Economic Consequences of Educational Backwardness in Twentieth-Century Brazil

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Abstract: This paper evaluates the economic impact of alternative policies for investing in public education in Brazil between 1933 and 1985. It tests the hypothesis that increased spending on schooling beginning in the 1930s would have appreciably raised GDP per capita. We assess the economic impact of potentially higher levels of educational attainment by taking into account two distinct channels: a demographic channel in which schooling reduces fertility rates, and a production channel by which schooling raises productivity per worker. We quantify these effects by specifying counterfactual scenarios with higher public spending on education and measuring estimating the resulting increase in educational attainment. In a simple growth model in which human capital is augmented by schooling, raising outlays on public education by one percent of GDP each year increased the counterfactual GDP per capita. between 18 and 40 percent over its observed level in 1985. According to the intermediate scenario, GDP per capita increased as much as 29 percent, and reduced the estimated size of the population by 20 percent. Raising educational outlays by two percent of GDP increased per capita output by almost 35 percent and reduced the counterfactual population by 30 percent. These results are consistent with our hypothesis and suggest that low levels of spending on primary education in the twentieth century were costly to Brazil.

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1 Introduction

A well-established literature argues that investment in human capital plays a central role in raising output and productivity. Human capital depends critically on education. Populations of poorer countries have lower average levels of educational attainment, despite notably high rates of return to investment in human capital. That high potential returns to schooling can go unrealized is one of the more puzzling features of developing economies in the twentieth century; substantial economic benefits from education are simply left on the table. The failure to invest more in human capital is viewed as one of the principal factors accounting for the gap in productivity between high and low-income societies.

This paper uses a basic growth accounting exercise to highlight the costs to Brazil of having underinvested in schooling during the twentieth century—what Claudia Goldin has called the "human capital century" (Goldin, 2001). We quantify these effects by specifying counterfactual scenarios with higher public spending on education between 1933 and 1985 and measuring the impact of the resulting increase in the level of educational attainment in a simple growth model. In particular, we assess the economic effects of (counterfactual) higher levels of schooling via two channels: a demographic channel in which additional schooling lowers fertility rates, and a productivity channel by which additional schooling raises output per worker. Our results strongly suggest that increased spending on schooling beginning in the 1930s and running into the 1980s would have had an appreciable positive impact on the level of GDP per capita. To our knowledge, our study is the first to provide estimates of human capital for Brazil over such a lengthy span of time, and the first to estimate the gains in output per capita occasioned by the reduction in fertility following from increased educational attainment.

Our findings relate to several literatures. One is the body of work emphasizing the importance of human capital in economic growth. This includes classic early works (Schultz, 1960, 1961, and 1963; Becker, 1962 and 1964) and later studies that related schooling to aggregate productivity and growth (for example, Lucas, 1988; Barro, 1991; Hall and Jones, 1999; Krueger and Lindahl, 2001; Hanushek and Woessmann, 2013). Barro (1991) was one of the first studies to demonstrate that a proxy for the level of human capital was positively related to growth, based on evidence from 85 countries between 1960 and 1985. Mankiw et al. (1992) uncovered a positive and significant effect on growth from matriculation rates. Hall and Jones (1999) found that educational attainment was positively related to the level of GDP per capita, using data for 1988 from 127 countries. While some scholars found fault with the importance of educational variables in these studies (see for example Benhabib and Spiegel, 1994; Pritchett, 1996), authors working with improved measures of human capital have largely restored the thrust of the original findings (Cohen and Soto, 2007; de la Fuente and Doménech, 2006; Hanushek and Woessmann, 2013). According to Hanushek (2013), differences in school attainment explain a quarter of the variance in growth rates between 1960 and 2000 in a panel of 50 countries.[1] The results from cross-country aggregate studies using improved educational data point to higher levels of human capital as a cause of higher levels of GDP per capita. Work on the impact of increased schooling in Brazil, using states as units of observation, is consistent with the findings of cross-country studies. Indeed the closest predecessor work to ours found that in the 1970s one additional year of education for persons in the labor force increased real output by 20 percent, with increases in human capital accounting for 25 percent of the growth in GDP across Brazilian states (Lau et al., 1993).

A second broad literature with which this paper intersects is that on the consequences of the under provision of education in developing nations. A variety of studies in the social sciences have highlighted the low levels of educational attainment in Brazil. Estimates of the returns to schooling suggest that substantial benefits from education go unrealized over a long span of time (Castro, 1970; Langoni, 1974; Sachsida, Loureiro and Mendonça, 2004; Barbosa Filho and Pessôa, 2008). An obvious implication of these results is that if the potential gains from schooling could be achieved, average incomes would be higher in Brazil.

A third literature focuses on the origins of low levels of education attainment. The question of determinants of local and state-level public spending on schooling in early twentieth-century Brazil has attracted growing scholarly attention (Carvalho Filho and Colistete, 2010; Summerhill, 2010; Musacchio, et al., 2014; Kang et al., 2024). Various elite-

[1] An improved measure of human capital (skills test results in math and science) accounts for 3/4 of the variance (Hanushek, 2013).

capture theories have been advanced to explain the under-provision of schooling in developing countries more general. These studies have highlighted how policies governing educational expenditures evolve in accordance with the preferences of early elites (Engerman and Sokoloff, 2000; Mariscal and Sokoloff, 2000; Acemoglu and Robinson, 2006; Engerman et al., 2009). In settings where elites seek to keep labor costs and mobility low they may purposively restrict access to education.

We build on the findings that investment in human capital (proxied by schooling) matters for raising output and productivity. It permits us to model the Brazilian economy in such a way that output depends not just on capital, labor, productivity, but also the enhancement of the labor input that arises when there is investment in human capital. Taking the level of schooling as a proxy for human capital, we use counterfactual scenarios to estimate the impact of higher levels of schooling on GDP per capita. The results from these scenarios show that by making only modest increases in spending on primary public education (in the range of one to two percent of GDP per year) beginning in the 1930s, per capita output would have been higher by as much as 26 percent to 79 percent than it actually was in 1985. These estimates indicate the cost to Brazil from having undersupplied education in the twentieth century.

For Brazil, initial low levels of schooling were quite likely tied to key historical-institutional features, such as the prevalence of slavery until very late in the nineteenth century. But rather than accept a distant historical determinism, we highlight another factor: development strategies that emphasized physical capital formation while neglecting education. By the 1930s Brazil was under a highly centralized government that broadened the electoral franchise and implemented a strong developmental vision for the nation based on rapid industrialization in an increasingly captive domestic market. Investment in human capital by means of a broad-based provision of education simply did not figure into this development strategy. Across the century, through successive cycles of democracy and authoritarianism the developmentalists' relative neglect of education persisted. By the 1980s the costs of this approach were plainly apparent. Low levels of schooling contributed to low levels of aggregate productivity, while high inequality characterized the labor market.

The paper proceeds in seven sections. The second provides an overview of schooling in Brazil, including comparative educational attainment, matriculation rates, the cost of education per pupil over time, and government outlays on education. The third presents the basic model of the economy that we employ. The fourth sections address topics that are key components of the model: the return to schooling in Brazil, the computation of the stock of human capital, and demographic response to increases in spending on education. In section five we present the data. The sixth section presents estimates of the impact on GDP per capita from increasing spending on education, under various scenarios. The final section concludes.

2 Education in twentieth-century Brazil

Brazil stacks up poorly in international comparisons of human capital. In the second half of the twentieth century the population's level of educational attainment, as indicated by average years of schooling, was strikingly low. This is true even by Latin American standards. Tables and Figures

Table 1 and Table 2 presents data from 1950 through 2015 on the average years of schooling by major world regions, drawn from country data in Barro and Lee (2018), and for Brazil according to both Barro and Lee (2018) and to a more recent study by Walter and Kang (2024). On a regional basis, only sub-Saharan Africa and South Asia have consistently lower average levels of attainment than Brazil, whatever the source we use for Brazilian data.

The relative change in educational attainment over time shows that Brazil actually reduced somewhat its gap with the group of predominantly English-speaking countries and with continental Europe, especially between 1960 and 1980. Against all other cases, however, Brazil lost ground. According to Barro and Lee (2018)'s data, the lower-income countries of the Mediterranean, and the other large countries of Latin America, were 11 percent and 27 percent ahead of Brazil in 1960. By 2000 their advantage had increased to 35 percent and 43 percent, respectively. South Asia and sub-Saharan Africa both gained on Brazil over the period, with South Asia countries nearly eliminating by 1980 what had been a substantial gap in 1960. In

1960 Brazil's level of educational attainment was about average; between 1960 and 2000 it progressively fell behind the world mean.

Results from skills testing, a measure the quality of schooling, suggests the extent of the gap is worse than the average years of schooling indicates. In all comparable testing areas Brazil ranks far closer to the bottom than the top. In 2022, by way of example, mathematics test performance by 15-year old students in Brazil ranked between 64th out of 80 nations and territories, on par with Albania, Argentina, and Jamaica (OECD, 2024).

A longer-term perspective would be useful in considering the origins of low educational attainment in Brazil. But it is not clear that the return to the economy from schooling in, say, the eighteenth century would have been particularly high; the bulk of the labor force (both enslaved and free) performed manual labor in agriculture or mining.[2] In these sectors experience probably contributed more to productivity within enterprises than did the prevailing forms of schooling. Creating an established system of broadly accessible schools in the nineteenth century would have certainly provided a stronger foundation. But the crux of the matter in historical terms is the deficient nature of the educational response to the demographic transition of the twentieth century. Population growth rates peaked twice during the century: first in 1905 during the era of mass immigration, and then again around 1955 as a result of the rapid fall in mortality and a continuing high level of births. Over the same period manufacturing's share of output increased quickly, and urbanization accelerated.

To confront the resulting population explosion head on would have required substantial outlays on schools, teachers, and materials. That was most certainly not what occurred. Figure 1 shows that primary enrollment rates were at most only around fifty percent of school-age children in 1955. One effect of this was Brazil's literacy rate in 1950s was roughly that of New England some 200 years before. By 1982 the gross enrollment ratio (GER) in primary education was 100 percent of primary age children, and continued to increase thereafter.[3] The seemingly

[2] In fact, Mokyr has called attention to the relative importance of upper-tail human capital in the First Industrial Revolution. The importance of mass education grows with the advent of the Second Industrial Revolution.

