuming no explicit costs. But plugging in both Cossa's Mincer coefficients and his private rates of return did not allow for Y_a to be a reasonable value, due to methodological differences between how Cossa calculated Mincer coefficients and internal rates of return.

for 1989. Excluding the unemployed from their surveys and making slightly different assumptions, these researchers estimate returns to primary education that are much higher than those estimated by Cossa or myself. This observation casts some doubt on the accuracy of my estimates for primary education in Argentina.

There are several other caveats to my estimates for private and social returns in Argentina and Brazil. In Argentina, sensitivity analysis suggests my estimates of Y_a may have reduced the accuracy of the private and social returns by perhaps as much as a quarter of a percentage point. In addition, the accuracy of the social return in that country is lessened because earnings data represents metropolitan areas, but expenditure data reflects an average for all of Argentina. In Brazil, an assumption I made about wages may have reduced the precision of the private and social rates of return by a fraction of a percentage point. Private and social returns are probably overestimated in Brazil because wage differentials do not account for unemployment.[27] In addition, the dataset used for Brazil does not include people under 20 years of age, excluding the teenage working years of individuals who do not attend college. This selectivity bias may slightly inflate the returns to primary education. Sensitivity analysis suggests my estimations of social returns at all education levels in both Brazil and Argentina may be up to a percentage point less accurate because the data on expenditure may be somewhat unreliable.

There is another methodological difference that makes any precise comparison of levels in the rates of return difficult across countries. Both private and social rate of return estimates for Argentina and Brazil use income before taxes, as is standard, but Riveros uses income after taxes in calculating the private return and income before taxes

[27] Tannen (1991) adjusted for unemployment in Brazil when calculating private rates of return for 1980 and found that returns fell by 8.1% at the university level, 3.2% at the secondary level, and about 9.2% at the primary level.

in calculating the social return. While improving the accuracy of his private estimates, Riveros' method of accounting for taxes also reduces the size of his estimates relative to the private returns I estimated for Argentina and Brazil.[28]

Brazil and Argentina do not charge tuition at any level of education, but estimates for Chile do account for tuition at the university level. In addition to data on average tuition costs, Riveros incorporates actual direct private outlays.[29] Other assumptions are identical for each country.[30]

Tables 6, 7, and 8 present private and social returns by country. As expected, the private returns exceed social returns. The bottom of each table displays averages of the years before and after the point at which my findings in Section 3 suggest trade liberalization may have begun to effect relative wages. The high level of fluctuation in the returns underscores the importance of having a time series of estimates. Appendix Figures B5, B6, and B7 depict the trends in the private returns. While differences among studies prevent me from comparing countries with respect to small changes in the absolute values of returns, I can draw conclusions from general patterns and trends.

[28] The treatment of income taxes in Chile makes it possible for social returns to exceed private returns in that country.

[29] For Brazil and Argentina, where tuition is free, I make the standard assumption that explicit costs are offset by the wages earned by teenagers and equal zero. This appears to be a reasonable assumption: Andres (2003) writes that in Argentina a large proportion of university students work while attending classes in the evening, and Cossa (2000) notes that the explicit costs to schooling are low.

[30] For both Brazil and Argentina, I make the standard assumptions that foregone earnings are associated with the last two years of primary education cycle and the average working life is 41 years. Riveros also makes these assumptions for Chile.

Table 6. Private and Social Internal Rates of Return: Brazil

Year	Private Internal Rate of Return			Social Internal Rate of Return			Index of Subsidization*		
	P	S	U	P	S	U	P	S	U
1981	23.7	10	16.8						
1982	23.5	9.5	16.8						
1983	22.5	10	16.6						
1984	22.4	9.9	16.3						
1985	23.0	10.1	17.0	20.2	8.9	13.6	12	12	20
1986	20.9	9.2	16.9	18.5	8.2	13.4	11	11	21
1987	22.1	10.5	16.7						
1988	23.2	10.6	17.7						
1989	23.0	10.3	16.3						
1990	22.6	10.1	16.9						
1991	21.7	9.8	16.2						
1992	20.7	9.4	15.3						
1993	20.3	10.3	16.9						
1994	20.4	9.9	17.5						
1995	20.6	9.6	18.1	17.9	7.4	12.2	13	23	33
1996	20.0	9.1	18.1	17.4	7.1	12.2	13	22	33
1997	20.3	9.6	17.9	17.6	8.5	12.2	13	11	32
1998	19.4	9.4	19.1						
1999	18.9	9.4	19.3						
1981-1992	22.6	10.0	16.7	19.4	8.6	13.5	12	11	20
1993-1999	20.1	9.6	17.8	17.6	7.7	12.2	13	19	32

*Index of Subsidization: [(P-S)/P)*100

Source: Author's calculation based on Green et al. (2001).

