The Effects of Governmental Incentives on Higher Education Choice: A Theoretical Model

Os Impactosde Incentivos Governamentais na Escolha de Educação Superior: Um Modelo Teórico

Camila Rafaela Alvarenga[1]
Joanna Georgios Alexopoulos[2]

Abstract: Human capital attainment through higher education gives poverty-trapped individuals a chance to escape poverty. In Brazil, incentives in the form of educational loans (FIES), college scholarships (ProUni) and expansion of public universities (REUNI) are some of the paths through which the government may affect human capital formation. The main goal of this paper is to develop a model that explains how governmental incentives for higher education impact on educational choices of young individuals. The analytical results indicate that agents who have enough resources to succeed in the selection process will further their studies in the public system, and that financially constrained individuals may prefer working and saving in detriment of their studies. The partial equilibrium analysis reveals that the FIES fund allows that some financially constrained individuals be given a chance to attend university, as does the ProUni scholarship. However, the analysis suggests that REUNI is the most effective educational incentive in the sense that it favors equality of opportunity in the Brazilian higher education selection system.

Key-words: Human capital, higher education, educational policies.

Resumo: A obtenção de capital humano através da educação superior oferece a indivíduos pobres uma chance de sair da pobreza. No Brasil, incentivos na forma de empréstimos educacionais (FIES), bolsas de estudos (ProUni) e expansão de universidades públicas (REUNI) são alguns dos programas através dos quais o governo pode estimular a formação de capital humano. O objetivo principal deste trabalho é desenvolver um modelo que explique como incentivos governamentais ao ensino superior impactam nas escolhas educacionais de jovens indivíduos. Os resultados analíticos indicam que pessoas que possuem recursos suficientes para ter sucesso nos processos seletivos frequentam uma universidade pública, e que indivíduos com restrições financeiras podem preferir trabalhar e poupar em detrimento dos estudos. A análise de equilíbrio parcial revela que o FIES propicia aos jovens sem recursos uma chance de frequentar uma universidade, assim como o faz o ProUni. Entretanto, a análise sugere que o REUNI é o programa mais eficaz na promoção de igualdade de oportunidade no sistema de seleção do ensino superior brasileiro.

Palavras-chave: Capital humano, ensino superior, políticas educacionais.

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[1]Doutoranda em Economia Aplicada na Universidade Federal de Viçosa. E-mail: camila.alvarenga@ufv.br.
[2]Professora da Universidade Estadual de Londrina. Departamento de Economia. E-mail: jalexopoulos@uel.br

1 Introduction

Over the last decades, the Brazilian government, through its Ministry of Education (MEC), has designed and implemented incentive programs for higher education, aiming to expand access to universities, in a broad sense, and more specifically, to increase the stock of human capital in Brazil. In view of this goal, the incentives have been directed at young individuals belonging to lower social classes, both through the expansion of public universities and through financing and subsidy of private institutions. Investments in human capital through schooling and training result in skill gains, which in turn have a positive and significant effect on individual labor earnings (MINCER, 1974). In the long run, such investments are expected to lead to increase in economic growth, as well as decrease in income and wealth inequality (SCHULTZ, 1960; BECKER, 1962; ROMER, 1989; GALOR; ZEIRA, 1993; BARRO, 2001; KOCHAR, 2008; CASELLI; CICCONE, 2013), although the effects of current human capital investments on economic development in the future is contingent to what happens with the rate of return to education between now and then (BOURGUIGNON; FERREIRA; LEITE, 2003).

In order to discuss the matter of formation of – and returns to – human capital in the context of higher education, it is necessary to point the basic differences between public and private university in Brazil. The more notable distinction is the cost – while public institutions of higher education do not require payment of a tuition for attendance, private universities do, which makes them inaccessible to poor individuals in the absence of financial aid. In addition to being free of charge, public university is comparatively associated with higher education quality, seeing that the public system is estimated to be responsible for 90% of the scientific production in the country (HILU; GISI, 2011). The selection method, which ranks candidates based on an exam named ENEM[3], tends to favor the applicants who had the resources to go to private school in the childhood and to take preparatory courses for the exam. Provided that public university in Brazil is typically excluding to candidates coming from public high school, it raises a concern over the matter of inequality of opportunity[4] in the higher education system, known to be conducive to income and wealth inequality.

The Brazilian government has approached this issue through the implementation of three main programs: REUNI, ProUni and FIES. REUNI is a program intended to restructure and expand Brazilian federal universities. It aims to raise the number of openings in the public system by expanding courses, reducing dropout rates, and occupying vacant positions. Furthermore, REUNI intends to restructure the academic environment, as well as renew higher education pedagogically and improve quality of education. The expansion of federal institutions was initiated in the year of 2003, with the inauguration of campuses on smaller cities across the country. As reported by MEC, until 2013 there were created 14 new universities and over 100 new campuses. Additionally, the number of enrolled students in public universities has reached 1.9 million, in contrast to 1.1 million in 2002.

The University for All Program, or ProUni, was institutionalized in the year of 2005, with the purpose of expanding access to higher education for financially constrained individuals. If accepted into the program, the student is awarded with a full or a partial scholarship in a private university. A candidate is eligible for a ProUni scholarship if she obtains the minimum of 450 out of 1000 points on ENEM, although the score may need to be higher, depending on the institution, the course, and the competition. Furthermore, the candidate must prove that her family does not have the means to afford the tuition at a private university. In that interest, the monthly family income *per capita* cannot exceed 3 times the minimum wage. Moreover, the individual has to satisfy at least one of the following conditions: complete high school in a public school; complete high school in a private school with a full scholarship; attend part of high school in a public school,

[3]Initials for High School National Exam.