[3] Gross enrollment ratio in a given schooling level is defined by the number of enrolled students in that schooling level, regardless of their age, divided by the population of the age group that corresponds to that level.

impossible feat was an artifact of the large number of children enrolled in primary schools who were older than traditional primary school grades. Some of these enrollments were due to delayed entry, some were a result of children who had not passed one or more grades, and some were due to children who had dropped out one or more years and then re-entered.

The cost of schooling differed greatly by level. Primary and secondary education has been far less expensive over the twentieth century than has higher education, as evident in Figure 2. Table 3 presents that annual per-student cost by level of schooling as a percentage of GDP per capita, beginning in 1950. Cost per pupil at the primary level rose over time. By 2000 it equaled 13% of annual GDP per capita. The cost at the secondary and higher levels of education declined. At the secondary level it had fallen by almost an order of magnitude, almost to the level of primary education. Post-secondary education, however, remained relatively very expensive. Even after a steep reduction over time, in year 2000 college still cost more than 200 percent of per-capita GDP.

Public outlays on all levels of education were only around one percent of GDP in the 1930s, and did not breach the two-percent level until the 1960s. Figure 3 compares public outlays on education since 1933 in Brazil and the United States.[4] The only time that U.S. spending dipped below two percent of GDP was during World War II. Relatively speaking Brazil did not place as high of a priority on educational spending as did the United States. By the mid twentieth century the United States was very far along in its demographic transition, while Brazil was just beginning. In the latter setting the failure to invest more in human capital proved especially costly.

2.1 The economic gains from schooling

In Schultz's classic formulation (1960), education impacts GDP directly via higher productivity. Higher levels of human capital increase output, independent of changes in the stock of either labor or physical capital. In the labor market higher productivity will reflect in

[4] U.S. data taken from www.usgovernmentspending.com.

higher compensation. The benefits that accrue to the economy from outlays (both private and public) on schooling represent a social return to the investment in human capital. There exist several possible positive externalities from increasing schooling, which we discuss briefly at the end of this section. Given our conjecture that the benefits from higher levels of schooling for the Brazilian economy might be substantial, we will employ in the quantitative analysis a more restrictive definition of the gains from education.

Under certain conditions the internal rate of return to education equals to the estimated coefficient on the schooling variable, S, in equations of the type:

$$\ln w = \ln w_u + \emptyset X + \beta S + \gamma_1 E + \gamma_1 E^2 \qquad (1)$$

where w is the individual's wage, w_u is the wage for an unskilled worker, and E is the level of experience (Mincer, 1974). The coefficient on schooling (β) gives the return from an additional year of education. Estimates of Mincer coefficient exhibit some countervailing biases. Measurement error in the schooling variable biases downward OLS estimates, while error in measuring skills biases the coefficient upward.[5]

A number of studies have estimated Mincer coefficients for Brazil (Loureiro and Galrão, 2001; Ueda and Hoffman, 2002; Sachsida, Loureiro and Mendonça, 2004; Resende and Wyllie, 2006). Their findings imply positive and high returns to schooling (ranging from around 10 percent to as much as 27 percent). Three conditions must be met in order for the Mincer coefficient to reliably indicate the rate of return on education: schooling involves no pecuniary outlays on the part of the individual, agents must share the same expectation of the time they will spend in the labor force irrespective of schooling, and the role of years of schooling in determining compensation must be separable from that of experience. Research using evidence from the 1980s and 1990s shows that the second and third of these conditions do not hold for

[5] The upward bias tends, in practice, to be small in magnitude (Griliches, 1977; Card, 1999), and correcting by means of IV estimation yields Mincer coefficients that actually exceed those obtained by OLS.

Brazil's labor market. Estimated Mincer coefficients for recent decades in Brazil are likely upward-biased (Moura, 2008).

An alternative is to consider the internal rate of return to schooling, defined as the return that equates the present value of the cost of an additional year of study to the present value of the benefits that derive from an additional year of study. The benefit of a year's worth of schooling is taken as the average increment in an individual's earnings (by total years of study), calculated from census data and household surveys. The unit cost of providing a year of education, by grade level, is available for recent decades from official sources. Table 4 reports the rates of return for four different levels of schooling in Brazil from 1960 to 2004. Calculations of the internal rate of return for the 1960s and early 1970s revealed extremely high rates of return to education, especially at lower grade levels (Castro, 1970; Langoni, 1974). For most grade levels the rates of return in Brazil have declined since the mid 1980s. But for nearly all years, and all levels of schooling, the estimated rate of return has been 10 percent or greater (Barbosa Filho and Pessôa, 2008). Returns to primary schooling have fallen the most over time, while returns to higher education have actually risen.[6] This shift in relative returns is likely due in part to the fall in the per-student cost of higher education since the 1950s that one observes in Table 3, and partly to the increasing adoption of technologies in manufacturing and services that require more technical knowledge.

For the pre-1960 decades there are no estimates of the rate of return to investment in education. Given the level of returns calculated for primary and secondary schooling in 1960,it is possible that returns were also substantial in earlier decades. Historical evidence shows that manufacturing workers in Brazil in the 1920s received a Mincer-type wage premium for possessing some basic schooling (Melo et al., 2002). In the computations below we rely on Mincer return to a year of schooling of eight percent.[7]

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[6] The decline in returns to primary and secondary education since the 1980s may be related to two factors. One is the way in which the shift to a "federal" system of transfers from the central government creates opportunities to locally divert funds from the schools (Ferraz, et al., 2012). The other is a worsening of teacher quality (Rands Barros, 2004).

[7] For an overview of Mincerian returns, see Barbosa Filho and Pessôa (2010).

It is possible that neither Mincer-type measures, nor internal rates of return, capture all of the possible benefits from education. Complementarities that could result from additional schooling could imply an even higher social rate of return. Externalities from schooling not reflected in higher compensation might include reductions in "social distance" (Gradstein and Justman, 2002); lower rates of criminality (Lochner and Moretti, 2001); higher savings rates, better health, and improved cognitive development (Grossman, 2006); and greater resilience of democratic governments (Glaeser, et al., 2006). In Brazil there is a strong relationship between a mother's educational attainment and that of her offspring (Lam and Duryea, 1999), and the correlation between parents' educational attainment that of children is stronger than even in the U.S. (Ferreira and Veloso, 2003; Mahlmeister et al., 2019). We do not discount these externalities as important consequences of schooling, but we do not attempt to incorporate them into our estimates for Brazil, which are by design restricted to the gains that would register directly in GDP.

3 Model

To estimate the impact of increased investment in educational attainment on GDP, population, and GDP per capita we employ a basic model of close economy using the Cobb-Douglas form (Hall and Jones, 1999). The aggregate production function relating output to physical capital, human capital, and productivity is:

$$Y_t = K^{\alpha}(AH)^{(1-\alpha)} \tag{2}$$

The stock of human capital (*H*) is the sum across these individuals of the return to each person's level of educational attainment. It is a function of the size economically active population (a proxy for the labor force) (*L*), the rate of return to schooling (φ), and the average amount of schooling acquired in the population (*h*):

$$H = Le^{h\phi} \tag{3}$$

GDP per capita can be expressed in terms of the capital-output ratio, the elasticity of output to capital (α), educational attainment per capita (h), and aggregate productivity (a residual).

$$y = \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}} hA \tag{4}$$

Because we consider human capital as an input into the aggregate production function, the evolution of GDP depends not just on the size of the labor force, but also the level of educational attainment, and the return to schooling. Moreover, the size of the population is also a function of educational attainment. We take up each of these components of the model in turn.

In our computations once an individual turn 15 they enter the labor force, unless they continue to study. The economy realizes the return on that person's education every year from age 15 until age 65, when we remove them from the labor force.

$$L = \sum_{i=15}^{65} (L_i - seats_i) \tag{5}$$

Throughout the trajectory of the factual and the counterfactual scenarios, the closed economy macroeconomic constraint is satisfied. The consumption from population and government is expressed by the aggregate supply function, where *G* is represented here by the public spending in education and *I* is the Gross Fixed Capital Formation. We consider here all the government spending but public spending in education as consumption.

$$C = Y - G - I \tag{6}$$

The level of Gross Fixed Capital Formation is determined by the Law of Motion for Capital, that is affected by the depreciation rate (δ):

$$K_t = (1 - \delta)K_{t-1} + I_{t-1} \tag{7}$$

3.1 Calibration

For the baseline model of production, represented by equation (4), we take the output elasticity of capital (α) as 0.4, and the rate of return to a year of schooling (φ) is 0.1, such that:

$$Y = K^{0.4}\left(ALe^{h0.08}\right)^{0.6} \tag{8}$$

We tested alternatives functions that incorporate non-linearity rate of return to an additional year of schooling, as described in Bils and Klenow (2000). Micro-Mincer estimates across countries suggests that exist diminishing Mincerian returns to schooling. Other studies suggest that the rate of return to a year of schooling is different for each level of education (Hall and Jones, 1999) or over time (Barbosa Filho and Pessôa, 2010). We adopted, for simplicity, a linear function with intertemporally constant parameter.

We chose a Mincer coefficient (0.08) lower than the literature estimates in order to accommodate eventual difficulties that the country would have to face for increase spending in education. First, in some regions, where younger people performed manual labor in agriculture or mining, the increased number of vacancies could not have been filled due to lack of demand. Second, despite the historical low quality of education in Brazil, we consider the possibility that the new graduates would have a quality lower than the one existing schools. Estimates of (1) based on cross sections of individuals are biased upward if high-ability individuals obtain more education. Third, due to the significant rural population and continental country size, new education investments could have had diminishing scale return.

4 Counterfactual scenarios

Counterfactuals are applications of Hempelian covering laws, under which valid inferences require that the changes used to generate the counterfactual scenario be limited in number and in size—the "minimal rewrite" rule (McClelland, 1975; Tetlock and Belkin, 1996). This guiding principle delimits the size of the increases in educational spending that we can reasonably consider in our scenarios. At the same time, the fact that it is not just productivity that changes substantially in response to additional schooling, but also fertility (and hence population size), means that the counterfactuals we consider must admit both of these channels. Doing so with the data that are available requires a number of assumptions, some of which have already been introduced above. The other key assumptions involved in operationalizing the counterfactual scenarios are detailed here.

We consider two main counterfactual scenarios. First, we use the historical data as input to test the adherence of the model. Second, we test three hypotheses of alternative public spending in education between 1933 and 1985 and assess the effect in 1985.

4.1 Key assumptions

To generate the predicted GDP and population series we employ our own measures of educational attainment (and implicitly, the stock of human capital), historical estimates of the capital stock in relation to GDP (K/Y), and the implied level of productivity each year (A), derived using observed levels of Y, K, and L. The goal is to isolate human capital as the unique explanatory variable to GDP.

