Policy Paper

University financing: sustainability, efficiency and redistribution

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Fedea Policy Paper 2024/01
Mayo de 2024

fedea

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February 28, 2024

Abstract

Students across the globe employ a diverse array of financial mechanisms to fund their higher education: from grants to subsidies. Even within Europe, there is a significant variance in financing systems. For instance, the Nordic countries rely on a model of generous scholarships. Conversely, in the United Kingdom and the Netherlands, loan-based financing is more prevalent. Meanwhile, nations such as Austria, France, and Spain, among others, exhibit less developed financial instruments—private or public—and have long used direct subsidies to educational institutions funded with general taxes. When the main part of university resources is publicly and directly provided, government budget cuts have a strong impact on the survival and quality of tertiary education institutions. In the face of an ageing population and large and increasing public deficits, we analyze whether a subsidized system of progressive Income Contingent Loans (ICL) is feasible in Spain, and how it would impact different strata of the population. 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.

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1 Introduction

Europe is going to face in the coming decades intense pressures on the fiscal outlooks of many countries. The continent is becoming older very fast, and that affects health and pensions' expenses. There will be also need for additional expenses toward a quick green transition, and defense because of external military threat. This will most likely create a threat to sustain a competitive higher education system, because in many OECD countries relies mostly on tax-financed subsidies, at a time when the digital transition will make it even more necessary for the citizens.

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. This regressiveness might have been acceptable at a time when public funds were abundant. When that stops being true, the countries will need to study alternatives that circumvent the main issues of the current systems, such as 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 zero or 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, payments are not dependent on actual income after graduation and market determined interest rates. To ease the introduction of this scheme, a natural starting point for the government would be to consider a zero interest rate, which is the baseline policy in our analysis. In this sense, a more appropriate name for this scheme is *Returnable Fellowships.*

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.

We will then offer a quantitative illustration of the implications of our model that uses real data to show how Spain could transit to a model more similar to the one currently used in the UK. For context, some figures of Spain in the OECD context are useful. Based on Education at a Glance 2023, Spain is at the tail regarding budget efforts towards tertiary education compared to other OECD countries. Indeed, in 2020, 2.1% of total government expenditure was spent on tertiary education, well below the OECD average (2.7%).

The evolution of expenditure has not been good either. In 2010 public university spending reached its peak, 0.94% of GDP. With the crisis this indicator went down, reaching 0.75%. It recovered only slightly afterward, to 0.87% in 2021, still far from pre-crisis levels. This is not surprising. Spain is suffering an extreme case of the European malaise of an ageing population, insufficient public finance, and early climate change effects.

But the need for education is still strong. According to Statista, the number of students enrolled at universities in Spain from the academic year 2008/2009 to 2022/2023 has increased 20% (reaching about 1.73 million students). But, interestingly, the number of students in private universities have been increasing steadily, and they are almost 3 times more in 2022/2023 than in 2008/2009. This seems a clear reaction from the citizens to the budget tightness in public institutions. Clearly, if one wants to prevent inequalities from growing even more, some reaction from the public sector is needed and ICL seems a possibly solution.

Another reason why a quantitative application to Spain is interesting has to do with and important challenge to the viability of ICL systems: 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. Spain offers a particularly extreme example of these situations. In 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 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.

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] For a complementary review of the university financing literature and institutional framework, see Montalbán Castilla (2019).

The literature does not find concluding evidence to indicate that the level of enrollment

[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. Related, de Silva (2023) shows, in the context of Australia's ICL structure, that there are some labor supply responses to lower payments but are too small compared to the welfare gains from this repayment structure.

[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.

fees alone has a clear effect on a greater access or more equitable access (such as for example in individuals from more disadvantaged contexts). Dynarski (2003) analyses the effect of a subsid removal in the access to university, which was granted during 1965-82 to the children of dead, retired or disabled parents. The results show that access rates decreased very significantly (almost one third) for the children with a dead parent while for the other categories the decrease was very insignificant. Since the children of retired or disabled people can still be helped by their parents, the result reinforces the idea of that inefficiencies in the credit market prevent the access to university for students without resources. Joensen and Mattana (2021) explore the Swedish reform in 2001 which changed the financial aid system in several dimensions: scholarships increased, the tax income at the end of studies was reduced and the initial conditions to obtain a loan and the repayment system changed as well. They conclude that a mixed scholarship-loan system does not affect the student behavior when there is a greater weight on loans.

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.

