"Evolution of Higher Education Systems: Size and Funding"

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Abstract

In many countries, more and more higher education institutions are established over time. There is an ongoing debate related to the issues of quality and efficiency of these institutions resulting in questioning their public funding. Our goal is to examine the theoretical justification for the establishment of these institutions, subsidized or unsubsidized by the government, and their contribution to the economic growth. We study an economy in which heterogeneous young individuals, following the basic education stage, optionally invest in higher education to achieve skills. Initially, universities enjoy excess-demand and provide publicly funded uniform student subsidies. Given the capacity constraints of the universities, our analysis explores the impact of adding new institutions, to be called colleges, to the higher education system, focusing on two issues. Given that colleges are less productive than universities, (a) Should the government establish colleges? (b) Should the government divert some of the higher education budget from universities to colleges? Based on economic growth considerations, we obtain positive answers to both questions. Then, we compare several common policies of student subsidies. Comparing uniform-based subsidies to merit-based subsidies within each higher education institution (universities as well as colleges), we argue that merit-based subsidies may cause a shift of students to a lower quality education; that is, a shift of university students to colleges and a shift of college students to basic education, reducing their human capital. The reason is that certain students are slightly above the university admission standard, but may prefer a college over a university because in college they are eligible to subsidies. However, directing subsidies to disadvantaged students may alleviate the shift to lower quality education. Our model accounts for several stylized facts that characterize developed countries, including (1) the increase in the number of institutions and in the number of students and the decline in college admission standards over time; (2) the decline in the public budget per student and the corresponding increase in the net student out-of-pocket payments to higher education.
Introduction

Many European countries have experienced an expansion of their higher education system over time, in terms of both number of institutions and number of students. For example, Cottini et. al (2017, see Figure 1) present an increase in the number of universities in the years 1859-2009 in France, Germany, UK and Italy. Figure 1 documents the evolution of the higher education system in Israel in the last 50 years.

Figure 1: Higher Education Institutions and Students in Israel, 1965-2014

Source: Authors calculations based on Council for Higher Education (1994, p. 181) and (2016, p. 25), and the Statistical yearbook of Israel (2016, chapter 8.13).
Higher education institutions include universities, academic colleges and colleges of education. Student Register in thousands - based on files obtained from higher education institutions.

Figure 1 shows that since 1965 (7 universities and about 15,000 students in Israel) the number of institutions has increased by about 10 times and the number of students by about 17 times.
Accounting for the expansion in higher education systems, this article examines the recent criticism on the allocation of public funds to higher education systems, and specifically to colleges. This criticism is more pronounced in Western countries where governments plan to cut their contributions to higher education (through various forms of student subsidies, e.g., UK, USA, the Netherlands and Israel) and shift to private funding (based on tuition fees). The claim is that with scarce resources and budgetary pressures, it is difficult to justify massive funding for institutions that in many cases are costly, inefficient and unreachable to disadvantaged young individuals1.

To study these issues, we use an Overlapping-Generations (OLG) open economy model, where intergenerational transfers (from altruistic parents to their children) take place. At the outset, the higher education system relies mainly on universities characterized by highly productive educational system (say, due to better curriculum and faculty), excess demand, and publicly funded uniform student subsidies. Given the capacity constraints of the universities, we consider the introduction of less productive higher education institutions, to be called Colleges, that usually accept lower ability students that have been rejected by Universities2.

We address two issues that are often raised both normatively and positively: (1) is it worthwhile to establish colleges, or what is the justification for the observed expansion of the higher education through the introduction of more and more colleges

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1 A common criticism on public funding of higher education is that while low-skilled workers contribute a portion of their labor income taxes to the higher education budget, they do not directly benefit from their investments in higher education (see Garrat and Marshall, 1994; Fernandez and Rogerson, 1995; Gradstein and Justman, 1995; Taber, C., 2001; Bevia and Iturbe-Ormaetxe, 2002). Because of this concern, it has been argued that improving the basic schooling, for example, may generate a higher social value than investing in higher education (Johnson, 1984).

2 A more exact definition than 'colleges' would be 'type-B institutions', because in some cases colleges may be more productive than universities.
over time? (2) Should the government divert some of the higher education resources to colleges at the expense of universities?

Our analysis suggests that whether the college students are subsidized by public funding or not, colleges play a crucial role in generating future human capital (or earning potential). Therefore, based on economic growth considerations it is recommended to establish colleges and even divert some of the higher education funding from university students to college students.

Considering the form of funding, we further find that each higher education institution (a university or a college) should allocate the subsidies to its disadvantaged students (need-based subsidies). Moreover, the typical combination of merit-based subsidies (allocated to students with high initial endowments) and need-based subsidies is quite desirable as well.

These questions are examined using hierarchical education (with two stages, basic education and higher education). Young individuals, born with heterogeneous 'initial endowment' (a factor of random innate ability and family background), attain basic compulsory education. Then, individuals optionally obtain higher education to achieve supplementary skills by enrolling to universities or colleges. The heterogeneous initial endowments (that shape the returns to education) and the subsidies structure endogenously determine who attends a higher education institution and becomes a 'skilled worker'.

In this framework, we characterize non-stationary dynamic competitive equilibria and analyze how the stock of human capital and output are affected by: (i) establishing colleges (ii) diverting public funding from universities to colleges. These
questions are highly relevant in a reality of recent shifts in higher education systems around the world towards lower shares of public funding per student and higher tuition fees. These shifts are partly a response to the expansion of higher education, in terms of both the number of students and the number of institutions. (iii) We compare common policies of student subsidies: uniform, merit-based, and need-based.

Comparing dynamic equilibrium paths period by period, we obtain the following results: (a) establishing colleges has two effects. On the one hand, it leads to an initial loss in the stock of human capital in the economy. The reason is the foregone earnings of young individuals who acquire college education instead of working as low-skilled workers.

On the other hand, their additional skills as college graduates improve the stock of human capital in the following periods (including their children's), compensating for the loss of their earnings as low-skilled workers. Moreover, over time the tax revenues increase. The rising funding for education augments the funds for basic education and higher education, causing an increase in the demand for colleges accompanied by a decline in college admission standards over time.

