Income contingent university loans: policy design and an application to Spain*

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Abstract

In Europe, the need for additional funding coming from either budget cuts and/or increased costs due to increased competition in university quality has reopened the debate on the financing of university systems. An attractive alternative to the current general-tax-financed subsidies are *Income Contingent Loans* (ICL), a flexible scheme that puts more weight on private resources while enhancing progressivity. One challenge of the viability of ICL systems is the functioning of the labor market for university graduates. This paper offers a general analysis of the economics of ICL, followed by an application to Spain. We set up a loan laboratory in which we can explore the distributional effects of different loan systems to finance tertiary education at current costs as well as to increase university funding to improve in its quality. We use simulated lifetime earnings of graduates matching the dynamics of employment and earnings in the Spanish administrative social security data to calculate the burden of introducing ICL for individuals at different points of the earnings distribution and for the government. We find that (1) our proposed structure is highly progressive under all specifications, with the top quarter of the distribution paying close to the full amount of the tuition and the bottom 10% paying almost no tuition; and (2) the share of total university education subsidized by the government is between 16 and 56 percentage points less than under the current system.

JEL Codes: I22, I23, I24

Key words: Income contingent loans, university quality, progressivity

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1 Introduction

In Europe, the need for additional funding coming from either budget cuts and/or increased university quality competition has reopened the debate on the financing of tertiary education. To date, the prevailing system in the OECD relies on general-tax-financed subsidies to higher education institutions. The main advantage of this system lies on its low costs for the students, which end up bearing a small fraction of the total bill. When the main part of university resources is publicly provided, however, government budget cuts have a strong impact on the survival and quality of tertiary education institutions. This can have perverse effects such as making university quality cyclical or exposing higher education institutions to political uncertainty. In addition, tuition fees are flat across the income distribution of students and the subsidy to institutions is financed with taxes from both college and non-college educated families, making the system regressive. Attractive alternatives that circumvent the main issues of the current systems are graduate taxes or income contingent loans (see Diris and Ooghe (2018)). In this paper, we focus on *Income Contingent Loans*, which offers flexibility in different dimensions and puts more weight on private resources while enhancing progressivity with respect to the prevailing system. This paper offers a general analysis of the economics of ICL, followed by an application to Spain.

In a nutshell, an ICL can be characterized as follows. University students obtain a loan from the government to pay their fees (this could also cover maintenance costs). Repayments start upon graduation and depend on ex-post labor income and are paid at low interest rates. There is a minimum exemption income level below which graduates do not need to pay. Repayments are made for a certain number of years up to a maximum established. It is worth noticing that these loans are very different to traditional students loans, which in general have no insurance aspect and payments are not dependent on actual income after graduation.

We first offer a simple theoretical framework to understand how the general-tax-financed subsidies and the ICLs systems work, as well as their comparison from the government, the tax payers and the universities' points of view. This will allow us to understand government spending, subsidies in both systems and tax burdens in both systems. This simple framework allows to comprehend, among other things, why a general-tax-financed subsidies system is highly regressive, while terminating *free* universities would make the system more progressive. It would also become clear that moving from a general-tax-financed subsidies system to an ICL system would free public resources. We discuss the case in which these resources could be used for other public spending as well as the case that these could be used to increase university quality.

One challenge of the viability of ICL systems is the functioning of the labor market for university graduates. To the extent that the labor market features high unemployment rates for the youth and/or high incidence of temporary employment with low and unstable incomes, as in several European countries, a switch from a general-tax-financed subsidies system to an ICL system is non-obvious. In these dysfunctional labor markets, the high volatility that characterizes flows in and out of temporary employment poses a challenge to expected future income and repayments. In this respect, our application to the Spanish case is particularly interesting, given that the labor market shares a wide set of features with other European countries but it is more extreme.

The university system in Spain has struggled to keep up with the the increasing competition from a more globalized labor and education market. The European University Association defines the Spanish university system as *declining and under pressure*, due to a 16% decrease in public funding and an increase of 26% in enrolled students during the period 2008-2016. According to Education at a Glance (OECD (2016)), Spain is at the tail in education spending compared to other OECD countries. Moreover, the percentage allocated to scholarships and student aid is quite small, below 5% overall and 2% for tertiary education.

In contrast to Spain, the United Kingdom (UK) has been working on increasing university resources through a series of reforms implemented during the last two decades. Among other countries in Europe, the UK was one of the precursors in designing a progressive loan system subsidized by the government to finance higher education. The UK has undergone three main reforms during the last 20 years[1] that included increasing fees and designing an income-contingent-loan system. While it is still relatively early to evaluate the long-run effects, the evidence so far reveals that the system has been working reasonably well in the UK, especially in its progressive nature (Dearden et al., 2008; Azmat and Simion, 2017). Our reference application is to study how a loan system similar to that in the UK 2007 reform would work to finance higher education in Spain and study the distributional implications for lifetime income, the burden of repayments on workers, and the cost to the government.

A common feature of countries with the prevailing financing system is the lack of credit markets for university loans. Beyond the extensive participation margin, which is outside the scope of this paper,[2] the availability of borrowing against future human capital can determine the earnings distribution of the skilled workers by improving the allocation of talent. An example relevant to a case like Spain would be geographical mobility.

[1] In 1998, 2007 and 2012.

[2] Azmat and Simion (2017) show that in the UK the increase in university fees together with the introduction of ICL did not affect the participation margin.

Indeed, the main objective of this study is to set up a *loans laboratory* to explore different loan policies and the effects along the income distribution. As mentioned above, one challenge of this exercise will be adding the specifics of the dysfunctional labor market in Spain. In this sense, unlike previous literature, a contribution of this paper is to model permanent and temporary contracts separately.

There is a substantive literature on university funding (see for instance García-Peñalosa and Walde (2000), Diris and Ooghe (2018) and references within) and also several studies have looked into university financing in Spain.[3] Of those, very few have analyzed alternative arrangements to the general-tax-financed status quo. The analysis of the impact of education loans in Spain has been limited to one paper, which focuses on the specific case of loans-to-masters that was implemented in 2007 and lasted only until 2011 (see Collado Muñoz et al. (2017)).[4]

A fundamental element in our loan laboratory are the dynamics of earnings over life. In our analysis, we use simulated lifetime earnings of graduates matching the dynamics of employment and earnings, as well as the earnings cross-sectional distribution, in the Spanish administrative social security data (Muestra Continua de Vidas Laborales y el Módulo Fiscal). Employment transition probabilities are modeled using probit regressions on a set of covariates, including past income and contract duration.

Our framework can replicate the dynamics of employment and earnings in Spain. We use the simulated profiles to calculate the burden of introducing public loans for individuals at different points of the earnings distribution and for the government under different combinations of the aforementioned parameters. We find that (1) our proposed structure is highly progressive under all specifications, with the top quarter of the distribution paying close to the full amount of the tuition and the bottom 10% paying almost no tuition; and (2) the share of total university education subsidized by the government is between 16 and 56 percentage points less than under the current system.

The rest of the paper is organized as follows. In Section 2 we offer a theoretical framework for thinking about the economics of ICLs. In the rest of the paper we analyze the distributional implications of introducing ICLs to Spain. We discuss the simulation of the life-cycle earnings of graduates in Section 3 and then analyze different settings of ICLs in

[3]See, among others, de la Fuente and Jimeno (2011); Beneito et al. (2016); Mora et al. (2002); Escardibul and Perez-Esparrells (2014).

[4]The loans-to-masters program did not prove to be very successful, partly due to the lack of consistency of the conditions (interest rate, repayment horizon, and the like) across years. There was also a grace period stipulated independently of the income level and a monthly fixed repayment, which imposed a heavy burden to graduates at the lower end of the income distribution.

the loan laboratory in Section 4. In Section 5 we offer a discussion of our findings in terms of policy and conclude.

2 The Burden of University Financing: A Theoretical Framework

In this section, we propose a simple theoretical framework to understand the impact of ICLs on public and universities finances, as well as the implied cost for families. We begin by laying out a generic framework in which the government, universities, and individuals interact with each other. We then use that framework to compare the burden of different higher-education financing schemes, starting with the prevailing general-tax-financed subsidies, the intermediate case of a a graduate income tax, and finally the ICLs in more detail.

In addition to the share of the cost born by public and private agents, we will compare the different systems along two dimensions: (1) *between-group progressivity*, or the extent to which these shift the cost of higher education to skilled and away from unskilled workers; and (2) *within-group progressivity*, referring to redistribution across the income distribution of future university graduates.

Three types of agents compose our economy: the government, the public university sector, and workers.[5] Figure 1 summarizes the main features of this section and makes the link between agents explicit. While the earnings dynamics of the workers play a central role, the policy will be evaluated in terms of present values.

Workers

There are two kinds of workers: skilled (s) and unskilled (u), with a mass of N^s and N^u, respectively. Skilled workers are those who have finished college. All individuals live for $T+1$ periods: period $t=0$ is mapped into the 4 years of schooling for the skilled agents.

Resources. Within each group, workers are heterogeneous in their earnings. These earnings are exogenous and evolve in a stochastic fashion. Let y^j_{it} denote the individual earnings of a worker i of type j ($j=s,u$) in period t. The specific dynamics of earnings will be discussed in detail in the next section. For this section, it suffices to assume that the average skilled earnings are higher than the average unskilled earnings at all times. Unskilled workers begin receiving earnings in period 0, while skilled workers have to wait until period 1 to receive wages. Depending on the specific financing scheme, skilled workers can receive transfers from

[5]We abstract from unemployed individuals for the moment since the relevant burden measures are not affected by their presence. In the empirical section, workers will be allowed to become unemployed.

the government during the schooling years, denoted by g_H^E, in the form of grants or loans to cover fees and maintenance. We assume these transfers are the same for all university graduates. Similarly, unskilled workers can receive transfers g^{-E} from the pool of public resources that are not devoted to financing higher education.

Expenses. All workers pay income taxes. We assume workers in the same group face the same proportional income tax and that $\tau^s > \tau^u$, which captures the progressive nature of the tax code in a simplified manner. In addition, skilled workers' expenses include college fees f whenever they are in college and loan repayments whenever applicable. Workers *eat* everything left after covering fees, loan, and tax payments. We denote this residual consumption of the numeraire good as c_i.

Government

Resources. The only public resources are the income taxes paid by the workers, as described in subsection 2. The total resources of the government are therefore given by

$$T \ = \ \tau^s Y^s + \tau^u Y^u, \tag{1}$$

where $Y^j = \sum_{t=1}^{T} Y_t^j$ and $Y_t^j = \int_{i \in \mathcal{S}} y_{it}^j$, for $j = s, u$, where $\mathcal{S}$ is the set of skilled workers. That is, Y^j denotes aggregate lifetime earnings of workers of type j.

Expenses. Let G denote total public spending. We decompose G into two components:

$$G \ = \ G^E + G^{-E}, \tag{2}$$

where G^E denotes public spending devoted to financing public higher education and G^{-E} all other public spending. It will be useful to further decompose the amount of government spending in education G^E into payments directly made to institutions G_I^E and transfers to households $G_H^E = N^s g_H^E$.