Holding constant the capital-product ratio means that capital stock adjusts to maintain the same rate of return of capital in both scenarios, not affecting investment decisions. As the aggregate supply function must hold, this hypothesis implies that, in the counterfactual scenario, the increase in investment in education is followed by reduction in consumption. The investment in education only affects the capital trajectory indirectly through eventual gains/losses in human capital. In this case, the physical capital investment must be adjusted to keep constant the capital-product observed in the factual.

Extra spending on schooling is obviously not a free good. However, we assume that the resources involved in raising enrollments do not represent an additional burden on the tax base, but rather are simply reallocated from other areas of the federal budget using taxes already collected. The tradeoff that the population faces is between public goods supplied by government or public spending in education. This lets us use the observed historical cost data in imputing the additional cost of education per student each year.

Although the return to a year of schooling is constant for each level of instruction, the extra spending in public education can be differentiated for each level. We also discriminate public and private spending: while the first is endogenous, the later remains constant.

4.2 Schooling and demography

Each individual at each age can be characterized by a level of educational attainment, and the rate of return to an additional year of schooling. The stock of human capital any year is the sum across these individuals of the return to each person's level of educational attainment, as represented in equation (2).

In constructing both the actual stock of human capital, and the counterfactual scenarios, the labor force is assumed to include all individuals between 15 and 65 years of age that are not enrolled. The possible levels of schooling for these individuals range from zero to 16 years, spread over three levels: primary (grades one through eight), secondary (grades nine through eleven), and post-secondary (five years).[8] An individual begins schooling at seven years of age and attains a year of schooling any time they satisfactorily complete an academic year of study. If they matriculate but do not complete the year, we do not assign a partial year of educational attainment.

[8] The definition of schooling levels changed throughout Brazilian history. Here we adopted the official education levels after the 1971 reform in primary and secondary education.

We use the data on individual level, $L_{i,h}$, to account the educational attainment in counterfactual scenarios, that is, we compute the human capital for each age-education population group and then calculate que average level of educational attainment:

$$h_t = \frac{\sum_{i=15}^{65} \sum_{h=0}^{16} L_{i,h,t} * h_{i,t}}{\sum_{i=15}^{65} L_{i,t}} \tag{9}$$

The population in year t is the sum of births less deaths, which equals:

$$L_{i,h,t} = L_{i=0,h,t-1} + L_{i>0,h,t-1} * (1 - m_{i,h,t-1}) \tag{10}$$

Where $L_{i,h,t}$ is the population of age i, and schooling h, at time t; the first term represents the new born. In the various scenarios for which we construct counterfactuals, the time path of the labor force depends on the acquisition of additional schooling, the mortality rate, and the fertility rate:

$$L_{i=0,h,t} = \sum_{i=15}^{49} (1 - m_{i,t}) * L_{i,h,t-1} * n_{i,h,t-1} \tag{11}$$

Where n is the probability of reproducing in year t for a female of age i ($15 \leq i \leq 49$) and m is the probability of dying (at any age i). The probability of dying (m) we take as a function solely of age, and not of education. Women's fertility (n) we take as dependent on age, and on years of schooling. The second term in equation (15) represents the live population education attainment:

$$L_{i>0,h,t} = \left[Max\left(L_{i-1,h-1,t-1}; seats_{h,t}\right) + L_{i-1,h,t-1}\right] * (1 - m_{i,t-1}) \tag{12}$$

The first term in brackets is the population age ($i - 1$), with schooling $h - 1$ at time $t - 1$ that attains one additional year of schooling by year t; the second term in parentheses is the population of age $i-1$ and schooling h at time $t-1$ that did not attain an additional year of schooling, and m is the mortality rate.

We employ this relationship between fertility, age, and schooling below in our counterfactual scenarios to adjust the level and trajectory of Brazil's labor force and population in response to increases in spending on education that raise educational attainment.

The evolution of educational attainment in the counterfactual Brazilian population depends on three main variables: public outlays on education by level of instruction; the cost per student at each level of instruction; and the school-year completion rate at each level. The effective number of seats available for students by level of instruction is given by:

$$Seats_{h=level,t} = \left(private\ seats_{level,t} + public\ seats_{level,t}\right) * completion\ rate_{level,t} \tag{13}$$

Data on completion rates are knowingly inaccurate, since data from the Ministry of Education often underestimated repetitions. According to the best available data, completion rates for the primary level (at the time comprised of four or five grades) students in Brazil did not reach 60 percent until around 1959. In 1971 a reconfiguration of the school system created a new primary level (eight grades) that resulted from the merge between the former primary level with the former lower secondary level. In the early 1980s, completion rates in the new primary level were close to 65 percent, when they once again began to rise. By 2004 the completion rate in the new primary level was around 75 percent of students who matriculated. There is little information on completion rates in the secondary and post-secondary levels, particularly in earlier years. To account for that, we assumed a completion rate of 90 percent in these levels until 1975, when we start to have more information on completion in secondary and post-secondary education. Whereas 90 percent is probably an overestimation, these completion rates are compatible with a good calibration of the model, given our modest assumption for Mincerian returns (8 percent).

Public outlays are endogenous and depend on enrollments and cost per student. The cost per student by level of instruction (primary, secondary, or post-secondary) is taken as given, based on historical data presented in Figure 2.

$$public\ seats_{level,t} = \frac{public\ outlays_{level,t}}{unit\ cost_{level,t}} \tag{14}$$

We transform seats by level of instruction to grade by considering the proportion of the population that is in the right age ($i = h + 6$) for that grade within the level. For example, the number of first grade seats ($h = 1$) in t is equal the number of primary level seats (h = primary level) multiplied by the proportion of population of age seven ($i = 7$) within the population in primary level ($7 \leq i \leq 14$).

$$Seats_{h,t} = Seats_{h=level,t} * \frac{L_{i=h+6,t}}{\sum_{i=level} L_{i,h,t}} \tag{15}$$

4.3 The path of spending in public education

We calculate counterfactual educational trajectories for Brazil's population in the following manner. When we increase counterfactual public spending on education, two assumptions come into play. The first involves the origin of the additional outlays, highlighted above. The second assumption involves the rule we impose on how seats (enrollments) in school are allocated by level of schooling and grade year in response to an increase in educational spending. We assume that the additional spending on enrollments goes first to primary education. Within primary schools, seats for students are allocated for each series in accordance with the share of that series' age group in the total population. Table 6 provides an illustration.

If the (counterfactual) increased spending creates more vacancies than there are children available in the population to fill them, two scenarios are possible. First, the extra seats are transferred to the next higher grade, and so on, until exhausted. If for any year there are more seats than needed overall at the primary level, the extra seats are transferred to the secondary level, where the rule governing the allocation of seats by grade is applied again, and so on.

The estimates from any counterfactual scenario we might specify are necessarily sensitive to our definitions of parameters, and to the assumptions we employ. One particularly interesting case is our initial assumption that grade-level completion rates in our counterfactual schools would be the same as the historical rates that we observed in recent decades (and estimated for earlier ones). Rates of grade-level completion are low for Brazil (about 75 percent in 2004). If we required that some of the additional spending be directed to reducing failure and dropout rates, then the estimates above would change. Educational attainment and human capital would increase because more students would complete their schooling. But total costs would also rise. Assume that failing students can pass by attending an additional session of classes each day, and that the cost of the additional session doubles the cost of educating each student.

So, in the second scenario, we emulate a policy that prioritize non-completion student recovery in the early grades rather than open more vacancies in higher grades. We define this assumption henceforth as No Child Left Behind policy. In this scenario, prior to transfer to the next higher grade, the vacancies are directed first in recovering the non-completion student at the cost of one more seat. When all the students at that level are enrolled and completing, then the extra seats are transferred to the next higher grade.

Finally, we require a starting value for the population in 1933 by age cohort and educational attainment. We maintain the structure of educational achievement by age group (in five-year bins) reported in the census of 1960, and apply a multiplier on the number of available seats in order to reach the average schooling of 1.24 years in 1933.

5 Data

The quantitative analysis of our model requires three key sets of data: economics, demographics and educational. The data set is annual and cover the period 1933-2004.

Regarding the economic data, GDP and Gross Fixed Capital Formation are gathered from Instituto Brasileiro de Geografia e Estatística (IBGE). For Gross Stock of Physical Capital, between 1933 and 1949 we rebuilt using the Perpetual Inventory Counting considering depreciation rate of 2% (1/50). From 1949 onward we use data from Instituto de Pesquisa Economica Aplicada (IPEA).

The demographics data set consist on information about population, fertility and mortality. We use population data by age from IPEA. The fertility rate is calculated as the number of live births divided by the number of women, on the basis of five-year age cohorts from 15-19 up through 45-49. From 1970 onward fertility rates is calculated using the censuses of 1970, 1980, 1991, and 2000. Rates for intervening years are interpolations.

For fertility by educational attainment before 1970 we draw on data from Horta, Carvalho, and Frias (2000). These authors provide adjusted population and age cohort data, along with fertility, using censuses from 1940 and later. They do not, however, detail the relationship between fertility and schooling. To obtain fertility rates for an individual by age and year of schooling before 1970, we first note the fertility rate for the same age and educational attainment in 1970. Then we multiply it by the ratio of the fertility rate for the corresponding age group (15 to 19, 20 to 24, etc.) in the earlier year, to the fertility rate for the same age group in 1970. For example, to estimate the fertility rate of the representative female aged 21 in 1963 with three years of schooling, we start with the specific fertility rate for someone from 1970 with the same age and schooling characteristics (0.197). We multiply it by the ratio of the fertility rate in 1963 for the age group 20 to 24 (0.275), to the fertility rate in 1970 for the same age group (0.179), resulting in an estimated specific fertility rate in 1963 of 0.302. Figure 5A through 5G illustrate the relationship between fertility, age, and schooling in Brazil, from 1933 through 1998. Fertility in the youngest group (age 15-19) progressively increased over time. But for all years and age groups there is a negative relationship, on average, between fertility and schooling up through age 45.

For mortality we use data from censuses, interpolating the intervening years. Figure 4 shows the mortality rates for Brazil by age. The decline in mortality, especially in middle age, is clear between 1950 and 1980.

