HUMAN Capital Contracts in Chile : An excercise based on Income data on Chilean HE graduates

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HUMAN CAPITAL CONTRACTS IN CHILE:

AN EXERCISE BASED ON INCOME DATA ON CHILEAN HE GRADUATES

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Given that a significant proportion of the Chilean education system is financed with household resources, we present human capital contracts (HCC) as an option for higher education financing for students facing financial constraints, but who could use their expected future income flows as collateral. We analyze the feasibility of HCC implementation in Chile over a set of college majors. We find that HCC can *partially* fund any college major in Chile and finance some majors *completely,* under certain conditions. Among the variables analyzed, those affecting most severely the contract pricing are initial wage level after graduation and graduation rate.

JEL classification: C01, I22, J24, J31

Keywords: Higher education returns, education financing, human capital contracts, human capital earning functions, income contingent schemes.

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1. INTRODUCTION

The role of market mechanisms in higher education (HE) financing becomes relevant in contexts where government resources are constrained, especially in developing countries where expenditure priorities are located elsewhere. It is also relevant because HE investment exhibits high return from a private perspective, so funding with public resources may be regressive. Several authors (Barr 2004, Chapman 2006, Palacios 2003) have stated that the best way to finance HE is a mix of state intervention accompanied by private sector mechanisms, where governments mainly support the most vulnerable students. Still, several authors (Barr 2001; Chapman 2006; Meller 2009) recognize that HE underinvestment exists.

The purpose of this study is to analyze the viability of human capital contracts (HCC) as a market mechanism for HE funding and their theoretical scope in the Chilean system. Overall, under HCC a student receives funding in exchange for a percentage of the future income he/she will earn during an agreed period of time. Our study aims to examine the feasibility of implementing HCC in Chile on a massive scale using a valuation model nourished with data from the *Futuro Laboral* database[2].

[2] *Futuro Laboral* (2009), Higher Education Division, Ministry of Education. Available at: www.mifuturo.cl

The article is divided into seven sections. Section 2 presents the general HE financing conditions in the Chilean system. Section 3 contains a review of the economic theories regarding education and the evolution of financing mechanisms, including HCC. Section 4 presents the simple theoretical model used to evaluate HCC, where we complement the original version of Palacios (2004) with the inclusion of the probability to complete an academic program successfully. Section 5 presents the risks associated to HCC. Section 6 develops a deterministic valuation for HCC for some majors described in the database. Finally, Section 7 presents some concluding remarks.

2. STUDY BACKGROUND AND RATIONALE

Chile has made significant efforts to provide massive access to HE, increasing the amount of public resources spent and developing financial schemes to enable various social sectors to receive HE. The gross enrollment rate increased from 17% in 1990 to 40% in 2009, with an enrollment increase from 250,000 to 876,000 during that period[3]. This increase meant that the population passing through the HE system has more than tripled in the last 20 years.

HE investment in Chile is around 2.2% of GDP, with 1.7% private participation versus 0.5% government participation. However, HE costs are constantly rising, due to increased access and the increased costs of providing HE; hence the necessity to study the feasibility

[3] Socioeconomic Characterization Survey (*Encuesta de Caracterización Socioeconómica*, or CASEN), 2006, applied by the Social Development Ministry. Available at: http://observatorio.ministeriodesarrollosocial.gob.cl/index.php

of mechanisms that increase resources, with special attention on the effect those mechanisms have on access. The present article focuses on HCC as an instrument that increases resources without limiting access, and provides arguments for the advantages of HCC over traditional mechanisms. In the following section we explore the Chilean HE system, the current status of financial aid for students and the need to explore innovative mechanisms.

2.1 Current financing instruments

Government aid in HE can be distributed mainly in two ways: to institutions and directly to students. Given that we are interested in studying HCC as an instrument to finance the private costs of HE, and that tuition constitutes the private portion to be covered by families, we can determine if there is room for other financial instruments by asking how much government aid currently covers student needs.

The Chilean government has several funding instruments for institutions and students that differ in their objectives, scope and impact. In 2009, the HE division of the Ministry of Education (*División de Educación Superior*, or DIVESUP) received resources amounting to US$892 million, of which US$538 million were allocated to student aid[4], specifically subsidies and credit lines; this aid was received by 334,000 students. Among the mechanisms the government makes available to students to support access to HE we find:

[4] Higher Education Division of the Ministry of Education. This information does not include loans from the Chilean Development Agency (*Corporación de Fomento de la Producción*, or CORFO)or private participation in the government warranted credit.

- Government warranted credit lines (*crédito con aval del estado*, or CAE): These are administered by the Ministry of Education and the Ingresa Commission. In 2009, the resources allocated for these lines of credit totaled US$146 million[5] to acquire credits issued by banks involved in the program, and a total of US$164 million[6] was allocated with the participation of private banks. This credit line is available to all students studying at an accredited HE institution.
- Income-contingent loans from the Solidarity Fund (*Fondo Solidario de Crédito Universitario*, or FSCU): Administered by the Ministry of Education. In 2009 US$158 million[7] was approved and an additional US$180 million[8] was allocated with resources from previous collection of repayments. These loans are available to students who can prove that their household income is within the first three income quintiles and who are enrolled at the country's traditional universities, a group that consists of 16 public universities, six non-profit, private Catholic universities, and three non-profit, private universities that have been in existence since before 1981.
- CORFO loans for undergraduate and postgraduate studies: These are provided by the Ministry of Economy and CORFO. In 2009, resources of US$94 million[9] were

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[5] Idem.

[6] Ingresa Commission.

[7] Finance Ministry Budget Office (*División de Presupuestos*, or DIPRES). Available at: www.dpres.cl

[8] Higher Education Information Service (*Servicio de Información de Educación Superior*, or SIES).

[9] DIPRES.

made available to all HE students with monthly family income below 120 *unidades de fomento*, or UF (US$4,800).

- Scholarships from the Ministry of Education: In 2009, scholarships amounting to US$237 million[10] were approved. There are several programs, most of which benefit the traditional universities; only one type of scholarship benefits students from all institutions.
- Indirect fiscal allowance (AFI): Although not a student aid facility, this mechanism allocates resources among the institutions that enroll students earning the highest scores on the college entrance test (PSU), to ensure that HE institutions provide internal scholarship programs that attract the top students. Hence, if HE institutions were to transform 100% of AFI resources into scholarships, this would directly impact the size of the tuition market.

Figure 1 shows how different financing mechanisms reach students. The quantity of beneficiaries, assuming each person only has access to one type of student aid program, reached 57% of the total student population. Comparing the amounts involved (including the AFI as a proxy for college scholarships) to the total tuition market, coverage is even lower, at 24%; when private bank financing is included, the total is 26%. The remaining 74% is covered by student savings and family income.

The private sector also provides funding mechanisms for students, including scholarships and donations, as well as loans issued by the financial system. According to a report from

[10] SIES.

the banking and financial institutions regulator (*Superintendencia de Bancos e Instituciones Financieras*, or SBIF), credit not tied to public programs and issued by private banks totaled 17% of loans and 20% of the amounts lent as of June 2008[11]. There are no more recent data allowing comparisons to include CAE increases. However, if private banks have kept pace with the market by allocating resources in the same proportion, they would have a 2% share of the total tuition market.

