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Modelling alternative student loan schemes for Brazil

Lorraine Dearden[a,b,c], Paulo Meyer Nascimento[d,e,*]

[a] University College London, 20 Bedford Way, London WC1H 0AL, United Kingdom
[b] Institute for Fiscal Studies, 7 Ridgmount Street, London WC1E 7AE, United Kingdom
[c] Institute of Labor Economics (IZA), Schaumburg-Lippe-Strasse 5-9, 53113 Bonn, Germany
[d] Institute for Applied Economic Research (IPEA), SBS quadra 1, bloco J, edf. BNDES, 11° andar. Brasília-DF, 70076-900, Brazil
[e] Federal University of Bahia (UFBA), Department of Economics. Praça Treze de Maio, n° 6, 5° Andar, Sala 502 – Dois de Julho, Salvador-BA, 40060-300, Brazil

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ABSTRACT

This paper simulates student loan schemes for Brazil. A copula approach is applied to simulate dynamic earnings paths for graduates. Repayment patterns are then simulated for time-based and income-contingent loan designs. The results show that the Brazilian time-based scheme involved unsustainable repayment burdens for many graduates and contributed to the scheme's high default rates. We also show that the new income-contingent scheme is also likely to involve high taxpayer subsidies. We consider alternative designs with different strengths and weaknesses but favour an income-contingent scheme with a loan fee, repayment rates at 50% of current income tax rates and an interest rate at the government's cost of borrowing upon graduation and above initial tax threshold. We conclude by emphasising that full involvement of the federal revenue system is more desirable than the present approach of employer withholding. This would increase the earnings base and reduce costs, which is important for Brazil's current precarious fiscal situation.

1. Introduction

Brazil is a large developing country with growing, but still low, participation rates in higher education. Expanding access and completion at the pace required to meet the goals stated by the 2014–2024 National Education Plan (NEP) of adding 50% more enrolments by 2024 to the numbers registered in 2014 (with 40% of the growth target to be served by the public sector), involves several challenges. One of these is how to finance such an expansion, especially considering the additional constraints imposed on the government's budget by the 2014–16 Brazilian recession. A politically sensitive reform, namely introducing tuition fees in the currently mostly free-of-charge public sector, frequently arises in the debate but faces fierce opposition from politically organised groups. In parallel, high default rates and fiscal constraints have jeopardised the government-administered loans and bursaries that have long been subsidising expansion in the private sector.

In the wake of the recent economic recession, there have been major changes to the Student Financing Fund (FIES), the large student loan scheme designed to finance fee-payment in private higher education institutions (HEIs). The FIES had been historically a conventional time-based repayment loan (TBRL), that is, from its introduction in 1999 until 2017, it followed a fixed-schedule loan repayment, irrespective of the debtor's capacity to pay. As of 2018, existing debtors can migrate to an income-based plan. For new borrowers, the income-based plan is the only option available. The FIES has also been extended to students studying at the few public HEIs in Brazil that are permitted to charge tuition fees.[1] If well implemented, the new income-contingent FIES could help to tackle two problems likely to arise in meeting the government's ambitious expansion plan: the need for additional resources

Abbreviations: BCB, Central Bank of Brazil; BRL, Brazilian Reais; CDF, cumulative distribution function; CPI, consumer price index; Continuous PNAD, Continuous Annual National Household Sample Survey; FIES, Student Financing Fund; FNDE, National Fund for Educational Development; FRS, federal revenue system; GDP, gross domestic product; HE, higher education; HEIs, higher education institutions; IBGE, The Brazilian Institute of Geography and Statistics; ICL, income contingent loans; IPCA, Extended Consumer Price Index; IPEA, The Brazilian Institute for Applied Economic Research; ISCED 2011, International Standard Classification of Education; NEP, National Education Plan; NPV, net present value; OECD, Organisation for Economic Co-operation and Development; PISA, Programme for International Student Assessment; PPPs, purchasing power parities; RB, repayment burden; TBRL, time-based repayment loans; USD, US dollars

* Corresponding author at: SBS - Quadra 1 - Bloco J - Ed. BNDES, 11° andar, 70076-900 - Brasília-DF, Brazil.
E-mail addresses: l.dearden@ucl.ac.uk (L. Dearden), paulo.nascimento@ipea.gov.br (P.M. Nascimento).

[1] HEIs maintained by municipal levels of government can charge tuition fees, but these institutions represented 1.2% of total enrolments in 2017.

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for public HEIs which are currently free of charge, and the need to make student loans sustainable in Brazil (for borrowers and for the government).

To our knowledge, this is the first paper that uses dynamic simulations of graduate earnings to look at student loans in Brazil using the method proposed by Dearden (2019). This is a major contribution and throws new light on the old TBRL and the new income contingent loan (ICL) version of FIES. Secondly, it uses these same simulations to examine the feasibility of different income contingent student loan alternatives for the higher education student financing system in Brazil and compares both the cost implications for taxpayers and the distributional implications for the cohort of borrowers. As has been shown in other countries (see Armstrong, Dearden, Kobayashi & Nagase, 2018; Dearden, 2019), allowing for mobility in the graduates' earnings distribution provides more realistic estimates of the cost of a loan design. We provide evidence that a broadly based ICL system is feasible in Brazil, could be extended to both public and private sectors, and has major advantages over the old TBRL system.

The rest of the paper is organised as follows. Section 2 discusses the context of higher education student financing in Brazil. Section 3 summarises data and methods used to simulate graduates' earnings by means of the approach of Dearden (2019). Section 4 presents the results for the TBRL scenarios, in which repayment burden (RB) calculations illustrate the problems with this loan type, and presents several ICL scenarios, starting with a design resembling the new FIES implemented in 2018. Section 5 concludes.

2. Higher education student financing in Brazil

Brazil is one of the largest democracies in the world and home to 208 million people. The country is a middle-income, mostly urban and Christian country, with a moderately diversified economy that maintains a higher education (HE) system in which public institutions are elite, selective, and free-of-charge. Three-quarters of the eight million HE students are enrolled in the fee charging but subsidised private sector. Still, relatively few adults hold a HE degree – according to the OECD (2018a), only 15% of Brazilians from 25 to 64 years old have completed a tertiary degree, while the average for OECD countries is 37%. The annual flow of new graduates has nearly trebled in the last 20 years, but further expansion faces four major constraints:

1 *Low completion rates of secondary education*: official household data show that only 57% of the Brazilians who in 2017 were between 18 and 24 years old had already completed secondary education.
2 *Low learning performance in secondary education*: results from the Programme for International Student Assessment (PISA) show that Brazilian students have historically performed much worse than the OECD average in all three assessed subjects – see OECD (2016).
3 *Signs of saturation in the private sector:* data from the national HE censuses indicate that the growth of enrolments in private HEIs has been mostly deaccelerating over the last two decades.[2]
4 *Fiscal austerity*: the Brazilian Congress approved an amendment to the Constitution in December 2016 linking public spending growth to the official rate of inflation for twenty years, starting in 2017 – hereafter referred to as the *spending freeze amendment*, following terminology used in English by Cardim de Carvalho (2017).

Effective cost sharing initiatives, as well as broad and well-designed student aid and loan schemes, are particularly relevant in light of the latter two constraints.

2.1. Free public colleges in Brazil

Public HEIs are free of charge in Brazil, but the bill for the taxpayer is substantial. In 2015, the taxpayer cost per student enrolled in tertiary degrees at public institutions (including research and development – R&D – activities) was approximately 91% of the average amount in USD purchasing power parity (USD PPP) spent per tertiary student by OECD members. The public cost per tertiary student in Brazil is 3.7 times the expenditure per secondary school student, as compared to an OECD average of 1.7 times. Total public expenditure on tertiary education consumed 4.2% of Brazil's total public expenditure in 2015, well above the OECD average of 3.0%.[3] Enrolments in the public sector HEIs grew by 25% between 2010 and 2017, but it would need to grow by another 72% by 2024 to achieve the NEP targets. This is simply not economically viable in the current climate whilst public universities in Brazil remain free-of-charge.

