
Financing Higher Education: impacts of an income-contingent loan in Portugal

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Abstract

Financing Higher Education is important since it is one of the main drivers for economic growth. As the costs of Higher Education rise and governments' capacity to ensure universal access declines, cost-sharing becomes increasingly necessary. One method for cost-sharing that is becoming popular in some developed countries is the Income Contingent Repayment Loans to students. This dissertation investigates the potential implementation of an income-contingent loan (ICL) system in Portugal, where current funding models face significant challenges. The literature review focuses on the theoretical foundations of Higher Education financing, the challenges of cost-sharing, and the empirical analysis of the state-supported loan scheme implemented in Portugal and the existing ICL scheme in England. The study is divided into two key methodological components: the first involves forecasting future income trajectories for graduates, and the second adapts the UK's income-contingent loan repayment model to the Portuguese context. The analysis reveals that while an ICL system could alleviate immediate financial pressures on students, it would still require substantial government subsidies, with an estimated Resource Accounting and Budgeting (RAB) charge of 28.9%, indicating that 29% of the loan value may not be repaid. These findings offer a foundational understanding of the financial dynamics and policy considerations essential for the potential adoption of an ICL system in Portugal.

Keywords: Income-contingent loans, Student loan design, Educational finance, Student financial aid

JEL Classification: I22; I28; J24

Resumo

O financiamento do Ensino Superior é importante, pois é um dos principais motores de crescimento económico. À medida que os custos do Ensino Superior aumentam e a capacidade dos governos de garantir o acesso universal diminui, a partilha de custos torna-se cada vez mais necessária. Um método de partilha de custos que está a ganhar popularidade em alguns países desenvolvidos é o *Income Contingent Repayment Loan* para estudantes. Esta dissertação investiga a potencial implementação de um sistema de empréstimos contingentes ao rendimento (*ICL*) em Portugal, onde os modelos de financiamento atuais enfrentam desafios significativos. A revisão da literatura foca-se nos fundamentos teóricos do financiamento do Ensino Superior, nos desafios da partilha de custos e na análise empírica do esquema de empréstimos apoiado pelo Estado implementado em Portugal e no atual esquema *ICL* em Inglaterra. O estudo está dividido em duas componentes metodológicas principais: a primeira envolve a previsão das trajetórias de rendimento futuro dos graduados, e o segundo adapta o modelo de reembolso dos empréstimos contingentes ao rendimento do Reino Unido ao contexto português. A análise revela que, embora um sistema de *ICL* possa aliviar as pressões financeiras imediatas sobre os estudantes, ainda exigiria subsídios governamentais substanciais, com uma estimativa de custo orçamental (*RAB*) de 28,9%, indicando que 29% do valor do empréstimo não é reembolsado. Estes resultados oferecem uma compreensão fundamental das dinâmicas financeiras e considerações políticas essenciais para a potencial adoção de um sistema de *ICL* em Portugal.

Keywords: Empréstimos contingentes ao rendimento, *Design* de empréstimos a estudantes, Financiamento educativo, Apoio financeiro a estudantes

JEL Classification: I22; I28; J24

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1. Introduction

Financing of Higher Education (HE) for students matters (Barr, 2017). The relevance of this topic is given by the underlying assumption that growth and competitiveness; education, skills and work; and equality and inclusion are three areas that drive the world economy's growth (Schwab, 2019). This dissertation is focused on the education area and certainly touches the other areas, as they are all interconnected (Schwab, 2019). It is framed in the current literature discussion about the Higher Education Funding problem (Friedman M. , 1955), the current trend of cost-sharing (Teixeira, Johnstone, Rosa, & Vossensteyn, 2008), and income-contingent loans (Britton, Erve, & Higgins, 2019) as a financing solution.

Despite the existence of some studies about the current state of Higher Education in Portugal, and its financing possibilities, this dissertation finds a literature gap, in the sense that in its methodology, it is inspired by the work of Barr, Chapman, Dearden, and Dynarski (2019) and applies it to Portugal. Our study for Portugal presents the simulated impact of an income-contingent loan on the State accounts and in the students' ability to pay back. It also studies the impacts of the advice given by the OECD in 2007, about Portugal's financial support to students:

“The matter of student financial support requires considerable attention. The financial supports currently available to students are inadequate, particularly as Portugal sets out to expand student access to Higher Education. An income-contingent student loans system should be introduced, designed taking local circumstances into account. However, there are a number of approaches – in the United Kingdom and Australia, for example – that can be consulted for inspiration.” (OECD, 2007)

What the consequences of an income-contingent loan scheme in Portugal would be to the State accounts, more specifically, how much of the loan provided would have to be covered by the State, is the main question that I intend to answer with this research. Why financing for students in Higher Education is important, who finances it, and what financing schemes are available are other important questions to frame this dissertation in the current literature about the topic.

The empirical purpose of this dissertation will be achieved by using a methodology similar to that of the work “US college loans system: Lessons from Australia and England” (Barr,

Chapman, Dearden, & Dynarski, 2019), but applied to Portugal. Similarly, it will use an adaptation of the model that the Department for Education in England provides to researchers, where one can simulate earnings profiles for graduates, which in turn allows one to calculate the implications of different Income Contingent Loan design features for government finances.

In Section 2, it is given an extensive theoretical background on why Higher Education is important, and why financing it through different parties is imperative. A theoretical review of the different types of loans to students is also conducted. Then, it is presented two different possibilities that exist to finance Higher Education, the English and Portuguese case. The empirical focus in this review will be on the income-contingent loans practised in England and the mortgage-type loan observed in Portugal, with high take-up rates in the first country (Barr, Chapman, Dearden, & Dynarski, 2019), but a much lower one in Portugal (Heitor, Horta, & Leocádio, 2016).

Section 3 provides the methodology approach to address the main objectives of this dissertation: to determine the percentage of necessary government contribution to an Income Contingent Loan (ICL) system for students, and to assess the impacts of various policy parameters. This section also includes the approach taken to forecast future income trajectories for graduates, which serves as the foundation for modelling the repayment of student loans. Finally, the results of the simulations conducted are presented.

In Section 4, I conclude with the main takeaways of this research, with a focus on what can be done in terms of Higher Education financing policy in Portugal and what further studies would be needed to increase knowledge in this field.

2. Literature Review

2.1 Theoretical fundamentals of the importance of Higher Education

Higher Education matters because it is a determinant source of economic growth. Endogenous innovation, in neoclassical economic growth models, is influenced by the externalities inherent to the accumulation process of technological knowledge (Arrow K. J., 1971). For Lucas (1988), the externalities take the form of public learning that increases the stock of human capital. In turn, this human capital improves the productivity of a single individual but also contributes to improving the productivity of all factors. The importance of human capital to economic growth is clear in the following statement:

“The main engine of growth is the accumulation of human capital - of knowledge - and the main source of differences in living standards among nations is differences in human capital. Physical capital accumulation plays an essential but decidedly subsidiary role. Human capital takes place in schools, in research organizations, and in the course of producing goods and engaging in trade.” (Lucas, 1993)

This improvement in productivity is even more important in the context of declining fertility and rising life expectancy, since the existence of less workers puts pressure in each existing worker to be more productive (Barr, 2017). For Barr (2017), improving the quality of teaching and research, widening participation for students from all backgrounds, and increasing the size of the Higher Education sector are all objectives that should be pursued in order to strengthen economic growth.

In Portugal, human capital was found to have a high importance to economic growth via productivity effects and innovation efforts. The estimate of the elasticity of total factor productivity (being this a proxy of technological progress) with respect to human capital stock, measured in average number of years of schooling, is 0.42 percentage points (Teixeira & Fortuna, 2004).

2.2 Higher Education funding problem

Countries have the pressure to increase access to Higher Education, for the reasons mentioned above. The rapid growth in enrolments worldwide shows the increasing demand for Higher Education: tertiary gross enrolment ratio (GER), which is given by the number of students, regardless of age, enrolled in tertiary education, expressed as a percentage of the official school-age population corresponding to the same level of education (UNESCO, 2024), has risen in the world from 18% in 1999, to 26% in 2007, to 42% in 2022 (World Bank, 2024). In Portugal, this value has risen from 45% in 1999, to 57% in 2007, and to 72% in 2021. Despite the impressive rise in participation in Higher Education in Portugal, this value is still below the European Union's average of 77%. It is important to note that only a value reaching or exceeding 100% would indicate that a country is, in principle, able to accommodate all of its tertiary education-aged population in Higher Education (UNESCO, 2024).

Portuguese statistics for demand for Higher Education can be seen in the number of candidates per year, where the number of candidates in the first phase of the National Competition for Access grew from around 47,000 in 2011, to around 59,500 in 2022/2023, a 26.6% increase (Direção-Geral do Ensino Superior, 2021, 2024).

The increase in demand for Higher Education can be explained by the filter theory, where having a degree is a signal that one is productive and is used by employers that have constraints to test the abilities of people before hiring them (Arrow K. J., 1973). Another explanation is given by Teixeira, Johnstone, Rosa, and Vossensteyn (2008), who point to the increasing prosperity in the global economy and increasing communication as the reason for the natural expansion of educational aspirations.

Another important consideration to complement the demand for Higher Education is the increasing per-student cost. This is explained by the cost disease, where in labour-intensive sectors of the economy, the productivity is resistant, because, first, education is inconsistent with standardization, and second because quality in teaching and learning is correlated with the amount of human labour devoted to it. Because teacher salaries rise more than the productivity growth per teacher-hour (which is zero), relative per-student cost will rise (Baumol, 1993).

With increasing demand, comes the necessity of increased supply, and Sanyal and Johnstone (2011) present a ratio that gives a rough measure of the capacity that a state has to accommodate the growth in Higher Education's needs for revenue. This ratio is given by the public expenditure per student to the GDP per capita (%). They also compared this ratio value in 1999 to that of 2009 and concluded that in 81 out of 104 countries, it dropped. In Portugal, this ratio was 27% in 1999, 29% in 2009, and 26% in 2015 (World Bank, 2020). This shows the Government's rather stagnant or decreasing ability to invest in Higher Education. Another statistic regarding the supply of Higher Education in Portugal is the number of vacancies available for entrants in the first phase of the National Competition for Access. From 2011 to 2023, the number increased from around 53,500 to 54,360, a 1.6% increase. The value of 2023 represents, however, a decrease from the peak value of 2020, around 56,100 (Direção-Geral do Ensino Superior, 2021, 2024).

Another relevant statistic is the fact that in 2023, in the first phase of the National Competition for Access, around 44% of the candidates didn't get placed in their first choice because there were no vacancies available for them. They were left to their 2nd to 6th choices in the course selection priorities (Direção-Geral do Ensino Superior, 2024).

This decrease in capacity of investing in the Higher Education is explained by the pressure that governments have to provide for other public needs, such as elementary and secondary education, public health, housing, clean water, and transportation (Sanyal & Johnstone, 2011). These public investments are seemingly more politically compelling than the claims of Higher Education (Johnstone, 2004).

To these problems, adds the high level of country indebtedness, where Portugal has a general government debt of 100.5% of its GDP as of 2024 (Banco de Portugal, 2024). This doesn't give a margin, nor does it give hope that government investment in Higher Education will be a priority in the next decades.

