Student Aid, Academic Achievement, and Labor Market Behavior: Grants or Loans?

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Abstract: We provide a framework for quantifying the impacts of implicit incentives in study aid schemes. We specify and estimate a dynamic discrete choice model of simultaneous education, work, and student loan take-up decisions exploiting the 2001 Swedish Study Aid reform for identification. This enables ex-ante evaluation of various changes to financial aid schemes. We find that the grant-loan mix does not affect student behavior as long as there is more weight on loans. When there is substantially higher weight on grants, however, more students graduate but stay enrolled longer. Moving from an income contingent to an annuity based loan repayment scheme substantially decreases student debt accumulation and improves the effectiveness of academic capital accumulation.

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Keywords: Student Aid, Education and Labor Market Outcomes, Dynamic Discrete Choice Model.

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1 Introduction

A highly educated labor force is key to sustain economic development, innovation, and growth. At the same time, the high levels of student debt are a core concern, as tuition, student aid, and debt have grown rapidly over the past five decades. Whether student debt is too high or not even high enough to overcome capital market imperfections is still an open question.[1] We take these capital market imperfections as given and analyze how financial aid can be spent more effectively in order to obtain the declared social goals of increasing graduation rates and the speed at which individuals obtain higher education. Despite the tremendous amounts of financial aid to students attending higher education, little is known about the impact of student aid on academic achievement and labor market behavior. Even less is known about the effects of frequently suggested and much debated policy reforms of study aid schemes. The aim of this paper is to better understand the implicit incentives in study aid schemes and quantify their behavioral impacts. We provide an economic model capable of evaluating how student debt accumulation, academic and labor market outcomes react to changes in these implicit incentives. This allows us to analyze the behavioral and economic impacts of a range of core student aid policies; including how debt accumulation and graduation rates would change if we put more weight on loans relative to grants, and how student behavior would change if we changed the income means testing or the loan repayment schemes. How can we spend scarce public study aid most effectively? Which are the most cost-effective policy instruments?

These are very challenging empirical questions to answer, since they depend on individual budget constraints and which individuals are close to college enrollment and graduation margins, as well as how they respond to monetary incentives. We specify and estimate a dynamic discrete choice model of joint education, employment, and loan take-up decisions of college students. The model also embeds how these choices affect college productivity (in terms of how many course credits are accumulated) and labor

[1] That student loans can improve economic efficiency by raising the supply of workers with a college degree and thus help overcome social underinvestment in human capital due to capital market imperfections was first noted in Friedman (1962).

market productivity (in terms of labor income). The Swedish reform of the study aid scheme implemented in 2001 provides us with a quasi-experiment to identify the key parameters of the structural dynamic model. Student aid in Sweden is provided by a universal central-government-run system that guarantees a maximum yearly sum of around SEK 80,000 (around USD 12,000) to all eligible students. Of this total sum, one third is a non-repayable grant and two thirds are in the form of a student loan. In 2001, four main aspects of the study aid scheme were changed: the amount of grant relative to loan was increased, the repayment installments of the loan went from a fixed proportion of labor income to an annuity based scheme, the eligibility rules were made more stringent, and the income threshold above which the aid amount is reduced was doubled - effectively reducing the implicit income tax for students. This identification strategy has four main advantages. First, it is more robust than identification strategies relying purely on functional form assumptions. Second, it allows us to estimate a richer model. Third, it enables us to go beyond ex-post evaluation of total effects and to disentangle the mechanisms by which specific parts of the study aid scheme affect academic achievement and labor market behavior. Fourth, we are able to simulate the ex-ante effects of various potential policy reforms of the study aid scheme.

The estimation of our structural dynamic model accounts for self-selection of student employment and loan take-up (based on both observed and unobserved heterogeneity) as well as of dynamic selection in terms of who is dropping out and graduating at various points in time. The model is estimated using the Conditional Choice Probability (CCP) estimator developed in Arcidiacono and Miller (2011).

Our estimated model does a good job fitting the observed patterns in the data, even along dimensions of heterogeneity (field of study, parental education and income) that we do not explicitly model. Notably our model very precisely predicts the timing of dropout and graduation, which is a very important aspect to consider when designing education policies. We estimate a loan aversion parameter, which reveals that students who take a full loan derive positive utility from having a pre-existing stock of debt while students who take a partial loan derive a negative utility from the pre-existing stock. Hence some students do not worry about repaying the loan but enjoy the financial freedom it provides, while others dislike having student debt even if they need taking up some of the loan. There is a positive correlation between full loan take-up and parental income - suggesting that students with high income parents worry less about repaying the debt or count on a lucrative labor market career, while students with low income parents are more loan averse. This intuition is strengthened by the fact that student income, course credits production, and Master's graduation are positively correlated with parental education, but not as strongly correlated with parental income. This result indicates that loan aversion is linked to parental income, and even if credit constraints are loosened, students who do not have high-income parents prefer not to borrow.

The uniformity of study aid rules and the detailed panel data allows us to model important aspects of student choices and outcomes, while both taking their simultaneous and sequential nature into account. This enables us to better assess which students are at which margins of change and how strongly they respond to financial incentives. This also enables us to simulate the impacts of study aid policies never previously implemented. We find that changing the weight of loans relative to grants does not have a strong impact on dropout and graduation if there is more weight on the loan. However, if the grant carries more weight than the loan there is an increase in graduation rates and a decrease in dropout rates, but students stay enrolled longer. Despite the beneficial educational outcomes, increasing the grant part of aid could be a costly measure for the government in the longer term - even if cost neutral in terms of total current study aid. Decreasing aid eligibility from six to five years (normalized time to Master's graduation) increases time to graduation by one semester, since students work more during college to compensate for the earlier loss of aid eligibility. On the other hand, extending time eligibility to seven years does not affect students significantly. We are particularly interested in the effect of different repayment schemes. We find that changing an income contingent scheme to an annuity scheme with a similar installment plan for the average student decreases the loan take up, increases dropout rates, and decreases time to graduation. Debt becomes costlier for the students expecting a lower post-college income and they become more effective at acquiring academic capital and minimize their stock of debt.

The rest of the paper is organised as follows. Section 2 reviews the related literature. Section 3 describes the details of the reform of the Swedish study aid scheme of 2001 that our identifications strategy exploits as a source of exogenous variation in the estimation of the model parameters. Section 4 sets up the structural dynamic model. Section 5 describes the estimation method and discusses identification. Section 6 describes the data. Section 7 presents the results of the estimation and assesses model fit. Section 8 discusses various policy simulations based on the estimated model. Finally, section 9 concludes.

2 Related Literature

There is a large and rapidly growing literature on how financial incentives affect educational attainment and achievement.[2] The impacts of student aid schemes depend on how strongly student behavior responds to changes in the direct and opportunity costs of education, as well as how many students are at the relevant margin of change. The literature provides ambiguous evidence on the impacts of financial aid on academic achievement. However, most of this literature does not control adequately for confounding unobservable factors. Quasi-experimental studies find that financial aid has a negative impact on college drop-out and retention, while it has a positive impact on completion (Bound et al., 2007; Dynarski, 2003; Bettinger, 2004; Dynarski, 2008). Goodman (2008), Oreopoulos et al. (2009), Scott-Clayton (2011), DesJardins and McCall (2010), Garibaldi et al. (2012), and Joensen (2013b) demonstrate the potential effectiveness of providing incentives related to merit and timing in financial aid packages. These papers study the effectiveness of one particular grant or scholarship at one particular margin in the financial aid distribution. They are thus neither informative as to which margins of choice are affected by the financial incentive nor how small changes to the incentive would change the magnitudes of the effects.[3] Our paper contributes to this literature by providing

[2]Recent contributions include Angrist et al. (2002), Oreopoulos et al. (2009) and Leuven et al. (2010).
[3]Joensen (2013b) is a notable exception, but she does not include loans in financial aid packages.

estimates of the direct effects of study aid on academic achievement and the indirect effects operating through student employment and loan take-up choices. The structural approach provides a framework that allows us to disentangle how different incentives affect different margins of college-work-loan choices. This also enables comparison of ex ante predictions to ex post evaluations, and a coherent and unified framework for interpreting existing evidence through evaluation of the effects of various study aid policy interventions on debt accumulation, academic and labor market outcomes.

Most of the earlier literature focuses on enrollment, mainly because the traditional models of human capital investment ignore the role of uncertainty by equating enrollment with graduation. In this paper, we build on the model of Joensen (2013a) and Joensen (2013b) who incorporates study grants into the model of Eckstein and Wolpin (1999). This model is more consistent with the empirical facts of high dropout rates, excess time to graduation, and students who work part-time while enrolled.[4] The structural dynamic model of education and student work hours choices in Joensen (2013a) and Joensen (2013b) is estimated exploiting a change in the threshold for maximum allowable students earnings and the implicit tax above this threshold in the Danish study aid scheme. We are able to extend and strengthen this estimation strategy by having exogenous variation in three additional policy instruments for identifying the key model parameters. The idea of combining a quasi-experiment with a structural dynamic model has been strongly advocated (Card and Hyslop, 2005; Todd and Wolpin, 2006; Heckman, 2010; Keane et al., 2011; Attanasio et al., 2012; Blundell and Shephard, 2012). This approach allows us to: (i) estimate a richer structural model exploiting exogenous reform variation to identify key parameters, (ii) make more elaborate model validation, and (iii) simulate effects of potential policies never previously implemented.

Students self-finance a considerable amount of their college costs through working

[4] 30% dropped out of higher education in the average OECD country in 2007; see OECD (2009). For the US, Altonji (1993) reports that in the NLS72 about 60% of college candidates actually complete college. Bound et al. (2007) show that both drop-out rates and times-to-graduation have increased over time in the US, where around 40% of students at 4-year colleges are employed, and 10% of students work more than 20 hours a week. Joensen (2013a) shows the same tendency for university students in Denmark, where both drop-out rates and the amount of student employment is similar to US 4-year colleges. In 2007, an average OECD country 15-29 year old student was employed the equivalent of 27% of full-time employment while enrolled in education.

part-time while enrolled in college: Leslie (1984) reports that US students self-finance around 20% of college expenses. Bound et al. (2007) show that student employment has increased over time and speculate that this reflects students self-financing increased tuition fees. Joensen (2013a) stresses the importance of explicitly modelling student employment choices when quantifying the impacts of study grants.[5] Joensen (2013a) demonstrates that the impact of student work hours on academic achievement is non-linear: working 1-9 hours a week is complementary to academic success, while working more than 18 hours is very detrimental. Therefore, redistributing study grants from those working more to those working less only leads to negligible positive increases in college graduation rates - less than 5 percentage points - while it has no impact on times-to-graduation. The declared social objectives of higher graduation rates and lower times-to-graduation can thus not be obtained through tilting the study grant scheme only. Joensen (2013b) extends these findings to further consider how redistribution across time (e.g. timely graduation bonuses) and from students who perform under a specified academic standard to those who perform better during college (e.g. merit aid) affects academic achievement. The main conclusion is that merit aid, where study grant eligibility is conditional on passing a requisite amount of courses each year, is the most effective way to induce students to graduate at a higher rate and faster.

Another way to redistribute student aid across time and students is to provide study loans. Although study loans are widespread,[6] little is known about the impacts of more generous loans or different loan repayment schemes on student performance. The interest in understanding the consequences of student loans has increased recently given the rise of student debt in the US.[7] The structural dynamic models of Joensen (2013a) and

[5]Ignoring students' ability to self-finance their studies through student employment will overestimate the opportunity costs of college. Furthermore, ignoring the direct impacts of student employment on academic achievement further biases any estimated effects of student aid on outcomes to the extent that these are correlated with college-work choices.

[6]According to OECD (2009), 75% of Swedish, 65% of Norwegian, and80% of UK, 55% of US students in higher education have loans, while very few Danish and Finnish students have loans. This amounts to 61% of student aid in Sweden, 67% in Norway, and 58% in the US.