We assume the government runs a balanced budget:

$$T \ = \ G^{-E} + G_I^E + G_H^E. \tag{3}$$

Using equations (2) and (3), and given our assumption that income taxes are proportional to earnings, we can also decompose the resources T into those that are used for higher education and those that are not as follows:

$$T \ = \ (\tau_e^s + \tau_{-e}^s)Y^s + (\tau_e^u + \tau_{-e}^u)Y^u, \tag{4}$$

where τ_e^j and τ_{-e}^j $(j = s, u)$ are artificial taxes that will depend on the actual income tax rate and the specific higher education financing scheme. This accounting distinction will be useful to define the burden of public financing on individuals.

University Sector

Resources. Public universities get funding from the government (G_I^E) as well as out of pocket fees paid for by the individuals directly $F = N^s f$.

Expenses. Universities need a minimum payment of C in the form of running costs. C can be thought of as including current professor salaries, maintenance, and the like. In addition, universities could shift extra resources to improve quality. Let $I(Q)$ denote the investment in university quality. We assume there is a basic level of quality $\underline{Q}$ achieved by simply running the university and paying C. That is, $I(\underline{Q}) = 0$. As a result, $I(Q)$ is the amount of university resources, in addition to the maintenance costs, that achieves a level of quality equal to $Q > \underline{Q}$. Higher quality will result in skilled earnings that are $A(Q)$ times higher.

The university budget constraint is therefore given by

$$G_I^E + F = C + I(Q) \tag{5}$$

Using this theoretical framework, we next proceed to introduce the specifics of different higher-education financing systems. For illustration, we will make the following the assumptions when comparing the different systems: (1) We keep quality at its base level so that $I(\underline{Q}) = 0$, which can be understood as $\underline{Q}$ being the current level of value added of university education. (2) The total cost of universities is fixed at $\bar{C}$. (3) Total public spending is fixed at $\bar{G}$ and the budget of the government is balanced, so the resources $\bar{T}$ are fixed as well. (4) We take the earnings streams $\{y_{ia}^s\}_{i\in\mathcal{S},a=1,\ldots,T}$ and $\{y_{ia}^u\}_{i\in U,a=1,\ldots,T}$ as given. Assumptions (3) and (4) also impose fixed total income taxes $\bar{\tau}^u$ and $\bar{\tau}^s$. These assumptions mean we will be evaluating the impact of revenue neutral policy changes in terms of burden shifts between agents.

More specifically, the different financing systems are going to be compared in terms of how they shift the total cost of higher education $\bar{C}$ between the public and private sector, how much of the public burden is paid by non-university graduates, and the degree of redistribution within university graduates. Table 1 summarizes the key dimensions for such comparison that we analyze in detail in the next subsections. Whenever comparing systems, to clearly differentiate the different variables corresponding to each scheme, we define

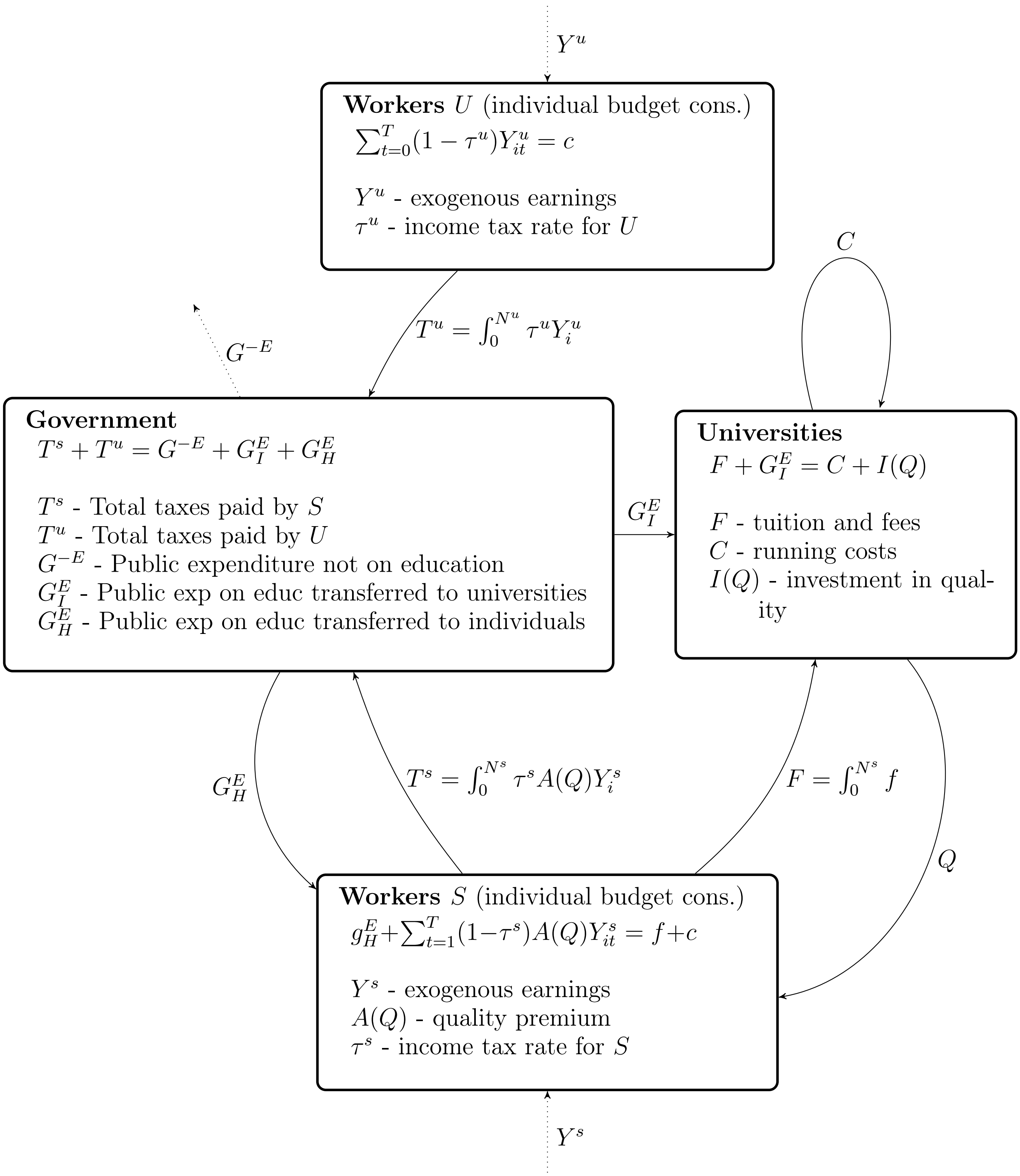


Figure 1: Theoretical Framework Summary

$F(system)$, $\tau_e^j(system)$, and $\tau_{-e}^j(system)$ as the level of fees, taxes to finance education, and remaining taxes, under each system GTF, GT, ICL.

2.1 General-tax-financed subsidies

We begin by discussing the system that is currently in place, in which university resources come predominantly from direct subsidies from the government, covering around 80% of the total cost of universities. The remaining 20% is paid for by the users at the time of paying tuition. This is the prevalent system in Europe.[6] The public subsidies are financed similarly to any public service using general taxes, hence its name. While the government offers some grants and fellowships to students, they are very small and the big part of the subsidy comes from the direct transfers to institutions. For illustrative purposes, we will assume public transfers to individuals for the purpose of paying for higher education are zero. Using the general framework developed above, that means $G_H^E = 0$ and $G^E = G_I^E$.

Therefore, the total cost of higher education $\bar{C}$ is split between the government and the university-graduates: $\bar{C} = G^E + F$. Given a level of fees F, $G^E = \bar{C} - F \geq 0$ is financed with general education resources $\tau_e^s Y^s + \tau_e^u Y^u$. In other words, everybody, independently of whether they attended university or not, contributes to university resources through the general income tax. In addition to their share of income taxes, skilled workers pay the full amount of fees for attending university, which is the same for all university-graduates.

2.2 Graduate Tax

Before moving on to our proposed ICL policy, it is worth discussing the case of the graduate tax. This type of system is used by some public universities in Uruguay. A graduate tax consists of shifting the total cost of higher education entirely to those that benefit from it through deferred payments in the form of a tax upon graduation and until retirement.

In that sense, the total cost of higher education $\bar{C}$ is financed entirely by the university-graduates through an income tax (in addition to the regular income tax) ϕ, without upfront or tuition payments. We can think of this as the government paying for the cost $\bar{C}$ initially and then recovering the full amount in the future, so that, in present value $G^E = \bar{C} - \Phi = 0$, where $\Phi = \phi Y^s$ denotes the total revenue from the graduate-tax. A consequence of $G^E = 0$ is that income taxes of the unskilled workers are never used to subsidy higher education, or $\tau_e^u = 0$. In addition to their share of income taxes $\bar{\tau}^s$, skilled workers pay the graduate tax, adding up to a total burden for university graduates of $(\bar{\tau}^s + \phi)Y^s$. Notice that this amount

[6] Countries such as England and The Netherlands have transitioned to an ICL scheme, but the majority of the European countries still maintain this system.

Table 1: Comparison of the Three Systems: Summary

GTF

Fees (upfront)	$F(GTF)$ (given)		
G^E	$\bar{C} - F(GTF) > 0$		
Public Savings	0		
Financing $\bar{C}$	**Gen.-Tax**	+	**Out of Pocket**
$Burden_e^u$	$\tau_e^u(GTF)Y^u$	+	0
$Burden_e^s$	$\tau_e^s(GTF)Y^s$	+	$F(GTF)$
Within-Group Prog.	**Gen.-Tax**	+	**Out of Pocket**
$Burden_{e,p10}^s$	$\frac{G^E}{\bar{G}}\bar{\tau}^s = \tau_e^s(GTF)Y^u$	+	$F(GTF)$
$Burden_{e,p90}^s$	$\tau_e^s(GTF)Y^s$	+	$F(GTF)$
Ratio	$\frac{\tau_e^s(GTF)Y_{p90}^s+F(GTF)}{\tau_e^s(GTF)Y_{p10}^s+F(GTF)}$		

GT

Fees (upfront)	$F(GT) = 0$		
G^E	$\bar{C} - \Phi = 0$		
Public Savings	$\Phi - F(GTF) = \bar{C} - F(GTF)$		
Financing $\bar{C}$	**Gen.-Tax (G^E)**	+	**Out of Pocket**
$Burden_e^u$	0	+	0
$Burden_e^s$	0	+	ϕY^s
Within-Group Prog.	**Gen.-Tax (G^E)**	+	**Out of Pocket**
$Burden_{p10}^s$	0	+	ϕY_{p10}^s
$Burden_{p90}^s$	0	+	ϕY_{p90}^s
Ratio	$\frac{Y_{p90}^s}{Y_{p10}^s}$		

ICL

Fees (upfront)	$F(ICL) = \bar{C}$		
G^E	$\bar{C} - \int_{i\in S}\sum_a^{\bar{a}_i} P_{ia} > 0$		
Public Savings	$\int_{i\in S}\sum_a^{\bar{a}_i} P_{ia} - F(GTF)$		
Financing $\bar{C}$	**Gen.-Tax (G^E)**	+	**Out of Pocket**
$Burden_e^u$	$\tau_e^u(ICL)Y^u$	+	0
$Burden_e^s$	$\tau_e^s(ICL)Y^s$	+	$\int_{i\in S}\sum_a^{\bar{a}_i} P_{ia}$
Within-Group Prog.	**Gen.-Tax (G^E)**	+	**Out of Pocket**
$Burden_{p10}^s$	$\frac{G^E(ICL)}{\bar{G}}\bar{\tau}^s = \tau_e^s(ICL)Y_{p10}^u$	+	$\int_{i\in p10}\sum_a^{\bar{a}_i} P_{ia} = \epsilon$
$Burden_{p90}^s$	$\tau_e^s(ICL)Y_{p90}^s$	+	$\int_{i\in p90}\sum_a^{\bar{a}_i} P_{ia} \approx \bar{C}$
Ratio	$\frac{\tau_e^s(ICL)Y_{p90}^u+\bar{C}}{\tau_e^s(ICL)Y_{p10}^u+\epsilon}$		

is again the same for all university-graduates. Given that we are assuming fixed $\bar{C}$, it has to be the case that:

$$\begin{aligned} \bar{C} = \Phi = \phi Y^s &= F(GTF) + \tau_e^s(GTF)Y^s + \tau_e^u(GTF)Y^u \\ \phi &= \frac{F(GTF) + \tau_e^s(GTF)Y^s + \tau_e^u(GTF)Y^u}{Y^s} \end{aligned} \tag{6}$$

2.3 Income Contingent Loans

We propose an income contingent loan (ICL) system. ICLs have become a popular alternative to general-tax-financed (GTF) subsidies among developed countries.[7] This system is in spirit similar to the Graduate-Tax, but its structure is more complex and flexible, allowing for varying degrees of cost shifting, as will become clear in the subsequent discussion. The key feature of ICLs is the combination of private contributions, in the form of repayments contingent to future income; and government subsidies, given directly to the individuals in the form of debt write-off and repayment exemptions.

