Human Capital Creation when Population Growth is Rapid: Lessons from Brazil

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July 2018

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Abstract

This paper investigates the creation of human capital through education when the overall rate of growth of the population is high. Our focus is Brazil in the period 1960-80. This was a period when population growth was three percent per year and the education level of the labor force was low with almost half working in agriculture. We start with a description of the changes in the education profile of the young adult labor force between 1960 and 2010. We show that while there was an impressive investment in education between 1960 and 2010, it did not come close to spreading primary or secondary education to the mass of new entrants. Indeed it is not until after 1980 that the growth rate of secondary and university grad in the labor force exceeds that of primary and less than primary. The second part of the paper considers the benefits and costs of an alternative education strategy, one which upgrades the education of new entrants to the labor force. We show that upgrading the education of the entire labor force takes a very long time because of the incremental nature of human capital formation. But we also showed that education upgrading had a high payoff. We constructed earnings regressions and calculated the internal rate of return from investing in primary and secondary education. The IRR was 22% for primary and 23% for secondary in 1970. It fell a bit for primary by 2000 but rose for secondary. Despite how long it may take, investing in people had a high payoff in Brazil.

Key words: Brazil, Education, Development, Population growth

This paper investigates the strategy of human capital creation through education when the overall rate of growth of the population is high. Our focus is Brazil in the period 1960-1980. In 1960 the country had a very poorly educated labor force and rapid population growth. This gave the country an opportunity to massively upgrade the education level and productivity of its labor force. We show that while there was an impressive investment in education between 1960 and 2010, it did not come close to spreading primary or secondary education to the mass of new entrants. Indeed it is not until after 1980 that the growth rate of secondary and university grad in the labor force exceeds that of primary and less than primary.

The key development problem for any country is how to raise the productivity and income of its labor force. Other than physical investment there are two ways to do this. One can make workers more productive by educating them or moving them to regions or sectors where jobs are plentiful. In 1960 Brazil was a less developed economy with a per capita GDP of $3400, with roughly half its labor force working in agriculture and living in the rural sector. At that time its population was growing at almost 3% per year, and the age cohort 15-34 comprised around 34% of the total adult population (>14). Population growth was even higher in the Northeast where economic activity remained stagnant while the Southeast was rapidly industrializing.

We are going to focus on education as a key factor in the creation of human capital and the transformation of the labor force. We start with a description of changes in the education profile of the labor force over the period 1960-2010. We will show that while there was an impressive investment in education during this period it was often of low quality and did not come close to spreading primary or secondary education to the mass of new entrants. We focus on new entrants or the age cohort 30-34 and use census data to show that despite efforts to upgrade its labor force, Brazil did not come close to spreading primary or secondary education to all new entrants. But even so schools did absorb a lot of the young who otherwise would have had to go into the labor market, and also resulted in a significant upgrading of the labor force. Education is a crucial part of the story in Brazil.

Education also has a time dimension that has to be considered. The process of human capital acquisition takes time. To create college grads, you need an adequate supply of high school grads, and high school grads depend on a supply of primary school grads. That implies that you cannot create college or high school skills instantaneously no matter how much money you are willing to devote to education. This is one of the reasons for the widening wage differential for the skilled over the period.

In the second part of the paper we develop a simple simulation model to more closely examine the time dimension of an education strategy and to show what would have happened and what would it have cost had Brazil speeded up the process of upgrading so that fewer entrants to the labor force would have less than primary levels of education. We did a simulation in which we tracked the change in the education level of the entire labor force when we forced down the share of new entrants with less than primary education. We showed that even when the share of new entrants with less than primary is pushed down to 5% by 1991 that share for the entire labor force only fell from 73% in 1970 to 48% in 1991. In that same simulation over the same period the share of primary school graduates in the labor force only rose from 16% to 25%.

Next we present a set of earnings regressions which permit one to calculate the payoff to more education and to migration. We estimated the payoff to education using the regression results and show that it was high and rising reflecting both the scarcity of better educated workers and the style of skill-intensive growth in Brazil. We then used the earnings regressions to get an estimate of the gains to be had from either acquiring more education or by migrating from the rural to the urban sector or from the low-income Northeast to the higher income Southeast. It turns out that workers with at least primary education could

increase their incomes by almost fifty percent by moving from the countryside to the cities and by even more than fifty percent by moving from the Northeast to the Southeast. The regression evidence shows that there was a big gain to be had by moving to where the good jobs were, especially for the better educated after 1980.

1. Changes in the sectoral and educational structure of the young adult labor force.

We begin the study with a presentation of changes in various components of the labor force of those aged 15-34 from 1960 to 2010. We focus on this cohort because any education strategy we choose will show up first in this cohort. Unless otherwise indicated we will call the 15-34 cohort new entrants. We start with changes in the employment structure of the group. (See table 1). In 1960, half of new entrants worked in agriculture. That proportion was cut in half over the following twenty years and half again by 2010. Even in 1980, it was no longer the case that agriculture was the entry level job of most of the young. Rather it was manufacturing, services, and construction. There is also an important gender difference in these results.

When one follows particular cohorts as they get experience to get a better idea of mobility over time, we found that many more of 1960's young adults found jobs in the service sector and many fewer stayed in the domestic household help category. The service sector provided an increasing proportion of entry level jobs over the period. Cohort analysis tells us that services also provided significant promotion possibilities. That is not true for manufacturing and household services whose share for 1960's new entrants fell over time. In other words despite the rapid industrial growth that occurred in Brazil over these years and despite offering a large number of entry level jobs, it was the non -household services sector that attracted most of 1960s young as they aged.

The difference between the short and the long run for the domestic help category should also be noted. The category provided an increasing number of entry level jobs over the period. But as those workers got older, it is clear from the cohort analysis that many of them sought work elsewhere.

TABLE 1: SECTOR STRUCTURE OF (AGES 15 TO 34) IN LABOR FORCE

	1960	1970	1980	1991	2000	2010
agriculture	53	42	26	20	16	12
industry	4	6	8	7	7	7
construction	12	14	21	18	16	16
services	5	9	7	8	8	6
private services	5	9	7	8	8	6
government	3	4	4	4	5	5
wholesale	8	10	12	14	16	21

Source: IBGE Demographic Censuses

The focus of this study is the age cohort 15-34. But since this is the time of life when one can either attend school, join the labor force, or drop out to get married and raise a family, one gets a somewhat distorted view by looking only at education or occupation profiles. Consider table 2 which shows the changes in time use by the 15-34 cohort from 1960 to 2010.