About "free" Higher Education, Barr (2004) argues that the often-asserted proposition that Higher Education is a basic right and therefore should be free is flawed. First, there is wide agreement that Higher Education is a basic right. But that doesn't mean that it should be paid entirely by the taxpayers. The argument is that what justifies something being free for everyone are market failures that make consumer choice problematic, and equity, where the good is consumed by everyone. Higher Education doesn't fit with either criterion, and so,

taxpayer subsidies are regressive. In fact, people choose whether to participate, and it is mainly people from wealthier backgrounds who do so (Barr, 2017). So, also the taxes of poorer people are subsidizing the superior good that Higher Education is (Barr, 2017).

The approach that governments have to address this increasing costly demand for Higher Education and lower capacity to provide more vacancies consists of two parts: lower costs, for example, merging institutions and increasing student-faculty ratios, providing economies of scale; and increasing revenues through private funding, for example with tuition fees (Teixeira, Johnstone, Rosa, & Vossensteyn, 2008).

To address this lack of revenue problem, Europe, which was the last geography with widespread “free” Higher Education, is shifting from this type of financing to cost-sharing (Johnstone, 2004). In Portugal, this happened in 1992 with the introduction of tuition fees. In this way, the cost of Higher Education shifted from being only financed by the State – by tax-payers - to also parents and students (Vieira & Vieira, 2012).

2.3 Theoretical fundamentals of cost-sharing in Higher Education

Cost-sharing takes the form of splitting the burden of financing Higher Education between four main parties: the taxpayers (in the form of government spending), parents, students, and individual or institutional donors (Johnstone, 2004).

Economic efficiency is a factor that plays in favour of cost sharing. This efficiency is accomplished with pricing, which brings the cost of Higher Education closer to what are its real costs and trade-offs. As already mentioned, if it was free to the student, he would have an incentive to over-consume or consume with insufficient academic effort. Thus, tuition fees introduce incentives for students to work harder - thus, learn more – and for them to be more demanding towards the institution, both pressing it to keep tuitions low – in order to attract and retain students – and to provide students what they want in term of knowledge – which ultimately benefits the employers as well and productivity (Woodhall, 2002) (Teixeira, Johnstone, Rosa, & Vossensteyn, 2008).

Both the USA and the UK, pressed by the increasing Higher Education costs and higher demand, adopted cost sharing. In the US, tuition fees at public universities rose by 84% in the 90s decade, where at the same time the share borne by taxpayers diminished (U.S. Department of Education, National Center for Education Statistics, 2002). In 1997, the UK became the first European country to impose more than a nominal tuition fee (Teixeira, Johnstone, Rosa, & Vossensteyn, 2008). An empirical overview of the UK's cost-sharing system will be covered in Section 2.5.1.

2.4 Loans as a cost-sharing strategy

Sharing the cost of Higher Education through tuition fees is a practice that is becoming mainstream in the developed world, as mentioned before. This tuition fees alone are paid by the students and their families. With tuition fees and the disappearing “free” Higher Education, it is important that the goal of making tertiary studies available for everyone is achieved (Barr, 2004). Thus, a notion of equity, cost and manageability is needed to better understand how a country can achieve that goal, using the support of loans to students (Teixeira, Johnstone, Rosa, & Vossensteyn, 2008). Christou and Haliassos (2006) note that simply making loan schemes and work opportunities available does not automatically improve access to Higher Education, as there is no guarantee that these will be taken up by students belonging to demographic groups of policy interest.

Let’s start by analysing the case of mortgage-type loans. In 1945, Friedman and Kuznets (1945) proposed that an individual could sell shares of his future income, to finance his studies, instead of taking a mortgage-style loan. Friedman (1955) argued that conventional mortgage-type didn’t work well for student loans, because there is lack of collateral, as the student has nothing to sell if he defaults, and there is asymmetric information, because students know if they plan to seek a successful career with steady income, or instead if they don’t want to work after taking the degree.

So, Friedman (1955) concludes that mortgage-type loans lead to a sub-optimal investment in human capital, as borrowers face too much risk because they lack a collateral, and lenders face too much risk too because of the same reason, plus the asymmetric information problem. For Friedman two elements are thus needed, in order to have an efficient level of investment in human capital: consumption smoothing, as the loan needs to be large enough to provide consumption smoothing during the period of the loan; and because of the problem of lack of collateral, there needs to be also an element of insurance in the case of low working income from the borrower – which affects both lender and borrower.

Because of this market imperfections regarding mortgage-type loans, Friedman (1955) restores his notion of the student selling a share of his future incomes in return of a loan from the government:

“The individual would agree in return to pay to the government in each future year x per cent of his earnings in excess of y dollars for each \$1,000 that he gets in this way. This

payment could easily be combined with payment of income tax and so involve a minimum of additional administrative expense” (Friedman M. , 1955, p. 140)

This is the birth of the notion of income contingency, but in an equity finance form, since the graduate tax that Friedman is implicitly proposing is for life or till the graduate stops working, and people who get higher incomes will pay more in present-value terms. In contrast, an income-contingent loan is grounded in the notion that repayments from the graduate happen until he pays 100% of the borrowed amount in present-value terms (Barr, Chapman, Dearden, & Dynarski, 2019).

Let’s now analyse what are the core elements of an income-contingent loan (ICL). Barr, Chapman, Dearden, and Dynarski (2019) propose 7 elements that a well-designed ICL should have:

- “The repayment rate(s), that is, repayments as a per cent of a person's current income;
- The repayment threshold, that is, the level of income at which repayments start;
- The interest rate and/or loan surcharge/administrative charge;
- A cap on total and/or annual borrowing from the student loan system;
- The maximum number of years of repayment, that is, forgiveness after n years;
- Conditions for early repayment;
- A robust collection mechanism.”

A more detailed analysis of the impacts of each of these elements of an ICL will be discussed in the methodology section. Also, the existing literature analyses how the design of the ICL affects equity, cost, and enrolment, which will be discussed in the following Section 2.5.1.

2.5 Financing schemes cases

The following sections have an empirical look to what are the practices of financing Higher Education in England and Portugal. These two countries use different types of financing, with England having an income-contingent loan scheme and Portugal having a mixed financing system, where the State and privates contribute to the financing.

England is an important case study for this dissertation, as it has had an income-contingent loan scheme since the 1990s. The historic financing development, as well as a description of the current system will be provided in section 2.5.1.

Portugal will be the object of this dissertation's research question, so a historic development in Higher Education funding schemes and values will be provided in section 2.5.2.

2.5.1 The English case – Income Contingent Loans

England has had an Income Contingent Repayment Loan system for 26 years, having started in the academic year of 1998/99. Income Contingent Student Loan balance reached £236.2 billion for Higher Education borrowers in the academic year of 2023/24, including English students and students coming from the European Union, which compares to a value of £54.355 billion in the 1st quarter of 2014 (Student Loans Company, 2024). These student loans are issued by the English-domiciled Student Loans Company (SLC), which is a non-profit government organisation that acts as an agent on behalf of the Secretary of State for Education in England (Student Loans Company, 2024).

Universities in England operate in the public sector with tuition charges set by the government. These tuition fees are, for more than 95% of the Universities, £9,250 per year. Students can take out an income-contingent loan to cover the full amount of these fees. Students can choose whether they want to pay the tuition up-front or defer the payment through an income-contingent repayment plan. The majority of students in England (95% in 2021/22) chose the latter option (Student Loans Company, 2023).

The most recent repayment plan – repayment plan 5, for the students who started after the 2023 alterations of the loan system – must start the repayment in April after they finish the course. They only must start making repayments if their income is over the repayment threshold, which is currently £25,000 a year in the UK. The repayment is done monthly and

is equal to 9% of the income above the threshold, being automatically deducted from the graduate's salary, along with income tax and National Insurance. If the income rises or falls, the repayment amount will automatically adjust to reflect this change. If the income falls below the repayment threshold, the repayments stop and only restart when their income is over the threshold again. Also, for the most recent repayment plan, if students don't pay completely their loan after 40 years of the start of the repayment, the loan will be forgiven (Student Loans Company, 2024).

The interest rate of this loan is based on the Retail Price Index, or RPI, which is a measure of inflation, and is compounded, computed daily and added to the loan balance each month. The actual interest rate of the loans for the most recent repayment plan (repayment plan 5) is set by the RPI only (Student Loans Company, 2024).

The English case is more similar to the one defended by Barr, Chapman, Dearden, and Dynarski (2019), which has a superior theoretical advantage over mortgage-type loans and "free" Higher Education. According to Murphy, Scott-Clayton and Wyness' study (2019) on the implications of transitioning from a free Higher Education system to an income-contingent loan system in England, there were merits in terms of quality, quantity and equity of doing this transition.

During the free Higher Education period, student enrolment increased significantly, which put the government funding under strain. In response, the government imposed, in 1994, a limit to the number of state-supported students each university could enrol. By 1998, the funding per student had fallen to around half of that of 1973, as the government didn't keep up with the increasing need for funding, as more students enrolled in Higher Education (Murphy, Scott-Clayton, & Wyness, 2019).

In terms of equity, the expansion of Higher Education didn't benefit young people equally. In fact, according to Blanden and Machin (2013), despite the overall increase in the percentage of graduates by the age of 23 across all income cohorts from 1981 to 1999, there was a divergence in the proportion of increase. The gap between high- and low-income increased from 14 percentage points in 1981 to 37 percentage points in 1999.

There were, then, concerns about the decrease in per-student funding, and about quantity and equality in accessing Higher Education (Blair, 1997), as lack of funding meant that enrolment numbers were capped and thus when competing for existing vacancies high-

income families' youngsters have an advantage (Chowdry, Crawford, Dearden, Goodman, & Vignoles, 2012).

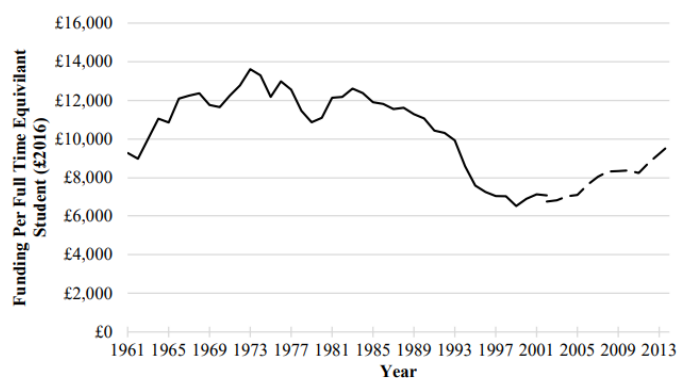
As already mentioned above, from 1998 onwards, a system of Income Contingent Loans was introduced. Its technical specificities were already discussed, so the focus now is understanding whether the system provided increased participation, equity and funding.

In terms of enrolments, from 1998 to 2015, enrolment rates for students aged 19 and 20 years old more than doubled from around 16% pre-1998 to 35% in 2015, with similar doubling observed among older age groups. Here, the relaxation in the cap on maximum students since the introduction of the ICL might have contributed to this increase (Murphy, Scott-Clayton, & Wyness, 2019).