For the purpose of this description, we will focus on the extreme case where the fees cover the total cost of education in present terms, which makes it comparable to the GT case discussed above: $F = \bar{C} = \Phi$. This implies that $G_I^E = 0$ and $G^E = G_H^E = F = \bar{C}$. We will briefly comment on intermediate cases in the discussion below. We begin by introducing the elements that characterize the loans and repayments and then proceed to discuss the implied burdens.

A Rich Set of Instruments

An attractive feature of ICLs is the flexibility in its design compared to other progressive financing alternatives, such as a graduate tax. A rich number of instruments are combined to achieve varying degrees of public savings and progressivity:

- $d-$ Principal: total tuition fees over all years + maintenance (maybe)
- $p-$ Repayment rate: fraction of gross earnings that is used for repayment
- $x-$ Exemption level above which workers start repaying debt
- $m-$ Write-off year after which the debt is canceled

[7] In Europe, Hungary, the Netherlands, and the United Kingdom adopted ICLs in the last decade, see (Diris and Ooghe, 2018). Outside Europe, Australia and New Zealand have been pioneers of this scheme.

$r-$ Interest rate of debt

University students obtain a loan d from the government during schooling years to pay their fees and, possibly, room and board. Repayments start upon graduation and are a fraction p of ex-post labor income and are paid at low interest rates (r). There is a minimum exemption income level x below which graduates do not need to pay. Repayments are made for a certain number of years up to a maximum established (m). Because of the nature of this repayment scheme, it will be useful to adopt a life-cycle perspective and think of a period as an age year, denoted by a. In the remaining of this section, we discuss the main elements of debt repayment in detail.

Income-Contingent Repayment. Repayment is contingent on income and the first x euros are exempt for everyone. That means that those who earn less than x do not repay in a given year, and the rest pay a fraction of their income above x. We define non-exempt earnings for individual i at age a as:

$$Y_{i,a}^{NE} = \max\left\{Y_{i,a} - x, 0\right\}$$

Let $\bar{a}_i$ be the full-repayment age of individual i. Annual payments for individual i at age a are therefore calculated as

$$P_{i,a} = \begin{cases} pY_{i,a}^{NE} & \text{if } a < \bar{a}_i \\ \min\left\{(1+r)D_{i,a-1}, pY_{i,a}^{NE}\right\} & \text{if } a = \bar{a}_i \\ 0 & \text{if } a > \bar{a}_i \end{cases} \tag{7}$$

where $D_{i,a-1}$ is the outstanding debt of individual i at the beginning of age a and, therefore, predetermined in period $a-1$. Equation (7) states that repayment is fixed and proportional to the non-exempt amount of earnings, resembling a graduate tax. Notice that the only dependence of payments on the outstanding debt $D_{i,a}$ appears in the last period of debt repayment and simply to indicate that, should the fixed payment of pY^{NE} exceed the remaining debt plus interests, then only the remaining debt has to be paid.

Full-repayment age. Graduates pay for a maximum of m years unless they have been able to pay their complete debt before in which case their full-repayment age is when their last payment pays is able to cover their outstanding debt

$$\bar{a}_i = \min \left\{ m, \widetilde{a} \text{ s.t. } \sum_{a=1}^{\widetilde{a}} P_{i,a} \geq D_{i,\widetilde{a}} \right\} \quad (8)$$

Debt. Starting from $D_{i,0} = d$, outstanding debt is calculated at the end of each period as $D_{i,a} = (1+r)D_{i,a-1} - P_{i,a}$ until the repayment age. A full description of the repayment structure and explicit formulas for $D_{i,a}$ and $\bar{a}_i$ can be found in Figure 2 and equation (8) below.

Therefore, the total cost of higher education $\bar{C}$ is split between the government and the university-graduates: $\bar{C} = G^E + \int_{i \in \mathcal{S}} \sum_{t=1}^{\bar{a}_i} P_{it}$. A useful way to think about public financing in this system is to assume university-graduates pay the full amount of fees and can obtain a loan for the same amount immediately. As a result, the fees cancel in the government budget and G^E covers the part of the fees that university-graduates are not able to repay: $G^E = \bar{C} - F + F - \int_{i \in \mathcal{S}} \sum_{t=1}^{\bar{a}_i} P_{it} > 0$. In addition to their share of income taxes, skilled workers pay a share of the loan given by their income history, which is different for each university-graduate, adding up to a total burden for university graduates of $\bar{\tau}^s Y^s + \int_{i \in \mathcal{S}} \sum_{t=1}^{\bar{a}_i} P_{it}$. Notice that, similarly to GTF, and in contrast to GT, $G^E \geq 0$ is financed with general education resources $\tau_e^s Y^s + \tau_e^u Y^u$. We will discuss in the next subsection how $\tau_e^u(GTF)$ and $\tau_e^u(ICL)$ compare, as well as the conditions under which ICLs imply a public savings compared to GTF and the advantages over GT.

2.4 Comparing the Three Systems

Next, we will use all the information in subsections 2.1, 2.2, and 2.3 to summarize the distributional implications of each system in two results. For the sake of clarity, we relegate the calculations and details to Appendix A.

Result 1: *Between-group progressivity (the ratio of the burden for non-university- and university-graduates) is highest (lowest) under the GT system and, provided a minimum level of debt repayment under ICL, lowest (highest) under GTF.*

We focus on the total burden of each system for the workers, defined as $Burden^j$ $(j = u, s)$, that measures the cost of financing the public sector $\bar{G}$, including the financing of the university sector G^E, the non-university-sector G^{-E}, plus possible out of pocket spending on the payment of fees. At this point, it is necessary to make an

Table 2: ICL Repayment Scheme

Period	Initial debt	Resources	Payments: Educ related	Payments: Other	Outstanding debt	Eat
$a=0$ (College)	0	d (principal)	f (tuition and fees)	0	$D_0=d$	$c_0=d-f$
$a=1$	$(1+r)D_0$	Y_1	$P_1=pY_1^{NE}$	$\tau^s Y_1$	$D_1=(1+r)D_0-P_1$ $=(1+r)d-pY_1^{NE}$	$c_1=Y_1-pY_1^{NE}-\tau^s Y_1$
$a=2$	$(1+r)D_1$	Y_2	$P_2=pY_2^{NE}$	$\tau^s Y_2$	$D_2=(1+r)D_1-P_2$ $=(1+r)^2 d-p\left[(1+r)Y_1^{NE}+Y_2^{NE}\right]$	$c_2=(1-\tau^s)Y_2-p(Y_2-x)$
⋮						
⋮						
a	$(1+r)D_{a-1}$	Y_a	$P_a=pY_a^{NE}$	$\tau^s Y_a$	$D_a=(1+r)D_{a-1}-P_a$ $=(1+r)^a d-p\sum_{j=1}^{a}\left[(1+r)^{a-j}Y_j^{NE}\right]$	$c_a=(1-\tau^s)Y_a^s-p(Y_a-x)$
⋮						
$a=\bar{a}$ (Full repayment)	$(1+r)D_{\bar{a}-1}$	$Y_{\bar{a}}$	$P_{\bar{a}}=\min\left\{(1+r)D_{\bar{a}-1},pY_{\bar{a}}^{NE}\right\}$	$\tau^s Y_{\bar{a}}$	$D_{\bar{a}}=0$	$c_{\bar{a}}=(1-\tau^s)Y_{\bar{a}}^s-P_{\bar{a}}$
$T\geq a>\bar{a}$	0	Y_a	0	$\tau^s Y_a$	0	$c_a=(1-\tau^s)Y_a^s$

assumption about the use of the resources shifted out of the public sector when moving away from the GTF system. One option is to think of it as investment in other public services, such as primary public education, which could benefit both types of workers. For simplicity and without affecting our main results, we will assume that the extra amount of G^{-E} will entirely be used as transfers to low-income families. For comparison, we take fees in the GTF as given by the status quo and write the formulas as a function of these, as well as of previously defined fixed policy parameters.

We first define $PublicSavings$ is defined for each system with respect to the current GTF system:

$$\begin{aligned} PublicSavings(GTF) &= 0 && (9)\\ PublicSavings(GT) &= \Phi - F(GTF) = \bar{C} - F(GTF) && (10)\\ PublicSavings(ICL) &= \int_{i\in\mathcal{S}} \sum_{a=1}^{\bar{a}_i} P_{ia} - F(GTF). && (11)\end{aligned}$$

We can now concisely define the ratio that characterizes between-group progressivity:

$$\frac{Burden^u(system)}{Burden^s(system)} = \frac{\bar{\tau}^u Y^u - PublicSavings(system)}{\bar{\tau}^s Y^s + F(GTF) + PublicSavings(system)} \quad (12)$$

Assuming the repayment share in the ICL case is sufficiently large so that Result 1 holds, it is easy to see that

$$PublicSavings(GT) \geq PublicSavings(ICL) > PublicSavings(GTF) \quad (13)$$

with equality if there is full repayment, which concludes our discussion of Result 2.

Result 2: *Within-group progressivity (redistribution between university graduates) is zero under GTF and GT, beyond the progressivity of the income tax code.*

Let $Burden^s_{prc}$ denote the corresponding burden for a subgroup of skilled workers in the percentile prc of the earnings distribution. We will define within-group progressivitiy as the ratio of the burden for those university-graduates on the top 10% of the income distribution (group $p90$) and the burden for those university-graduates on the bottom 10% of the income distribution (group $p10$) , as follows:

$$\frac{Burden^s_{p90}(GTF)}{Burden^s_{p10}(GTF)} = \frac{\bar{\tau}^s Y^s_{p90} + F(GTF)}{\bar{\tau}^s Y^s_{p10} + F(GTF)} \tag{14}$$

$$\frac{Burden^s_{p90}(GT)}{Burden^s_{p10}(GT)} = \frac{\bar{\tau}^s Y^s_{p90} + \Phi}{\bar{\tau}^s Y^s_{p10} + \Phi} = \frac{(\bar{\tau}^s + \phi) Y^s_{p90}}{(\bar{\tau}^s + \phi) Y^s_{p10}} = \frac{Y^s_{p90}}{Y^s_{p10}} \tag{15}$$

$$\frac{Burden^s_{p90}(ICL)}{Burden^s_{p10}(ICL)} = \frac{\bar{\tau}^s Y^s_{p90} + \int_{i \in p90} \sum_a^{\bar{a}_i} P_{ia}}{\bar{\tau}^s Y^s_{p10} + \int_{i \in p10} \sum_a^{\bar{a}_i} P_{ia}} \approx \frac{\bar{\tau}^s Y^s_{p90} + \bar{C}}{\bar{\tau}^s Y^s_{p10} + \epsilon}, \tag{16}$$

where $Y^s_{prc} \equiv \int_{i \in p10} Y_i$, for $prc = p10, p90$, and ϵ is used to denote a small amount, always smaller than $F(GTF)$. The last relation in equation (16) follows from our empirical results in the next section for all reasonable parameter combinations.