Table 7. Private and Social Internal Rates of Return: Argentina

Year	Private Internal Rate of Return			Social Internal Rate of Return			Index of Subsidization*		
	P	S	U	P	S	U	P	S	U
1975	3.5	7.0	5.6						
1976	2.8	6.6	9.3						
1977	1.8	7.1	10.7						
1978	1.6	8.7	10.6						
1979	2.2	8.2	11.0						
1980	2.9	7.6	11.3		6.0	8.0		21	29
1981	2.7	8.0	9.7						
1982	2.5	8.3	12.0						
1983	2.2	8.7	10.4						
1984	2.0	6.3	10.6						
1985	2.8	8.3	8.8		7.0	7.0		16	20
1986	1.5	8.1	9.6						
1987	3.0	8.7	11.3						
1988	3.7	10.6	12.2						
1989	2.5	10.3	11.9						
1990	2.6	7.4	10.7						
1991	2.0	7.0	11.3						
1992	1.0	6.9	10.8						
1993	1.6	6.4	12.2						
1994	1.8	8.3	11.4			8.6			25
1995	0.9	8.1	13.4						
1996	1.0	9.3	12.5	0.0	6.4		100	31	
1997	2.4	8.9	13.4						
1998	3.3	9.6	14.5	1.9	6.7	11.1	42	30	23
1975-1992	2.4	8.0	10.4		6.5	7.5		18	25
1993-1998	1.8	8.4	12.9	1.0	6.6	9.9	71	31	24

*Index of Subsidization: [(P-S)/P)*100

Source: Author's calculation based on Cossa (2000).

Table 8. Private and Social Internal Rates of Return: Chile

Year	Private Internal Rate of Return			Social Internal Rate of Return			Index of Subsidization*		
	P	S	U	P	S	U	P	S	U
1960	33.1	12.5	11.6	17.2	10.6	6.8	48	15	41
1965	27.9	10.6	8.4	15.7	8.8	4.4	44	17	48
1968	31.6	12.3	11.3	16.4	10.0	7.3	48	19	35
1972	27.7	10.1	8.9	12.4	7.7	4.2	55	24	53
1976	27.9	12.2	10.4	11.5	9.7	6.9	59	20	34
1978	27.4	11.1	9.9	11.9	8.8	6.7	57	21	32
1982	27.8	11.2	10.1	12.1	9.0	6.8	57	20	32
1985	27.6	11.0	10.3	12.4	9.2	6.9	55	16	33
1960-1976	29.6	11.5	10.1	14.6	9.4	5.9	50	19	42
1978-1985	27.6	11.1	10.1	12.1	9.0	6.8	56	18	32

*Index of Subsidization: [(P-S)/P)*100
Source: Riveros (1990).

4.4 Analysis and Comparison with International Evidence

Rates of return in Brazil, Argentina, and Chile do not generally conform to the theoretical predictions or international patterns that are present in Table 5. In Section 3, I found that marginal and gross returns in each country do not generally fall, suggesting that labor demand has increased or that the quality of education has improved. In Tables 6-8 we observe that private and social returns tend to move in tandem with the marginal wage differentials, rather than fall over time as per the international trends.[31] A second international pattern, observed in Table 5, is that private and social returns tend to decrease with each level of education, with the exception of private returns to higher education. Neither Brazil, Argentina, nor Chile conform to this pattern entirely. A third observation from Table 5 is that public subsidization of education, represented by the

[31] In Chile, the private internal rate of return to university education increases more slowly than the marginal return, and from 1976-1978 the private return falls despite an increase in marginal returns. As the internal rates of return in Chile account for explicit costs, we can deduce that during this period direct costs became increasingly important relative to benefits, an observation noted by Riveros (1990).

difference between private and social returns, generally increases by level of education. None of the three countries appear to follow this trend, except perhaps for Brazil.

Private and social returns corresponding to certain education levels in all three countries are lower than the average returns in countries with similar income. For Brazil, this is true for secondary education; for Chile, secondary and university education; and for Argentina, where returns are particularly low, primary, secondary and, except for during the late 1990s, university education. In most of these cases, private and social returns fall below the expected rate of return to physical capital, 10%. Most striking, private and social returns to primary education in Argentina are around 2% and 1%, respectively.[32] Low rates of return suggest that individuals have low financial incentives to attend school, although observed rising enrollment rates suggest that non-market externalities not accounted for in rates of return still make acquiring education productive at most education levels. The low social return to primary education in Argentina indicates that investing in primary education may be inefficient for the state, in the sense that other investments are more profitable, even after accounting for non-market externalities and the probability that a primary school student will complete higher education levels in the future.

These findings suggest that at many education levels labor demand is low or that quality of education is poor. One explanation for low returns is that the economies have not been able to fully absorb the additional human capital reflected in the increasing supply of educated workers. Indeed, growth in GDP per capita was very low overall in each country. Returns to education did not increase substantially, however, during periods of high income growth. Cossa (2000) notes that common explanations for the

[32] Recall that my estimates for primary education in Argentina may not be highly reliable.

low private rates of return in Argentina include the change in demand toward more qualified workers, globalization, and economic liberalization.

Another explanation for the low returns in each country is poor quality of education. This hypothesis is consistent with observed high grade repetition and low graduation rates in each country. That the changes mentioned by Cossa occurred largely during the 1990s, fifteen years after the low returns are first observed, and that returns to primary education are unusually low in Argentina, suggests poor quality of education may be the culprit in that country. Improving the quality of primary education should induce demand for primary graduates and thereby help increase the rates of return.

Table 4 suggests that Argentina spends more per student on primary education than Brazil and Chile, on average. This observation implies that poor quality is not the result of insufficient funding, but of internal inefficiencies. It appears that the state should consider improving the quality of primary schooling by addressing internal inefficiencies in the education system, rather than simply increasing spending.