2 Institutional Framework and International Comparisons

The OECD (2014) classifies the countries into four financing models in university, depending on two factors: the level of tuition fees and financial aid available through the national aid system for students enrolled in tertiary education programs.[5] Next, we briefly describe these

[5]In the OECD report, tertiary education is defined as tertiary education programs type A, which corresponds to the ISCED 5A category of the classification international education ISCED. This level educational corresponds to theoretical programs designed to provide sufficient training to facilitate access to advanced

models.

Model 1: Countries with low or without tuition fees and generous support systems for students

The countries that are included in this model are typically Nordic countries, namely, Denmark, Finland, Iceland, Norway and Sweden. These countries have a more progressive tax structure and students do not pay tuition fees, while they benefit from very generous aid systems. However, individuals have to pay very high taxes. For example, in these countries, more than 55% of students benefit from public scholarships, public loans or a combination of the two (Tables B5.1 B5.2 and figure B5.1 in Education at a Glance 2014). Besides, the average rate of access (which represent the percentage of an age cohort entering an education program throughout its life) to type A tertiary education is 74%, well above the OECD average (59%).

The mentality that the government should provide its citizens free access to tertiary education is a prominent feature of the culture of education in these countries: the financing of institutions and students are based on the principle that access to tertiary education is a right, and not a privilege. In addition, aid to students allow them to study anywhere in the world country they want, which, it is very beneficial for the competition, and therefore the quality of universities. However, in recent years, Sweden and Denmark (as of 2011) introduced tuition fees for international students to increase resources available to university institutions. Iceland also considered it. The risk is that this measure could stop the flow of university students to these countries. In fact, in Sweden, the number of international students has been reduced since this reform was implemented: between the fall of 2010 and the fall of 2011, the number of students who came from outside of the European Economic Area and Switzerland fell by almost 80%.

Finally, in these countries families do not have tax deductions nor specific aid that can cover expenses of housing, transportation or any other type of associated cost to the student. In these countries, the student is considered as an individual, and is the same individual the one who receives the help.

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research programs and professions that require special skills, such as medicine, stomatology or architecture. They last like minimum 3 years full time, but most last 4 years or more. These programs are not offered exclusively in universities; and not all programs nationally recognized as university programs can fall into this category. Programs of Type A tertiary education also includes masters from United States.

Model 2: Countries with high enrollment rates and developed aid systems for students

The second group includes Australia, Canada, Netherlands, New Zealand, the United Kingdom and the United States. In these countries there are potential high financial obstacles for access to tertiary education, but at the same time offer significant public support to the students. The rate of access to tertiary education for the countries in this group is 75%, significantly above the average of the OECD and higher than most countries with low tuition fees (except Nordic countries). In these countries, private entities (e.g. private companies and non-profit organizations) are the ones that contribute the most to the financing of the tertiary institutions. Therefore, in these countries, the cost of education is distributed between the government, individuals and private companies (Graph B3.2 and Table B3.1 in Education at a Glance 2014).

Enrollment rates in tertiary education in these countries exceed $1,500, but more than 75% of university students receive public aid (in Australia, the Netherlands, New Zealand, the United Kingdom and the United States, Tables B5.1 and B5.2 in Education at a Glance 2014). The proportion of public spending on tertiary education that is dedicated to public aid in these countries it is higher than the average of the OECD (22%) in 5 of the 6 countries in this group: Australia (35%), Netherlands (29%), New Zealand (48%), the United Kingdom (74%) and the United States (29%). Likewise, the access rate to tertiary education in this group of countries it is above average of the OECD. For example, Australia and New Zealand have one of the highest access rates in education tertiary (96% and 79%, respectively, although these rates also include the high proportion of international students enrolled at this level of education).

Model 3: Countries with high enrollment rates and less developed aid systems for students

In Chile, Japan and Korea, the majority of students have to pay high tuition fees (on average, more than US dollars 4,500), but the support system students are less developed than in countries in Models 1 and 2. Access rates are below the OECD average in Chile (45%) and Japan (52%), but significantly above in Korea (69%). In Japan and Korea, some students who excel academically but have difficulties economic to finance their studies can benefit from admission and/or registration fees reduced or receive a complete exemption. Japan and Korea are among the countries with the lowest level of public spending allocated to tertiary education as a percentage of GDP (Table B4.1 in Education at a Glance 2014). This partially explains the low proportion of students who benefit from public loans. However, recently

both countries have implemented reforms to improve their aid systems to help students.