In terms of equity, while participation rates rose across all income groups, data from the Universities and Colleges Admissions Service (UCAS) shows that, despite an increase from £1,000 per year in tuition fees in 2004 to £9,000 in 2016, the proportion of students from the most disadvantaged quintile enrolling in college has approximately doubled, from 10% to 20% (Murphy, Scott-Clayton, & Wyness, 2019).

Finally, in terms of funding, an initial graph compiled by the authors provides insight into the evolution of funding per any type of Higher Education student in the UK from the 1960s to 2013 (Murphy, Scott-Clayton, & Wyness, 2019):

Figure 5: Average Funding per Full-time Equivalent Student



Sources: Statistics for 1961-2002 are taken from *Carpentier (2004)* and Statistics for 2002-2014 taken from Higher Education Information Database for Institutions All figures expressed in constant 2015 pounds sterling, *authors' calculations*. FTE enrolments used in the computation contain all student types (full-time, part-time, postgraduate, undergraduate, UK, EU, overseas); funding per head is for all students and comprises teaching grants and tuition fee income (the latter for all student types listed above).

Figure 1: Funding per student in the UK (1960-2013)

Source: Murphy, R., Scott-Clayton, J., & Wyness, G. (2019). The End of Free College in England: Implications for Quality, Enrolments, and Equity. *Economics of Education Review* 71, p. 7-22.

Additional data compiled in the same study by Murphy et. al (2019), now focusing only on full-time domestic undergraduate students, shows that Government grants from 1998 to 2015 fell sharply, as the intention is to shift expenditures away from the State to the students. Data shows that the decrease in government funding was more than compensated by the increase in tuition fees, thus we see in Figure 1 an increase in funding per student values. Funding per student is now at around £10,500 (real 2016) for lab-based courses and around £9,000 for classroom-based courses, compared to £6,000 (real 2016) and £2,000, respectively in 1998. This value still falls short of the highs of the 1970s, where average funding per student reached almost £14,000 (real 2016) but reveals a recovery from the steady drop from the 1980s to the late 1990s.

2.5.2.1 RAB charge

This section focuses on understanding the Resource Accounting and Budgeting (RAB) charge and its outcomes in England. The RAB charge represents the estimated cost to the government of subsidizing the student finance system, calculated as the proportion of loan outlay each year that is not expected to be repaid, discounted to present value using the Treasury discount rate (Department for Education, 2024).

For instance, for the financial year 2023-24, the RAB charge for full-time Higher Education under Plan 5 is forecasted to be 29%, indicating that 29% of the loans issued are not expected to be repaid. Compared to other payment plans that students benefited from before 2023/24, such as Plan 2, Plan 5 RAB charges are lower due to longer repayment terms and lower repayment thresholds, resulting in a lower proportion of outlay not expected to be repaid (Department for Education, 2024).

The RAB charge is then a measure of the long-run cost of student loans, and based on this metric, I'll develop the methodology for this dissertation. A more detailed description of the RAB charge formula and the variables that can influence its value will, thus, be given in the methodology section of this dissertation.

2.5.2 The Portuguese case

Higher Education institutions in Portugal are primarily financed by the State on a historical basis. While there is a financing formula in place, accounting for the number of students enrolled in the institution and cost factors, it is not actively applied. The formula was

introduced in the financial crisis period of 2010 to 2014, and the State wasn't able to comply with the financing requirements resulting from the formula (Luís, Cerdeira, & Sarrico, 2022).

Currently, Portugal is one of the few countries of the OECD, alongside Mexico, that relies predominantly on historical funding for its Higher Education institutions (OECD, 2019). This method ensures financial stability but can limit the growth of newer institutions and the flexibility of the existing ones.

The sources of public financing in Portugal are three: State Budget transfers, Other National Funds, and EU funds (Instituto de Gestão Financeira da Educação, I.P., 2024).

The evolution of the State Budget transfers to Universities in the last twelve years and the value of that funding per student is the following:

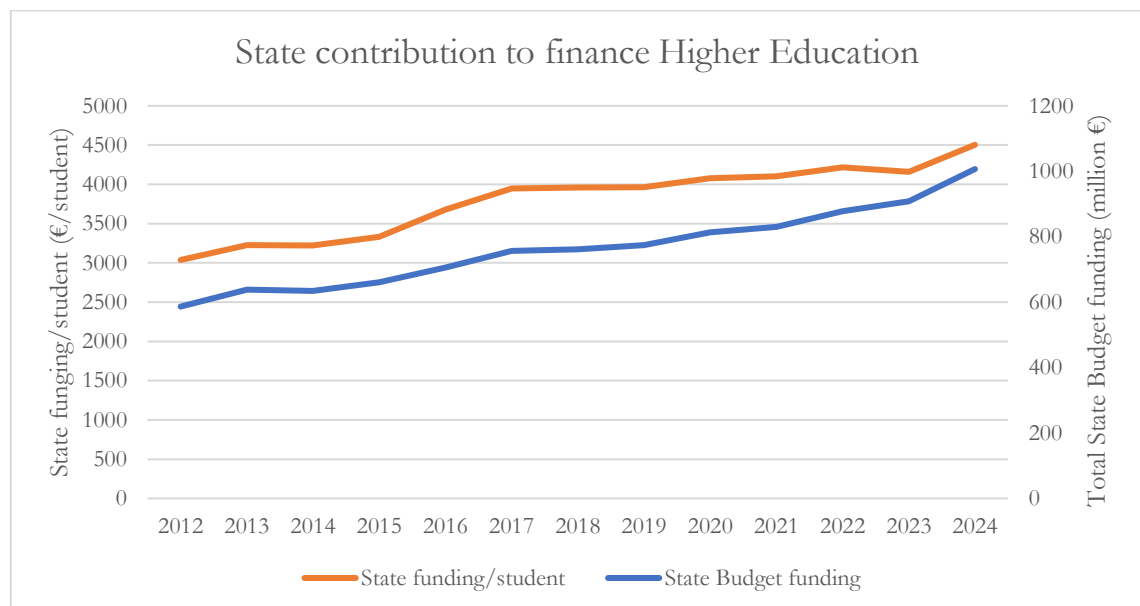


Figure 2: Portuguese State contribution to finance Higher Education

For Figure 2, the calculation was made with funding transfer from every State Budget from 2012 to 2024, and the numbers of enrolled students at Universities from the General Directorate of Education and Science Statistics (DGEEC). I divided the total funding coming from taxes by the number of enrolled students in universities from the previous year to get the State funding per student value. It would be insightful to have a full picture of total funding per student that would include not only state transfers but also EU funding and own revenues from universities. However, to the best of my knowledge, that detailed data isn't centrally available, and one would have to do the exercise for each Portuguese University.

For that reason, these numbers in Figure 2 only include State Budget transfers. The values are for every type of program (i.e. bachelor's, master's, and others), since there is no data with disaggregation of funding per type of program.

Over the previous twelve years, the State increased the State Budget transfers to universities yearly. Nevertheless, according to OECD data from 2020, the Portuguese Government spends 0.7% of GDP on Tertiary (Higher) education, which is below the 1.1% average of the OECD countries (OECD, 2023).

As mentioned previously, there are other sources of financing for institutions other than State Budget transfers, which are their own revenues, mainly through tuition fees, and EU funding. The weight of each financing source varies from university to university because each has its own State funding's, EU transfers' and own revenues' values. Since we don't have the Portuguese aggregate data of funding according to the source, and to give an illustrative, but representative, example of a major institution in Portugal, I'll focus on the case of the University of Porto to analyse the evolution of total funding and funding per student according to financing source.

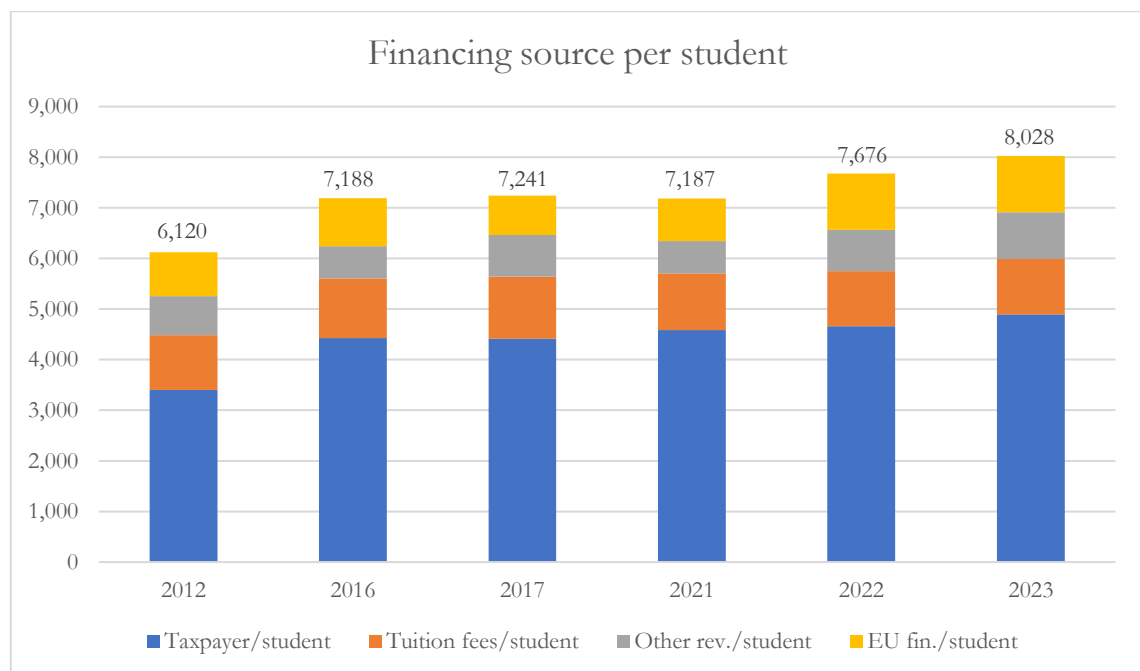


Figure 3: Financing source per student in University of Porto (2012-2023)

The values presented in Figure 3 were computed using the data coming from the yearly report of the University of Porto (2013, 2017, 2018, 2022, 2023, 2024). Every selected year, I took taxpayer financing, which the majority comes from the State Budget, tuition fees, other own revenues, and EU financing. I then divided each value by the number of enrolled students in the corresponding academic year to get a per-student value of financing. I chose the selected years so it's possible to see an evolution of the values and their relative weight in student financing. These values account for all revenue and all students enrolled, as it's not possible to disaggregate revenue values per level of education.

The relative share of taxpayer financing in total financing per student increased from 56% in 2012 to 61% in 2023, as tuition fees decreased their share by 4 percentage points in the same period (18% to 14%). Tuition fees' nominal value is very similar to the one of 2012, at €1,095/student as of 2023.

According to the calculated values shown in Figure 3, there's a nominal increase of 31% in financing per student total values. Using the CPI data from INE (2024) to adjust these values for inflation, we have the following trend:

Total Financing (€/student)	2012	2016	2017	2021	2022	2023
Real 2023	7 136	8 111	8 123	7 848	8 275	8 028
Nominal	6 120	7 188	7 241	7 187	7 676	8 028

Table 1: Total Financing/student per year in the University of Porto (nominal and real terms)

Even accounting for inflation, there was a 13% real increase in total per-student financing according to U. Porto data from 2012 to 2023, mainly led by a real increase of 23% in taxpayer financing, 11% increase in EU financing and partially offset by a real 13% decrease in tuition fees' financing.