[4]Inequality of opportunity is borne by the fact that wealth and social status affect how an individual does in life (ALEXOPOULOS; CAVALCANTI, 2010).

and part in a private school with a full scholarship; have a disability; be a teacher in elementary school. The number of ProUni scholarships has increased significantly – in 2005, 475 scholarships where offered, in contrast with the 128 thousand contracts in the year of 2013.

FIES is a student finance fund that makes loans to private university attendees, or candidates, at lower rates than those practiced by commercial banks – MEC stipulates 3.4% per year in 2015. Such as ProUni, the goal of FIES is to reach less privileged high school graduates, which is why eligibility is conditional to a set of prerequisites relating to family income. FIES finances from 50 up to 100% of tuition costs, and the beneficiary has to start paying her debt 18 months after graduation, given that she completes the course. The program was institutionalized in 1992, but it went through several changes over the years. Nowadays, it is mandatory that the candidate take the ENEM exam, and the attainment of a low score may be disqualifying – a recent change in legislation determines that the minimum score must be 450, the same as ProUni. While the selection criteria for FIES have become more rigorous, the offer of loans has increased over 6 times since 2005, reaching almost 560 thousand contracts in 2013. A total of 688 thousand students were contemplated with private university incentives in 2013. They represent almost 13% of enrollments in the Brazilian private university system that year.

Cavalcanti, Guimarães & Sampaio (2010) demonstrated empirically that inequality of opportunity in Brazil – on what concerns human capital formation – prevents people who cannot afford early private education from being admitted in a public university, and thus, impairs the ability of these individuals to better their skills. Their results testify to the perverse effects of the combination between inequality and low social mobility between generations (BOURGUIGNON; FERREIRA; MENÉNDEZ, 2003). In the same spirit, Galor (2011) asserts that income inequality separates society into two clubs; "a club of poor, uneducated individuals and a club of rich, educated individuals". When lack of resources and difficult access to credit prevent individuals from investing in education or training, the long term result is deficient human capital accumulation, which hinders economic development. Galor & Moav (2004) develop a general equilibrium model that highlights the role of human capital in this interaction, and demonstrates that underinvestment in education and training is associated with credit constraints and diminishing marginal returns in human capital formation.

Notwithstanding the fact that human capital attainment can assume various forms, such as on-the-job training and learning-by-doing – which may be just as important as schooling for the process of accumulation – we emphasize the role of the latter in the workings of social mobility mechanisms. Education provides individuals with more than just tools to achieve a successful career and a sizeable income wage. Education spills over to society and contribute to development in many fronts, by inducing individuals to innovate, stimulate critical thinking and raise political awareness. Through these channels education enables poverty-trapped individuals to promote the structural changes necessary for them to actually move upward in the social ladder.

Our main objective in this paper is to develop a theoretical model that explains the dynamics of higher education choice and its relation to governmental incentives in Brazil, building from the Theory of Search[5]. Although search models are more commonly applied to labor market analysis, they may be used to model other situations that involve an individual (or a group of individuals) choosing between two different courses of action. We departure from the standard usage of search theory by applying it to a problem of higher education choice. In our model, heterogeneous agents who have finished high school choose whether they will take a job right away or further their education before starting a career. They make decisions according to their preferences and the constraints they face. Moreover, those who decide against working have yet to choose between

[5]Lucas (1987) described search theory as being a "real social science: an attempt to model, to understand, human behavior by visualizing the situations people find themselves in, the options they face and the pros and cons as they themselves see them". Search models are widely used in the investigation of labor markets, in particular for matters related to job search. They place unemployed workers in a setting where they are faced with work opportunities that arrive randomly, and where they have the option to reject an available offer if they think they will receive a better offer in the future. See McCall (1970) and Neal (1998) for more on job search models.

public or private university. We also contribute to the literature by modeling the trade-offs between different governmental policies – FIES, ProUni and REUNI – for human capital formation.

The results indicate that, while the existence of FIES allows that some financially constrained individuals be given a chance of overcoming poverty, the fact that they will be acquiring debt and also giving up the opportunity of working and saving presently deters many of them from attending private university. ProUni appears to be more effective in increasing the share of poor individuals in the higher education system, however, when we look at public university access, this form of incentive is not satisfactory. Given that public university gives students better conditions to improve their skills, it is debatable whether ProUni does much for reducing inequality of opportunity. Accordingly, the analysis indicates that the expansion of public universities (REUNI) is the most effective educational incentive in the sense that it prevents wealth bias and promotes equality of opportunity in the higher education selection system.

2 The Model

We develop an overlapping generations model in which agents live for two periods, youth and adulthood. The dynamics between generations are such that each young individual is endowed with a bequest that is a result of the optimal choice of resource allocation made by the previous generation, given that each adult has to distribute her lifetime income among consumption and bequest. The latter is applied to the investment in human capital for the offspring, in form of education. When a young individual is finished with high school – which can be more or less suitable to the pursue of a higher education degree depending on family wealth – she has to choose whether to join the labor force straightaway (offering one unit of unskilled labor) or to continue her education in a university. If she decides to attend university, the subsequent choice is between the private and the public system of higher education.