Model 4: Countries with low enrollment rates and less developed aid systems for students

This fourth group includes the rest of European countries (Austria, Belgium, Czech Republic, France, Ireland, Italy, Poland, Portugal, Switzerland and Spain) and Mexico. In all these countries it is charged moderate tuition fees compared to those of Models 2 and 3. In these countries, to access tertiary education, financial barriers are relatively low (in Ireland and Mexico there are no tuition fees) and also, financial aid to students is very low and intended for specific groups of students. Tuition fees charged by public universities in these countries do not exceed $1,300 US dollars, and, in countries where data is available, less than 40% of students benefit from public aid (Tables B5.1 and B5.2 in Education at a Glance 2014).

In the countries of this group, tertiary institutions depend heavily on the funding situation and levels of participation in tertiary education are normally below OECD average. The average rate of access to tertiary type A education is relatively low, of a 56%. Furthermore, spending per student in tertiary type A is also low (Graph B5.2 and Indicator B1 in Education at a Glance 2014).

While high tuition fees could be a potential barrier to access to university the experience of the countries in this model suggests that low tuition rates do not necessarily guarantee greater access. Furthermore, the absence of aid for students makes mobility difficult, which is why university students do not abandon the family home. Apart from the consequences of this fact for personal development, the least competition by students reduces incentives of universities to improve the quality of services that they provide.

A possible solution to the problem highlighted in the paragraph above is that students and their families can benefit from the help provided by others institutions other than the ministry of education (for example, accommodation subsidies, discounts on taxes and/or credits for studies). In France, rental subsidies (housing allowances) represent approximately 90% of the scholarships, and close one third of students benefit from them. Poland stands out for the fact that studies of the majority of students enrolled in a full-time program are subsidized entirely by the state, while part-time students pay all tuition costs. In a well-defined sense, this makes countries like France or Poland de facto look very similar to the Model 1 countries. In the countries of this group, there are no public loans or loans guaranteed by the state, or in case available, they are aimed at a small proportion of students from that country (Table B5.2 in Education at a Glance 2014).

Another country is worth mentioning within this international comparison is Uruguay (we will refer to this case later), with low tuition fees and a scholarship system for tertiary students. Indeed, in 1994, the Solidarity Fund (FS) was created with the objective of financing a scholarship system for low-income students of public universities. The system is based on the concept of intergenerational solidarity: graduates of the public tertiary system are the ones who contribute to the financing of the FS. This contribution is made based on the curricular duration of the degree and does not depend on the taxpayers' ability to pay (Doneschi et al., 2014).[6]

The viability of a new model for Europe

As we mentioned in the introduction, many countries are already experiencing severe budgetary pressures. The challenges arising from demographic transitions are likely to exacerbate those problems, or to create them in countries that have been exempt from them so far. We have documented in this section that higher education is, in many countries, heavily subsidized by the state. One way to alleviate those budgetary pressures is to transfer more of the cost of higher education onto the students. This is reasonable because they reap a substantial part of the benefits. Doing it via loans or graduate taxes is a good way to achieve this, while taking care of equity issues arising from the imperfect functioning of credit markets.

But the details have to be considered carefully. For example, in many European countries, young graduates may spend a substantial part of their early working life in short-term labor relationships with small wages. This could make a loan system financially unsustainable. Since there have been no good natural experiments in countries with those characteristics, we propose to study this problem with a quantitative experiment. We first propose a model where graduates become workers with realistic dynamic career paths, and they have to repay their costs of education with a fraction of their salary. Then we choose parameters of the model so the career trajectories match closely those observed in the data. This allows us later to estimate the impact and viability of different loan systems.

As mentioned, we will illustrate our exercise using Spain, an relevant country in model 4 above, moving towards a system like the UK, a country in model 2 above.

[6]More information about the system, available at: https://www.fondodesolidaridad.edu.uy/

3 Aggregate and Distributional Implications of University Financing: A Conceptual Framework

In this section, we introduce a simple theoretical framework to understand the changes from moving from models 4 to 2 explained in section 2; in other words, how ICLs affect government and university budgets, as well as on 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 different higher-education financing schemes along aggregate and distributional measures.

A Simple Theoretical Framework

Three types of agents compose our economy: the government, the public university sector, and workers.[7] 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_{it}^j 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 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

[7] 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 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 3. 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

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

3.1 Aggregate and Distributional Implications of Different Financing Schemes

Using this theoretical framework, we next proceed to introduce the specifics of different higher-education financing systems. We consider three alternative schemes: the general-tax-financed subsidies (i.e., prevailing system in countries in model 4), an intermediate case of a graduate income tax, and finally the ICLs in more detail (i.e., the prevailing system in countries in model 2). For illustration, we will make the following 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.