Historically, there has been strong political opposition in Brazil to the introduction of tuition fees at public HEIs, despite the high average private economic returns from tertiary education degrees[4] and the need for extra resources for expansion. Nonetheless, a joint analysis of recent legislative proposals to introduce cost sharing for public HEIs suggests that: (a) although sensitive, free provision of higher education is not an absolute commitment from any of the parties represented in the Brazilian Congress; (b) some form of protection for low-income individuals is highly valued in the Brazilian context; (c) though upfront fees in public HEIs would be politically difficult to introduce, there is scope for the discussion of schemes involving fee waiving and/or deferment mechanisms. Therefore, ICL arrangements seem to have political potential to be raised as a feasible and fair alternative for cost sharing in public HEIs in Brazil as they ensure the cost of HE is free at the point of access. This topic has been discussed in academic and policy-making fora and gained more relevance since the approval of the spending freeze amendment,[5] which will impose new barriers to additional budgetary resourcing for public HEIs.

2.2. Loans for students enrolled in fee-paying programmes

Student loans were first offered by the Brazilian Federal Government in 1975. The original scheme was discontinued in 1997 but was replaced two years later by the FIES. Unlike the previous scheme, students can borrow from FIES to pay for tuition fees, but not for living costs.

FIES experienced its largest wave of expansion between 2010 and 2014, when a ten-fold increase in the number of new loan contracts was observed. Fiscal constraints alongside increasingly high prospects of default resulted in successive changes in its design since 2015. The most significant changes were introduced in 2017 (becoming effective in 2018) which involve changing FIES from a TBRL to an ICL system for all new borrowers (existing borrowers were offered the option to migrate). The new regulations are relatively broad in scope, and most of the parameters have yet to be announced

[2] Microdata for Brazil's higher education census from 1995 to 2017 can be downloaded from http://inep.gov.br/web/guest/microdados#.

[3] Figures obtained from data reported by OECD (2018a).

[4] Carnoy et al. (2013) estimated a 24.6% private rate of return to higher education in Brazil for 2008. Barbosa Filho and Veloso (2015) arrived at a similar figure, 25.6%, for 2012. Both references report declining trends over the years, but their numbers are still above the world average private rates of return to investment in higher education reported by Psacharopoulos and Patrinos (2004).

[5] See, as examples of the recent debates on introducing tuition fees in Brazilian public HEIS, The World Bank (2017) and policy notes (in Portuguese) published by the Brazilian Institute for Applied Economic Research (Ipea), available for download at http://www.ipea.gov.br/portal/index.php?option=com_content&view=article&id=29665%3Aradar-2017-fevereiro-no-49-&catid=158%3Adiset&directory=1&Itemid=1.

by a committee headed by the Minister of Education and consisting of officials and bureaucrats from the Federal Government (hereafter, the FIES Committee).

The new FIES law, enacted in December 2017, establishes that an employer withholding system will collect income-contingent payments with a maximum repayment rate of 20% on total gross earnings. The FIES Committee later established that repayment rates will vary incrementally with income. No repayment thresholds have yet been set, but the Committee announced that loans undertaken in 2018 would be charged a maximum repayment rate of 13%. This rate will be applied in the initial scenarios simulating alternative designs for a broad-based ICL arrangement for Brazil (see Section 4). Parameters of the old FIES will also be used to simulate the TBRL version of FIES that was operating between 2015 and 2017. These simulations will be useful in illustrating the advantages of ICLs compared to TBRLs. Before that, the next section presents the data, methods and estimates for the graduates' age-earnings profiles that will be used in the simulations.

3. Simulating age-earnings profiles for Brazil's graduates

In this section, lifetime earning profiles are simulated for a future cohort of Brazilian graduates. We use the method proposed by Dearden (2019) to incorporate earnings mobility across the lifecycle but also construct more simplistic simulations where no earnings mobility is allowed. These simulated static and dynamic lifetime earnings profiles are used later in the paper to assess the extent of loan repayment hardship for TBRL borrowers with typical loans. They are also used to look at the implication for graduates and taxpayers of various ICL designs.

Data from Brazil's Continuous National Household Sample Surveys (Continuous PNAD) for the years 2014 and 2015 are used to estimate the models for our simulations.[6] The analysis focusses on male and female tertiary-degree holders aged between 24 and 64 years. This age range was chosen because a typical university graduate under-taking a four-year degree[7] will graduate at age 23[8] and not start earning until the age of 24. A retirement age of 65 was chosen as this is the minimum retirement age proposed in the reform of the social security system currently under review in the Brazilian Congress. Each graduate in the 24–64 age range for whom we have data in 2014 and 2015 is included and all earnings (including zero earnings for those who are not in employment) are in Brazilian Reais (BRL). All earnings have been uprated to 2017 prices.

The samples of graduates aged 24–64 for the years 2014 and 2015 consists of 147,319 observations, 39.2% of which are males and 60.8% of which are females. The panel with graduates appearing in both consecutive years has 25,240 individuals, 38.4% of which are males and 61.6% are females.[9] All graduates are included in the analysis, even those who have reported zero earnings. As Higgins and Sinning (2013) highlight, it is important to include zero earners in this type of analysis because those debtors not earning are particularly vulnerable with TBRLs.

Table 1 compares the descriptive statistics for earnings, age and number of graduates by sex in the whole sample and panel by year. In this paper only labour earnings are considered. Ideally data from all sources of income should be used, particularly for the estimation of RBs. The surveys for the years 2016 and 2017 report both labour earnings and income from other sources. However, 2016 was the year the domestic labour market was particularly adversely affected by Brazil's recent economic recession, so relying on data from 2016 and 2017 are less likely to be representative of the Brazilian labour market going forward.[10]

We follow the method of Dearden (2019) using our data from Brazil. The static age-earnings profiles are obtained by regressing raw earning percentiles by age and gender on a quintic polynomial of age which provides the projected percentiles of graduate earnings at each age. These approximate the true marginal distribution of earnings at each age in a reliable way which can be used in our simulations.

We then use Copula models to model the joint distribution of the adjoining continuous marginal cumulative distribution functions (CDF) of earnings at each age in our panel data.[11] Sklar (1959) shows that there always exists a copula function that can exactly map n continuous marginal distributions into their joint n-variate joint distribution – see Dearden (2019) for more details. In our example, we only have a panel of two time periods, so we are restricted to choosing among joint bivariate copulas. We follow Dearden (2019) and find the bivariate Copula that best captures the joint distribution of the adjacent marginals (essentially the continuous transition matrix) for each age transition from 24 to 64. Zero incomes are randomly distributed for this exercise.

As was the case for the US (see Dearden, 2019), the student's t copula (t-copula) provides the best fit for most ages for both female and male graduates from the short panel data from Brazil.[12] The Akaike Information Criterion (AIC) was used to pick the t-copula amongst all the bivariate copula families available in the BiCopSelect function of R's "VineCopula" package.[13]

Having established the appropriate copula to formalise the dependence structures of the graduates' earnings distribution in Brazil, R's "Copula" package[14] was used to estimate the relevant parameters for t-copulas: ρ (the rho correlation parameter) and ν (the degrees of freedom). Fig. 1 shows, by age, the estimates of the ρ parameter, its confidence intervals and its age-smoothed estimates for both male and female earnings.

[6] The Continuous PNAD collects data on workforce indicators every quarter, with households remaining in the sample for up to five quarters (i.e., 20% of the households are replaced every quarter). Individual information on education, age and salary are included. The Brazilian Institute of Geography and Statistics (IBGE) specifies a group-wise ID to nest surveyed individuals into their respective households, but an appropriate ID to be used for panels at the individual level is still to be incorporated to the datasets released so far. In addition to the required variables to form the group-wise ID suggested by IBGE, we have also concatenated the variables for day, month and year of birth, plus a dummy variable for sex, deleting all observations not informing year of birth. With this procedure, we identified individuals surveyed in these two consecutive years of Continuous PNAD.