(b) Diverting funds from universities to colleges in order to provide college students with the same government subsidies as university students qualitatively affects the economic growth as in case (a), and further accounts for the worldwide shifts in higher education systems towards lower shares of public funding per student and higher out-of-pocket payments.

(c) Compared to uniform subsidies, targeting subsidies to disadvantaged students may be more desirable than merit-based subsidies. Intuitively, merit-based subsidies may generate competition on students between colleges and universities.
Certain students will be eligible to subsidies in colleges but not in universities, and thereby will face a trade-off between college subsidy and university productivity. If colleges are sufficiently productive, they may prefer to study in a college.

On the other hand, if subsidies in each institution (or at least a sufficient share of the subsidies) are targeted to disadvantaged students, these students surely remain in universities, enjoying both higher productivity and a subsidy. At the same time, colleges extend the opportunities of disadvantaged young individuals to gain a college degree and become skilled workers.

Note that besides the crucial role in the economic growth and the welfare of future generations, the education policies analyzed in this article (establishing colleges, subsidizing colleges, and certain student subsidies) alleviate the concern that higher education is unreachable to disadvantaged young individuals by improving their opportunity to gain a college degree.

Some features of our model have been analyzed before in different hierarchical education frameworks. Particularly, Driskill and Horowitz (2002) find that the optimal investment in hierarchical human capital exhibits non-monotonicity in human capital stocks. Su (2004) examines the efficiency and income inequality in a hierarchical education system and the effects of introducing subsidies to higher education. Blankenau (2005) finds a critical level of expenditure above which higher education should be subsidized because its impact on growth is positive. Arcalean and Schiopu (2010) study the interaction between public and private spending in a two-stage education system. They observe that increased enrolment in tertiary education does not always enhance the economic growth. Kaganovich and Su (2016) analyze the diverging selectivity of colleges and examine its implications on the labor market.
The Economic Framework

The following model illustrates the implications of establishing colleges and granting subsidies to their students on the stock of human capital (or earning potential) in the economy. We apply a model similar to that used by Viaene and Zilcha (2013). We consider an OLG economy with a continuum of individuals in each generation. Each individual is characterized by a family name \( \omega \in [0,1] \) where \( \Omega = [0,1] \) denotes the set of all families in each generation and \( \mu \) denotes the Lebesgue measure on \( \Omega \). Individual live for three periods: a youth period, a working period and a retirement period.

During the youth period, individuals are engaged in education. Then, they live as adults for two periods: At the outset of their working period, they give birth to one offspring (the population growth is zero), and take economic decisions about their savings and the future of their child. In the retirement period, they simply consume their savings.

While in each period three generations with the same family name co-exist (a child, a parent, and a grandparent), the analysis focuses on the behavior of parents, whose decisions matter for their child’s human capital (and therefore for the aggregate human capital and output in the following periods).

Consider generation \( t \), denoted \( G_t \), consisting of all children born at the outset of date \( t \), and let \( h_{r,s1}(\omega) \) be their human capital (specific to each child \( \omega \)) at the beginning of the working period. We assume that \( h_{r,s1}(\omega) \) is achieved by a
hierarchical (or two-stage) formation process of human capital like in Restuccia and Urrutia (2004):\footnote{Blankenau (2005), Hatsor (2015), and Gilpin and Kaganovich (2012) model education as a sequence of stages, where the human capital achieved in lower stages acts as an input in the education technology at higher stages. See also Su (2004), Blankenau and Camera (2006), Kaganovich and Su (2016).}

A child $\omega$ obtains general skills from fundamental, or basic, education (assumed to be compulsory, common to all, and funded by public resources), $X$, and may additionally acquire specialized skills from higher education.

Each child is born with a random innate ability, $\tilde{\theta}(\omega)$, assumed to be independent and identically distributed across individuals in each generation and over time. In addition to the innate abilities, the empirical literature has established that parental inputs and home environment together with school inputs are key factors affecting the human capital\footnote{See Keane and Wolpin (1997, 2006), Cameron and Heckman (2001), and Ge (2011). Investing in well-being and education early in life has high individual and social rates of returns and is a crucial preparation for subsequent stages of education (see a review of the evidence in a number of fields in Cunha et al. (2006)). Correspondingly, in a number of OECD countries (The Czech Republic, Germany, New Zealand and Poland) annual expenditures per student are higher on pre-primary education than on primary education.}. Accordingly, these inputs are included in our process of human capital formation.

The human capital of an individual $\omega \in G_i$ who does not enroll in higher education, also called a \textbf{low-skilled worker} (denoted by $l$), is given by:

\begin{equation}
\begin{align*}
    h^l_{t+1}(\omega) &= \tilde{\theta}(\omega)h^y_1(\omega)X^\xi_t
\end{align*}
\end{equation}

where $h_1(\omega)$ stands for the parental human capital (specific to each parent $\omega$).

The elasticities $\nu$ and $\xi$ represent the effectiveness of home and public inputs in educating the child, respectively: $\nu$ is affected by home education and family background while $\xi$ is affected by the schooling system, teachers, size of
classes, facilities, neighborhood, etc.

Define $Z_{t+1}(\omega) = \tilde{\theta}_t(\omega)h_t(\omega)^\nu$, a product of both ability and parental human capital, as the initial endowment of child $\omega$, or the heterogenous background inherited prior to any education. In the sequel, the initial endowments will have a crucial role in determining the sets of skilled and low skilled workers.

Attending a university augments each individual’s basic skills by some factor, $B > 1$, to the level:

$$h_{t+1}^s(\omega) = B h_t^l(\omega) = B \tilde{\theta}_t(\omega) h_t^s(\omega) X_t^\delta$$

He/she is then called a skilled worker (denoted by $s$).

Higher education is costly and (in most countries) requires the payment of a tuition fee, denoted by $z^*$, assumed to be exogenously given and accurately reflecting the cost of higher education per student.