We next compare each financing scheme along three dimensions: (1) the cost born by public and private agents, (2) *between-group progressivity*; or the extent to which these shift the cost of higher education to skilled and away from unskilled workers; and (3) *within-group progressivity*, referring to redistribution across the income distribution of future university

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	$\frac{\tau_e^s(ICL)Y_{p90}^u + \bar{C}}{\tau_e^s(ICL)Y_{p10}^u + \epsilon}$		

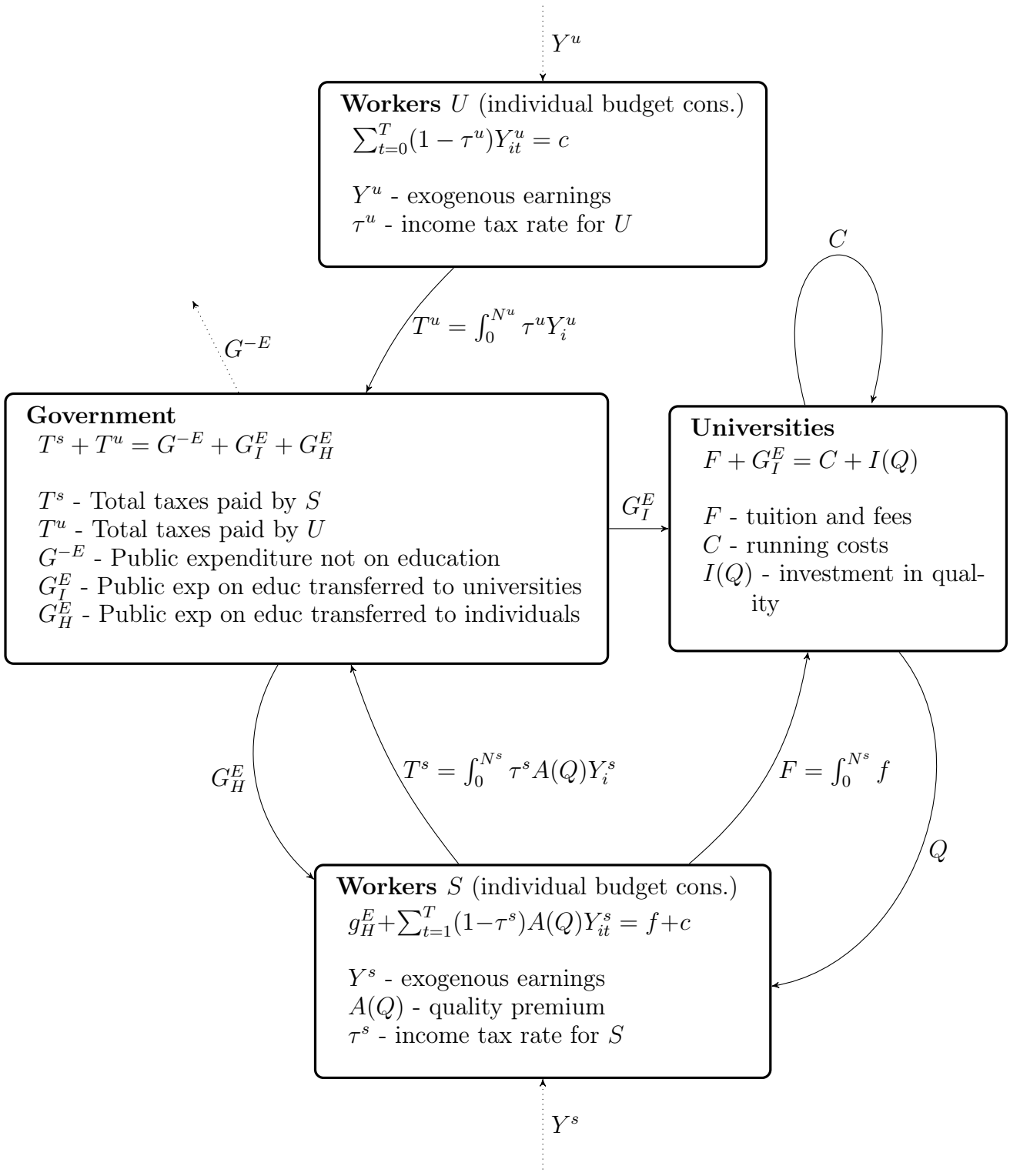


Figure 1: Theoretical Framework Summary

graduates.

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

3.1.1 General-tax-financed subsidies

We begin by discussing the system in model 4 using as example the details currently in Spain, 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 also the prevalent system in most Europe.[8] 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.

3.1.2 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-

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

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

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

3.1.3 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 that is, moving from models 4 to 2 explained in section 2.[9] 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:

[9] 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.