It is very easy to see in equations (14) and (15) that there is no redistribution from top to bottom earners under the GTF and GT systems, beyond the intrinsic differences in income and income taxes. Looking at the same part of equation (16) for ICL, however, the top earners end up paying nearly the full amount of the cost of universities while the bottom earners pay even less than in the GTF case.

We conclude this section by discussing both the importance of the combination of the between-group and within-group progressivities in each system. To make our point, we take the extreme case of the US higher education system, where fees cover the total cost and commercial banks offer classic loans. As mentioned in the introduction, these traditional loans are very different to income contingent loans as repayments are not a function of future income nor they allow for write-offs or exemptions. Moreover, these traditional loans are repaid at the market rate. This system does feature total between-group progressivity, similarly to the GT, but they do not have any progressivity component within the university graduates. Actually, within-progressivity tends to be negative because higher earning graduates repay their loan faster and thus paying less in terms of accumulated interests than the lower earning graduates, who end up accumulating large amounts of debt over time. This example highlights the importance of considering both kinds of redistributions and, while this case is more extreme, is reminiscent of the case of the GT, where the within-group component is not negative but it is close to zero. In this sense, the ICL offers a balanced combination of both between and within progressivity through a rich set of instruments.

In the rest of the paper we analyze the distributional implications of introducing ICLs to Spain. In other words, the degree of within-progressivity of different specifications of ICLs. In order to do so, we first need to simulate the life-cycle earnings of graduates using a model of earnings dynamics and employment transitions. We do so in the next section.

3 Simulating Life-Cycle Earnings Dynamics

While many of the elements of our ICL design are policy instruments that will be analyzed within the context of our application, there is one element that needs empirical discipline: the life-cycle dynamics of earnings. We simulate these using a estimated model that combines employment transitions and earnings dynamics.

3.1 The Data: Social Security and Tax Records

We use administrative data from the Continuous Sample of Working Histories (MCVL hereafter, for its acronym in Spanish) on earnings and working histories of Spanish workers. The data is provided by the Spanish Social Security Administration in cooperation with the IRS counterpart in Spain. In this section we give an overview of the data source and a description of our sample. For the database specifics and more details we refer to Section 2 in Bonhomme and Hospido (2013).

The MCVL consists of a 4% representative random sample of all workers affiliated with the social security administration within a given year between 2004 and 2015. We use data starting in 2005, when the sample has a panel design: all individuals present in each wave subsequently remain in the sample. Retroactive information on the whole working history is provided as early as 1962 for work variables and 1980 for earnings. Bonhomme and Hospido (2013) show that the sample is representative at least since the late 1980s. The information from the Social Security records can be obtained at a daily frequency, but earnings are often top-coded at a preset industry-specific threshold. We complement the earnings data with an IRS supplement matched to the Social Security records. The tax supplement contains non-top-coded information on annual earnings. Our baseline frequency will therefore be annual.

Sample Selection

We select college graduates that are at least 22 and at most 60 years old.

Main Variables

Earnings. The earnings data are extracted from the "Annual summary of retentions and payments for the personal income tax on earnings, economic activities, awards, and income imputations" (known as *Modelo 190*). All employers are required to fill out *Modelo 190* with the total compensation paid to each of their employees during the year, independently of whether or not they pay labor income taxes. To obtain a measure of total annual labor earnings, we add all the incomes that correspond to each worker during the reference year.

All amounts are deflated to 2011 euros. We exclude self-employment income.

Annual Employment Status. Given that our period of observation is one year, it is not uncommon to find workers that hold different simultaneous jobs or that change jobs within the same year. In some cases, some of those contracts are temporary and some permanent. This poses a challenge when defining employment spells at the annual level. We define employment status in terms of share of annual time spent in each kind of job: permanent, temporary, or none. Workers who have zero annual earnings or earn less that the corresponding amount to a month minimum-wage salary are considered unemployed.

Lifetime Earnings Quantiles. Using our longitudinal data we calculate lifetime earnings for every individual assuming no discount rate. This in turn determines in which quantile of the lifetime earnings distribution every individual is. We group individuals according to this variable to understand progressivity in our loan laboratory.

3.2 Employment Transitions

We adapt the framework of Dearden et al. (2008) for the Spanish labor market. A key contribution of this paper is to allow for differentiated levels of labor market attachments to capture realistic job transitions in two-tier markets, as it is the case in Spain.

At each point in time, a worker can be in one of three statuses: unemployed (U), employed in a permanent contract (P), and employed in a temporary contract (T). Let Π be the transition matrix that determines the probabilities of entering status s_t from status s_{t-1}.

$$\begin{pmatrix} P_t \\ T_t \\ U_t \end{pmatrix} = \underbrace{\begin{pmatrix} \pi_t^{PP} & \pi_t^{PT} & \pi_t^{PU} \\ \pi_t^{TP} & \pi_t^{TT} & \pi_t^{TU} \\ \pi_t^{UP} & \pi_t^{UT} & \pi_t^{UU} \end{pmatrix}}_{\Pi_t} \begin{pmatrix} P_{t-1} \\ T_{t-1} \\ U_{t-1} \end{pmatrix}, \tag{17}$$

where

$$\pi_t^{jk} \equiv Pr\left(s_t = k \mid s_{t-1} = j\right) \text{ for } i, j = P, T, U$$

We estimate these transitions with probit regressions by regressing a dummy variable that takes 1 in the case of a transition on a constant, a quartic in age, and additional covariates depending on the type of the transition. In particular,

$$\pi^{s_{t-1},s_t} = \begin{cases} \Phi\left(\beta_1^y y_{t-1} + \beta_2^y y_{t-1}^2\right) & \text{if } (s_{t-1},s_t) \in \{(P,T),(P,U),(T,U)\} \\ \Phi\left(\beta_1^d dur1_{t-1} + \beta_2^d dur2_{t-1}\right) & \text{if } (s_{t-1},s_t) \in \{(U,P),(U,T)\} \\ \Phi\left(\beta_1^y y_{t-1} + \beta_2^y y_{t-1}^2 + \beta_1^d dur1_{t-1} + \beta_2^d dur2_{t-1}\right) & \text{if } (s_{t-1},s_t) \in \{(T,P)\} \end{cases}, \tag{18}$$

where

$$\begin{aligned} dur1_t &\equiv I\{s_t = j \mid s_{t-1} = k \text{ and } j \neq k\} \text{ for } i,j = P,T,U \\ dur2_t &\equiv I\{s_t = j \mid s_{t-1} = k \text{ and } j = k\} \text{ for } i,j = P,T,U \\ y_t &\equiv \text{ log earnings in } t \\ \Phi &\equiv \text{Normal distribution } cdf \end{aligned}$$

denotes whether the worker had spent one of more years in the initial state. For example, in the case of a transition from unemployed to permanent $(s_{t-1}, s_t) = (U, P)$, $dur1_{t-1} = 1$ if the worker was unemployed only for one period last year, and $dur2 = 1$ if the worker had been unemployed for two or more periods last year. All specifications include a constant and a quartic in age in the set of regressors, that we have omitted for the sake of exposition.

At the beginning of an employment spell within a contract, each worker draws a level of earnings determined by its previous status and age. This type of transition earnings will be explained in detailed below.

3.3 Earnings Dynamics

Transition Earnings

Whenever the worker changes status, we estimate the new initial earnings as a function of age, duration of previous spell, and past earnings.

More specifically, let

$$y_t^{ss'} \equiv y\left(s_t = s' | s_{t-1} = s\right)$$

denote log earnings at t of a worker who just moved from status s to s'.

We pose the following specification for the log of earnings in the first year at the new status:

$$\log Y_t^{ss'} \quad = \quad \beta_1 dur1_{t-1}^s + \beta_2 dur2_{t-1}^s + \beta_2 y_{t-1}^L + \xi_t,$$

where y_{t-1}^L denotes the level of earnings in the previous status s if $s \in \{P, T\}$, the last earnings observed if $s = U$ and the worker has been unemployed for only 1 year, or a dummy that equals 1 indicating that the last level of earnings is missing in the case of $s = U$ and the worker has spent 2 or more years unemployed. $dur1$ and $dur2$ are as above. A constant and a quartic in age are also included in the set of regressors.

Continuation Earnings

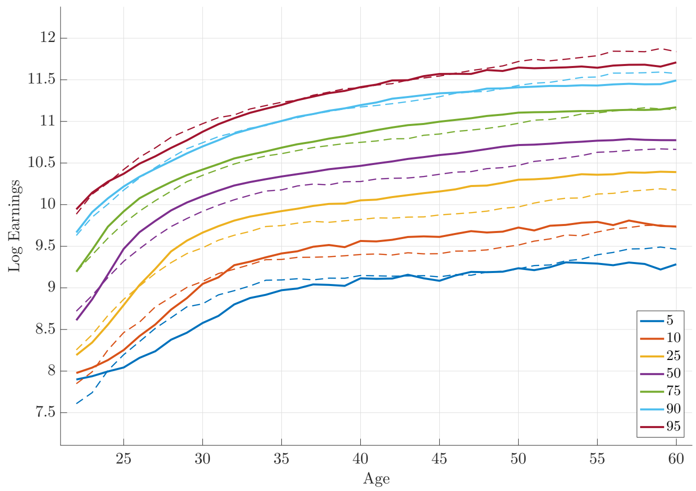
If the worker remains in the same job status, earnings follow a flexible age-dependent autoregressive process. The basic statistical framework follows Karahan and Ozkan (2013) and emphasizes the age dynamics of persistence and volatility of earnings. In particular, we borrow the specifics and estimates from our companion paper Cabrales et al. (2018), where we show the importance of allowing the type of contract – temporary or permanent – to influence uncertainty, and earnings dynamics in general, in the case of a fragmented labor market like the Spanish one.

In a nutshell, continuation earnings follow an ARMA(1,1) stochastic process with fixed effects and profile heterogeneity. To capture the evolution of uncertainty over life, the persistence of the AR(1) component and the variance of both idiosyncratic shocks are functions of age and contract. We introduce contract-specific uncertainty by separately estimating the process for a sample of workers that have spent most of their life linking temporary contracts. The idea is to capture that continuation within temporary contracts entails more uncertain earnings than continuation within permanent contracts. The parameters are estimated by minimizing the distance between the empirical and the model-implied covariance matrix using Generalized Method of Moments with efficient weighting matrix.