The government may participate in the cost by taxing labor incomes. Denote by $g_t$ the government (or public) uniform subsidy allocated to each student in the higher education system at date $t$. Thus, $z_t(\omega) = z^* - g_t$ is the out-of-pocket payment (or net tuition fee) of parents at date $t$ if their child attends higher education, denominated in dollars of the working period (financed by

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$^5$ $Z_{t+1}(\omega) = \tilde{\theta}_t(\omega)h_t(\omega)^\nu$ is a product of two distributions whose algebra is explained in Springer (1979). Very likely, $h_t(\omega)$ is log-normally distributed. Whether $\tilde{\theta}_t$ has a uniform distribution or a log-normal distribution, the product $\tilde{\theta}_t(\omega)h_t(\omega)$ is log-normal. However, the probability distribution function of $Z_{t+1}(\omega) = \tilde{\theta}_t(\omega)h_t(\omega)\nu^{-1}$ is unknown except for extreme values of $\nu$. In all cases, it can be evaluated by implementing numerical algorithms as in Glen et al. (2004).

$^6$ Assuming that $B$ is time-independent simplifies our analysis without restricting the generality.
The wage earnings of skilled workers and low-skilled workers are determined according to their human capital level. Instead of attending a higher education institution, low-skilled individuals work during a portion \( m (0 \leq m < 1) \) of their youth period using their basic skills given in Eq. (1). Since they work fully at period \( t+1 \) as well, the lifetime after-tax wage income earned by a low-skilled worker \( \omega \) is:

\[
(1-\tau)h_{t+1}'(\omega)[mw_t(1+r_{t+1})+w_{t+1}]
\]

where \((1+r_{t+1})\) is the return to capital at date \(t+1\); \(w_t\) and \(w_{t+1}\) are the wage rates per unit of effective labor at date \(t\) and \(t+1\), respectively, and \(\tau\) is the education tax imposed on wage incomes, assumed to be exogenously given.

If individuals acquire higher education, their after-tax lifetime wage earnings as a skilled-worker (working only in period \(t+1\)) are given by

\[
(1-\tau)h_{t+1}'(\omega)w_{t+1}
\]

The following assumption guarantees that the returns to universities, \((B-1)w_{t+1}-mw_t(1+r_{t+1})\), is positive (universities augment the earnings potential more than the loss of forgone earnings during the youth period).

**Assumption 1:** Given the exogenous wage and interest rate, the economy's parameters \(m\) and \(B\),

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7 Different combinations of tuition fees and government subsidies in our model can reproduce the relative shares of private investment and public investment in tertiary education observed in the data. For example, in 2006 the proportion of private funding of tertiary education ranged between 3.6% in Denmark and 83.9% in Chile (see OECD, 2009, Table B3.2b).
\[
\frac{W_{t+1}}{1+r_{t+1}} > \frac{m}{B-1} W_t \quad \text{holds at all dates } t, t=0, 1, 2, \ldots
\]

Assumption 1 is essential for the existence of universities. To further understand how individuals become skilled or low-skilled workers, we assume that the lifetime preferences of each parent } \omega \in G_{t-1} \text{ are represented by a Cobb-Douglas utility function,}

\[(A1) \quad U_t(\omega) = \left(c^a_t(\omega)\right)^{\alpha_1} \left(c^r_t(\omega)\right)^{\alpha_2} \left(y_{t+1}(\omega)\right)^{\alpha_3}\]

where consumption when 'active' (in the working period) and 'retired' are denoted by } c^a_t(\omega) \text{ and } c^r_t(\omega) \text{, respectively, and } y_{t+1}(\omega) \text{ is the offspring’s lifetime (wage and non-wage) income. That is, our framework assumes that parents are altruistic towards their children, deriving utility directly from the child's lifetime income.}

The altruistic motives of parents are conveyed in three forms of intergenerational transfers from parents to their children. The first two involve investment in education of the younger generation. First, parents pay taxes to finance the public education budget. Second, they pay the net tuition fee of higher education.

Lastly, parents transfer tangible assets, } (1+r_{t+1})b_t(\omega) \text{, like } \text{inter-vivos} \text{ gifts and bequests, to their children (see Viaene and Zilcha, 2002; Zilcha, 2003). These financial transfers are the lifetime non-wage income of their offspring.}

Given the human capital of skilled and low-skilled workers, (1) and (2), it

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8 This representation of parental altruism is a more common and tractable than a dynastic model where the utility of all future generations enters the utility of the current generation.

9 We assume that intergenerational transfers are unidirectional and therefore cannot take negative values along the equilibrium path.
is straightforward to calculate variables at the economy level, the aggregate human
capital that serves as a primary factor in production and the government balance
sheet. First, the aggregate (or mean as well in our case) stock of human capital,
$H_t$, at date $t$ is given by

$$
H_t = \int h_t(\omega) d\mu(\omega) + m \int h_{t+1}(\omega) d\mu(\omega)
$$

where $A_t$ denotes the subset of children in $G_t$ who attend higher education and
$\sim A_t$ denotes the complement of $A_t$, children not attending higher education.
Accordingly, the stock of human capital $H_t$ is the sum of two terms: the first is the
aggregate human capital of all individuals in generation $G_{t-1}$ (all work at time $t$), and
the second represents the human capital of their children not attending higher
education (the set $\sim A_t$ in generation $G_t$).

The second aggregate variable to be defined is the government balance sheet.
The government budget at date $t$ is balanced if the following identity holds$^{10}$:

$$
\tau w_t H_t = X_t + g_t \mu(A_t)
$$

The left-hand side is the government tax revenues ($H_t$ is defined in Eq. (7)),
and the right-hand side is the total expenditure on both stages of education, basic
education and higher education. The expenditure on higher education is $g_t$ (the
subsidy per student) multiplied by $\mu(A_t)$, the measure of higher education
students.

$^{10}$The importance of including both sides of the government balance sheet has been confirmed by
empirical studies on growth effects of public education spending (see, e.g., Bassanini and Scarpenta,
2001; Blankenau et al., 2007b).
To simplify the presentation, let $\gamma$, $0 < \gamma \leq 1$ be the fraction of government revenues allocated to basic education (the share of basic education). Then:

$$X_t = \gamma w_t H_t$$
$$g_t \mu(A_t) = (1-\gamma) w_t H_t$$

With $\gamma = 1$, the government revenues are fully allocated to compulsory education, and tertiary education is privately financed, $g_t = 0$. We assume that $\gamma$ is exogenous, and focus the analysis on the implications of diverting public funding from universities to colleges, given the exogenous share of higher education.