[7]Lochner and Monge-Naranjo (2011b) and Avery and Turner (2012) provide recent reviews. Debt burdens can have various consequences for individuals. Rothstein and Rouse (2011) show that high debt burdens decrease the likelihood of choosing low-payed careers (e.g. as teachers) and Gicheva (2012) shows that a higher student debt decreases the probability of getting married.

Joensen (2013b) are estimated on Danish data, where take-up rates of student loans are too low to feasibly quantify the impacts of loans. We extend those models with the intertemporal dependence implicit in undertaking a loan and analyze the effects of this particular aspect. This enables us both to analyze how providing student aid in the form of a grant (or scholarship) or a loan, and whether the nature of the loan repayment scheme matters for student behavior and economic success.

This paper also contributes to the literature on borrowing constraints. This literature finds that despite the tightness of borrowing constraints, removing them has a small and negligible impact on educational attainment and achievement. This is found both for the US; Keane and Wolpin (2001), Carneiro and Heckman (2002), Cameron and Taber (2004), Johnson (2013) and for Denmark; Nielsen et al. (2010). Recently, some papers have questioned this result. Lochner and Monge-Naranjo (2011a) underline the increasing importance of credit constraints for students in the US context, with raising tuition fees and an increasing share of students borrowing the maximum student loan amounts. Solis (2011) exploits the design of student loans in Chile to estimate the effects on college enrollment of access to loans and finds that access to loans eliminates the importance of parental background for enrollment. Brown et al. (2012) and Mattana (2013) stress the importance of strategic interactions in the family to understand the real impact of credit constraints on educational outcomes. These papers make significant contributions to our understanding of the nature and importance of borrowing constraints. However, none of these papers allow students to self-finance consumption during college by working, which is an important source of income and a potential source of bias in assessing the importance of borrowing constraints (Leslie, 1984; Bound et al., 2007; Joensen, 2013a). Keane and Wolpin (2001) and Johnson (2013) allow student income to be a source of consumption, however, do not allow it to directly affect college achievement which we show is a significant channel when evaluating student aid policies.

To the best of our knowledge, this is the first paper to simultaneously model study grants and loans in great detail embedded in a dynamic model of key student choices (enrollment, employment, and loan take-up) and outcomes (course credit production and earnings). The register based panel data and the universal nature of the Swedish study aid scheme enable us to specify the educational and student aid environment in such great detail. Two other notable papers assessing borrowing constraints in a dynamic model of joint college enrollment and student employment choices have to be mentioned here: Keane and Wolpin (2001) and Johnson (2013). Johnson (2013) introduces student loans into the Keane and Wolpin (2001) model by approximating the Federal Family Loan Program (FFEL) loan program rules in a dynamic model also including private credit limits, tuition differences across states, as well as need- and merit-based grants. However, due to the complexity and multiplicity of the US student aid and limited data availability, it is not possible to get a good measure of actual student aid. In order to understand how we are better able to address core policy concerns related to student aid, we thus also need to highlight some important aspects of the student aid schemes.[8] Important differences between the US and Sweden make it easier to accurately model potential funding opportunities of Swedish students, thus minimize non-trivial non-random measurement issues. First, US grants and loans are mainly provided by the federal government, states and colleges, while Swedish aid is predominantly provided by the central government. The multiplicity of scholarship and loan programs and complexity of eligibility rules make it impossible to estimate study aid opportunities in the US. The uniformity and simplicity of study aid rules in Sweden enable accurate measurement of actual study aid oppotunities that can be matched up with actual loan take-up choices observed in the data. Second, US grants depend on parental income - typically grants are a decreasing function of parental income, because of need based grants and loans (e.g. the Pell grant and the Stafford loans) whereas Swedish student aid is largely independent of parental income. Third, Swedish aid depends on student earnings, making it pivotal to jointly model student employment choices and their impacts on academic achievement. Fourth, tuition is university-specific and depends on student characteristics. Most papers assume a uniform tuition level, while Johnson (2013) proxies tuition differences by setting state as an initial condition. Tuition is uniformly zero in Sweden. On top of having very precise

[8] Kane (2006), Lochner and Monge-Naranjo (2011a), Brown et al. (2012), Avery and Turner (2012), and Dynarski and Scott-Clayton (2013) provide a more detailed description of financial aid in the US.

information on the public study aid scheme and the college costs individuals face, we also have individual level data on students' (and their parents') income. This allows us to estimate their alternative funding opportunities with more accuracy than is previously done.

Two additional measurement and modelling issues are worth highlighting. First, previous papers on borrowing constraints have not been able to measure student debt directly, but try backing it out from survey questions on total debt. Student loan borrowing has thus been indirectly assessed by including net worth as a state variable. We have individual panel data on student aid from age 16 and can directly measure student loan amounts. Second, we are able to distinguish between time spent in college relative to accumulated course credits. Previous papers only estimates degree premiums and model degree completion, as no other college achievement measure is available in datasources like the NLSY79 and NLSY97. We model grade level progression at the course credit level, as we have detailed data on accumulated course credits each semester. This is another important margin, as it allows us to assess achievement much more accurately and estimate how close students are to degree completion. A significant contribution is thus that we can both model students college progression and actual funding opportunities much more accurately.

Student aid policies can play a welfare enhancing role by increasing college graduation rates. This has been known since Friedman (1962), but if they actually do and by how much is still an open question. Dynarski (2008) concludes that dropout rates are high even with free tuition. This suggests that the direct costs of college are not the only impediments to college completion. Hence, more than tuition reductions is needed in order to substantially increase college graduation rates; for example, aid that extends beyond direct costs to opportunity costs. Since there is no variation in the US data for college costs extending below zero, evaluating these types of policies is not possible using US data. For example, the most generous relaxation of borrowing constraints in the policy simulations in Keane and Wolpin (2001) and Johnson (2013) allows students to borrow up to the full cost of college. Sweden provides an ideal environment to analyze study aid policies that include student loans, because it is one of the most generous in the world with free tuition and large public grants and loans to which most enrolled students are eligible. A substantial fraction of students also take up the loan. Moreover, the reform of the study aid scheme provides a unique quasi-experimental setting for our analysis. Avdic and Gartell (2011), analyze the impact of the 2001 Swedish study aid reform on individual study efficiency. We depart substantially from their approach, both in means and in scope. Avdic and Gartell (2011) estimate short run ex-post total effects of the reform as a whole, hence are not able to separate out its various components; e.g. loan repayment schemes, less weight on loans relative to grants, tighter eligibility requirements, and more generous income means testing. Furthermore, they do not account for student employment decisions and important dynamic selection; i.e. the fact that it is not random who is still enrolled in college at any given point in time. Hence, they are neither able to disentangle the impacts of the various policy instruments changed by the reform nor the mechanisms by which they affect study efficiency. This paper contributes to the literature by providing estimates of the direct effects of study grants and loans on academic achievement, as well as their indirect effects operating through student employment choices. These estimates are pivotal for better ex-ante policy evaluation and knowing which components of the study aid scheme affect which margins of choices and outcomes.

College enrollment, grade level progression, student debt accumulation, and work experience are thus all endogenously determined in our model. Thus building the study aid scheme into our model enables us to disentangle the effects of financial aid and student employment on drop-out rates, college achievement, timing of college graduation, accumulated student debt, and labor market productivity. Particularly, the impacts of loan repayment schemes have not been previously quantified.

3 The Swedish Study Aid Scheme

Sweden is one of the European countries with the highest share of college graduates in the population. The annual public expenditure per student in tertiary education is about 14,000 euros per year - one of the highest in Europe with an average of 8,000 euros per year.[9] Higher education is free of tuition for all students and largely financed by the government. Moreover, 26% of the sizable total public expenditure on higher education is targeted to grants and loans for students. Student financing is administered by the central study aid authority, Centrala Studiestödsnämnden (CSN).

Students who are eligible for study aid can decide whether to receive the grant and to take up the student loan. Eligibility for study aid and the amount of aid are determined both through means testing and through merit. Means testing (*inkomstprövning*) determines the total amount per week the student is eligible for. Students are required to complete 75% of the course credits (ECTS) they enroll for in order to maintain eligibility for the following year. The student can decide how many weeks of loan to receive - up to a maximum of 20 weeks per semester for full-time students and 10 weeks per semester for part-time (50%) students.

3.1 The 2001 Reform

The 2001 reform affected four major aspects of the study aid scheme: the proportion of grant and loan in the total aid amount, means testing and income requirements, time and merit requirements, and the loan repayment schemes. These aspects of change are detailed in the following four subsections.[10]

3.1.1 Grant and Loan Proportions

The total aid amount remained unchanged, but the grant part was made more generous: the proportion of grant went from 27.8% to 34.5%. This is illustrated in Figure 1. Higher grants imply looser credit constraints and lower incentives to take up loans. This

[9] Source: Eurostat (2009)

[10] See CSNFS (2001) for even more details on the reform.

is also evident from the loan propensities in the data: 82% of students receiving grants would also take up loans in 2000, compared to 77.3% in 2001.

3.1.2 Student Income Thresholds and Means Testing

Students are means tested on a half-year basis. If student income is above a the maximum allowable threshold, the aid amount they are eligible for decreases as labor income increases. This is illustrated in Figure 2: the threshold went from 28,425 SEK in 2000 to 43,375 SEK in 2001 (from 1.5 to 2.5 of the inflation adjusted base amount, *prisbasbelopp*). This is equivalent to a reduction of the labor income tax: the income of students, composed of aid and labor income, is thus taxed less after the reform. This is depicted in Figure 3. An immediate effect of the maximal income threshold increase was that only 5,500 students got a reduction in their grant because of too high income in fall 2001, compared to 22,300 students in 2000 (CSN (2002)).

3.1.3 Time and Merit Eligibility Requirements

Eligibility requirements were also changed along five dimensions: First, students became eligible for study aid up to a maximum amount corresponding to 240 weeks (12 semesters) of higher education and enforcement of this eligibility rule was tightened.[11] Second, part-time enrollment choices were expanded to include 75% of full-time studies, compared to only 50% before the reform. The merit requirements for the first year of higher education were relaxed from 75% to 62.5% of the ECTS enrolled for at the beginning of the year.[12] Finally, it became easier to regain eligibility after losing it for one or more semesters.

[11]According to CSN (2002) the enforcement of this rule was not very strict before the reform, so the real time limit was more like 14-15 semesters. However, we do not include this stricter enforcement in the model, since we do not observe any change in actual study aid by time since initial enrollment in the data.

[12]One year of full-time courseload amounts to 60 ECTS, however, we observe many students enrolling for more than 60 ECTS.

3.1.4 Loan Repayment Schemes

The loan repayment scheme went from an income contingent repayment scheme (*studielån*) to an annuity based scheme (*annuitetslån*). Before the reform the installments consisted of 4% of the labor income from 2 years earlier (with a minimum installment of 1,320 SEK). The debt was written off in case of (a) 65 years of age are reached, (b) death, (c) sickness, (d) enrollment in Natural Sciences or Engineering or for primary school teachers in grades 4 to 9 in Math and Natural Sciences. After the reform the installments became a 25 years annuity calculated according to the following formula:

$$A_t = DEBT \times (r - p) \times \frac{\left(\frac{1+r}{1+p}\right)^{25}}{\left(\frac{1+r}{1+p}\right)^{25} - 1} \times (1 + p)^{(t-1)}.$$

Where $p = 2\%$ is an increment of the annuity to mimic wage growth and the interest rate r is set by the government to be 70% of the average cost of government borrowing over the past three years. A flavor of income contingency was kept, as it was twice possible to apply for an installment consisting of 5% of current income for three years - after which the 25 years annuity repayment scheme is resumed. The debt is now written off in case of (a) 68 years of age are reached, (b) death, (c) sickness. Figures 4 and 5 show the expected repayment schedules under the two regimes for a simulated student with maximum cumulated loan and different labor market entry incomes. For an entry income of SEK 20,000 per month (slightly higher than the average income of a college dropout) the two regimes are not very different. For lower starting salaries however the new repayment scheme consists of much higher installments than the old, while the opposite is true for higher starting salaries.[13] The new regime thus reduces the disincentive to work in high-paid jobs, which is typical for income contingent repayment schemes.