Simulation Fit

We combine the employment transitions and earnings dynamics estimates to simulate the earnings of 20,000 individuals between the ages of 22 and 60. Figure 2 compares the data (solid) and the simulated (dashed) cross-sectional distribution of earnings at each age. More specifically, Figure 2 plots different percentiles of the earnings distribution, for a given age, and therefore characterizes the evolution of the cross-sectional distribution of earnings for the purpose of comparing the fit to the data. Overall, our statistical model does a good job matching the distribution of earnings at all ages.

Figure 2: Quantiles of Log earnings: Data (solid) vs. Simulation (dashed)



4 Loans Laboratory

We next use the panel of simulated lifetime income profiles $\left\{\{Y_{i,a}\}_{a=22}^{60}\right\}_{i=1}^{N}$ to study the implications of introducing a menu of public income-contingent loans in Spain. Remember the basics of our model: fees can be deferred until starting to work, repayments will depend on ex-post labor income and minimum exemption, and there will be a debt write-off and low interest rates.

We start describing the current general-tax-financed subsidies in Spain in the next subsection. Then, in subsection 4.2, we consider several policy experiments modifying the different parameters of the ICLs. Finally, in subsection 4.3, we consider the effects of using the potential additional resources generated by ICLs to increase university quality.

4.1 Current Subsidies in Spain

The current university financing system in Spain is basically characterized mostly by subsidies to universities coming from general income taxes.The following are the key figures of the current costs and subsidies in Spain (see de la Fuente and Boscá (2014)). For 2010, average total expenditure by the government across different universities and programs in Spain is around $8,900$ million euros. That year, households spent around 2,600 million euros in higher education. This means that the share of public resources in public education in Spain, or the subsidy defined in equation (24) below, is around 80%. We will use this benchmark in our policy experiments in the next subsection.

4.2 Policy Experiments

For each of the parameters defined in Section 2.3, we evaluate different sets of values that can be thought of as reflecting different fiscal scenarios and/or political preferences. For every policy experiment, we will show the following outcomes:

- Burden of the cost of education: As explained in our theoretical framework, the burden of the cost of education is the sum of taxes paid that finance education as well as the repayment of loans in the case of ICLs; or the fees in the case of GTF (see equations (14) and (16), respectively). In terms of the within-group progressivity that each financing system generates, the key lies in the repayments and fees rather than the taxes. We therefore consider two measures of the burden, with and without the taxes. In this quantitative section of the paper, we introduce time discounting denoted as β. The corresponding individual burden in each system, that is, net present discounted value of all repayments: is:

$$NPV_i(ICL) = \sum_{a=1}^{\bar{a}} \beta^a P_{i,a} \tag{19}$$

$$NPV_i^{total}(ICL) = \sum_{a=1}^{\bar{a}} \beta^a P_{i,a} + \sum_{a=1}^{T} \beta^a \underbrace{\tau_e^s(ICL)}_{\frac{G^E}{G}\bar{\tau}^s} y_{i,a} \tag{20}$$

$$NPV_i(GTF) = f \tag{21}$$

$$NPV_i^{total}(GTF) = f + \sum_{a=1}^{T} \beta^a \underbrace{\tau_e^s(GTF)}_{\frac{G^E}{G}\bar{\tau}^s} y_{i,a}, \tag{22}$$

- Public subsidy, as defined by share of higher-education financed with public resources. We find the share more appropriate for the empirical section than the G^E that we used in Section 2 given that the total aggregate amounts will be sensitive to the specifics of the simulation.

$$Sub(ICL) \equiv \frac{G^E}{\bar{C}} = \frac{\bar{C} - \int_{i\in\mathcal{S}} \sum_a^{\bar{a}_i} \beta^a P_{i,a}}{\bar{C}} \tag{23}$$

$$Sub(GTF) \equiv \frac{G^E}{\bar{C}} = \frac{\bar{C} - F(GTF)}{\bar{C}} \tag{24}$$

  In addition, for the case of the ICL, we define an individual counterpart of equation (23) in order to capture the distributional differences implied by the repayments structure.

The share of the total cost for the university-graduates not repaid by individual i is defined as:.

$$Sub_i = \frac{d - \sum_a^{\bar{a}_i} \beta^a P_{i,a}}{d} \tag{25}$$

- Repayment year, as defined by equation (8).

In what follows, we present the individual measures in equations (19) to (25) aggregated by percentiles of the lifetime income distribution, and the aggregate ones in equations (23) and (24) as reference flat lines. We will display these outcomes in three different graphs. In all experiments shown, we assume time discounting is equal to $\beta = 0.978$, which corresponds to a discounting interest rate of 2.2%.[8]

Baseline (2007 UK Reform). We start with our baseline scenario which follows broadly the 2007 UK reform. In particular, we set:

$$\begin{aligned} d &= 21,000 \text{ euros} \\ r &= 0\% \\ p &= 10\% \text{ annual earnings} \\ x &= 15,000 \text{ euros} \\ m &= 25 \text{ years} \end{aligned}$$

A level of debt of 21,000 euros is close to the current cost for the government of degrees that last 3 years in Spain. We assume for now that the loan interest rate is 0% and that the repayment rate is 10%. There is an exemption income level at 15,000 euros. This means that university graduates pay 10% of their earnings once income is above 15,000 euros. Finally, the debt write-off is such that there is a maximum of 25 years of repayment. If after 25 years the loan has not been fully returned, then the university graduate does not need to pay any more.

First, we display the *net present value of repayments* in the top graph in Figure 3 with and without the taxes paid to finance general education. Let's focus first on the ICL repayments. As expected, the NPV of repayments (without taxes) is an increasing and concave function of income, with the lowest percentile paying around 1,000 euros in total, while the median pays around 13,000 euros and the top percentile pays near 18,000 euros. Notice that there is

[8]Following Dearden et al. (2008), we set $\beta = 1/1 + dr$, where dr is the discounting interest rate, set to 2.2% to approximate the interest rate the government faces when borrowing.

a subsidy for everyone, including the lifetime-richest. This is due to an *interest rate subsidy*, or the presence of time discounting when interest rates are 0. The repayment with taxes displays a similar profile, which is shifted upwards for all income levels. Note that the shift is a bit higher the higher the income reflecting the nature of the progessive income tax.[9] This shows that the bulk of the progressivity in the ICLs comes from the repayments to the debt rather than income taxes devoted to higher education. We next look at the profile for GTF. The NPV of repayments without taxes are simply the university fees which are flat. The NPV of repayments with taxes show a slight disproportionate increase for the richest, which shows that the only source of progressivity in the GTF system is inherited from the progressivity of the income tax. Besides being overall smaller, the rate at which it increases with the level of income is very slow, indicating that the flatness of the fees dominates for most of the distribution. Overall, we confirm result 3, that the bulk of the progressivity of the ICLs comes from the repayments without taxes. In the next ICL experiments we will therefore concentrate on the NPV if repayments without taxes.

Next, we display the *public subsidy* in the bottom panel in Figure 3. The solid line is the subsidy coming from the ICLs by income levels. As expected, it is decreasing in lifetime income, as the higher-percentile workers are able to repay a larger amount of the loan. The two flat lines correspond to the average (or aggregate, given that the size of the population is normalized). It is clear to see that the average subsidy after introducing the ICLs (dashed line) is about half ot the current subsidy under GTF (dotted blue line), which, as already pointed out, is around 80%.

Finally, we display the *years to repay the loan* since graduation in the middle panel in Figure 3. This indicator is useful to understand the individual burden from a different point of view. As expected, it is decreasing with income. Overall, the range of years we observe for this baseline case ranges from 25 years to 15 years and only the bottom 17% is unable to repay its debt.

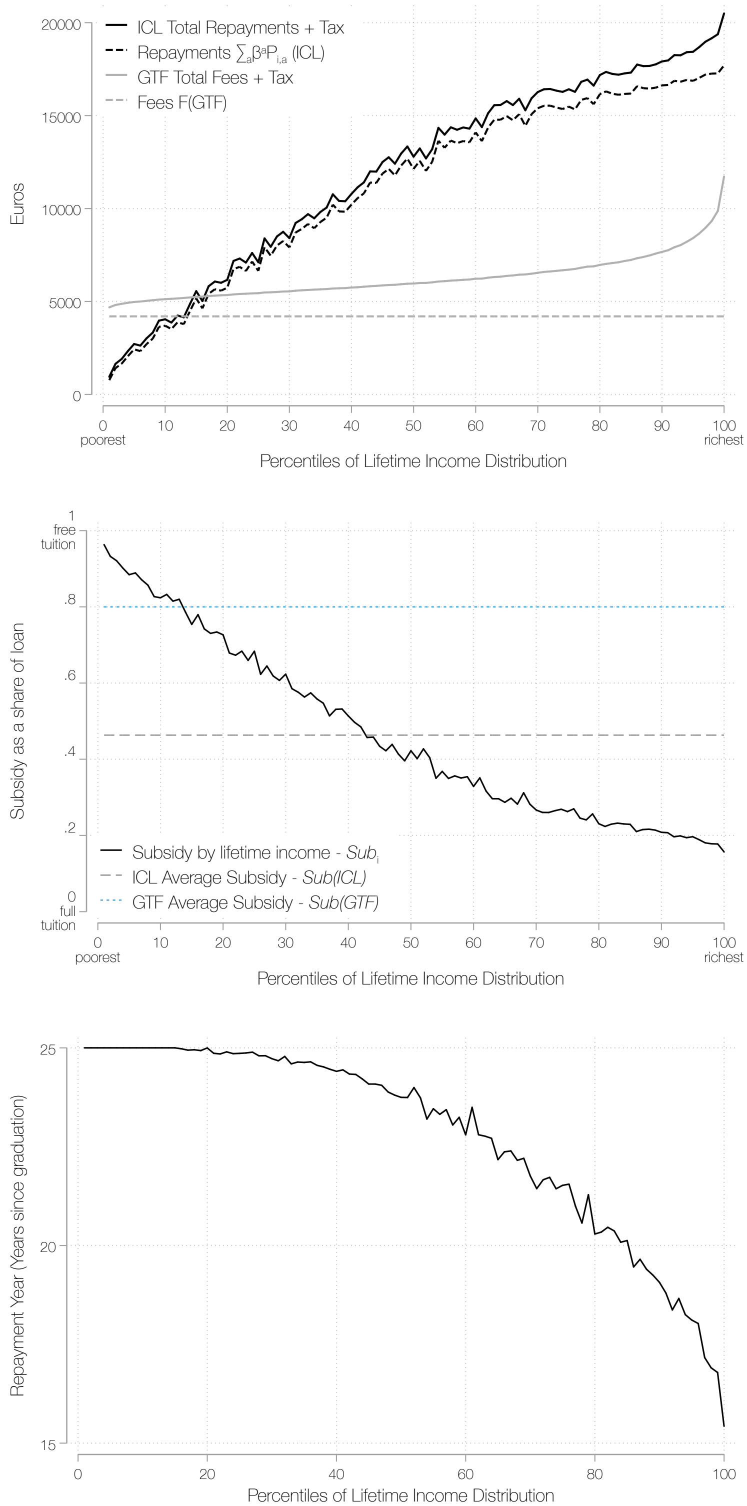
In the following subsections we consider different levels of debt, exemption levels, debt write-off years, repayment rates, as well as different loan interest rates. For each case, we vary one parameter at a time, leaving the remaining values fixed at the baseline level.

The impact of the total amount of debt (fees)

In this subsection, we consider five different levels of debt, keeping everything else constant. Different levels of debt can be thought of as different levels of fees and/or allowing for the loan to cover maintenance costs. We leave the discussion of what can be done with the

[9] To mimic the Spanish tax code, we have proxied income taxes with a step function with 5 income thresholds.