Deep diving into 2023 values, according to the University of Porto's financial statements, we have:

Source of financing	Value (thousands of €)	Relative weight
Taxpayers	171 745	61%
State Budget	148 392	-
Own revenues	70 954	25%
Tuition fees	38 456	-
EU financing	39 184	14%
Total	281 883	100%

Table 2: Source of Financing of University of Porto in 2023

In the academic year 2022/23, U. Porto had a total of 35 111 students enrolled. Having these numbers, we can decompose the financing sources' weight per student for a year of operation. This exercise is insightful in understanding what the main financing sources' needs are to finance Higher Education for a student.

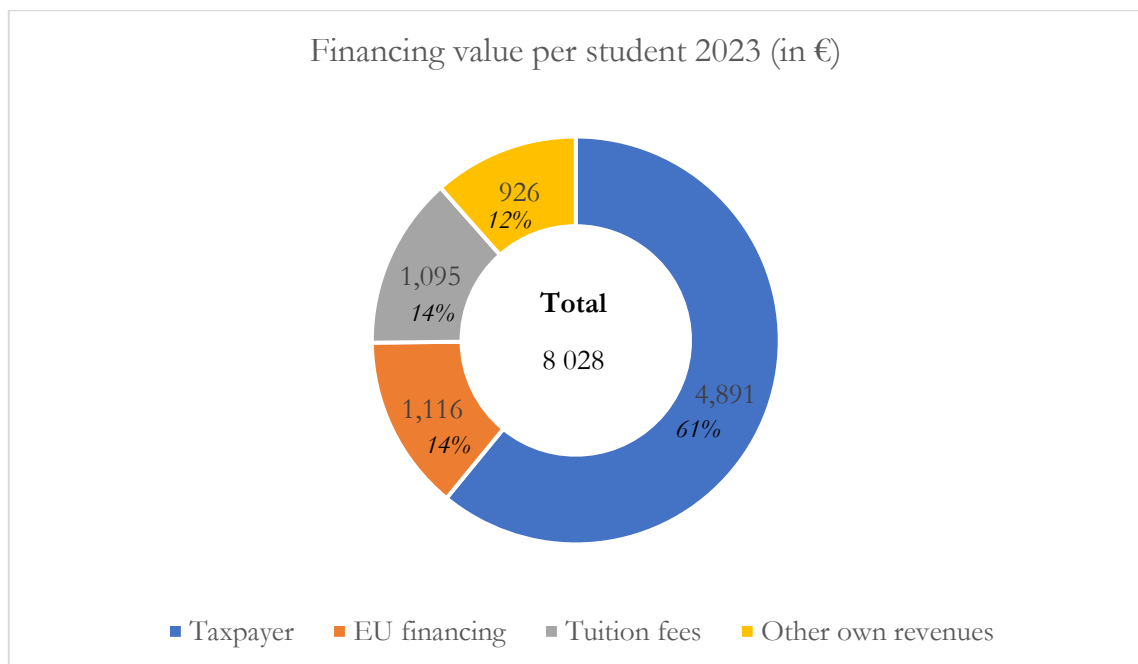


Figure 4: Financing value per student in 2023 in the University of Porto

This disaggregation shows that, in U. Porto, the yearly financing needs for a student are about 7.3 times higher than the value paid by the student, which is consistent with the proportion calculated by EDUCA in 2016 (Cerqueira L. C., 2018).

Students in Portugal can receive financial support through a system of social action, which includes direct support via scholarships and indirect support through access to food and housing. Scholarships are available for economically disadvantaged students and those with exceptional academic performance (European Commission, 2024).

Portugal has had a mortgage-type student loan scheme with mutual guarantees underwritten by the State and other private entities. The scheme was active for the first time from 2007 to 2014 when it was suspended. It returned in 2018 and was active until the end of 2023.

The loan scheme worked with private banks providing direct credit to college students in Portugal. The amount varied from €1.000 to €5.000 per year depending on the course duration, which could go from 1 to 6 years (students already enrolled could ask for a loan too). The disbursement of the loan could be every month, quarter semester or year, and after one year, it was contingent on the performance of the student. The reimbursement period was normally double the course length and students only start repaying the loan after they end their studies plus a possible additional two years. The interest payments are due right from the beginning of the loan disbursement period. The interest rate is fixed, and it is equal to the Euribor swap rate for the ending period of the loan, plus a maximum spread of 1.25% (SPGM, 2020) (Instituto de Gestão Financeira da Educação, I.P., 2024). In case of default, the Mutual Guarantee Society (MGS), which has mainly private shareholders, covered up to 10% of the total portfolio of loans issued by the bank from 2007 to 2014, while from 2018 onwards it was up to 15%. In turn, SPGM, the Mutual Counter Guarantee Fund whose equity is mainly public, fully covers the MGS risk. So, the State, in the worst-case scenario only has to pay 10% or 15% of the total portfolio of student loans (Heitor, Horta, & Leocádio, 2016) (Instituto de Gestão Financeira da Educação, I.P., 2018).

The contracted credit value and number of loans given until 2021 (the most updated data in the government website) were the following:

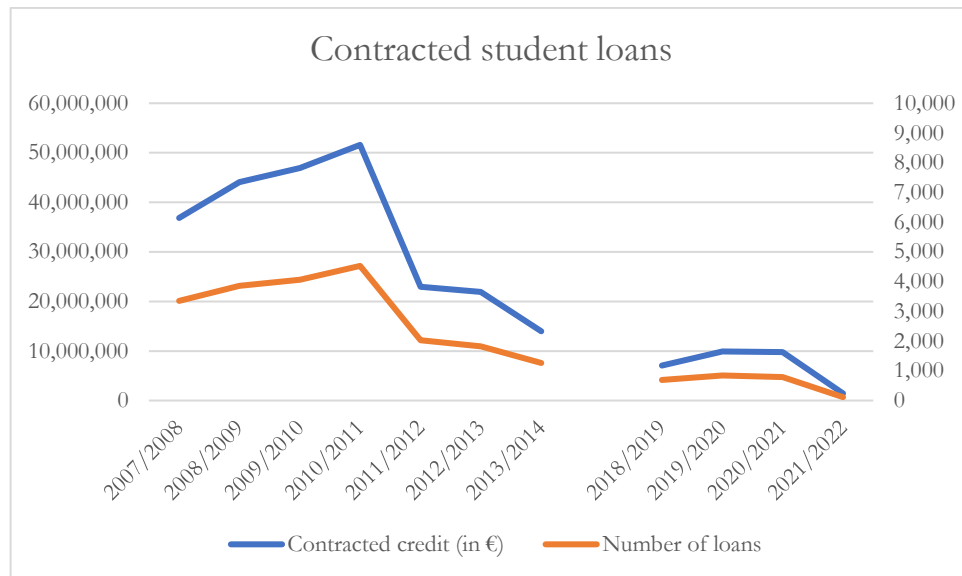


Figure 5: Contracted student loans in Portugal's mutual guarantees student loan (2007-2022)

As shown by the graph, the take-up rates were low. The value of contracted credit from 2007 to 2014 was €238.25 million. In the second period of the scheme (2018 to 2023), there were €85 million available in the credit line, while until 2021 only €28 million had been used.

As ministry officials have acknowledged, this low take-up rate was due to weak demand for loans and a limited supply of loans. On the demand side, the penetration rate and the number of advantages of the public social support system fundamentally decrease demand. On the supply side, during the first period of the scheme (2007-2014), banks exhibited a strong aversion to default risk, given the lingering impact of the recent financial crisis (OECD, 2019).

Observing the theoretical literature regarding the market failures of mortgage-type loans by (Friedman M. , 1955), it is not a surprise that on the borrowers' side, the design of the loans puts students at risk in the event of unemployment or falling incomes, a condition that is aggravated by not having collateral. On the lender side, banks have been reluctant to expose themselves to loan default, moreover, not having collateral to collect from the student.

There is currently in Portugal an income contingent type of support for students provided by the José Neves Foundation (FJN). The ISA° FJN (Income Share Agreement) covers the full tuition fees for eligible students enrolled in selected courses, which includes only master's degrees, postgraduate programs and bootcamps, focusing on high-demand fields such as technology and management. The program is open to all Portuguese residents, regardless of

age or financial background. The funding is assured by the European Union's Fund for Strategic Investments and private partners (Fundação José Neves, 2024).

The value of the loan is dependent on the course's tuition fees value and repayment only begins after the student completes their education and secures a job with a salary above a predetermined threshold, which is again dependent on the specific course. In periods when the graduate is below the income threshold, the repayment stops. The monthly repayment amount is calculated as a percentage of the student's income, and the number of maximum repayment periods is pre-defined. The repayment obligation ends when a graduate reaches the maximum repayment periods, or the maximum repayment value is reached, or when the repayment contract reaches its duration. The value of the repayment in nominal terms is maximum 1.05 times the value of total tuition fees (Fundação José Neves, 2024).

Since its inception in 2020, the ISA^o FJN program has funded over 400 students, with total tuition payments close to €3 million. According to an impact assessment made by the Foundation and NOVA SBE, the employment rate of the graduates is 87% and their income increased more than 20% after graduation (Fundação José Neves, 2023).

Although a seemingly good example of how an income contingent scheme could help fund Higher Education, the impact of this Foundation's scheme is still limited and is assured by the EU.

3. Methodology

The methodology used in this dissertation is inspired by the work of Barr, Chapman, Dearden, and Dynarski (2019), for designing an appropriate Income Contingent Loan system. This work will also use a similar but simplified model, that the Department for Education in England provides to researchers (Department of Education, 2024), where one can calculate the implications of different Income Contingent Loans variables for the ability to pay back the student loans. The necessity of building a simplified model for this study comes from the different availability of graduates' income data in the UK and in Portugal and from the necessary adjustments to economic assumptions and policy parameters to adjust the model to the Portuguese reality.

The methodology for this study is divided in two major sub-chapters: Income Forecasting (Section 3.1) and the Portuguese ICL model (Section 3.2). Inside each section, there will be sub-sections to further detail specific variables that are important to the calculation of the lending charge.

3.1 Income Forecasting

The Stochastic Earnings Path (StEP) is the model used by the Department for Business, Innovation & Skills (BIS) to estimate the financial cost of income-contingent student loans to the Government (Department for Business, Innovation & Skills; Department for Education, 2016). The StEP model uses wage equations to estimate the next year's wage, and its repeated usage allows to generate simulated earnings paths that are then used in the UK ICL model to calculate repayments. The wage equations use multiple years of historical earnings with data coming from the Student Loans Company (SLC). The benefit of using SLC data is that this data is longitudinal, so one can track an individual earning path throughout the years. The data has information about gender, age, course type and subject, institution, previous earnings, and non-employment status. This detailed information about graduates' earning path provides realism because it allows to build multivariate regression models that help to forecast a person's change of fortune over their lifetime (Department for Business, Innovation & Skills; Department for Education, 2015).

For Portugal, to the best of my knowledge, there's no longitudinal data available for graduates' earnings. Given this unavailability of longitudinal data, I used a pseudo-panel approach, where I used repeated cross-sectional data to form cohorts based on age.