Public university is more desirable because it is free of charge and associated with a higher quality, providing a higher share of qualified graduates in comparison to private university. The selection process benefits those whose family wealth is higher, because entrance in the public system is constrained by the costs of high quality basic education. The way through which governmental policies can affect individual choice is alleviating the financial constraints of poor individuals. In this spirit, we model governmental incentives in form of loans and subsidies in the private system (FIES and ProUni) and mitigation of the entrance cost in the public system (REUNI). Finally, we perform a theoretical analysis of the dynamics in the model economy, in terms of the impact on the educational choices of young individuals.

2.1 Overview of The Model

The economy is defined over an overlapping generations model, introduced by Samuelson (1958). In this model, agents type i live for two periods, youth and adulthood. There is no population growth, such that each adult has only one parent and only one child. We define that the measure of the population is the unity. In this economy, the initial wealth of agents is a_0^{2i}, and it varies across individuals. They optimize their discounted lifetime utility, where the discount rate is given by β. Agents' preferences are homogeneous, and defined only over consumption, c_t^{1i}, if the agent hasn't reached adulthood. The instantaneous utility for a young individual is $u(c_t^{1i})$. In the case of adults, lifetime utility is defined over consumption, c_t^{2i}, and future utility of offspring, $u(c_t^{1i})$. The mechanism through which parents contribute to their children's welfare, and therefore, to their own, is by saving and making intergenerational transfers, a_{t+1}^{2i}. Instantaneous utility for an adult can be written as:

(1) $$u(c_t^{2i}, a_{t+1}^{2i}) = (c_t^{2i})^{\gamma}(a_{t+1}^{2i})^{1-\gamma}$$

where $0 < \gamma < 1$.

The problems of the agents will be solved recursively. To make notation simpler, we will not use a time subscript on variables from now on, neither will we use a superscript to differentiate individuals. In this model, young agents choose whether they will further their education or not. If they choose not to go to a university, then they will join the workforce offering one unit of unskilled labor now and in the adulthood, earning w^u as income wage. If they choose to go to a university, they subsequently have to choose between a public or a private institution. Let $e \in \{0,1\}$ be the discrete variable that indicates the agent's choice – its value is 1 when she goes to a university, and 0 when she chooses to work.

There exists a probability Q^n of becoming a skilled professional associated with graduation in a university, where $n \in \{0,1\}$ describes the type of institution – public or private. If the agent attends a public university, with $n = 0$ (given $e = 1$), the probability that she becomes a skilled worker is Q^0. Similarly, if the agent goes to a private institution, the probability that she becomes a skilled professional is Q^1. Public institutions graduate a higher share of skilled workers than private ones, so $Q^0 > Q^1$. Furthermore, private universities require payment of a tuition, δ. Public universities do not, but they have an entrance cost, ϕ. We define that $\delta > 0$ and $\phi > 0$ are given exogenously, in terms of the final good in the economy.

Moreover, there exists a temporal gap which makes the payment of ϕ relatively more costly than δ. In contrast to private institutions, the entrance in a public university is conditional to the attainment of a good grade in the entrance exam which, in turn, depends on the quality of basic schooling and preparatory courses. Both these elements require that the family wealth is sufficiently large when the individual is at a young age, so public universities are often inaccessible to poor agents. Finally, there exists a government subsidy τ which is given to agents to encourage them to attend private university. The aggregate state variables for all agents are the aggregate capital in the economy, K, and the total amount of skilled and unskilled labor, L^s and L^u. Let Ω be the set of aggregate state variables.

2.2 The Adult's Problem

For the adults in this economy, the individual state variables are wealth, a^1, past education, $e \in \{0,1\}$, past choice of institution, $n \in \{0,1\}$, and characterization of labor, $h \in \{\mathrm{u}, \mathrm{s}\}$ (unskilled or skilled). The control variables for adults are consumption, c^2, and intergenerational transfers, a^2. The resulting optimization problem is:

(2)
$$\begin{aligned} & V_{hen}(a^1; \Omega) = \max_{c^2, a^2} \{u(c^2, a^2)\} \\ & s.t.: \\ & c^2 + a^2 = w^h + (1+r)a^1 - en\delta[(1+r)(1-\tau)] \\ & c^2 \geq 0; a^2 \geq 0 \end{aligned}$$

2.3 The Young Agent's Problem

The individual state variable for young agents is the bequest they receive from their parents, a^2. The control variables are consumption, c^1, savings, a^1, education, $e \in \{0,1\}$, and choice of institution, $n \in \{0,1\}$, so that:

$$W_{en}(a^2;\Omega) = \max_{e}\{\mathrm{W}_{00}(a^2;\Omega);\mathrm{W}_{1n}(a^2;\Omega)\} \tag{3}$$

In order to make facilitate the solution of equation (3), we will solve two different problems: one for the agents who attend university and other for the ones who do not. The agent whose choice is $e=0$, that is, work instead of studying, knows that she will be offering one unit of unskilled labor now and in adulthood, so she knows exactly what her income wage will be in the future. The resulting problem is:

$$\begin{aligned} & W_{00}(a^2;\Omega) = \max_{c^1,a^1}\{u(c^1)+\beta[V_{u00}(a^1;\Omega)]\} \\ & \text{s.t.:} \\ & c^1 + a^1 = \mathrm{w}^u + (1+r)a^2 \\ & c^1 \geq 0, a^1 \geq 0 \end{aligned} \tag{4}$$