TABLE 2: NEW ENTRANT TIME USE 1960-2010

	1960	1970	1980	1991	2000	2010
labor force	49.8	41.8	44.4	45.2	37.6	37.1
Inactive	38.7	30.9	26.2	23.6	15.5	16.3
Students	11.5	27.3	29.4	31.2	46.8	46.6

Source: IBGE Demographic Censuse

Table 2 tells us that the real story on how Brazil absorbed the growing number of young is not just through an expansion of the labor force. Rather it is the role of schools, particularly after 1980. The participation rate fell from 50% to 45% by 1980 and then to 37% by 2010. The real action is the growth in enrollments. The fraction of new entrants who stayed in school grew from 12% to 29% from 1960 to 1980 and then to 47% by 2010. Meanwhile the share of inactives fell from 39% in 1960 to 16% in 2010. In other words this was a labor market dynamic enough to reduce the share of inactives by twenty percentage points. But for the most part the inactives were drawn to school not the labor force.

Changes in the education level of the young between 1960 and 2010

When evaluating the performance of the education system, there are three separate questions to consider. The first is the coverage of the system. How many of the relevant age group are in school in a given year? The second is the quality of the education they are receiving.[1] The third is the education profile of those in the cohort who are in the labor force but no longer in school.

In 1960 only 17% of the 15-19 age group and about half of the cohort of 11-14 year-olds were in school. Twenty years later, 41% of the 14-19s and 70% of the 11-14s were in school as were almost one-third of young adults. This was an impressive effort, particularly since the growth of the 11-19 cohort was itself so rapid. Over that twenty year period the school population of 11-19 year-olds more than doubled and yet Brazil managed to increase significantly the percent of the cohort in school. To put this another way, almost three-fourths of the entire increase in the 11-19 year-old cohort between 1960 and 1980 was in school in 1980. The increase in human capital that this effort implies was bound to make a positive contribution for these cohorts in the years after 1980.

Instead of looking at how many of a cohort were still in school in a particular census year, if we look instead at the educational profile of successive cohorts of young adults, we find a large jump in educational attainment.(see table 3). Overall, 91% of the new entrants of 1960 had less than a primary school education. That number had shrunk to 73% by 1980. By that year 32% of the 1960 cohort of 15-24 year-olds had completed primary school and another 9% had completed secondary school. Twenty years before only 6.8% had completed primary and a further 1.7% had completed secondary.

Brazil made a large investment in education in the 1960-80 period. In 1960 only 54% of 10-14 year-olds were in school. In other words, almost half of Brazils' pre-teens were not in the school system at all. That obviously has dire implications for the skill level of new entrants to the labor force. In 1960 13.5% of the preteen group were both out of school and in the labor force where at best they could perhaps have had a primary school education. By 1980, 70% of that age group were in school.

Overall the education system more than tripled enrollments of 10-29s from 1960 to 1980, absorbing a total of 12.5 million or 20% of the total number of new entrants (10-29) over the period. Not only did this

[1] Birdsall et al (1996) point out that despite the expansion in coverage, schools in Brazil lagged behind other countries at similar income levels in both average quality and variances in quality across schools and regions.

help in the absorption of this wave of new entrants, it also permitted a significant upgrading of the skill levels of the entire 1980 labor force as we shall see in a moment.[2]

One of the difficulties in tracking changes in education over time for a cohort of 15-34s is dealing with those who are in the labor force but still in school in any given census year. A better way to appreciate the changes in the education profile of those going into the labor force is to look at the 30-34 year cohort since by that age virtually no one is still in school. Table 3 tells the story.

TABLE 3: SHARES OF 30-34 YEAR-OLDS IN LABOR FORCE BY YEARS OF EDUCATION

	1960	1970	1980	1991	2000	2010
Less than primary	91.6	86.93	73.17	54.77	44.17	22.77
Primary	4.11	6.8	11.99	20.93	27.07	27.8
Secondary	2.57	4.49	9.79	17.5	22.28	32.98
University	0.97	1.63	4.92	6.8	6.48	13.47

Source: IBGE Demographic Censuses

In 1960, 92% of the 30-34 cohort - those just entering the labor force and beyond the reach of the education system - had less than two years of education. This group reflects the dismal education level of the entire Brazilian labor force. Now consider the change in structure over the next fifty years. The pre-primary group shrank by 18 percent points up to 1980 and then by a further fifty pp by 2010, while each of the higher groups increased by a large amount Look particularly at the high school and college graduate group. Together that group grew from 4% of the cohort to 6 % by 1970 and then to 46% by 2010. Over time that was a big enough improvement to make a significant difference in the entire labor force as we shall see. But that improvement took a lot of time and came after 1980. Partly that is because this particular cohort was a small fraction of the entire labor force. But it is also because it takes a lot of time to produce a college or high school graduate when one starts with a low level of education. If a college level education represents 16 years of schooling, and if the labor force starts with new entrants having less than primary, then it is going to take at least 10 years (those with 5 years of education have less than primary) to transform a member of the 1980 group from pre-primary to college graduates.

To see the education problem more clearly, we looked first at the three cohorts which were 25-29 in the 1960, 1970 and 1980. We produced two way tables with the numbers in and out of school and in and out of the labor force (not shown). What is immediately clear is that being out of school did not mean that one was in the labor force because the category of "inactives" comprised almost 50% of those not in school in both 1960 and 1970.[3]

The first conclusion from these two-way tables is the tiny fraction of 25-29 year-olds still in school in 1960. That reflects the tiny fraction of new entrants with university education in that year. The second pattern is the large fraction of those not in school who are not in the labor force. Only 1% of the 1960 cohort was still in school in 1960, but only 57% of those not in school were in the labor force. By 1970 that 1% had grown to almost 8% still in school. More and more of Brazil's young were getting higher and higher levels of education.

If one thinks of the education system as the producer of human capital relevant to the production process, it is clear that in Brazil one must qualify that assertion. 43% of those exiting the school system in 1960

[2] Note again that this measure makes not distinction between schools of various qualities. See Birdsall et al (1996)
[3] The category in the census was inactive which meant out of school and not in the labor force.

did not join the labor force but became inactives instead. Education is a powerful determinant of social welfare. But the high inactive ratios meant that it was going to take a proportionally greater amount of education investment to create employable human capital.