Production is carried out by competitive firms that produce a single commodity which is both consumed and used as a production input. Physical capital $K_t$ (assumed to fully depreciate) and the stock of human capital $H_t$ (computed in Eq.(7)) are inputs of a neo-classical production function that exhibits constant returns to scale; it is strictly increasing and concave.

We consider a small open economy that, as of date $t = 0$, is integrated into the rest of the world in two ways. First, the final good is freely traded which implies a single commodity price worldwide. Second, physical capital is assumed to be internationally mobile while labor is internationally immobile. With the small economy assumption, $\{r_t\}$ must be equal to the foreign interest rate$^{11}$. Moreover, the equal interest rates and the similar final goods prices imply

$^{11}$A more general assumption about a partial capital mobility would not modify our results qualitatively. For example, suppose $\lambda \neq 1$ is a constant proportional difference in the rate of return to physical capital between the domestic economy and the rest of the world. With capital market integration, the equality between rates of returns implies $r_t = \lambda r^*$ and our results hold.
that the domestic wage equals the pre-determined foreign wage.\footnote{Though, different production technologies would cause a cross-country difference in wages and trigger international migration of labor.}

In this framework, any education policy that leads to human capital accumulation is expected to temporarily increase the domestic marginal return to physical capital and hence, bring about an inflow of foreign physical capital. The increase in both inputs of production must increase the domestic output as well.

**Competitive Equilibrium**

Given the variables at the economy level (the stocks of physical capital and human capital, $K_0, H_0$, the share of basic education, $\gamma$, and the tax rate $\tau$), parents in each period $t$ make forward-looking decisions regarding financial transfers, $b_t(\omega)$, together with the level of savings, $s_t(\omega)$, and investment in the higher education of their child, $z_t(\omega)$, considering the international prices of capital and labor $\{r_t, w_t\}$, so as to maximize:

\[
\text{MAX}_{t, b, z} \left[U_t(\omega) = \left(c^a_t(\omega)\right)^{\alpha_1} \left(c^r_t(\omega)\right)^{\alpha_2} (y_{t,t}(\omega))^{\alpha_3}\right]
\]

subject to constraints:

\[
\begin{align*}
z_t(\omega) &= 0 \quad \text{or} \quad z_t(\omega) = z^* - g_t, \quad b_t(\omega) \geq 0 \\
c^r_t(\omega) &= y_t(\omega) - s_t(\omega) - b_t(\omega) - z_t(\omega) \geq 0 \\
c^a_t(\omega) &= (1 + r_{t+1})s_t(\omega) \geq 0
\end{align*}
\]

We rely on Viaene and Zilcha (2013) for a full definition and solution of the competitive equilibrium, $\{(c^a_t(\omega), c^r_t(\omega), s_t(\omega), b_t(\omega), z_t(\omega); w_t, r_t)_{t=0}^\infty\}$. 

Specifically, inserting the first order conditions (with respect to savings, \(s_t(\omega)\), and financial transfers, \(b_t(\omega)\)) into the utility function (Eq. (9)) yields a reduced-form utility function:

\[
U_t(\omega) = \Phi\left(\frac{1}{1+\alpha y_{t+1}(\omega)}\right)^{\alpha_1} y_{t+1}(\omega)^{\alpha_2} + \alpha_3
\]

where parameter \(\Phi\) is a constant independent of time and independent of \(\omega\).

Note that in this framework the reduced-form utility is proportional to the lifetime income of the offspring. Consequently, maximizing the parents' utility is the same as maximizing their offspring's future income (thus a utilitarian social planner is equally concerned with the next generation’s aggregate income).

The next step is to define the demand and supply for universities, and thereby define the set of skilled and low-skilled workers in the equilibrium. Then, we examine how the introduction of colleges (subsidized or unsubsidized) affects the equilibrium.

**Demand and Supply of Universities**

Using the reduced-form utility function, Eq.(18), parents decide whether to invest in the higher education of their child by comparing his/her future lifetime earnings as a skilled worker or a low-skilled worker\(^{13}\). Proposition 1 defines the demand for universities, the set \(A^U_t\).

**Proposition 1:** Let \(A^U_t\) denote the demand for universities. Then,
(a) Assumption 1 is necessary for \(A^U_t\) to be nonempty.

\(^{13}\)Eicher (1996) also model a partition of the labor force between skilled and low-skilled workers but in contrast to our model, individuals make their own occupational choice based on their respective career paths as skilled or low-skilled workers.
(b) Define:

\[
\Lambda_t = \left(1 - \frac{1}{1-\tau}\right) \left\{ \frac{1}{(B-1)} \frac{1}{1+r_{t+1}} \right\} \left\{ \frac{z^* - g_t}{X_t^*} \right\}. \quad \text{Then:}
\]

\[
A_t^U = \{ \omega \mid Z_{t+1}(\omega) \geq \Lambda_t \}
\]

That is, all individuals \( \omega \in G_t \) with initial endowments above \( \Lambda_t \) generate the demand for universities.

We relegate all proofs to the Appendix. Note that according to assumption 1 (the returns to universities, \( (B-1)w_{t+1} - nw_t(1+r_{t+1}) \), is positive), the threshold \( \Lambda_t \) is positive.

Proposition 1 illustrates the role of initial endowments, relative returns and relative cost of universities in the decision whether to apply to a university. First, all children with sufficiently large initial endowments (above \( \Lambda_t \)) apply to universities. Second, the demand for universities increases (\( \Lambda_t \) declines) if the returns to universities rises, if universities become less expensive (the out-of-pocket payment, \( z^* - g_t \), declines), or if the basic education, \( X_t \), improves.

After describing the demand for universities, the next assumption defines the supply side. Typically, the demand for universities is larger than the supply, because universities have binding capacity constraints.