Figure 1. Student aid reach in the tuition market

Another perspective on student aid is its incidence and objectives. If the HE system is 100% publicly financed, the impact will be regressive as students with the highest income levels are more likely to begin and successfully finish their studies. The influence of socioeconomic background on the probability to succeed in an HE program is widely recognized for Chile (OCDE-World Bank 2009; Gonzalez and Uribe 2006; Canales and De Los Ríos 2007; *Centro de Microdatos* 2008).

There are insufficient HE funding resources and therefore the study of instruments to increase them without reducing access is imperative. HCC are a financing instrument that is contingent on the student's future income: the payments students will have to make correspond to a proportion of the income they will receive in the future, rather than the fixed installments of traditional loans. Beneficiaries receive student funding in exchange for

[11] "*Financiamiento de Estudios de Educación Superior (Antecedentes 2006-2008)*" [Higher Education Financing (Background Information, 2006-2008)]. Research Department, Financial Products and Banking Industry Unit, SBIF (2008:10).

a share of their future income and investors "bet" on the return on investment in human capital that a student can generate, without subordinating the beneficiary's freedom of choice and without requiring any other collateral.

Furthermore, from a collection perspective it has been found that the main factors explaining default rates in student loans are graduation achievement, employment status and income level after graduation of student loan beneficiaries (Dinarsky 1994; Woo 2002 for the United States). The recent increase in enrollment in Chile has relied mainly on traditional loans for support, a policy that has its own risks as the beneficiaries of those loans are beginning to graduate or drop out. Not surprisingly, if the country's economic performance is poor and the loan burden becomes unsustainable for students, there will be an increase in default rates. HCC offer students consumption smoothing while transferring attrition, unemployment and income variance risks to investors, while the latter can adjust their funds by selecting students with different characteristics to obtain a risk-adjusted return on investment.

3. HE FINANCING AND HUMAN CAPITAL CONTRACTS

The role of government in education depends on the magnitude of the externalities that reduce private investment to levels lower than what would be socially desirable. In this sense, Friedman (1955) makes a distinction between elementary and vocational education on the one hand and HE on the other hand. In the early years of study, pupils receive instruction in a fundamental set of rules and values that a society has agreed are needed to subsist; these values have a greater impact on social welfare. In contrast, the vocational

education received during years of HE creates a differentiation in the labor market that can be partially appropriated by individuals. Regardless of the role of government in the provision of HE, and regardless of the most widely accepted view about the value of education, private financing should be enhanced as it can contribute to solving the budget limitations students face.

Friedman (1955) laid the foundations of HCC. In his view, the acquisition of skills becomes a risky investment like any other investment. The most effective financing mechanism for risky investments is to offer shares that give control rights over firms, but with limited liability on the part of investors. In exchange, the shareholders receive a promise to receive the returns on the investments the firm may obtain. Friedman himself questioned why such financing was not available for HE students at the time and concluded that barriers affecting students, investors and the environment in which they made decisions prevented them from engaging in an equity-like contract like HCC.

Barr (2001) summarized these barriers, which thus far have obstructed human capital investments, by comparing the investment in HE to a mortgage or real estate investment: HE cannot be offered as real collateral, while a house can; HE is not a liquid investment, while a house is; HE may become obsolete at any time, while a house can age gradually; and the value of HE is uncertain, while a house only fails to meet its purpose when a disaster occurs. With HE, repayment starts years after the disbursement has been made, while mortgage repayment starts almost immediately, if not immediately. Furthermore, there are institutional concerns about "greed" determining who will obtain funding for HE and how; this fear may prevent investors and students from connecting and ultimately leave

more students outside HE[12]. All of these characteristics prevent private investors from offering financing for HE, even though it is a widely held belief that HE is a profitable investment.

In this sense, innovative ways to increase HE enrollment without affecting the public budget must be considered. There are two groups of tools for that purpose: those enhancing available resource efficiency and those increasing the resource supply. Given that students are well-informed (Barr 2004) about instruments that generate competition among HE institutions, these instruments are able to affect positively the quality of the education provided. Other means, such as the cooperation with the private sector could increase the availability of resources.

In general, from the student perspective, the ideal scenario would be a system in which the costs of HE could be recovered without reducing access. Lower-income students face reduced access to private sector credit because they lack either resources or collateral. In addition, their risk aversion and opportunity cost are higher because they could be working instead (Palacios 2004). If students are aware that they don't need financial resources or collateral to gain access to financing and attend HE, and if they perceive that the payments

[12] This has been one of the main reasons for the limited success of the Solidarity Fund, as universities have had to overcome the image cost implied by being in charge of collection from graduates. I am grateful for the remarks made by Dr. E. Fernández and Dr. L. Huerta, of the *Universidad Alberto Hurtado* and *Universidad de Talca*, respectively, associated researchers of the *Programa Anillo* SOC - 01.

they will have to make after earning their degree will not become unaffordable, the instrument will succeed.

3.1 HCC evolution and a comparative perspective

As mentioned, private HE funding through equity-like investment contracts is a concept that has been studied by academics for over 50 years. During this period the idea has evolved and several experiments have been attempted. Each case highlights the importance of the diverse elements of the contracts: their duration, the payment collection agency and the level of involvement of HE institutions, among others.

Friedman's original idea was transformed and implemented by several governments during the 1990s, giving rise to the income-contingent loan (ICL). This instrument's implementation began in Australia with the Higher-Education Contribution Scheme Program in 1989, where in exchange for highly subsidized financing from the government, the student agrees to pay a percentage of future income until balance repayment. Similar experiments have been tried in several countries, including Ghana, New Zealand, South Africa, South Korea and Great Britain. In Chile there is also a subsidized income-contingent mechanism: the Solidarity Fund, in which financed students agree to pay part of their future income. Its success has been limited by poor performance in terms of collection, which is managed by the universities.

In recent years the concept has returned to academia in the form of HCC due to the proliferation of investment funds and the degree of securitization, which reduce investor risk and lower financing costs.

The HCC have the potential for consumption smoothing in comparison with traditional loans, and the possibility of attracting private sector resources, unlike scholarships or income-contingent loans, which provide a direct subsidy from the government to those students who cannot fully repay the balance (Palacios 2004; Chapman 2006). The latter problem is solved in HCC by high-performing students, who by paying a constant share of their greater income compensate the investor for low-performing students, whose payments are lower.

To illustrate the difference between ICLs[13] and HCC, Figure 2 shows the relationship between income (share) after graduation and the instruments' payoffs. For loans (L), assuming zero default, payoff is not related to income and payments are fixed: this is represented by a straight black line. The payoffs of HCC, on the other hand, are perfectly related to the income share committed during the repayment period. This can be either above or below the amount of financing provided to the student, and is represented by a blue line. The fraction to the left of the (L) dotted line, underneath the red line, represents students whose income does not cover the initial amount, and the fraction to the right represents students whose income exceeds the amount financed initially. The red line represents ICL; if during the maximum agreed repayment period the student does not cover his or her balance, the obligation is forgiven (left portion of the graph). If the student reaches an income level sufficient to cover the outstanding balance, he or she will pay as

[13] Income-contingent loans as described here correspond to the ICL of the risk-sharing type described by Chapman (2006).

maximum the outstanding balance and will not exceed that (the portion on the right, where the maximum payment is (L)).