Figure 3: Baseline



additional resources for section 4.3. The different levels of debt considered are: (i) 5,000 euros, which is close to the current level of total fees for a degree; (ii) 21,000 euros, which is our baseline and is close to the current level of total cost; and (iii) 40,000 euros, which can be can be thought of as a loan that covers fees and maintenance. We also consider intermediate cases of 10,000 euros and 30,000 euros, but, for ease of exposition, we highlight the former three in Figure 4 (the others are included with a light grey color).

The main finding from this experiment is that the NPV of repayments, the repayment years and the subsidy all follow similar patterns along the income distribution for the different levels of debt. As expected, we find that the repayments, the number of years to repay and the subsidy are increasing with the level of debt (given that the repayment rate is constant).

The impact of the exemption level

In this subsection, we consider four different exemption levels, keeping everything else constant. The different exemption levels considered are: (i) 10,000 euros; (ii) 15,000 euros, which is our baseline; and (iii) 25,000 euros. We also consider an intermediate case of 20,000 euros, but, for ease of exposition, we highlight the former three in Figure 5 (the other is included with a light grey color).

Again, we find that the NPV of repayments, the repayment years and the subsidy all follow similar patterns along the income distribution for the different exemption levels. This can be visualized in Figure 5. As expected, the higher the exemption level, the higher probability not to fully repay and thus the higher the subsidy.

The impact of the debt write-off year

In this subsection, we consider four different debt write-off years, keeping everything else constant. The different write-off years considered are: (i) 15 years; (ii) 25 years, which is our baseline; and (iii) 30 years. We also consider an intermediate case of 20 years, but, for ease of exposition, we highlight the former three in Figure 6(the other is included with a light grey color).

Once again, we find that the NPV of repayments, the repayment years and the subsidy all follow similar patterns along the income distribution for the different debt write-off years. This can be visualized in Figure 6. As expected, the higher the number of write-off years, the lower is the amount of the loan that will be returned and thus the higher the subsidy will be.

Figure 4: Different debt levels

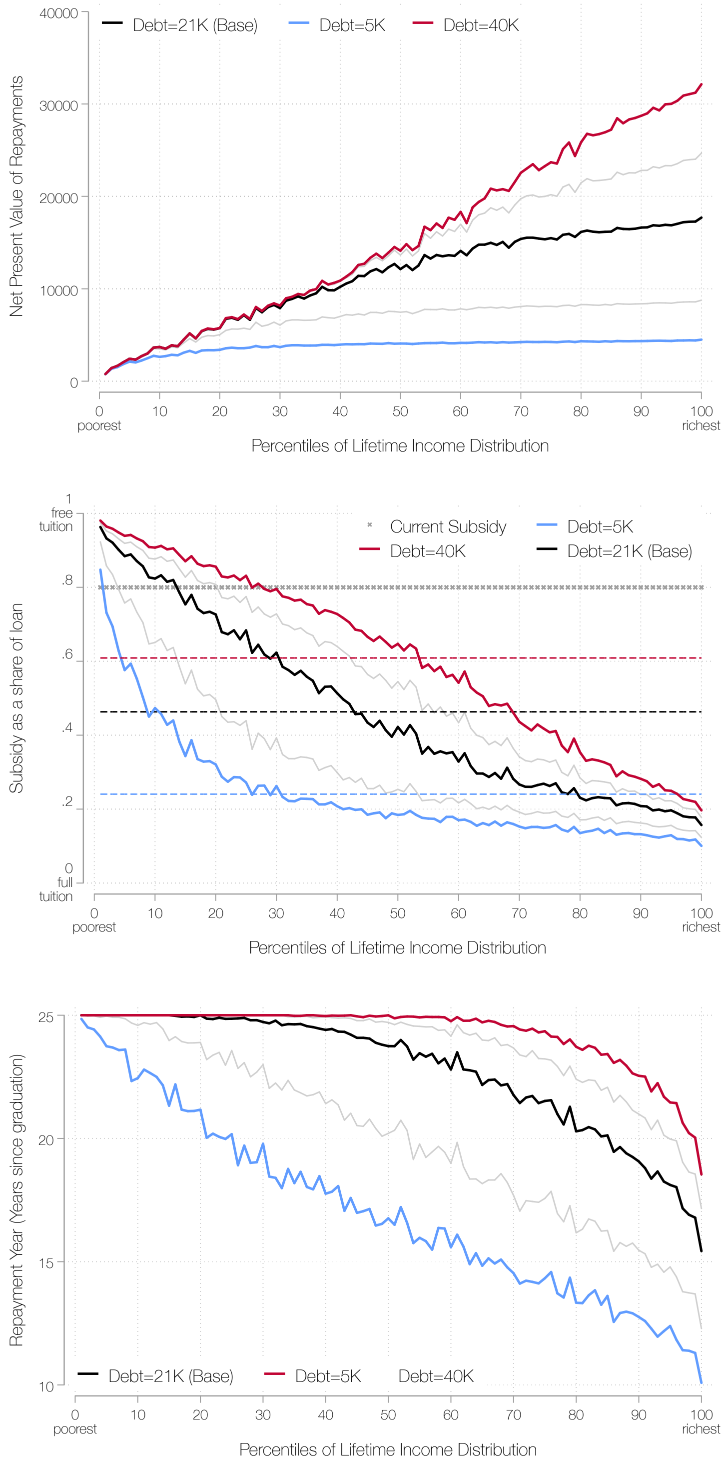


Figure 5: Different exemption levels

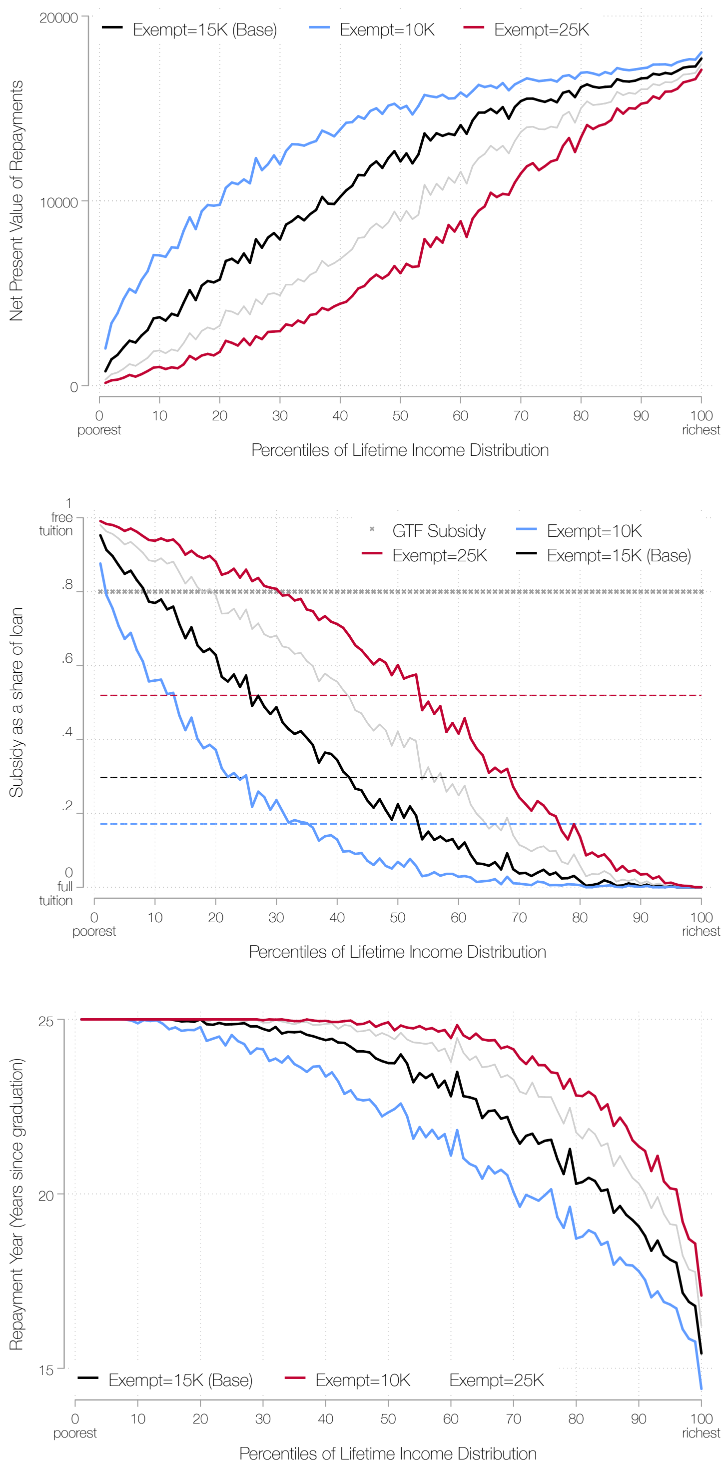
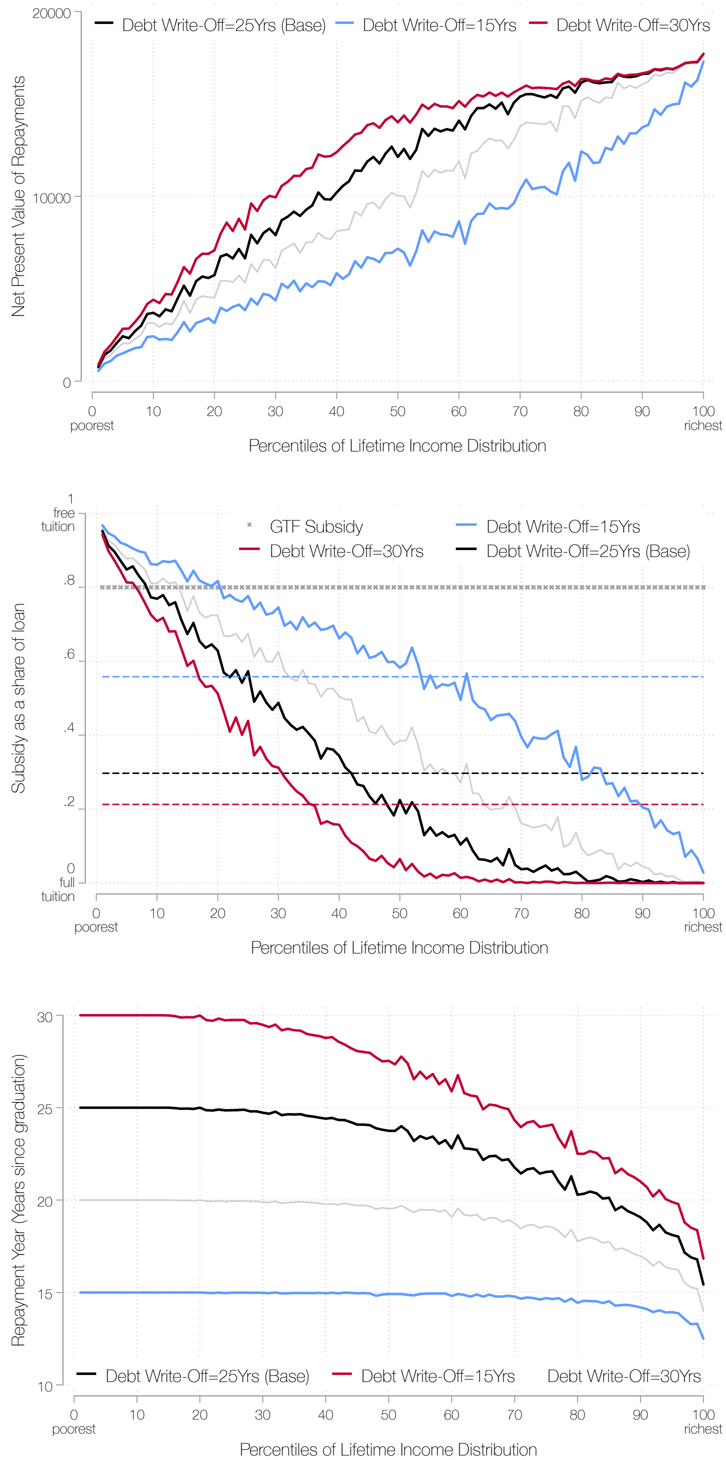


Figure 6: Different debt write-off years



4.2.1 The impact of the repayment rate

In this subsection, we consider four different repayment rates, keeping everything else constant. The different repayment rates considered are: (i) 5 percent; (ii) 10 percent, which is our baseline; and (iii) 15 percent. We also consider an intermediate case of 8 percent, but, for ease of exposition, we highlight the former three in Figure 7 (the other is included with a light grey color).