**Assumption 2:** The set of higher education students (accepted applicants) at date \( t \), denoted by \( A_t \), is given by:

\[
(19b) \quad A_t = \{ \omega \mid Z_{t+1}(\omega) \geq \lambda \},
\]

where \( \lambda > \Lambda_t \) is an exogenous access restriction imposed by universities.
Because of the excess demand for universities, the supply actually determines the set of students who attend universities. Only applicants with sufficiently large initial endowment (above $\lambda$) are accepted to universities and become skilled workers, while all other applicants (within $\{\Lambda, \lambda\}$) do not meet the university requirement and become low skilled workers. The excess demand for universities has caused the emergence of less selective institutions in many countries.

**Demand and Supply of Colleges**

Typically, colleges alleviate the access restrictions of universities. For simplicity, we assume that the tuition fee is identical in universities and colleges, and that colleges accept all applicants (college admission standard is determined by the demand for colleges). As a result, individuals with initial endowments $\{\Lambda, \lambda\}$, who are not accepted to the universities, can now attend colleges.

Nevertheless, the demand for colleges is lower than the demand for universities because of two reasons: college quality and college cost. First, college quality (or productivity) is lower than university quality. That is, while universities augment each individual’s basic skills by some quality factor $B > 1$, it is likely that colleges have a lower quality factor because of lower investments in teaching quality and facilities, $B > B_c > 1$. Thus, if agent $\omega$ attends a college, his/her human capital accumulates to the level:

$$h^{c}_{t+1}(\omega) = B_c h_{t+1} = B_c \tilde{h}^{c}_t(\omega)h^v_t(\omega)X^v_t$$

To guarantee the existence of colleges despite their lower productivity, we modify assumption 1 to assure that the returns to college, $(B_c - 1)w_{t+1} - mw_t(1 + r_{t+1})$,
is positive (colleges augment the earnings potential more than the loss of forgone earnings during the youth period).

**Assumption 1a:** Given the exogenous wage and interest rate, the economy's parameters $m$ and $B_c$,

\[
\frac{w_{t+1}}{1+r_{t+1}} > \frac{m}{B_c - 1} w_t \quad \text{holds at all dates } t, t=0, 1, 2, \ldots.
\]

Besides their lower productivity, the second reason for the lower demand for colleges is that, in some cases, the government allocates smaller funds to colleges. We assume for now that the government does not participate in the cost of colleges, and therefore college students pay the whole tuition fee.

Formally, denote by $g_{ct}$ the government (or public) allocation to each college student. Thus, $z_{ct}(\omega) = z_{ct} = z_t^* - g_{ct}$ is the out-of-pocket payment of college students and $g_{ct} = 0$. Because of their lower quality and larger cost, colleges are less attractive than universities.

The next result defines the demand for colleges. Using the reduced-form utility, Eq. (18), parents whose children are not accepted to a university decide whether to apply to colleges by comparing the future lifetime earnings of their child as a college-educated worker or a low-skilled worker.

Because all applicants are accepted to colleges, the demand for colleges actually determines the set of college students, $C_t$. 
**Proposition 2:** Let $C_t$ denote the set of college students at date $t$. Then:

(a) Assumption 1a is necessary for $C_t$ to be nonempty.

(b) Define:

$$\Lambda_{ct} = \left(\frac{1}{1-\tau}\right)[\frac{1}{(B_{ct}-1)\frac{w_{t+1}}{1+r_{t+1}}}] \left(\frac{z^* - g_{ct}}{X_t^s}\right).$$

Then:

$$C_t = \{ \omega \mid \lambda \geq Z_{t+1}(\omega) \geq \Lambda_{ct} \}$$

That is, all individuals $\omega \in G_t$ with initial endowments $[\Lambda_{ct}, \lambda]$ attend colleges.

Note that according to assumption 1a (the returns to colleges, $z^* - g_{ct}$, is positive), the threshold $\Lambda_{ct}$ is positive.

Proposition 2 illustrates the role of the initial endowments, the relative returns and the relative cost in the decision to acquire college education. It sheds some light into the large cross-country variations in the skill composition of the work force. First, while all children with sufficiently low endowments (below $\Lambda_{ct}$) become low-skilled workers, all other children (above $\Lambda_{ct}$) become skilled workers: The set $\{\Lambda_{ct}, \lambda\}$ attends colleges and the set with initial endowments above $\lambda$ attends universities (also called college students or university students, respectively).

Second, the demand for colleges increases ($\Lambda_{ct}$ declines) if the returns to colleges rises, if colleges become less expensive (the out-of-pocket payment, $z^* - g_{ct}$, declines), or if the basic education, $X_t$, improves.

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For example, in the year 2007, the share of skilled workers (approximated by the share of age group 25-64 with upper secondary education), was 27, 29, and 33 percent in Portugal, Turkey and Mexico and 80, 88, and 89 percent in Israel, Estonia, and Russian Federation, respectively (see OECD, 2009, Table A1.2A, column 1).
After defining how individuals are divided between the three levels of education (universities, colleges, and basic education), attendant questions arise regarding the role of colleges in the economy.

Results

Emergence of colleges

Colleges alleviate the excess demand for universities by offering an alternative for higher education, expanding the set of skilled workers, $A_i$. Not only individuals with initial endowments above $\lambda$ attend universities, but also individuals within $\{A_{cr}, \lambda\}$ attend colleges.

There are two attendant questions: (a) is it worthwhile to establish colleges; or specifically, does the resulting expansion of the set of skilled workers leads to higher stock of human capital that is available for production? (b) is it justified to divert public funding to colleges?

The next proposition answers the first question and to fix ideas let us make an assumption on the cost-effectiveness of colleges.

Assumption 3: \[ B_c > 1+m \] holds.

According to assumption 3, colleges augment the productivity of their graduates, $(B_c - 1)$, more than the loss portion $m$ of their youth during college studies. If assumption 3 holds and wages do not decline over time, then assumption 1a holds as well (assuring that the returns to colleges, $(B_c - 1)w_{t+1} - mw_t(1+r_{c+1})$, is
positive). Note that both these assumptions can be empirically verified, given that $B_c$ represents the education wage gap between college-educated workers and low-skilled workers.\(^{15}\)

Proposition 3 compares a regime with only universities to a regime where both universities and colleges co-exist. This way, we assess how the emergence of colleges affects the economy.