The educational dataset relies on the relationship between the demographics variables and education to obtain the return on schooling. We start from the studies of Kang and Menetrier (2024) and Kang et al. (2021), which respectively provide the historical public expenditure on education and enrollment number by level of instruction and year. We divide the first by the second to calculate the cost of one seat by level of instruction and year. Join them the data on school evasion and grade repetition, as explained in the previous section.[9]

Private outlays are taken as given, based on historical data. Estimated completion rates are likewise drawn from historical sources. For the average amount of schooling acquired in the population in factual scenario we use Walter and Kang (2024).[10]

6 Results

6.1 Testing the model

We test the model accuracy by comparing Brazil's actual population and GDP between 1933-1985 to the population and GDP that are predicted by our estimates of h and L over the same period. As our baseline results, we consider the model with only productivity effects.

The predicted value for population in 1985 is 1.5 percent smaller than the factual level (see Figure 6) and the predicted value of educational attainment, h, is 0.4 year lower than the factual. These two Human Capital inputs leads to accurate estimative in the rest of variables. The predicted GDP per capita from our simulation is close to the observed level. The results appear in Table 5, and Figure 6, 7, and 8. Figure 7 shows that the predicted GDP falls short the observed GDP by only 0.6 percent. This results in a predicted value for GDP per capita that differs from observed GDP per capita by around one percent (Figure 8).

[9] Until 1991 only primary education data on grade progression was available. Between 1933 and 1941 the source is Teixeira de Freitas (1947). Between 1944 and 1953 and 1963 we use data from Teixeira (1968). For 1975 and 1976 we use Ministério da Educação e Cultura (1980). Between 1981 and 1990 we use Ribeiro (1991), between 1991 and 1994 we use Inep (2003), and after 1999 IBGE/Censo Escolar.

[10] Barro and Lee (2018)'s estimates to Brazil are particularly unreliable. See Mation (2014) and Walter and Kang (2024).

On the one hand, this error may be significant depending on the purpose to which one puts the model. On the other hand, given that the estimated GDP per capita is generated over nearly seven decades, it is remarkably close to the actual value of output per person. The precise difference between the observed and predicted levels of GDP per capita is probably less important than its relative magnitude when compared to the results below for specific counterfactual scenarios. And in this regard, the baseline model seems adequate for considering the economic impact of alternative paths of spending on schooling in twentieth-century Brazil.

6.2 Effects of increased spending on public education

In this section we test three public spending counterfactual scenarios – increase of 1%, 2% and 4% of GDP –, directed to primary level, during the period of 1933 and 1985. We consider three different assumptions sets, the first set consider just the effect on productivity gains (our lower bound estimates); the second assumption set is the first set plus the impacts through demographic channel, described at section 4.2; the third is the previous set added by the No Child Left Behind policy, described at section 4.3 (our upper bound estimates). Our baseline scenario for comparison is the model prediction with no additional education spending (described in the previous subsection), rather than the factual.

The size of this increase relative to actual outlays declined over time. In 1933, by way of example, spending on primary education was only 0.97 percent of GDP, so the counterfactual increase here of one percent of GDP would more than double the outlay. By 1985, spending on primary education was 2.0 percent of GDP, so that adding another percent of GDP in the counterfactual would have raised primary school outlays by less than one half.

Table 7 summarizes the impact that this additional spending would have registered by 1985. The model results with no additional education spending within the three assumptions scenarios are similar, which reinforces the model accuracy.

The effects on all key variables in the public spending scenarios highly depends on the assumptions set. Considering the second assumptions set, that we believe is the most similar to what have happened in the past, (third scenario on Table 7), the direct effect of spending on production is significantly positive, but quickly decrescent. With spending on primary education raised by one percent of GDP, GDP per capita would rise from R$ 6,517 to R$ 8,392. The direct effect indicated by this difference would be 29 percent of 1985 GDP.

The effect disregarding the demographic channel however would be slightly smaller considering all counterfactuals. In 1% public spending counterfactual, the average years of schooling in 1985 would be 7.66 years, instead of 7.83 if considering the demographic channel. The observed was 4.80 years. The decline in fertility that would have accompanied the slow but progressive increase in educational attainment over a period of some 50 years would have resulted, by our estimates, in an appreciably smaller population by 1985 of 20 million persons (134 million without and 103 million with demographic channel). As a result, disregard the demographic assumption would reduce the GDP per capita effect by more than 10 percent points, from 29 percent to 18 percent of 1985 GDP. In other words, the demographic channel assumption responds to around 28% of the effect, while the other 72% are related to educational attainment effect on productivity gains. In the higher public spending counterfactual scenarios, the effect of demographic channel is even smaller.

The second counterfactual scenario repeats the exercise (column 5 in Table 7), but doubles the increase in spending each year on primary schooling from 1 percent to 2 percent of GDP. Although, the 100% increase on spending from one scenario to the other, the GDP per capita increases in only 6 percent points, from 29% to 35% of 1985 observed GDP. The counterfactual population is 30% less than the observed 1985 population, but just 10 percent points less than the 1% increase spending (128 million persons vs. 103 million vs. 90 million). The results on third counterfactual scenario replicate the relation between second and first counterfactual scenarios. While the spending being double, the key variables does not exhibit same proportion of earnings.

When the No Child Left Behind policy is considered, the direct effect of spending on variables turn to be more positive and less decrescent. For example, the 2% increase spending counterfactual considering the third assumptions set produce greater educational attainment than 4% increase spending counterfactual under second assumptions set. The second counterfactual exhibits a GDP per capita increase of R$ 2,378, against an increase of R$ 2,766 in the first counterfactual. The third counterfactual represents a R$ 1,453 GDP per capita increase, considerably minor, but similar with the return of the first counterfactual if not considered the No Child Left Behind policy (R$ 1,678).

GDP per capita effects

The decomposition of the counterfactual scenarios effects by gains in productivity per worker, demographic channel and universalization, suggest that remedying (or preventing) failures would have further boosted the gains from investing in human capital. This is especially true in the cases of greater magnitudes public spending in education (more than 1% of GDP per year), as shown in Table 8. While in the first counterfactual scenario approximately 41% of GDP per capita increases comes from productivity per worker, in the second and third counterfactual scenarios the No Child Left Behind policy respond for 59% and 65% respectively.

Under the baseline assumption of high dropout and non-completion rate, the first increase in public spending would produce high returns by filling the gap of absence of vacancies in primary and secondary levels. After all students are enrolled in primary and secondary levels (but most of them not completing), what is possible with the 1% increase in public spending, the following resources would be allocated in post-secondary levels, that represents lower return, due to the high cost of this level seat.

The main "No Child Left Behind policy" advantage is to prioritize of recovering non-completion in primary and secondary levels, what, in per capita terms, costs much less than post-secondary levels. It is due our assumption that the non-completion student recovery cost is equivalent of one more seat.

Double-digit percentage differences between the counterfactual and observed levels of GDP per capita are intuitively "significant." It is insightful to compare these results with those involving other policy innovations, large projects, or technological changes. Not many such estimates exist for Brazil. One area for which they are available is for transportation infrastructure, in an earlier era. The economic impact of railroads was assessed by comparing the economy in 1913 with one deprived of its railroads and forced to adjust using next-best modes of overland transportation (Summerhill, 2005). Despite the fact that the railroad sector was fairly small, the difference between actual and counterfactual GDP per capita was in the range of 10 percent to more than one third of GDP. Such an effect was quite large in comparison with results from studies of the impact of railroads other countries. Railroads were quite likely the single most important factor in transitioning the economy from stagnation to growth around 1900. Our results on education for a later period suggest that investing in additional primary school enrollments in would have had similarly large effects and might have been equally transformative.

7 Conclusion

There is no quick fix for the problem of shortfalls in human capital. Investments in primary education do not register an economic impact until years later. In Brazil there is much recent emphasis on the use of conditional cash transfer programs to increase primary school enrollments. As attractive as these programs are, they are no panacea for more than a half-century of under-investment in education.[11] In populations that either do not internalize the expected benefits of schooling, or that prefer more immediate pecuniary gains to the deferred and uncertain benefits from the schooling of younger generations, high rates of return to education may not be sufficiently appealing for many. But the problem is not just demand; education must be "supplied" in order for the potential gains from schooling to be relevant in agents' decision making.

The inadequate provision of education over the twentieth century is one of the more glaring aspects of economic underdevelopment in Brazil. In this paper we argue that Brazil's approach to spending on education since the 1930s consigned the population to a relatively low level of educational attainment. Though our focus is on the "quantity" of schooling, there is evidence suggesting that the quality of education may be even worse than the educational attainment data reveal. Our estimates, using various counterfactuals in which we either increase

[11] Bursztyn's (2015) experimental findings suggest a surprising set of preferences. Poorer voters may not want the government to spend to improve the quality of education. They may instead prefer that the government spend on other types of programs that have an earlier payoff.

spending at the primary level, show that the gains to the economy from modestly higher levels of spending on primary schooling would have been considerable by the early twenty-first century. The implication is clear: Brazil's educational policies were very costly in terms of benefits and productivity foregone.

Given the high returns to education, why did Brazil not spend to provide more of it? The failure to invest more in public education did not result from a lack of resources, or an absence of interest in fostering development, or a lack of state capacity. By the 1930s, obsolescence loomed for the caricature of Brazil as a country that was ruled by a narrow elite of plantation-owning oligarchs interested solely in lining their own pockets. The state increasingly took a direct role as owner in the most technologically advanced sectors of the economy. Industrial policy was designed to promote development by protecting the market from external competition, and channel resources to industry at artificially low cost. State-owned enterprises of all types—railroads, steel companies, mining concerns, energy, and telecommunications—were created. These firms came to count among the state's assets. Many proved to be even greater liabilities; the overall benefits they created could not be justified in terms of their cost (Trebat, 1983). One could argue that some countries successfully applied similar policies. However, overprotection and capture by special interest groups were rampant given the Brazilian institutional context. Moreover, few of these interventions were undertaken in accordance with any criterion of market failure. By the late 1950s the government borrowed in international markets, at high effective rates of interest, to spend on its projects, many of which had poor prospects. Continued borrowing to sustain public investment rested on excessively optimistic forecasts of the benefits of state intervention (Reis, 2004). This approach to development made for rapid capital accumulation for a while. It culminated in the severe fiscal and economic crisis of the early 1980s that initiated Brazil's lost decade.