3.1.1 Data sourcing and filtering

For this dissertation, I used the “Quadros de Pessoal” database from “Gabinete de Estratégia e Planeamento”, which provides anonymised yearly data from 1985 to 2019 about, among 33 other variables, the reference year, gender, qualification level, age, and wage (GEP - Gabinete de Estratégia e Planeamento, 2020). A table containing all the variables in the database will be provided in the appendix.

From the database, I retrieved the following variables:

Year (ano)	Reference year of the data (from 1985 to 2019)
Age (idade)	Age of a graduate in the reference year
Total income (rganho)	Total monthly income (base + overtime work) in nominal euros of a graduate in the reference year

Table 3: Variables retrieved from “Quadros de Pessoal” database

From the pool of data, and to adjust it to this dissertation’s goal, I filtered the data to account only for graduates who completed a bachelor’s degree, that is, filtering out levels of education both lower and higher than bachelor’s degree (e.g. basic education and master’s degree). Another filter applied to data was the age, where the lower bound is at 21 because students in Portugal finish high school at least at 18 and with 3 years of bachelor’s degree, they can only start working at 21. The upper bound is 67 years old because the retirement age in Portugal is 66 years and 4 months as of 2024 and so that’s the age that a graduate stops having a working income (Instituto da Segurança Social, 2024).

Even applying these filters, the data points sum up to 7 million in total. So, to make the dataset simpler and save computing power, I made random samples for each reference year with 31,758 values. Most reference years had more than 100,000 values, and in the reference years with less than 31 758 values, all data points were considered. The resulting table that will serve as an input to build the pseudo-panel looks like the following:

Year	Age	Income
1985 to 2019	21 to 68	0 to 17 077

Table 4: Schematic input table for pseudo-panel build

The final table has around 1 million rows, with every year having around 31,000 data points, with various ages with various incomes.

3.1.2 Forecasting income to 2050

With panel data not accessible for Portuguese graduates’ salaries, I’ll utilise pseudo-panel data as an alternative. Pseudo-panel data is constructed from repeated cross-sectional surveys, where different individuals are observed at various points in time. This method leverages the idea that individuals sharing specific characteristics, such as age, can be grouped into cohorts, allowing for the analysis of temporal dynamics in a manner analogous to panel data (Deaton, 1985).

Using a pseudo-panel approach assumes that within each cohort, individual variations average out, and the aggregate behaviour of the cohort remains stable and representative over time. The aggregation process reduces measurement errors and biases that might arise from individual-level fluctuations, thus offering a reliable framework for longitudinal analysis. Verbeek and Nijman (1992) expanded on this by concluding that for estimators to be consistent, the cohorts must be sufficiently large (i.e. more than 100 individuals).

I chose age as an appropriate variable for cohort formation because it influences many socioeconomic outcomes, such as labour market participation, income trajectories, and the time since graduation. As mentioned above, the filtered dataset has around 31,000 data points per year, and the large majority of the age cohorts have more than 100 data points per year, so there's confidence that the cohort averages accurately reflect the underlying population parameters.

The pseudo-panel was created using the software Stata, and the code used is presented in Appendix B. The process assures that for each age there is only one income value per year, which results from the average of incomes for a given year, for a given age. After this transformation, the resulting table looks like the following Figure 6, which is a cropped screenshot of the actual table used.

	idade	rend1985	rend1986	rend1987	rend1988	rend1989	rend1991	rend1992	rend1993	rend1994	rend1995	rend1996	rend1997	rend1998	rend1999	rend2000
5	21	113.8887	146.67278	119.27333	191.38351	247.51882	.	.	.	521.12625	471.26552	371.9141	449.98639	366.61563	453.28017	494.66949
6	22	144.01115	146.47649	178.53533	292.71108	307.30162	.	543.46362	549.70435	464.01909	637.25426	586.99043	580.70952	576.35313	606.16184	753.57675
7	23	152.77198	171.40195	228.11388	278.00542	367.35658	.	694.18205	686.76464	602.54746	681.02903	694.16033	634.08414	691.636	733.58587	808.82736
8	24	194.37424	208.84563	246.61697	325.2245	431.38314	.	694.78463	772.89308	739.26584	756.50657	758.78832	755.96588	789.82665	812.98507	959.76473
9	25	198.55933	244.60772	255.41042	350.91446	431.60028	.	788.18185	889.63447	839.71734	845.40545	808.45202	824.8243	844.20704	845.40227	978.39588
10	26	209.35794	264.44603	313.93359	385.92168	464.98044	.	843.02692	923.8423	892.93741	882.10774	911.20759	880.49258	899.65453	904.95833	1014.8832
11	27	240.3657	272.9674	317.03052	397.38	498.66234	.	898.09752	980.78544	957.99277	992.98399	946.77619	914.12327	951.24397	1002.0743	1098.0788
12	28	265.31588	292.4492	350.19766	438.65894	506.49374	.	896.80324	1036.1673	1018.508	1024.6811	1046.993	1015.5181	989.00308	1019.557	1132.0986
13	29	280.14703	317.83943	380.54347	438.14476	530.76696	.	942.7374	1074.8809	1113.525	1115.4485	1086.0325	1132.6009	1107.1362	1100.0458	1223.0529
14	30	289.37938	334.27971	382.19129	459.49292	544.97267	.	991.61016	1061.3289	1172.8514	1086.9673	1205.2984	1159.9406	1152.6097	1223.5437	1313.9376
15	31	301.30398	333.51019	404.19387	503.0915	578.4564	.	962.34644	1135.3507	1119.859	1170.8036	1189.8641	1199.1328	1212.4714	1253.9004	1371.3281
16	32	298.099	336.59114	392.8895	505.99428	588.24058	803.49987	1015.8666	1157.4731	1242.1916	1192.3226	1222.8586	1259.3593	1345.9076	1266.7529	1447.9466
17	33	298.17449	348.56863	389.15659	511.59393	608.42135	825.38968	1071.0743	1166.8268	1230.3888	1278.5696	1315.5712	1342.1955	1331.576	1427.9451	1493.4971
18	34	306.22486	340.7709	395.35926	521.03542	606.40332	803.54533	1128.9134	1264.1843	1280.9234	1280.844	1362.5154	1378.1746	1375.3452	1361.5013	1561.6225
19	35	342.08766	356.71899	391.42404	531.02765	601.11485	820.28497	1142.0157	1280.9469	1293.7852	1237.9315	1428.0576	1371.6964	1434.5693	1421.6694	1540.0529
20	36	323.54919	359.14169	425.00559	520.06865	626.32206	809.88122	1122.0792	1263.0714	1344.5574	1360.5778	1476.3891	1447.2412	1456.4151	1382.2545	1514.8981
21	37	319.27161	356.06921	446.88944	522.83912	608.17688	801.28871	1173.0707	1311.9926	1394.4752	1383.7863	1491.0057	1474.7303	1491.3125	1543.1719	1560.0792
22	38	338.60536	360.00137	403.56708	578.58074	630.47003	842.0536	1082.3628	1258.2067	1358.684	1372.3266	1406.3406	1430.8525	1451.449	1522.3908	1551.8159
23	39	329.43207	361.00437	398.42795	574.87965	688.46376	818.37583	1092.9961	1150.171	1352.7799	1369.9931	1479.3387	1464.8822	1470.1092	1479.7456	1753.6641

Figure 6: Stata's longitudinal table with income path for different age cohorts

The resulting longitudinal table shows the income path throughout the historical years for every considered age - the cohorts. As one might notice, some data is missing for 1990, 1991, 1992 and 1993. The reason is that no data was available for those age-year pairs in the original database. The way I worked around this absence of data was to make a linearisation from 1989 to 1993 for the missing pairs of age-year.

To forecast each cohort's income paths, I first performed a fixed-effects regression of the dependent variable income on the independent variable year for the years 1985 to 2019.

The fixed effects model is particularly suitable for this analysis because it controls for unobserved heterogeneity that may vary between the defined cohorts (age groups) but remains constant over time within the age group. These time-invariant characteristics could be, for example, cultural attitudes towards work, and labour market conditions during entry.

By accounting for these time-invariant characteristics, the fixed effects model ensures that the estimated relationship between year and income is not biased by factors that do not change within each age group. This method isolates the within-group variation, allowing us to observe the true effect of the year on income without the influence of unobserved, age-specific traits (Baltagi, 2005).

The fixed effects model has the following formulation:

$$y_{it} = \alpha_i + \beta x_{it} + u_{it} \quad (1)$$

Where:

y_{it} is the dependent variable income for age cohort i at time t

α_i is the individual-specific intercept term (fixed effect) for age cohort i

x_{it} is the independent variable year for age cohort i at time t

β is the coefficient for the independent variable year

u_{it} is the error term for age cohort i at time t

The results of this regression are shown in Figure 7, with detailed comments being provided below.

. xtreg rend ano if ano < 2020, fe						
Fixed-effects (within) regression			Number of obs		=	1,551
Group variable: idade			Number of groups		=	47
R-squared:			Obs per group:			
Within = 0.6582			min =		33	
Between = .			avg =		33.0	
Overall = 0.4792			max =		33	
			F(1,1503)		=	2894.67
corr(u_i, Xb) = -0.0000			Prob > F		=	0.0000
rend	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
ano	56.04625	1.04171	53.80	0.000	54.00289	58.08961
_cons	-110725.9	2085.942	-53.08	0.000	-114817.5	-106634.2
sigma_u	434.4247					
sigma_e	417.63923					
rho	.51969213	(fraction of variance due to u_i)				
F test that all u_i=0: F(46, 1503) = 35.71				Prob > F = 0.0000		

Figure 7: Fixed-Effects Regression Results for Income Forecasting Model

The dependent variable income is written as “rend” and the independent variable year is written as “ano”. The group variable is stated as “idade” which corresponds to the age cohort. The “fe” indicates that a fixed-effects model is used.

The detailed results show the following:

For 47 different age groups (ages 21 to 67), we have 33 years of data in each one (1985 to 2019, excluding 1990 for complete missing data), resulting in 1,551 observations being used in the analysis.

The within measure gives the proportion of the variance within groups explained by the model, which is 0.6582. The overall measure gives the proportion of the total variance explained by the model, which is 0.4792.

The correlation $\text{corr}(u_i, Xb)$ shows the correlation between the fixed effects and the regressors, which is zero, suggesting the fixed effects are uncorrelated with the explanatory variables, which is the desirable outcome in this fixed effect model.

The p-value associated with the F-statistic is zero, which indicates that the null hypothesis, that all coefficients are zero, can be rejected, meaning the model is statistically significant.

The coefficient for year (“ano”) is 56.04625, which suggests that for each additional year, the income (“rend”) increases by approximately €56.05, all other factors constant. The p-value for this variable is zero, indicating it is statistically significant.

The intercept is statistically significant, given its p-value being zero. It indicates that there is a substantial baseline level of income variation that is not explained by the year alone and is consistent across all age groups after accounting for the fixed effects.

The between-group variance (σ_u) is 434.4247, indicating significant differences in income levels across age groups that are not explained by the year variable alone. The within-group variance (σ_e) is 417.63923, reflecting substantial fluctuations in income within each age group over time. The intra-class correlation (ρ) is 0.51969213, suggesting that approximately 52% of the total variance in income is due to differences between age groups, while the remaining 48% is attributed to variations within age groups over time.