2. Labor Force Dynamics

We are going to divide the labor force into four education classes: less than primary, primary secondary and university. On the demand side, we are going to assume that the demand for each of these four skill classes is a weighted average of the growth rates of the different sectors of the economy adjusted for the observed rate of sectoral productivity growth. The weights are the fraction of the labor force with that level of education or skill in each sector. In Brazil data limitation force us to divide the economy into the standard two digit sectors. We are dividing the labor force into four education groups to be consistent with the presentation in the previous section. The least skilled are those with less than two years of education. They primarily work in agriculture so the overall growth in demand for pre-primary mainly depends on what is happening in agriculture. For each of the other skill classes both manufacturing and services drive the factor growth rate.

We made this calculation for the period 1960-80 and showed that demand was indeed skill intensive. The growth in the demand for all three of the better educated skill groups was about two percentage points higher than for the unskilled.[4] What was happening on the supply side? We are going to measure the education of new entrants to and retirees from the labor force between 1960 and 2010. (See Table 4). We first show the fraction of the population who were either in school, inactive or in the labor force subdivided into their education attainment. The labor force in any year is equal to the labor force in some prior year plus new entrants less retirees. New entrants for any ten year period are composed of two age groups-those who were 10-24 in the prior year. (they are now 20-34 in the current year) New entrants from that group are the difference between the number in the labor force in the 20-34 year old group in the current year less those in the labor force from the 10-24 group in some prior year. To that we add those in the group 10-19 in the current year. (They cannot have been in the labor force in year t-1.) Exiters or retirees are the simple difference between those in the labor force with ages above x in year t-1 and x+10 in ten years later. But note that the labor force in any year t is exactly equal to the labor force in year t-1 plus new entrants less exiters.

As the reader can see, the net new entrants more than doubled the size of the labor force between 1960 and 1980 and again between 1980 and 2010.[5] But what is striking about the data in the first period is that despite twenty years of investments in education upgrading, 66% of the new entrants came into the labor force with less than two years of education. Even in 1980 over five million of the 10-19s were out of school and in the labor force with less than two years of education.

The situation improved dramatically after 1980. Many fewer of the new entrants went into the labor force with less than primary and at the same time poorly educated older workers retired in greater numbers. Over the entire period the growth rates of each of the higher education classes was over 7% per year, but the less than primary group actually declined after 1980. Since the country started with such low levels of

[4] The demand for each of the better educated grew at about nine percent in the 70s and about seven percent in the sixties while the growth for the unskilled was about 2.5 percentage points less in both periods.
[5] Between 1960 and 1980 net new entrants were 19.9 million while the entire 1960 labor force was 19.0 million. The comparable figures for 1980 to 2010 were 37.9 million compared to a 1980 labor force of 38.9 million.

education (only 3% of the labor force had secondary education or above in 1960), even the high rates of growth of all three higher education categories only expanded the share with secondary or above to 12% from 3% between 1960 and 1980. Even in 1980 over 75% of the labor force still had less than two years of education. It was only after 1980 that one could begin to see the fruits of the earlier education strategy as the share of the labor force with less than primary fell to 27% while the university group rose to 13%.

What is curious about these numbers is that it appears that the growth in the supply of the better educated exceeded the growth in the demand for their services. And yet there is little evidence that relative wages declined over the period. We will turn to this part of the story further on

TABLE 4: LABOR FORCE DYNAMICS

1960 to 1980								
	New entrants	**leavers**	**Net additions**	**1960 labor force**	**1980 labor force**	**yearly growth rate**	**Initial shares**	**Final shares**
Less than primary	15,902,225	4,402,065	11,500,160	17,773,240	29,273,400	0.02	0.93	0.76
Primary	4,263,625	-36,885	4,300,510	666,720	4,967,230	0.11	0.04	0.12
Secondary	2,709,915	-115,475	2,825,390	391,020	3,216,410	0.11	0.02	0.08
University	1,116,060	-168,070	1,284,130	175,060	1,459,190	0.11	0.01	0.04
total	23,991,825	4,081,635	19,910,190	19,006,040	38,916,230	0.03	1	1
1980 to 2010								
	New entrants	**leavers**	**Net additions**	**1980 labor force**	**2010 labor force**	**yearly growth rate**	**Initial shares**	**Final shares**
Less than primary	10,810,149	19,444,568	-8,634,419	29,273,400	20,638,981	-0.012	0.76	0..27
Primary	17,703,353	1,107,459	16,595,894	4,967,230	21,563,124	0.050	0.12	0..28
Secondary	22,180,162	731,587	21,448,575	3,216,410	24,664,986	0.070	.08	0.32
University	7,872,606	-653,969	8,526,575	1,459,190	9,985,765	0.066	0.04	0..13
total	58,566,270	20,629,644	37,936,626	38,916,230	76,852,856	0.023	1	1

Source: IBGE Demographic Censuses

3. Education simulations

The labor force in 1960 had 19 million people in it. New entrants aged 10-24 over the 1960s added 7.5 million potential workers or 39% of the 1960 labor force. This was the period when Brazil experienced its most rapid population growth. We have been analyzing education as a way of increasing the human capital of the labor force. But another way to think about this is to see the education system absorbing some fraction of potential new entrants and keeping them out of the labor market, at least temporarily.

What would have happened if Brazil had changed its education strategy in 1960? Suppose it had made a concerted effort to expand primary education and to reduce the number of young adults coming into the labor force with less than two years of education. In other words, suppose that Brazil had made a big effort to keep the young in school longer? That is the question we want to address here. We will show that if the country had followed our most ambitious simulation and driven the pre-primary new entrant fraction to 5% by 1991, that would have kept 4.5 million new entrants in school in 1970. Had that happened, the increase in the labor force would have been 3.0 million instead of 7.5 million. That is, the expansion of the school system would have absorbed 4.5/19 or 24% of the new entrants[6].

By 1980 some of the population pressure of prior years had subsided. The base line labor force had 38.9 million workers of whom 11.2 million or 29% were new entrants aged 10-24. If the country had followed our most ambitious simulation, 5.8 million of those new entrants would have stayed in school. That would have meant that the labor force during the 1970s would only have had to expand by 5.4 million or 19% instead of 39.4%.

Obviously there will be a cost to such a program. If students were going to stay in school longer, the system would need more class rooms and more teachers. That would be costly. It will not be enough to call for an expansion in primary school enrollments without considering the cost of such a strategy.[7]

We are going to address both the question of factor supply growth and cost in our simulations. Part of the motivation for this exercise is to explore the time dimension involved in any education strategy. For these simulations we extend our time horizon out to year 2010. That should give whatever education strategy we chose sufficient time to significantly change the education structure of the entire labor force.