Figure 2. Relationship between income and financing instrument payoffs

In HCC, investors can diversify the risk of investing in a single student by investing in a group of students whose incomes will tend to behave more closely to the average and exhibit a lower variance than individual students. In this regard the criteria used to group students are determinants of HCC financial performance. The risk is mitigated because if a funded student earns less, the other students who earn the average or better compensate for the first one. In Figure 2, students whose income share falls to the right of the dotted line compensate the investor for those who fall to the left side, reaching a risk-adjusted return for the investor.

Students benefit by transferring to the investor the risks carried by the investment in HE. They know they will never be unable to make future payments, which is a latent risk with a conventional loan; this is because they know from the start what percentage of their income they are committing for repayment. Students also benefit as grouping spreads the risk among different individuals through access to less expensive financing, compared to funding each student individually, and also because the required collateral is the expected flow of income. In addition, students have a source of information on labor market variables without conflicts of interest, as is the case with information provided by institutions.

Still, many investors are concerned about the ability of new human capital funds using direct collection to recover the investment without the support of a broad, reputable collection agency such as the national internal revenue service. All successful cases of income-contingent loans have in common the presence of a government agency that carries out collection of repayments, such as in New Zealand and Australia. However, Lumni, which began in 2002 in Chile and is now present in Colombia, Mexico and the U.S., has funded more than 2,000 students while maintaining a stable portfolio. A discussion of collection mechanisms is beyond the scope of this article and there is no better way to validate its feasibility than experience. However, contract enforceability is one of the key issues for its success, as well as the quality of the information available to the administrator to collect the proper amounts earned by students as income.

Several studies have examined contract enforcement feasibility in countries such as Germany (Weldi 2007), Belgium and Great Britain (Vandenberghe and Debande 2005) and Colombia (Lozano 2009). This study is the first to evaluate the HCC for Chile, improving the available financial valuation model of Palacios (2004).

4. THEORETICAL MODEL FOR HCC VALUATION

For our model, the contract must specify what each party involved expects from it, as much the investor as the student. It should also ensure that contract requirements do not give rise to investor interference in student decisions. In addition, the contract must specify the percentage of income the students are to commit and the maximum amount this figure could reach; also, the period over which repayment will occur must be clearly established.

Our study aims to examine the hypothetical behavior of HCC solely in financial terms, and thus, to discuss under what circumstances private investment could be attracted as a supply of resources for HE financing. The theoretical framework used to analyze the feasibility of HCC will be that suggested by Palacios (2004), improved with the inclusion of dropout risk:

Let PVI be the present value of income, and u, a , d the costs related to non-employment[14], administration and default, respectively, then the HCC value will be given by:

$$HCCV = \gamma \cdot PVI \cdot (1-(u+a+d)) \quad (0)$$

The HCC value is given by the present value of the portion, a percentage γ, of the income cash flow an individual generates and commits to the HCC, discounted for the probability of the person being unemployed, administration costs, and the probability of not being able to corroborate income information, which in this case we will call default. Assuming continuous compounding, the present value of income will be rewritten as:

$$PVI = \int_{s}^{s+k} Y(t)e^{-it}dt = Y_s e^{-is} f(i,k,G(t)) \quad (0)$$

Where $f(i,k,G(t)) = \int_0^K G(t)e^{-it}dt$ and s represents time to graduation, k is the repayment period, i is the interest rate, Y_s is starting salary upon graduation and $f(.)$ is the income growth function up to the year K.

[14] Non-employment, u, should not be limited to the unemployment rate as it should include any state where an individual does not engage in income-generating activities. What is to be considered a productive month, in the sense of the HCC, should be clearly specified in the contract as well.

Using the preceding expression, assuming that markets are competitive and that there are no profits ($\pi = VCCH - C = 0$ and C stands for the financed amount), an expression can be found to determine the income to be committed by the student:

$$\gamma = \frac{C \cdot e^{is}}{Y_s \cdot f(i,k,G(t)) \cdot (1-(a+d+u))} \quad (0)$$

Equation 3 has an intuitive sense. If wages upon graduation or the potential income growth are higher, then the percentage committed by the student decreases. Similarly, increased costs and uncertainties in the operation lead to a higher percentage of income committed to the HCC.

To incorporate the probability that the student successfully finishes his/her academic career without being expelled or dropping out before earning the degree for any reason, we assume the contract does not have a preventive option[15] and if the student drops out, the investor will receive the income percentage initially agreed in the contract. Convertibility options can also be included in the contract. Hard data from CASEN surveys provide evidence that dropping out limits the income development potential and dropouts exhibit lower income cash flows than graduates. Non-employment and default rates for dropouts will also differ from graduates' rates. Hence, Equation 3 can be rewritten:

$$equation 4 \quad (0)$$

[15] Preventive options against dropping out might be established in the contract where in the case of dropping out, the student enters a different kind of repayment schedule as a traditional loan or the execution of the promissory note.

$$\gamma = \frac{c \cdot e^{is}}{[(\theta_s \cdot PVI_{GR}) + (1-\theta_s) \cdot PVI_{DO}] \cdot [1-(a+(\theta_s \cdot d_{GR}+(1-\theta_s) \cdot d_{DO}) + (\theta_s \cdot u_{GR}+(1-\theta_s) \cdot u_{DO}))]} \quad (4)$$

where θ_s is the graduation rate s years from graduation; the GR subindex represents measures for graduates while, on the other hand, the DO subindex represents dropout measures. Thus, the dropout probability $(1-\theta_s)$ is a function of the time left to graduation and affects HCC valuation depending on the difference between what would be expected from graduates' and dropouts' performance in the labor market. In general, and also in particular for Chile, the *PVI* for graduates is higher than that for individuals with incomplete HE. Thus, an increase in the dropout probability increases the percentage to be committed by the student in HCC. Non-employment, non-participation in the labor market and informality rates are also higher for individuals with incomplete HE than those of HE graduates, as shown in Figure 4.

Among the restrictions of HCC are that ideally the financing does not last longer than a mortgage (15 to 20 years at maximum), nor should it require the student to commit more than 15% of their income (Palacios 2004). Subject to those conditions, the contract behavior, as per Equation 4, will be evaluated in next section, using *Futuro Laboral* income data for Chilean HE graduates and CASEN 2006 data to build the wage curve for dropouts.

4. DATA, PRELIMINARY ESTIMATES AND RELATED RISKS

This section presents the data used, analyzing the factors on HCC valuation. First, we present the process of estimating the expected wages of graduates and dropouts using the *FuturoLaboral* database and 2006 CASEN data, adjusted to 2009 prices according to the

CPI published by the Chile's Central Bank. Subsequently, other risks associated to investment in HE are introduced, the data for which are extracted from *Futuro Laboral* statistics. Finally, we present data from the Cohort Retention Study (*Estudio de Retención por Cohorte*, CNE[16]), from which the graduation rates were obtained.

