Educational outcomes and enfranchisement*

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Abstract

We estimate the impact of democratization on the distribution of educational outcomes in a developing country using an overlapping generations model. The model features a standard quantity-quality trade-off between fertility and education provision to children. The government subsidies each educational level following a policy function in which the bias of the policy towards early years of education is decided by an election. We fit the model using Brazilian data between 1900 and 2000 and do counterfactuals simulating different levels of democratization. The results suggest that an universal suffrage in 1900 would have led to greater primary schooling subsidy and enrollment rates, besides a slightly reduction of inequality, greater fertility rates, worse college enrollments and a reduction in product per capita. The suffrage would have caused a marginal improvement in living standards among the middle and low income classes, but a considerable reduction of well-being for the rich. The elite would be willing to reduce their consumption up to 11.2% to avoid the suffrage.

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1 Introduction

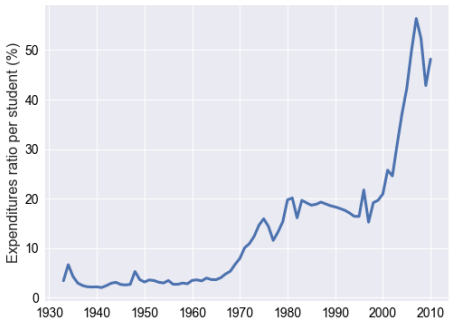
Education is one of the major concerns of governments and influences a variety of important individual and society outcomes. All around the world, governments influence education with regulations or with the provision of direct investments in primary schools, high schools, and colleges. These investments may have different effects on families and face support or resistance from different social groups.

In the last decades, there was a great increase in the provision of education in Brazil and the focus of the educational policy changed towards primary schooling. The share of government expenditures in education grew from 1.2% of GDP in 1940 to 4.5% in 2010. It is notable the relative increase in primary schooling investments. Figure 1(a) shows the increase in the government expenditure per student in primary school. In 1940, the average expenditure per primary student was 2.2% of the average expenditure per college graduate. In 2010, this number grew to 48.2%. During this period, the focus of the educational policy changed towards primary schooling, virtually universalizing access to primary education. [1]

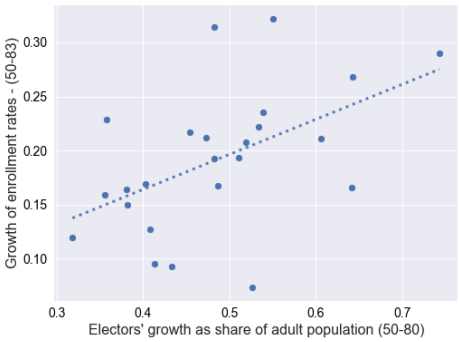
Figure 1: Evolution of public expenditures on education

((a)) Basic and tertiary public expenditures in education ratio

Source: IBGE, TSE



((b)) Enrollment rates in primary school and electors' share differences by UFs



The growth of government investments in education and the focus on primary schooling were accompanied by the increase in the number of adults reg-

[1] See Kang (2019).

istered to vote in the national and subnational elections. Figure 1(b) exhibits the increase in the change of share of children enrolled in primary school between 1950 and 1983 by the growth in the share of registered voters between 1950 and 1980 for each federal state (IBGE, 2003). The correlation between these metrics motivates the question of whether the increase in registered voters was one of the factors in the switch of the government educational policy towards primary schooling.

The link between enfranchisement and government investments in schooling education has a vast literature in Economics and other social sciences. Lindert (2004) says that "the spread of democratic voting rights played a leading role in explaining the rise of primary schooling". This view has received a lot of empirical support in the last decades (Avelino et al., 2005; Brown and Hunter, 2004; Harding and Stasavage, 2014; Busemeyer and Trampusch, 2011; Hoffman, 2015; Ansell, 2010). The main causal mechanism cited in these studies comes from median voter theories: the transition from autocracy or oligarchy to democracy generates an increase in the political power of the middle and low-income classes, creating more fertile ground for redistributive policies, such as public schooling for children.

Some authors, however, contest this argument, suggesting that the relative increase in education investments in primary schooling might have happened before democratization (Cantoni et al., 2017; Paglayan, 2021). They defend that providing primary schooling to the poor might be beneficial to the elites through speeding industrialization or military development, spreading the elite's ideology throughout schools, or helping legitimate the government by increasing support among the poor and middle class.

A structural framework can provide important insights into the role of the incentives that different social classes face when deciding the government educational policy. The middle class might directly benefit from an educational policy focused on primary schooling, whereas the elite would prefer college-level education.

In this paper, we took a structural approach to the question of whether democratization helped increase the relative importance of primary schooling in government educational policy. The framework follows an overlapping generations model with a standard quantity-quality trade-off in fertility choices. The government subsidizes the cost of different levels of education following a

policy function where the focus of the policy towards early or later years of education is decided by an election. The model consider the equilibrium effects of the educational policy on fertility rates, labor and capital prices, and how these changes affect the following generations. It then permits answering counterfactual questions: how the entire economy would look like if democratization in Brazil happened before or if the elite maintained the monopoly of political power.

We provide three counterfactuals to the baseline model. In the first case, there is universal suffrage in the economy in 1900. In the second, the elite restricts the participation in the political process of poorer households. In the third, the poor have a decisive vote on the educational policy. These alternative scenarios allow us to see how important variables such as product per capita, inequality, fertility rates, average years of schooling, and welfare evolves when the democracy levels are different.

The results suggest that an early universal suffrage in 1900 would have led to greater primary schooling subsidy and enrollment rates, a small reduction of inequality, greater fertility rates, worse college enrollments and a reduction in product per capita during almost all years. These changes would be accompanied by an improvement in living standards among the middle and low income classes and a sizeable reduction of well-being for the rich. The elite would be willing to reduce their consumption up to 11.2% to avoid the suffrage. Results are similar in the scenario where the low income class has all the political power. In the case where the top 1% of the income distribution holds power, college enrollment rates grow faster, with a slow growth rate in primary schooling. The middle and low income classes are worse-off than compared to the baseline scenario.

The political economy of the model is simple and it abstracts from the main political regime shifts that occurred during the 20th century in Brazil. During one-third of the century, the country was ruled by dictatorships, between 1930 to 1934 and from 1937 to 1945 by Getulio Vargas, and between 1964 and 1985, by a military regime. Democratization, thus, did not happen continuously. Nevertheless, voter registration rates grew steadily during almost all the period and it is used to estimate the model. The model implicitly assumes that the greater share of voters in the population might had imposed incentives to autocracies regarding the educational policy, even in times where there were not direct elec-

tions to the Executive.

The model in this article is inspired by the one developed in Cavalcanti et al. (2021), where the authors use an overlapping generations model with a quantity-quality trade-off in fertility choices to estimate the impact of exogenous family planning interventions on fertility, savings and human capital investment. We use a similar framework to analyze the impact of different educational policies in the economy, but here the political decision is endogenous and depends on the number of voters.

This paper communicates with two different strands of economic literature. First, it contributes to the macroeconomic literature that links democratization with the provision of public goods. Cooley and Soares (1999), Galasso (1999) and Boldrin and Rustichini (2000) model economies with political equilibriums that use the median voter theorem. Focusing on education, Rauh (2017) does an overlapping generation model where education policies are endogenized via probabilistic voting and finds a negative relation between inequality and public education expenditures.

The paper also contributes to the literature that studies education using structural models. Herskovic and Ramos (2017), Glomm and Ravikumar (1992), Epple and Romano (1996), Glomm and Ravikumar (1998, 2003) focus on the relation between public and private schools on determining inequality in the economy. Restuccia and Urrutia (2004), Erosa et al. (2010), Cunha (2013), Manuelli and Seshadri (2014), Blankenau and Youderian (2015), Herrington (2015), Lee and Seshadri (2019), and Caucutt and Lochner (2020) emphasize the relationship between investments in education and intergenerational mobility. There is also a literature that specifically focuses on the impact of government investment on different levels of education, particularly Brotherhood and Delalibera (2020) and Arcalean and Schiopu (2010). The contribution to this literature is to provide a framework that allows the educational policy to be endogenous and specific to various levels of education, using heterogeneous agents and credit constraints.