[13]Figures 4 and 5 are constructed without the reduced installment possibly allowed twice.

3.2 Immediate Impacts of the 2001 Reform

Did the reform actually have an impact on student choices and outcomes? Figure 6 displays student income, total aid, grant, and loan amounts before and after the reform, while Figure 7 displays student employment and loan take-up rates. All numbers are displayed separately by years since initial college enrollment. Figure 6 shows that student income increases for all enrollment years. In accordance with the study aid scheme: total aid stays roughly constant, while the grant amount increased and the loan amount decreased. Students thus tend to self-finance more of their college education through working and accumulate less debt after the reform. Thus the intensive margins of outcomes seem to have been affected by the reform. Figure 8 reveals that student debt decreased both for dropouts and those who eventually acquired a college degree. This decrease is present already during their first enrollment year. A closer look at student choices reveals that even the extensive margins seem to have changed. Figure 7 shows that more students decide to work after the reform and fewer students take up loans. Student employment tends to increase particularly much during the first college years, while loan take-up tends to decrease most in the first and later college years.

Overall, the major reform of the study aid scheme seems to have increased student employment and income, while is has decreased loan take-up rates and student debt. This is the exogenous variation in the data we exploit in order to identify our model parameters. We now turn to describing the model that will assist us in quantifying and disentangling the channels through which the various components of the reform affected student choices and outcomes.

4 The Model

In this section we set up the dynamic discrete choice model of joint education, employment, and student loan take-up decisions. Choices are made at the individual level, but we suppress individual subscripts throughout this section for the ease of exposition.

4.1 Individual choices

We model choices from time of initial college enrollment to exit. At every point in time students are characterized by initial abilities A, cumulated course credits G_t, highest achieved education E_t, cumulated loan D_t, and cumulated labor market experience H_t. They enter university at $t = 0$, every period they have to choose whether to stay enrolled, $S_t \in \{0, 1\}$, whether to work while studying, $h_t \in \{0, 1\}$, and how much student loan to take up, $d_t \in \{0, \frac{1}{2}, 1\}$. These choices are going to determine next period's cumulated course credits, highest achieved education, cumulated loan, and labor market experience. When they exit college: either drop out or graduate, they work full-time for a wage that depends on their cumulated course credits, level of education, and labor market experience.

Students thus face seven mutually exclusive and exhaustive choices: $(S_t, d_t, h_t) \in \big\{(0,0,1), (1,0,0), (1,\frac{1}{2},0), (1,1,0), (1,0,1), (1,\frac{1}{2},1), (1,1,1)\big\}$. The discrete choices are denoted by $\delta_t \in (\delta_t^0, \delta_t^1, \delta_t^2, \delta_t^3, \delta_t^4, \delta_t^5, \delta_t^6)$ where δ_t^k takes value 1 if the corresponding alternative is chosen and zero otherwise. Students discount the future at rate $\beta \in [0, 1]$, and maximize their future expected utility. They choose $\{\delta_t^*\}_{t=1}^T$, a set of decision rules for every possible realization of the observed and unobserved variables each period, denoted by (X_t, ϵ_t), such that:

$$\delta_t^* = arg \max_k \mathbb{E}\left[\sum_{\tau=t}^{T} \beta^{\tau-t} \sum_{k+0}^{7} \left[\delta_\tau^k U_\tau^k(X_\tau) + \epsilon_\tau\right]\right]. \tag{1}$$

The state variables in $X_t = (A, G_t, D_t, H_t, h_{t-1}, t)$ are also observed by the econometrician, while those in $\epsilon_t = (\epsilon_t^w, \epsilon_t^g, \epsilon_t^0, \epsilon_t^1, \epsilon_t^2, \epsilon_t^3, \epsilon_t^4, \epsilon_t^5, \epsilon_t^6,)$ are observed only by the individuals. The utility of the individual is assumed to be additively separable in X_t and ϵ_t.[14] All stochastic components are revealed after the choices for the period are made, hence students observe the deterministic state variables, form expectations about the stochastic components of the state vector and then make decisions.

[14]This assumption is crucial for the method we apply here. Keane and Wolpin (1994) provide a thorough discussion of this assumption.

By the Bellman principle of optimality, the problem can be rewritten as:

$$V_t(X_t, \epsilon_t) = U_t^k + \beta\,\mathbb{E}\left[V_{t+1}(X_{t+1}, \epsilon_{t+1})\right] \tag{2}$$

and given the discrete nature of the choice, it can also be written as:

$$\begin{aligned} V_t(X_t, \epsilon_t) &= \max_k V_t^k(X_t, \epsilon_t) \\ V_t^k(X_t, \epsilon_t) &= U_t^k + \beta\,\mathbb{E}\left[V_{t+1}(X_{t+1}, \epsilon_{t+1}) \mid X_t, \epsilon_t, \delta_t^k = 1\right] \end{aligned} \tag{3}$$

where $V_t^k(X_t, \epsilon_t)$ denotes the alternative specific value function. The last term is typically refered to as the $\mathbb{E}\max$ as it is the expectation over future optimal values, which makes solution and estimation of the model challenging.

In the following subsections we analyze the details of the specifications of the labor market, the academic environment, and the preferences of the individuals over the feasible college-employment-loan choices.

4.1.1 Academic Environment

Individuals enrolled in a university program full-time complete one year when they produce 60 ECTS. In Sweden two and three years (120-180 ECTS) are the minimum requirements for 2-year college and BA/BSc degrees and additional one or two two years (240-300 ECTS) are necessary for acquiring a 4-year and MA/MSc degree. The highest completed education is thus a function of accumulated course credits:

$$E_t = \begin{cases} 0 & \text{if } G_t < 120 \\ 1 & \text{if } 120 \leq G_t < 240 \\ 2 & \text{if } G_t \geq 240 \end{cases}$$

We denote course credits accumulated from t to $t+1$ by g_t, accumulated credits then follow the law of motion: $G_{t+1} = G_t + S_t g_t$. We allow the accumulation of course credits to depend on initial abilities A measured by whether the student was in the top 10% of the high school cohort GPA distribution. We also allow it to depend on whether the student has already acquired a degree, $E_t = 1$, already accumulated course credits, G_t, whether the student is working while studying, $h_t = 1$, time since initial enrollment, and an idiosyncratic shock, ϵ_t^g. Production of academic course credits is given by:

$$\begin{aligned} g_t^* &= \gamma_1 A + \gamma_2 \mathbf{1}_{\{E_t=1\}} + \gamma_3 G_t + \gamma_4 t + \gamma_5 \mathbf{1}_{\{h_t=1\}} + \epsilon_t^g \\ &= g(X_t) + \epsilon_t^g \end{aligned} \tag{4}$$

where the unobservable term ϵ_t^g is logistically distributed and the probability of producing g_t course credits is thus of ordered logit form. Course credit production is thus probabilistic in the sense that students are not sure of how many courses they will pass during the academic year about to start.

The continuous latent variable g_t^* reflects the academic knowledge acquired during the year, which we measure by the eight discrete values: $g_t \in \{0, 1, 2, 3, 4, 5, 6, 7\}$. This is equivalent to actual ECTS production being $g_t * 10$.

Importantly, we allow students to face uncertainty about how much academic capital they will acquire and also allow it to depend on employment status. Joensen (2013b) shows that the relationship between hours worked and academic achievement is nonlinear: few hours of work have a positive effect on credits production, while working more hours has a detrimental effect. We do not have detailed data on hours worked, but capture the potential effect of working during enrollment on course credit production by γ_5. The dependence on G_t also captures self-productivity of academic skills as reviewed and formulated by Cunha et al. (2006) and Cunha and Heckman (2008).

4.1.2 Labor Market

Every period the individuals receive a wage offer with probability $p_w = 1$. The wage is assumed to depend on the highest acquired degree, E_t, work experience, $H_t = H_{t-1} + h_{t-1}$, whether the individual is a student or not, S_t, and an idiosyncratic labor market productivity shock, ϵ_t^w. Earnings are given by the type equation:[15]

$$\log(Y_t) = \alpha_0 + \alpha_1 \mathbf{1}_{\{E_t=1\}} + \alpha_2 \mathbf{1}_{\{E_t=2\}} + \alpha_3 G_t + \alpha_4 log(H_t) + \alpha_5 \mathbf{1}_{\{h_t=1,S_t=1\}} + \epsilon_t^w \tag{5}$$

The unobservable term ϵ_t^w is normally distributed with mean zero and variance σ_w^2. We are able to separate out the pecuniary importance of degrees and credits by allowing the wage to both depend on highest acquired degree and cumulated course credits during college enrollment. Thus allowing for nonlinearities in the wage return to education - meaning the individuals who have completed a degree receive higher wages than individuals that completed all the course credits necessary to obtain the degree but did not graduate. This is also know as *sheepskin* effects which are not present in our data if $\alpha_1 = \alpha_2 = 0$.[16] Note that this has not been possible in previous paper as Keane and Wolpin (2001) only model 4-year college completion and Johnson (2013) only models 2- and 4-year college completion, thus implicitly assuming that only degrees matter on the labor market. The availability of detailed data on course credits each semester allows us to distinguish between the labor market returns to course credits and degrees.

4.1.3 Preferences

Individuals gain utility from consumption, which is equal to earnings, Y_t, minus the repayment of student loan if the individual is working full time and not enrolled, to the student aid if he is studying and not working and to wage plus student aid if he is working while studying. Hence the budget constraint is:

$$\begin{aligned} C_t =& Y_t + S_t b_t(Y_t, L_t) + S_t \hat{d}_t(Y_t, L_t) d_t \\ &- (1 - S_t) \left(I_t(Y_{t-2}, D_{t-1}) \mathbf{1}_{year \leq 2001} + I_t(D_{t-1}, r) \mathbf{1}_{year \geq 2001} \right) \end{aligned} \tag{6}$$

[15]We also tried estimating standard Mincer type earnings equations with linear quadratic dependence on experience, however, given that we follow most individuals from having no experience through their very early career the $log(H_t)$ specification fits our earnings-experience profiles much better.

[16]See e.g. Heckman et al. (2006) for a thorough review of non-linearities in the return to education and other specification issues of the earnings equation.

where b_t is the student grant amount, $\hat{d}_t$ the potential student loan amount, and I_t the installment of loan repayment. The budget constraint is static in the sense that we do not model savings. Budget constraints are, however, intertemporally linked through student debt accumulation and loan repayment. We model study aid as close as possible to the scheme described in Section 3 conditional on the information we have in the data. Study aid is thus following the function plotted in Figure 2 and Figure 3 subject to the eligibility requirements described in Section 3. The total amount of study aid for which the student is eligible depends on income in the current year, Y_t (if income is higher than a threshold amount the total aid decreases with income) and the limit that the maximum number of total weeks of student aid $\bar{L} = 240$ is not reached.[17] The grant thus follows the rule:[18]

$$b_t(Y_t, L_t) = \bar{b}(Y_t)\mathbf{1}_{\{L_t \leq \bar{L}\}} \tag{7}$$

Where $\bar{b}$ is the share of the maximum base amount (*prisbasbelopp*) that depends on enrollment status and student earnings. When $S_t = 0$ the individual is not enrolled and $b_t = 0$. The loan amount $\hat{d}_t$ depends on the loan take-up choice of the student, student earnings if exceeds the maximum allowable threshold, and the maximum weeks of student aid eligibility have been reached.[19] Debt accumulation thus follows the law of motion:

$$D_{t+1}(X_t) = D_t + d_t(1 - \bar{b}(Y_t, L_t))\mathbf{1}_{\{L_t \leq \bar{L}\}} \tag{8}$$

Note that despite the static budget constraint (6), the current loan amount affects the expected future value through the accumulation of debt to be repaid post college exit.

Utility is assumed linear in consumption.[20] The value of full-time work is thus as

[17]Eligibility also depends also on course credits produced in the prior period, g_{t-1}, in the Swedish study aid scheme. We do not model this aspect here, but plan to include it into the specification of aid in a future version of the paper.

[18]The data reveal that only 2.8 percent of eligible students turn down the grant, hence in the model and estimation we assume that all eligible students receive the grant.