The result of the F test that all $u_i=0$ indicates a p-value of zero, indicating that the fixed effects are statistically significant, meaning that there are meaningful differences between age

groups that are not captured by the year variable alone. These group-specific effects significantly contribute to explaining the variation in income. By rejecting the null hypothesis that all group-specific intercepts are equal to zero, the F test confirms the necessity of using a fixed effects model to control for unobserved heterogeneity across age groups.

The income forecast until 2050 is what follows the regression, and several steps were taken using Stata. The detailed commands for the income forecast are available on Appendix C. First, I calculated the prediction errors and then averaged the residuals by cohort. After, I created the forecast model, adjusted the forecast with the residuals and finally, generated the forecast from 2020 to 2050. The following paragraphs will describe the forecasting process in more detail.

First, prediction errors (residuals) were calculated by comparing the estimated income from the fixed effects model to the actual observed values. These residuals were stored for further use. Let $\hat{y}_{it}$ be the predicted value of income for cohort i at time t , such that:

$$\hat{y}_{it} = \alpha_i + \beta x_{it} \quad (2)$$

The prediction error (residual) is, thus, given by:

$$u_{it} = y_{it} - \hat{y}_{it} \quad (3)$$

where y_{it} is the actual observed income.

Next, the average residual for each age cohort was computed, providing a cohort-specific adjustment factor that accounts for systematic prediction errors within each group:

$$\bar{u}_i = \frac{1}{T_i} \sum_{t=1}^{T_i} u_{it} \quad (4)$$

where $\bar{u}_i$ is the average residual for each cohort i and T_i is the number of periods observed for cohort i , which in this case is 33 years.

A forecast model was then created, incorporating the stored fixed effects model estimates. The forecasted income values were adjusted by adding the cohort-specific average residuals, ensuring that the model accounted for the inherent biases observed in each cohort's predictions. The adjusted forecast model, then, comes as:

$$\hat{y}_{it}^{adjusted} = \hat{y}_{it} + \bar{u}_i \quad (5)$$

This approach allowed for a more accurate and cohort-specific projection of future income, accounting for both the time-variant effects captured by the fixed effects model and the systematic biases observed within each cohort.

Finally, the forecast was extended from the year 2020 to 2050, generating projected income values for each age cohort over this period. In Figure 8 we can see the results for illustrative selected cohorts, ages 21, 30 and 50.

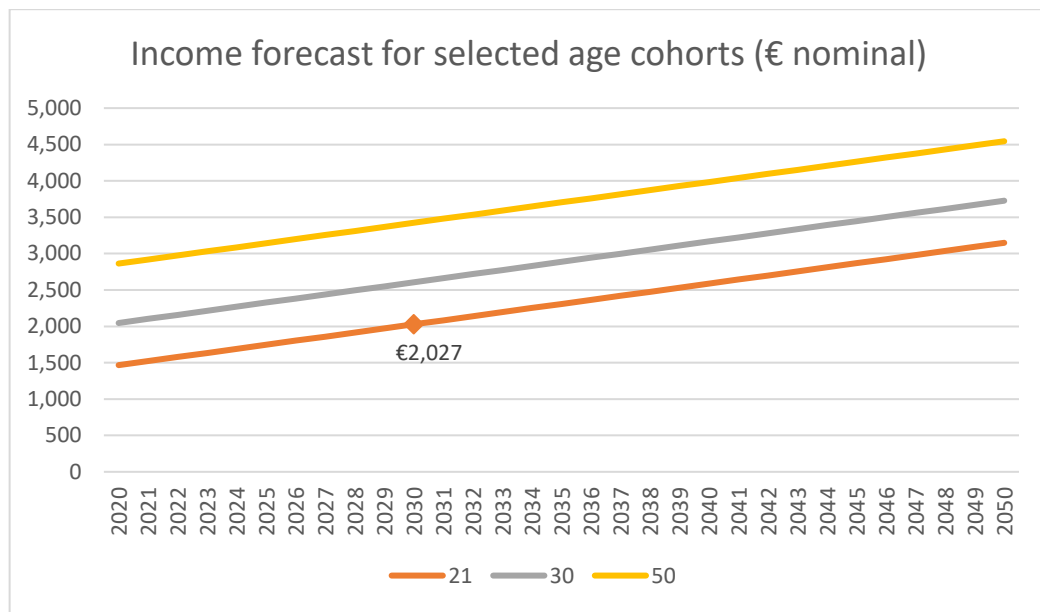


Figure 8: Income forecast for selected age cohorts (2020-2050)

The graph in Figure 8 shows, for each future year, what the expected salary of a graduate who is 21, 30, and 50 years old will be. For example, a 21-year-old graduate in 2030 is expected to have a monthly gross salary of €2,027 nominal.

Since in this dissertation's exercise, we want to test the availability to repay a loan throughout the life of a graduate, the income result should be taken from every additional cohort, one additional year to get an income path. Visually, the income path will be given by retrieving the diagonal of the age/year matrix, such as the one in Table 5:

Age/Year	2020	2021	Year N	2050
21	1st-year income			
22		2nd-year income		
Age cohort N			N year income	
51				30th-year income

Table 5: Schematic age/year matrix to retrieve income path result

The income paths for graduates starting with 21, 22, and 23 years old (the most important starting ages, since most graduates start working at these ages) are thus the following:

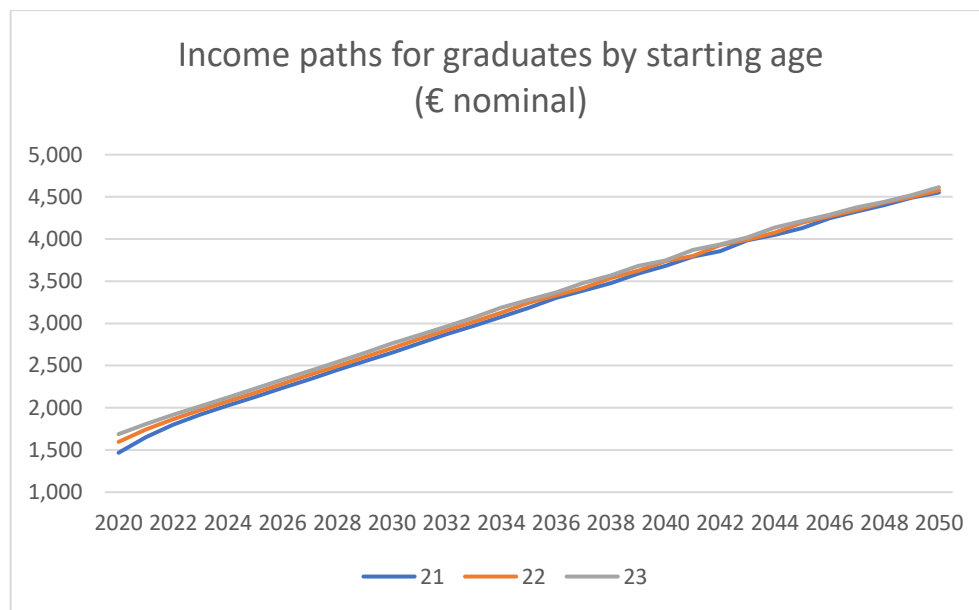


Figure 9: Income paths for graduates by working starting age

According to the forecast results show in Figure 9, a graduate with 21 years old in 2020 was expected to have an average monthly salary of €1,467, while his income would increase to €4,552 in 2050, when he would be 51 years old. For a graduate with 22 years old in 2020 its income is expected to be €1,596, while its income would increase to €4,578 in 2050. The resulting compound annual growth rate for graduates starting with 21, 22 and 23 years old can be seen in the following Table 6:

Entry age	CAGR (2020 to 2050)
21	3,85%
22	3,58%
23	3,41%

Table 6: Compound annual growth rate for graduates' income by work entry age

The results show an expected annual growth rate of around 3.5% from 2020 to 2050 for graduates, which is above the most common inflation target of main central banks of 2%, possibly reflecting an increased real remuneration from increased value added from graduation. These results reflect the historical Portuguese trend, which, according to the data from Quadros de Pessoal (GEP - Gabinete de Estratégia e Planeamento, 2020), experienced periods of significant increases in graduates' salaries.

3.1.3 Extending forecast to 2065

In this dissertation, I want to account for all the years that graduates could be repaying the loan. I'm considering the loans to be outlaid from 2016 to 2019, with the initial repaying period being, at the earliest, 2020. In the UK, with Plan 2 of repayment of the ICL, which was the one in effect until 2023 (Student Loan Company, 2024), the student loan would be written off 30 years after the first repayment. For our exercise, a student beginning repayment in 2020 would be due to repay until 2050, and the forecast performed in Section 3.1.2 would be sufficient.

However, we have that the current repayment plan for students entering after the 1st of August of 2023 (Plan 5), has a 40-year duration after the start of repayment (Student Loans Company, 2024). If I assume that a student starting in 2020 will be due to repay the loan 40 years, I need a forecast until 2060. Given that not every student will start repaying in 2020, because of the period to finish their studies and employment, I would need the forecast to go up until 2065 (assuming 5 years to start repayment).

To extend the forecast I'll use the CAGR calculated above and apply that growth rate for the years 2051 to 2065, for the different entry ages, which correctly accounts for the pairs age/year. The reason I'm performing this extension using the CAGR is that the fixed effects regression model used in Section 3.1.2 was initially applied to forecast up to 2050 (30 years of forecast) based on historical data from 1985 to 2019 (34 years). To extend the forecast beyond 2050 to 2065, using the CAGR provides a consistent and practical method. It allows

for a straightforward extrapolation of future income levels by assuming a stable growth rate, which is reasonable given the absence of expected drastic economic changes. This approach ensures methodological continuity and aligns the forecast period with the length of the historical data (fixed effects method for 30 years using 34 of historical data, and extending the final years assuming a stable growth rate, using CAGR), thereby maintaining the integrity of the projections.

3.1.4 Simple backtesting

The data from INE (2023) shows that the average salary of people with Higher Education in Portugal is the following:

Year	Monthly average salary (€)
2020	2,289
2021	2,414

Table 7: Average salary for Higher Education graduates in Portugal (INE, 2023)

The forecasted income resultant from the model gives the following simple income average (income of year divided by number of age cohorts) results:

Year	Monthly simple average salary (€)
2020	2,488
2021	2,544

Table 8: Forecast results for average salary for Higher Education graduates

The lack of data in Portugal for the average remuneration per year per age for people with bachelor's doesn't allow for a completely accurate backtesting exercise of the forecast model.

However, comparing these simple averages with real data shows for 2020 and 2021 a deviation of 8.7% in 2020 and 5.4% in 2021. With a simple average, we are attributing the same weight to the salary of a 50-year-old as we do for a 21-year-old. Also, on average, older people tend to have higher salaries (INE, 2023). So, we may be overestimating the simple average salary on the forecasted data in this comparison. It is, then, expected that the 5-8% error would be lower if we would make the calculation weighted by the age representation. There is confidence that this forecast is reliable and can be used in the loan repayment model to be described in the next section.