The rest of this paper is organized as follows. Section 2 summarizes the main historical facts regarding democratization and the educational policy in Brazil since the beginning of the last century. Section 3 describes the theoretical model. Section 4 presents the estimation strategy for the initial distribution of human capital and the evolution of educational prices and technology. Section 5 de-

scribe the counterfactuals and compare them with the baseline model. Section 6 poses concluding comments.

2 Historical facts

During the 20th century, there were main regime changes in Brazil regarding the level of democracy. The country was ruled by dictatorships for almost one-third of the century, between 1930 to 1934 and from 1937 to 1945, by Vargas[2], and between 1964 and 1985, by the military regime. The beginning and the end of such dictatorships marked the main political shifts in Brazil and are strongly related to changes in the educational policy (Kang, 2019).

These regime changes and the autocracy periods show that democratization in Brazil was not a sustained process during the last century. The number of registered voters, however, grew during almost all years, as shown in Figure 2 for the period following 1946 (IBGE, 2003; Walter, 2021). This fact is explained by mandatory registration requirements after 1932 and by the continuation of elections for the Legislative and local Executive during almost all the period (Nicolau, 2012).

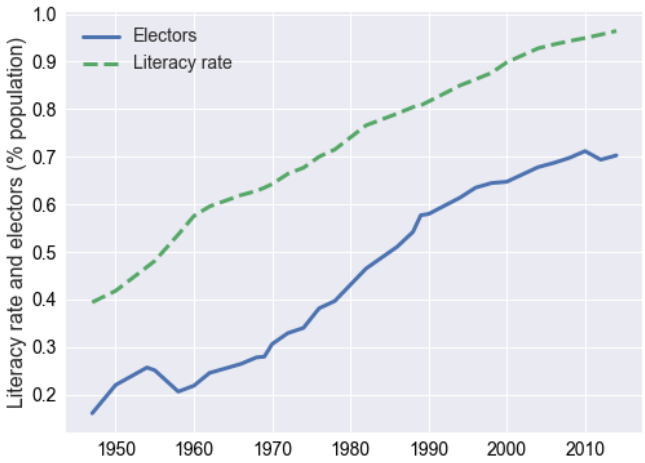
Although the registration for elections even during the autocratic periods was possible, Brazil had major limitations in voting rights. Before 1932, women were not allowed to participate in elections and illiterate citizens did not have voting rights until 1988. These two facts restricted the potential number of voters to a small share of the population for many decades. This might also be related to the focus of the educational policy towards secondary and tertiary education, that only changed after the universal suffrage brought by the Constitution of 1988.

2.1 Voting rights and education (1900-2020)

At the beginning of the 20th century, Brazil was a very recent republic. The monarchy was dissolved in 1889 and a new Constitution was implemented in 1891. The republic made significant changes to voting rights, extending voting

[2]In fact, Vargas ruled over a Provisional Government (1930–1934), waiting for the adoption of a new Constitution and a short democratic period between 1934 and 1937, where the democratically elected Constituent Assembly of 1933–1934 chose Vargas to continue as president. In 1937, Vargas imposed a restricted autocratic regime that finished in 1945.

Figure 2: Literacy rate and share of adults registered to vote (1946-2015)



to foreigners, abolishing the income threshold necessary to vote that existed during the monarchy period, and reducing the minimum age to vote from 25 to 21 years old. The new regime also created a literacy requirement to be eligible to vote, which would be maintained until 1988.

The changes introduced by the republic probably reduced the number of voters due to the literacy requirement.[3] The literacy requirement also limited the growth in the number of voters during almost all the century. The share of voters in the adult population was almost constant between 1900 and 1930, being around 10%, compared to 22% adults who were literate in 1900. The flaws in the political system might also be reasons for the low voter registration rates. The electoral system had frequent frauds, voters were coerced by local elites due to the vote being not secret between 1904 and 1916 and there was also a widespread sense of corruption regarding politicians (Nicolau, 2012).

In this first period of democracy, the focus of the educational policy was tertiary education (Brasil, 1916; Abranches, 1904). Investments in primary schooling were the responsibility of the federal states and, at the time, they did not have fiscal capacity (Musacchio et al., 2014). In opposite, tertiary education was centralized in the central government. The relatively low investments in pri-

[3]It is hard to conclude the effect of these changes since there is a lack of data for the national number of registered voters, but the number of voters indeed decreased in some municipalities (Nicolau, 2012)

mary schooling might also be related to the literacy requirement to vote. Since the citizens whose children would probably benefit most from primary schooling were aside from the political process, local and central governments might have had little incentive to invest in it.

In 1930, there was a *coup d'état* by Getulio Vargas and the Congress was dismissed until the formulation of a new Constitution. In 1932, there were significant changes in the electoral rules. Women got the right to vote, elections for the Legislative became proportional, important measures to prevent fraud during the elections were created and voting became mandatory for men. Men who did not vote could not work in the public sector and were required to pay an annual fine. These changes increased the number of registered voters by 85% between 1933 and 34, reaching 7% of the total population.

The education was centralized and minimum levels of investment were created. The new democratic Constitution of 1934 declared that a minimum share of the government budget must be invested in education, being 10% for the central and counties governments and 20% for federal states (Silva, 2011). The central government had, for the first time, the responsibility to coordinate the educational policy and supervise the subnational investments.

The new rules, nevertheless, had a short duration. In 1937, Vargas implemented a restricted dictatorship and a new Constitution was enacted. The Constitution of 1937 did not establish minimum quotas for investments in education and stated that the focus of the educational policy should be secondary education to facilitate industrialization. In the lower secondary school, enrollment increased by 234% between 1933 and 1945, whereas in primary school enrollment only grew 25% in the same period (Kang, 2017).

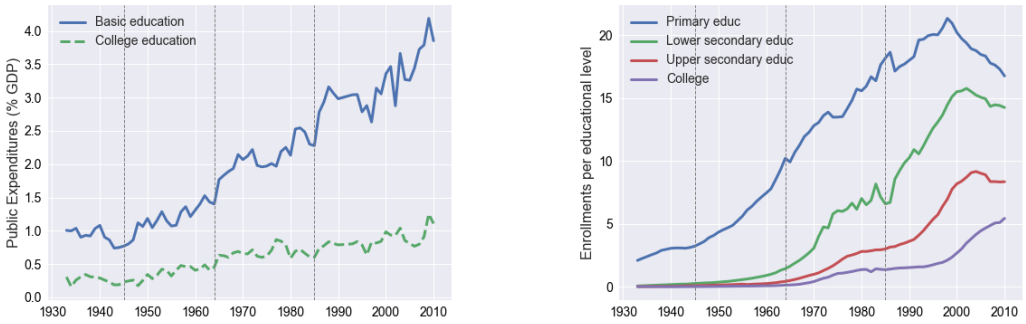
In 1945, with the end of Vargas' dictatorship, the new democratic republic maintained the main electoral rules of 1932 (Nicolau, 2012). Besides the previous rules, the minimum age to vote was reduced from 21 to 18 years old and voting became also mandatory for adult women who had an income coming from labor. The literacy requirement was maintained, which made almost half of the population aside from the election process. At the beginning of this period, the share of voters in the total population increased sharply, from 31% in 1947 to 49% in 1954, possibly due to mandatory voting and democratization.

There were remarkable changes in the educational policy during this period. The minimum quotas for investments in education implemented by the Consti-

tution of 1934 were also present in the Constitution of 1946, which contributed to a rise in education expenditures and in enrollments. Figure 3 exhibits the evolution of public expenditures in basic and tertiary education.