[7] The Brazilian higher education system includes degrees with different lengths, but it is not possible to trace the length of the degrees pursued by individuals surveyed by the Continuous PNADs. Simulations will assume a typical degree lasts four years, because the highest intake of students is in four-year degrees.

[8] This was the modal age for graduating students registered in recent years by the official Higher Education Census.

[9] Beltrão and Alves (2009) show that the reversal of the gender gap in higher education completion happened in Brazil in the 1970s and the proportion of women with tertiary degrees is almost twice that of men at the youngest cohorts. Data from the most recent Population Census (2010) confirms this trend, as well as the official household sample surveys and the higher education censuses.

[10] Average unemployment rate, calculated from the Continuous PNADs, was 12.0% for the 2016–2017 period, against 7.5% for the 2014–2015 period.

[11] The marginal CDFs are uniformly distributed between 0 and 1 and hence can be easily mapped onto the percentile estimates of the marginal distributions at each age once the simulations have been completed.

[12] Copulas were tested for all 40 age transitions from ages 24 to 64. The t-copula was best for 22 age transitions for female earning dynamics and for 29 age transitions for male earning dynamics. The t-copula performed particularly well for most of the age transitions from ages 24 to 50 amongst women and 24 to 55 amongst men. The t-copula was not as appropriate at later ages, possibly reflecting lower sample numbers and the more notable changes in earnings paths as graduates grow old.

[13] Version v2.1.6, documented by Nagler (2018).

[14] Version v0.999-18, documented by Maechler (2018).

Table 1
Descriptive statistics (Continuous PNAD 2014–2015).

		All graduates		Male graduates		Female graduates	
		Whole sample	Panel	Whole sample	Panel	Whole sample	Panel
Total gross earnings in 2014 (in BRL)	Mean	53,779.94	56,454.53	75,183.00	79,896.78	39,393.04	41,217.58
	(SD)	(77,972.38)	(73,821.12)	(100,458.80)	(93,605.60)	(53,553.17)	(52,034.51)
Total gross earnings in 2015 (in BRL)	Mean	51,679.72	55,007.19	71,580.89	76,977.47	38,147.39	40,724.45
	(SD)	(71,355.40)	(73,566.29)	(87,547.27)	(87,478.38)	(53,756.42)	(58,635.09)
Age in 2014 (in years)	Mean	39.9	40.7	40.2	41.1	39.7	40.4
	(SD)	(11.1)	(11.1)	(11.3)	(11.2)	(11.0)	(11.0)
% with zero earnings in 2014		16.9%	16.0%	10.4%	9.7%	21.1%	20.1%
% with zero earnings in 2015		18.3%	17.2%	11.4%	10.2%	22.7%	21.7%

Note: 1. Sample weights were applied; 2. Earnings were uprated to 2017 average prices using an official consumer price index called the Extended Consumer Price Index (IPCA, the acronym in Portuguese); 3. Graduates include all individuals holding degrees classified by the International Standard Classification of Education (ISCED 2011) as level 5 to level 8.

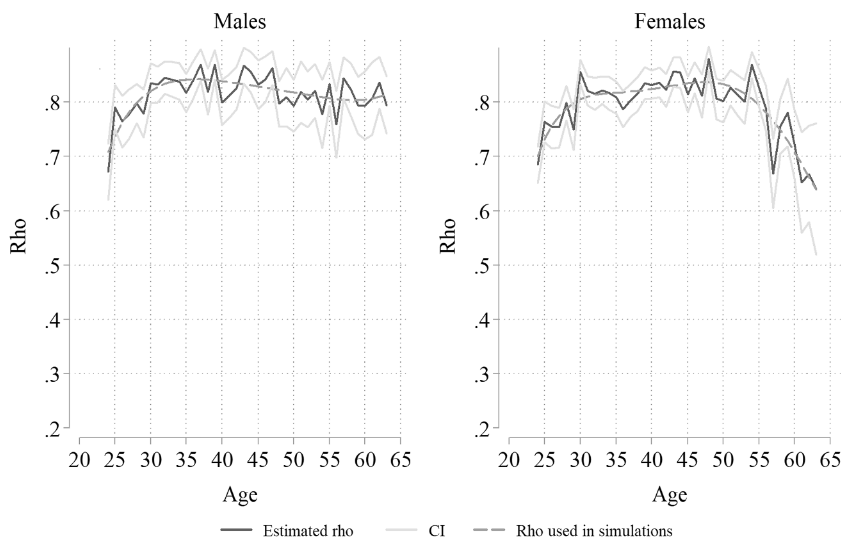

Fig. 1. Estimates of rho (ρ) from *t*-copula.

As highlighted by Dearden (2019), the ρ parameter describes the overall level of immobility in the distribution. The higher the ρ parameter, the lower the mobility across the graduates' earnings distribution. The diagrams plotted in Fig. 1 show an increasing level of immobility in the earnings distribution for graduates in Brazil for approximately the first ten years from graduation. Then the earnings distribution becomes slightly more mobile for males until their mid-50s, but the level of immobility for female graduates continue to rise until they reach their early-50s. After those points, immobility for men returns approximately to the same level observed for their 30s, but it drops sharply for women over the age of 50. In both cases, Fig. 1 implies considerably less earnings mobility among graduates in Brazil as compared to US graduates examined by Dearden (2019), but more mobility than that found in Japan (see Armstrong et al., 2018).

The other parameter, ν (the degrees of freedom), measures tail-dependence, that is, excess immobility in the tails of the distribution. The lower the ν parameter, the lower the mobility in the tails. Fig. 2 shows, by age, the ν degrees of freedom estimates, their confidence intervals and the corresponding smoothed estimates for both males and females.

Fig. 2 implies that individuals at the bottom (or top) of the earnings distribution face higher chances of upward (or downward) mobility in the first years upon graduation and again at later ages. However, the large confidence intervals at later ages, especially where graduate sample sizes are much smaller (particularly for women), mean that caution is needed.

Having obtained our estimates, we have a relatively straightforward

Fig. 2. Estimates of degrees of freedom (ν) from *t*-copula.

way of simulating forward for a sample of 24-year-old graduates taken from our 2014–15 Continuous PNAD panel. This involves:

1 Drawing a sample of 10,000 women and 10,000 men aged 24 with replacement from our panel;
2 Estimating the conditional distribution function of u_{25} given u_{24} which is given by:

$$c_{u_{24}}(u_{25}) = \frac{\partial}{\partial u_{24}} C_{24}(u_{24}, u_{25})$$

where C_{24} is the estimated Copula (*t*-Copula) with parameters ν and ρ from our smoothed estimates at age 24.
3 Generating a random standard uniform variable r with the same dimension as u_{24}, i.e., 10,000.
4 Generate $u_{25} = c_{u_{24}}^{-1}(r)$ to get our uniformly distributed predicted rank at age 25 which has a stochastic element due to the rank prediction being determined by the draw from the random uniform.
5 Repeat steps 2 to 5 for each sequential age.

These simulations are then re-weighted by gender to reflect gender-specific graduation rates for Brazil in 2016 (the most recent annual edition of the Higher Education Census available when this work was done).[15]

How do our simulations perform? In Fig. 3 we compare the rank or monotone dependence of the actual panel data, the predictions from our *t*-Copula model and our simulations (using our smoothed parameter estimates) for all age transitions. Following Dearden (2019), the measure of rank dependence we use is Kendall's tau (see Dearden, 2019, for details about the estimation of τ).