Once again, we find that the NPV of repayments, the repayment years, and the subsidy all follow similar patterns along the income distribution for the different repayment rates. This can be visualized in Figure 7. As expected, the higher the repayment rate, the higher is the amount of the loan that will be returned and thus the lower the subsidy will be.

4.2.2 The impact of the interest rate

Last but not least, in this subsection, we consider five different levels of the interest rate. This is a policy variable that receives high attention. The different interest rates considered are: (i) 0 percent, which is our baseline; (ii) 0.5 percent; and (iii) 2.2 percent. We also consider intermediate cases of 0.8 and 1.5 percent, but, for ease of exposition, we highlight the former three in Figure 8 (the others are included with a light grey color).

Once again, we find that the NPV of repayments, the repayment years, and the subsidy all follow similar patterns along the income distribution for the different interest rates. This can be visualized in Figure 8. It is worth remembering that the repayments are independent of the interest rate, they are just a share of worker's income. However, a higher interest rate means that the debt generated is higher and therefore in general it takes longer to repay the loan. So, in general, we find that the higher interest rates imply a higher NPV of repayments, it takes more years to repay and thus that the subsidy will be lower. However, it is worth highlighting that, as opposed to the general perception, higher interest rates does not increase the burden of the debts for the lower part of the income distribution given the other parameters. This is because the total debt to be repaid in these cases is bounded by the exemption level and the debt write-off. That is, lower income individuals do not get to pay the increased debt due to the higher interest rates because they reach the debt write-off. Our findings are comparable to those in Dearden et al. (2008).

Figure 7: Different repayment rates

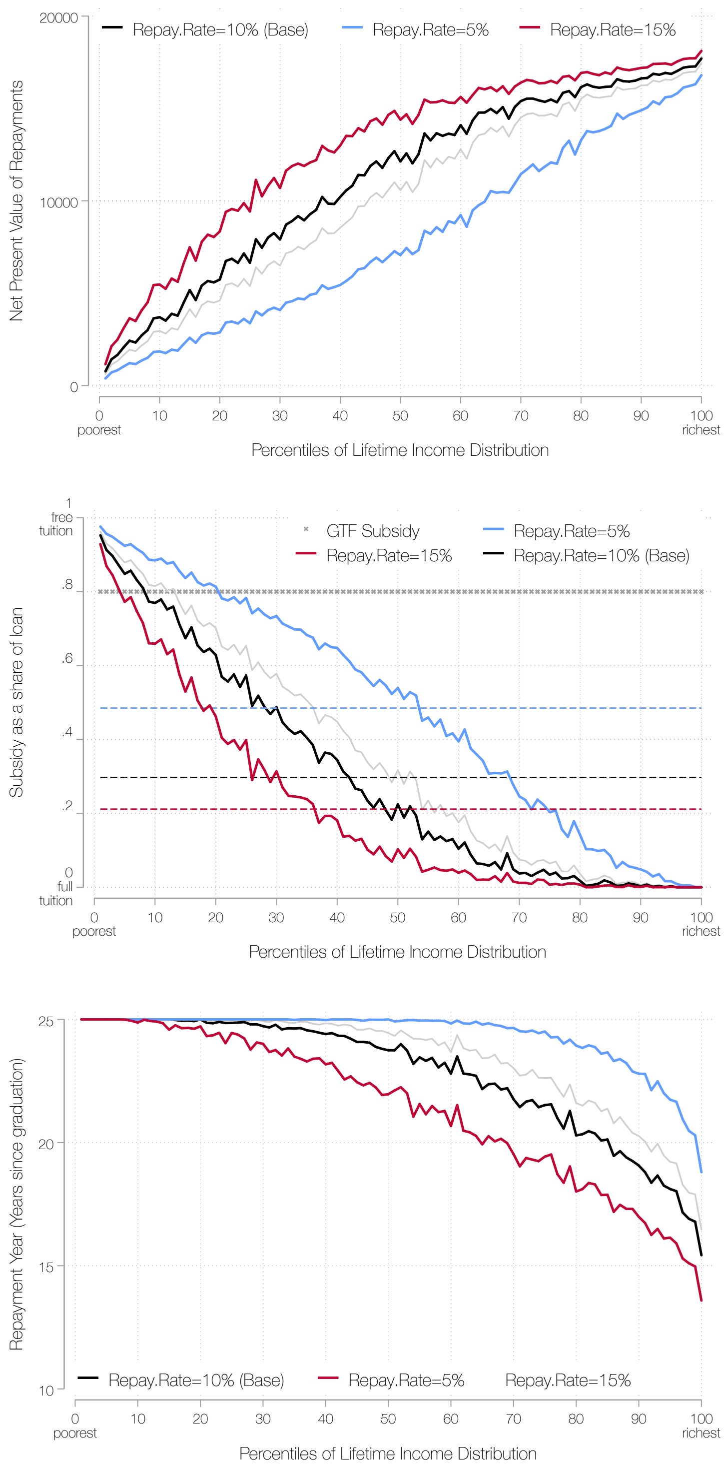
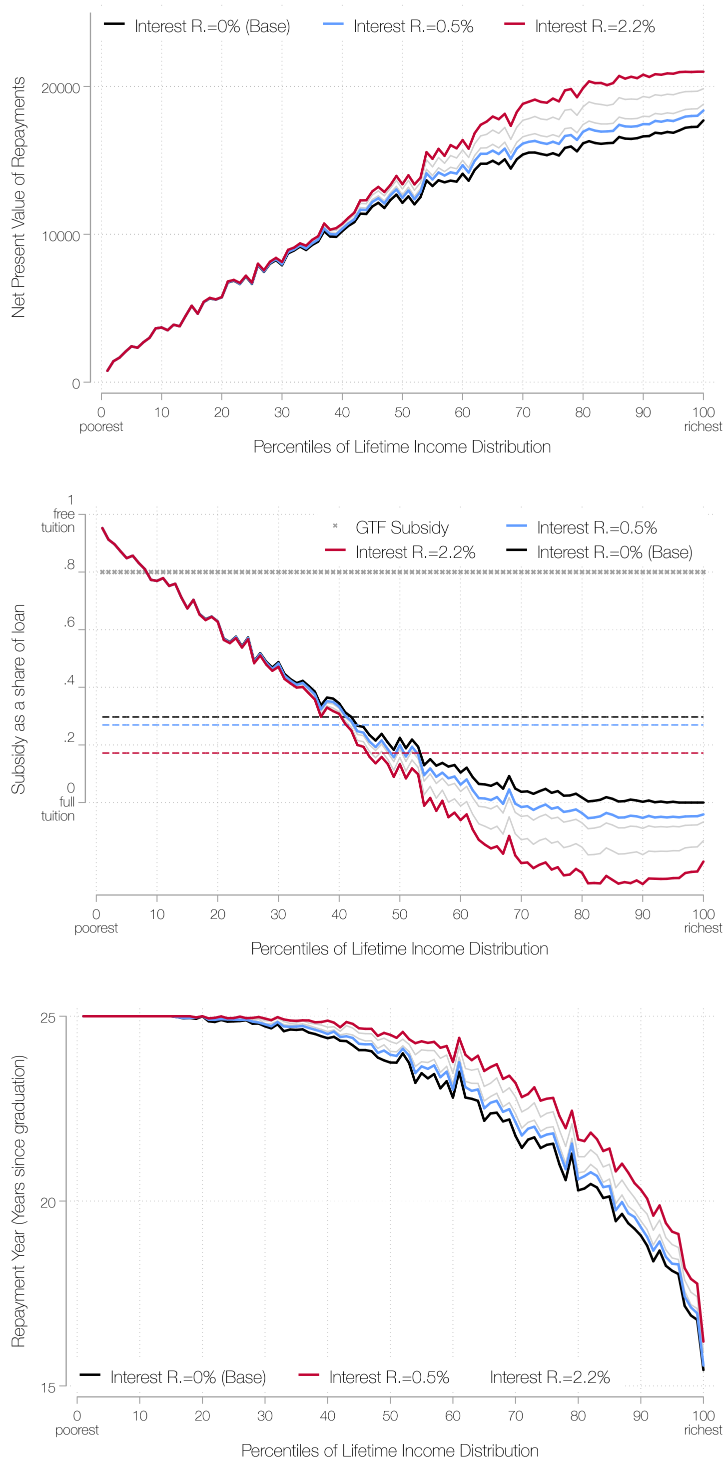


Figure 8: Different interest rates



4.3 Using Resources to Increase Quality

In the theoretical framework of Section 2, we briefly discussed alternative uses for the potential increase in university resources under the ICL system. Of particular interest to us is the option to channel those resources to university quality increases. In this Section, we evaluate the implications of such a policy for loan repayment, the public subsidy to higher education, and the income distribution net of debt.

We assume that the increase of university resources lead to higher quality of education. This could be interpreted as either a larger investment to the university (better faculty, R&D, etc.) or as a way of financing geographical mobility that could lead to better student-university matching. Ichino and Terlizzese (2013) studies this channel in the context of Italy and highlights that ICLs, by giving the economic means directly to students allows them to choose which university to attend, which in turn would reward the best universities and penalize the worst ones. Coupled with the ability of universities to increase fees, as well as to redesign their programs, this means the ICLs can improve the quality of the university system.

We model an increase in higher education quality as a uniform and permanent increase in the productivity of skilled workers. We denote the new earnings at age a for individual i with Y^Q, given by

$$Y_{ia}^{Q} = A(Q)Y_{ia},$$

where $A(Q)$ can be understood as the private internal rate of return (IRR) for a young person attaining tertiary education, which is basically the interest rate that an individual can expect to receive on the investment made by spending time and money to obtain an education. We use the data and methodology from the OECD and set $A(Q)$=10% (OECD, 2013). In the remaining of this section, we incorporate this quality improvement in our baseline specification and compare the average subsidy with the case without quality improvement. In general, the conclusions regarding the three outcomes that we focused on the previous section extend to this case. This is straightforward, as the earnings increase is uniform along the income distribution. There are, however, two points worth noting.