$d-$ 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

$r-$ 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:

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

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

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

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 Table 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.

3.2 Comparing the Three Systems

Next, we will use all the information in subsections 3.1.1, 3.1.2, and 3.1.3 to summarize the distributional implications of each system in two results.[10]

Result 1: *Between-group progressivity (the ratio of the burden for non-university- and*

[10]Detailed calculations can be found in our previous work Cabrales et al. (2020).

Table 2: ICL Repayment Scheme

Period	Initial debt	Resources	Payments		Outstanding debt	Eat
			Educ related	Other		
$a=0$ (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	$P_2 = pY_2^{NE}$	$\tau^s Y_2$	$D_2 = (1+r)D_1 - P_2$ $= (1+r)^2 d - p\left[(1+r)Y_1^{NE} + Y_2^{NE}\right]$	$c_2 = (1-\tau^s)Y_2 - p(Y_2 - x)$
$\vdots$						
a	$(1+r)D_{a-1}$	Y_a	$P_a = pY_a^{NE}$	$\tau^s Y_a$	$D_a = (1+r)D_{a-1} - P_a$ $= (1+r)^a d - p\sum_{j=1}^{a}\left[(1+r)^{a-j}Y_j^{NE}\right]$	$c_a = (1-\tau^s)Y_a^s - p(Y_a - x)$
$\vdots$						
$a=\bar{a}$ (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	$c_a = (1-\tau^s)Y_a^s$

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 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. In this sense, as mentioned before, our proposed system resembles more a scheme of *Returnable Fellowships*, provided a zero interest rate, which is our baseline scenario. 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.

4 Simulating Life-Cycle Earnings Dynamics: Projections using Social Security Data

Having established the theoretical grounds of the different financing systems, we next simulate a panel of individual incomes over working ages to evaluate the aggregate and distributional measures of each system. In particular, we use estimate a model of employment transitions and earnings dynamics using social security and tax records for Spain.

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

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. Using the longitudinal dimension of the 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. Given the annual nature of the earnings data, 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.

4.2 Estimating Earnings Dynamics

We adapt the framework of Dearden et al. (2008) based on England 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). Workers can switch status following a transition matrix with probabilities of entering status s_t from status s_{t-1}, for all statuses. We estimate[11] these transitions using 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.

At the beginning of an employment spell within a contract, each worker draws a level of earnings determined by its previous status and age. Whenever the worker changes status, we estimate the new initial earnings as a function of age, duration of previous spell, and earnings in the last contract before the change. If the past status is unemployment, *last earnings* is replaced by a dummy that equals 1 if the unemployment spell is not longer than a year and 2 the unemployment spell is longer than a year, and 0 otherwise.

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,

[11] The estimation is performed separately for female and male college graduates.

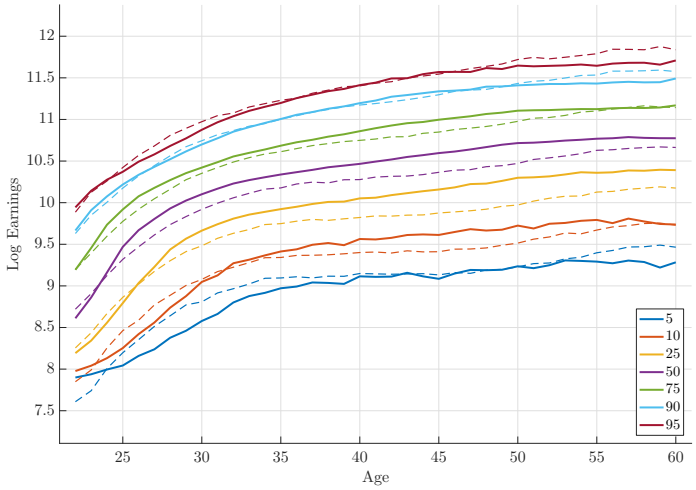
we allow for the type of contract – temporary or permanent – to influence uncertainty and earnings dynamics in general. In a nutshell, continuation earnings follow an ARMA(1,1) stochastic process with fixed effects and profile heterogeneity. To capture the evolution of uncertainty over life, the persistence 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. This differentiation is important in the case of a segmented labor market like the Spanish case. 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. More details on the estimation procedure can be found in Cabrales et al. (2020).

4.3 Earnings Distribution and 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)



5 Income Contingent Loans: A 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 5.2, we consider several policy experiments modifying the different parameters of the ICLs. The advantage of setting up such laboratory is that we start with our baseline case which illustrates the case of the UK as of 2007. And then we change different parameters to undertand how ICLs would work in Spain.