Futuro Laboral data are best suited for the evaluation of HCC in Chile because they allow for differentiating among majors to estimate students' income flow during their first years in the labor market. The data also discloses five points over the distribution of income as well as some measures of the volatility of income flow. Moreover, this source provides other pertinent information such as the proportion of HE graduates in remunerative work, the number of graduates (2007), those enrolled in the first year of HE (2008), and the real and formal length of time for each major included. The database is built by combining the income databases of the national tax service (*Servicio de Impuestos Internos*, or SII) with those on university graduates collected by the National System for Higher Education Information (SIES). The data includes all individuals reporting income to the SII from the 2000-2001 and 2005-2006 cohorts.

5.1 Present value of income

Traditionally, income and education functions work with a specification in which the income and time relationship is concave. Time is measured by experience (Becker 1975) or

16 Cohort Retention Study (2009), *Consejo Nacional de Educación* (CNED). Available at: http://www.cned.cl/public/secciones/SeccionIndicesEstadisticas/indices_estadisticas_retencion.aspx

age (Heckman 2005). The concavity is given in most of the relevant range of the income-time profile and if that is the shape of the whole curve, the income function specification would include time measurement in a quadratic form. However, there is uncertainty about the early years of work experience, when income is likely to increase at a less accelerated pace, producing an initial convexity. Studies incorporating the time unit in a cubic form (Weldi 2008), with significantly better data matching, demonstrate this fact. The *Futuro Laboral* data only provides income at the first and fifth year from graduation, so regardless of the form of the real curve, it must pass through those two points. Tests cannot be done in order to identify the real income curve without access to observation information. Given the way the information is disclosed, we used the linear continuous growth rate, which could overestimate income flow during part of the period of HCC payment if the form is cubic, and underestimate it if the shape is quadratic. From an undetermined point, the inverse situation takes place: wages are overestimated in the case of the cubic shape and undervalued in the case of the quadratic form.

To estimate graduates' PVI for Equation 4 according to Palacios (2004), taking h as the linear growth rate of income (when the rate of slowdown in wage growth tends to zero) we have from Equation 2:

$$VPI = Y_s e^{-is\frac{e^{(h-i)k}}{h-i}} \quad (0)$$

In the case of dropouts' wages, an income equation was used built from 2006 CASEN data[17] through a linear splines model, as in Hungerford and Solon (1987), and matched to 2010 with the inflation rate. Changes in the slopes of the coefficient of years of schooling were incorporated after the years of graduation from elementary, high school and tertiary education (ϕ); also, premiums were incorporated for the degrees at each of the educational levels (*pri*, *sec*, *CFT*, *IP*, *UNI*). Finally, a socioeconomic variables vector (ΓX) including the number of hours worked in the month, gender, the individual's region and the selection bias correction are included. The form of the equation used is:

$$\ln y = \alpha + \rho_s s + \beta_1 edad + \beta_2 edad^2 + \beta_3 \phi_{pri} + \beta_4 \phi_{\text{sec}} + \beta_5 \phi_{uni} + \beta_6 pri + \beta_7 sec + \beta_8 CFT + \beta_9 IP + \beta_{10} UNI + \Gamma X + \varepsilon$$

Where: $\phi_{prim} = prim \times (s-8)$; $\phi_{secun} = sec \times (s-12)$; $\phi_{univ} = UNI \times (s-17)$ (1)

Originally, Equation 6 could be used for the estimation of graduate income but relevant information would be lost regarding the income differential across majors. The estimation of Equation 6 enables identification of the expected income flow for individuals with incomplete HE, i.e., those who drop out. For the calculation of the present value of the income for the dropouts, according to Palacios (2004) we have:

$$PVI = Y_d \cdot e^{-is} \cdot e^{\frac{(h'-i)^2}{4 \cdot g}} \cdot \sqrt{\frac{\pi}{g}} \cdot \left(N\left(a\right) - N\left(b\right) \right), \qquad (7)$$

[17] Estimates were drawn from an internal Lumni Research document, "Salary Curves: Cross-Section Analysis CASEN 1990-2006." Available upon request.

where $a = \sqrt{2 \cdot g} \cdot \left(K - \frac{h' - i}{2 \cdot g} \right)$, $b = \left(- \frac{h' - i}{2 \cdot g} \right)$ and $h' = h - 2 \cdot A_d \cdot g$. Y_d is initial income when dropping out, *g* measures the deceleration of income growth and A_d represents the age when dropping out.

5.2 Risks related to HE investment

Figure 3. HE graduates' income – empirical distributions

A factor that generates uncertainty in HE investment is the volatility of student income. Graduates from different majors receive different wage levels due to varying labor market conditions. Wage differentials within the same major can be explained as much by differences in individual innate or acquired skills, as by brand or signaling effects associated with each HE institution, which are impossible to distinguish from *Futuro Laboral* data. Figure 3 illustrates the distributions of some of the majors with higher and lower dispersion in the *Futuro Laboral* database at the first and fifth year from graduation. In Figure 3, data dispersion is very low for Elementary Education and Nursing, in contrast to Geology and Mining Engineering.

Figure 4. HE risk and return

To analyze income dispersion, *Futuro Laboral* offers the variation coefficient. Simulating the methodology of Christiansen, *et al*. (2006), which describes the efficient frontier of human capital investment, we explore Figure 4, where the ordered pairs of the logarithm of the present income value calculated from Equation 5 and the coefficient of variation for all

university professional careers are located. As in the mentioned study, no clear efficient frontier is found and most of the careers appear below the boundary established by the spots highlighted in red. Income dispersion constitutes the most important risk to consider when pricing an HCC. The ability of the selection process to replicate or improve conditions of the salary attainment of HCC beneficiaries determines the rate of return of the investment.

Christiansen, *et al*. (2006) explained why investments in human capital are not located on the efficient boundary, mentioning that this kind of investment cannot be scaled up indefinitely and cannot be diversified, as is the case with other financial assets. Even though the cause is not entirely clear, and further research could be done, major choice is determined by individual preferences which are beyond the scope of a mean-volatility financial analysis.

We do not include stochastic estimates that incorporate income variance or individuals' academic performance, both for simplicity and given the fact that more information would be needed to relate these factors to HCC value determinants. However, the same risks make HCC attractive to students as they will be able to transfer the uncertainty generated by the HE investment to investors.

5.3 Attrition and risk of not graduating

Figure 5. Fifth-year retention rates – 2004 cohort

Academic performance may determine the college dropout decision (*Centro de Microdatos* 2008; Canales and de los Ríos 2007). However, other factors such as lack of information,

motivation problems (especially in the early years in HE) and financial difficulties often play a more important role. The Cohort Retention Study (CNED) shows statistics of the cohorts for different majors. Figure 5 shows retention rates at fifth year of the 2004 cohort.

The major showing the highest retention in the fifth year is Medicine, followed by Odontology; however, the comparison is complex given that the actual duration of these majors, according to *Futuro Laboral* ,is close to eight years for the former and seven years for the latter. Majors with the lowest retention in the fifth year are Accounting and Law, and the average length of these careers is six and nine years, respectively.

Chile's HE system generates great uncertainty about the actual length of the careers. Although few majors indicate a formal length of more than six years, in practice the vast majority last more than seven years. Uncertainty about major duration affects the valuation of HCC in two ways: first, it increases the cost of resources for students because a longer delay is expected before entrance to the labor market and the earning of wages to pay back the financing received; second, the risk of attrition is higher. In this exercise, a maximum of five years is established for financing through HCC.