Young agents who decide to attend university, $e=1$, solve a problem to choose whether they will go to a public or a private institution:

$$W_{1n}(a^2;\Omega) = \max_{n}\{W_{10}(a^2;\Omega);W_{11}(a^2;\Omega)\} \tag{5}$$

Again, we will solve a different problem for type of institution. The agent who chooses to go to a public university ($n=0$) solves:

$$\begin{aligned} & W_{10}(a^2;\Omega) = \max_{c^1,a^1}\{u(c^1)+\beta[Q^0V_{s10}(a^1;\Omega)+(1-Q^0)V_{u10}(a^1;\Omega)]\} \\ & \text{s.t.:} \\ & c^1 + a^1 + \phi = (1+r)a^2 \\ & c^1 \geq 0, a^1 \geq 0 \end{aligned} \tag{6}$$

Likewise, the young agent who decides to attend a private university ($n=1$) solves:

$$\begin{aligned} & W_{11}(a^2;\Omega) = \max_{c^1,a^1}\{u(c^1)+\beta[Q^1V_{s11}(a^1;\Omega)+(1-Q^1)V_{u11}(a^1;\Omega)]\} \\ & \text{s.t.:} \\ & c^1 + a^1 = (1+r)a^2 \\ & c^1 \geq 0, a^1 \geq 0 \end{aligned} \tag{7}$$

3 Partial Equilibrium Analysis

3.1 Analytical Results

Appendix shows the solution for the problems of each type of agent in the economy – adults, young individuals who go to public university, young individuals who attend private university, and young individuals who don't further their studies and go straight to the work market. Those problems are solved recursively, starting with the adult's problem and replacing the optimal value function into each young agent's problem, so that we can find the optimal value functions for these individuals as well.

Proposition 1: If $a^2 \geq \frac{\phi + c^1*}{(1+r)}$, then:

1. The consumption is optimal, i.e., c^1* is given by equation (A16) in Appendix.

2. $a^1* \geq 0$

Proof: According to Proposition 1, bequest does not constrain the agent's decision as long as a^2 is large enough to pay for both the present value of university entrance cost, ϕ, and present consumption, c^1*. With regard to a^1*: by contradiction, if $a^1* < 0$, then $a^2 < (\phi + c^1*)/(1+r)$, which cannot be true, since the agent's received bequest needs to be large enough to cover her expenses. Therefore, $a^1* \geq 0$. This condition holds if and only if $a^2 \geq (\phi + c^1*)/(1+r)$.

From now on, we will distinguish between savings made by agents who attend public institutions, a^1_{10}, and agents who go to public ones, a^1_{11}. It is already know, from (A18) and (A25), that $a^1_{10}* \neq a^1_{11}*$, given that $\phi \neq 0$.

Assumption 1: $\frac{E(w^h \mid \mathrm{n}=0) - E(w^h \mid \mathrm{n}=1)}{(1+r)} \geq \phi - \delta(1-\tau)$

The assumption above guarantees that, if an agent is rich enough, i.e., $a^2 \geq (\phi + c^1)/(1+r)$, with c^1* given implicitly by (A16), then the agent who decides to further her education will choose a public university instead of a private one. Therefore, the choice of university depends on the agent not being constrained by her wealth. Moreover, the higher the cost of entrance of public universities, the higher the likelihood of being constrained by wealth, and the higher the share of young agents who choose private institutions (if it is the case that they can afford both consumption and school debt in the next period of their lives).

Putting such information in context with REUNI, an increase in the number of openings in the public system of higher education is associated with a decline in relative competition. In the model economy, this is equivalent to a decrease in the cost of entrance, ϕ. Consequently, expansions in public universities increase the share of young agents who attend public institutions.

Proposition 2: $W_{10}(a^2;\Omega) \geq W_{11}(a^2;\Omega)$

Proof: Since optimal consumption is the same for all agents who choose to further their education, then agent with wealth a^2 will choose a public university if and only if

$W_{10}(a^2;\Omega) \geq W_{11}(a^2;\Omega)$. Using the proposed relation and equations (A10), (A16) and (A18) we have that:

$$(8) \qquad Q^0 w^s + (1-Q^0)w^u - [Q^1 w^s + (1-Q^1)w^u] \geq (1+r)(a_{11}^1 * - a_{10}^1 *) - \delta(1+r)(1-\tau)$$

We will call the expression $Q^0 w^s + (1-Q^0)w^u$ the expected income wage for a public university attendee, or $E(w^h | \mathrm{n}=0)$. Similarly, the expression $Q^1 w^s + (1-Q^1)w^u$ will be called the expected income wage for a private university attendee, or $E(w^h | \mathrm{n}=1)$. Also, from equations (A17) and (A23) we have that $a_{11}^1 * - a_{10}^1 * = \phi$. Replacing these expressions into equation (8) and rearranging the terms we get Assumption 1:

$$(9) \qquad \frac{E(w^h | \mathrm{n}=0) - E(w^h | \mathrm{n}=1)}{(1+r)} \geq \phi - \delta(1-\tau)$$