5.1 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 (22) below, is around 80%. We will use this benchmark in our policy experiments in the next subsection.

5.2 Policy Experiments

For each of the parameters defined in Section 3.1.3, 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:

$$NPV_i(ICL) = \sum_{a=1}^{\bar{a}} \beta^a P_{i,a} \tag{17}$$

$$NPV_i^{total}(ICL) = \sum_{a=1}^{\bar{a}} \beta^a P_{i,a} + \sum_{a=1}^{T} \beta^a \underbrace{\tau_e^s(ICL)}_{\frac{G^E}{\bar{G}}\bar{\tau}^s} y_{i,a} \tag{18}$$

$$NPV_i(GTF) = f \tag{19}$$

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

- 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 3 given that the total aggregate amounts will be sensitive to the specifics of the simulation.

$$Sub(ICL) \equiv \frac{G^E}{\bar{C}} = \frac{\bar{C} - \int_{i\in\mathcal{S}} \sum_a^{\bar{a}_i} \beta^a P_{i,a}}{\bar{C}} \tag{21}$$

$$Sub(GTF) \equiv \frac{G^E}{\bar{C}} = \frac{\bar{C} - F(GTF)}{\bar{C}} \tag{22}$$

  In addition, for the case of the ICL, we define an individual counterpart of equation (21) 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:.

$$Sub_i = \frac{d - \sum_a^{\bar{a}_i} \beta^a P_{i,a}}{d} \tag{23}$$

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

In what follows, we present the individual measures in equations (17) to (23) aggregated by percentiles of the lifetime income distribution, and the aggregate ones in equations (21) and (22) 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%.[12]

5.2.1 Baseline (UK)

We start with our baseline scenario which follows broadly the 2007 UK reform that established a loan system to finance higher education.

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% (i.e. a returnable fellowship) 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 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.[13] 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.

[12] 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.

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

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.

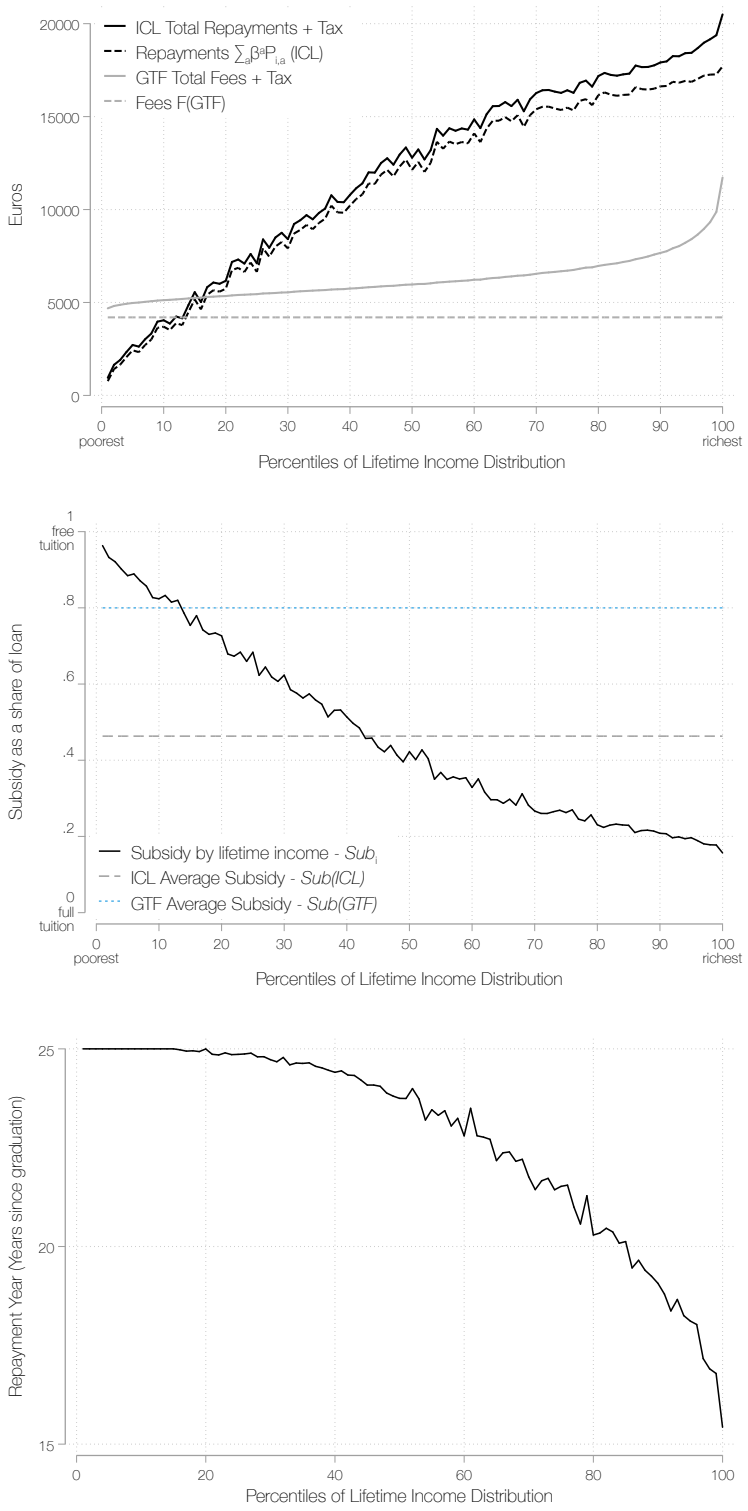
In the following subsection we consider different levels of debt, exemption levels, debt write-off years, repayment rates, as well as different loan interest rates. For each case, we vary one parameter at a time, leaving the remaining values fixed at the baseline level.