Although the CNED study does not provide an accurate determination of the number of years before initiating payments since information upon graduation is not disclosed, it is one of the best studies of HE survival data in Chile. The cohort used is that of 2004 because it is the cohort with the longest time under analysis. The CNED study provides information for five years of follow up but not the exact rates of graduation. For simplicity, we use the institutional retention rate for the valuation exercise.

Table 1. Graduation rates used for HCC valuation

	Years to Graduation					
	5 Years	4 Year	3 Year	2 Year	1 Year	E(Graduated)
Students	100	79	61	61	56	53
E (GraduationRate)	53%	67%	87%	87%	95%	100%

Source: Cohort Retention Study – CNED.

The probability of graduation within s years is given by the ratio of graduate students in the last year to the entire population of students. Thus, if for 100 students the time remaining to graduate is five years and 53 of them graduate, the instantaneous graduation rate at five years to graduation is 53%. Proceeding in the same manner, if 61 students are two years from graduation and 53 earn their degree, the instantaneous graduation rate at two years prior to earning the degree is 87%. Table 1 shows the number of students based on institutional retention indicators for universities included in the CNED study.

6. VALUATION OF HCC IN CHILE

Table 2. Main assumptions for HCC valuation

Variable		Remarks
Non-Employment	15.2%	Weighted average, college graduates (*Futuro Laboral*)
Default	6.2%	2 times the proportion of HE graduates in the informal sector (CASEN 2006)
Discount rate	7.5%	Average Psacharoupulos / Meller + 100bps

Administration Costs	5%	Palacios (2004)

More assumptions for HCC valuation are presented in Table 2. An average of the proportion of graduates working in the first two years after graduation is used as the non-employment probability. Five percentage points above the graduates' rate were added to the dropouts' non-employment rate. The default rate is estimated according to Palacios (2004) based on the proportion of people in the informal sector with HE; this ratio is intentionally increased as a conservative provision. The discount rate follows the average discount rates used by Psacharoupulos (8%) and Meller 2009 (5%) to discount income flows in previous estimations of education returns. To the above rate a risk overcharge of 100 basis points is added. Finally, management expenses are set at 5% of the investment. A sensitivity analysis is conducted of each variable in order to establish the strength of their weight in HCC valuation and to estimate the effect of the assumptions.

The amount to be financed was set at CLP2 million (US$3,850) from the weighted average of the annual tuition following the Indices database from the CNED for 2009 (CLP2.3 million or US$4,420). We followed 15 majors, replicating Meller (2009), and in addition to two others that were included due to their relevance in the previous analysis (Mining Engineering and Geology).

Equation 4 is evaluated by incorporating the calculations of the present value of income described in Equations 5 and 7 and results are presented for the HCC for different time lengths to graduation (five years to one year to graduation). The results of the percentages committed in each HCC are presented in Table 3 for the valuation of contracts with five-

and ten-year payment periods. If a Geology student who is three years from graduation wants to enter into an HCC to finance his studies, he must commit 5% of his income for 10 years, or 12% for five years, to obtain resources for the next three years and compensate the investor with a risk-adjusted rate. The results are presented in colored text to enhance the result of the feasibility of implementation: the results in blue are within the range of 15% as a commitment percentage; those in light blue fall within the commitment range of 10% of future income, which shouldn't be too onerous; and those in dark blue up to 15% are within the range considered by Lumni. Those in red are contracts that would require between 15% and 25% of income. Contracts that would require commitments over 25% are shown in green; these are completely disregarded, while results over 35% are omitted.

Table 3. γ% of income to commit in an HCC (*s* years to graduate – K = 5 , 10)

	Repayment Period (K) - 5 Years					Repayment Period (K) - 10 Years				
	Time to Graduation					Time to Graduation				
	s=1	s=2	s=3	s=4	s=5	s=1	s=2	s=3	s=4	s=5
Mining Engineering	3%	6%	11%	16%	25%	1%	3%	5%	8%	12%
Geology	3%	7%	12%	18%	28%	2%	3%	6%	9%	14%
Industrial Eng.	4%	10%	17%	26%		2%	4%	7%	12%	17%
Civil Engineering	4%	10%	17%	27%		2%	4%	7%	12%	17%
Medicine	5%	10%	17%	27%		2%	4%	7%	11%	17%
Law	5%	11%	19%	29%		2%	4%	7%	11%	17%

Business Admin.	6%	13%	21%			3%	6%	10%	16%	23%
Odontology	6%	13%	22%			3%	6%	10%	15%	22%
Civil Works Eng.	6%	13%	23%			3%	6%	10%	16%	24%
Agronomy	7%	17%	28%			3%	7%	12%	18%	26%
Accounting	8%	17%	29%			4%	8%	14%	22%	
Architecture	8%	18%	30%			4%	8%	14%	21%	
Nursing	8%	19%				5%	10%	18%	27%	
Psychology	9%	20%				4%	9%	15%	23%	
Elementary Education	14%					8%	18%	29%		

Source: Lumni Research calculations.

As our first result, we find that HCC are able to finance HE for all majors considered when students are in their last year before graduation, independently of the repayment period chosen: A student in his/her last year of Mining Engineering must commit 3% of income for five years, or 1% in an HCC with a 10-year repayment period. At the other extreme, a student majoring in Elementary Education must commit 14% of his/her income for five years or 8% for 10 years to obtain funding for the last year of studies. Increasing the repayment period enhances the ability of the HCC to finance HE and in the case of Mining Engineering and Geology, HCC are able to finance the entire college tuition if the student graduates after five years, while in Industrial Engineering it could finance up to four years with full recovery of the costs associated with the investment. As a comparison, the CAE

offers a repayment period of up to 16 years, so the periods we analyzed are within the range of other instruments.

Table 3 indicates that, at the very least, HCC could be used to fund the last year of any major. This might release resources to fund more grants for low-income or high-performing students. Table 3 also indicates that the contracts should be tailored differently across majors, and if some motivational factors are included, probably across individuals[18].

It is important to note that HCC should not be discarded at first glance even if the percentage shown here seems high. An investment fund in human capital can be structured without pursuing a risk-adjusted return as we analyze here. Human capital funds pursuing different goals (i.e., philanthropic) can also be structured, in which case the interest rate used to discount the flows will be lower and more costs may be recovered than through a scholarship scheme, and in addition it will be able to finance more students.

As the sensitivity analysis will be focused on HCC one year to graduation, we present the results of the percentage of income to commit when the graduation rate is 100%, five years before graduation. The greater the time to graduation the stronger the effect of the attrition rate on HCC valuation. Table 4 shows these results: Dropout risk represents an extra cost ranging from less than 1 percentage point up to 8 percentage points in the share of income to commit in an HCC. For example, a Mining Engineering student who is five years away

[18] I am grateful for the contribution of an anonymous referee for pointing out these particular findings.

from graduation should commit 12% of his/her income to enter into a HCC with 10-year repayment period, but should commit only 8% without attrition risk.