Figure 3: Evolution of expenditures and enrollments by educational level

((a)) Expenditures by GDP ((b)) Enrollments

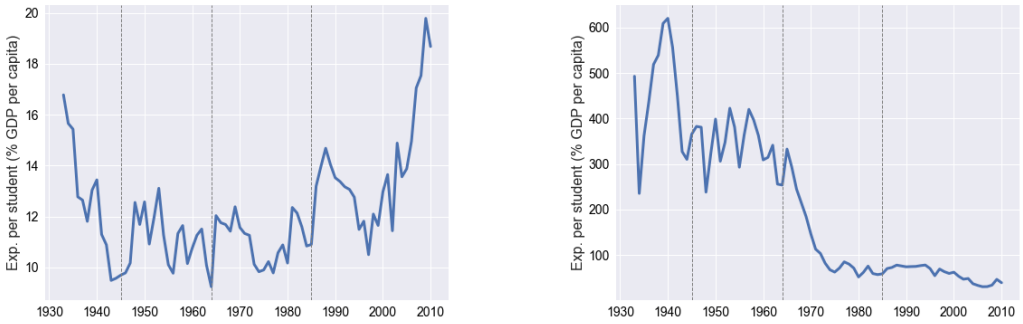


There was a slightly increase in public expenditures in basic education in the democratic period between 1945 and 1964. This expansion was partially used to accommodate the greater number of students. Figure 3(b) shows the evolution of total enrollments per educational level. Primary school students tripled between 1945 and 1964 and enrollments in lower secondary schools and colleges were multiplied by a factor of five during the same period. The increase of investment were not high enough to compensate for the high enrollment rates during the period, and education expenditures per student shrunk in all levels of education, as shown in Figure 4(a) and Figure 4(b).

Following this period of democracy, an autocratic regime was implemented in 1964. A coalition of military forces took the power and maintained it until 1985. The multiparty system was changed to a bi-party system and direct elections only occurred for the Legislative. For the Executive, elections were indirect for governors and presidents. The power of the Legislative shrunk and the Executive had the right to dismiss the Congress between 1964 and 1978. A new electoral code in 1965 made voting mandatory for literate women and stronger sanctions were created for those who did not vote, such as the impossibility of borrowing money from public banks, enrollment in public education establishments and restriction to get a passport. Even with the autocratic regime, the number of voters increased constantly during the period. The reasons for this

Figure 4: Evolution of expenditures per student by educational level

((a)) Basic education ((b)) College



are probably the increase in literacy rates during the period and the institution of stronger sanctions.

Enrollment rates in primary, secondary and tertiary education grew substantially during the first years of the period as shown in Figure 3(b). This growth was accompanied by an increase in the total expenditures in education, which was possible by a series of tax reforms between 1964 and 1967 that expanded by a great extent the fiscal capacity of the government. The expenditures per student in the tertiary education suffered a great reduction due to the remarkable growth of enrollments (Kang, 2017).

In the final years of the military dictatorship, there were massive social movements towards the restoration of direct elections to the president and, later on, for a new Constitution. In 1985, the first non-military president was elected, although through an indirect election, and, in 1988, a new Constitution was enacted. By the new Constitution, illiterate citizens could vote for the first time since the monarchy period and 25% of the government budget of federal states and counties were required to be invested in education.

There were also major programs implemented to subsidize the investments in education. FUNDEF, created in 1996, and later transformed in FUNDEB, were essential to increase the transfers between the central government and subnational governments. Between 1996 and 2010, the share of government expenditures per student in the GDP per capita grew 60% for the basic education and the same number almost doubled for the high school. This increase was also helped by the smaller number of primary schooling children due to the

reduction in fertility rates. Nevertheless, the recent decades constitute the first time that investments per student in basic education grew substantially and the political regime did substantial reforms to make this possible.

In the tertiary education, enrollments grew remarkably, with a slight growth in expenditures per GDP. The increase in enrollments was derived from the creation of a national program to finance tuition (FIES) in 1996 and its reformulation in 2010, besides the opening of dozens of new federal universities during 2000s. The increase in investments did not follow the substantial growth in enrollment and public expenditures per student in tertiary education dropped gradually (Figure 4(b)).

In summary, the main turning points in the focus of the educational policy occurred in 1964 and 1996. In 1964, despite the dictatorship, the tax reform increased the fiscal capacity of the state and benefited more the primary schooling. In 1996, with the FUNDEF and the new investment quotas to education implemented by the Constitution of 1988, the federal government specifically targeted the primary and lower secondary schooling as objectives of the educational policy. Although the educational policy history was made by these turning points, it is noteworthy that enrollments increased continuously, suggesting that these reforms took time to be fully incorporated in households decisions.

3 The model

The economy follows an overlapping generations model where the individuals live for three periods: childhood, young adulthood and old adulthood. Children do not make any economic decision, but can acquire skills. Young adults live with their spouses and decide on how many children to have, n, the level of education of their children, e, consumption, c_y, and savings, s. Young adults have one unit of productive time and are endowed with skills that they acquired during their childhood. Old adults do not work and simply consume their savings, with consumption denoted by c'_o.

3.1 Households

3.1.1 Human capital

The human capital formation function follows

$$h' = \varepsilon \tilde{h}(e) \tag{1}$$

where $\tilde{h}(e)$ is increasing, differentiable, concave with respect to e. We also assume $\tilde{h}(0) > 0$, thus an adult has a positive value of human capital even she did not enroll on school when she was a child.[4] The shock $\varepsilon \sim F(\varepsilon)$ has positive support and summarizes unobserved factors that influence the human capital production process. Investment in education is in terms of the consumption good. Children are time consuming, with each child taking a fraction $\chi \in (0, 1)$ of her parents time endowment.

There are different levels of education and each one is provided by a competitive market of schools with marginal cost $\lambda(e)$. Enrollment in education level e is allowed only if the student has completed all education levels $e' < e$.

3.1.2 Household's problem

Let $U(c_y, c'_o, n, h')$ be the utility function that represents the preferences of the household, where U is differentiable, increasing and concave in all arguments. The government has a subsidy rate of $\phi(e)$ for each education level e. There is a credit constraint in the economy, such that $s \geq 0$. The problem of the household with human capital h is then equal to:

$$V(h) = \max_{c_y, c'_o, n, s, e} \quad \mathbb{E}_\varepsilon \left[U(c_y, c'_o, n, h') \right] \tag{2}$$

$$\text{subject to} \quad c_y + s + n \sum_{e' \leq e} (1 - \phi(e'))\lambda(e') = (1 - \tau) w h (1 - \chi n), \tag{3}$$

$$c'_o = Rs, \tag{4}$$

$$s \geq 0, \tag{5}$$

[4] This assumption also imposes that the quality of children's income elasticity is increasing with income.

where R is the interest rate received by the household and w is the wage per unit of human capital.

3.2 Government budget

The government uses the revenues from the income tax to subsidy education and other government expenditures, where the share of education expenditures in the government budget for a given period is fixed at ρ. The government finances a percentage $\phi(e)$ of the incremental cost of acquiring education level e such that ϕ follows

$$\phi(e) = \pi e^{-\mu} \tag{6}$$

where $\pi \geq 0$ is a parameter of scale and μ is related to the curvature of the function. In this setting, μ can be interpreted as the bias of the educational policy towards early years of education.[5]

Note that $\mu = 0$ stands for a flat subsidy program, whether $\mu < 0$ means that $\phi(e_1) > \phi(e_0)$ for $e_1 > e_0$, so there is a subsidy regime that benefits more advanced levels of education. If $\mu > 0$, then there is a progressive subsidy regime in the sense that it subsidies more the initial phases of education.

Let $\Upsilon(h)$ be the cumulative density function of the human capital distribution in the economy and let $\psi(e)$ represents the total cost of the government with a child that enrolls in education level e, so,

$$\psi(e) = \sum_{e' \leq e} \phi(e')\lambda(e'). \tag{7}$$

The government budget constraint is then

$$\int n(h)\psi(e(h))d\Upsilon(h) = \rho\tau w \int h(1 - \chi n(h))d\Upsilon(h). \tag{8}$$

[5]It is easy to show that $\phi(e_1)/\phi(e_0)$, for $e_1 > e_0$ is decreasing in $\mu > 0$. In other words, if $\mu > 0$ increases, maintaining π constant, the ratio between subsidy rates for later years of education and early years of education will decrease, justifying the interpretation of μ as the bias towards early years of education.