5.2.2 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 and room and board. See Cabrales et al. (2020) for a discussion on the case where the additional resources are used to improve the quality of tertiary education. 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

Figure 3: Baseline



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).

5.2.3 The impact of other policy instruments and robustness

We further explore sensitivity to varying other policy instruments in the ICL scheme. Table 3 summarises the effects of the different policy experiments, including the change in the size of the loan described 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. Columns 8 and 9, display the within-group progressivity for both the GTF and the ICL systems, as defined in equations (14) and (16).

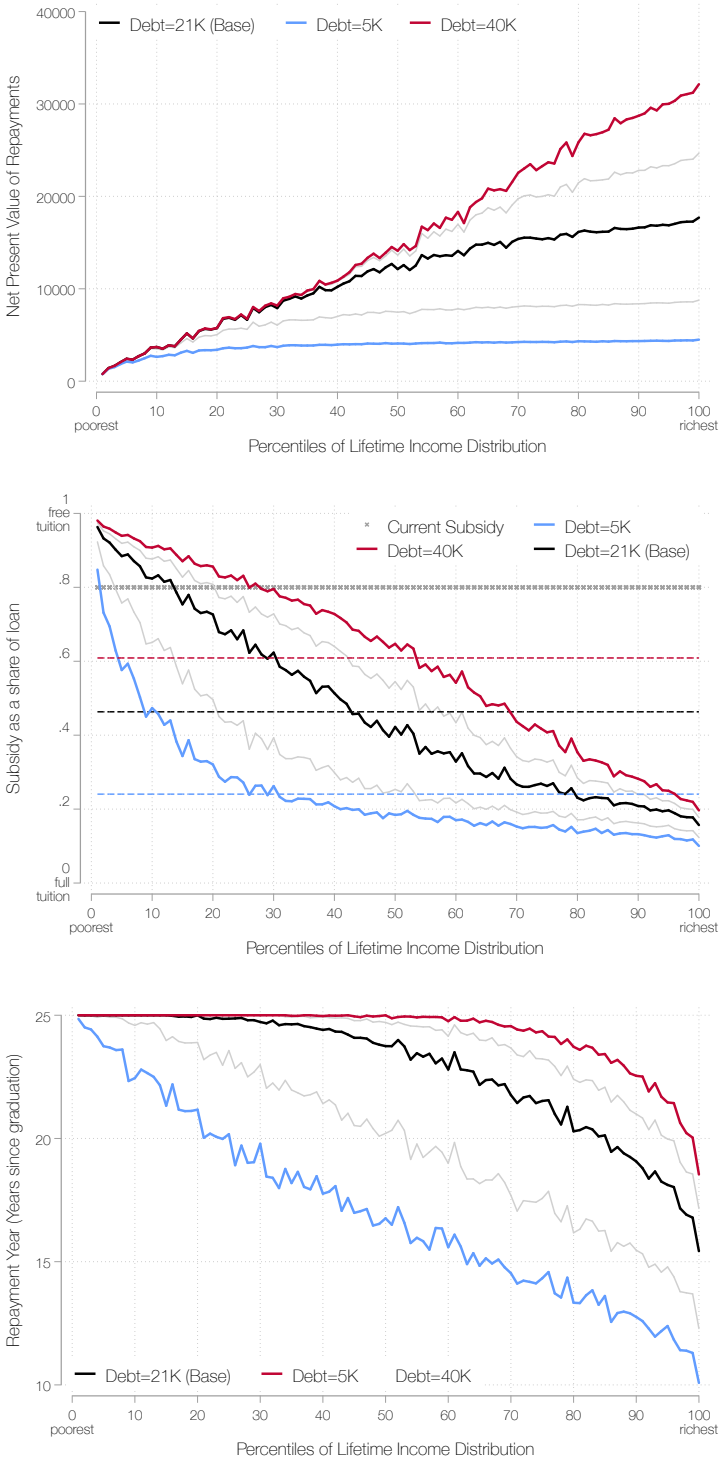
As expected, within-group prorgressivity for the GTF does not change with the ICL parameters. A special case is the case of different levels in the principal (d) as we have imposed that the total amount given in the form of ICL adds up to the total cost of higher education. To make things comparable, 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. More details on each of the experiments are available in Cabrales et al. (2020).