Fig. 3 shows that estimates for both the *t*-copula and the simulated sample satisfactorily replicate the dependence structures over adjacent ages of the panel data obtained from the Continuous PNAD. Figs. 1, 2 and 3 suggest that the graduates' earnings distribution in Brazil is characterised by low mobility and high dependence at adjacent ages, particularly compared to US graduates analysed in Dearden (2019).

It is worth highlighting that mobility and dependence trends are likely to change for future graduates. Moreover, the copula models used in this paper only consider first order rank dependence, and it is likely that where a person ends up in the earnings distribution now may be determined partially by earlier outcomes. It is not possible to test for this in Brazil because we only observe transitions over one year. These limitations need to be emphasised, but age-earnings profiles obtained from the simulated sample are a first best guess about future earnings paths for graduates in Brazil for the analysis in the next section.

4. Assessing alternative student loan schemes for Brazil

In this section, hypothetical student loan schemes for Brazil are analysed in terms of repayment hardship and taxpayer costs. Results from both the static and dynamic approaches will be presented. This is because the static approach will over-estimate the cost of an ICL and provide an upper bound on costs – see Higgins and Sinning (2013) and Deaden (2019), whereas dynamic simulations will provide more robust evidence on likely taxpayer costs and the implications for graduates in different parts of the lifetime graduate earnings distribution. Static and dynamic age-earnings profiles obtained in the previous section are adjusted annually, assuming a real wage growth rate of 1.0% per annum (p.a.). Then, patterns for the alternative student loan schemes are obtained by applying each scheme's parameters to the adjusted age-earnings profiles.

We assume that a typical four-year degree costs BRL 50,000.[16] This is roughly equivalent to the average annual earnings of graduates in our whole sample (pooling male and female graduates together). It is also assumed that loans fully cover the tuition fees but not living costs.

[15] Graduation rates in Brazil in 2016 were: 61.4% females, 38.6% males.

[16] According to the National Fund for Educational Development (FNDE), the federal agency controlled by the Ministry of Education that is responsible for the administration of FIES, the average tuition fee paid by the federal government for FIES contracts signed in 2014 was BRL 45,840.

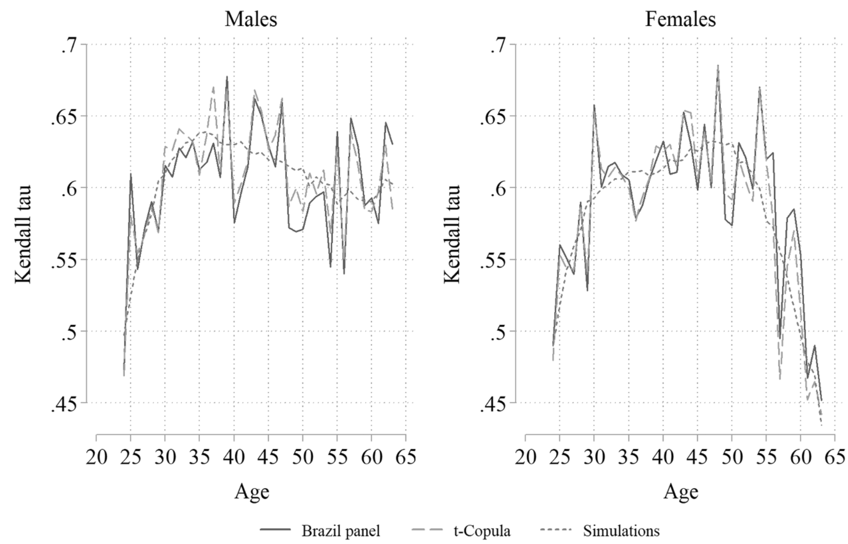

Fig. 3. Measuring the degree of concordance of the earnings CDFs at adjacent ages using Kendall's tau (τ): estimates from the initial panel, from the *t*-copula and from the simulations with pseudo-observations.
Note: zero earners are randomly distributed at the bottom of the cumulative earnings distribution at each age.

Further, we assume loans are log-normally distributed and have a standard deviation of BRL 25,000. Students can borrow a minimum of BRL 5,000 and a maximum of BRL 300,000 in our simulations.[17] Unlike FIES, no payments are required during the study period. Inflation is assumed to be 4.5% p.a., which is the centre point of the official inflation target range in Brazil since 2005, and we apply a real discount rate of 5% which is consistent with market expectations for the long-term cost of borrowing to the Brazilian government.[18]

A scheme resembling the last TBRL version of FIES (offered in 2017) will be discussed. Then, some alternative designs for a broad ICL system will be assessed, starting with one replicating parameters for the income-based FIES offered in Brazil in 2018.

4.1. Results for TBRLs

The last TBRL version of FIES was offered in 2017, with a nominal interest rate of 6.5% p.a., an 18-month grace period upon graduation and a repayment period of up to three times the normal length of the degree plus 12 months (i.e., thirteen years for individuals borrowing to pay tuition fees of a typical four-year degree). We simulate a TBRL with these parameters to illustrate the proportions of Brazil's graduates who would be likely to face RBs above a manageable level if borrowing from this TBRL.

Two features of the FIES TBRL are not incorporated into our simulations. First, in the actual scheme loans were defined based on the student's family income, the area of the degree and the location of the HEI. Most of the loans did not cover 100% of the tuition fees while in our simulations we assume they do. Second, during the study and grace periods of the actual FIES, small quarterly payments were required to cover part of the accrued interest. Our simulations do not incorporate these payments.

4.1.1. Defining manageable RBs

Defining manageable RBs is not straightforward. They differ from context to context, and the literature is still vague in this sense: there are only *ad hoc* general definitions. Woodhall (1987) argues that manageable RBs are those not higher than 8% or, at most, 10% of disposable personal income. Carlson (1992) assumes a maximum feasible RB of approximately 10%. Salmi (1999) claims that 18% of disposable personal income should be the limit to classify RBs as manageable. Baum and Schwartz (2006) propose benchmarks for debt service ratios[19] for student debt according to individual income levels, with the top being 18% of pre-tax (rather than disposable) income or 20% of discretionary income, with discretionary income defined as income exceeding 150% of the poverty level for a single person. In the absence of specific definitions, an upper limit of 18% of pre-tax income is used in this paper as a rule of thumb for manageable RBs.

4.1.2. Prospects of repayment hardship

We begin by reporting RBs by age for selected percentiles of the graduate earnings distributions for debtors taking out a typical student loan of BRL 50,000. This is the typical static approach used in RB analysis and follows the approach taken in Chapman and Doris (2019), Cai, Chapman and Wang (2019) and Chapman and Lounkaew (2015). This shows significant repayment hardship for debtors in bottom 20% of the graduate earnings distribution. Even median earning graduates face excessive RBs at young ages, particularly women (Fig. 4).

[17] Initially, the ICL version of FIES allowed student s to borrow up to BRL 30,000 per semester (which is equivalent to BRL 240,000 over four years). Contracts signed from the second half of 2018 will be subject to a loan cap of BRL 43,000 per semester (which is equivalent to BRL 344,000, over four years). Our BRL 300,000 upper limit is, therefore, realistic. Converting it into 2017 USD using PPPs for Gross Domestic Product (GDP) (following OECD, 2018b), the maximum amount to borrow in our simulations is approximately USD 148,200. The minimum amount would be equivalent to USD 2,470.

[18] According to a survey conducted in April 2017 by the Central Bank of Brazil (2017), a real rate of interest of between 4 and 5 per cent per annum best approximates the Brazilian government's cost of borrowing.

[19] The term *debt service ratio* is used here as a synonym for RB.