5. CONCLUSIONS AND POLICY IMPLICATIONS

I investigated rates of return in Argentina, Brazil, and Chile over three overlapping time periods in which each country liberalized its trade policies. This paper contributes to a strand of literature that runs counter to the predictions of standard trade theory and suggests that the opening of trade increases income inequality by raising rates of return for higher levels of education relative to lower levels. In each country, rising labor demand increased returns to university education following trade reform, although the increase in demand appears temporary in Brazil. In Argentina and Chile, demand for

high school graduates also rose. These findings are consistent with hypotheses about trade reform that involve skill-biased technology. While the evidence suggests trade reform was associated with increasing returns to skilled labor, I am far from being sure the relationship is causal.

I extend the analysis by providing estimates of a time series of private and social internal returns to education, which reflect the costs of education in addition to the benefits. I find that the economic returns to education have been low for certain education levels in Brazil, Argentina, and Chile, in particular at the primary education level in Argentina. This finding suggests that, generally, the demand for skilled and unskilled labor has been weak or the quality of education has been poor. I also find that, contrary to the predictions of theory and international patterns, rates of return do not generally fall in the three countries, implying that labor demand has been increasing or the quality of education has been improving.

My findings have several policy implications for developing countries. Low private rates of return imply that incentives for workers to attend school have been low in at least three South American countries, although not enough to prevent enrollment rates from rising. My findings indicate that trade liberalization may increase the returns to university education and thereby provide an incentive for individuals to attend college. When making choices about the pattern and speed of trade liberalization, policy makers in developing countries should take into account that trade reform may increase income inequality, which is high in South America. Finally, governments should ensure that the quality of the education they provide is adequate. To the extent that my estimates are

correct, Argentina may have severe internal inefficiencies in its primary education system.

We do not have sufficient data for Chile that would allow a regression analysis that could identify the separate effects of policy changes and macroeconomic shocks on rates of return. However, pursuing this approach in Argentina and Brazil would help identify causal relationships including the effects of trade liberalization on the pattern of wages. In addition, better data in Brazil and Argentina would permit internal rates of return to be calculated more accurately and for more years. Recalculating internal rates of return for primary education in Argentina would shed light on the reliability of my finding that the productivity of primary education is low.

APPENDIX A: TABLES

Table A1. Wage Differentials by Education Level: Brazil

Year	Marginal Returns			Gross Returns	
	P/N	S/P	U/S	S/N	U/N
1981	2.7	1.7	2.4	4.5	10.6
1982	2.9	1.6	2.4	4.7	11.2
1983	2.7	1.7	2.3	4.5	10.6
1984	2.7	1.7	2.3	4.5	10.4
1985	2.8	1.7	2.4	4.7	11.2
1986	2.4	1.6	2.4	3.9	9.4
1987	2.6	1.7	2.4	4.5	10.7
1988	2.8	1.7	2.5	4.9	12.1
1989	2.8	1.7	2.3	4.7	11.0
1990	2.7	1.7	2.4	4.6	11.0
1991	2.6	1.7	2.3	4.3	9.8
1992	2.4	1.6	2.2	3.9	8.7
1993	2.4	1.7	2.4	4.0	9.6
1994	2.4	1.7	2.5	4.0	9.8
1995	2.4	1.6	2.5	3.9	10.0
1996	2.3	1.6	2.5	3.7	9.4
1997	2.4	1.7	2.5	3.9	9.8
1998	2.2	1.6	2.7	3.7	9.8
1999	2.2	1.6	2.7	3.6	9.6
1981-1992	2.7	1.7	2.4	4.5	10.7
1993-1999	2.3	1.6	2.5	3.8	9.6

P/N: ratio between wage differentials associated with the primary (P) level and the level of no formal education (N).
U/S: ratio between wage differentials associated with the university (U) and secondary (S) levels.
Source: Author's calculations based on Green et al. (2001).

Table A2. Wage Differentials by Education Level: Argentina

Year	Marginal Returns			Gross Returns	
	P/N	S/P	U/S	S/N	U/N
1975	1.1	1.5	1.4	1.6	2.0
1976	1.1	1.4	1.6	1.6	2.3
1977	1.1	1.5	1.7	1.6	2.6
1978	1.1	1.6	1.7	1.7	2.7
1979	1.1	1.5	1.8	1.7	2.7
1980	1.1	1.5	1.8	1.7	2.7
1981	1.1	1.5	1.7	1.7	2.5
1982	1.1	1.6	1.9	1.7	2.9
1983	1.1	1.6	1.7	1.7	2.7
1984	1.1	1.4	1.7	1.5	2.5
1985	1.1	1.6	1.6	1.7	2.5
1986	1.1	1.5	1.6	1.6	2.5
1987	1.1	1.6	1.8	1.7	2.8
1988	1.1	1.7	1.9	1.9	3.3
1989	1.1	1.7	1.9	1.9	3.2
1990	1.1	1.5	1.7	1.6	2.6
1991	1.1	1.5	1.8	1.6	2.6
1992	1.1	1.4	1.8	1.5	2.5
1993	1.1	1.4	1.9	1.5	2.7
1994	1.1	1.5	1.8	1.7	2.8
1995	1.1	1.5	2.0	1.6	3.1
1996	1.1	1.6	1.9	1.7	3.1
1997	1.1	1.6	2.0	1.7	3.2
1998	1.1	1.6	2.1	1.8	3.5
1975-1992	1.1	1.5	1.7	1.7	2.6
1993-1998	1.1	1.6	1.9	1.7	3.1

P/N: ratio between wage differentials associated with the primary (P) level and the level of no formal education (N).