[19]The data only include total student aid received during the year. We assume students will receive the full grant amount before taking up the loan. In order to calculate the loan amount, we thus subtract the grant amount the student is eligible for from the total study aid observed in the data.

[20]This is the most common utility function in the dynamic discrete choice literature, so we adopt it here. Unlike most papers in the literature, however, identification of our parameters does not rely exclusively on the functional form assumed for the utility function. Therefore, we plan to explore other

follows:

$$
\begin{aligned}
U_t^0(X_t, \epsilon_t^0) =& Y_t + \epsilon_t^0 - I_t(Y_{t-2}, D_{t-1})\mathbf{1}_{year \leq 2001} \\
& - I_t(D_{t-1}, r)\mathbf{1}_{year \geq 2001}
\end{aligned} \tag{9}
$$

Once individuals exit university they cannot enroll again, full-time work is thus assumed to be an absorbing state. Note that the utility after university exit is deterministic and depends only on the choices made during university enrollment. This feature will be very important in the solution and estimation of the model, leading to a relatively simple expression for the value of university exit and the $\mathbb{E}\max$ in (3).

The value of college attendance is instead modelled as follows:

$$
\begin{aligned}
U_t^k(X_t, \epsilon_t^k) =& Y_t + b_t(Y_t, L_t) + \hat{d}_t(Y_t, L_t)d_t + n_t + \epsilon_t^k \\
& n_t = \nu_0 + \nu_1 \mathbf{1}_{\{h_t=1\}}\mathbf{1}_{\{h_{t-1}=0\}} + \nu_1^d \mathbf{1}_{\{D_t>0\}} + n_t^h \\
& n_t^h = \nu_1^h A + \nu_2^h t \\
& h = 0, 1.
\end{aligned} \tag{10}
$$

The utility value of college attendance is determined by the wage the students who work and the aid. We also allow it to depend on a psychological cost of learning, that captures both the cost of college attendance per se, and the cost of the effort put in studying, that depends on the abilities of the student. We allow this cost to be dependent on employment status: this measures whether working during college generates a utility loss. We allow the cost of schooling to depend also on how long the student has been enrolled. To capture psychological costs related to cumulate loan we add an indicator for whether the student has positive cumulated loan, and we allow this cost to differ by today's loan status, partial, full time or no loan undertaking. We add alternative specific preference shocks, ϵ_t^k, to capture the fact that new information about alternative specific tastes is revealed to students each period.

utility functions in a future version of this paper.

4.2 Discussion

Our model allows for several channels through which the student aid policy could affect work and study behavior and the take-up of student loans.

First, working increases current consumption through labor income. Therefore students may work in order to relax credit constraints and how much they work depends on the available student aid (lowering the direct university cost) and implicit incentives in the student aid scheme. For example, the study aid scheme works like an earned income tax credit (or income tax) giving students a work disincentive if their income exceeds the maximum threshold. Thus working may also reduce the amount of aid received and hereby reduce current consumption. The aid scheme thus implies that working increases consumption at a rate decreasing in labor income (if labor income exceeded the maximum income threshold).

Second, working may reduce the consumption value of university enrollment if it implies increased effort in learning or if it inhibits participation in study-related activities.

Third, working may reduce the cost of the university-to-work transition by reducing job finding costs or the utility cost of getting a feel of the labor market.

Fourth, working may increase future consumption through higher future wages caused by the accumulated work experience. Since higher (non-graduate) wages increase the opportunity cost of university attendance, this will make students more likely to drop-out of university earlier.

Fifth, working may also lower future consumption through lower future wages to the extent that working is detrimental to course credit production and ultimately graduation. This will make individuals more likely to stay enrolled longer in order to obtain a given degree. Note that individuals therefore both face the trade-off between the time opportunity cost of university enrollment and the future degree premium, as well as the trade-off that working while enrolled may affect both the opportunity cost (through experience) and the degree premium (through graduation probabilities) since being enrolled without graduating is very costly.

All in all, working lowers current opportunity costs, but increases future opportunity costs of education through increased labor market experience. Working can also increase the direct costs by lowering study grants, as well as affect the consumption value and decrease future opportunity costs of enrollment to the extent that there are adverse effects on academic achievement. These effects further depend on the direct effects of student work on wages and grade level transitions. Taking up a student loan is an alternative mean to finance consumption while studying. However, it introduces a trade-off between current and future consumption: the loan needs to be repaid once the student graduates and starts working, lowering future consumption. Student loans may increase the cost of staying enrolled without graduating by further decreasing future income, on the other hand they may decrease the cost of staying enrolled by increasing consumption during school. Different repayment schemes have different incentives attached to them. Income contingent loans may decrease incentives of graduating and taking a productive high-paid job, because lower earnings means a lower repayment rate. Annuity based loans may instead incentivize students to work during enrollment in order to start in the labor market with higher wages, and for the same reason they may increase effort in academic production. The choice of field of graduation may as well be influenced by the repayment scheme, annuity based schemes may in fact drive students to graduate in fields with higher expected wages.

5 Solution and Estimation

5.1 CCP Estimation

Our goal is to estimate the parameters of the law of motions of the course credit production function (γ) and the earnings equation (α), as well as the utility function parameters (ν). We use a maximum-likelihood based estimation procedure. We assume conditional independence of the state variables and the unobservables as in Rust (1987). That is, we assume that, conditional on today's realization of the state X_t and the choice δ_t, next period's realization of the state X_{t+1} is independent of the unobservable shocks ϵ_t. This assumption is adopted in most dynamic discrete choice papers and implies separability between the choice probability and the transition for the observable state in the likelihood function. Denote the individuals observed in our data by $i = 1, \ldots, N$. $\hat{\theta} = \{\nu, \gamma, \alpha\}$ denotes the parameters to be estimated. The likelihood function for every individual can be written as follows:

$$\begin{aligned} L_t(\delta_{it}, X_{nt+1} \mid X_{it}; \theta) &= p_t(\delta_{it} \mid X_{it}; \theta) P(X_{nt+1} \mid X_{it}, \delta_{it}; \theta_2) \\ &= p_t(\delta_{it} \mid X_{it}; \theta) P_t(G_{nt+1} \mid X_{it}, \delta_{it}; \gamma) P_t(W_{it} \mid X_{it}, \delta_{it}; \alpha) \end{aligned} \tag{11}$$

And the estimation problem is thus as follows:

$$\begin{aligned} \hat{\theta} = \ arg \max_{\theta} \sum_{n=1}^{N} \sum_{t=1}^{T} \big(&\ln[p_t(\delta_{it} \mid X_{it}; \theta)] + \ln[P_t(G_{nt+1} \mid X_{it}, \delta_{it}; \gamma)] \\ &+ \ln[P_t(W_{it} \mid X_{it}, \delta_{it}; \alpha)] \big) \end{aligned} \tag{12}$$

Where $p_t(\delta_{it} \mid X_{it}; \theta)$ is the conditional choice probability (CCP) of the choice δ_{it}. The entire set of model parameters enters in the likelihood component specific to the utility and the sets specific to course credit production and wages enter also separately in the likelihood components of the two states.

The separability of the likelihood function allows a sequential maximum likelihood approach. We can then first estimate the wage and the course credit law of motions separately and then use the parameter estimates for $\hat{\gamma}$ and $\hat{\alpha}$ to estimate the conditional choice probabilities.

$$\ell(\theta) = \sum_{n=1}^{N} \left(\ell_n^w(\alpha) + \ell_n^g(\gamma) + \ell_n^k(\theta) \right) \tag{13}$$

Hence, we need to derive and estimate the CCPs. This involves solving the model by backward recursion. Define the ex-ante (integrated) value function as the continuation value for an agent in state X_t just before ϵ_t is revealed. This is the value function before the choice is made:

$$\bar{V}_t(X_t) = \sum_k \mathop{\mathbb{E}}_{\epsilon_t} \mathbf{1}[\delta_t(X_t, \epsilon_t) = \delta^k][U^k(X_t) + \epsilon_t^k + \beta \mathop{\mathbb{E}}_{G_{t+1}} \bar{V}_{t+1}(X_{t+1})] \tag{14}$$

Where the future value of the agent is the future value of the choice k, given the realisation of the shocks and given that choice k is taken. Define then the conditional value function as the present discounted value (net of ϵ_t) of choosing δ^k and behaving optimally from period $t+1$ onwards. This is the value function after the choice is made, conditional on the choice.

$$v_t^k(X_t) \equiv u^k(X_t) + \beta \underset{G_{t+1}}{\mathbb{E}} \bar{V}_{t+1}(X_{t+1}) \tag{15}$$

Hence the choice is defined as follows:

$$\delta_t(X_t, \epsilon_t) = arg \max_k \left\{ v_t^k(X_t) + \epsilon_t^k \right\} \tag{16}$$

The probability of observing the alternative k conditional on X_t is then found integrating out ϵ_t from $\delta_t(X_t, \epsilon_t)$:

$$\begin{aligned} p(\delta^k \mid X_t) &= \underset{\epsilon_t}{\mathbb{E}} \, \mathbf{1}[\delta_t(X_t, \epsilon_t) = \delta^k] \\ &= \underset{\epsilon_t}{\mathbb{E}} \, \mathbf{1}\left[arg \max_k \left(v_t^k(X_t) + \epsilon_t\right) = \delta^k\right] \end{aligned} \tag{17}$$

We assume that the ϵ_t^k's follow a Type I Extreme Value distribution. The assumption of an extreme value distribution for the error term has been introduced in this literature by McFadden et al. (1978). It is computationally convenient as it guarantees closed form expressions for the CCPs and the ex-ante value functions. The CCP's become:

$$p_t(\delta^k \mid X_t) = \frac{exp[v_t^k(X_t)]}{\sum\limits_{k'=0}^{6} exp[v_t^{k'}(X_t)]} \tag{18}$$

The ex-ante value function becomes:

$$\bar{V}_t(X_t) = \ln \left\{ \sum_{k'=0}^{6} exp[v_t^{k'}(X_t)] \right\} + \gamma \tag{19}$$

Where γ is the Euler constant ($\gamma = 0.57722$).

Given the closed form solution of the CCPs we only need to estimate the conditional value functions. Hotz and Miller (1993) show that the conditional value can always be written as a function of current utilities and future CCPs. Generalized extreme value errors, together with the assumptions of (i) structural errors additively separable from the flow payoff, (ii) conditional independence of the state transitions, and (iii) independence of structural errors over time, guarantee that differences in conditional value functions can be expressed as functions of choice probabilities alone.

Divide and multiply the ex-ante value function $\bar{V}_t(X_t)$ in 19 by $exp[v_t^0(X_t)]$, where $k = 0$ is full-time labor market work:[21]

$$
\begin{aligned}
\bar{V}_t(X_t) &= \ln\left(\left\{\frac{\sum_{k'} exp[v_t^{k'}(X_t)]}{exp[v_t^{k^*}(X_t)]}\right\} exp[v_t^{k^*}(X_t)]\right) + \gamma \\
&= \ln\left\{\sum_{k'} exp[v_t^{k'}(X_t) v_t^0(X_t)]\right\} + v_t^0(X_t) + \gamma \\
&= -\ln[p_t(\delta^0 \mid X_t)] + v_t^0(X_t) + \gamma
\end{aligned} \tag{20}
$$

Where $p_t(\delta^0 \mid X_t)$ is the CCP of choosing $k = 0$.

Therefore, the conditional value function becomes:

$$
\begin{aligned}
v_t^k(x_t) &= U^k(X_t) + \beta \mathop{\mathbb{E}}_{G_{t+1}} \bar{V}_{t+1}(X_{t+1}) \\
&= U^k(X_t) + \beta \mathop{\mathbb{E}}_{G_{t+1}} \left(v_{t+1}^0(X_{t+1}) - \ln[p_{t+1}(\delta^0 \mid X_{t+1})]\right) + \beta\gamma
\end{aligned} \tag{21}
$$

Hence, we only need to know the law of motion of the course credits and the conditional value function and CCP of exiting university and entering the labor market full-time. Choosing the absorbing state as the reference choice simplifies the solution as its continuation value is deterministic and does not dependent on possible future choices. This means that the $\mathbb{E}\max$ is particularly easy to compute as we only need to compute the one-period ahead value function for the absorbing state and the CCP of entering it.[22]:

$$
v_t^k(x_t) = u^k(x_t) + \beta \mathop{\mathbb{E}}_{G_{t+1}} \left(v_{t+1}^0(X_{t+1}) - \ln[p_{t+1}(\delta_t^0 = 1 \mid X_{t+1})]\right) + \beta\gamma.
$$

[21] Note that we could have normalized with respect to an arbitrary choice, but choosing the absorbing state is computationally more efficient.