We start with a baseline. (See table 5). This is the actual observed trajectory of the education structure of the Brazilian labor force derived from various population censuses. The first thing to note in the table is just how slow the progress has been. Despite decades of expansion of enrollments in primary school, even in year 2000 almost half the labor force still had less than two years of education. It shows both the dismal education profile of the Brazilian labor force and the gradual improvement in that profile over fifty years. Apparently it was not until the last two decades (1991-2010) that real progress was made in bringing down the share of new entrants with less than primary and raising the share with high school or university educations. The baseline also shows how even the dramatic improvements in the education of new entrants in the last two decades has only gradually changed the education profile of the entire labor force over the same period.

The other pattern to note here is the skew in the system. In every decade except the 1990s the number of university graduates more than doubled, with the growth in the numbers for secondary school not far behind. Meanwhile it is not until the first decade of the twenty first century that the absolute number of

[6] Note here that for simplicity we assume that the new entrants go into the labor market only in 1970 rather than entering over the 1960s. In 1970 those new entrants simply expand the primary and secondary groups..
[7] Note that in the simulations we ignore the cost differences between good and poor quality schools.

pre-primaries falls[8]. That is the legacy of a regressive educational system whose chief characteristic was the rapid expansion of universities and to some extent secondary schools at the expense of primary schools.[9] It is not clear how much education a worker needs to succeed in the labor force. But whatever that was, too many workers for too many years came into the labor force ill-equipped to take advantage of the rapid growth in the demand for the more educated.

TABLE 5: BASELINE SKILL SHARES OF NEW ENTRANTS INTO LABOR FORCE

Entrant profile						
	1960	**1970**	**1980**	**1991**	**2000**	**2010**
Less than primary		83.16	54.73	39.56	22.47	-2.82
Primary		8.82	23.89	27.96	28.7	33.34
Secondary		5.64	15.17	23.2	39.62	49.23
University		2.38	6.2	9.28	9.21	20.24
Labor force profile						
	1960	**1970**	**1980**	**1991**	**2000**	**2010**
Less than primary	93.51	89.09	75.22	60.73	48.26	26.86
Primary	3.51	5.65	12.76	18.65	22.64	28.06
Secondary	2.06	3.58	8.26	14.3	21.85	32.09
University	0.92	1.68	3.75	6.32	7.25	12.99

Source: Author's calculations based on Demographic Censuses from IBGE

We made three simulations (of which only the most ambitious is shown here) (see table 6) based on how fast we want to drive down the share of new entrants going into the labor force with less than six years of education by 1991. In the base line in 1970 83% of the new entrants had less than six years. That percentage fell to 55% by 1980 and to 40% by 1991. The simulation reduces the 1991 number from 40% to 5%. The simulations gradually reduce the share of pre-primary new entrants over the period 1960-1991 such that it reaches the desired level in 1991. The first and most ambitious simulation shown here reduces the pre-primary new entrant share in 1991 to 5% by 1991.

Clearly if more people stay in school rather than joining the labor force, the proportion graduating from primary and secondary levels has to rise. We will assume that the proportions in primary and secondary levels stay the same as they were in the base run in 1970.[10] We keep the share of university graduates at the baseline level. That means that whatever reduction we simulate in the pre-primary group will increase the share going on to primary or secondary education. It also means that what happens in the primary and secondary levels of education is totally dependent on changes in the share of new entrants with no more than pre-primary in 1991.

[8] The definition of new entrants is net of retirements

[9] For more on the regressive, university dominated education followed by Brazil see Birdsall et al (1996)

[10] For example, in a given simulation suppose that 15% of new entrants in a particular year had more than pre-primary, but less than university, of which 10% had primary and 5% had secondary. Then the primary share for that year will be set equal to two-thirds of one minus the share of pre-primary in that year. We set the ratio of primary to secondary in each year to the actual ratio observed in in the baseline for the same year.

TABLE 6: SIMULATION RESULTS FROM HUMAN CAPITAL ACCUMULATION[11]

Decline in non-educated class: 5% by 1991- Sim 1					
Entrant profile					
	1970	**1980**	**1991**	**2000**	**2010**
Less than primary	36	14	5	5	5
Primary	37	49	47	36	30
Secondary	24	31	39	50	45
University	2	6	9	9	20
Labor force profile					
Less than primary	73	60	48	44	29
Primary	16	22	25	25	27
Secondary	10	14	20	24	31
University	2	4	6	7	13

Source: Author's calculations based on the demographic censuses from IBGE

The first and most obvious conclusion to be drawn from table 6 is just how long it takes to translate even the most aggressive education strategy into meaningful changes in the education structure of the entire labor force. Look at the simulation. The country brings the proportion of new entrants with less than primary to 5% by 1991. This is a very ambitious goal. It means quadrupling the number of primary school graduates over thirty years. And yet, even by 1991, thirty years into the program, still 48% of the labor force has less than pre-primary. New entrants with better education enter the labor force where they replace older workers who retire. They also expand the entire labor force because there are many more new entrants than retirees. Since the retirees have a far worse educational profile than new entrants, eventually the labor force will look like the new entrants. But even in 2010, fifty years into the simulation, the education structure of the entire labor force has still not reached that equilibrium. In the simulation there are still 29% with only preprimary and 27% with primary in the labor force, both lower than the shares for new entrants. The point to take away from this is that it takes a very long time to improve the education of the entire labor force when you are only educating new entrants, even when there is a large number of new entrants with better education going into the labor force every year.

As we have pointed out, the 1960 Brazilian labor force had a dismal education profile. There really is only one way to correct that and that is to invest in the education of new entrants. One can see in the table just how much of an impact such a strategy has. Look again at our simulation where we keep new entrants in school longer. Obviously that means that when young workers finally enter the labor force, they will have more education. In our simulation we distribute those staying in school between primary and secondary according to the share observed in the base line. That means that roughly five out of each eight of those staying in school in the 1960s go into the labor force with primary and the other three with

[11] In the simulation we force down the fraction of new entrants with less than primary to 5% by 1991. But because the actual share with less than primary in 2010 was lower than that thanks to a massive education effort in the new millennium, the 2010 labor force in the simulation had a worse education profile than it had in the baseline. The simulation outcome leads to a more educated labor force in each previous year.

secondary. After 1991 there is a big shift toward secondary. Those who don't go into the labor force tend to stay in school longer so that when they do leave school, many more have at least a high school education. Over the fifty years covered in the table that makes quite a difference in the education profile of new entrants. By 1980, instead of 24% of new entrants with primary and 15% with secondary, almost half of new entrants have primary and another 31% have secondary. By year 2000 95% of new entrants have at least a primary school education compared to 77% in the base run. But as we noted before, those big educational improvements in the simulation take a long time to really affect the education structure of the entire labor force. Even in year 2000 forty years into the program, less than half of the entire labor force has primary or secondary education compared to 86% of new entrants with that amount of education.