3.3 Production

The consumption good is produced with a technology that uses capital, K, and efficiency units of labor, L, as inputs. The technology is represented by

$$Y = AK^{\alpha}L^{1-\alpha}, \alpha \in (0,1), A > 0. \tag{9}$$

Capital depreciates fully after use. Let w be the wage rate by unit of human capital and R be the rental price of capital. Profit maximization implies that input prices are paid according to their marginal productivity, such that

$$w = (1-\alpha)AK^{\alpha}L^{-\alpha}; \tag{10}$$

$$R = \alpha AK^{\alpha-1}L^{1-\alpha}. \tag{11}$$

3.4 Equilibrium

In a competitive equilibrium, agents and firms optimally solve their problems and all markets clear. The household optimal behaviour defines optimal policy functions $c_y(h)$, $c'_o(h)$, $n(h)$, $s(h)$ and $e(h)$. The equilibrium in this economy is characterized by a human capital distribution associated with the optimal behavior of households and firms.

Let first define the transition probability function of human capital, which computes the probability that a child attains human capital level h' conditional on having parents with state h. The transition probability function is given by

$$P\left(h' \mid h\right) = \int 1(h, \varepsilon, h')dF(\varepsilon),$$

where the indication function above takes the value of one if a child comes from parents with a state h, a shock ε and it has a human capital level h', so $h' = \varepsilon\tilde{h}(e(h))$.

Let Υ_t be the distribution of human capital on period t. Thus, the following period distribution function of human capital is

$$\Upsilon_{t+1}(h') = \frac{\int n(h)P(h' \mid h)d\Upsilon_t(h)}{\int n(h)d\Upsilon_t(h)}. \tag{12}$$

Definition: A competitive equilibrium for this economy consists of allo-

cations for firms $\{K_t, L_t\}_{t=1}^{\infty}$, a collection of policy functions for households $\{c_y(h), c'_o(h), n(h), s(h), e(h)\}_{t=1}^{\infty}$, a collection of distributions $\{\Upsilon_t\}_{t=1}^{\infty}$, a vector of prices $\{w_t, R_t\}_{t=1}^{\infty}$ and adult population $\{P_t\}_{t=1}^{\infty}$ such that

1. Given the vector of prices $\{w_t, R_t\}$, policy functions $\{c_y(h), c'_o(h), n(h), s(h), e(h)\}_{t=1}^{\infty}$ solve $V(h)$ for each t, so equations (2), (3), (4) and (5) are satisfied;

2. The equations (6), (7) and (8) related to government subsidies for education and government budget constraint are satisfied;

3. Given the vector of prices $\{w_t, R_t\}$, the vector $\{K_t, L_t\}$ solves the problem of the firms for each t with solution given by equations (10) and (11);

4. The adult population evolves according to the fertility decisions of the households, thus

$$P_{t+1} = \int n(h) d\Upsilon_t(h) P_t;$$

5. Market clearing conditions holds in the consumption good market, labor market and capital market for each time period t, which (omitting the subscript for the time period t in the household optimal decisions) gives

$$\int \left[c_y(h) + s(h) + \lambda(e(h))n(h)\right] d\Upsilon_t(h) P_t + \int c_o(h) d\Upsilon_{t-1}(h) P_{t-1} = AK^{\alpha} L_t^{1-\alpha},$$

$$L_t = \int h(1 - n(h)\chi) d\Upsilon_t(h) P_t,$$

$$K = \int s(h) d\Upsilon_t(h) P_t.$$

3.5 Political Economy

There is an election in the beginning of each time period where voters choose the parameter $\mu \in \{\mu_1, \ldots, \mu_N\}$ that determines the educational policy for the period. The grid for $t \geq 2$ has the previous period optimal μ in the center and maintains the same range $(\mu_N - \mu_1)$ in every time period. Thus, voters can always choose the elected μ of the previous period.

The income tax, τ, and the share of education in government expenditures, ρ, are fixed and it can be understood as imposed by the Constitution. For a given time period t, only adult households with income above a certain threshold can

vote in the election. When voting in the election, voters internalize the effects in equilibrium variables, such as prices. Taking some additional assumptions, it is possible to guarantee that the election result will be the most preferred policy of the voter with median income among those who can vote.

Suppose that all voters have single-peaked policy preferences over $\{\mu_1, \ldots, \mu_N\}$,[6] that households make the policy choices by majoritarian voting and there is sincere voting.[7] Additionally, take the assumption that households vote over pairs of policy alternatives, such that the winning policy in one round is posed against a new alternative in the next round, and the set of alternatives includes all feasible policies.[8] If these assumptions hold, the result of the election will be the median-ranked most preferred policy among households (Acemoglu, 2010, Chapter 22.7).

Finally, if the most preferred policy among households has a monotonic relation with the income of the household, the result of the election must be the the preferred policy of the voter with median income among those who can vote. In the following results, this assumption is taken, which is in line with the empirical results found.

4 Estimation

In our model we assume five educational levels represented by illiteracy, primary schooling, secondary school, high school and college, so $e \in \{0, 4, 8, 12, 16\}$. The period has a length of 20 years and the target year for the time invariant parameters' estimation is 1940, the earlier date for which there is enough reliable data to estimate them.[9]

The deterministic component of the human capital formation function is

[6] Let μ^* be the preferred policy of a given household. She has single-peaked policy preferences if, for any $\mu'' < \mu' \leq \mu^*$ or $\mu'' > \mu' \geq \mu^*$ there is $U(\mu'') < U(\mu')$. Her preference ordering, thus, is determined by the relative distance to the most preferred policy μ^*.

[7] A version of the median voter theorem exists when one allows for strategic voting. In this version, sincere voting is a weakly dominant strategy for each household.

[8] For example, in the first round, the households vote between $\{\mu_1, \mu_2\}$ and by majority rule they prefer μ_2, then, in the second round they vote over $\{\mu_2, \mu_3\}$ and so on.

[9] The 1940's Census is the first Brazilian Census to report fertility rates across subnational entities, which are used to estimate the relationship between education and fertility.

assumed to be

$$\tilde{h}(e) = h_0 + h_1 e^{\zeta}.$$

The shock ε is assumed to follow a log-normal distribution such that $\ln \varepsilon \sim N(0, \sigma_\varepsilon^2)$.

The utility function $U(c_y, c'_o, n, h')$ assumes a log-linear form such that

$$U(c_y, c'_o, n, h') = \log(c_y) + \beta \log(c'_o) + \gamma \log(n) + \xi \log(h').$$

This specification allows us to separate the utility function in deterministic and stochastic components. The shock ε in the human capital formation function is additive separable from the deterministic component of the utility function, which makes the optimal decisions in the maximization of expected utility independent of the shock.

Some parameters in the model evolve exogenously, such as the share of voters in the adult population, the income tax rate, the share of education in government expenditures, prices of each educational level and the TFP. The parameters related with human capital and utility functions are set to be constant. The parameter regarding the bias of the educational policy, μ, is decided by the election described in Section 3.5.

The strategy for estimation is first to estimate the time invariant parameters using 1940's data. In a second stage, we reestimate the prices of education and TFP level for each time period between 1900 and 2000 in order to match the education distribution of the children and growth in product per capita.

4.1 Time invariant parameters' estimation

The parameters α related to the production function, and β associated with the way people discount the future, are calibrated using previous studies' results. We use the results from Cavalcanti et al. (2021). The initial level of technology A is set in order to normalize the product to 1. The population in 1940 is also normalized to 1.