[22] In the terminology of Arcidiacono and Miller (2011), the model is said to exhibit the one period dependence (OPD) property, since the current value function only depends on the one-period ahead value of university exit and the probability of choosing to exit the university and start working full time on the labor market.

5.2 Unobserved Heterogeneity

Individuals enter university with different characteristics that make it unlikely for them to have the same preferences for education, ν_0^m, unobserved abilities with respect to course credit production, γ_0^m, and labor market productivity, α_0^m. Understanding this unobserved heterogeneity also allows us to study which initial traits explain the propensity to drop out or to spend long excess time in college, as well as how they differ from the other individuals and how these characteristics relate to family background. To account for unobserved heterogeneity and dynamic selection and to relax the i.i.d. assumption of the unobservable shocks, we introduce an additional state that is unobserved and persist over time. Following Heckman and Singer (1984), the standard approach in the literature is to treat these initial traits as unmeasured and drawn from a mixture distribution; see e.g. Keane and Wolpin (1997), Eckstein and Wolpin (1999), and Arcidiacono (2004). This way of accounting for unobserved heterogeneity allows for flexible correlation of the errors across the various alternatives as well as correlation over time.

We assume there is a finite mixture of $m = 1, ..., M$ discrete types of individuals who differ in the parameters that describe their preferences, in , their academic ability and motivation, and their labor market ability. Each type comprises a fixed proportion of the population. To reduce the number of parameters and avoid identification issues, we only allow for first-order heterogeneity effects. This approach is common in the literature; see e.g. Eckstein and Wolpin (1999).

We estimate the model with unobserved heterogeneity using the algorithm described in Arcidiacono and Miller (2011). They extend the class of CCP estimators by adapting the application of the EM algorithm to sequential likelihood developed in Arcidiacono and Jones (2003) to CCP estimators developed in Hotz et al. (1994).

The joint likelihood of the choice δ_{it} and the state X_{it}, with the addition of the types m_{it}, becomes a finite mixture of the type-specific likelihood in equation (11):

$$L_t(\delta_{it}, X_{nt+1} \mid X_{it}; \theta) = \sum_{m=1}^{M} \pi(m \mid X_{it}) L_t(\delta_{it}, X_{nt+1} \mid X_{it}, m; \theta) \tag{22}$$

The probability of being in unobserved state m given the state at the first observed time period, X_{n1}, is denote by $\pi(m \mid X_{n1})$. Note that since the state m is here assumed to be time invariant, it is decided from time period 1, but identification relies on all the available information in X_{it}.

The problem is then augmented with the π's.

$$(\hat{\theta}, \hat{\pi}) = arg \max_{\theta,\pi} \sum_{n=1}^{N} \ln \left[\sum_{m=1}^{m} \pi(m \mid X_{it}) \prod_{t=1}^{T} L_t(\delta_{it}, X_{nt+1} \mid X_{it}, m; \theta) \right] \tag{23}$$

The log likelihood is now no longer additively separable, implying that maximization cannot be done sequentially. However, the expectation-maximization (EM) algorithm simplifies this optimization problem substantially by reintroducing additive separability in the log-likelihood functions through an iterative maximization approach. The EM algorithm splits the problem in two stages and yields a solution to the initial maximization upon convergence. It is an iterative process in which the outer loop (expectation step) solves the distribution of m and the πs and the inner loop (maximization step) solves for the parameters, θ. Arcidiacono and Miller (2011) show that the EM algorithm is easily adapted to CCP estimation.

Given values for $\theta^{(n)}$ and $\pi^{(n)}$, the $(n+1)$ iteration of the the EM-CCP algorithm is as follows. In the expectation step, we update the conditional probabilities of individual n being unobserved type m given the data and the model parameters:

$$q^{(n+1)}(m \mid \delta_n, X_n) = \frac{\pi^{(n)}(m \mid X_{it}) \prod_t P_t(X_{nt+1} \mid X_{it}, \delta_{it}, m; \theta_2^{(n)}) p_t(\delta_{it} \mid X_{it}, m)}{\sum_{m'} \pi^{(n)}(m' \mid X_{it}) \prod_t P_t(X_{nt+1} \mid X_{it}, \delta_{it}, m'; \theta_2^{(n)}) p_t(\delta_{it} \mid X_{it}, m')} \tag{24}$$

The conditional probability of being in each unobserved state is linked to the probability of being in state m given the data at the first observed time period (given time invariability). Hence we update the population type probabilities $\pi(m \mid X_{it})$ as:

$$\pi^{(n+1)}(m \mid X_t) = \frac{\sum_n q^{(n+1)}(m \mid \delta_n, X_n t) \mathbf{1}(X_{tn} = X_t)}{\sum_n \mathbf{1}(X_{it} = X_t)}. \tag{25}$$

In the maximization step, we take $q^{(n+1)}(m \mid \delta_n, X_n)$ as given and obtain $\theta^{(n+1)}$:

$$\theta^{(n+1)} = arg\max_{\theta} \sum_{m=1}^{M}\sum_{n=1}^{N}\sum_{t=1}^{T} q^{(n+1)}(m \mid \delta_n, X_n)\left(\ln[L_t(\delta_{it}, X_{it+1} \mid X_{it}, m, p^{(n)}; \theta^{(n)})]\right). \tag{26}$$

When the types are treated as observed, additive separability can be reintroduced, and the maximization step can be divided in two parts: first the law of motions of the states G_t and W_t are estimated given the type distribution estimated in the expectation step. Then we retrieve the parameters of the payoff functions according to the CCP method described in section 5.1.

$$\begin{aligned}\theta^{(n+1)} =& arg\max_{\theta} \sum_{m=1}^{M}\sum_{n=1}^{N}\sum_{t=1}^{T} q^{(n+1)}(m \mid \delta_n, X_n)\ln[p_t(\delta_{it} \mid X_{it}; \theta)] \\ &+ \ln[P(G_{nt+1} \mid X_{it}, \delta_{it}; \gamma)] + \ln[P(W_{it} \mid X_{it}, \delta_{it}; \alpha)].\end{aligned} \tag{27}$$

Finally, we update the CCPs of the choice of exit college - which is the only one we need for the CCP method described in section 5.1 - augmented with the unobserved state m from the likelihood:

$$p_0^{(n+1)}(\delta_t^0 \mid X_t, m) = L_t(\delta_t^0 \mid X_t, m; p^{(n)}, \theta^{(n+1)}). \tag{28}$$

Arcidiacono and Miller (2011) show that this algorithm converges to a fixed point and is computationally feasible for many problems with the finite time dependence property.

5.3 Identification

The endogenous variables in the model include the choices: university enrollment, employment, and student loan take-up, as well as the outcomes: accumulated course credits, labor market experience, and student debt accumulation. Labor market experience and student debt accumulation evolve deterministically conditional on the choices, while course credit production is probabilistic.

We control for endogeneity using all the restrictions implied by our economic model of the entire university enrollment period as a sequence of endogenous choices that drive subsequent outcomes. Importantly, our identification strategy also incorporates exogenous variation stemming from a major change of the study aid scheme. Identification of the course credit production and earnings functions rests on variation in earnings, employment, enrollment, and course credit data.

The problem of identification can be viewed as a sample selection problem, since wages are only observed for individuals who choose to work and course credits are only observed for those who are enrolled. The exclusion restrictions, the functional form, and distributional assumptions embedded in the model serve the same purpose as would a sample selection correction in a two-step or full information estimation procedure. We impose the exclusion restriction that ability only affects course credit production, g_t, and does not directly affect earnings, y_t, other than through accumulated course credits, G_t, and accumulated labor market experience, H_t, which they affect indirectly through affecting course credit production (through γ_1) and the consumption value of university attendance, ν, as well as how this value is affected by student employment, ν^h.

Our approach to incorporate unobserved heterogeneity identifies the type distribution through the principle of revealed preferences: the idea is to allow individuals to differ in permanent ways unobserved to the econometrician and estimate the distribution of types to fit the persistence of choices and outcomes of the individual. If two individuals with identical observable characteristics persistently make different choices and have different outcomes, they are assumed to have different unobservable characteristics. The data could be fit perfectly if the number of types approached the number of observations and were allowed to vary over time, but discipline is imposed by fixing a small number of types and requiring unobserved heterogeneity to be permanent.

The α parameter vector is identified from earnings data and the state variables: accumulated course credits, G_t, highest completed academic degree, E_t, and accumulated labor market experience, H_t. Unobserved heterogeneity, α_{0m}, is identified by cross-sectional variation in wages conditional on these state variables at each t.

The γ parameter vector is identified from course credit data and the state variables: ability, A, accumulated course credits, G_t, and employment status, h_t, and the unobserved heterogeneity parameters, γ_{0m}, are identified by cross-sectional variation in acquired course credits conditional on these state variables. The remaining utility function parameters in the ν vector are identified based on the principle of revealed preferences. If the model were static, then identification of the utility function parameters would come from observing their college-work choices and outcomes. The dynamic optimization problem resembles a static multinomial logit model with the future component of the value function treated as a known quantity based on the estimated earnings parameter vector, α, and the course credit production parameter vector, γ, that controls the expectation of next period's state variable for a given discount factor, and the CCPs that are treated as nuisance parameters.

Finally, identification of the study aid effect on college-work choices incorporates exogenous variation stemming from the major changes made to the Swedish study aid scheme in 2001. These changes are detailed in Section 2.1 and their immediate impacts shown in Section 2.2.

6 The Data

We use register based individual panel data of the Swedish population. The data is hosted by the Institute for Evaluation of Labour Market and Education Policy (IFAU). The dataset contains the cohorts of high school graduates that enrolled in higher education in the years 1995-2003. We have complete educational event histories for this population; including 9th grade and high school GPA and course choices. For every college enrollment spell we observe the duration, level and field of study, and targeted and actually acquired course credits (ECTS) every semester - both in the program they are enrollment in and their additional courses.[23] We also have study aid accumulated each year. Labor market histories include employment status and yearly earnings. Finally, we observe a range of demographic characteristics and background variables. We measure parental and family background variables in the year before college enrollment. We ob-

[23]Students are allowed to attend courses outside the educational program they are enrolled in and gain credits that can be merited valid towards their degree.

serve parental yearly income, field and level of education, employment and civil status. We also have information on number of siblings, birth order, and the age distribution of siblings - both registered with the same mother and with the same father.

We select a sample of high school graduates who enroll in college in 1995-2003 and are younger than 23 years ultimo their initial enrollment year.[24]

Descriptives are shown in Table 1. Individuals are around 20 years old when at initial college enrollment and 54% are females. College dropout rates are 24%, while graduate with a.[25] Fewer females drop out (40%) and more females get a shorter college degree (69%). The approximately two thirds of high school graduates enrolling in college have a higher than average GPA of 3.42 (on a 1-5 scale), half of them are in the top quartile, and 22% of them are in the top decile of their respective high school cohorts. Dropouts and those with a 2-year college or BA/BSc degree do not significantly different, but those with a 4-year college or MA/MSc degree are even more positively selected on GPA. 41% of students are employed and those graduating with a shorter college degree tend to be employed more (48%) and those graduating with a longer degree employed less (38%) during their studies. Students accumulate around two thirds of mandates course credits each enrollment year and those eventually acquiring a longer college degree also tend to be more productive at accumulating course credits in each enrollment year. Dropouts only produce 31 ECTS on average per enrollment year, while those graduating with a shorter (longer) degree produce 39 (44) ECTS. Students tend to accumulated more than the required course credits at university exit. This could reflect switching between fields, a high consumption value of university attendance, or simply a high return to course taking. Those with longer degrees also accumulate more student debt, while dropouts actually have accumulated more debt than those with a shorter college degree at university exit. There only seems to be a substantial degree premium to acquiring a longer college degree,

[24]Out of 1,045,455 students who graduate from high school between 1990 and 2002, 670,613 (64%) enroll in college. Of these, 299,968 individuals enroll between 1995 and 2002, and 204,738 are 22 years old or younger at initial enrollment. We drop other two individuals who start college having already obtained a college degree. Our estimation sample thus comprises 204,736 individuals and 2,280,130 yearly observations of their choices and outcomes from initial enrollment until ultimo 2009.