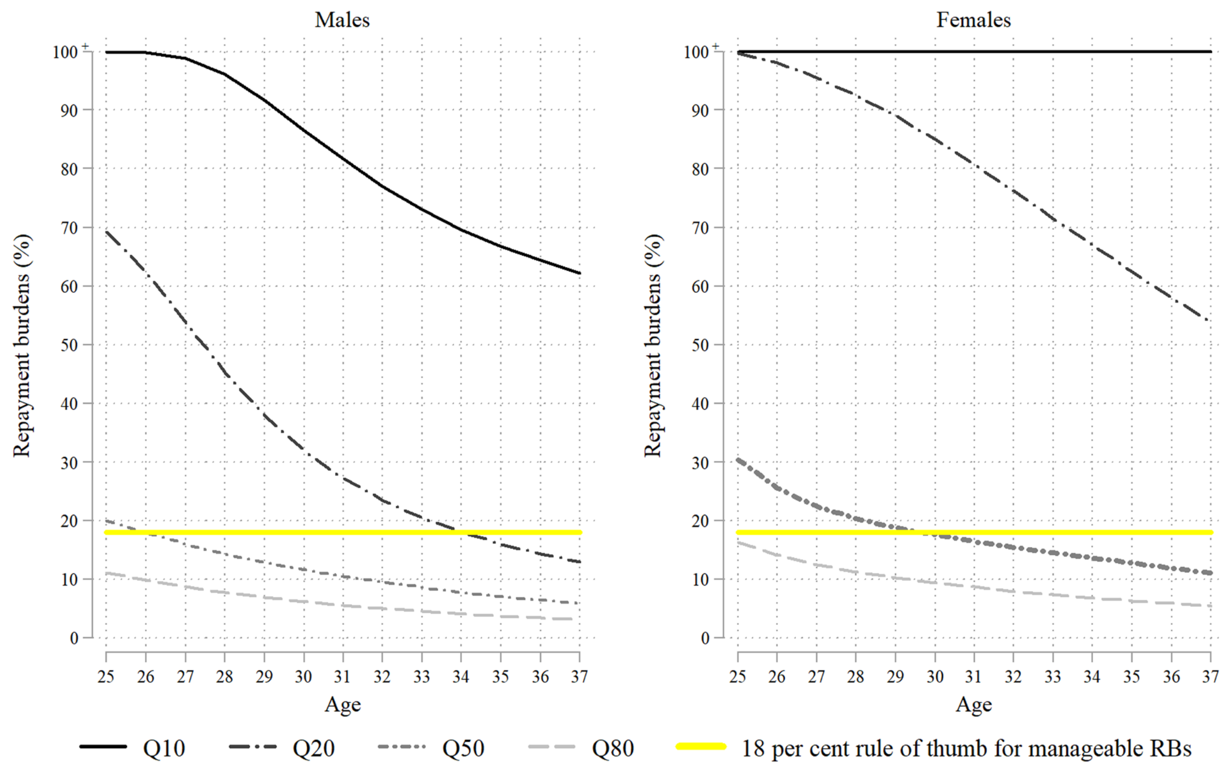

Fig. 4. Repayment burdens for FIES TBRLs, various quantiles of the earnings distribution.

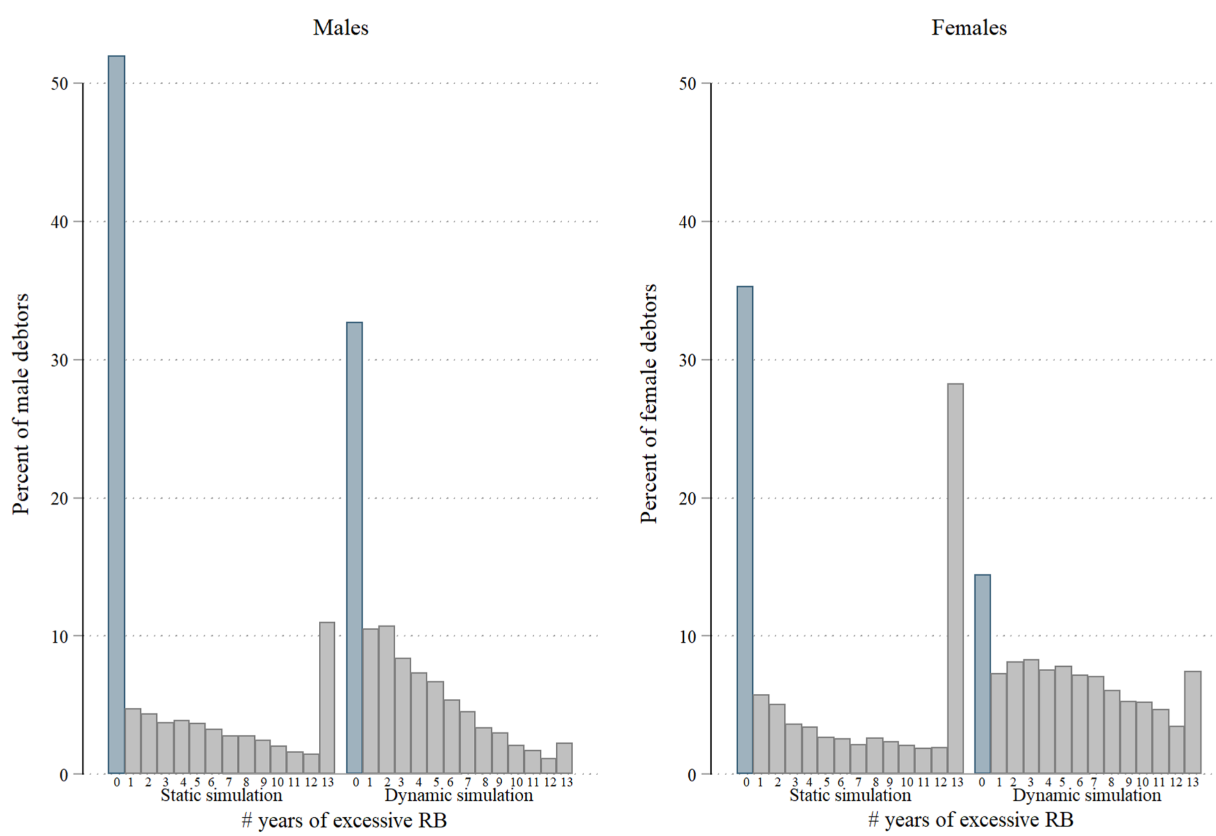

Fig. 5. Measures of years of excessive RBs for simulated TBRL scheme.

Dearden (2019) shows that the extent of repayment hardship is likely to be understated if earnings mobility is ignored. To examine this, we use the dynamic simulations to calculate the number of years a debtor is likely to face ‘excessive’ RBs. Fig. 5 plots the proportions of borrowers facing RBs above the 18% rule of thumb for manageable RBs drawn from the literature. In its TBRL format, the FIES typical loan involves a thirteen-year repayment period so this can occur in up to thirteen years (i.e., $n = 1, 2, \ldots, 13$). The blue bars show the proportions

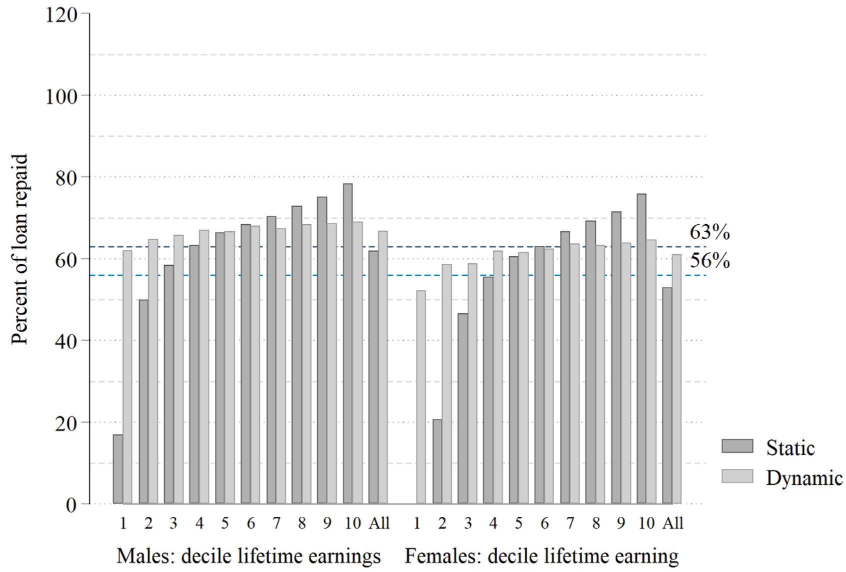

Fig. 6. Scenario 1: proportion of ICL loan repaid by decile of male and female lifetime earnings, static vs dynamic earning simulations.
Note: dotted lines refer to the overall proportion of loan repaid. Light blue for static simulations and dark blue for dynamic simulations.

of borrowers not facing any years of excessive RBs (i.e., $n = 0$). The diagrams report results separately by sex for both static and dynamic simulations.