6 Discussion and Conclusion

In conclusion, the challenges facing European countries regarding fiscal sustainability, demographic shifts, and the need for investments in various sectors pose significant threats to the maintenance of competitive higher education systems. The reliance on tax-financed subsidies, coupled with flat tuition fees across income distributions, exacerbates regressiveness in funding mechanisms, especially as public funds become scarcer. This necessitates exploring alternatives to the current systems, such as Income Contingent Loans (ICLs), which offer flexibility and progressivity.

Drawing insights from the successful implementation of progressive loan systems in countries like the United Kingdom, in our analysis we focus on Spain. Given that the Spanish labor market is an extreme case in terms of the high levels of unemployment and high inci-

Figure 4: Different debt levels



dence of temporary contracts among OECD countries, this can provide an important lesson for other countries. Our analysis reveals the potential feasibility and benefits of transitioning towards a subsidized system of progressive ICLs. By offering a highly progressive structure wherein the top quarter of earners bear the majority of tuition costs while the bottom 10% pay minimal fees, ICLs present a promising solution to address inequality in access to higher education. Additionally, our findings suggest that under the proposed ICL model, the burden of total university education subsidies borne by the government could decrease by a significant margin compared to the current system.

Given the highlighted advantages of ICLs for the median voter, a question remains of why there is not a large demand for these. In the next two paragraphs we discuss two justifications for this. One issue is that the ICL are perceived as traditional loans. But as we have discussed, all in all, the ICLs are isomorphic to *returnable fellowships* of different amounts in the sense that the sum of repayments does not exceed the fees except for the case where interest rate is above zero. Also, Diris and Ooghe (2018) offer a discussion from the political economy literature on this exact question. They explain 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. This highlights an interesting aspect that we would like to highlight: that ICLs break the link between parents and children in tertiary education financing because repayments are set as function of children's future earnings, independently of family background. This, in turn, implies that, unlike other social policies, ICL systems represent 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.

Another possible explanation for the lack of ICL support is ignorance by the voters. But given that the example of countries where they exist is quite notorious, and its analysis in Dearden et al. (2008) is about a decade old, it is surprising that no political entrepreneur has used it to move up the political ladder. A more intriguing explanation would rely on the fact that real politics are multidimensional, and a coalition of the winner in this issue could have formed with those of other issues on a stable platform. Levy (2005) is an example of how this explanation could work. She models a society in which there are two issues, public education and redistribution. She then shows that when the cohort size of the young is not too large, a coalition between the rich and the young segment of the poor can form

with public education used as a political compromise. Future research could explore whether another coalition might have formed around public funding for higher education.

Finally, while in this paper we are focusing on the gains associated to more resources and higher progressivity, there are both limitations and benefits of the ICL system that we find worth mentioning but fall beyond the scope of this paper. On the one hand, our approach is limited in the sense that it ignores endogenous responses to the policy changes. On the other hand, additional benefits of moving away from the GTF system that have not been explicitly analyzed in this paper that we find of particular interest include: (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. Moving forward, further research and policy discussions are warranted to refine and implement these proposed solutions effectively.

Table 3: Cases Comparison

Case	Value	Units	Avge. Subsidy (%) (Sub_i)	Repayment of ICL ($\sum P/C$)			Within-group Progressivity		Comparison
				Total	Top 10%	Lower 10%	GTF $\left(\frac{\tau_e^s Y_{p90}+F}{\tau_e^s Y_{p10}+F}\right)$	ICL $\left(\frac{\tau_e^s Y_{p90}+\int_{i\in p90}\sum_a \beta^a P_{ia}}{\tau_e^s Y_{p10}+\int_{i\in p10}\sum_a \beta^a P_{ia}}\right)$	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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