The government's emphasis on physical capital formation suggests that the political equilibrium of the era simply did not favor greater investments in human capital. In post-WWII rural Brazil, where those who would have benefitted the most from increased access to primary education resided, local elites wielded tremendous influence over voters, and had little interest in spending on schools. Business, for its part, had a keen interest in government protection and subsidy to industry. Increased educational spending offered little. The rapidly growing urban population supported the state provision of services and utilities, because of the heavily subsidized prices charged. For the beneficiaries of state-owned enterprises the opportunity costs of the resources used for subsidy, such as education that was not supplied, were much less visible. In short, few to none of the politically salient actors had much to gain from prioritizing spending on primary education.

Two other factors may have contributed to the problem. First, awareness of the importance of human capital in economic growth, in a scholarly sense, did not really exist in Brazil before the late 1950s. This may also have been true in other countries as well, but in Brazil it was believed that educational advance would follow economic growth, not cause it (Pires, 2010). Second, even after evidence on the importance of human capital became available, a peculiar set of ideological blinders made it irrelevant in Brazil. The prevailing interpretation of underdevelopment, shared and advanced by a sizable portion of the country's most influential social scientists, focused on Brazil's position in the international division of labor as the main explanatory factor in economic backwardness. The "national-developmentalist" school of economic thought, as it was known, emphasized strategies to firewall Brazil off from the ostensibly more harmful aspects of the world market, and promote industrialization from within. An agenda of broad-based primary education did not figure into this strategy in any significant way, either in theory or in practice.[12] Not until the late 1980s and early 1990s did two practical concerns foster the beginning of a broad reassessment. One was the realization that global competitiveness, and productivity gains, depended in part on investing in human capital. The other was the growing awareness that the lack of education had contributed to some of the worst economic inequality on the planet.[13]

[12] See, for example, Furtado (1997). Of the many works he published over nearly a half century, education did not appear as an important factor in economic development. Other developmentalists grasped the importance of higher education in science and technology, because of its importance to industrialization under import substitution. Primary education was simply not emphasized.

[13] Decompositions of income inequality by Barros and Mendonça (1995) for 1990 show that educational disparities accounted for anywhere from 30 percent to 50 percent of income inequality.

8 References

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9 Tables and Figures

Table 1 - Average years of schooling, population between 15-64 years old, 1950-2015

Region/country	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Global Average	3.2	3.5	3.8	4.2	4.6	5.1	5.7	6.1	6.5	7.0	7.6	8.0	8.4	8.8
Advanced Economies	6.6	6.9	7.2	7.7	8.2	8.7	9.3	9.6	10.1	10.6	11.1	11.6	12.0	12.0
East Asia and the Pacific	1.8	2.2	2.7	3.3	4.0	4.7	5.5	5.9	6.2	6.9	7.4	7.9	8.3	8.8
Europe and Central Asia	4.7	5.1	5.5	6.1	6.8	7.6	8.5	9.2	9.9	10.5	11.2	11.5	11.7	11.8
Latin America and the Caribbean	2.7	2.9	3.2	3.5	4.0	4.2	4.7	5.5	6.2	6.8	7.5	8.2	8.7	9.1
Middle East and North Africa	0.8	0.9	1.1	1.5	1.9	2.5	3.3	4.2	5.0	5.7	6.4	7.0	7.6	8.3
South Asia	1.0	1.1	1.2	1.4	1.7	2.1	2.5	3.0	3.5	4.2	5.1	5.8	6.4	7.1
Sub-Saharan Africa	1.3	1.4	1.6	1.8	2.1	2.5	2.9	3.4	4.0	4.5	4.7	5.1	5.6	6.4
Brazil (Barro and Lee)	**2.1**	**2.3**	**2.5**	**2.8**	**3.3**	**2.9**	**3.1**	**4.1**	**4.9**	**5.8**	**6.8**	**7.7**	**8.2**	**8.6**
Brazil (Walter and Kang)	**1.6**	**1.8**	**2.1**	**2.5**	**2.8**	**3.4**	**4.2**	**4.8**	**5.2**	**5.9**	**6.5**	**7.5**	**8.3**	**9.0**

Source: Barro and Lee (2021), Walter and Kang (2024)

Table 2 - Schooling relative to Brazil (Brazil=1.0), 1950-2015

Region/country	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Global Average	2.03	1.92	1.76	1.69	1.66	1.49	1.36	1.27	1.25	1.20	1.17	1.07	1.01	0.98
Advanced Economies	4.14	3.81	3.38	3.12	2.92	2.56	2.23	2.00	1.94	1.82	1.72	1.54	1.44	1.33
East Asia and the Pacific	1.16	1.22	1.27	1.34	1.44	1.36	1.32	1.23	1.20	1.17	1.15	1.05	1.00	0.97
Europe and Central Asia	2.96	2.82	2.56	2.47	2.45	2.23	2.04	1.92	1.91	1.80	1.73	1.53	1.41	1.31
Latin America and the Caribbean	1.72	1.62	1.49	1.44	1.43	1.24	1.14	1.15	1.19	1.16	1.16	1.09	1.05	1.00
Middle East and North Africa	0.49	0.51	0.52	0.60	0.69	0.72	0.79	0.88	0.95	0.97	0.99	0.93	0.91	0.92
South Asia	0.64	0.59	0.55	0.55	0.60	0.61	0.59	0.63	0.68	0.72	0.80	0.77	0.77	0.79
Sub-Saharan Africa	0.81	0.78	0.73	0.72	0.75	0.72	0.70	0.70	0.77	0.77	0.73	0.68	0.67	0.71
Brazil (Barro and Lee)	1.33	1.27	1.18	1.15	1.18	0.84	0.73	0.86	0.95	0.99	1.05	1.02	0.99	0.96
Brazil (Walter and Kang)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: Barro and Lee (2021), Walter and Kang (2024)

Table 3 - Public spending on education, 1935-2000

Year	Public Spending on Education (% GDP)	Cost per student of public schooling (% GDP per capita)		
		Primary	Secondary	Higher
1935	1.3	19	191	932
1940	1.4	16	203	1598
1945	1.0	11	113	941
1950	1.5	14	183	1027
1955	1.4	11	115	754
1960	1.7	12	91	934
1965	2.4	14	53	857
1970	2.7	13	42	376
1975	2.6	11	27	167
1980	2.4	10	21	129
1985	2.9	12	16	143
1990	3.8	16	18	196
1995	3.6	13	12	176
2000	4.3	15	11	205

Source: Kang and Menetrier (2024)

Table 4 - Annual rates of return to different levels of schooling in Brazil, 1960-2004

Age range	1960	1969	1981	1989	1999	2004
0 - 4	48.1	32	17.4	23	12.4	9.8
4 - 8	23.8	19.5	13.1	14.4	10.3	14.8
8 - 11	14.8	21.3	20.2	38	13.7	13.9
11 - 15	4.9	12.2	16.9	18.6	13.6	13.8

Sources: 1960 and 1969 from Langoni (1974); 1981-2004 from Barbosa Filho and Pessôa (2008).

Table 5 - Actual and predicted GDP, population, and GDP per capita, 1985

Variable	Factual (actual value)	Predicted value	Difference
GDP (R$ billion)	854	836	-2.15%
Population (million)	133	128	-3.54%
GDP per capita (R$)	6,425	6,517	1.44%
Educational attainment	4.80	4.51	-5.97%

Table 6 - Allocation of educational capacity by grade level (example)

Age	% of age i at Level = primary		Seats at Level = primary		Seats at age = i
7	13,42%				1.326.009
8	13,06%				1.290.434
9	12,71%				1.256.432
10	12,27%	X	10.701.665	=	1.212.252
11	11,87%				1.173.559
12	11,71%				1.157.414
13	12,23%				1.208.314
14	12,74%				1.259.150
Total	100%				10.701.665

Table 7 – Results

Assumptions set	Key Variables	Counterfactual scenarios: Increase in public spending in education (% GDP)			
		0%	+1%	+2%	+4%
Factual	GDP (R$ billion)	854			
	Population (million)	132			
	GDP per capita (R$)	6.425			
	Educ. Attainment	4.80			
Productivity gains	GDP (R$ billion)	849	1,004	1,051	1,066
	Population (million)	134	134	134	134
	GDP per capita (R$)	6,360	7,519	7,873	7,985
	Educ. Attainment	4.43	7.66	8.76	9.48
Productivity gains + Demographic channel	GDP (R$ billion)	836	867	795	815
	Population (million)	128	103	90	86
	GDP per capita (R$)	6,517	8,392	8,789	9,489
	Educ. Attainment	4.51	7.83	9.22	10.22
Productivity gains + Demographic channel + No Child Left Behind policy	GDP (R$ billion)	835	915	870	832
	Population (million)	128	100	82	72
	GDP per capita (R$)	6,504	9,128	10,612	11,597
	Educ. Attainment	4.49	8.96	11.00	12.11

Table 8 - Effects decomposition

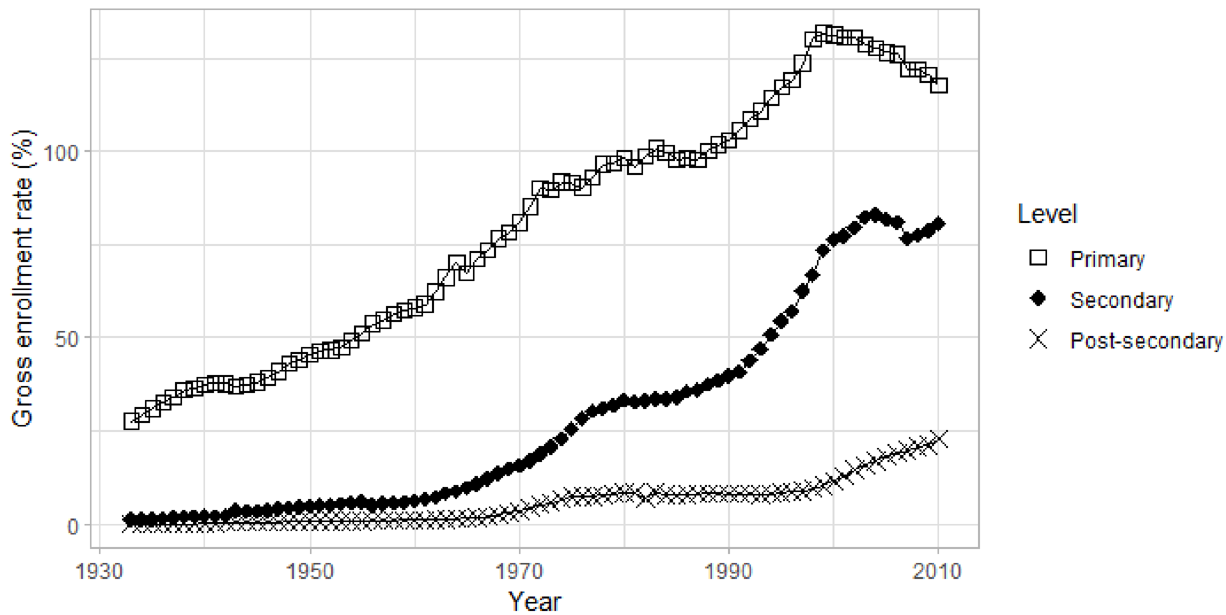
Effects decomposition	Counterfactual scenarios: Increase in public spending in education (% GDP)					
	1%		2%		4%	
	GDP per capita	Δ	GDP per capita (R$)	Δ	GDP per capita (R$)	Δ
No additional spending (model)	6,517		6,517		6,517	
Productivity per worker	7,519	1,002	7,873	1,356	7,985	1,468
Demographic channel	8,392	873	8,789	916	9,489	1,504
Universalization	9,128	736	10,612	1,823	11,597	2,108