First, given the higher earnings of the skilled workers, the repayment ability of individuals increase, therefore decreasing the government subsidy. This decrease is disproportionally born by the lower part of the distribution, particularly by those who were not able to repay before. This point can be easily seen in Table 3. Second, notice that the fact that the average subsidy is lower as quality increases is an important result, since this means a multiplying effect on the university surplus that can translate into further quality increases over time.

Table 3: Average Subsidy

	All	Lower 10%	Top 10%
No Quality Improvements	46.33%	88.71%	18.95%
Quality Improvements	41.40%	84.74%	17.75%

5 Discussion and Conclusion

Table 4 summarises the effects of the different policy experiments undertaken above. Columns 1 to 3 indicate the case being considered. Column 4 displays the average subsidy for the total population, that was represented as a flat horizontal line in the graphs. Columns 5 to 7 display the total average repayments, as well as the total repayments for the workers in the lower 10% of the lifetime income distribution and the total repayments for the workers in the top 10% of the lifetime income distribution. These three columns are complementary to the graphs and do not add new information. Columns 8 and 9, display the within-group progressivity for both the GTF and the ICL systems, as defined in equations (14) and (16). As expected, within-group prorgressivity for the GTF does not change with the ICL parameters. A special case is the case of different levels in the principal (d) as we have imposed that the total amount given in the form of ICL adds up to the total cost of higher education. To make things comparable, fees are adjusted accordingly. Therefore higher debt translates into higher fees which makes the GTF less progressive as the flat component of the burden becomes more important. Finally, column 10 offers a comparison of the ICL progressivity with respect to the baseline case, that is, the difference between each case in column 9 with the baseline, i.e., the first line of such column.

Table 4 highlights that there are many different ways to achieve a higher subsidy and/or more progressivity. Within each experiment, both the average subsidy and the progressivity measure are monotonous to changes in the parameter of interest. Furthermore, increases in the average subsidy are associated to increases in progressivity. The largest changes in progressivity are found in changes in the level of exemption. Overall, increases in the repayment rate and the debt write-off year have regressive effects and the savings from the lower subsidy could be achieved by increasing the interest rate. Despite its unpopular nature, the interest rate has redistributive effects at a very low cost for the taxpayers. Finally, increasing the debt can have large effects, but they are concentrated at the top of the lifetime income distribution.

To conclude, we want to go back to one of our lead questions: Would the introduction of an ICL system be feasible in a dysfunctional labor market like the one in Spain? Our concern here was that low and unstable earnings among university graduates could make the repayments of loans insufficient. However, in this respect, we have found that for a wide set of reasonable parameter values, it would be feasible. In particular, in all our experiments, the subsidy paid by the government under the ICLs is lower than the current subsidy at 80%. Therefore, the government saves in the new system. This could translate into lower taxes, or investment in other public goods or in improvements in university quality[10]. Given that the Spanish labor market is an extreme case in terms of the high levels of unemployment and high incidence of temporary contracts among OECD countries, this an important lesson for countries with similar labor markets.

Looking at the other agents in the economy, universities cannot be worse off with the implementation of ICLs, as they could have more resources. Individuals without a university degree would be better off as they would pay lower taxes as a result of the lower subsidy. Finally, regarding university graduates it would depend on their position in income distribution. Those at the lower tail would be better off, as they could benefit from a better university and/or lower income taxes at no education additional cost compared to the prevailing system. Moving up in the income distribution means that the subsidy received is lower and it becomes less obvious that the benefits can compensate the costs.

A natural question is why ICL systems are implemented in some few countries and not in many others. Diris and Ooghe (2018) offer a discussion from the political economy literature on this exact question. They explain that this literature discusses the fact that the transition from a general-tax-financed subsidy to ICL generates winners and losers and therefore it is not obvious to have a majority for the change; also, other key aspects for a majority include the relative usage of higher education versus the relative tax contribution of users and non-users, the presence of private education as well as the importance of risk aversion on future labor market outcomes. Diris and Ooghe (2018) conclude that it is likely that support for ICL comes from parents of talented poor and middle income families. An interesting aspect that we would like to highlight is the fact that unlike other social policies, ICL systems imply a transfer from the older cohorts to the younger cohorts. Moreover, it is the richer older cohorts that would finance university the poorer younger cohorts, thus potentially enhancing intergenerational mobility.

[10] Moen (1998) shows how ICLs can help restore optimal levels of investment in human capital in the presence of search frictions and wage bargaining.

It is worth noting that, in this paper, we are focusing on the gains associated to more resources and higher progressivity. There are, however, a number of additional benefits of moving away from the GTF system that have not been explicitly analyzed in this paper. To name a few that we find of particular interest: (1) The ICL scheme also features an insurance component through the exemption level, the debt write-off, and the repayment factor. While this is partly captured by our measures of within-group progressivity, in the context of a highly volatile and uncertain labor market like the one in Spain, this is likely to provide additional benefits to the workers to the extent that lower uncertainty affects consumption and savings decisions. (2) When the main part of university resources is publicly provided, government budget cuts have a strong impact on the survival and quality of tertiary education institutions. This can have perverse effects such as making university quality cyclical or exposing higher education institutions to political uncertainty and the business cycle. We leave these questions for future research.

Table 4: Cases Comparison

Case	Value	Units	Avge. Subsidy (%) (Sub_i)	Repayment of ICL ($\sum P/\bar{C}$) Total	Top 10%	Lower 10%	Within-group Progressivity GTF $\left(\frac{\tau_e^s Y_{p90}+F}{\tau_e^s Y_{p10}+F}\right)$	ICL $\left(\frac{\tau_e^s Y_{p90}+\int_{i\in p90}\sum_a \beta^a P_{ia}}{\tau_e^s Y_{p10}+\int_{i\in p10}\sum_a \beta^a P_{ia}}\right)$	Comparison ICLs with baseline
Baseline			46.33	70.30	99.84	14.78	1.77	7.05	0.00
Interest R.									
r	0.5	%	44.45	73.06	104.88	14.78	1.77	7.36	0.30
r	0.8	%	43.30	74.75	108.11	14.78	1.77	7.56	0.50
r	2.2	%	37.86	82.82	125.40	14.78	1.77	8.63	1.57
Debt									
d	5000	Euros	24.05	91.86	100.00	50.86	3.17	2.37	-4.69
d	10000	Euros	32.75	84.42	99.99	30.40	2.38	3.80	-3.25
d	40000	Euros	60.90	52.95	98.41	7.76	1.44	11.67	4.62
Exempt									
x	10000	Euros	35.24	82.87	99.95	31.41	1.77	3.56	-3.50
x	20000	Euros	56.20	58.41	99.50	7.02	1.77	12.39	5.34
x	25000	Euros	64.44	48.09	98.54	3.46	1.77	18.01	10.95
Debt Write-Off									
m	15	Years	63.71	44.17	87.35	8.92	1.77	8.80	1.75
m	20	Years	52.83	59.84	98.25	12.15	1.77	7.92	0.87
m	30	Years	41.64	78.73	99.99	18.36	1.77	6.10	-0.95
Repay.Rate									
p	5	%	62.04	51.52	98.11	7.39	1.77	11.24	4.18
p	8	%	51.17	64.74	99.69	11.82	1.77	8.38	1.33
p	15	%	38.37	78.86	99.94	22.10	1.77	5.00	-2.06

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Appendix

A Comparing the Three Systems: Further Results and Details

In this section, we provide further details on and complementary results to the calculations shown in Section 2.4 to support our statement in Result 2.

Detailed calculations behind equations (12).

$$
\begin{aligned}
Burden^u(GTF) &= \bar{\tau}^u Y^u && (26)\\
Burden^s(GTF) &= \bar{\tau}^s Y^s + F(GTF) && (27)\\
Burden^u(GT) &= \bar{\tau}^u Y^u - \underbrace{(\bar{C} - F(GTF))}_{PublicSavings(GT)} && (28)\\
Burden^s(GT) &= (\bar{\tau}^s + \phi) Y^s \\
&= \bar{\tau}^s Y^s + F(GTF) + \underbrace{\frac{G^E(GTF)}{\bar{G}} \left[\bar{\tau}^s Y^s + \bar{\tau}^u Y^u\right]}_{=(\bar{C}-F(GTF))=PublicSavings(GT)} \\
&= \bar{\tau}^s Y^s + \bar{C} && (29)\\
Burden^u(ICL) &= \bar{\tau}^u Y^u - \underbrace{\left(\int_{i\in S} \sum_{a=1}^{\bar{a}_i} P_{ia} - F(GTF)\right)}_{PublicSavings(ICL)} && (30)\\
Burden^s(ICL) &= \bar{\tau}^s Y^s + \underbrace{\int_{i\in S} \sum_{a=1}^{\bar{a}_i} P_{ia}}_{=PublicSavings(ICL)+F(GTF)}, && (31)
\end{aligned}
$$

Burden (cost) of financing G^E. Besides the total cost in the form of out of pocket expenses and total general tax financing, we look at the burden directly associated to financing universities. Let $Burden^j_e$ $(j = u, s)$ denote the cost of financing higher education for each type of private agent, both out of pocket and in the form of taxes that are used to subsidy the public spending on higher education.

As a first step, we show that the public subsidy to higher education is lowest under the GT system and, as long as there is a minimum level of ICL debt repayment, highest under GTF. Formally, this states, that $G^E(GTF) > G^E(ICL) > G^E(GT) = 0$, where the last equality follows directly $G^E(GT) = \bar{C} - \Phi = 0$. To understand the last inequality, it suffices to make the plausible assumption that there is not full repayment of the ICL. For the first inequality, we need a minimum level of ICL repayment sufficient to cover at least for the GTF level of fees. Formally, $\int_{i \in \mathcal{S}} \sum_{a=1}^{\bar{a}_i} P_{ia} > F(GTF)$. While this is a empirical question that will be at the core of out loan laboratory, we can anticipate it is a very plausible assumption and feasible under various ICL parameter configurations.

Next, we calculate and compare the burden of public higher education for the different agents under the different systems.

$$
\begin{aligned}
Burden_e^u(GTF) &= \tau_e^u(GTF)Y^u = \frac{G^E(GTF)}{\bar{G}}\bar{\tau}^u Y^u && (32)\\
Burden_e^s(GTF) &= \tau_e^s(GTF)Y^s + F(GTF) && (33)\\
Burden_e^u(GT) &= 0 && (34)\\
Burden_e^s(GT) &= \phi Y^s = F(GTF) + \tau_e^s(GTF)Y^s + \tau_e^u(GTF)Y^u \\
&= F(GTF) + \frac{G^E(GTF)}{\bar{G}}\left[\bar{\tau}^s Y^s + \bar{\tau}^u Y^u\right] && (35)\\
Burden_e^u(ICL) &= \tau_e^u(ICL)Y^u = \frac{G^E(ICL)}{\bar{G}}\bar{\tau}^u Y^u && (36)\\
Burden_e^s(ICL) &= \tau_e^s(ICL)Y^s + \int_{i \in S} \sum_{a=1}^{\bar{a}_i} P_{ia} \\
&= \frac{G^E(ICL)}{\bar{G}}\bar{\tau}^s Y^s + \int_{i \in S} \sum_{a=1}^{\bar{a}_i} P_{ia} && (37)
\end{aligned}
$$

Essentially, in the GT system, the total education burden of the unskilled is absorbed by the skilled workers. In the case of the ICL, the portion of the fees that is not repaid is financed by both the skilled an unskilled similarly to the GTF case, with the difference that now $G^E(ICL) < G^E(GTF)$. Therefore, the burden for the unskilled is lower.