4. Quantitative analysis

In order to understand the feasibility of alternative education strategies, we need to find ways to measure both costs and benefits of upgrading the labor farce. Our strategy for measuring benefits is to estimate an earnings regression that allows us to identify the respective "payoffs" to different paths an individual might make. This allows us to measure the perceived benefits of acquiring more education, moving to the cities or moving to different regions of the country. On the cost side, our approach was to simply count the additional supply of educated labor and attach a cost to it according to constitutionally mandated - for public education - expenditure per pupil. Once we have the perceived benefits of entering the labor force with primary only versus secondary education for example, we can compute the associated costs and finally ascertain whether the benefits outweigh the costs. In our analysis, we do not consider general equilibrium effects on wages and such a framework may be needed in order to analyze post-decision outcomes. Our analysis is sufficient from the point of view of a household that compares potential benefits of various decisions and acts accordingly. As stated above, the scenario that we are most interested in are those in which we drive down the share of least educated labor force entrants faster than it was achieved in the baseline scenario. Below we describe in detail the methods used for both the earnings regressions and the labor share simulations performed.

For both the regression analysis and labor force profile simulation, we used the Brazilian population census that took place in 1960, 1970, 1980, 1991, 2000 and 2010. The census was a nationally representative cross section of the population and we focused on the employed labor force as means of assessing returns to labor mobility (migration) and/or human capital investment. The census has information on education, place of residence, earnings and various other demographic characteristics. We focus on those that shed light on earnings and stock changes of labor force of different education levels.

Earnings regressions

In an attempt to assess the gains from further education along with gains from migration, we estimated a standard earnings regression with fixed effects.[12] The fixed effects include gender and regional dummies and allow us to check whether individuals can earn more by moving rather than attaining further education. The regional dummies represent an income change from living in a particular region holding constant experience, education, gender, and urban status. This implies that the regional dummies represent potential income from living in a particular region. In terms of assessing payoffs to migrating, this abstracts away from factors that may affect employment opportunities for migrant workers (moving

[12] See Strauss and Thomas (1996) for an econometrics analysis of the relationship between wages and education using the 1982 PNAD household survey.

costs, sorting of opportunities for migrants, etc.) but still represent a perceived income change from the perspective of the household. Our model can be formally stated as follows:

$$\ln(inc_{it}) = \alpha_{it} + \beta_{exp,it}\exp_{it} + \beta_{exp,it}\exp_{it}^2 + \boldsymbol{\beta_{reg,it}}\,\boldsymbol{reg}_{it} + \beta_{gen,it}gen_{it} + \beta_{urb,it}urb_{it} + \epsilon_{it}$$

Where $i \in \{less\ than\ primary, primary, secondary, university\}$ and $t \in \{1970,1980,1991,2000\}$ represents years the demographic census took place in Brazil from 1970 to 2000. Experience is proxied by *potential experience (age – edu – 6),* a measure that is common in this literature (XXX should cite something here). The fixed effects in our regression assign dummy variables for the different regions, rural versus urban status, and male versus female workers.[13] This regression allows us to estimate lifetime income for different levels of education. We can then compare lifetime income to the costs of obtaining primary education and compute the internal rate of return of obtaining more education and working over a lifetime with the higher level of education. Also using equation 1, we can assess whether *migrating* presents a better avenue towards higher income than acquiring *skills (further education).* It's worth noting again that the data used here do not contain a panel structure, and instead, each census year is a cross section of the Brazilian population. In the census, we restrict the sample to only include employed individuals earning an income.

Regression results

The regressions in Table 7 show income in various sub groups relative to incomes of rural females in the Center-West. What do they tell us about education and experience and their trends over time? In 1970 the average female college graduate working in the rural sector earned 13.3 times the rural female with only pre-primary education at the start of her career.[14]By year 2000 that education differential had been cut to 7.1. But the main reason for that is that the pre–primary group gains relative to the primary school graduates. The differential between college or secondary also widened relative to the less educated but they all lose relative to the unskilled. As Brazil upgraded the education level of its labor force, the supply of the unskilled tended to lag behind the demand for their skills which resulted in a narrowing of the education income differential.

TABLE 7: REGRESSION RESULTS BY YEAR AND LEVEL OF EDUCATION

Less than Primary									
	exp	**exp^2**	**north**	**northeast**	**southeast**	**south**	**male**	**urban**	**cons**
1970	0.054	-0.001	0.075	-0.44	0.113	0.14	0.641	0.601	5.82
1980	0.06	-0.001	0.085	-0.395	0.18	0.145	0.743	0.432	6.851
1991	0.052	-0.001	-0.011	-0.508	0.079	0.022	0.536	0.428	9.278
2000	0.041	0	-0.126	-0.476	0.114	0.094	0.432	0.345	4.216
primary									
	exp	**exp^2**	**north**	**northeast**	**southeast**	**south**	**male**	**urban**	**cons**
1970	0.093	-0.001	-0.082	-0.225	0.176	0.011*	0.444	0.382	6.539
1980	0.095	-0.001	-0.07	-0.311	0.161	0.05	0.56	0.271	7.351
1991	0.064	-0.001	0.008*	-0.447	0.097	0.002*	0.489	0.359	9.738
2000	0.064	-0.001	-0.144	-0.388	0.102	0.059	0.462	0.313	4.404
secondary									
	exp	**exp^2**	**north**	**northeast**	**southeast**	**south**	**male**	**urban**	**cons**
1970	0.069	-0.001	-0.182	-0.3	0.115	-0.055	0.688	0.29	7.403
1980	0.082	-0.001	-0.15	-0.356	0.073	-0.089	0.645	0.28	8.226
1991	0.061	-0.001	-0.015	-0.489	0.04	-0.04	0.548	0.397	10.372
2000	0.061	-0.001	-0.208	-0.409	0.041	-0.021	0.439	0.356	5.094

[13] All the results in table seven show the log of income relative to the base group which is rural females with less than primary in the Center West.