Fig. 5 reinforces the importance of dynamic models for RB analysis. The diagrams emphasise an important point: static simulations underestimate the total proportions of borrowers facing high RBs at some point during the repayment period and overestimate the proportions of borrowers facing no excessive RBs over the entire repayment period. Overall, the proportion of individuals facing one or more years of excessive RBs is considerably higher in simulations incorporating earnings mobility than in static simulations. If no mobility is assumed, 51.9% of males and 35.3% of females would never face RBs greater than 18% when repaying a typical FIES TBRL. The estimates from the dynamic models are much lower: only 32.7% of males and 14.4% of females are estimated not to face high RBs over the term of the loan. So, even in a country like Brazil, where earnings mobility is relatively low, static and dynamic simulations entail very different results.

4.1.3. *The relevance of RB analysis*

RB analysis is relevant to assess potential repayment hardship.[20] This is useful for policy analysis because the higher a debtor's RB the higher their probability of defaulting on a loan at some point, although it is worth emphasising that debtors might choose to default even if they can afford repayment so long as the financial costs of repayment outweigh the costs associated with the penalty for defaulting (Chapman & Lounkaew, 2016). It is also important to note that delinquency and default are normal ‘repayment states’ and do not necessarily imply inefficiencies in the TBRL's schemes, especially because, to some extent, borrowers can resort to defaulting as an insurance mechanism in the absence of income-contingency features in the loan design (Lochner & Monge-Naranjo, 2016). Notwithstanding, the key point here is that excessive RBs lead to high prospects of debtors defaulting, and this influences governments’ decisions on the size of the subsidies implicit in the policy design (Chapman & Lounkaew, 2015).

The RB calculations reported in this paper illustrate that TBRLs are likely to impose problems for individual graduates in Brazil. The high default rates reported by Brazil (2017) for FIES TBRLs seem to provide an additional support to this statement: nearly 30% of contracts in repayment period were over a year in arrears, and there was a prospect of default eventually reaching 50% of all loan disbursements. Next, it will be discussed whether ICLs are a feasible alternatives to balance this trade-off between taxpayer subsidies and RBs in a hypothetical government-guaranteed student loan system for Brazil.

4.2. *Possible ICLs for Brazil*

This section uses the graduate lifetime earnings simulated previously to look at the implications of four different possible ICL arrangements for Brazil. Unlike with TBRLs, RBs in ICLs are controlled by the policymaker, as maximum RBs can never exceed the maximum repayment rate of the ICL (see Barr, Chapman, Dearden & Dynarski, 2019). Besides that, default is not an issue for the borrower, as repayments are automatically suspended in periods of low or zero earnings (depending on the repayment threshold) and continue until the loan is repaid or the debtor retires or the debt is written off. Non-repayment does not affect the debtor's credit reputability and becomes a built-in design factor of the ICL. This means that subsidies can be more effectively aligned with public preferences over time with adjustments in parameters such as the loan's size, coverage, length, rates of interest, and repayment rates and thresholds (see Barr et al., 2019).

Repayment rates can be levied on marginal income (as is the case in England) or total income (as is the case in Australia). In our scenarios, repayment rates are levied on total gross earnings in all but the last case. Any outstanding debt is forgiven at age 65, implying a loan write-off after 41 years for the 24-year-old graduates in our simulated sample. We simulated the following scenarios:

- Scenario 1: a crude baseline scenario with no earnings threshold and subsidised zero per cent real interest rate.
- Scenario 2: real interest rate is introduced, and it is equal the government's cost of borrowing;
- Scenario 3: an initial threshold is introduced, as well as a loan fee; interest rate at the government's cost of borrowing applies upon graduation, so long as earnings are above the initial threshold.
- Scenario 4: four different repayment rates are introduced, aligned with repayment thresholds valid for taxing personal income.

[20] Ideally, RB analysis should rely on longitudinal data on the earnings and borrowings of real debtors, incorporating other factors affecting the ability to pay, such as debts other than student debts, number of dependents, and household taxes and benefits (Dearden, 2019; Dynarski, 2015).

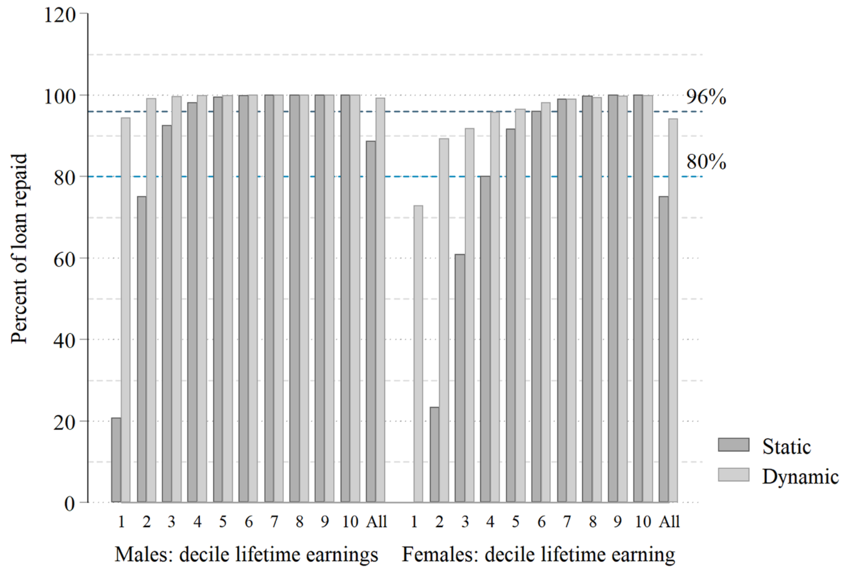

Fig. 7. Scenario 2: proportion of ICL loan repaid by decile of male and female lifetime earnings, static vs dynamic earning simulations.
Note: dotted lines refer to the overall proportion of loan repaid. Light blue for static simulations and dark blue for dynamic simulations.

4.2.1. Scenario 1: a flat repayment rate with no earnings thresholds and zero real interest rate

The first simulated ICL scheme applies parameters of the income-based scheme introduced by the Brazilian federal government in 2018: a flat 13% repayment rate with no earnings threshold and zero real interest rate. Static and dynamic results are shown in Fig. 6 by deciles of lifetime earnings for both male and female graduates.

Our simulations suggest that the overall subsidy involved with the current FIES ICL will be around 37% based on the dynamic model. Assuming no mobility, the estimate of the subsidy rises to 44%, a difference of 7 percentage points. This involves a subsidy of 39% for women and 33% for men in net present value (NPV) terms.

The size of the taxpayer subsidy depends on the individual lifetime earnings profile, the size of the loan, the scheme's parameters, the discount rate and, importantly, the assumed real earnings growth. We can see under this scheme that the subsidies involved are progressive, with those with higher lifetime earnings paying a higher proportion of their loan. However, all graduates, including those doing the best in the labour market, receive a substantial taxpayer subsidy as they benefit from the zero real interest rate which is significantly below the government's real cost of borrowing. Given the precarious nature of Brazil's government finances, the subsidies involved with this current FIES ICL seems unreasonably large.