Moreover, the government may choose to give a subsidy, τ, to young agents who attend private universities. The government may choose any value between 0 and 1 as a subsidy rate. If $\tau = 1$ then the agent's debt will be equal to zero, which means that the government is paying in full for the agent's education. Using equation (9):

$$(10) \qquad \frac{E(w^h | \mathrm{n}=0) - E(w^h | \mathrm{n}=1)}{(1+r)} \geq \phi$$

The existence of a full subsidy makes it less likely that an agent will choose a public university, because the subsidy makes it relatively less costly to attend a private institution. Accordingly, the share of *financially constrained* young agents who choose to attend private university in detriment of public university is higher. Note that an agent who is not constrained by wealth will choose a public university (see Assumption 1). In contrast, when $\tau = 0$ the agent will have to pay δ to the government after her education is complete and she gets a job. Once more, we will use equation (9) to show that:

$$(11) \qquad \frac{E(w^h | \mathrm{n}=0) - E(w^h | \mathrm{n}=1)}{(1+r)} \geq \phi - \delta$$

Firstly, if the cost of public university does not constrain the agent, she will choose a public university regardless of whether the government is paying the costs of private education or not (again, see Assumption 1). On the other hand, for the case of a financially constrained individual (for whom public university is desirable but not necessarily accessible), the absence of a subsidy (which entails that the agent will own δ to the FIES fund in the future) makes attendance to a private university relatively more costly. If a poor agent goes through with university with $\tau = 0$, when she becomes an adult with budget constraint $c^2 + a^2 = w^h + (1+r)a^1 - \delta(1+r)$, it may be the case that she will not be able to pay for her FIES loan *and* save. Through this mechanism, it is likely that the next generation will be subjected to the same constraints. This result is consistent with Galor & Zeira (1993), who have found that skilled individuals who pay student loans do not leave as many resources for the next family generation as individuals who have come from a wealthy family.

Therefore, equations (9) to (11) assure that the higher the subsidy τ from the government, the higher the share of agents who choose to attend private university. For those individuals who

cannot access public university due to wealth constraints, where $a^2 < (\phi + c^1)/(1+r)$, and conversely, for those who do not want to (or cannot) risk acquiring educational debt (FIES) without guarantees of future income, subsidy in the form of a program such as ProUni may be the only path for escaping poverty.

As done previously for other agents, we will call the savings made by agents who do not further their education a^1_{00}. From (A17), (A23) and (A29) we know that $a^1_{00}* \neq a^1_{10}* \neq a^1_{11}*$, given $\phi \neq 0$.

Assumption 2: $\dfrac{E(w^h \mid \mathrm{n}=0) - w^u}{(1+r)} \geq w^u + \phi$

This assumption makes it so that the higher the share of young agents who are constrained by their wealth, the higher the share of agents who choose to work instead of going to a university. Furthermore, the higher the unskilled wage, the higher the proportion of young agents who choose to work. Additionally, Assumption 2 guarantees that, if agent is rich enough, she will choose to further her education.

Proposition 3: If initial wealth, a^2, is so that $W_{10}(a^2;\Omega) \geq W_{11}(a^2;\Omega)$, then $W_{00}(a^2;\Omega) < W_{10}(a^2;\Omega)$.

Proof: If studying in a public university is at least just as good as studying in a private one, then studying in a public university has to be better than not studying at all. Using equations (A10), (A16) e (A24) on $W_{00}(a^2;\Omega) < W_{10}(a^2;\Omega)$ we can show that:

(12) $\quad w^u + (1+r)(a^1_{00}* - a^1_{10}*) < Q^0 w^s + (1-Q^0)w^u$

As we did previously, we will call the expression $Q^0 w^s + (1-Q^0)w^u$ the expected income wage for a public university attendant, or $E(w^h \mid \mathrm{n}=0)$. In addition to that, from equations (A17) and (11) we have that $a^1_{00}* - a^1_{10}* = w^u + \phi$. Using that information on equation (12) we get that:

(13) $\quad \dfrac{E(w^h \mid \mathrm{n}=0) - w^u}{(1+r)} \geq w^u + \phi$

It is interesting to notice that the term $w^u/(1+r)$ represents the discounted income wage of a young agent who chooses to work instead of studying. We don't call it *expected income wage* because we know for sure that an agent who does not attend university will offer one unit of unskilled labor, and therefore will receive w^u as payment for her work. Moreover, from equations (11) and (13) we have that:

(14) $\quad \dfrac{E(w^h \mid \mathrm{n}=1) - w^u}{(1+r)} \leq w^u + \delta$

Equation (14) indicates that higher values of unskilled wage and private university's costs are associated with a smaller share of agents attending private university and consequently a higher share of young agents joining the labor force. When we consider individuals with limited family wealth, faced with the *possibility* of a position as a skilled professional *in the future* (alongside with

a student loan to pay) and, on the other hand, *the certainty of wage right now* (which will guarantee consumption and maybe saving), foregoing university attendance may be the best option for the bulk of young agents in this position. The temporal gap between unskilled and (possibly) skilled wage may be too costly for some, so they choose consumption and saving over investments in human capital which, in turn, may result in families being poverty trapped for generations to come.