Table 9 - Differences between consumption to output ratio (*C/Y*) in the factual (counterfactual of factual) and counterfactual scenarios (five years moving average)

Increase in Public Investing	1935*	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000
+ 1% GDP	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.02	-0.01	0.02	0.03	0.02	0.03
+ 2% GDP	-0.02	-0.03	-0.04	-0.04	-0.03	-0.04	-0.03	-0.02	-0.02	-0.01	0.01	0.04	0.04	0.04
+ 4% GDP	-0.03	-0.06	-0.07	-0.07	-0.06	-0.05	-0.04	-0.03	-0.03	-0.02	-0.03	0.05	0.04	0.05

*1935 represents the average of 1933, 1934 and 1935

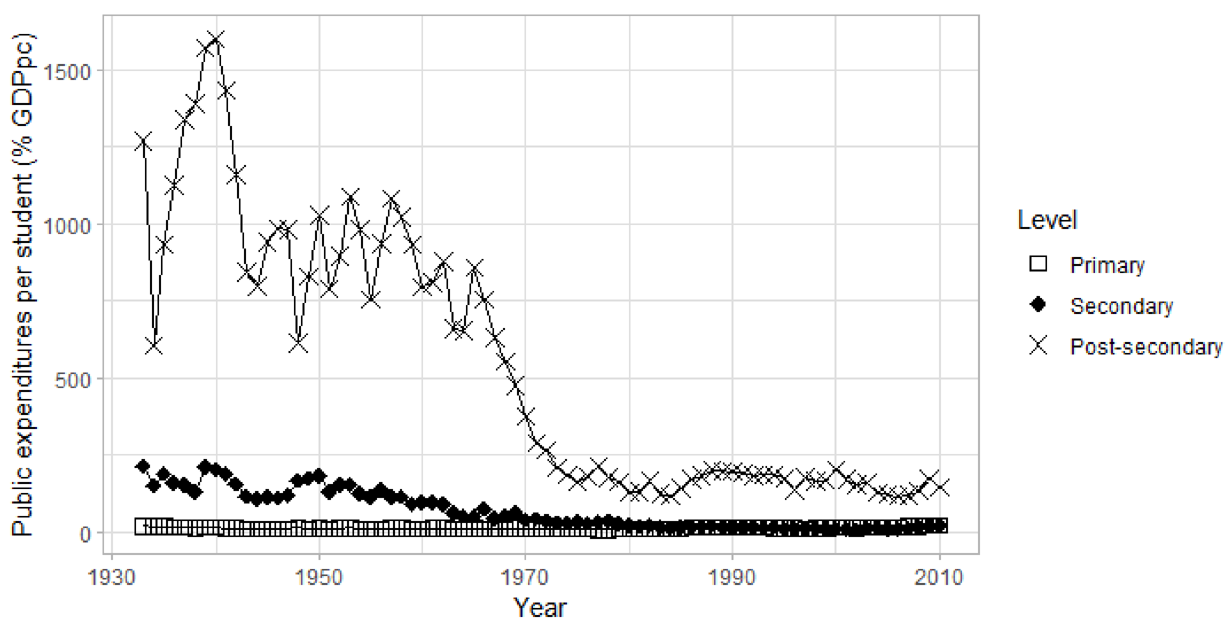
Figure 1 - Gross enrollment rate (% of age cohort), by level of education, Brazil, 1933-2010



Source: Kang et al. (2021)

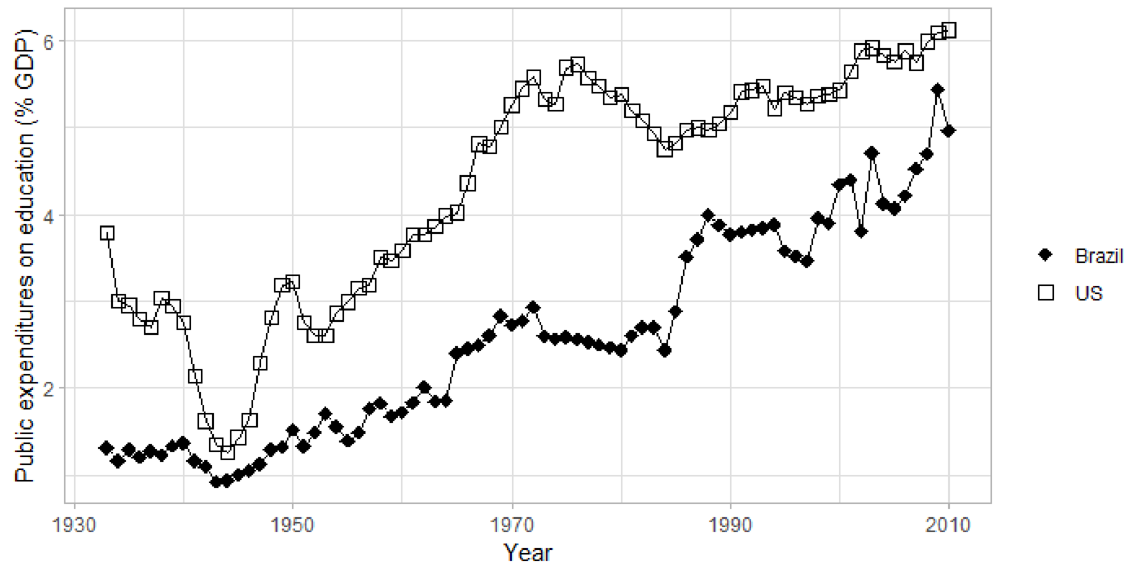
Note: Primary level refers to grades 1-8, while the secondary level refers to grades 9-11.

Figure 2 - Cost per student per year, by educational level (as a percentage of GDP per capita), Brazil, 1933-2010



Source: Kang and Menetrier (2024)

Figure 3 - Public spending on education as a share of GDP, Brazil and the United States, 1933-2010



Source: Kang and Menetrier (2024), Chantrill (2024)