[14] Here we use the regressions to calculate the relative incomes of different groups at the start of their working life rather than over their entire lifetimes.

college									
	exp	**exp^2**	**north**	**northeast**	**southeast**	**south**	**male**	**urban**	**cons**
1970	0.058	-0.001	-0.067*	-0.128	0.13	-0.131	0.726	0.201	8.407
1980	0.071	-0.001	-0.142	-0.266	-0.094	-0.249	0.826	0.153	9.329
1991	0.067	-0.001	-0.024*	-0.366	-0.078	-0.233	0.622	0.306	11.345
2000	0.055	-0.001	-0.132	-0.339	-0.052	-0.189	0.543	0.361	6.182

Source: Author's calculations based on the Demographic Censuses from IBGE
Notes: * represents lack of significance at the 0.05 level confidence

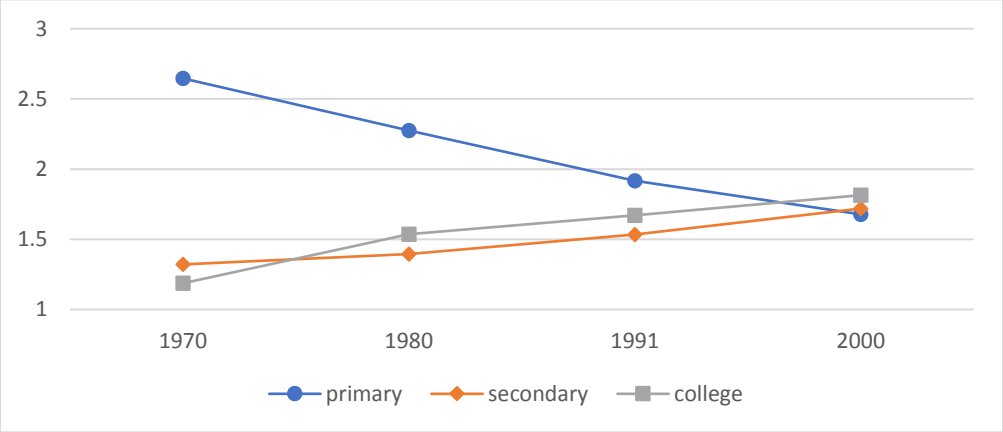
What about experience? The experience term shows the expected trajectory of income over a forty year lifetime. The regressions include an experience squared term to capture possible non-linearities in the lifetime income profile and are negative (and significant) for all groups. That implies that each of the lifetime profiles has a slightly inverted U shape. To dig deeper we used the regressions to calculate lifetime income for each of the groups for which we had dummy variables (gender, region and urban-rural) The data confirm the conclusion that years of experience widened the income differential for college and secondary and the primary group lost ground relative to the other three education groups. At the start of their working life in 1970 male college grads in the rural Southeast earned 12.1 times the pre-primary group, and 2.9 times secondary. By year 2000 the college/pre-primary differential had fallen a bit to 6,8 but at the same time the college/secondary differential had widened slightly to 3.00 thanks to skill intensive growth.

The rural-urban income differential can be seen by looking at the coefficient on the urban dummy. The regressions tell us that the urban differential fell sharply for the unskilled, was about constant for those with primary school and rose for workers with college. Education became increasingly valuable for workers in the cities of Brazil.

Figure 1 shows the gains to education visually. It shows the lifetime incomes of those with a certain level of education relative to those with the next highest level of education. What we see from the figure is the fall in the relative return to primary over pre-primary and the simultaneous rise in the payoff to secondary and college. Over this period the income differential shrank between the pre-primary group and everyone else. But that is entirely due to the relative gain of the pre-primary relative to the primary group. For both secondary and college graduates, lifetime income differentials actually widened a bit between each group and those with less education. In other words, skill intensive growth increased the demand and the incomes for those with more education while the shrinkage in the supply of the uneducated raised the wages of those at the very bottom of the income pyramid.

What all this means is that absorbing the newly educated was not a problem for Brazil. The country started with a poorly educated population and labor force. It made an effort to improve access at the bottom. But the system increased education far more at the top than the bottom. It devoted too many resources to private secondary schools and public universities and not enough to expand the coverage of the basic education system. (Birdsall et al 1996) As a result we see that even in 1980, 55% of that year's young new entrants went into the labor force with less than two years of education while at the same time there was a very rapid increase in the supply of high school and college graduates.

FIGURE 1: PROPORTIONAL PAYOFF GAINS TO ATTAINING LEVEL OF EDUCATION OVER PERVIOUS HIGHEST



SOURCE: AUTHOR CALCULATIONS

5. Returns to education and migration

In this section we are going to use the earnings regressions from the previous section to get a rough estimate of the returns to education and to migration**.** In order to do this we first need to measure the cost or burden of upgrading the labor force in our simulations. Our estimation of costs was fairly simple and consistent with the Brazilian constitution that determines the lowest cost per pupil per year for secondary and primary education that every state must follow. Several reports describe the cost of education per pupil in terms of share of GDP per capita. We picked the first year for which there was data on both state GDP and government mandated cost per pupil per year (1991). We determined what this cost was as a share of the lowest (by state) GDP per capita of Brazil. Based on this measure our figure for cost of educating a pupil for one year was 17% of GDP per capita for secondary and 13% for primary education. We use the surveys to get the fraction of the cohort which is still in school and their education level. We then multiply the per student cost in 2005 dollars by the number of students and compute the cost ratios shown in table 8. As a rough check on the procedure we note that the total education costs for primary and secondary relative to GDP reported for 1959 is roughly consistent with the estimate we present here for the baseline.

Since the population of students expanded rapidly even in the baseline, in addition to the total cost of the simulation we want to know the additional cost of the simulation relative to the base line. We show the total and the additional cost of the simulation in the RHS of table 8. Consider first the base line. In the first column of the table we show the number of students in primary and secondary school whether or not they are in the labor force. Brazil made a considerable effort, particularly after 1980 to reduce the share of new entrants going into the labor force with less than two years of education. Recall that in 1970 83%

of new entrants had less than two years of education. That fraction dropped to 40% by 1991 and to zero by 2010. But of course that meant the dramatic expansion of primary and secondary that we see in the table.