U/S: ratio between wage differentials associated with the university (U) and secondary (S) levels.

Source: Author's calculations based on Cossa (2000).

Table A3. Wage Differentials by Education Level: Chile

Year	Marginal Returns			Gross Returns	
	P/N	S/P	U/S	S/N	U/N
1960		1.0	2.2		
1965		1.1	2.2		
1968		1.2	2.5		
1972		1.09	2.2		
1976		1.16	2.6		
1978		1.23	2.8		
1982		1.22	3.2		
1985		1.19	3.3		
1960-1976		1.1	2.3		
1978-1985		1.2	3.1		

P/N: ratio between wage differentials associated with the primary (P) level and the level of no formal education (N).

U/S: ratio between wage differentials associated with the university (U) and secondary (S) levels.

Source: Author's calculations based on Riveros (1990).

Table A4. Income for Primary School Graduates: Argentina

Year	Income Decile	Income (1995 US$)
1975-1977	4	3321
1978-1980	3.5	2994
1981-1983	3	2414
1984-1986	3	2315
1987-1989	3	2239
1990-1992	3	2225
1993-1995	3	2604
1996-1998	2.5	2448

Source: Author's calculation, as explained in text.

APPENDIX B: FIGURES

Figure B1. GDP per Capita: Argentina, Brazil, Chile (WDI)

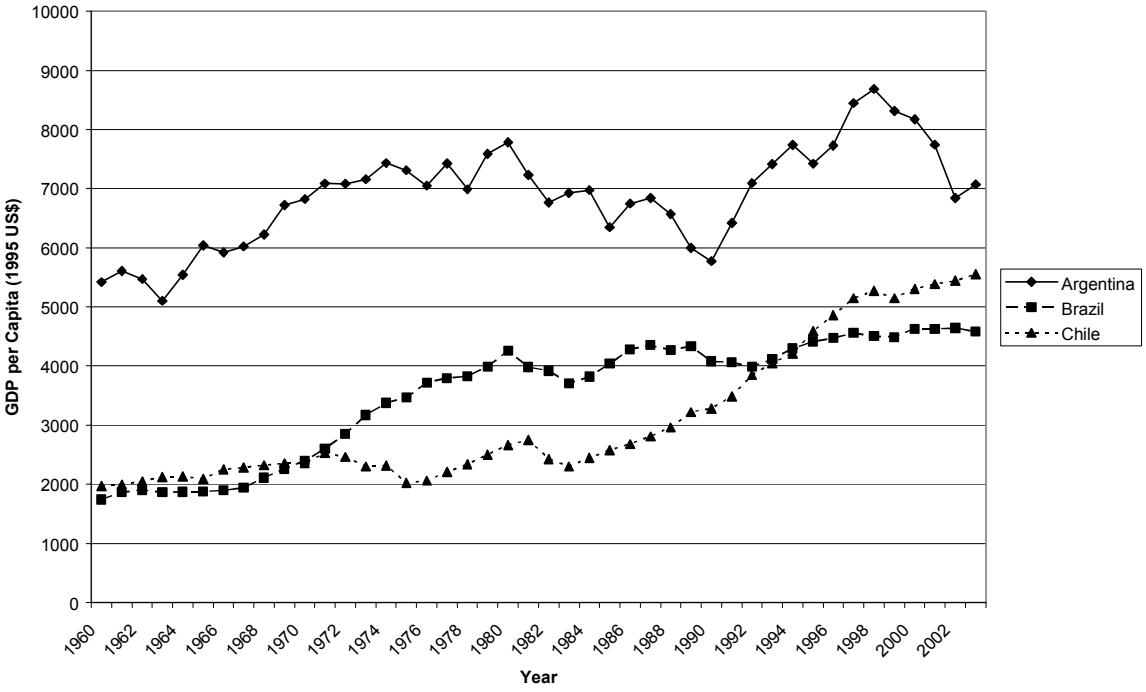


Figure B2. Gross Primary Enrollment: Argentina, Brazil, Chile (WDI)