The income tax rate τ follows the total tax burden data. The share of government expenditures that goes to education, ρ, is calculated using the ratio of government expenditures in education by government primary expenditures,

including national and subnational entities. Data related to education expenditures come from Kang (2019) and primary expenditures and tax burden data are from IBRE (2006) and IBGE (2006). The income threshold of those who vote is chosen such that the percentage of people that vote is equal to the share of the adult population registered to vote from different administrative reports available at TSE (2006).

The parameters associated with the incremental prices of education ($\lambda_4, \lambda_8, \lambda_{12}, \lambda_{16}$), human capital function ($\sigma_\varepsilon^2, h_0, h_1, \zeta$), utility ($\gamma, \xi, \chi$) and educational policy, μ, can be summarized in the vector $\boldsymbol{\theta}$. This vector is estimated by Simulated Method of Moments (SMM) such that

$$\hat{\boldsymbol{\theta}} = \arg \min_{\theta} \theta' W \theta$$

where W is a weight matrix.

There are 15 targeted moments in the model. Five of them are related to the educational distribution in 1940 estimated by Walter (2021).[10] Three moments are associated with the share of government expenditures by educational level, compiled using government's data by Kang (2019). Another five moments represent the average number of children by educational level, estimated using a regression of average years of schooling against fertility averages by federal states weighted by their respective populations, available in the 1940 Census.

There is one moment regarding the wealth inequality, calculated by the GINI coefficient and estimated in Gómez León (2018)[11]. Finally, there is one moment that captures the share of savings in GDP, calculated by IBGE (2003).

The weight matrix W is chosen such that high school and college education levels have more weight in the estimation. We follow this strategy in order to discipline the model to find non zero values for these moments, since they are considerably small for 1940 (less than 1%).

Table 1 shows how the model matches the estimated moments with data moments. The model replicates well the distribution of education in the Brazil-

[10]Since the information regarding primary and lower secondary school completion rates in the population are estimated together, we calculate them assuming that the ratio between primary school graduates and lower secondary school graduates is the same as the ratio between enrollment rates.

[11]Gómez León (2018) uses average wage rates in dozens of occupations available in the 1940's Census to estimate the Gini coefficient to be 0.46. The author argues that this low estimation is due to the income of the majority of households being near subsistence levels.

ian economy in 1940. The average fertility rate by educational levels and Gini coefficient are also similar to the data. This shows the model is flexible enough to accommodate the patterns seen in the real moments.

Table 1: Data and Estimated Moments for 1940

Moments	Data	Estimated
Share of pop without education (%)	42.44	43.85
Share of pop with 4 years of school (%)	49.54	49.43
Share of pop with 8 years of school (%)	5.14	4.04
Share of pop with 12 years of school (%)	2.09	2.19
Share of pop with 16 years of school (%)	0.78	0.49
Gov educ spending - 4y (% GDP)	0.85	0.44
Gov educ spending - 8y and 12y (% GDP)	0.23	0.41
Gov educ spending - 16y (% GDP)	0.29	0.22
Household savings (% GDP)	14.82	14.32
Gini coefficient	0.46	0.46
Avg. children p/women without educ	3.05	2.89
Avg. children p/women with 4y of educ	2.51	2.66
Avg. children p/women with 8y of educ	1.97	2.10
Avg. children p/women with 12y of educ	1.43	1.45
Avg. children p/women with 16y of educ	0.88	0.99

The government spending by educational level in the model matches the college level data, but it does not reproduce well the measurements for the primary school and secondary plus high school. This might be related to the closed form used to calculate the subsidy rates (Equation 6), which restricts the relation among the subsidy rates for different educational levels. Nevertheless, the model does well in matching the government spending in basic education (primary + secondary + high school).

The estimated parameters that generate the results above are presented by Table 2. The negative μ estimated shows there is a educational policy mildly biased towards high school and college. The cost of having a child, $\chi = 3.9\%$, is in line with the estimation of Cavalcanti et al. (2021). Estimated prices of education indicate that colleges and high schools are on average 31 and 14 times more expensive than primary schools, respectively.

Table 2: Estimated parameters

Parameter Parameter	Description Description	Value Value	Method Method
λ_1	Education cost: primary school (0y-4y)	0.0051	SMM
λ_2	Education cost: secondary school (5y-8y)	0.0316	SMM
λ_3	Education cost: high school (9y-12y)	0.0715	SMM
λ_4	Education cost: college (13y-16y)	0.16	SMM
σ_ε^2	Standard deviation of the log of ability shock	0.40	SMM
h_0	Human capital-fixed	1.8999	SMM
h_1	Human capital-marginal	0.0014	SMM
ζ	Human capital-curvature	1.841	SMM
γ	Utility weight on fertility	0.17	SMM
ξ	Utility weight on human capital	1.987	SMM
χ	Time cost per child	0.0387	SMM
A	TFP parameter	0.67	SMM
μ	Educational policy-curvature	-0.06	SMM
π	Educational policy-marginal	0.5132	Equilibrium
α	Capital share in income	0.33	Literature
β	Discount factor	0.35	Literature
τ	Income tax rate	0.135	Data
ρ	Education share in gov expenditures (%)	13.4	Data

4.2 Economy's evolution

The estimation of the economy's evolution is done by changing the income tax rate, τ, the share of education in government budget, ρ, and the share of voters in adult population following the data. Data regarding the share of education in government budget in 1900 and 1920 refers to the average of federal states, calculated by Musacchio et al. (2014). Share of voters in adult population for 1900 and 1920 are estimated by Nicolau (2012). Data from 1940 to 2000 can be found in the same data sources cited in the first step of estimation.

The estimation of the educational distributions of 1900 and 1920 are done using illiteracy rates from Musacchio et al. (2014). Secondary school and high school enrollment rates were very low in 1925, with all being smaller than 2% (Walter, 2021). College enrollment rates were even lower, with only 2481 students enrolled in 1907 in a population of nearly 21.5 million (IBGE, 1908). Thus, we suppose they grow in a linear way using the linear growth rate between 1925 and 1930. Primary school enrollment rates are calculated by residual.

The initial human capital of 1900 is estimated using the educational distri-

bution of 1900 and the human capital formation function simulating the shock ε (Equation (1)). The prices of education and the TFP level for each period are re-estimated using a SMM approach and targeting as moments the educational distribution of the following period and the growth in GDP per capita between the current period and the previous one.

Table 3 displays how the income tax rate, τ, share of education in government budget, ρ, the share of voters in adult population and the growth in product per capita evolved between 1900 and 2000.

Table 3: Evolution of time variant parameters and GDP per capita (%)

	Voters	Income tax	Educ Exp	Growth	Growth - model
1900	10	10.62	13.4	-	-
1920	10	7	11.7	16.5	17.72
1940	31.7	13.55	10.1	78.43	78.97
1960	31.6	17.42	9.84	112.81	114.51
1980	81.5	24.45	11.12	144.79	145.49
2000	96.5	32.74	13.26	8.4	8.41

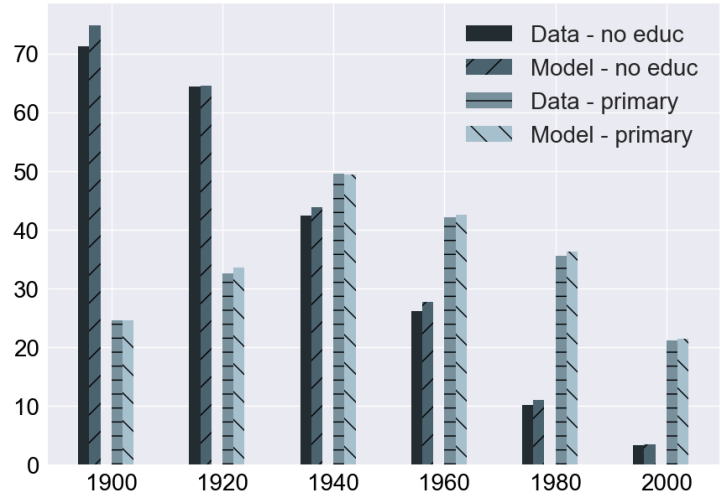
[a] Voters represent the share of voters in adult population.
[b] Income tax rate are calculated from the total tax burden in the economy, including direct and indirect taxes.