Table 4.γ% of income to commit in an HCC and attrition risk

Time to Graduation (s)	Time to Graduation (s) - 5 Years				Time to Graduation (s) - 1 Year			
Repayment Period (K)	K = 5		K = 10		K = 5		K = 10	
E(Graduation)	**100%**	**53%**	**100%**	**53%**	**100%**	**95%**	**100%**	**95%**
Mining Engineering	**18%**	**25%**	**8%**	**12%**	**2.57%**	**2.71%**	**1.18%**	**1.25%**
Geology	**20%**	**28%**	**10%**	**14%**	**2.87%**	**3.03%**	**1.45%**	**1.53%**
Industrial Eng.	**29%**		**13%**	**17%**	**4.14%**	**4.35%**	**1.85%**	**1.94%**
Civil Engineering	**29%**		**13%**	**17%**	**4.25%**	**4.46%**	**1.83%**	**1.92%**
Medicine	**30%**		**12%**	**17%**	**4.29%**	**4.51%**	**1.78%**	**1.87%**
Law			**12%**	**17%**	**4.67%**	**4.89%**	**1.80%**	**1.89%**
Commercial Eng.			**17%**	**23%**	**5.33%**	**5.58%**	**2.51%**	**2.63%**
Odontology			**17%**	**22%**	**5.49%**	**5.75%**	**2.41%**	**2.52%**
Civil Works Eng.			**18%**	**24%**	**5.65%**	**5.91%**	**2.61%**	**2.74%**
Agronomy			**20%**	**26%**	**7.19%**	**7.48%**	**2.94%**	**3.07%**
Accounting			**25%**		**7.33%**	**7.62%**	**3.64%**	**3.79%**
Architecture			**24%**		**7.59%**	**7.89%**	**3.48%**	**3.62%**
Nursing			**31%**		**8.01%**	**8.31%**	**4.54%**	**4.70%**

Psychology		26%	8.69%	9.00%	3.82%	3.97%
Elementary Education			13.86%	14.14%	7.98%	8.09%

Source: Lumni Research.

5.1 Sensitivity analysis

The different assumptions made about the variables may affect the results, so in this section we examine the sensitivity of the percentage of income to commit in an HCC with respect to the variables used in a comparative statics exercise. For this exercise the point of departure is the financing of the last year and a repayment period of 10 years, other variables remaining stable, except when they are the object of analysis. Without loss of generality we analyze a smaller set of majors. The variable weighing the most in HCC valuation is the expected income after graduation. Figure 6 presents the change of the percentage to commit in an HCC as a function of the initial wage and as a function of the wage growth rate.

Figure 6. γ% - initial wage andγ% - wage growth (*K*=10, *s*=1)

The graph shows the curves for Nursing, Commercial Engineering and Industrial Engineering majors with their respective figures from *Futuro Laboral*. As the wage increases, the percentage required in an HCC decreases but the convex relationship makes every wage increase have less than a proportional impact on the decline in the percentage to commit in an HCC. A negative relationship is also observed for the wage growth rate,

which also positively affects the present value of the graduates' income; the relationship is far less convex than in the case of the starting salary. A remarkable result is that the HCC can continue to finance the last year of studies for these three majors at very low levels of initial salary.

If human capital investment is combined with other types of social or philanthropic goals, the interest rate adjusted for risk used in this exercise could be affected. In that case, some kind of subsidy could be provided to students. The graph shows the UF interest rate currently applied by the CAE in Chile. The CAE interest rate is subsidized; government or foundation funds could do the same with a human capital investment fund , thus expanding the resources available for HE financing.

Figure7 . γ% - interest rate and γ% - financed amount (*K*=10, *s*=1)

Also, reductions in tuition charged by HE institutions can lower the share of income to commit in an HCC. Figure 8 shows the effect of interest rates and tuition, in which the HCC amount is compared to mentioned variables. On the other hand, increases in interest rates make HCC more expensive for students, as they must compete to justify the opportunity cost of the investor. The interest rate effect is relevant and progressively more than proportional due to the convex relationship. Similarly, a rise in contributions increases the HCC requirements because a larger proportion of future income must be committed to compensate for the additional resources to be financed.

Figure 8. %γ - *(a+d+E(u))* and %γ - repayment period (s=1)

In the current structure of the analysis, the set of variables including administration costs, default and non-employment has a moderate effect on the HCC pricing for levels at which the aggregate of these variables stays below 40%. From that level onwards, due to the convex relationship an increase in any of these variables generates a more than proportional increase in the percentage of income to commit in an HCC. In the current exercise, the aggregate of these rates was 30%, including estimations for default and non-employment. The repayment period, as mentioned in the latter section, also negatively affects the percentage of income to be committed in an HCC, as shown in the second panel of Figure 8. The Figure presents the relationship for the three majors under analysis and underlines those periods analyzed in the previous section, five and ten years. An increase in the repayment period has a major impact when the repayment period is low; however, after 12 years of repayment the change in the income share to commit is very low, so periods that are too long cannot be justified, at least under the conditions assumed for this exercise.

Finally, the graduation rate is presented in Figure 9, but now in its effect on a partial contract in the last year of studies: if the graduation rate is zero, the income share to commit would be determined exclusively by the future income flow of a dropout. As the graduation rate tends to 1, the lower the risk is and therefore, the lower the income share to commit in an HCC.

Figure 9. %γ - graduation rate (K=10, *s*=1)

7. CONCLUSIONS

Chile is one of the countries that relies most heavily on family income to finance its HE. Nowadays, private banks and government aid covers barely 30% of the tuition needs. Despite this, enrollment continues to increase, as more young people gain access to HE. Currently, public policy instruments focus on providing aid to students in the most vulnerable sectors, playing an important role in protecting students whose opportunity cost is higher and whose elementary and secondary education does not adequately prepare them for the demands of higher education. In addition, a relatively neglected group is made up of students from middle- and upper-income quintiles who do not necessarily have enough resources to cover HE expenses.

Student financial requirements are growing faster than government aid, as increasing access means increasing demand previously not covered, and providing high-quality HE requires additional resources for infrastructure, materials and state-of-the-art teaching facilities. For these reasons, there is room for research on instruments that can increase the resources available for human capital investment. In this article, we analyzed HCC as an instrument that allows students to use their future income cash flows as collateral to finance HE. In an HCC, a student makes a commitment to pay a fixed percentage of income during an agreed repayment period. The HCC transfer to the investor several of the risks of education: those arising from variation in income, unemployment and attrition. The investor, in return, can earn a risk-adjusted interest rate, receiving substantial returns on private investment by learning to manage labor market risks and diversifying with a broad set of students.

Given the information from *Futuro Laboral* and the construction of a simple model for HCC valuation, we found that that HCC can *partially* finance all majors considered, and that some majors could be *totally* financed under some conditions. Given their characteristics in the labor market, the most suitable majors to be financed through HCC are those related to engineering (mining and industrial) and geology. These are the majors with the best conditions; provided that funds are structured in a diversified way to achieve average behavior. Elementary education and psychology are at the other extreme, but , these majors are like risk-free assets, due to the low dispersion of their wages.

In the sensitivity analysis we found that the variable with the greatest weight in determining an HCC value is the present value of future income. Also, our valuation model allows for incorporating the instantaneous probability of graduation for each length of time to graduation we analyze. The probability of dropping out is the second most important variable in determining the contract value and can make HCC prohibitive for students: the longer the period to graduate, the weight of the probability of non-graduation could explain up to one-third of the percentage of income to commit in the contract.