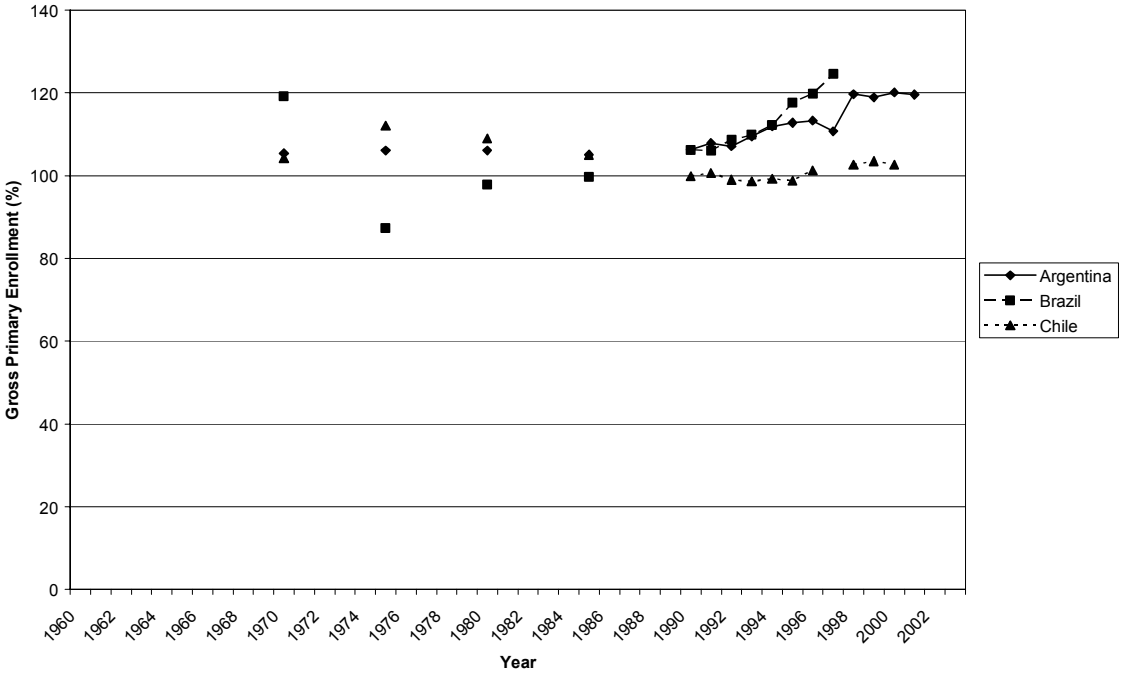


Figure B3. Gross Secondary Enrollment: Argentina, Brazil, Chile (WDI)

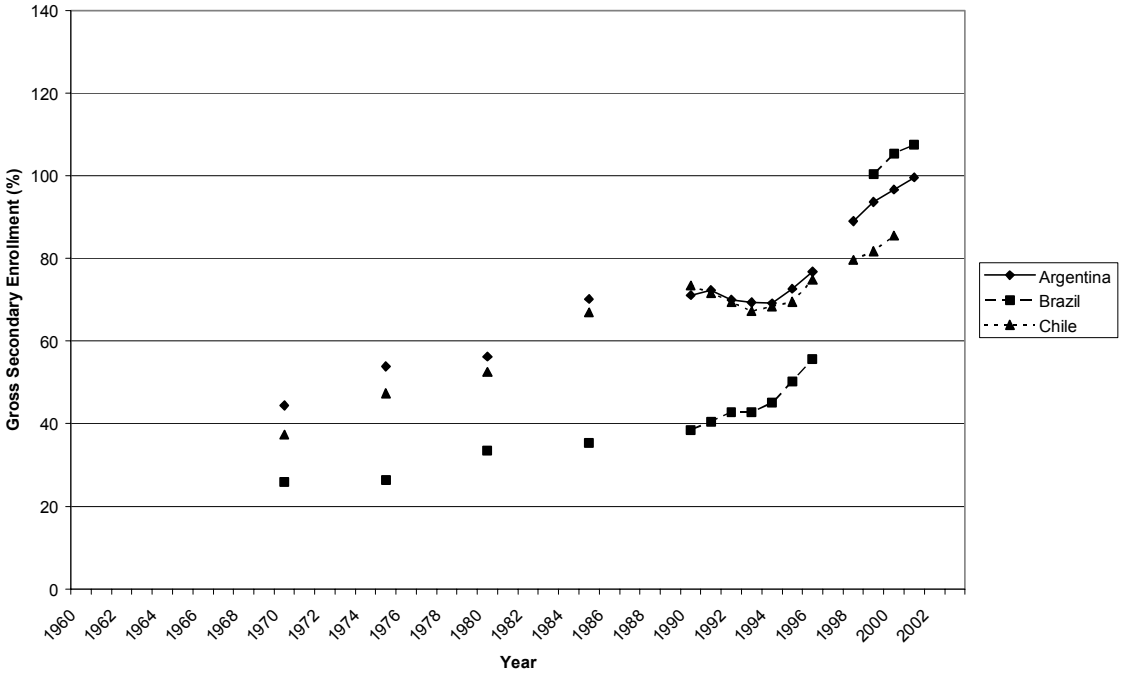


Figure B4. Gross University Enrollment: Argentina, Brazil, Chile (WDI)