Figure 4 - Mortality rate by age, 1940-2003

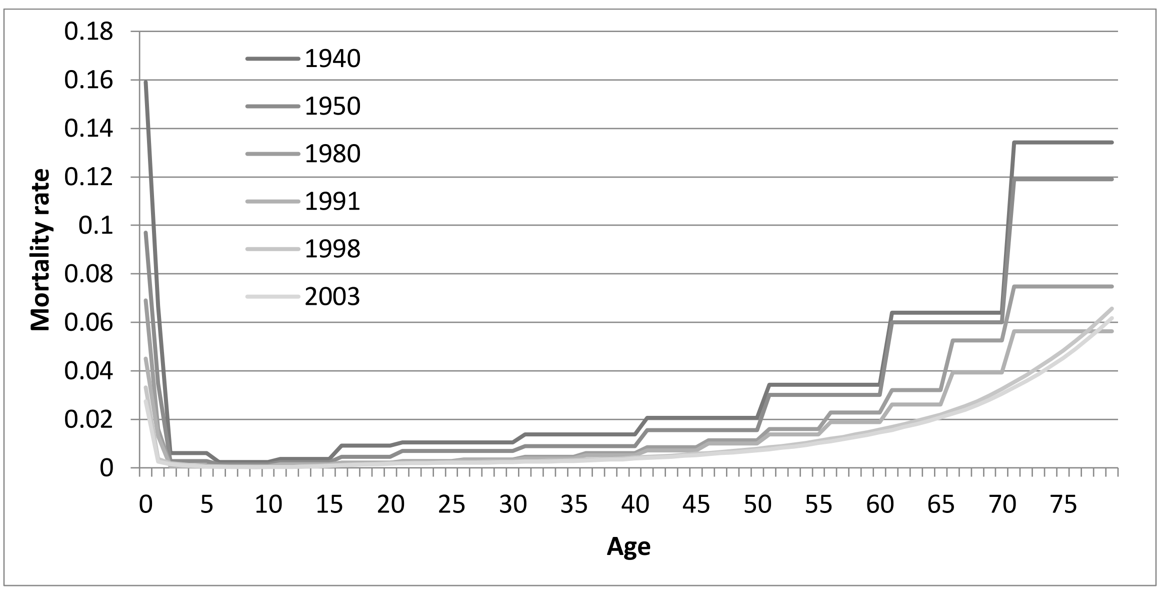


Figure 5A - Fertility by educational attainment, ages 15-19

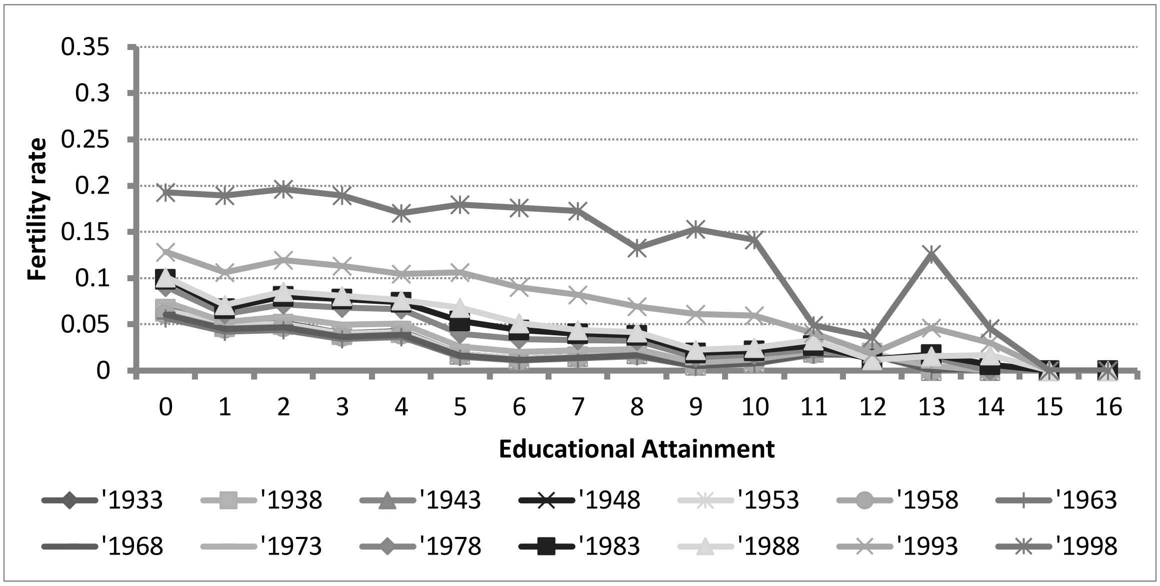


Figure 5B - Fertility by educational attainment, ages 20-24

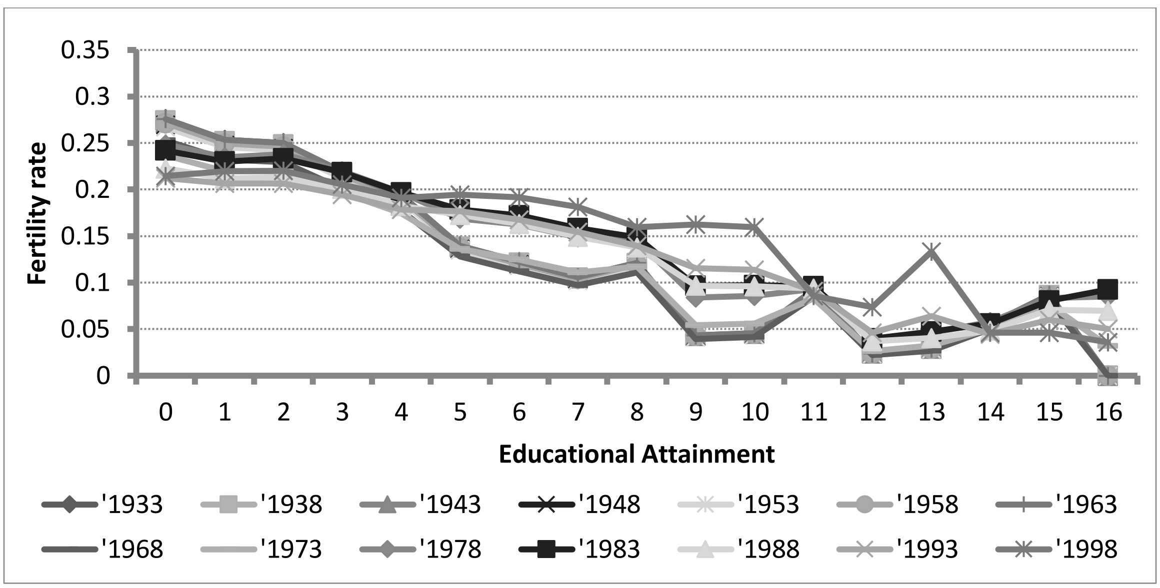


Figure 5C - Fertility by educational attainment, ages 25-29

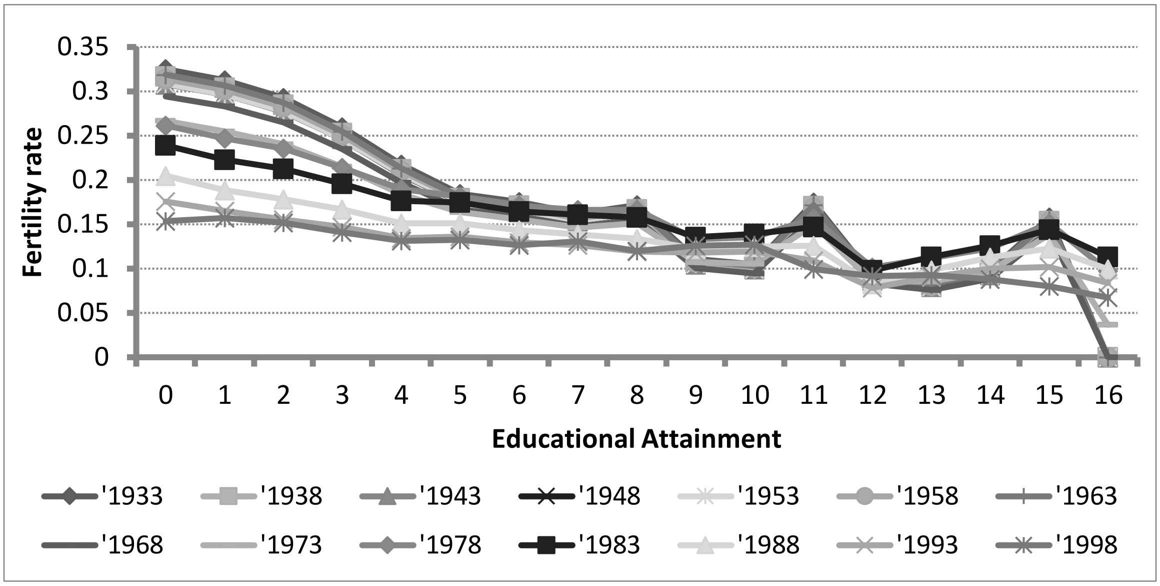


Figure 5D - Fertility by educational attainment, ages 30-34

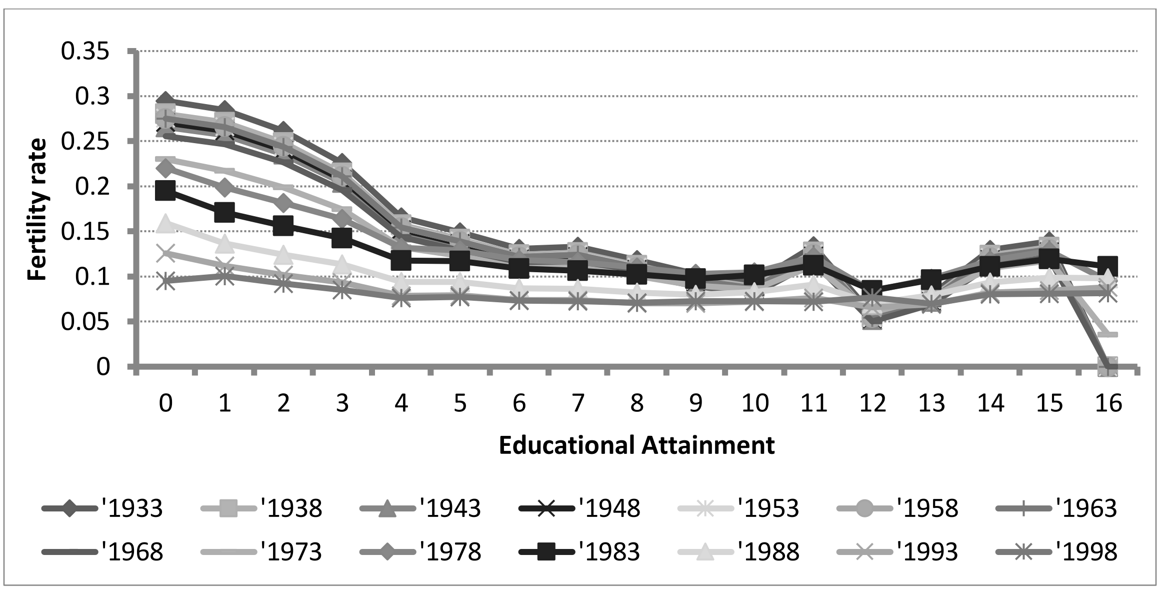


Figure 5E - Fertility by educational attainment, ages 35-39