3.2 Qualitative results

Figure 1 shows that individuals born with bequest inferior to a^* choose not to attend university. Those born with bequest between a^* and a^{**} choose to study in a private institution and pay back the FIES fund when they are through with their studies. Note that the government is paying a fraction of the costs through ProUni. Moreover, anyone born with bequest superior to a^{**} chooses public university. This corroborates Assumption 1 in the previous section: as long as the agent is not constrained by her wealth, that is, $a^2 \geq (\phi + c^1)/(1+r)$, she will choose to attend a public university, where her chances to become a skilled professional in the future are higher. Wealth inequality makes it so that only individuals with a minimal amount of wealth are able to make unconstrained decisions of higher education, in detriment of poor agents. As Banerjee & Newman (1993) have argued, differences in wealth at least partially explain different choices of occupation (or comparatively, education).

A change in the subsidy parameter to $\tau = 0$, which means that the government gives no financial aid to poor individuals, results in the situation depicted in Figure 2. When subsidies for private university (ProUni) do not exist, attending university is not an option for poor individuals (see the trajectory of function value W_{11}). We have that a^* is the level of wealth associated with attendance of public university. Actually, the fact that an individual has the means to attend a public institution of higher education is indicative of the existence of enough resources to go through with private university. However, as we already know, an agent who is not financially constrained will prefer to continue her studies in the public system.

The outcome we get when the government gives full subsidy to poor individuals is illustrated in Figure 3, the case of ProUni full scholarships ($\tau = 1$). In this case, the existence of full subsidy allows individuals born with wealth between a^* and a^{**} access to higher education in private institutions, which accounts for a much wider range of assistance then what we observed in Figure 1. The wealth threshold for public university, in contrast, becomes extremely high. Note that the trajectory of W_{10} does not reach W_{en} in the visible area of the graph. This suggests, on the one hand, that public university is accessible to a very small share of young individuals in the presence of $\tau = 1$. On the other hand – and more intuitively – it may simply be a case of ill-directed governmental incentive.

The case of REUNI is illustrated in Figure 4. When the government chooses to direct part of the budget for higher education incentive to the expansion of public universities (which is associated with a decrease in the cost of entrance ϕ, given Assumption 1) we get that the wealth gap between individuals who choose private university and those who choose public university diminishes substantially – note the distance between a^* and a^{**} in the graph. Although individuals who are not as rich as a^* will not be able to further their education, among those who will do it there will be more equality of opportunity in the competition for spots in public universities. Consequently, poor and rich individuals will have, if not equal, at least similar chances of becoming skilled professionals when they graduate[6].

[6]We conducted a sensitivity analysis using the one-factor-at-a-time procedure, which consists of (i) changing one input parameter while keeping others at their baseline values and (ii) repeating first step for all interesting parameters while returning the previous parameter to its baseline value. We found that the model is robust to 1 and 5% increases in the parameters of interest Q^0, Q^1, $\emptyset$, τ and δ.

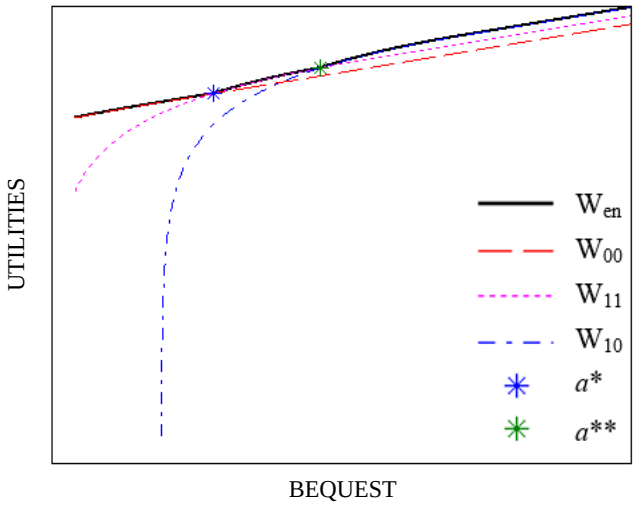

Figure 1: Lifetime utility of young agents with $\tau = 0.5$
Source: Research results

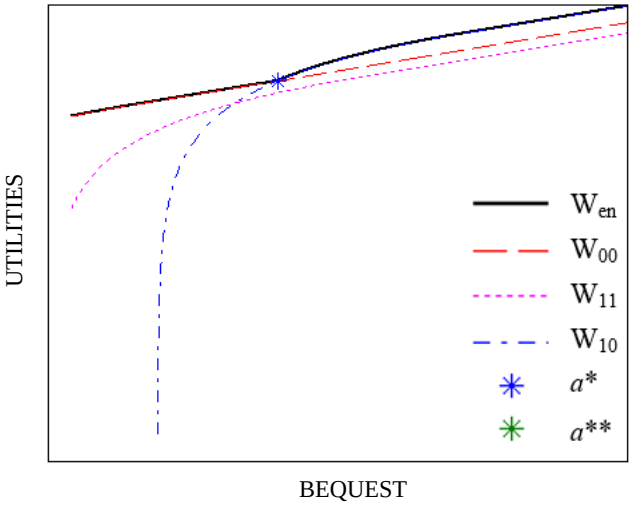

Figure 2: Lifetime utility of young agents with $\tau = 0$
Source: Research results