[25]The 7% with right censored college enrollment spells because they are still enrolled at the end of our sample period are not included in the last three columns of Table 1.

Table 1: Descriptives

Individual Characteristics	All	Dropouts	2-year degree BA/BSc	4-year degree MA/MSc
At University Entry				
Age	20.37	20.30	20.44	20.22
	(1.04)	(1.06)	(1.05)	(1.00)
Female	0.54	0.40	0.69	0.52
Employed	0.27	0.28	0.32	0.24
High school GPA ($\geq P75$)	0.49	0.34	0.40	0.66
High school GPA ($\geq P90$)	0.22	0.12	0.12	0.36
High school GPA	3.42	3.25	3.31	3.60
	(0.57)	(0.57)	(0.54)	(0.53)
During enrollment				
Employed	0.41	0.41	0.48	0.38
Course Credits (per year)	39.00	31.04	38.99	43.61
	(23.60)	(22.25)	(23.10)	(23.45)
Loan (per year)	23,789	22,590	22,922	24,948
	(21,508)	(21,148)	(21,198)	(21,827)
At University Exit				
Total Course Credits	234.38	174.80	208.85	296.81
	(88.63)	(97.84)	(97.91)	(46.78)
Debt	147,884	130,425	126,262	175,560
	(86,197)	(87,894)	(70,085)	(87,083)
Work Experience (years)	2.58	2.22	2.32	2.14
	(1.99)	(2.30)	(1.83)	(1.79)
After University Exit				
Employed	0.93	0.88	0.95	0.94
Yearly Earnings	232,144	212,682	207,597	269,232
	(137,102)	(137,642)	(110,850)	(149,795)
N individuals	204,736	49,341	57,132	82,902
Fraction of Sample		0.24	0.28	0.41

Sample averages, standard deviations in parenthesis. One year of full-time studies corresponds to 60 ECTS. All amounts are in real SEK 2000. The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

but not to a shorter degree. There does, however, seem to be a benefit in terms of a higher employment probability after university exit as 95% of those with a college degree are employed and only 88% of dropouts.

The period by period choice transitions are displayed in Table 2 which reveals a lot of persistence in most choices. Our absorbing state assumption is reasonable, since 92% of those not enrolled in college and working full-time at $t-1$ are also doing so at t. Though we observe transitions between all the feasible choices, which is important for identification of the model parameters. The only two choices that are not persistent are those involving the partial loan; $k \in 3, 6$. Individuals are very likely to transition from first taking up a partial and then a full student loan. This could indicate that students are debt averse and the partial loan option is a stepping stone for them to eventually taking up a full student loan. This is consistent with Stinebrickner and Stinebrickner (2008) who take a direct approach of assessing borrowing constraints for low-income students at Berea college. Their survey data reveals that the vast majority of students would not take up a loan if offered to them at the market interest rate. Stinebrickner and Stinebrickner (2008) conclude that borrowing constraints are likely only an important reason for dropping out for some students, but not for the vast majority - even if among the half of students dropping out, two thirds cite the lack of money being part of the reason. Johnson (2013) also finds that students are reluctant to borrow. Our model incorporates two possible factors underlying this observation: Uncertainty about graduation and being able to comfortably pay back the loan, as well as a utility cost of having debt (loan aversion).

Table 2: Choice transition.

	k_t						
k_{t-1}	0	1	2	3	4	5	6
0	91.61	0.94	0.50	0.17	5.58	1.15	0.06
1	14.90	43.51	12.52	9.31	8.77	9.46	1.54
2	4.11	6.86	53.03	5.91	6.26	22.58	1.24
3	7.01	13.73	46.42	12.91	5.53	13.09	1.32
4	54.79	4.48	2.88	1.20	29.10	6.87	0.68
5	27.42	3.56	16.97	2.13	14.67	33.98	1.27
6	16.92	9.76	24.58	6.01	11.85	28.26	2.62

Figure 9 shows college-to-work transitions by employment and loan status. These are the seven discrete choices $k \in 0, ..., 6$ we model. The figure reveals how students gradually flow from college enrollment to working full time on the labor market (k=0). 60% have entered the labor market full-time after six years and almost 90% ten years after initial enrollment. The most common choice during the first college years is to study without working and taking up the full student loan (k=2). This choice becomes less popular with time since enrollment, while being a working student and taking up the full loan (k=5) becomes increasing popular and is the most common choice in the fifth enrollment year. Most students thus take up the full loan during their eligibility period - initially 50% not working and 17% working.[26] Conforming with eligibility requirements, loan take-up rates fall sharply after six years after initial enrollment when being a working student with no loan (k=4) becomes the most common choice.

Figure 10 shows course credit production over time for the model choices. Students who do not work and take up the full loan persistently produce most course credits (around 50 ECTS per year) followed by students working and taking up the full loan. This can indicate that students with higher ability expect a high wage and borrow more because they expect being able to repay their students debt swiftly after graduation. This mechanism should be more important after the reform and the switch from the income contingent to the annuity based repayment scheme. Whether this is the case will be quantified in our cost neutral policy simulations. Figure 10 also reveals that working students produce fewer course credits conditional on loan take-up choice. Lastly, the decreasing production of course credits over time since enrollment - especially the steep decline around normal graduation years - indicates the importance of accounting for dynamic selection when estimating the model, since students who are more productive will graduate faster.

7 Estimation Results

The parameter estimates are presented in Table 3. The earnings equation parameters, α, reveal that while there is a positive Master's degree (4 or 5 year degrees) earnings premium, there is actually a negative Bachelor's degree (2 or 3 years degrees) earnings premium. This surprising effect can be due to signalling low academic ability in the labor market if the shorter degrees are the backup option of college students who find out

[26]This change is not driven by partial enrollment, which we do not model. Partial enrollment is in principle an option, but according to the data not a popular one among Swedish students. Part time enrollment increases slightly with time since initial enrollment, but never exceeds 1% of the student population.

they are not academically skilled. There is a large positive effect of accumulated course credits on earnings. This indicates that knowledge accumulation through course taking is important. Including this course credit effect, however, Master's earn 49 log points more and Bachelor's earn 14 log points more than college dropouts. Students working earn significantly lower wages than full-time workers. This effect in part captures the lack of hours worked information in the data, hence the likely fact that students work fewer hours. The parameter estimates are not substantially different when including unobserved heterogeneity through $M = 3$ types: the Master's degree premium increases, the Bachelor's degree penalty becomes smaller, and the return to experience slightly lowers. In terms of earnings ability, type 3 has the highest and type 2 has the lowest labor market productivity.

Turning to the course credit production function, we see that our measure of ability has a positive effect on ECTS production. Having already acquired a Bachelor's degree has a negative effect, which probably reflects that courses at the Master level are more challenging on average and students progress more slowly. The positive effect of cumulated course credits captures the self-productivity of academic skills, as already accumulated academic knowledge enhances future academic learning. Working while studying has a negative effect on course credit production. Including unobserved heterogeneity does not affect these qualitative conclusions. Type 1 has highest academic ability, while type 3 has lowest academic ability.

Finally, from the utility function parameters we learn that there is a positive cost of entering the labor market, ν_1, for students. Time since initial enrollment has a negative effect on utility, indicating that the psychological cost of studying increases with time spent in college. This is capturing both the fact that courses can become increasingly challenging towards the end of a degree (both because of the curricula or because the student leave the most difficult exams last), the fact that the more time passes the higher is the graduation pressure, and it becomes increasingly likely that ones' peers have already graduated or dropped out and campus networks are evaporating. Ability has a positive effect on utility for full time students who do not work, and a small negative effect for

Table 3: Estimates of Model Parameters

	One type (M=1)		Three types (M=3)	
		w_t		
α_0	10.702	(.0023)	-	-
α_0^1	-	-	10.999	(.0045)
α_0^2	-	-	10.523	(.0023)
α_0^3	-	-	11.100	(.0026)
(Bachelor degree) α_1	-.056	(.0022)	-.047	(.0021)
(Master degree) α_2	.027	(.0025)	.0679	(.0025)
(Course Credits) α_3	.033	(.0001)	.037	(.0001)
(log(Experience)) α_4	.482	(.0011)	.459	(.0011)
(Student employed) α_5	-.687	(.0019)	-.658	(.0019)
		g^*		
γ_0^2	-	-	-.0712	(.0008)
γ_0^3	-	-	-.0834	(.0008)
(High school GPA$\geq$ P90) γ_1	.209	(.0037)	.148	(.0033)
(Bachelor degree) γ_2	-.815	(.0080)	-1.187	(.0058)
(Course credits (acc)) γ_3	.051	(.0003)	.069	(.0003)
(Time since enrollment) γ_4	-.229	(.0012)	-.520	(.0010)
(Employment status) γ_5	-.867	(.0035)	-1.286	(.0032)
		$P(d_t^k = 1)$		
ν_0	.126	(.0117)	-	-
ν_0^1	-	-	-.1681	(.0074)
ν_0^2	-	-	-.3705	(.0074)
ν_0^3	-	-	-.110	(.0074)
($h_t = 1$ & $h_{t-1} = 0$) ν_1	.636	(.0058)	-.113	(.0039)
(Accumulated Loan) $\nu^{k=1,4}$	.278	(.0117)	.006	(.0071)
(Accumulated Loan) $\nu^{k=2,5}$	.981	(.0117)	.710	(.0071)
(Accumulated Loan) $\nu^{k=3,6}$	-.591	(.0119)	-.862	(.0072)
(Time since enrollment) $\nu_1^{k=1,2,3}$	-.499	(.0008)	-.414	(.0005)
(Time since enrollment) $\nu_1^{k=4,5,6}$	-.417	(.0008)	-.334	(.0005)
(High school GPA$\geq$ P90) $\nu_2^{k=1,2,3}$	.749	(.0050)	.732	(.0005)
(High school GPA$\geq$ P90) $\nu_2^{k=4,5,6}$	-.022	(.0050)	-.034	(.0030)
π_1	-		.030	
π_2	-		.791	
π_3	-		.179	
Log Likelihood	-7774759		-1.49e^{+7}	

Standard errors in parenthesis. All parameters are significant at a 1% level of significance.

working students. This suggests that working takes away more of the enjoyable study time for high ability students. The effect of the stock of cumulated debt is separated by loan choice: those who today take no or full loan derive positive utility from the pre-existing stock, while students who decide to take a partial student loan are affected negatively by the stock of debt. One possible interpretation can be that students who take the full loan are not worried about repaying it, and enjoy the financial freedom that it gives, while students who take partial loan are worried about repaying it but need to borrow the money anyway. This is in line with the descriptives indicating that the partial loan option is not as persistent as the other options and a common first step to taking up the full loan. Again, accounting for unobserved heterogeneity does not change these conclusions. Type 2 dislikes studying the most and type 3 derives most utility from studying relative to working - even if having highest labor market ability and lowest academic ability.

7.1 Model Fit

This section assess model fit in order to increase the credibility of our policy simulations. First, we assess how well the model fits the key aspects of our data described in Section 6. Second, we assess whether our model also fits well out of sample. This is done by looking at two important dimensions of heterogeneity in choices and outcomes that we do not explicitly model: college field and parental background.