3.2 Portuguese ICL model

The model I'm using in this dissertation to calculate the proportion of the student loans that the government has to subsidy because of lack of repayment by the graduates is inspired by the one used by the Department of Education in the UK. The "Student loan earnings and repayments model" is structured as a micro-simulation model. This model forecasts student loan repayments by predicting future earnings for individual borrowers, as mentioned in Section 3.1 (Department of Education, 2024).

Repayments are accounted for by calculating each borrower's earnings year by year and determining the repayments, according to the loan's parameters set in the model. Variables such as the loan amount, the interest charged, the loan's term, the repayment % charged, and the income threshold, influence the ability of the simulated graduates to repay. The model also adjusts for voluntary repayments, overseas repayments, and irregular income patterns. Simulated borrowers also could experience unemployment, death, disability and migration (Department of Education, 2024).

The goal of this model is to calculate the Resource Accounting and Budgeting (RAB), as it represents the proportion of loan outlay not expected to be repaid. It is calculated by estimating the future repayments valued in present terms under the value of the initial outlay:

$$RAB\ charge = \left(1 - \frac{NPV\ of\ repayments\ in\ respect\ of\ outlay}{Value\ of\ outlay}\right) \quad (6)$$

The repayments, as discussed in Section 2.5.1, are calculated with the following formula:

$$R = \frac{\max(0, E - T)}{12} \times r \quad (7)$$

Where

R = Monthly Repayment Amount

E = Annual earnings of the borrower

T = Annual repayment threshold

r = Repayment rate

The discount rate used by the Department of Education to discount future repayments is the rate set by HM Treasury for financial instruments. As of 2024, the Treasury sets the discount rate for financial instruments at RPI-1.05% per year until the end of the financial year 2029-30, and RPI-0.05% per year from the financial year 2030-31. (Department of Health & Social Care, 2024). The discount rate to be used in the case of the Portuguese exercise will be discussed in a following sub-section.

The ICL model for Portugal is a simplification of the one used by the UK's DoE. The exercise will take place as if students received loans for the academic years of 2016/2017, 2017/2018 and 2018/2019. 2020 will be the first forecasted year and the first year of repayment.

It considers the earnings forecast for Portugal according to the model built in the last section 3.1.2.. It takes 100 illustrative students and adjusts the forecasted income to take into consideration unemployment probability and time to begin working.

For the first 3 years of the exercise, students' loan balance will increase each year to an amount equal to the yearly loan disbursement. Interest starts accruing to their loan balance right from the first year and then accrues yearly according to that year's interest rate and loan balance. Students only start repayment after their yearly earnings are above the defined income threshold, and the repayment is equal to the difference between yearly earnings and the income threshold times the repayment rate. For each year, for each student, it is calculated how much the repayment value is, and then that repayment decreases their loan balance. The loan balance will decrease (increase) throughout the years, depending on the student's ability to repay more (less) than the interest accrued. When the loan balance reaches zero, the repayment stops.

The unemployment assumptions, repayment rate, maximum repayment term, interest rate, loan amount, discount rate and inflation are all variables that influence the exercise and will be discussed in the following sub-sections in more detail.

3.2.1 Yearly Student Income

In the Student Income section of the model, there are 100 illustrative students, whose income paths come from the income matrix discussed in Sections 3.1.2 and 3.1.3. The income paths are then adjusted to account for entry years in the job market and unemployment.

According to OECD (2022) data, in Portuguese Public institutions, 37% of the students finish their bachelor's degree by the end of the theoretical duration of the programme (3 years), while 73% have finished their bachelor's by the end of the programme's duration plus 3 years (6 years). On top of this adjustment, I also applied the employment rate of recent graduates. According to Eurostat (2024), in 2022, 86.7% of recent graduates were employed in the 3 first years after completing their programme (maximum since 2019).

For simplification, and not having more precise data, I'll assume that from the 37% of the students that finish in 3 years, 87% start working right away, which accounts for 32 illustrative students that are 23 years old in 2020, as 20 is the average age of first-time entrants in tertiary education in Portugal according to the OECD (2023). For all students, I assume an entry age in education of 20 years old, so, they all will be 23 years old in 2020.

Then, until 2023, the percentage of students finishing the programme increases to 73%, of which I assume again an 87% employment rate. I'll add 10 students per year that start repayment, which comes from $\frac{73-37}{3} \times 87\%$. In 2023, we have 64 students who have finished HE and are employed ($73\% \times 87\% = 64\%$). For this analysis, I assume that 73 (in 100 illustrative students) is the final number of students who completed HE. I also assume 87% to be the final employment rate for graduates (OECD, 2023). For each of the 73 HE students, every year, there is an 87% probability of being employed. So, the employment rate average for the whole period will be 87%. These 73 students will have their income paths according to the forecast performed in Section 3.1.2.

We still have 36 students (100-64) who either didn't finish education or finished education but didn't get a job. The expected number of students who finished education but are unemployed at any given time is 9 ($(100\%-87\%) \times 73$), since there is an unemployment probability of 13% each year for each student.

Finally, we must calculate the number of students who didn't finish Higher Education. Taking my early assumption that 73 is the final number of students who finished education, I assume the rest didn't, which gives 27 students. According to OECD (2023), the employment rate of students who have completed upper secondary education is 84%, which in this exercise leaves us with an 84% probability of being employed for each student in each year. The expected number of employed non-HE graduates is 23 ($84\% \times 27$), while for unemployed is 4 ($16\% \times 27$).

These students can't have an income equal to the ones forecasted in Sections 3.1.2 and 3.1.3, as they are only for graduates who landed jobs. However, with the scarcity of data on their income paths, I assume that their income, at any given time, is the forecasted income for graduates' times a discount factor, which is based on the income premium calculated by the OECD (2023) of having finished Higher Education in Portugal. According to the OECD, people who finish Higher Education earn 53% more than the ones who only finished an upper secondary programme (High School), for ages 25-34. For ages 45-54, this difference increases to 93%. The overall premium for ages 25 to 64 is 71%. Thus, for this exercise, I take the income forecast for an HE graduate and, depending on the graduate's age, divide it by $(1+x\%)$ to get the income at any given time for a non-HE graduate (the students who dropped out).

3.2.2 Loan amount

For this dissertation, I assume the student loans will be disbursed in the academic years 2016/2017, 2017/2018 and 2018/2019. I take the values calculated in section 2.5.2 for the University of Porto for those years to get an annual value of loan disbursement. According to the report on the budget of the University of Porto (2017, 2018, 2019) for the mentioned years, we have:

	2017	2018	2019
Taxpayer/student	4 414	4 330	4 389
Tuition fees/student	1 230	1 339	1 359
Other rev./student	821	1 091	998
EU fin/student	776	836	1 382
Total fin/student	7 241	7 596	8 128

Table 9: Financing per student at the University of Porto

For the exercise, I consider that the amount of the student loan takes only into account the value of taxpayer per student and the tuition fees per student. I assume that EU financing and other revenues are financing sources that will be maintained in the future and don't need to be replaced by a student loan financing scheme.

So, for this dissertation, I consider the following loan disbursement per year:

	2017	2018	2019
Taxpayer/student	4 414	4 330	4 389
Tuition fees/student	1 230	1 339	1 359
Total loan value/student	5 643	5 669	5 747

Table 10: Student loan values per student per year for Portugal's ICL exercise

3.2.3 Threshold and repayment rate

From the analysis in Section 2.5.1, we learned that the threshold above which students start repaying their loans is £25,000 in the UK (Student Loan Company, 2024). According to the Office for National Statistics (2023), the median gross salary of full-time employees in the UK in 2023 is £34,963. Thus, the threshold for repaying loans is about 72% of the median earnings. However, in Plan 2, set initially in 2012, the threshold was £27,295, when the median earnings were £26,472, which makes it higher than 100% of the median earnings. The decrease observed in the threshold setting for the new borrowers aims at reducing the proportion of the outlay that is expected not to be repaid (Student Loans Company, 2024).

For Portugal, we have that the median monthly salary in 2020 was €1,000, which is equivalent to €14,000 yearly income, considering the twelve months of the year plus the Christmas and Holiday bonus (INE, 2023). Applying a threshold which is 100% of the median earnings, similar to Plan 2 in the UK, we have a value of €14,000 ($100\% \times €14,000$) of yearly income.

This threshold should be updated yearly to increase in line with the inflation rate so that repayment demands on students do not increase in real terms year-on-year. This will be the practice also for the new repayment plan in the UK (Department for Education, 2022).

For the repayment rate, I'll use 9% above the threshold for Portugal's exercise. The 9% rate was used in all repayment plans in the UK, excluding postgraduate loans (Student Loan Company, 2024).

3.2.4 Interest and discount rate

There are several options for choosing an interest rate, each with different impacts on borrower protection and government expenditure. Barr et. al. (2019) discuss the following different possibilities to charge interest on student loans:

- Real interest rate above government cost of borrowing.

Borrowers who repay their loan in full will repay more than the cost of their loan in present value terms. This approach helps to reduce taxpayer subsidies, as the additional interest payments contribute to covering the costs of the unpaid loans. However, it can be less progressive since higher-income graduates repay their loans faster and thus contribute less proportionately in present value terms.

- Real interest rate below government cost of borrowing

Setting a real interest rate below the government's cost of borrowing results in no borrower repaying in full in present value terms. This outcome means that the government bears a larger share of the cost, leading to increased taxpayer subsidies. This approach is more progressive in terms of the proportion of the loan paid by the borrowers across the earnings distribution.

Here, we can also consider a zero real interest rate, which is the current interest rate in effect for the latest repayment plan in the UK (Student Loan Company, 2024). In this case, the debt increases only with inflation, providing a significant subsidy to borrowers, as the cost for the government increases. This option is progressive as it helps the lowest graduate earners the most, since those with lower incomes repay their loans for longer and are more likely not to repay in full.

In New Zealand, for borrowers who remain in the country, the nominal interest rate is zero, and so the loan balance does not increase over time, making it highly favourable for borrowers as they only repay the principal amount. This approach places a significant financial burden on the government (Inland Revenue - New Zealand, 2024) (Britton, Erve, & Higgins, 2019).

For this dissertation exercise, I continue to adopt the same design as the UK has, so I consider a zero real interest rate. The interest charged is then only the yearly consumer price index. For the years 2020 until 2023, I take these values from the Portuguese Central Bank's historical data (Banco de Portugal, 2024). For the years 2024 to 2026, I use the Central Bank's forecast (Banco de Portugal, 2024). After 2026 I use the 2% target of the European Central Bank (European Central Bank, 2024).

Similarly to the UK, I consider that the interest rate accrues on students' loans beginning on the first year of studies (year 2016) (Student Loans Company, 2024). For this dissertation, I also consider that the interest is added yearly to the student's loan balance.

For the discount rate, as seen previously, the UK uses the HM Treasury's discount rate to reflect the cost of Government borrowing (Department of Education, 2024). This is to account for the fact that repayments recovered in the future are worth less to the government than repayments made today, as repayments made today immediately reduce government debt, thereby reducing the interest that the government would have to pay on this debt to finance the student (Britton, Erve, & Higgins, 2019).

For this dissertation's exercise, I use the historical data on 30-year Portuguese government bonds to calculate the discount rate, as 30 years is the longest maturity available with quality market data that I found. Since I am assuming the loans would be made in 2016, 2017 and 2018 (for the corresponding academic years), it is appropriate to use the government's cost of borrowing for the long term at that time. Using the data available at Investing.com (2024), I take the monthly average yield on 30-year Portuguese government bonds from 2016 to 2018, which is equal to a nominal rate of 3.665%.