Results producing high percentages of income to commit beyond the pre-established range (up to 15% of income) do not imply that such contracts should be completely discarded. This exercise attempted to find a rate of return to make HCC competitive in the financial market by paying a risk-adjusted interest rate. However, investment funds that pursue different goals can be structured, for example for philanthropic purposes, or to benefit a larger number of students with null or negative rates of return.

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FIGURES

Figure 1. Student aid reach in tuition market

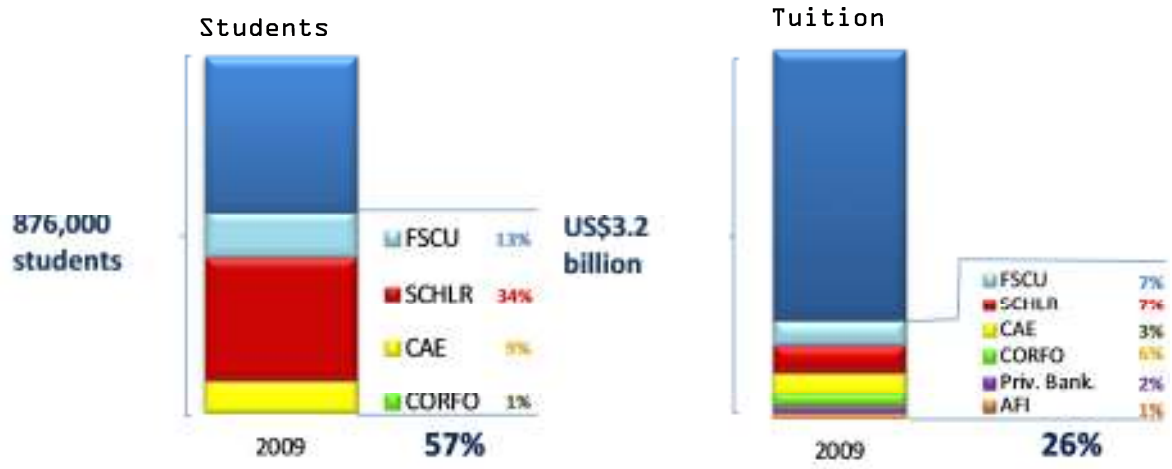
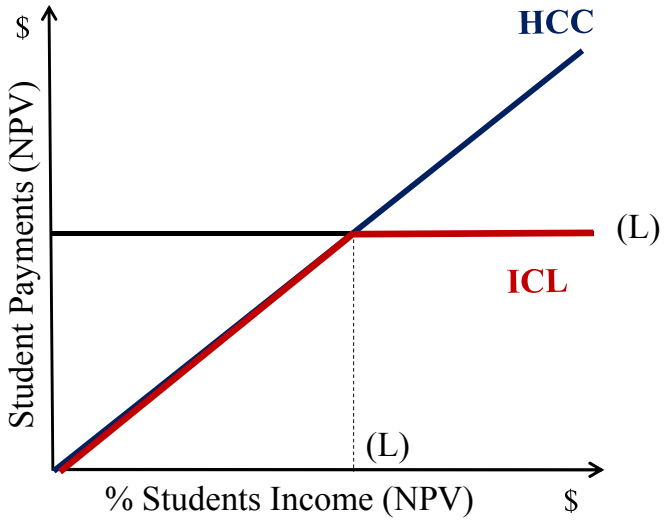
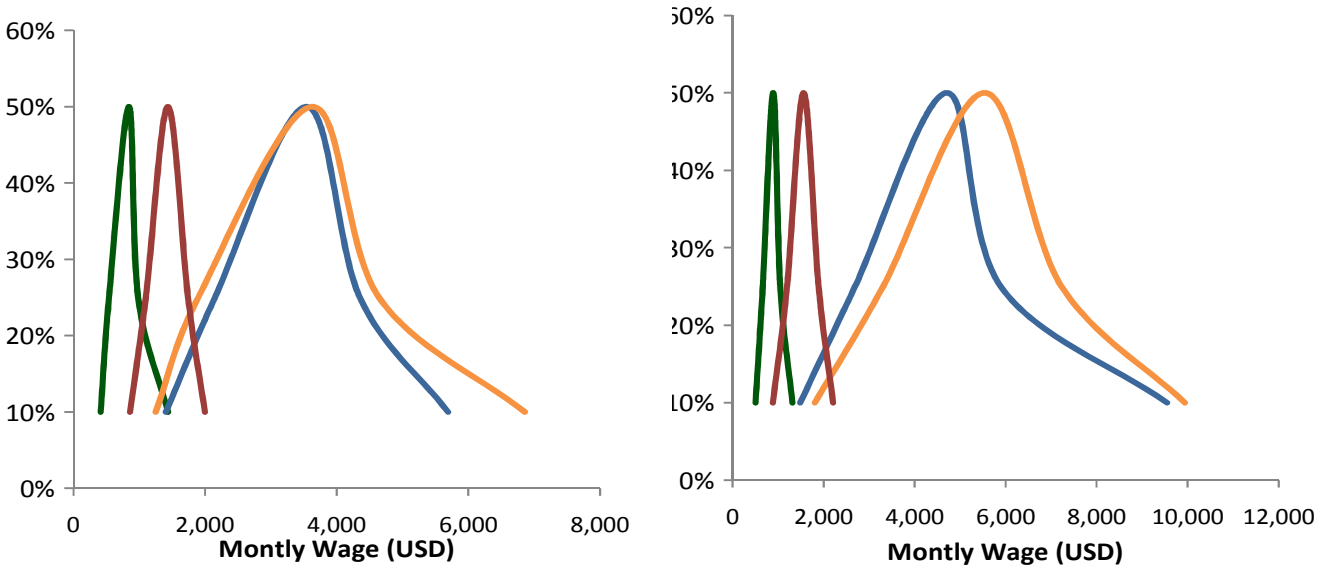


Figure 2. Relationship between Income and Different Financing Instruments Payoffs