Table 7 in Appendix B presents actual and predicted choices and outcomes. Looking at academic achievement, our model perfectly predicts the probabilities of producing each feasible amount of course credits. However, we slightly underpredict productivity for students taking up the full loan and slightly overpredict productivity of students making the other choices. Our model does not capture the fact that those taking up the full loan perform better than those taking up the partial loan, but it does capture the other patterns - including that students who work produce fewer credits. The model slightly overpredicts accumulated course credits and overpredicts graduation rates by a large margin. Accumulated debt at university exit is predicted quite accurately, while earnings are overpredictd at all levels of education. Overall the model fits the fractions making each choice and their rankings quite well, but does not predict other time patterns as well. Slightly more (fewer) students are predicted to work (not work). There is a slight underprediction of the no work and full loan choice (k=2) in earlier time periods

($t = 1, ..., 4$) and a slight overprediction in later enrollment years ($t > 5$). The reverse is true for the work and no loan (k=4) and work and full loan (k=5) options. To get all the time transitions between choices right we thus need to incorporate a more flexible dependence on time. It is noteworthy that our model predicts the timing of university exit very accurately. This is pivotal as the timing of university exit is a margin of key policy interest. In the simulations in Section 8 we quantify how study aid policies affect the timing of both dropout and graduation.

Note that we here assess model fit of the most parsimonious one type model. There are several obvious ways we could improve model fit: First, we are estimating models with unobserved heterogeneity. Second, we are incorporating differences in initial skills proxied by level of mathematics from high school. This will likely introduce heterogenity making the model better able to fit some of the magnitudes of effects and differences in profiles.[27] Third, we are getting more detailed data on employment in each month. This will also allow us to use the course credit data on the semester level, whereas we now need to aggregate to yearly observations as employment information is only available for November each year. This will further allow us to distinguish between the effects of working during the semester and working during the summer break.

Tables 11 and 13 reveal that dropout rates, timing of graduation, and wages differ substantially across college fields. We aggregate into six broad fields of education. Ranked from highest to lowest paying fields: (i) Technical Sciences, Engineering; (ii) Social Sciences, Law, Business, Services; (iii) Math, Natural, Life and Computer Sciences; (iv) Health Sciences, Health and Social Care; (v) Humanities and Arts; (vi) Education. 4-year college and MA/MSc graduation rates are clearly highest for the three highest paying fields (44-48%). Two fields stand out with high 2-year-college and BA/BSc graduation rates: Health Sciences, Health and Social Care (55%) and Education (50%). The highest dropout rates are in Humanities and Arts (51%) and the lowest in Health Sciences, Health and Social Care (12%). Study effectiveness seems to be highest in Social Sciences, Law, Business, Services - despite the high MA/MSc graduation rates, individ-

[27] Joensen and Nielsen (2009) and Joensen and Nielsen (2013) document a large causal effect of advanced high school math courses on academic achievement and earnings.

uals initially starting in this field transition to full-time labor market work faster and 87% are working full-time 10 years after enrolling. Study effectiveness seems to be lowest in Humanities and Arts, where only 77% are working full-time 10 years after enrolling. Overall, our model captures these differences quite well and the prediction errors mirror the ones we already laid out above. Not surprisingly, our model does not yet have sufficient individual heterogeneity to capture the large magnitudes of some of the differences by field of education - particularly with respect to highest acquired degree.

Finally, Tables 17 and 19 show differences across parental income and education. Tables 17 shows that both course credit production and earnings are generally increasing in both maternal and paternal education. Dropout rates are quite similar (35-36% if parents have no more than high school education and 30% if parents have postgraduate education), while MA/MSc graduation rates are strongly increasing with parental education (31-32% if no more than high school education, 37-39% if 2-year or some college education, 44-45% if at least a BA/BSc degree, and 56-59% if postgraduate). Children whose parents have a postgraduate education are more likely to be enrolled and more likely to be a student not working and not taking up the loan (k=1). Distinguishing between mother's and father's education does not seem crucial for choices and outcomes, as they are remarkably similar for the same level of parental education. All these patters are captured by the model. Tables 23 and 25 presents differences between individuals whose parents are in the bottom and top decile of the income distribution in the year before college enrollment. All numbers are shown separately by mother's, father's and total household income. The differences by parental income are not as stark as the differences by parental education. Course credit production is only weakly increasing in parental income. Dropout rates are similar, but MA/MSc graduation rates are much higher for children of high income parents (48-51% compared to 32-34% for low income). Children of high income parents are more likely to take up the full loan (k=2 and k=5). Again, all these differences are captured by our model - with the same misfits on some of the magnitudes as for the overall model fit.

On the one hand, we want as parsimonious a model as possible to avoid the curse of dimensionality and enable solution of the stochastic dynamic programming problem for the policy simulations. On the other hand, we want a rich enough model to capture the relevant margins of behavior that are affected by the student aid policies. Having assessed model fit along important dimensions of heterogeneity that our model is not tailored to fit, gives us more confidence in making more precise ex-ante policy predictions.

7.2 Initial Conditions and Heterogeneity

We will further explore how unobserved heterogeneity relates to other individual initial conditions, not incorporated into the model and estimation, but observed in the data. Individuals in our model are heterogeneous along three dimensions when they first enroll in college: high school GPA, employment experience, and their type. The type embodies unobserved genetic differences and early childhood investments. Parental and family background could thus be related to initial conditions through both nature and nurture; i.e. both through intergenerational genetic correlations, the upbringing environment, intellectual and monetary resources for earlier investments in child and youth human capital.[28]

How does the unobserved type interact with parental background in predicting academic outcomes?[29] First, we will analyze if the types have different parental and family background in the year prior to initial college enrollment and the interrelation between initial conditions. Second, we will study how parental and family background are correlated with all educational achievement measures, as well as debt accumulation. Table 29 shows significant correlations between background characteristics and academic outcomes: dropout and graduation rates, timing of university exit for dropouts and graduates, as well as cumulated debt at university exit for both dropouts and graduates. Parental

[28]The dynamic effects of parental influences on skill formation have been well documented in a large literature growing out of Todd and Wolpin (2003), Cunha and Heckman (2007), Cunha and Heckman (2008), Cunha et al. (2010). The extensive literature on intergenerational mobility, reviewed in Black and Devereux (2011), is also lately focusing on the causes of intergenerational mobility, and on the various channels underlying the correlation of parental and child outcomes: these channels can be genetic, suggesting a limited role for policy, or due to parental education and income (e.g. through investment in education and social networks), that instead leave room for education policies among others.

[29]We will extend the analysis to better answer this question in the model with initial skill heterogeneity and M types.

and family background are thus strong predictors of academic success. Next, we will analyze how sensitive these correlations are to controlling for type probabilities, since types may embody some of the same predictive power as parental and family background - through genes, childhood and youth social environmental, as well as intellectual and financial investments in abilities and skills. This relationship has been tested extensively, but how much is nature and how much is nurture is still an open and much debated question. Some papers do not find significant effects of parental income once controlling for ability; see e.g. Carneiro and Heckman (2002) and Johnson (2013). However, recently Belley and Lochner (2007) have challenged this result showing significant correlations - even after controlling for ability. They attribute this reversal to increased tuition costs leading college success to depend more strongly on parental income to finance tuition costs. Reassessing this issue with more comprehensive data and better methods allows us to relate this puzzle directly to study aid policies.

8 Policy Simulations

We perform three sets of policy simulations: First, we separately assess the impacts of changing means testing of study aid and time eligibility requirements. Second, we examine the impacts of changing the mix of loans and grants in study aid packages. Finally, we simulate how changing the loan repayment schemes would affect student behavior, academic success, and debt accumulation.

Given the state $X_t = (G_t, A, h_{t-1}, D_t, H_t, t)$, we solve the model for a state grid with $N_{grid} = 32 \times 2 \times 2 \times 45 \times 21 \times 10 = 1,209,600$ grid-points. We allow the grids for cumulated course credits and experience to comprise all possible states while we simplify the cumulated loan grid to take values between zero and the maximum available cumulated loan amount with linear steps equal to a quarter of the maximum loan amount available per year. First, we solve for the probabilities of achieving $g_t = 0, \ldots, 7$ course credits every year conditional on the choices $k = 0, \ldots, 6$. Second, we use course credit production probabilities and the parameter estimates to calculate the value functions for every choice, k. Third, we use the choice-specific value functions to calculate the CCPs of choosing $k = 0, \ldots, 6$. Finally, we simulate different sets of policies in the following way: we start with a cohort of students at $t = 1$ with zero cumulated course credits, $G_0 = 0$, zero cumulated student loan, $D_0 = 0$, but different initial abilities, $A_0 \in 0, 1$, and work experience, $H_0 \in 0, 1, 2$. Initial conditions are thus distributed to mirror our sample. We then simulate the choices and state progression of this cohort using the course credit production probabilities and CCPs for each study aid policy.

Tables 4, 5, and 6 show the simulated impacts of the study aid policies. The first column in each table shows the benchmark outcomes, choices, and policy parameters.

Table 4 shows the effects of changing time eligibility requirements and restrictiveness of means testing. The first two simulations change the time eligibility requirements by one year, such that in (Sim1) students are eligible for 5 years of aid and in (Sim2) they are eligible for 7 years. Dropout rates increase by 1.5 (decrease by 0.6) percentage points when the eligibility period is decreased (increased) by one year. This asymmetry in effects would be interesting to explore further, and is probably reflecting students with bad graduation and labor market prospects staying enrolled if they can receive student aid for longer - this is corroborated by the timing of dropping out being very close to the 5 year eligibility limit. Reversely, graduation rates decrease by 1.7 (increase by 1.5) percentage points when the eligibility period is decreased (increased) by one year. Decreasing the time eligibility to 5 years increases the time to graduation by a full semester, while increasing it to 7 years decreases time to graduation by almost a semester. This last result is surprising, and could be due to the fact that students are working more when receiving aid for a shorter time period and not taking up the loan to the same extent. We plan to explore these underlying mechanisms further in the future.

The last three simulations in Table 4 reveal the effects of changing the means testing which directly changes the work disincentive in the study aid scheme. (Sim3) increases the work disincentive by reducing the threshold from 0.75 to 0.50 of the base year amount, while (Sim4) reduces the work disincentive by increasing the threshold for allowable earnings from 0.75 to 1. Dropout rates increase by 1.9 (decrease by 0.9) percentage points when lowering (increasing) the threshold. Timing of university exit is not affected much by means testing. It seems immediately puzzling that fewer students become employed when the work is made less attractive, but the means testing does not have any effect on the extensive margin of student labor supply. The simulations also reveal that students are just taking the cut in the aid, work more (or at higher wages) and accumulating less debt.[30] (Sim5) changes the means testing of the benchmark to the post-reform one, i.e. allowing students to earn almost double what they earned before (the reform switched the threshold from 0.75 to 1.25 of the base year amount). As a consequence, students work more, and accumulate more debt. Dropout rates are lowered by 1.2 percentage points while graduation rates also are slightly lowered by 0.4 percentage points.