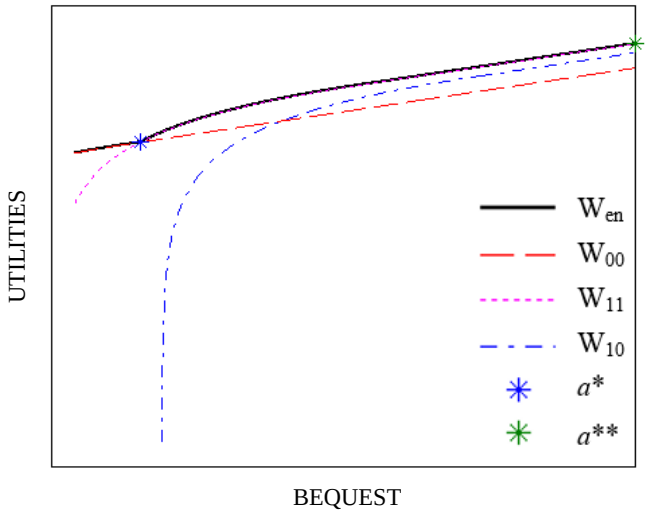

Figure 3: Lifetime utility of young agents with $\tau = 1$
Source: Research results

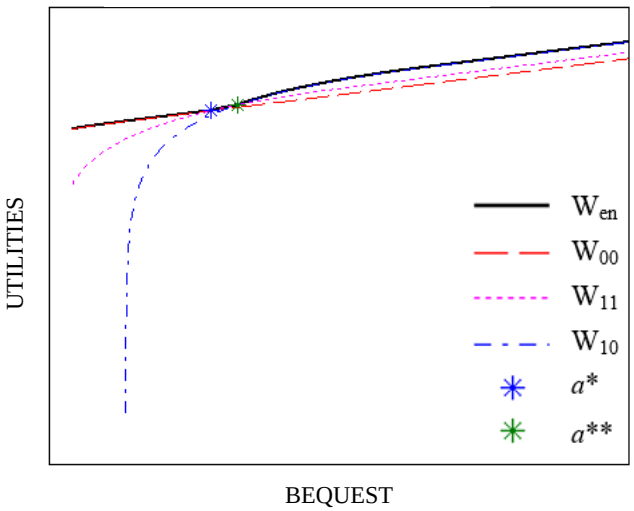

Figure 4: Lifetime utility of young agents with $\tau = 0.5$ and $\emptyset = 0.4$ (initially, $\emptyset = 0.5$)
Source: Research results

4 Concluding Remarks

This research aimed to contribute to the debate on human capital investment, and to develop a theoretical model that is fit to explain how individuals make educational choices in Brazil, and how the government can affect these choices through educational policies. This is the first effort of a broader investigation – the model developed in this paper will be calibrated for the case of Brazil in order to analyze the effects of governmental incentives on macroeconomic variables such as economic growth and wealth inequality. Moreover, simulation will provide quantitative results for variables such as skill premium.

The analytical results are consistent with the observed reality of higher education in Brazil – they reveal that public university is more desirable than private university, and that agents who have enough resources to succeed in the selection process will further their studies in the public system. Furthermore, the analysis reveals that individuals who are constrained by their wealth may choose not to further their education. Finally, the results indicate that the existence of governmental subsidies make it more likely that a financially constrained individual attend university.

The partial equilibrium analysis give us some insight on the impacts of governmental incentives on human capital formation through education. While the existence of FIES allows that some financially constrained individuals be given a chance of overcoming poverty, the fact that they will be acquiring debt and also giving up the opportunity of working and saving presently deters many of them from attending private university. In comparison, ProUni appears to be more effective in increasing the share of poor individuals in the higher education system. However, when we look at public university access, this form of incentive is not satisfactory. Given that public university gives students better conditions to improve their skills, it is debatable whether ProUni does much for reducing inequality of opportunity. Accordingly, the partial equilibrium analysis indicates that the expansion of public universities is the most effective educational incentive in the sense that it prevents wealth bias and promotes equality of opportunity in the higher education selection system.

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Appendix A: Solution to the Adult's Problem

Given that R^A denotes the resources of agents in adulthood, that is, $R^A = w^h + (1+r)a^1 - en\delta(1+r)(1-\tau)$, the adult's problem can be written as:

$$\mathrm{V}_{hen}(a^1;\Omega) = \max_{c^2,a^2}(c^2)^{\gamma}(a^2)^{1-\gamma}$$

(A1) $$s.t.:$$
$$c^2 + a^2 = R^A$$
$$c^2 \geq 0, a^2 \geq 0$$

(A2) $$L = (c^2)^{\gamma}(a^2)^{1-\gamma} + \lambda(R^A - c^2 - a^2)$$

The first order conditions are:

(A3) $$\{c^2\}: \gamma(c^2)^{\gamma-1}(a^2)^{1-\gamma} - \lambda = 0$$

(A4) $\{a^2\}: (1-\gamma)(c^2)^{\gamma}(a^2)^{-\gamma} - \lambda = 0$

(A5) $\{\lambda\}: c^2 + a^2 = R^A$

From equations (A3) and (A4) we have that:

(A6) $c^2 = \dfrac{\gamma a^2}{(1-\gamma)}$

Using equations (A6) and (A5) we get to the adult's optimal savings, as well as to the optimal consumption:

(A7) $a^2* = (1-\gamma)R^A$

(A8) $c^2* = \gamma R^A$

Note that both savings and consumption depend only on R^A (available resources). They do not depend on past decisions of consumption – they are history independent. From equations (A1), (A7) and (A8) we have that:

(A9) $V_{hen}^{*}(a^1;\Omega) = \gamma^{\gamma}(1-\gamma)^{1-\gamma}R^A$

This means that the solution for the adult's problem is linear in R^A, with slope $\gamma^{\gamma}(1-\gamma)^{1-\gamma}$.