**Proposition 3:** Under assumption 3, the emergence of colleges yields a decline in output at the current date $t$ but an increase in output accompanied by a decline in college admission standards in all subsequent periods $t + k$, $k \geq 1$.

After colleges are established, more individuals study in college instead of being low-skilled workers. During college studies, they don't participate in the labor market, reducing the stock of human capital available for production in period $t$, $H_t$, which further causes an outflow of physical capital. As a result, the economy faces a decline in output at the current date $t$.

However, in the following period, the low-skilled workers who have joined college increase the stock of human capital. Furthermore, their augmented human capital increases the initial endowments of their children, $Z_{t+1}(\omega)$, and the tax revenues, inducing more children to apply to college. As a result, the set of skilled workers, $A_t$, keeps increasing over time.

\(^{15}\) See Hotchkiss and Shiferaw (2011) and the references therein for measurement and estimation methodologies of the education wage gap.
Note that, the increase in tax revenues augments the public funding for education, causing a decline in college admission standards, $\Lambda_t$, over time along with the increasing demand for colleges (recall proposition 2).

Thus, except for the initial period, establishing colleges yields higher stocks of human capital and output and declining college admission standards over time, leading to the second question about subsidizing colleges. While the emergence of colleges may be worthwhile, supporting them financially at the expense of universities may have different consequences.

**Subsidizing colleges**

In this section, we focus the analysis on the implications of diverting public funding from universities to colleges (given the exogenous tax rate, $\tau$, and the exogenous share of higher education in the public budget, $1-\gamma$).

In proposition 4, we compare two cases: a regime with **universities only** vs. co-existence of **equally subsidized universities and colleges**. In the first case, the higher education consists of universities and uniform subsidies are allocated to their students, $g_t > 0$, whereas in the second case universities and colleges co-exist and all students enjoy uniform subsidies, $g_\alpha = g_t$. Comparing these two regimes, we assess how subsidizing colleges affects the economy.

**Proposition 4:** Under assumption 3, subsidizing colleges at date $t$ results in a decline in output and in the subsidy per student at the current date $t$ but an increase in output
accompanied by a decline in college admission standards in all subsequent periods $t+k$, $k \geq 1$.

Dividing the budget between more students reduces the subsidy per student in the initial period, $g_t = g_{ct} = \frac{(1-\gamma)\tau w_t H_t}{\mu(A)}$. Accordingly, the out-of-pocket payments, $z_t(\omega) = z^* - g_t$, rise, accounting for the recent shifts in many Western countries from public higher education funding (through various forms of subsidies) to private funding (larger out-of-pocket payments).

Note that because subsidies are equally divided to university and college students, universities, the more productive institutions, remain the first choice of applicants (who consider applying to colleges only if not accepted to universities).

The effect on the stock of human capital and output is qualitatively similar to the emergence of colleges discussed in the previous section, though the effect is much larger. When colleges are not only established but also provide student subsidies, they attract more students (who are not accepted to universities). Accordingly, the admission standards of colleges, $A_{ct}$, decline (recall proposition 2).

On the one hand, the forgone earnings of low-skilled workers (during their college studies) reduce the stock of human capital and the aggregate output at date $t$. On the other hand, their augmented human capital as college-educated workers increase the stock of human capital along the equilibrium path, increasing the initial endowments of their children and the tax revenues, both inducing more children to apply to college. As a result, the set of college students keeps increasing over time at the expense of the set of low-skilled workers.
The increasing tax revenues, allocated to both basic education and higher education, further reduce the college admission standards, $\Lambda_t$, over time along with the increasing demand for colleges (recall proposition 2).

Our results, that establishing and subsidizing less productive institutions (see Kaganovich and Su, 2016) enhances the economic growth, seemingly contradicts the common-knowledge that more productive institutions should be subsidized at the expense of less productive ones\(^{16}\). This result emerges in our framework because the more productive institutions, universities, have capacity constraints and cannot serve additional students. In this case, diverting public funds to colleges is the efficient policy.

In the next section, we examine the common policies of student subsidies, and show that our qualitative results remain as long as universities maintain their 'dominancy' as the first choice of students.

**Funding policies and university dominance**

To further understand the effect of establishing and subsidizing colleges, we examine alternative funding policies implemented equally in all higher education institutions: need-based or merit-based student subsidies.

First, recall that under our assumption so far, subsidies are uniform, $g_{st} = g_s$, and the out-of-pocket payments of students are identical in universities and colleges. Universities are 'more popular' than colleges because they are more productive

\(^{16}\) Hatsor (2014) suggests that allocating more funds to a less productive education system may be the optimal choice of the majority of voters, and may explain the observed 'budget puzzle', or why educational expenditures seem to be unrelated to educational achievements.
(augmenting the basic skills of their graduates by a larger quality factor, \( B > B_c > 1 \)). In this framework, with similar payment and higher returns to their graduates, universities are the first choice of students, or the dominant institutions in the market of higher education. Students attend colleges only if not accepted to universities (by failing to pass the university access restriction, \( \lambda \)).

This begs two questions. Given that universities are more productive than colleges, and subsidies in colleges and universities are provided according to the same policy, (a) is it possible that under certain funding policies colleges are the first choice of certain students, who attend colleges although accepted to universities? (b) What are the consequences of colleges becoming the first choice of these students, breaking the university dominancy in the market?

To answer these questions, we examine the common policies of student subsidies. In reality, much of the subsidies is directed to particular subsets of the population (see Blankenau et al., 2007a). Specifically, merit-based subsidies, allocated to students with the highest initial background, \( Z_{i,1}(\omega) \), are quite popular and typically argued to be growth-enhancing.

Accordingly, in proposition 5, assuming that universities and colleges co-exist, we establish that when subsidies are merit-based, colleges may be the first choice of certain students, who attend colleges although accepted to universities.

**Proposition 5:** Assume that subsidies are merit-based. Let \( C' \), denote the set of individuals who choose colleges at date \( t \), although accepted to universities. Then:

(a) A necessary condition for \( C' \), to be nonempty is:
Students in the set $C'$, are subsidized by colleges, i.e., $g_{ct} > 0$, but not by universities, i.e., $g_t = 0$.