The share of voters in adult population grow discontinuously, with jumps in 1940 and 1980, but it shows the gradual democratization of the Brazilian political process. Income tax rates increase sharply between 1940 and 2000, accompanied by fast growth rates of product per capita until 1980. The last column of the table indicates the model matches the growth in product per capita for all periods.

Figure 5 exhibits how the evolution of education found in the model compares to the data. The model captures well the patterns of changes in educational distribution and the growth of product per capita, such as the increase in primary schooling and later growth of high school enrollment rates.

Figure 5: Educational outcomes in adult population: data and model (%)

((a)) No education and primary school



((b)) High school and college

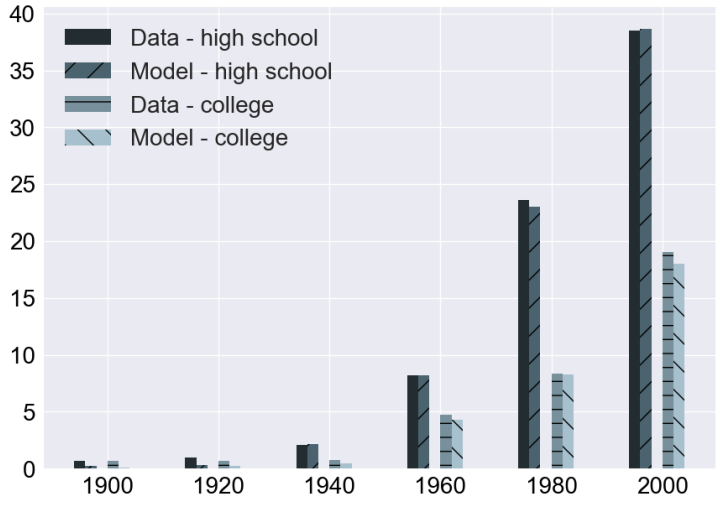


Table 4 displays how the education costs change over time in comparison to the primary school's cost. The model presents a decrease in relative prices of advanced levels of education compared to primary schooling, suggesting a relative technological improvement of providing advanced levels of education. The relative cost of a college student reduces from 31.0 in 1900 to 14.7 in 2000.

Table 4: Evolution of relative education prices

	1900	1920	1940	1960	1980	2000
Prim. school	1	1	1	1	1	1
Sec. School	5.94	5.29	4.75	4.11	3.92	2.94
High school	13.86	12.03	10.45	9.75	8.93	6.18
College	31.02	25.45	23.15	21.61	21.27	14.71

[a] Prices of primary school normalized to 1.

5 Effects of democratization

The model allows to estimate how the economy would have developed if the share of voters in the population had evolved differently. Changing the share of voters affects the median voter, which might impact the bias of educational policy towards the primary school, μ, affecting the prices of education to the household and the incentives to have children and to invest on education.

In this work, we provide three counterfactuals. In the first, there is universal suffrage since 1940, so the median voter becomes the household with median income. In the second, the elite restricted the right to vote only to itself. In the third, the policy is decided by the poor, being represented by the 10th percentile.[12] These counterfactuals provide insights regarding how the educational policy affects different social classes: the poor, the middle class and the elite.

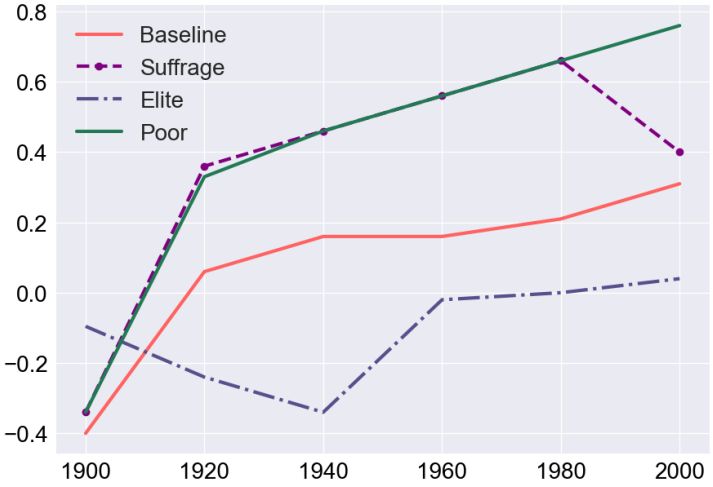
Figure 6 shows the elected level of bias towards primary schooling in the educational policy (μ) for each period and scenario. If $\mu > 0$, the subsidy rates of early years of education are greater than in later years and the opposite is true when $\mu < 0$. If $\mu = 0$, there is a flat subsidy regime.

In the elite's oligarchy scenario, the subsidies regime is biased towards college education until 1960, in 1980 it is flat and it becomes biased to early years of education only in 2000. Moreover, the elected μ is consistently lower when compared to the other three scenarios. The elite, thus, prefers to choose a college based educational policy, since the additional cost of providing college is greater than all the other educational levels.

In the other two counterfactuals, the subsidy rates are almost as biased towards primary schooling than the baseline. Middle class voters have an incen-

[12] In the universal suffrage scenario, the median voter is the median income household, therefore the very poor are not decisive voters in the election. Thus, it is worthwhile to see how the policy would have changed if the poor had have decisive political power.

Figure 6: Election results: bias towards primary schooling



tive to increase the subsidy rates of earlier years of education and to reduce the subsidies for later years. This figure shows an interesting fact: in almost all periods, the lower the income percentile of the decisive voter the greater the bias towards more lower levels of education.

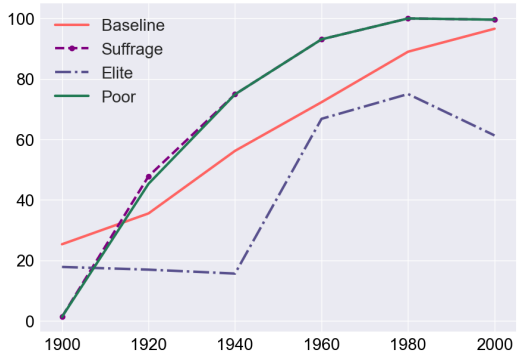
The only exception happens in 1900, where, in the suffrage or low income class' government, the educational policy is heavily biased towards college. The decisive voters in these two scenarios are so poor that they do not want to provide education to their offspring even with substantial subsidies from the government. Nevertheless, the elite would benefit from primary schooling subsidies, increasing education expenditures, reducing fertility rates and consequently increasing the supply of labor, which would cause a reduction in the wage rates. Seeing this, the decisive voter prefers to be in a society where the literacy rate is low as possible and chooses a policy with smaller subsidies for primary schooling compared to the baseline. In the following periods, the increase in the total factor productivity increases the income of poorer classes and makes it worthwhile to invest in education and to change the educational policy.

5.1 Educational outcomes

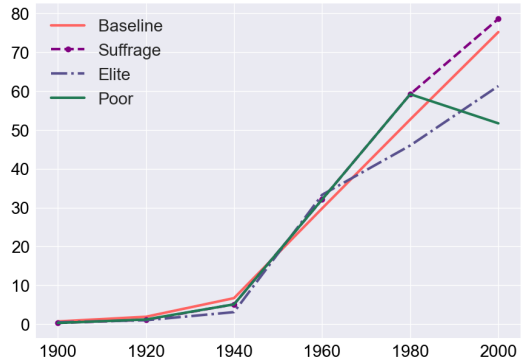
Figure 7 shows the evolution of enrollment rates by educational level of children for different scenarios.