Appendix B: Solution to the Young Agents' Problems

Agent who chooses a public university ($e=1$ and $n=0$)

The problem of the agent who chooses to attend a public university is:

$$W_{10}(a^2;\Omega) = \max_{c^1,a^1}\{u(c^1) + \beta[Q^0 V_{s10}(a^1;\Omega) + (1-Q^0)V_{u10}(a^1;\Omega)]\}$$

(A10) s.t.:

$$c^1 + a^1 + \phi = (1+r)a^2$$

$$c^1 \geq 0, a^1 \geq 0$$

(A11) $L = u(c^1) + \beta[Q^0 V_{s10}(a^1;\Omega) + (1-Q^0)V_{u10}(a^1;\Omega)] + \lambda[(1+r)a^2 - c^1 - a^1 - \phi]$

The first order conditions are:

(A12) $\{c^1\}: u'(c^1) - \lambda = 0$

(A13) $\{a^1\}: \beta[Q^0 V_{s10}^{'}(a^1;\Omega) + (1-Q^0)V_{u10}^{'}(a^1;\Omega)] - \lambda = 0$

(A14) $\{\lambda\}: c^1 + a^1 + \phi = (1+r)a^2$

In equation (A13), the values of $V_{s10}^{'}(a^1;\Omega)$ and $V_{u10}^{'}(a^1;\Omega)$ can be derived from equation (A9), which corresponds to the solution to the adult's problem. Therefore, from equation (A9) we have that:

(A15) $$V_{hen}^{'}(a^1;\Omega) = \frac{dV_{hen}^{*}(a^1;\Omega)}{da^1} = \gamma^{\gamma}(1-\gamma)^{1-\gamma}(1+r)$$

From equations (A12), (A13) and (A15) we have that:

(A16) $$u'(c^1) = \beta\gamma^{\gamma}(1-\gamma)^{1-\gamma}(1+r)$$

The agent's optimal level of consumption, c^1*, is given implicitly by (A16). Note that consumption is independent of bequest a^2. Moreover, the optimal level of savings can be derived from equation (A14):

(A17) $$a^1* = (1+r)a^2 - \phi - c^1*$$

Note that the consumption of these young individuals do not depend on the bequest they received, which derives from the solution to the adult's problem – equation (A9), or the value function of adults, is linear in R^A.

Agent who chooses a private university ($e=1$ and $n=1$)

The problem of the agent who chooses to attend a private university, and resulting Lagrange equation, are:

$$W_{11}(a^2;\Omega) = \max_{c^1,a^1}\{u(c^1) + \beta[Q^1V_{s11}(a^1;\Omega) + (1-Q^1)V_{u11}(a^1;\Omega)]\}$$

(A18) s.t.:
$$c^1 + a^1 = (1+r)a^2$$
$$c^1 \geq 0, a^1 \geq 0$$

(A19) $$L = u(c^1) + \beta[Q^1V_{s11}(a^1;\Omega) + (1-Q^1)V_{u11}(a^1;\Omega)] + \lambda[(1+r)a^2 - c^1 - a^1]$$

From (A19), the first order conditions are:

(A20) $$\{c^1\}: u'(c^1) - \lambda = 0$$

(A21) $$\{a^1\}: \beta[Q^1V_{s11}^{'}(a^1;\Omega) + (1-Q^1)V_{u11}^{'}(a^1;\Omega)] - \lambda = 0$$

(A22) $$\{\lambda\}: c^1 + a^1 = (1+r)a^2$$

As done in the previous problem, equation (A15) will be used to find the values of $V_{s11}^{'}(a^1;\Omega)$ and $V_{u11}^{'}(a^1;\Omega)$. Therefore, using (A15), (A20) and (A21) we will find that the optimal level of consumption of the agent who attends a private university is the same of the agent who

attends a public university. In other words, it is given implicitly by equation (A16). Conversely, the optimal level of savings varies. From equation (A22) we have that:

(A23) $a^1* = (1+r)a^2 - c^1*$

Agent who chooses not to attend a university ($e = 0$ and $n = 0$)

$$W_{00}(a^2;\Omega) = \max_{c^1,a^1}\{u(c^1) + \beta[V_{u00}(a^1;\Omega)]\}$$

(A24) s.t.:

$$c^1 + a^1 = \mathrm{w}^u + (1+r)a^2$$

$$c^1 \geq 0, a^1 \geq 0$$

(A25) $L = u(c^1) + \beta[V_{u00}(a^1;\Omega)] + \lambda[\mathrm{w}^u + (1+r)a^2 - c^1 - a^1]$

From (A25), the first order conditions are:

(A26) $\{c^1\} : u'(c^1) - \lambda = 0$

(A27) $\{a^1\} : \beta V'_{u00}(a^1;\Omega) - \lambda = 0$

(A28) $\{\lambda\} : c^1 + a^1 = w^u + (1+r)a^2$

We will use equation (A15) to find the value of $V'_{u00}(a^1;\Omega)$. Combining that with equations (A26) and (A27) we will find that the optimal level of consumption of the agent who does not attend a university is the same of the agent who attends a public university, which, in turn, is the same of the agent who goes to a private institution. Therefore, optimal consumption is given implicitly by equation (A16). Equation (A28) gives us the optimal level of savings:

(A29) $a^1* = w^u + (1+r)a^2 - c^1*$