(b) Assume that condition (a) holds. Define:

$$
\Lambda_{c't} = \left( \frac{1}{1-\tau} \right) \left( \frac{1}{B-B} \right) \left[ \frac{w_{rel}}{1+r_{rel}} \right] \left( \frac{g_{ct}}{X_t^2} \right).
$$

Then:

$$(23) \quad C'_t = \{ \omega \mid \lambda < Z_{rel}(\omega) \leq \Lambda_{c't} \}$$

That is, all individuals $\omega \in G_t$ with initial endowments $[\lambda, \Lambda_{c't}]$ attend colleges, although accepted to universities.

According to proposition 5, the set $[\lambda, \Lambda_{c't}]$ may pursue college education as their first choice if both the college subsidy, $g_{ct}$, and the college productivity, $B_c$, are relatively high (then $\Lambda_{c't} > \lambda$).

The reason is quite intuitive. In the case of merit-based subsidies, by definition students with the lowest initial endowments in universities are not eligible for a university subsidy. At the same time, the same individuals are the most favourable college applicants and as such are being offered college subsidies. Being subsidized by colleges but not by universities, their net tuition fee as college students is lower than as university students.

As a result, considering the alternatives for higher education, parents may face a trade-off between universities (more productive) and colleges (less costly), and prefer colleges if both the college subsidy and productivity are relatively high. Therefore, by implementing a policy of merit-based subsidies, colleges may draw
students who meet the university standard ($\lambda$) and impair the university dominancy in the higher education market\textsuperscript{17}.

By the same reason, it is easily verified that if subsidies are need-based, universities maintain their dominancy. In this case, universities subsidize their students with the lowest initial background, $Z_{t+1}(\omega)$ (who are not eligible for college subsidy), and as a result these students prefer universities (that are both more productive and less costly).

After showing that colleges may become the first choice of certain students in the case of merit-based subsidies, the second step is to analyse the consequences of differential subsidies on the economy. For this goal, assuming co-existence of universities and colleges, we compare a policy of uniform subsidies to three other common policies: 1) merit-based subsidies. 2) need-based subsidies. 3) an equal combination of merit-based and need-based subsidies, where an equal measure of university and college students are eligible to each subsidy.

**Proposition 6:** In the presence of universities and colleges, and uniform subsidies,

1) A shift to merit-based subsidies causes an increase in output in the current period, but a decline in output in all subsequent periods.

2) A shift to need-based subsidies, or a shift to an equal combination of merit-based and need-based subsidies, both cause a decline in output in the current period, but an increase in output in all subsequent periods.

\textsuperscript{17}Merit-based subsidies are one way to draw university students to colleges. Non-financial incentives may also increase the relative satisfaction from colleges. These include a friendlier approach, better availability of staff, flexible schedules, convenient locations and labor-oriented curriculums (see Kaganovich and Su, 2016; Eisenkopf and Wohlschlegel, 2012).
The proof of proposition 6 is straight-forward and is available by request. The first part analyses the implications of a shift from uniform subsidies to merit-based subsidies, which results in a shift of certain students to lower quality education.

First, according to proposition 5, certain students who are eligible to the merit-based subsidies in colleges but not in universities may apply to colleges as their first choice. Second, by definition the least favourable college applicants (with the lowest initial endowment) are not offered a merit-based subsidy. Consequently, instead of attending college they decide not to pursue higher education and become low-skilled workers (compared to the case of uniform subsidies the threshold $\Lambda_{e}$ rises).

These possible shifts of students to lower quality education (from universities to colleges and from colleges to basic education), caused by applying a merit-based subsidy policy, reduce the productivity of these students in the labor market. As a result, in contrast to the common-knowledge that merit-based subsidies are growth-enhancing, in our framework the stock of human capital and the output decline in all subsequent periods, though in the current period the additional earnings of low-skilled workers increase the stock of human capital and the output in the economy\(^{18}\).

The shifts of students to lower quality education are prevented if the merit-based subsidies are equally combined with need-based subsidies. When an equal measure of university and college students are eligible to each subsidy, the same students are eligible to merit-based subsidies in colleges and to need-based subsidies in universities. Obviously, with the same cost they prefer universities, the more productive institutions, as their first choice and do not shift to lower quality education.

\(^{18}\) This result holds in a more general framework with various qualities of universities and colleges. The results may change if the competition between universities and colleges may affect their behaviour.
Moreover, the need-based subsidies prevent disadvantaged college students, with the lowest initial endowment, from dropping from college. Therefore, need-based subsidies (combined with merit-based subsidies or not) are growth-enhancing compared to uniform subsidies shifting students to higher quality education, though in the current period their forgone earnings as low-skilled workers reduce the stock of human capital in the economy\textsuperscript{19}.

**Summary and Conclusions**

To study the effect of expanding the higher education system, we use an OLG model featured by basic education and higher education. At the outset, higher education is composed of ‘universities’ only, where students are partially subsidized by the government. Then, in the presence of university capacity constraints, we expand the higher education system to include colleges as well, and compare the dynamic equilibrium paths period by period.

Our findings demonstrate that the emergence of colleges, subsidized or not, increases the set of skilled workers, reducing the stock of human capital in the initial period (due to forgone earnings of young individuals who acquire college education), but augmenting the stock of human capital in all subsequent periods.

A more general conclusion emanates from our results about the allocation of resources between universities and colleges. Subsidizing colleges at the expense of

\textsuperscript{19} While not in the model, this type of subsidies may alter the individual incentives to invest effort in their basic education. Some individuals may underinvest in their basic education in order to be qualified for college subsidies, while others may overinvest in order to obtain university subsidies.
universities is a growth-enhancing policy as long as universities are the first choice of students (or the dominant institutions in the market for higher education).

Specifically, university dominancy remains if subsidies are uniform, need-based (or even need-based combined with merit-based), because in these cases universities are not only more productive but also less costly for all students. However, a shift from uniform subsidies to merit-based subsidies may drive some students to apply to colleges as their first choice. Moreover, not only university students may be pulled into colleges, but also disadvantaged students may drop from college.