We now turn to the cost of our simulations. (See table 8) Column three gives an estimate of the student population which would correspond to the desired profile of new entrants. Note the difference here between the growth of new entrants and the growth of the entire student population. In the table we assume that the growth in the total student population is equal to the percentage growth in the new entrant population where the share of new entrants with less than primary is driven down to 5% by 1991. That assumption may be unreasonable since there was a substantial inflow into the labor market of those who were out of school and out of the labor market. To reduce the effect of this uncertainty we show both the absolute number of students assumed in the cost calculation and the additional cost incurred in the simulation relative to the baseline. In columns four and five we show our estimate of the total and additional cost of educating these new entrants in the simulation. Note that we got these estimates by assuming that the cost per graduate in primary and secondary stays at .13 and .17 of GDP per capita (2005 dollars) in each year. Then to get the cost in any decade we multiply the cost per graduate in that year times the number of students in either primary or secondary shown in the table that correspond to the number of new entrants with either primary or secondary and divide that by the GDP in constant 2005 dollars.[15]

As we have already seen, the baseline implied that the number of secondary school students more than doubled between 1991 and 2010. That in itself implied an additional cost of about 1.5% of GDP in the baseline. If we want to drive the fraction of undereducated new entrants down to 5% by 1991, that raises total cost by around 1% of GDP up to 1991 and a smaller amount thereafter

The table gives us an estimate of the additional cost of pushing down the percent of new entrants with less than primary as they enter the labor force. As we saw previously, Brazil must have paid a very high cost for upgrading in the baseline. Here we see the additional cost of meeting an even more ambitious education target. According to the table, in order to reach the 5% goal for new entrants the society would have had to increase the number of primary students from ten million in 1991 to fifteen million and the number of secondary students from about 7 million to 9 million in 1991 and from 15 to 17 million in 2010. We estimate that the total cost of this effort would cost almost 2% of GDP for primary and somewhat less for secondary. After 1991 when those additional students move on into secondary education, the burden shifts to secondary. Recall that those costs are above and beyond what Brazil must have been spending in the baseline. That is why the cost shown in the table which is the additional cost of the simulation relative to the base line is generally well below one percent.

The reader should note that our estimates assume the same .13/.17 ratio between primary and secondary spending over all five observations. Keeping those assumptions in mind we estimate that the public sector spent about 1.91% of GDP on primary plus secondary education during the sixties. That number rose to 2% by 1980 and to over 3% in 1991 mainly because of a big expansion in secondary education and because of the size of new entering cohorts.[16] (Because the education profile is not separated by

[15] Our calculation of cost relative to GDP in one year is equivalent to assuming that all the new entrants only show up in year t to expand the school population. In fact they come into the school system over time which means that the cost relative to GDP is spread out over the decade.

[16] Note that we made all of our per student cost estimates relative to GDP per capita in 2005 dollars to be consistent with the World Bank WDI data base.

public and private this share has to be both public plus private spending as a share of GDP) Here we assume that private expenditure is equal to public expenditure per education year.

We draw two conclusions from this table. First the population bulge combined with the need to educate this mass of new entrants must have significantly raised the share of education in the budgets of the public sector, especially after 1980. It goes from 2% in the seventies to over three percent after 1991. That reflects the significant effort that Brazil was making during those years to upgrade its labor force. The second point here is how much of the increased expenditure after 1991 must have been in secondary education. The table confirms the rapid increases in the secondary school student population as the new cohorts advanced through the educational system. Bringing the share of secondary school graduates in the new entrant population from 15% in 1980 to 49% in 2010 was a real achievement, but the cost of that advance is clear in the table. In a way one could say that Brazil implemented the education strategy we are examining here, but they did it after 1980 when the wave of new entrants was getting smaller

TABLE 8: COST ESTIMATES FOR SIMULATION OUTCOMES

	baseline		*Simulation 1 (5% by 1991) results*		
	Millions of students	cost/GDP	Millions of students	total cost/GDP	adl cost/GDP
primary					
60-70	10.6	1.44%	13	1.70%	0.32%
70-80	9.7	1.03%	15.1	1.60%	0.57%
80-91	15.1	1.31%	19.7	1.70%	0.39%
91-2000	17.2	1.46%	11.6	1.00%	-0.48%
2000-2010	14.7	1.09%	16.3	1.20%	0.11%
secondary					
60-70	2.6	0.46%	4.5	0.80%	0.34%
70-80	7	0.96%	10.7	1.50%	0.53%
80-91	6.9	0.78%	9	1.00%	0.24%
91-2000	14.1	1.57%	9.5	1.20%	-0.40%
2000-2010	15.3	1.48%	16.9	2.10%	0.59%
total cost					
60-70		1.90%		2.50%	0.66%
70-80		1.99%		3.10%	1.10%
80-91		2.09%		2.70%	0.63%
91-2000		3.03%		2.20%	-0.88%
2000-2010		2.57%		3.30%	0.70%

Source: Author's calculations based on Demographic Censuses from IBGE and other sources

The rate of return to education

We now have good estimates of the cost of various levels of educational effort in Brazil. The question is whether these investments were worth it. Would it have paid Brazil to invest heavily in the education of new entrants? We will describe our rough estimate of the cost of such investments. Meanwhile our regressions give us an estimate of the payoff over a lifetime to the individual who enters the labor force with a primary or secondary education compared to entering with less than primary. This allows us to estimate an internal rate of return to additional education. Think of the individual as an investment

project. The state creates human capital which permits the individual to earn more. What is the rate of return to that investment? That is what we will try to determine here.

The problem is estimating the per student costs in primary and secondary school in a way that will not be disturbed by changes in the currency, devaluations and inflation when the only hard evidence we have on per student spending comes from 1959. How to bring this forward to 1970 or later was fraught with so much difficulty that we abandoned the attempt and made the cost per primary school student be equal to the income of secondary school graduates with ten years' experience in the same census year. The 1959 data also implied that the cost per student in secondary school was 2.67 times the per student expenditure in primary.

There is a good deal of evidence that secondary school spending per student in secondary is higher than 17/13 (1.3) times spending per primary student, but that ratio is probably smaller than 2.67 which is the figure implied in the 1959 report. In the calculations that follow we are going to use the .17/.13 estimate. In both cases we applied the cost per student per year for seven years for primary and for five years for secondary and adjusted for repetition and dropout rates. We also made an allowance for changes in the student teacher ratios over time.

In the simulation the society invests about 3 percent of GDP to raise 3.6 million new entrants from pre-primary to primary school and secondary school grads. Our 1970 regressions tell us that over a forty year lifetime on average the primary school graduate earns 2.5 times as much as the pre-primary new entrant. That implies an internal rate of return for investing in primary of 22%. The payoff to secondary is 23%. If we do the same calculation for 1980 and 2000 using the relevant regressions, the payoff to primary falls to 18% but rises to 29% for secondary. For 2000 the IRRs are 19% for primary and 22% for secondary. The message is clear. Investing in people to create human capital has a big payoff. It compares favorably with any investment in physical capital that we are aware of.

Furthermore there is no evidence that the rate of return fell over time. This is important in the context of the debate over education policies in Africa. If, upon further investigation, we can confirm that the skill differential in favor of the more educated did not narrow in spite of the upgrading of new entrants that took place. This means that the growth in the demand for the kind of skills provided by education did not fall short of the growth in the supply of such skills. But our analysis also showed that most of that demand for the more educated came from government and the services sector, not from manufacturing or agriculture.