Figure 7: Enrollment rates of children by educational level (%)

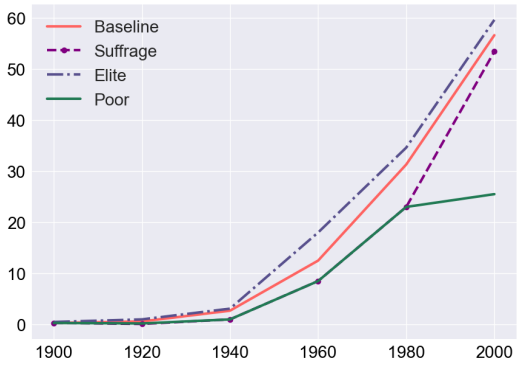
((a)) Primary school (0-4)



((b)) Lower secondary school (5-8)



((c)) High school (9-12)



((d)) College (13-16)

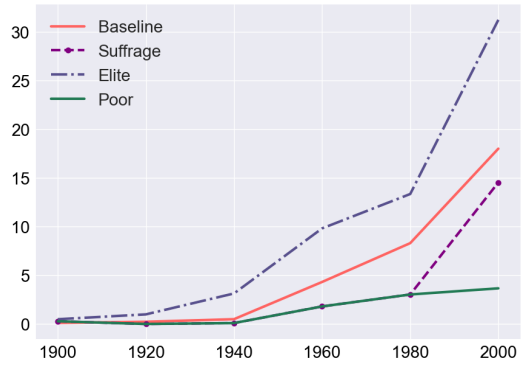


Figure 7(a) shows the literacy rates or primary school enrollment rates among children. The model indicates that, in the suffrage scenario and low income class' government, the literacy rates are zero in 1900, considerably smaller compared to the baseline, but they grow sharply in the following periods, being 47.8% in the suffrage scenario in 1920 and 74.9% in 1940, quickly surpassing literacy rates in both the baseline and the elite's government scenarios.

In the elite's government scenario, literacy rates reduce between 1900 and 1940 to experience a fast growth up to 1980, when they reach 75% and after that decrase to 61.3%. The reduction in primary school enrollment rates comes from the greater focus of the educational policy towards college level education. In 1960 and 1980, government's revenues and the share of education in government expenditures grow (see Table 3), which mechanically increase the subsidies rate for primary schooling. In contrast, with greater subsidies to advanced levels of education, the enrollment rates in high school and college grow sub-

stantially compared to other models, as shown in Figure 7(c) and Figure 7(d).

In the suffrage and low income class' government scenarios, there is universalization of access to primary schooling in 2000. In the suffrage scenario, around 80% of children completes 8 years of education and more than 50% of them is able to reach 12 years of schooling, but college enrollment rate remains small. In the low income class' government scenario, less than 30% completes high school and less than 5% completes college in 2000, which it is considerably slower than the baseline. In the oligarchy's model, around 60% of children completes high school and more than 30% graduates from college.

The analysis show that the educational outcomes are better in the oligarchy scenario in the end of the period, with greater average years of schooling (11.1) compared to 11 in the baseline, 10.8 in the suffrage model and 8.1 in the policy directed to the poor. However, it takes longer to improve literacy rates and access to the lower secondary school, which might bring drawbacks to the poor and middle class. In the following section, we provide measurements on welfare and inequality to check the benefits for each social class in the counterfactuals.

5.2 Effects on well-being and inequality

The heterogeneity of the agents in the model allows to examine the effects on well-being for households with different incomes. The political side of the economy allows to complement the model analyzing the effects that different ruling social classes have on each other and in both growth and inequality.

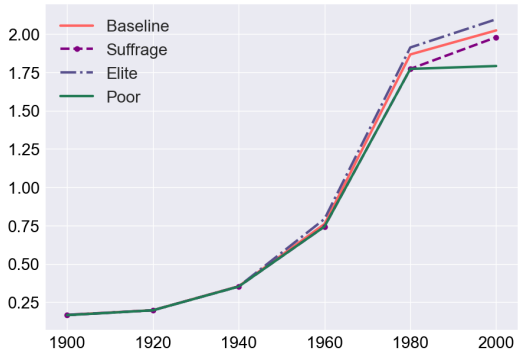
The improvement of educational outcomes along time might indicate a faster growth in product levels in the following periods since the better educated children provide more productive labor. However, the utility function specification creates a trade-off between having more children and providing more education. As education being less expensive, households might increase their fertility rates, which negatively affects the product per capita.

Figure 8 shows how the product per capita evolves with time according to the baseline model and the three counterfactuals. The evolution of product per capita follows a similar pattern in all models. In Figure 8(b), there is a growing difference in the product per capita between the scenario where the poor holds power and the elite counterfactual. In 2000, the product per capita in the

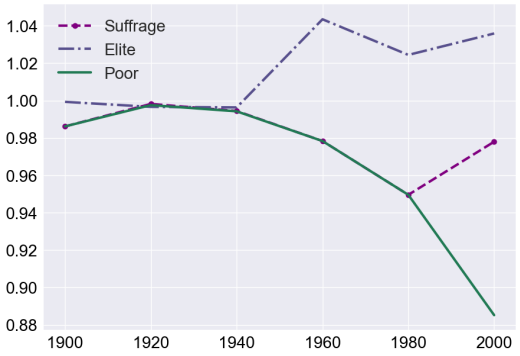
oligarchy scenario is 17% greater than in the economy where the poor takes power. Comparing the suffrage to the oligarchy scenario, we can see a growing gap in product per capita up to 1980, but after that, in 2000, this gap narrows a bit and the output per capita becomes around 6% greater in elite scenario compared to the suffrage.

Figure 8: Evolution of product per capita by model

((a)) Product per capita



((b)) Product per capita relative to baseline

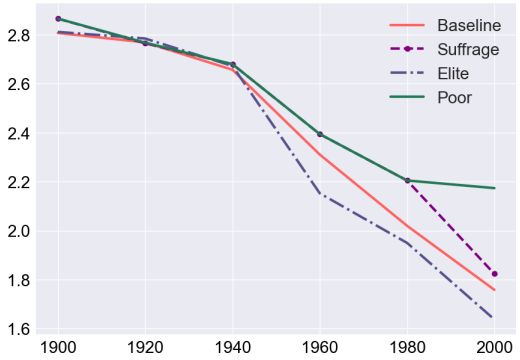


The increase in product per capita in the oligarchy model is partially caused by the reduction in average fertility rates. With less children, holding all else constant, the population would be smaller and the time spent at work by parents would be greater, increasing the product per capita. Figure 9(a) shows the evolution of average children per households. The models exhibits a similar trend of reduction of average fertility rates through time, but this decrease is more severe in the elite's government. Figure 9(b) shows there is a continuous increase in the average fertility rate in the poor model relative to the baseline. In 2000, the average number of children per household in the suffrage is 33% greater than in the oligarchy scenario. Thus, part of the relative increase in product per capita in the elite scenario seen in Figure 8(b) is related to this difference in fertility rates.

It is worthwhile to consider how the growth in the economy is shared among the households. Figure 10 shows two inequality metrics: the Gini coefficient and the 10:10 ratio. The 10:10 ratio is the ratio between the sum of the income of households above the 90th percentil and the sum of those below the 10th percentil.