Appendix

Proof of Proposition 1: Parents decide whether to invest in the higher education of their child (by applying to a university) if

\[
y^{i}_{t+1}(\omega) > y^{j}_{t+1}(\omega) \iff U^{i}_{t}(\omega) > U^{j}_{t}(\omega)
\]

which implies:

\[
(1 - \tau)B \tilde{\vartheta}_{t}(\omega)h_{t}(\omega)\gamma X_{t}^{x}w_{t+1} - (1 + r_{t+1})z_{t} > (1 - \tau)\tilde{\vartheta}_{t}(\omega)h_{t}(\omega)\gamma X_{t}^{x}[w_{t+1} + (1 + r_{t+1})mw_{t}]
\]

Rearranging this inequality, the demand for universities, \(A_{i}^{j}\), is given by Eq. (19).

Proof of Proposition 2: Parents decide whether to apply to college (if not accepted to universities) if

\[
y^{c}_{t+1}(\omega) > y^{j}_{t+1}(\omega) \iff U^{c}_{t}(\omega) > U^{j}_{t}(\omega)
\]

which implies:

\[
(1 - \tau)B \tilde{\vartheta}_{t}(\omega)h_{t}(\omega)\gamma X_{t}^{x}w_{t+1} - (1 + r_{t+1})z_{t} > (1 - \tau)\tilde{\vartheta}_{t}(\omega)h_{t}(\omega)\gamma X_{t}^{x}[w_{t+1} + (1 + r_{t+1})mw_{t}]
\]

Rearranging this inequality, the set of college students, \(C_{i}\), is given by Eq. (22).

Proof of Proposition 3: In the emergence of colleges, the set of skilled workers, \(A_{i}\), increases, because individuals with initial endowments \(\{A_{x}, \lambda\}\) enrol to colleges. Therefore, while the first term in the stock of human capital (Eq. (7)) remains unchanged, the second term decreases (reflecting the forgone earnings of college students while in college), and thereby \(H_{t}\) drops. Specifically, denote the stock of
human capital at date $t$ in the case of 'universities only' and by $H^U_t$, and by $H^{U+C}_t$ if universities and colleges co-exist. Then,

$$H^{U+C}_t = H^U_t - m \int_{\Lambda_{ct}} h'_{t+1}(\omega) d\mu(\omega)$$

Consider now later periods:

$$H_{t+1} = \int h_{t+1}(\omega) d\mu(\omega) + m \int h'_{t+2}(\omega) d\mu(\omega)$$

The emergence of colleges has two effects. First, low-skilled workers join the skilled work force by enrolling to college: $A_t$ increases but $\sim A_t$ decreases by the same number. Since we transfer low-skilled workers to the skilled labor force we obtain that $\int h'_{t+1}(\omega) d\mu(\omega)$ increases. Second, more individuals induce their children to be skilled workers ($\sim A_{t+1}$ decreases and $A_{t+1}$ expands), and therefore $\int h'_{t+2}(\omega) d\mu(\omega)$ increases. Specifically, the stock of human capital at date $t+1$ that corresponds to the co-existence of universities and colleges equals

$$H^{U+C}_{t+1} = H^U_{t+1} + \int_{\Lambda_{ct}} \left( h'_{t+1}(\omega) - h'_{t+1}(\omega) \right) d\mu(\omega) - m \int_{\Lambda_{ct+1}} h'_{t+2}(\omega) d\mu(\omega)$$

$$> H^U_{t+1} + (B_c - 1 - m) \int_{\Lambda_{ct}} h'_{t+1}(\omega) d\mu(\omega)$$

The last inequality is obtained using the human capital of college graduates (Eq. (20)). Moreover, college admission standards, $\Lambda_{ct}$, keep declining over time, because the tax revenues keep increasing (augmenting the public funding for education, recall the definition of $\Lambda_{ct}$ in proposition 2). Therefore,

$$\int_{\Lambda_{ct}} h'_{t+1}(\omega) d\mu(\omega) > \int_{\Lambda_{ct+1}} h'_{t+2}(\omega) d\mu(\omega).$$

This implies that $H^{U+C}_{t+1} - H^U_{t+1} > (B_c - 1 - m) \int_{\Lambda_{ct}} h'_{t+1}(\omega) d\mu(\omega)$, which is strictly positive by assumption 3. This process can be continued for the following periods since we obtained that $A_{t+1}$ also expands. Thus, our claim is proved. ■

Proof of Proposition 4: When the government establishes and subsidizes colleges at date $t$, $c_t = g_t > 0$, more individuals enrol to college and $A_t$ increases (even more than in the case that colleges are established but not subsidized, because the subsidies reduce the out-of-pocket college payments). Then, our claim is proved in a similar way to proposition 3. ■
Proof of Proposition 5: Assume that subsidies are merit-based. Therefore, some students who are accepted to universities, \( Z_{t+1}(\omega) > \hat{A} \), are eligible for subsidies as college students, \( g_c > 0 \), but not as university students, \( g_t = 0 \). Their parents decide to apply to colleges as their first choice if

\[
y_{t+1}^c(\omega) > y_{t+1}^u(\omega) \iff U_t^c(\omega) > U_t^u(\omega)
\]

which implies:

\[
(1-\tau)B\tilde{h}_t(\omega)h_t(\omega)^\nu X_t^\xi w_{t+1}^* - (1+r_{t+1}) \left( z^* - g_{ct} \right) > (1-\tau)B\tilde{h}_t(\omega)h_t(\omega)^\nu X_t^\xi w_{t+1} - (1+r_{t+1})z^*
\]

Note that this inequality holds only if condition (a) holds. Moreover, it is easy to verify that when condition (a) holds the set of skilled individuals is given by Eq. (23).

References


Cottini, E., Ghinetti, P., Moriconi, S., (2017), Local Competition in the Supply of Tertiary Education: Evidence from Italy, working paper

Council for Higher Education, Planning and Budgeting Committee, The higher Education System in Israel (1994) and (2016).


Statistical yearbook of Israel (2016), The Central Bureau of Statistics, Israel