Neither of these calculations take account of the potential earnings lost while the student is in school, but the payoffs for society of a more educated labor force are so clear and so large, that whatever correction one makes would not alter the general conclusion that the creation of human capital is among the most profitable investments that a society can make.

The Payoff to Migrating

The regressions presented above permit us to make a calculation of the gains from education and also from migrating. In table 9 we show the percentage gains in income that workers would expect to receive from migrating either from the rural to the urban sector or from the Northeast to the Southeast. Figure two shows the payoff to rural-urban migration over time visually. For unskilled workers with less than two years of education, in 1970 there was an 82% gain in income to be had by moving from the rural to the urban sector and a 74% gain by moving within the rural sector from the NE to the SE. The gains from rural to urban migration shrink fairly dramatically for pre-primary labor over the period while the gain from migrating to the urban sector increases for better educated labor as one would expect. It was in the

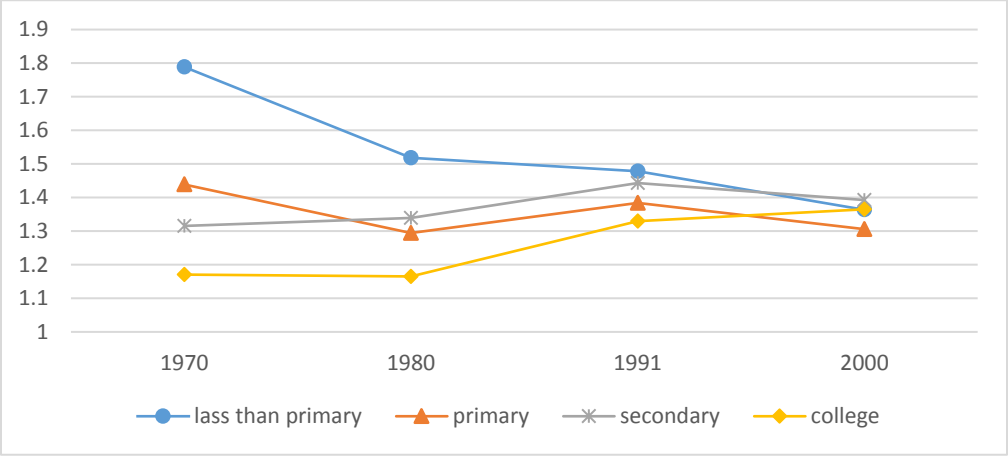
cities where the good jobs paying high wages and requiring more education were to be found. In short, the payoff to migrating was far higher in the urban than the rural sector, particularly for the better educated. Regionally, the payoff to be gained by moving from the low-income Northeast to the high income Southeast accelerated particularly for better educated labor. In the urban sector the return to pre-primary migrants actually fell quite sharply while it increased for both primary and secondary school graduates. The point is that if you had more education it paid to be in the Southeast rather than the Northeast. Brazil's growth strategy favored the Southeast, and increased the demand for workers with more education.

Table 9: Payoff to Migrating (in %)

rural to urban			
	pre primary	**primary**	**secondary**
2000	41%	37%	43%
1991	53%	43%	49%
1980	54%	31%	32%
1970	82%	47%	34%
NE to SE (rural)			
	pre primary	**primary**	**secondary**
2000	80%	63%	57%
1991	80%	72%	70%
1980	78%	60%	54%
1970	74%	49%	51%
NE to SE (urban)			
	pre primary	**primary**	**secondary**
2000	155%	123%	124%
1991	176%	147%	152%
1980	174%	110%	103%
1970	217%	119%	102%

Source: Author's calculations based on Demographic Censuses from IBGE and other sources

FIGURE 2: PROPORTIONAL PAYOFF GAINS TO MIGRATING FROM RURAL TO URBAN REGIONS AT DIFFERENT LEVELS OF EDUCATION



SOURCE: AUTHOR CALCULATIONS

6. Conclusion

Our main objective in this paper was to investigate how the actual education strategy followed by Brazil absorbed the growth of the new entrant population particularly during the 1960-80 period when the overall rate of population growth was almost 3% per year. We also used our census observations to simulate alternative, more progressive education strategies. Brazil started the period with about half of its population in the rural sector. Most worked in agriculture and had less than two years of primary education. Over the next fifty years two complementary processes occurred. First there was a massive move out of the rural sector and out of agriculture. That is true for both the overall population and for the 15-34 year-old subgroup. The services sector and construction provided an increasing proportion of entry level jobs over the period. Cohort analysis tells us that services also provided significant promotion possibilities. That is not true for manufacturing and household services whose share for female new entrants fell over time as they aged.

There was a massive upgrading of the education level of new entrants to the labor force, particularly after 1980. In 1960, only 3.5% of new entrants had at least a secondary school education. That increased to 15% in 1980 and then to 46% in 2010. That raised the public education cost from 1.9% of GDP in the sixties to over 3% in the nineties. But the upgrading of the education level of new entrants is not the same thing as upgrading the entire labor force, partly because of the relatively small size of the new entrant proportion of the labor force and partly of the length of time it takes to educate people. We did a simulation in which we tracked the change in the education level of the entire labor force when we forced down the share of new entrants with less than primary education. We showed that even when the new entrant share with less than primary is pushed down to 5% by 1991 that share for the entire labor force only fell from 73% in 1970 to 48% in 1991. In that same simulation over the same period the share of primary school graduates in the labor force only rose from 16% to 25%. Upgrading the education of the entire labor force is a very long range proposition. But we also showed that education upgrading had a high payoff. We constructed earnings regressions and calculated the internal rate of return from investing in primary and secondary education. The IRR was 22% for primary and 23% for secondary in 1970. It

fell a bit for primary by 2000 but rose for secondary. Despite how long it may take, investing in people had a high payoff even in the recessionary period in the nineties in Brazil.

There is no evidence that the rate of return to education fell over time. This is important in the context of the debate over education policies in Africa. If the skill differential in favor of the more educated did not narrow in spite of the upgrading of new entrants that took place, this means that the growth in the demand for the kind of skills provided by education did not fall short of the growth in the supply of such skills.

We also used our earnings regressions to calculate the payoff to migrating. Most migration during this period was from the rural to the urban sector. That migration increased expected lifetime income by around 40% in year 2000. There was an even bigger payoff from migrating from the low-income Northeast to the Southeast, particularly for urban migrants. Those with better education could expect their lifetime income to more than double by moving to where most of the good urban jobs were.

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