4.2.2. Scenario 2: raising interest rate to the government's cost of borrowing

The second simulated ICL scheme maintains the same parameters as in scenario 1 but applies a real rate of interest of 5% p.a., consistent with the government's cost of borrowing in Brazil. This ensures that those who pay off their loan in full will pay off the full NPV of their loan (see Barr et al., 2019). Fig. 7 shows the static and dynamic results for this scenario.

Fig. 7 illustrates that eliminating interest-rate subsidies decreases the taxpayer subsidy of the loan considerably whilst protecting those who do worst in the labour market. With an ICL, increasing the interest rate simply increases the duration of the loan and thus reduces the taxpayer burden. It has no impact on the RB whilst the loan is being paid (the maximum RB is 13% for the duration of the loan). This simple adjustment to the current FIES system could save taxpayers a considerable amount of money. Setting interest rate at the government's cost of borrowing is a possible solution if the government's aim is to concentrate ICL subsidies on graduates with low lifetime earnings. As Barr et al. (2019) point out, taxpayer subsidies could be further reduced by setting the real interest rate above the government's cost of borrowing. The problem with this strategy is that it is regressive within the cohort of borrowers as high earning graduates will pay the interest rate premium for a shorter period than low earnings graduates.

4.2.3. Scenario 3: introducing loan surcharges to reduce taxpayer subsidies

The third simulated ICL scheme sets the real rate of interest to the government's cost of borrowing, but introduces other changes:

(i) universal loan fee of 25% is charged on the initial borrowing[21];
(ii) a repayment threshold is introduced, below which no repayments are required. This is set at the initial threshold for personal income tax (in 2017 that was BRL 22,847.76 per year, roughly equivalent to USD PPP 11,300)
(iii) during the study period and whilst the debtor's earnings are below the income threshold, a zero real interest rate applies. The real interest rate is set at the government's cost of borrowing only when earnings are above this threshold.

The implications of this system are shown in Fig. 8.

A loan fee alongside providing concessional interest rates while the debtor studies or falls below an initial earnings threshold has two implications. First, it ensures the real value of debt cannot increase whilst the student is studying or has low earnings. Second, the choice of the initial threshold at the level valid for personal income tax purposes disentangles student loan repayments from the welfare system and simplifies the collection mechanism.

We have also tested an alternative threshold for scenario 3 (not shown in the diagrams of Fig. 8), setting it at the level of the national minimum wage. This follows the initial threshold adopted by the Hungarian ICL scheme (as described in Berlinger, 2009) and insures only debtors with very low earnings profiles. In the case of Brazil, setting the repayment threshold at the initial tax threshold implies relatively low revenue loss[22] in comparison with setting it at the level of the national minimum wage, even though the level of the former is more than twice the level of the latter. With the higher initial threshold, taxpayer subsidies in scenario 3 are estimated to be around 9%, which is only 5 percentage points lower than Scenario 2, where the interest rate was set to the government's cost of borrowing but

[21] The choice to apply 25 per cent in this scenario takes as benchmark the loan fees paid by full-fee undergraduate students borrowing from the Australian ICL system to study in private HEIs (see Norton & Cherastidtham, 2016).

[22] A difference of 2 percentage points was observed.

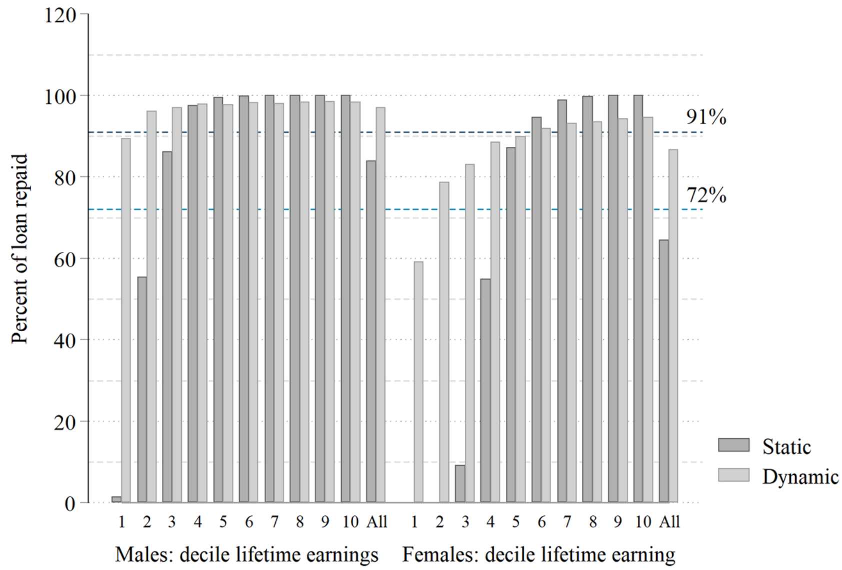

Fig. 8. Scenario 3: proportion of ICL loan repaid by decile of male and female lifetime earnings, static vs dynamic earning simulations.
Note: dotted lines refer to the overall proportion of loan repaid. Light blue for static simulations and dark blue for dynamic simulations.

Table 2
Annual thresholds and repayment rates for the ICL scenarios.

#	Annual thresholds		Repayment rate for ICL collection purposes	Aliquot for taxing personal income
	In 2017 BRL	In 2017 USD PPP		
1	22,847.76	11,288.42	3.75%	7.5%
2	33,919.80	16,758.79	7.5%	15%
3	45,012.60	22,239.43	11.25%	22.5%
4	55,976.16	27,656.20	13.75%	27.5%

Note: Income tax aliquots are levied on marginal income in Brazil, and some sources of income are not taxable. Repayment rates in our previous ICL simulations were levied on total (not marginal) pre-tax earnings. For this scenario, we compare results when repayment rates are levied on total gross earnings with results when repayment rates are levied on marginal earnings.

applied for the duration of the loan, including whilst the student was at HE.

4.2.4. Scenario 4: incorporating additional thresholds and marginal repayment rates

The fourth simulated ICL scheme uses all four income thresholds for personal income tax in Brazil as thresholds for the ICL, with progressive repayment rates instead of a flat 13% rate. It also compares the impacts when repayment rates apply over marginal rather than total earnings. Repayment rates are set to half of the respective aliquots for taxing income. The loan fee on the initial borrowing is maintained, and interest rates at the level of the government's cost of borrowing applies upon graduation, except while earnings remain below the initial threshold. Repayment rates and thresholds are reported in Table 2, along with the tax aliquots on which the repayment rates for collection of this hypothetical ICL scheme were based.

Introducing more thresholds and associating most of them to lower repayment rates than in the previous simulated schemes helps to make the ICL scheme more progressive, although it necessarily reduces revenue. Further reductions in revenue are observed when the repayment rates presented in Table 2 are levied on marginal earnings (not on total gross earnings, as in previous scenarios). Fig. 9 shows the results of this exercise. As compared to Scenario 3 (see Fig. 8), the subsidy increases by three percentage points if repayment rates are levied on total earnings, or by 17 percentage points if marginal rates apply.

Opting for marginal rates waives revenue in exchange for smoothing the discontinuity in taxable earnings around kink points. As Barr et al. (2019) emphasise, repayment schedules should avoid sharp discontinuities in graduates' earnings, because this kind of distortion may lead, for example, to reductions in labour supply and bunching of earnings below the threshold. Marginal rates also considerably reduce RBs for all earners and in this scheme most higher lifetime earners would face RBs significantly below the maximum rate of 13.75%. The final choice between the illustrated scenarios would depend fundamentally on political choices: in particular, whether reducing sharp discontinuities is worth an additional three or an additional 17 percentage points of revenue loss in comparison with scenario 3.