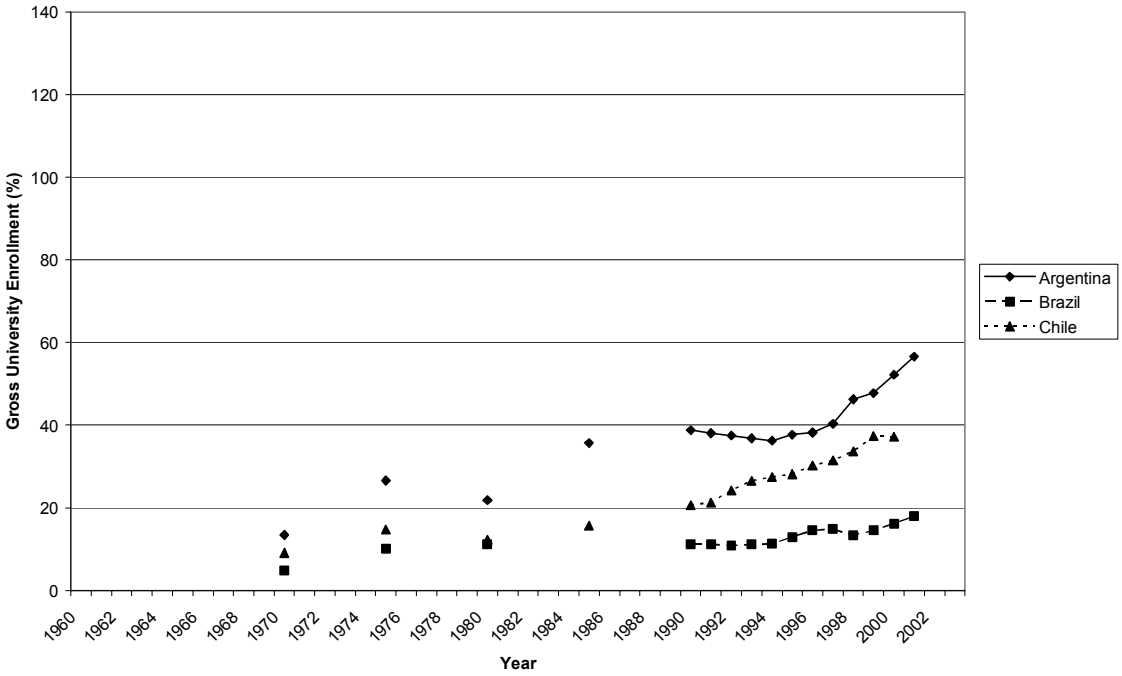


Figure B5. Private Internal Rates of Return by Education Level: Brazil

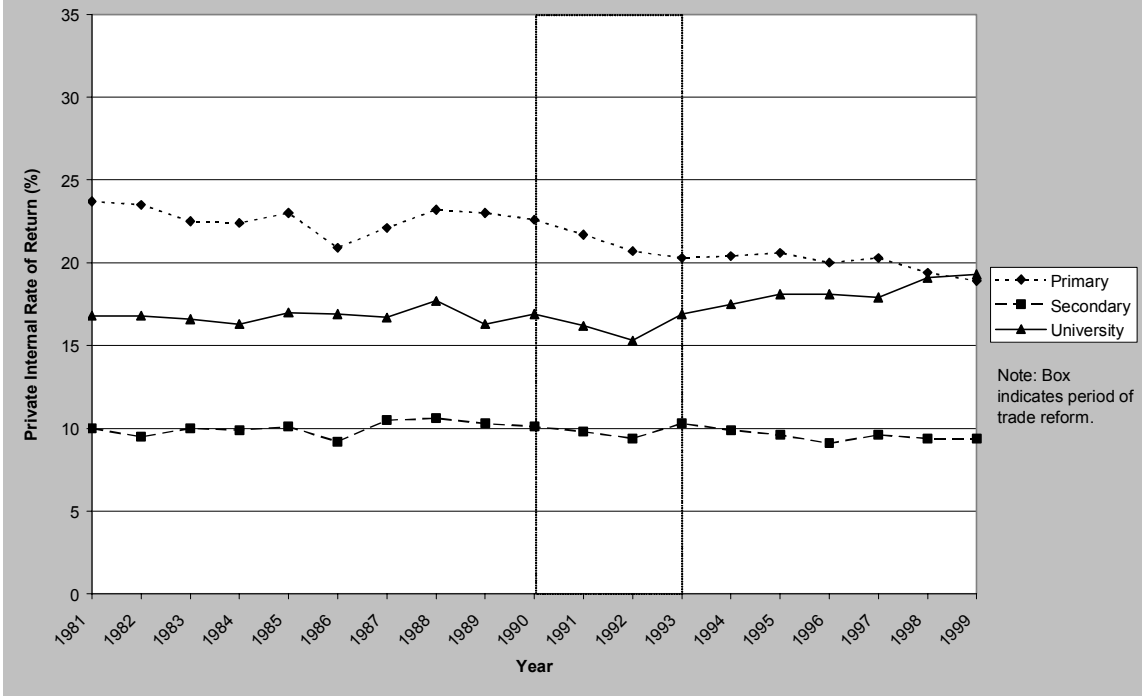


Figure B6. Private Internal Rates of Return by Education Level: Argentina

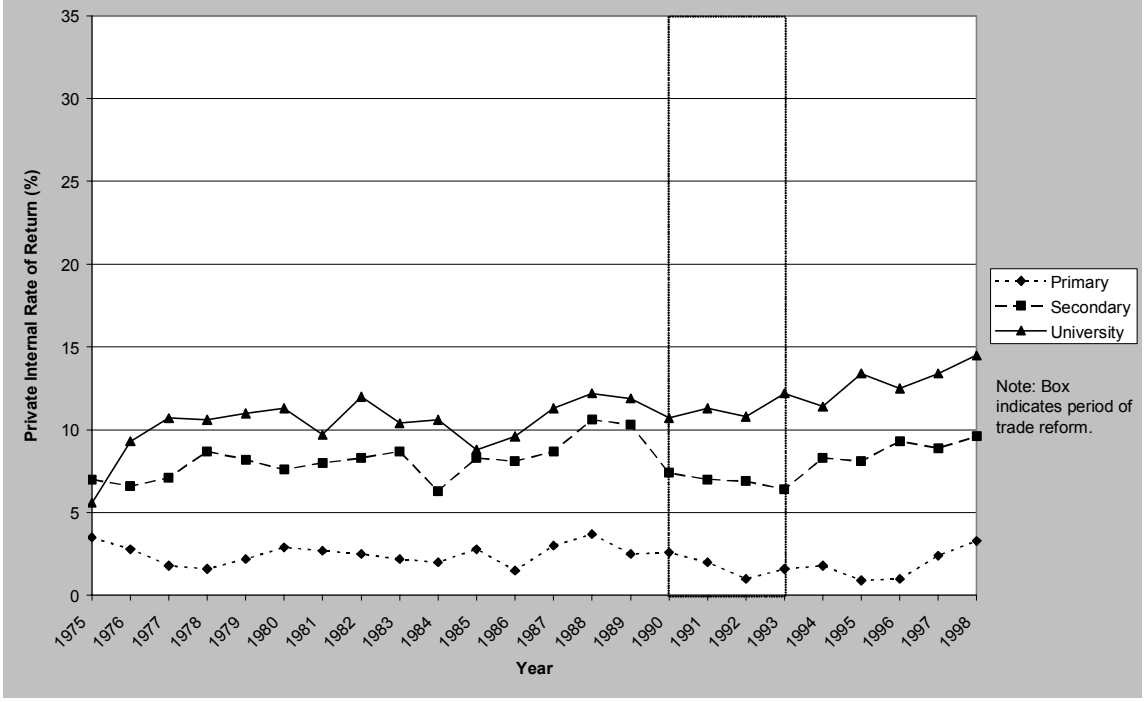
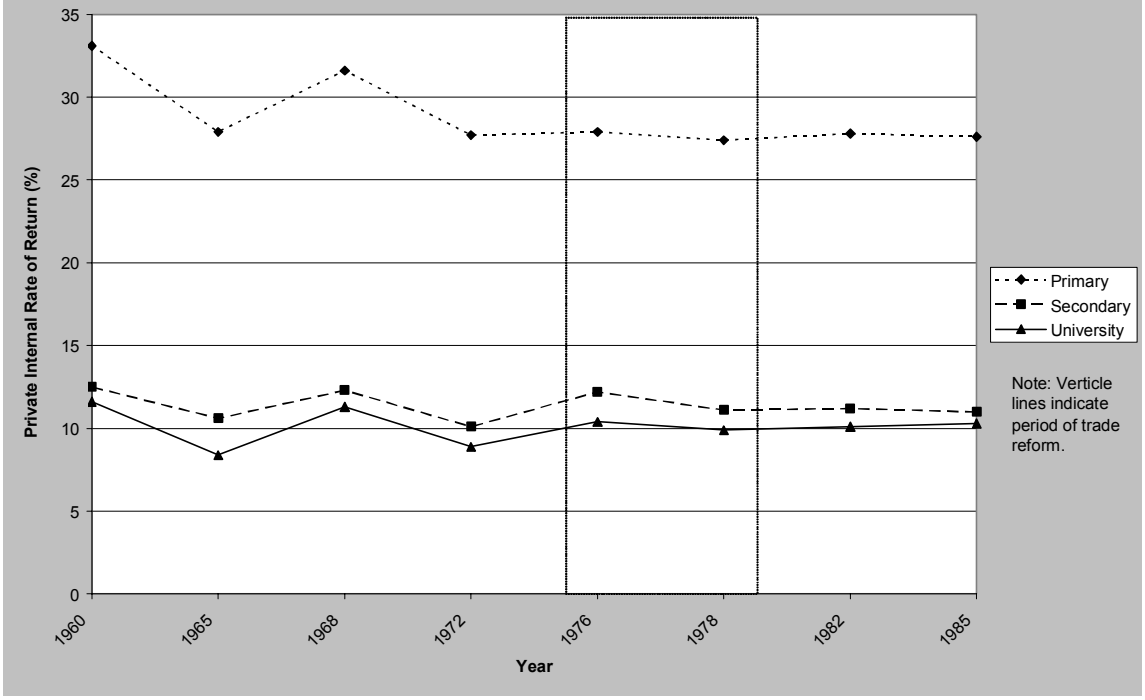


Figure B7. Private Internal Rates of Return by Education Level: Chile



APPENDIX C: ESTIMATES OF GOVERNMENT EDUCATION EXPENDITURE IN ARGENTINA AND BRAZIL

In Argentina, I estimate expenditure per student by multiplying GDP per capita (1995 US$) by expenditure per student (per capita GDP, %), for each level of education (WDI, 2004).