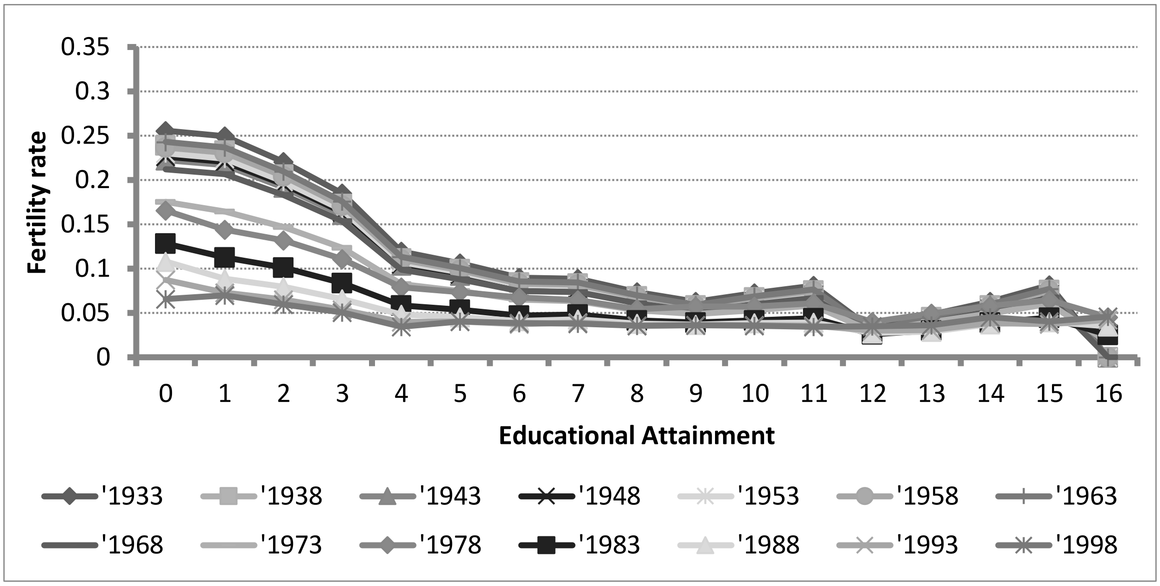


Figure 5F - Fertility by educational attainment, ages 40-45

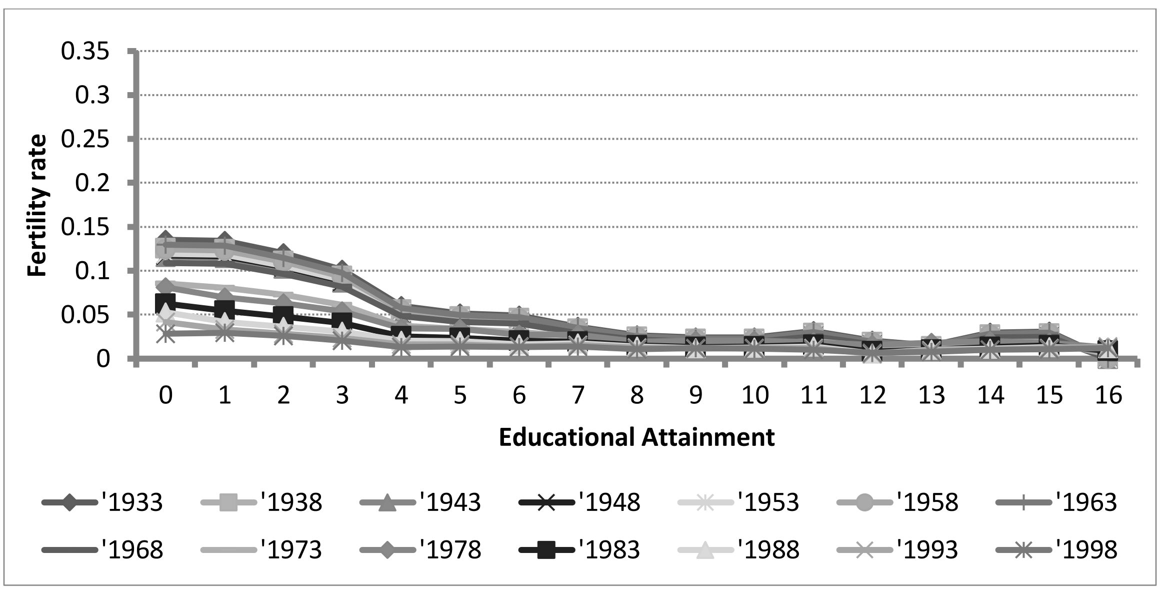


Figure 5G - Fertility by educational attainment, ages 45-49

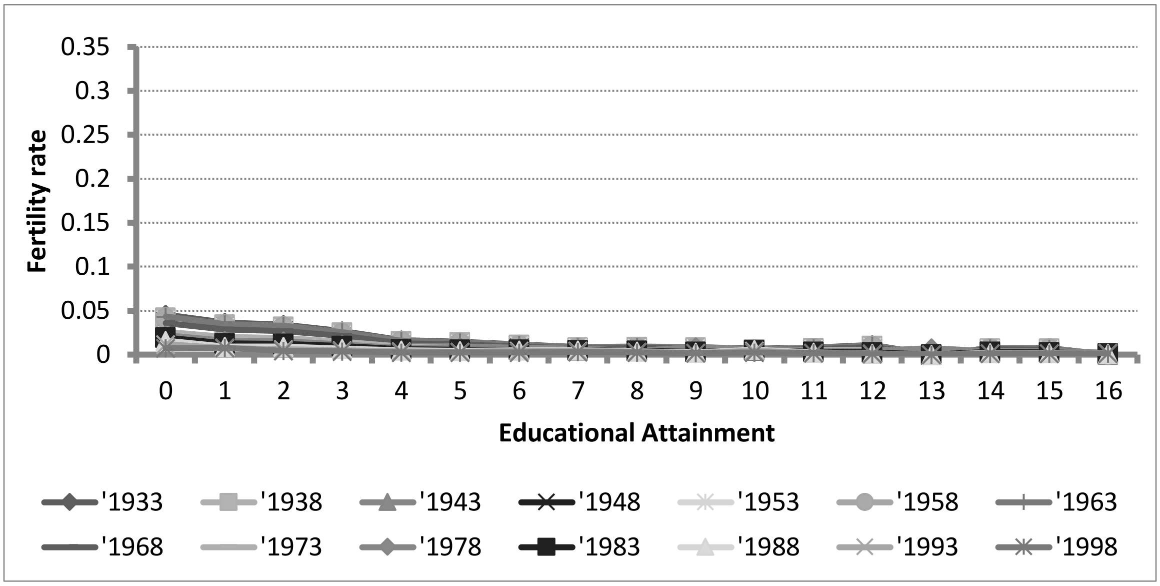


Figure 6 - Actual and predicted population

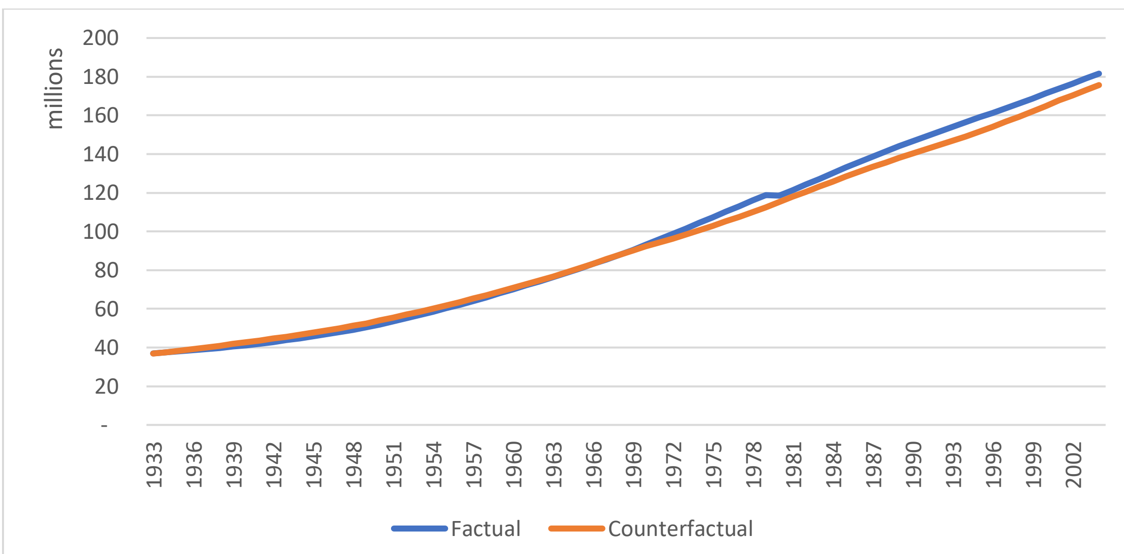


Figure 7 - Actual and predicted GDP

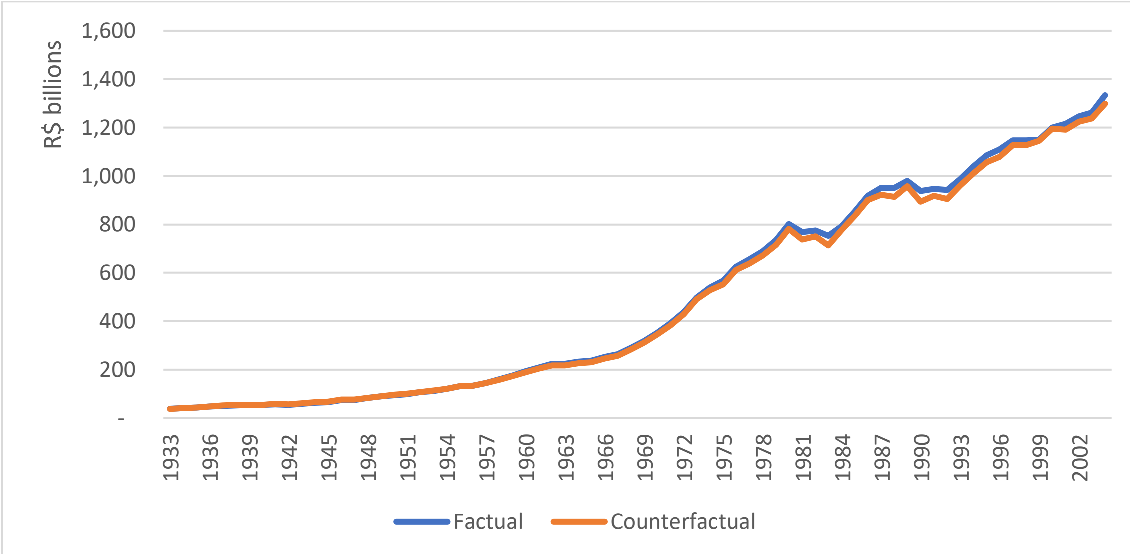


Figure 8 - Actual and predicted GDP per capita

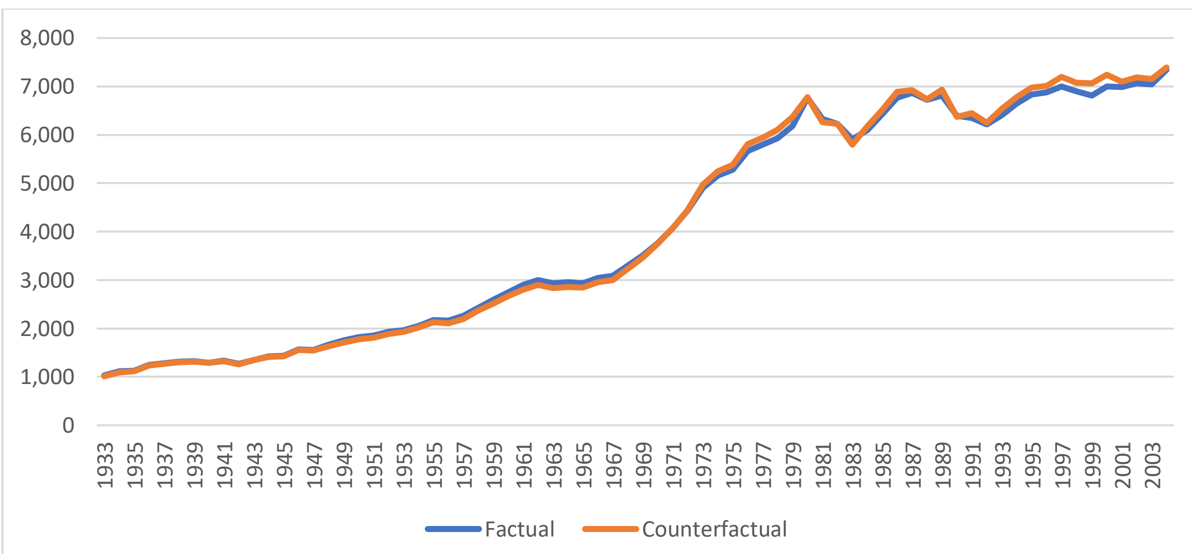


Figure 9 - Educational Attainment