3.3. Results and discussion

Using all the assumptions mentioned above for the ICL model for Portugal, we have a resulting RAB charge of 28.9%. This means that the Government is expected to subsidize around 29% of the issued value of loans, as that same percentage is not expected to be repaid in present value terms. Table 11 presents the detailed results:

Metrics	Result
Overall RAB charge	28,9%
Maximum RAB case	76%
Minimum RAB case	11%
Positive RAB cases	100
Negative RAB cases	-
Write-off cases	27

Table 11: RAB results of ICL model simulation for Portugal

The results show that, for the 100 illustrative students, the maximum RAB case was 76%, meaning that for that student, the Government had to take a 76% loss on the value of the loan issued. Analysing the results in more detail, I see that this student was part of the ones who didn't finish Higher Education, and thus had a much lower income during its lifetime. I observed that all students who didn't finish HE didn't manage to repay their debt, and so had their loans written off, and had a RAB charge averaging 72%. As seen previously, these amounted to 27 students in the 100-student sample.

The minimum RAB case was 11% and corresponds to one of the students who finished HE and didn't experience unemployment during the repayment period. The average RAB charge for HE graduates was 13%, and the expected final repayment year is 2041. By the end of 2041, more than 50% of the students in the sample had finished repaying the loan, reaching 73% in 2045.

These results show that HE graduates have, as expected, a much lower RAB charge than non-graduates and, being the majority of the cases of the sample, positively impact the overall RAB charge (by making it smaller) for Government expenditure.

Students who completed HE have an average yearly repayment nominal value of €1,054 until 2041. In Table 12 there's an illustrative repayment path of a HE graduate from 2020 until 2038:

Year 20xx																		
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
563	678	694	746	823	905	990	1071	1152	1237	1325	1399	1477	1557	1650	1710	1767	1854	1194

Table 12: Illustrative yearly repayment for a Higher Education graduate

This graduate didn't experience unemployment during its repayment period and had an average yearly repayment of €1,200. If a graduate experiences unemployment or/and starts repayment later, the number of years of repayment increases. Nevertheless, the average yearly repayment value doesn't seem excessive relative to a graduate's yearly salary, especially in the first years of repayment, in a time when the salary isn't considerable yet.

Another interesting takeaway is that all 100 students of the sample have a positive RAB, even the ones who managed to repay their loans completely. This means that, in present value terms, no graduate is fully repaying its loan, with the Government subsidy being always higher than zero. This result happens, because I assumed the interest rate to be equal to the inflation rate, as is the case in the UK Plan 5, while the discount rate is equal to the long-term cost of borrowing for the Portuguese government. Thus, while the Government is financing this debt at a 3.7% interest rate (equal to the discount rate of the future repayment cash-flows), it is providing a loan to students that is only repaid with a ~2% long-term average interest rate (equal to an expected 2% inflation long-term average). This result, having a real interest rate below the government's cost of borrowing, was one of the possible alternatives discussed in Section 3.2.4, resulting in the government always providing a subsidy, and being more progressive, as students that can't repay their loans quickly (lowest earners) sustain a lower interest cost throughout their lifetimes.

This result can also be compared with the current relative expenditure of the government. Taking the data from the University of Porto Budget Reports (2017, 2018, 2019, 2022, 2023), and recovering the information in Table 13 from Section 3.2.2, we have that the average government contribution for the period 2017-2019, excluding EU and own revenues financing, is 77%. Also, in recent years, this contribution has been increasing and, in the most recent data available, 2023, it reaches 82%:

	2017	2018	2019	2022	2023
Taxpayer/student	4 414 (78%)	4 330 (76%)	4 389 (76%)	4 660 (81%)	4 891 (82%)
Tuition fees/student	1 230	1 339	1 359	1 090	1 095
Total financing value/student	5 643	5 669	5 747	7 676	8 020

Table 13: Taxpayer financing per student contribution at the University of Porto (2017-2023)

4. Conclusion

This dissertation explored the impacts and feasibility of implementing an Income-Contingent Loan (ICL) system in Portugal as a strategy to finance Higher Education. Drawing from the theoretical literature available about the design of such a system and the potential virtues that it could bring, this study sought to determine the potential effects on government finances and student outcomes.

The modelling process benefited from a solid experience real case study from England, and so I draw empirical simulations of income and loan repayments tailored to the Portuguese context.

The study used a fixed effects econometric model to forecast the income trajectories of Portuguese graduates. It was found that the average compound annual growth rate of income for students entering HE at 20 years old, over the period from 2020 to 2050, is around 3.5%. This robust growth, which is above-forecasted inflation, suggests that a significant portion of graduates would be able to repay their loans in full over the repayment period.

The research found that the introduction of an ICL system in Portugal would likely result in a significant, though manageable, government subsidy, with an expected Resource Accounting and Budgeting (RAB) charge of approximately 29%. This indicates that the government would need to cover around 29% of the loan amounts due to expected non-repayment by graduates. The study also highlighted that students who do not complete their Higher Education and those with lower earnings would contribute disproportionately to this subsidy.

The simulation results indicate that the Portuguese government would need to subsidize a notable portion of the ICLs due to the progressive nature of the system (interest rate below cost of government borrowing) where lower earners receive a greater implicit subsidy. This outcome is consistent with other countries that have implemented ICL systems, such as the UK, where the expected RAB charge for loans being issued in 2023/2024 is also, coincidentally, 29% (Student Loans Company, 2024), the same percentage as this dissertation's result.

The findings suggest that while the ICL system would require ongoing government support, it would still represent a lower financing cost than the current model. When comparing the

ICL model with the current mixed financing model in Portugal, the study found that the ICL system could potentially reduce the reliance on direct government funding and shift most of the financial responsibility to graduates, while still providing a strong subsidy to low earners. Also, the current system's heavy reliance on historical funding and its lack of flexibility in accommodating new institutions or expanding access is a significant limitation that the ICL system could address.

4.1 Main limitations and Recommendations

Some limitations of the present study are worth mentioning. Firstly, and as mentioned in Section 3.1.2, the availability of longitudinal data would improve the accuracy of income forecasts. To increase the accuracy of income forecasts, future research could build on this study by incorporating more variables that influence graduate earnings, such as sex, field of study and employment patterns. Additionally, employing auto-regressive models could further enhance the realism of income projections by accounting for temporal dependencies in earnings. Auto-regressive models would allow future income levels to be predicted based on past values, effectively capturing the persistence of income shocks and the gradual adjustments in earnings over time.

Additionally, exploring the potential impacts of different ICL design features, such as varying interest rates, loan value, and repayment caps, would provide further insights into optimizing the system for the Portuguese context. Assessing the repayment burden on students would also be relevant, as the loan repayment would constitute, in practice, an additional income tax.

The introduction of an ICL system in Portugal would represent a strong shift in education financing policy in Portugal. Thus, a behavioural study could be conducted to assess how students would react to such a system, in terms of predisposition to follow Higher Education studies in the face of having a future debt to repay.

5. Appendix

A - Tables with the variables of the “Quadros de pessoal” database

Designação da variável (1985-2009)
Ano de referência dos dados
Número da Empresa
Número do Estabelecimento
Instrumento de Regulamentação Colectiva (IRC)
Número do Trabalhador
Sexo
Classificação Nacional de Profissões (CNP85 - 3 dígitos)
Classificação Nacional de Profissões (CNP85 - 2 dígitos)
Classificação Nacional de Profissões (CNP85 - 1 dígito)
Categoria Profissional
Situação Profissional
Nível de Qualificação
Níveis de Qualificações (1 dígito)
Níveis de Habilitações (1 dígito)
Habilitações Escolares
Idade / Grupo Etário
Antiguidade
Controle Remuneração
Remuneração Base (Euros)
Prestações Regulares (Euros)
Prestações Irregulares (Euros)
Prestações Extraordinárias (Euros)
Remuneração Ganho (Euros)
Diuturnidades (Euros)
Horas Mensais Remuneradas - Normais
Horas Mensais Remuneradas - Extraordinárias
Período Normal de Trabalho Semanal
Ano da Última Promoção
Idade
Nacionalidade
Tipo de Contrato
Regime de Duração do Trabalho
Natureza da negociação da última tabela salarial
CAE do IRC
Escalão Etário
Níveis de Habilitações (1 dígitos)
Níveis de Habilitações (2 dígitos)
Tipo de IRCT - Natureza Inicial

Designação da variável (2010-2019)
Ano de referência
Número de Identificação Fictício da empresa
Número da empresa (ligação com a série QP até 2009)
ID da empresa (ano 2010 e seguintes)
Número do estabelecimento (ligação com a série QP até 2009)
ID do estabelecimento (ano 2010 e seguintes)
Número do Trabalhador
Nacionalidade
Sexo
Idade (idade_Cod <= 17 ou idade_Cod >=68)
Data de admissão (mês ano)
Antiguidade na empresa
Data da última promoção (mês ano)
Instrumento de Regulamentação Colectiva do Trabalho (IRCT)
Instrumento de Regulamentação Colectiva do Trabalho (IRCT)
Categoria profissional
Situação na profissão
Tipo de contrato
Tipo de contrato (nível 1)
Regime de duração do trabalho
Habilitações literárias (1 dígito)
Habilitações literárias (2 dígitos)
Habilitações literárias
Nível de qualificação
Classificação Portuguesa de Profissões (CPP 2010 - 4 dígitos)
Classificação Portuguesa de Profissões (CPP 2010 - 3 dígitos)
Classificação Portuguesa de Profissões (CPP 2010 - 2 dígitos)
Classificação Portuguesa de Profissões (CPP 2010 - 1 dígito)
Controle de remuneração
Remuneração base paga (euros)
Remuneração ganho (euros)
Remuneração suplementar (euros)
Prestações regulares (euros)
Prestações irregulares (euros)
Escalão de remuneração mensal base
Escalão de remuneração mensal ganho
Período normal de trabalho semanal (PNT) (horas)
Horas mensais remuneradas - normais (horas)
Horas mensais remuneradas - suplementares (horas)

B – Stata commands to transform the repeated cross-sections into pseudo-panel data

```
# name the 3 columns that have the values of year, age, and income
rename var1 ano
rename var2 idade
rename var3 rend

# the collapse function ensures that for each age there is only one income value per year, which
results from the average of incomes for a given year, for a given age
collapse rend, by(idade ano)

sort idade ano rend

# get a longitudinal table in the following form
reshape wide rend, i(idade) j(ano)
```

C – Stata commands to perform the income forecast until 2050

```
# Here, within the sample, the average error of the estimation versus the real value is calculated for
each cohort

predict rend_u, u
estimates store rend

# Here, the error is extended to 2050 for each cohort (each cohort has a different value of
rend_u2)

by idade: egen rend_u2 = mean(rend_u)

forecast create rendmodel, replace

forecast estimates rend

# The income is equal to the estimation plus the error for each cohort

forecast adjust rend = rend + rend_u2

# The forecast is done starting in 2020 (the first year without real values) and ending in 2050.

forecast solve, begin (2020)
```

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