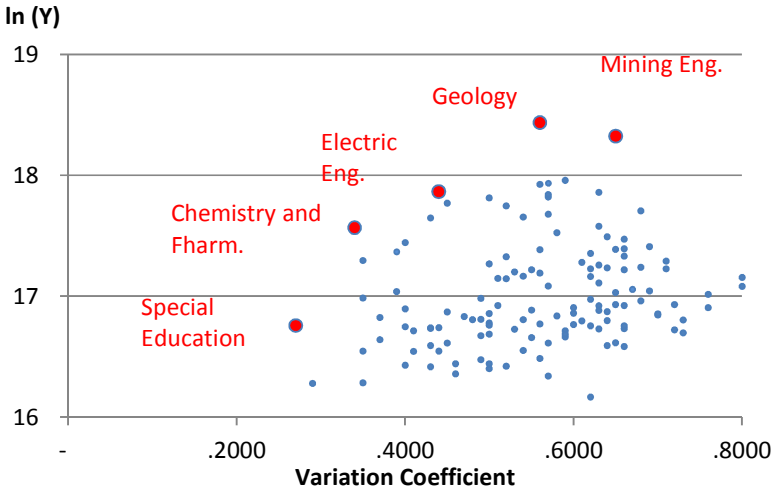
Source: Lumni Research

Figure 3. HE graduates' income – empirical distributions



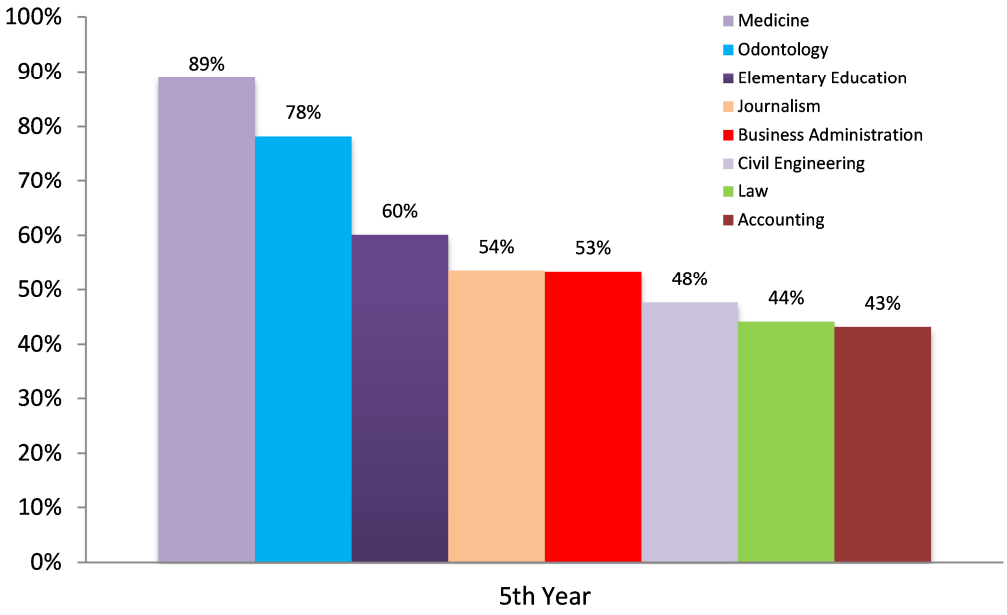
Source: *Futuro Laboral* and Lumni Research calculations.

Figure 4. HE Risk and Return



Source: *Futuro Laboral* and Lumni Research calculations

Figure 5. Fifth-year retention rates – 2004 cohort



Source: Cohort Retention Study, *Consejo Nacional de Educación* (CNED)

Figure 6. γ% - Initial wage and γ% - Wage growth (K=10, s=1)

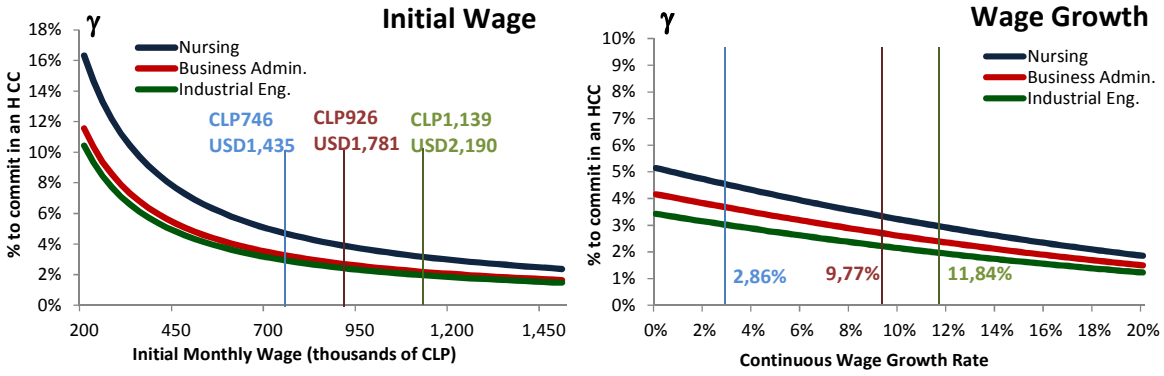


Figure 7. γ% - iInterest rate and γ% - Financed amount (K=10, s=1)

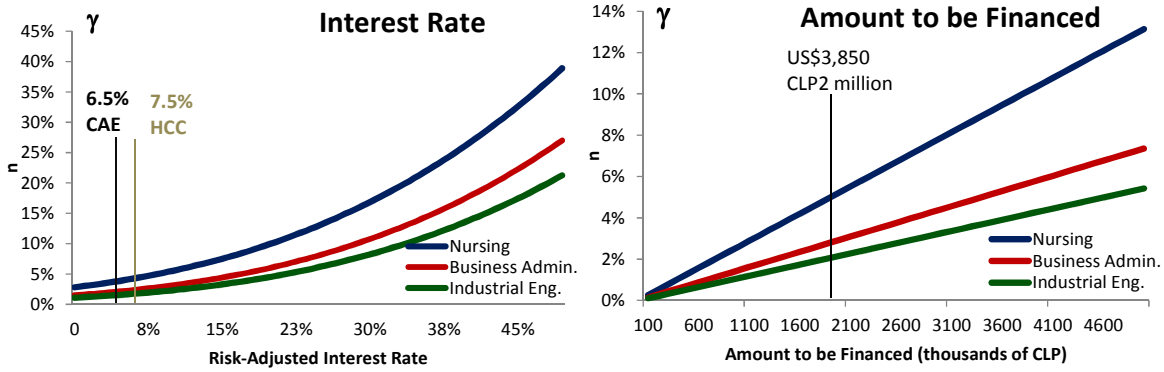


Figure 8. %γ - (a+d+E(u)) and %γ - Repayment Period (s=1)

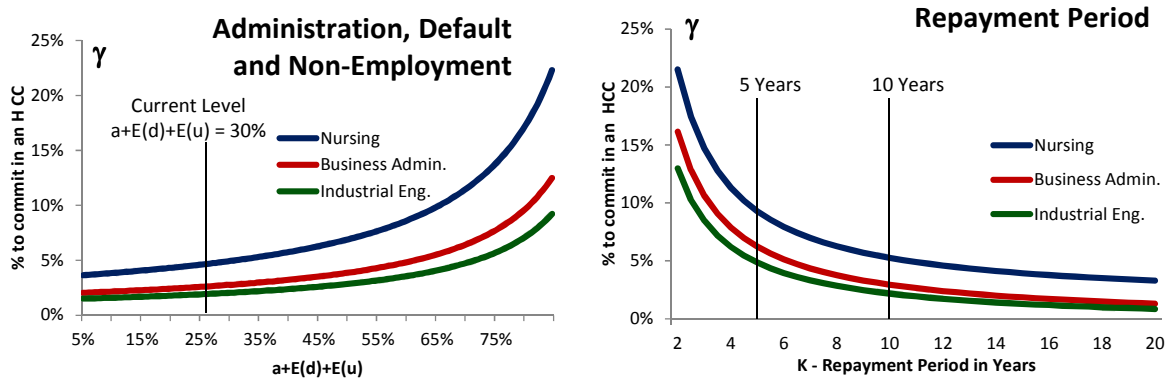


Figure 9. %γ - Graduation rate (K=10, s=1)