5. Conclusions

This paper uses simulations of graduate earnings for a cohort of future Brazilian graduates to consider the implications of different loan designs on both graduates and taxpayers. In order to have realistic dynamic simulations, the Copula method of Dearden (2019) is applied to the panel element of the Continuous PNAD data for 2014 and 2015. The model replicates the observed transitions in the panel data well and is used to simulate the future earning paths for a sample of 24-year-olds from the Continuous PNAD.

Using these lifetime earnings profiles, we then simulated repayment patterns for the FIES 2017 time-based and 2018 income-contingent loan designs. Problems with both loan systems were identified. The RBs with the FIES 2017 TBRL were too high for low earners and the taxpayer subsidies involved in the new FIES 2018 ICL are large and unsustainable given the current economic situation in Brazil.

Four alternative ICL designs were considered. The best design involves imposing a zero-interest rate whilst students are at HE and whilst debtors are below the first tax threshold and then setting the interest rate to the government's cost of borrowing when the graduate is earning above the first tax threshold. It also involves having ICL repayment rates that increase with the tax thresholds and are set at half of the current tax rates. If repayment rates are marginal, this effectively means that the marginal tax rate faced by graduates is 50% higher than non-graduates until they pay off their loan. The overall scheme involves a taxpayer subsidy of around 26%. Alternatively, if repayment rates are levied on total earnings, the taxpayer subsidy would be around 12%. This is very low as compared to most countries operating student loan schemes (see discussion in Britton, van der Erve, & Higgins, 2019).

Of course, some caution is needed. Firstly, the transitions observed

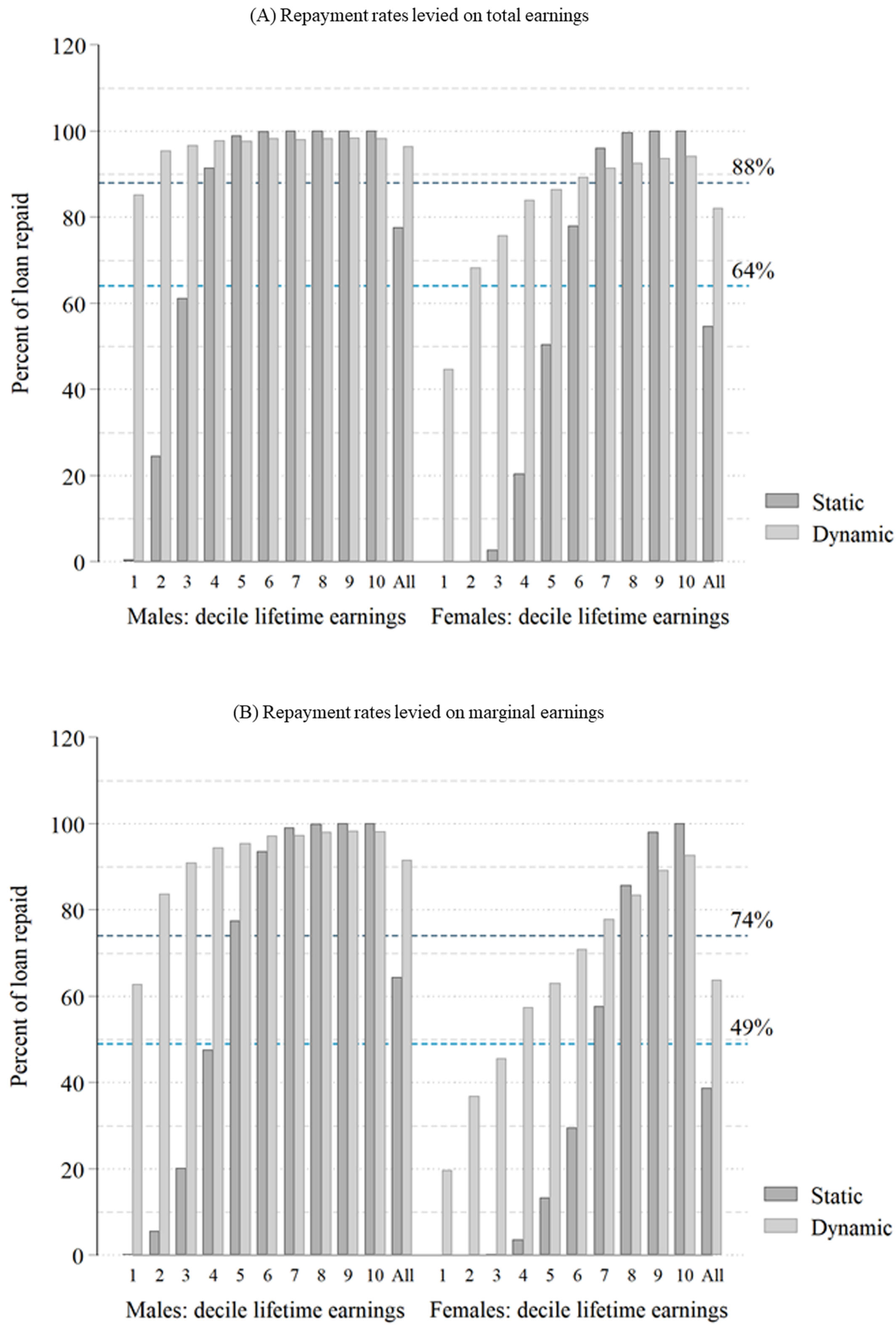

Fig. 9. Scenario 4: proportion of ICL loan repaid by decile of male and female lifetime earnings, static vs dynamic earning simulations, with repayment rates levied on total (A) or on marginal earnings (B).
Note: dotted lines refer to the overall proportion of loan repaid. Light blue for static simulations and dark blue for dynamic simulations.

in the Continuous PNAD data for 2014 and 2015 might not reflect what will happen to future graduates. Secondly, we have assumed real wage growth of 1% for all graduates going forward. Estimates of taxpayer subsidies are sensitive to this assumption. Thirdly, if the number of HE students expands considerably, graduate earnings may be lower than expected. This has not occurred in other countries which have significantly expanded HE, but this is hard to predict (see for example Oreopoulos & Petronijeciv, 2013). Fourthly, the estimates are sensitive to the government's cost of borrowing. A significant increase (decrease) in the government's cost of borrowing will significantly increase (decrease) taxpayer costs for future graduates. Fifthly, the cost of an ICL depends crucially on the earnings base used. We have assumed that it will apply to gross labour earnings and collected in the same way as tax through the federal revenue system (FRS), an essential feature to reach assessable labour earnings beyond wages and salaries. The FIES collects repayments through an employer withholding system which will necessarily involve a narrower earnings base.

Converting the existing FIES loans into ICLs is likely to enact efficiency and equity gains, but the larger potential for ICLs in Brazil is in the growing need to introduce tuition fees in the currently free-of-charge public HEIs. This topic has been discussed in academic and policy-making fora and has gained more relevance after the approval of the spending freeze amendment. It is unclear, however, to which way this debate will move in coming years, as a new government and a new Parliament will take office in early 2019.

Brazil has the infrastructure and potential to introduce a large-scale ICL scheme. In addition to calculating and collecting income tax and social security contributions, Brazil's federal government annually collects information on enrolments in higher education from the public and private sectors. These mechanisms operate electronically and can easily be linked by an identification key common to all of them: the *cadastro de pessoa física*, which is the individual national fiscal number. Moreover, the country's censuses, household surveys, tax records, and wide range of administrative datasets provide rich information on the key variables to construct evidence-based ICL arrangements, which are earnings, employment, and education. This paper demonstrates with only short panel data, great advances can be made in simulating lifetime graduate earnings and hence loan design. Access to government administrative data would improve the simulations greatly and ensure robust loan design. But what our paper makes clear is that an affordable and equitable ICL could be devised for Brazil and this has the potential to not only increase HE places and therefore access for students, but also to do this in a way that can cut costs for the Brazilian taxpayer in a fair and equitable way.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.econedurev.2018.11.005.

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