Figure 9: Evolution of average fertility rates by model

((a)) Average fertility rate



((b)) Avg. fertility rate rel. to baseline

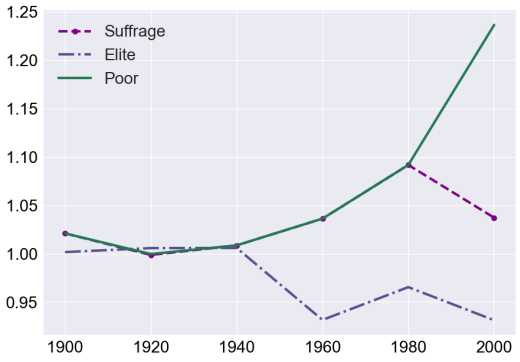
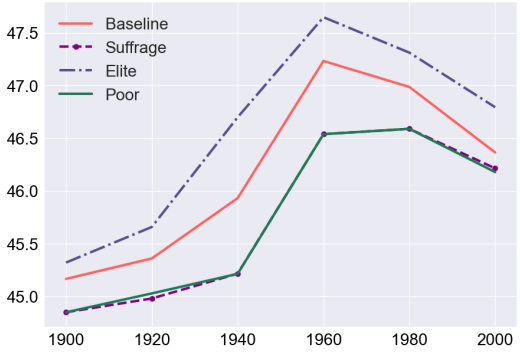
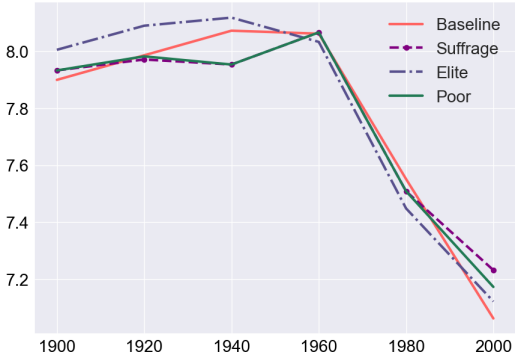


Figure 10: Inequality: Gini coefficient and 10:10 ratio

((a)) Gini coefficient



((b)) 10:10 Ratio



The Gini coefficient shows a slight difference in inequality among the models. However, the difference is not greater than 3 percentage points. With the universal suffrage, inequality drops in 1900 compared to the baseline and it continues to be smaller than the baseline model and the oligarchy model. In contrast, with the elite being in power, the inequality is a little bit greater in all periods.

The difference in inequality among the counterfactuals is also small when it's measured by the 10:10 ratio (Figure 10(b)). In all models, this metric reduces from approximately 8 in 1940 to 7 in 2000 following a similar pattern during the period. The difference between the models, however, diminishes over time, having a very similar inequality measurement in 2000, with the inequality in the elite's scenario being even smaller than in the suffrage.

The change in well-being for a specific household can be better analyzed measuring the consumption equivalent of some percentiles of the income distribution. The consumption equivalent for a given year is calculated as the increase or the reduction in consumption in the baseline model to reach the same utility level in a given counterfactual model. Table 5 shows the consumption equivalent with the suffrage counterfactual. In 1920, for example, the consumption in the baseline of the 50th percentile should increase in 0.07% in order to become indifferent between the baseline equilibrium in 1920 and suffrage equilibrium in 1920, which indicates that this household would be better in the suffrage scenario.

Table 5: Consumption equivalent by selected percentiles - suffrage (%)

	1900	1920	1940	1960	1980	2000	Average
10	0.14	0.05	0.11	0.43	1.26	0.43	0.40
25	0.14	0.05	0.18	-0.68	2.17	0.45	0.38
50	0.14	0.07	0.39	0.58	-0.26	0.10	0.17
75	0.09	0.22	0.33	0.49	-0.97	-0.02	0.02
99	-0.19	-3.04	-1.49	-11.17	-0.30	-3.37	-3.26

Table 5 exhibits a marginal improvement in the well-being of the 50th percentile, the median voter in this model, over almost periods. Poorer households also have a tiny improvement of living standards with democratization. Thus, despite the smaller product per capita and average years of schooling compared to the baseline, the middle and low income classes prefer the suffrage. The elite, in opposition, is remarkably worse in all periods. Between 1900 and 2000, the 99th percentile is, on average, willing to give up 3% of her consumption to remain in the baseline. It is interesting to see that, even with the political power belonging to the median income household, she is worse in 1980 compared to the same period in the baseline.

Table 6 displays the consumption equivalent calculated for the elite's oligarchic model. The results evidence the improvement in well-being of the ultra rich in the economy despite almost all other selected percentiles being worse compared to the baseline. The reduction in living standards of the poor and middle class are not so big compared to the reduction of well-being faced by the elite in the suffrage model. The maximum reduction in consumption that the poor and middle class are willing to give up to remain in the baseline is

always less than 2%.

Table 6: Consumption equivalent by selected percentiles - elite (%)

	1900	1920	1940	1960	1980	2000	Average
10	-0.03	-0.01	-1.05	-1.57	-0.46	-0.35	-0.58
25	-0.03	-0.01	-1.27	-1.55	-0.41	-0.29	-0.59
50	-0.03	-0.01	-0.22	-1.54	-0.44	-0.66	-0.48
75	-0.02	-0.24	-0.59	-0.95	0.63	0.17	-0.17
99	1.09	1.10	0.96	0.72	0.16	0.04	0.68

Table 7 exhibits the consumption equivalent when the 10th percentile holds the power to determine the educational policy. The results are very similar to the consumption equivalent calculated with full democracy in the first periods, since the educational policy is the same (see 6). In 1940 and in subsequent periods, the well-being of the poor is slightly greater compared to the baseline and suffrage scenarios.

Table 7: Consumption equivalent by selected percentiles - low income's government (%)

	1900	1920	1940	1960	1980	2000	Average
10	0.14	0.07	0.11	0.43	1.26	0.85	0.48
25	0.14	0.07	0.18	0.68	2.17	0.26	0.58
50	0.14	0.07	0.39	0.58	-0.26	-1.09	-0.03
75	-0.09	0.20	0.33	0.49	-0.97	-1.55	-0.23
99	-0.19	-2.98	-14.30	-0.49	-0.30	-4.93	-3.87

The analysis of well-being shows the dispute between the conflicting interests between the elite and other social classes of the society regarding different levels of democracy and, consequentially, the educational policy. The elite is willing to give up, on average, 3.3% of its consumption to avoid the suffrage and, in some years, this reaches 11.2%. The middle class is also willing to reduce up to 1.6% to prevent the elite's rule. The similarity between the low income class preferences and the middle class is remarkable, showing the poor (10th and 25th percentile) would be close to its optimal policy in the suffrage scenario.

6 Conclusion

In this paper, we study the relation between democratization and increase in educational outcomes and well-being using an overlapping generations model, featuring a quantity-quality trade-off in the choice of fertility rates. The framework allows to estimate how the educational policy would have changed if it had been decided by different households. It also provides a flexible model to be used in other human capital formation models.

The model is calibrated using Brazilian 1940 data and it performs well in matching targeted moments. The framework reproduces the educational distribution in the economy, inequality and the relation between fertility rates and educational levels. In a second step, prices and technology level are re-estimated to reproduce the educational outcomes of children between 1900 and 2000. The model is flexible enough to capture the evolution of educational distribution and the growth in product per capita.

The paper provides three counterfactuals: universal suffrage, elite's oligarchy and the control of the government by the poor. The decisive voter changes substantially among counterfactuals, providing insights in the effects of democratization on the educational outcomes, inequality and well-being. The model also shows that the elite and the middle class have different preferences over the educational policy. In general, the middle and low income classes prefer educational subsidy rates biased towards primary schooling, whereas the elite wants greater subsidies for high school and college.

The results show that average years of education have a small improvement under the elite's rule and the product per capita is 7% greater than in the economy with suffrage, besides having small difference in inequality measured by both the Gini coefficient and the 10:10 ratio. This growth is related to the increase in fertility rates in the suffrage scenario, where the average number of children per household is 15% greater than in the elite's government. The apparent improvement in well-being is not true for all social classes. Under elite's government, the low income class and part of the middle class is slightly worse than in the baseline. On average, poor households (10th and 25th percentile) would be willing to reduce their consumption up to 0.6% to inhibit elite's rule.

In opposite, under suffrage, the elite has substantial drawbacks in living standards. On average, the elite is willing to give up 3.3% of their consump-

tion in the baseline model to avoid the suffrage scenario. This shows a tension between the elite and the middle class regarding the level of democratization and the choice of the educational policy. In the simple political economy of the model, this conflict is solved exogeneously establishing the share of adults who vote in the economy.

The model also shows that middle and low income classes might not have an incentive to invest in education if their income is not sufficiently high. In 1900, the low income class would have preferred a society with small government subsidies to education. Only after some economic growth, the poorer households become rich enough to want to invest in education and start to demand that the government subsidies it. This, in addition to low levels of democracy, might be another factor to explain why Latin America countries stayed considerable behind developing ones in literacy rates during late 19th and early 20th centuries (Lee and Lee, 2016).

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