To estimate expenditure per student in Brazil, for each education level I multiply education expenditure (% total education expenditure) (EdStats, 2004) by total education expenditure, found by multiplying GDP (1995 US$) (WDI, 2004) by education expenditure (% GDP) (United National Commons Database [UNCDB], 2004). From 1985-1986, 26.8% of education expenditure was unaccounted for, so I distributed the remainder among the three levels according to each level's share of total enrollment, as Riveros (1990) did in estimating expenditures in Chile. I made some data fills by averaging values from adjacent years if data fills were safe and consistent with trends. I estimated: education expenditure (% GDP) from 1996-1997 (UNCDB); primary enrollment (UNCDB) for 1998; tertiary and secondary enrollment (UNCDB) 1997-1998 and 1995. The 1995-1997 World Bank data does not include capital expenditure, but the 1985-1986 data does. Therefore, I revised the 1995-1997 estimates upwards by 0.05%, which corresponds to the rough percentage of investment expenditure in total fiscal education expenditure per capita that Riveros calculated for Chile.

APPENDIX D: ESTIMATES OF RETURNS TO SCHOOLING IN BRAZIL

I calculate marginal and gross returns to education by adjusting estimates of wage gains from education provided by Green et al. (2001). Green et al. obtain their data from successive cross-sectional analyses of the Pesquisa Nacional por Amostras de Domicilio (PNAD), nationally representative household surveys conducted by the government's statistical agency, Instituto Brasileiro de Geografia e Estatistics, each September. The quality of the sample is known to be high. The sample uses a consistent methodology, and a consistent education classification has been available since 1981. The survey covers every year since then except 1980, 1991, and 1994. The authors restrict their analysis to positive wage earners, aged 18 to 65.

Using data from this survey, Green et al. perform a Mincerian regression, defining work experience in the standard way as age minus years of study minus six. They regress the log of real hourly wages against five education level dummies, a quadratic in experience, and, where appropriate, a gender dummy. Earnings are measured before taxes, as is standard.

The authors provide hourly wage data in terms of 1998 reals. (I fill in data for 1991 and 1994 by averaging contiguous years.) In order to account for the cost of education expenditure, which is measured annually, in calculating the social internal rate of return, I convert hourly wage data into the mean real yearly salary (1995 US$) by multiplying the mean real hourly wage by hours worked. I could not find data of hours worked by education level, so I took an average representative of the large and modern areas of Brazil from the PME government survey, presented in Blom et al. (2001). This measure of hours worked assumes hours worked did not vary across years. The estimate

is reasonable but high by international comparison. I convert Green et al.'s data from 1998 reals to 1995 US$ using the CPI for Cities (UNCDB, 2004) and the market exchange rate. To be consistent with PNAD data, I estimate this rate for September of each year by averaging the exchange rate at year end and the average yearly exchange rate (UNCDB).

APPENDIX E: ESTIMATES OF RETURNS TO SCHOOLING IN ARGENTINA

I calculate marginal and gross returns to education by modifying estimates of wage gains from education provided by Cossa (2000). Cossa's dataset is the Encuesta Permanente de Hogares, which closely resembles the Current Population Survey in the United States. The government's statistical agency, Instituto Nacional de Estadisticas y Censos, conducts the survey every May (April until the mid 1980s) and October. The survey is known to be of high quality. It consists of a random rotating sample of Argentine households in Greater Buenos Aires. The survey includes the unemployed and measures income before taxes.

Cossa uses data from this survey to perform a Mincerian regression that includes the variables gender, annual parental income, several family background variables, and yearly time dummies. He measures separate Mincer coefficients for males and females.

Cossa does not present data on wage differentials, so in order to calculate them I estimate the income of primary school graduates for periods of three years from 1975-1998 (Appendix Table A4). For each group, I measure income for primary school graduates by finding the average (rounded to the decile or midpoint between deciles) of the percentage of those in the population who completed primary school and the percentage of those who obtained some secondary school education (Cossa 2000). This average reflects the proportion of primary school graduates in the population, including those who attended some secondary school but dropped out. I multiply this number by the average yearly income in Greater Buenos Aires corresponding to that decile (Instituto Nacional de Estadística y Censos [INDEC], 2004). If the latter figure represented the

point half way between two deciles, I multiplied it by the average of the mean yearly income corresponding to the two surrounding deciles. Average income per decile, which I converted into 1995 US$, was available for the years 2001 and 2002 only. Making the crude assumption that relative earnings have stayed constant from 1975 to 2002, I indexed income for primary graduates according to the change in GDP per capita during this period.

While my method was a fairly poor estimate of the income of primary school graduates, other methods were worse. Lack of data prevented me from estimating income for primary school graduates using the minimum wage or income in the agricultural sector. Income in the manufacturing sector (INDEC, 2004) might be considered a good proxy for the income of primary school graduates, but the data seemed unreasonable.

APPENDIX F: ESTIMATES OF RETURNS TO SCHOOLING IN CHILE

Riveros (1990) takes his data from the Labor Force Surveys for the Greater Santiago Area. These surveys are conducted yearly and are well reputed regarding sample design and data consistency over time. The survey reports labor incomes net of some taxes but adds some fringe benefits. The sample excludes the unemployed. Riveros estimates earnings differentials by education level through a Mincerian earnings function that includes the explanatory variable of logarithm of hours worked during the month. He uses the standard proxy for labor market experience, age minus schooling years minus six. Because his dataset excludes the unemployed, Riveros factors the unemployment rate into his income calculations in estimating the internal rates of return, using an estimate of long term unemployment that fluctuates less over time than the observed open unemployment rate. Riveros estimates direct private outlays on the basis of family expenditure surveys and estimates of expenditures in transportation and school supplies.

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