Table 5 first shows the impacts of implementing all the 2001 reform changes, which align up well with the variation presented in Section 3. Then simulations from policies only changing the mix of grant and loan amounts in study aid are shown. (Sim6) increases the weight put on loans by almost 15 percentage points, such that 15% of aid is grant and 85% is loan. (Sim7) decreases the weight put on loans by 15 percentage points relative to the post reform, such that grants and loans have equal weight in the total aid amount. There are no significant impacts on dropout and graduation by changing the weights of grants and loans in this range. The only substantial impact is on student debt accumulation, where students cumulate over SEK100,000 more debt when there is a 35 percentage point higher weight on the loan. Hence, whether the weight on loans is in the range of 50-85% does not matter for student choices and outcomes - other than student debt. This is interesting from a policy makers perspective, since they can decide whether to privately (by the individual student) or publicly (by the government) fund college education - without altering educational outcomes. If even less weight is put on the loan, however, this is not true anymore. (Sim8) reveals the impacts of reversing the weights put on grants and loans relative to the benchmark, such that only 25% is loan. This implies that dropout rates decrease by 1.3 percentage points, but the time that dropouts are enrolled is also slightly increased. Graduation rates increase by 1.4 percentage points

[30]We are currently purchasing data on employment by month which should allow us to explore these effects in more detail.

and times to graduation by almost a semester. Cumulated student debt now becomes only a third of the benchmark. Hence when only 25% of aid is in the form of a loan there is a social trade-off as the substantially improved educational outcomes are considered socially desirable, but most of the cost is also born publicly. What is socially optimal requires quantification of these social welfare costs and benefits.[31]

Finally, Table 6 shows the results of changing the repayment scheme for the loan. (Sim9) increases the repayment from 4% to 5% of income, (Sim10) implements the reform mix repayment scheme implemented with the 2001 reform, 25 years-annuity with the possibility of switching to an income contingent repayment of 5% of income, and then going back to a new 25 years-annuity calculated on the remaining debt. Finally, (Sim11) implements a scheme only with the 25-years annuity. We find that increasing the income contingent repayment rate by one percentage point has small effects overall: decreasing the student debt by a mere SEK1,000 and increasing the time to master graduation by a month and a half. Implementing the annuity schemes has, however, a larger impact: student debt at exit decreases by around SEK10,000, the dropout (graduation) rate increases by 2.1 (0.5) percentage points, while the timing of dropout (graduation) decreases by a month. Fewer people take the full loan in favour of no loan. The three schemes do not significantly change the repayment installments with respect to the benchmark, as shown in Section 3, for the average earner. However, students expecting lower income (e.g. college dropouts) will face higher repayment rates and will be pushed to dropout earlier and with less debt.[32]

Overall, the policy simulations show many asymmetries and non-linearities where increasing or decreasing the same policy instrument in isolation has very different effects on student choices and outcomes. Detecting and quantifying these differences would not be possible without detailed panel data and a carefully specified and estimated dynamic model.

[31]These normative assessments are beyond the scope of this paper, but would be interesting to explore in a future extension.

[32]Exploring how much these underlying mechanisms are driving the policy responses is high on our research agenda.

Table 4: Policy Simulations, Time Eligibility and Means Testing.

		Time Eligibility		Means		
	Benchmark	**(Sim1)**	**(Sim2)**	**(Sim3)**	**(Sim4)**	**(Sim5)**
Academic outcome:						
Dropout rate	0.306	0.319	0.300	0.325	0.297	0.294
MA/MSc	0.247	0.23	0.262	0.254	0.244	0.243
Time of dropout	4.934	4.899	4.947	4.756	5.001	5.021
Time of MA/MSc	6.104	6.796	5.652	6.103	6.078	6.061
Debt at exit:	180,308	168,461	185,436	150,554	193,375	198,353
Choices:						
Employed	0.639	0.648	0.634	0.602	0.567	0.663
Full Loan	0.800	0.793	0.803	0.783	0.806	0.809
Partial Loan	0.098	0.1	0.096	0.116	0.097	0.096
Aid over Choice:						
k=1	16,987	15,408	17,647	17,115	16,911	16,879
k=2	62,822	60,003	63,901	62,985	62,699	62,645
k=3	40,631	39,854	40,945	40,666	40,603	40,592
k=4	13,605	12,649	13,912	9,133	15,456	16,071
k=5	53,768	52,110	54,183	40,200	58,993	60,834
k=6	38,726	38,334	38,831	34,128	39,948	40,284
Average Aid amount	51,059	48,950	51,770	43,958	54,032	55,115
Aid amounts:						
grant	17,856	17,856	17856	17,856	17,856	17,856
total	64,232	64,232	64232	64,232	64,232	64,232
Time Eligible:						
t=6	+			+	+	+
t=5		+				
t=7			+			
Means Testing:						
0.50*prisbasbelopp				+		
0.75*prisbasbelopp	+	+	+			
1.00*prisbasbelopp					+	
1.25*prisbasbelopp						+
Grant-Loan Mix:						
28% grant, 72% loan	+	+	+	+	+	+
Loan Repayment:						
income contingent	0.04	0.04	0.04	0.04	0.04	0.04

The Table displays policy simulations of the effects on student choices and outcomes of changing time eligibility and means testing. All amounts are in real SEK 2000. The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

Table 5: Policy Simulations, Grant-Loan Mix.

			Grant-Loan Mix		
	Benchmark	**Post-reform**	**(Sim6)**	**(Sim7)**	**(Sim8)**
Academic outcome:					
Dropout rate	0.306	0.315	0.306	0.306	0.293
MA/MSc	0.247	0.252	0.247	0.248	0.261
Time of dropout	4.934	4.89	4.931	4.929	5.008
Time of MA/MSc	6.104	6.113	6.122	6,087	5.618
Debt at exit:	180,308	168,788	215,711	120,617	58,566
Student choices:					
Employed	0.639	0.661	0.639	0.639	0.635
Full Loan	0.800	0.764	0.816	0.769	0.732
Partial Loan	0.098	0,107	0.091	0.106	0.114
Aid over Choice:					
k=1	16,987	21,117	9,098	30,880	46,561
k=2	62,822	62,290	62,851	62,758	62,531
k=3	40,631	42,708	36,541	47,731	55,685
k=4	13,605	20,246	7,177	25,317	38,941
k=5	53,768	60,285	53,890	53,516	52,825
k=6	38,726	42,388	34,804	45,528	53,151
Average Aid amount	51,059	53,805	50,682	52,076	53,891
Aid amounts:					
grant	17,856	22,160	9,635	32,116	48,174
total	64,232	64,232	64,232	64,232	64,232
Time Eligible:					
t=6	+	+	+	+	+
Means Testing:					
0.75*prisbasbelopp	+		+	+	+
1.25*prisbasbelopp		+			
Grant-Loan Mix:					
15% grant, 85% loan			+		
28% grant, 72% loan	+				
35% grant, 65% loan		+			
50% grant, 50% loan				+	
75% grant, 25% loan					+
Loan Repayment:					
income contingent	+	-	+	+	+
mixed	-	+			

The Table displays policy simulations of the effects on student choices and outcomes of changing the relative weight on grants and loans in study aid packages. All amounts are in real SEK 2000. The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

Table 6: Policy Simulations, Loan Repayment Schemes.

		Loan Repayment		
	Benchmark	**(Sim9)**	**(Sim10)**	**(Sim11)**
Academic outcome:				
Dropout rate	0.306	0.309	0.327	0.325
Graduating with Master	0.247	0.244	0.254	0.252
Time of dropout	4.934	4.910	4.818	4.832
Time of Master graduation	6.104	6.229	6.198	6.215
Accumulated debt at exit:				
Cumulated loan	180,308	179,327	170,494	171,724
Choices:				
Employed	0.639	0.640	0.643	0.642
Full Loan	0.800	0.799	0.765	0.770
Partial Loan	0.098	0.103	0.107	0.106
Aid over Choice:				
k=1	16,987	17,019	17,049	17,046
k=2	62,822	62,852	62,465	62,526
k=3	40,631	40,641	40,602	40,609
k=4	13,605	13,644	13,946	13,926
k=5	53,768	53,856	52,994	53,144
k=6	38,726	38,717	38,724	38,743
Average Aid amount	51,059	51,048	49,332	49,598
Aid amounts:				
grant	17,856	17,856	17,856	17,856
total	64,232	64,232	64,232	64,232
Time Eligible:				
t=6	+	+	+	+
Means Testing:				
0.75*prisbasbelopp	+	+	+	+
Grant-Loan Mix:				
28% grant, 72% loan	+	+	+	+
Loan Repayment:				
income contingent	4%	5%		
mix (reform)			+	
annuity				+

The Table displays policy simulations of the effects on student choices and outcomes of changing loan repayment schemes. All amounts are in real SEK 2000. The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

9 Conclusions

The design of financial aid to students can have an impact on the incentives to study and work during college, as well as a substantial impact on their budget constraint - both during college and afterwards - as is the case when student loans are an important component of aid. In this paper, we shed light on these behavioral and economic effects of study aid policies. We model students' choices of enrollment, work, and student loan undertaking in a structural dynamic model with observed and unobserved heterogeneity.

We find that it is pivotal to have good estimates of how many students are at the relevant margins of change, as this reveals asymmetric effects of both time eligibility requirements, income means testing, and how much weight is put on loans and grants in financial aid packages. If the weight on loans is in the range of 50-85% it does not affect student behavior and outcomes - other than student debt. Hence, policy makers can decide whether the individual student or the government should fund college education - without altering educational outcomes. However, if only 25% of the financial aid is in form of a loan this neutrality does not hold, as the increase of college graduates and the decrease in their cumulated student debt are substantial. The type of loan repayment scheme also has wide-ranging effects. Making an income contingent repayment stricter - basically increasing taxes on post-college labor income - does not have large impacts. However, moving from an income contingent to an annuity based schemes has beneficial effects, as both dropouts and graduates accumulate less student debt and enter the labor market earlier.

Our results are a step in the direction of better understanding the mechanisms driving student debt accumulation, study, and work behavior, and how they are affected by aid policies. More can be done starting from the setting in our paper, such as investigating more detailed work choices both during and after college, and heterogeneity along various skill dimensions and initial conditions. In particular, it will be very interesting to model student loans in a more realistic labor market setting to study the direct impacts of different repayment schemes on post-college labor market outcomes and careers; e.g. field of education, occupation, industry, search effort, and reservation wages. Another interesting result of our paper suggests that loan aversion depends on parental income, and even if credit constraints are loosened, students who do not have high-income parents prefer not to borrow. Especially in light of the borrowing constraint literature, it will be important to better understand the underlying mechanisms and their implications for optimal financial aid.

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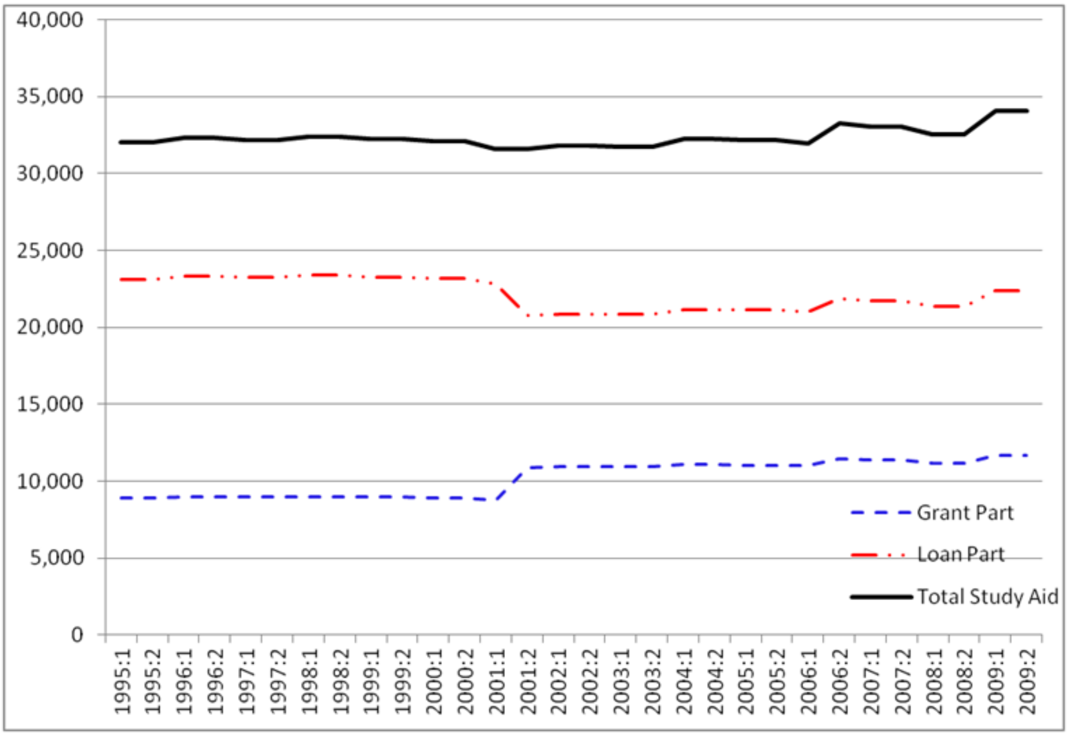
Appendices

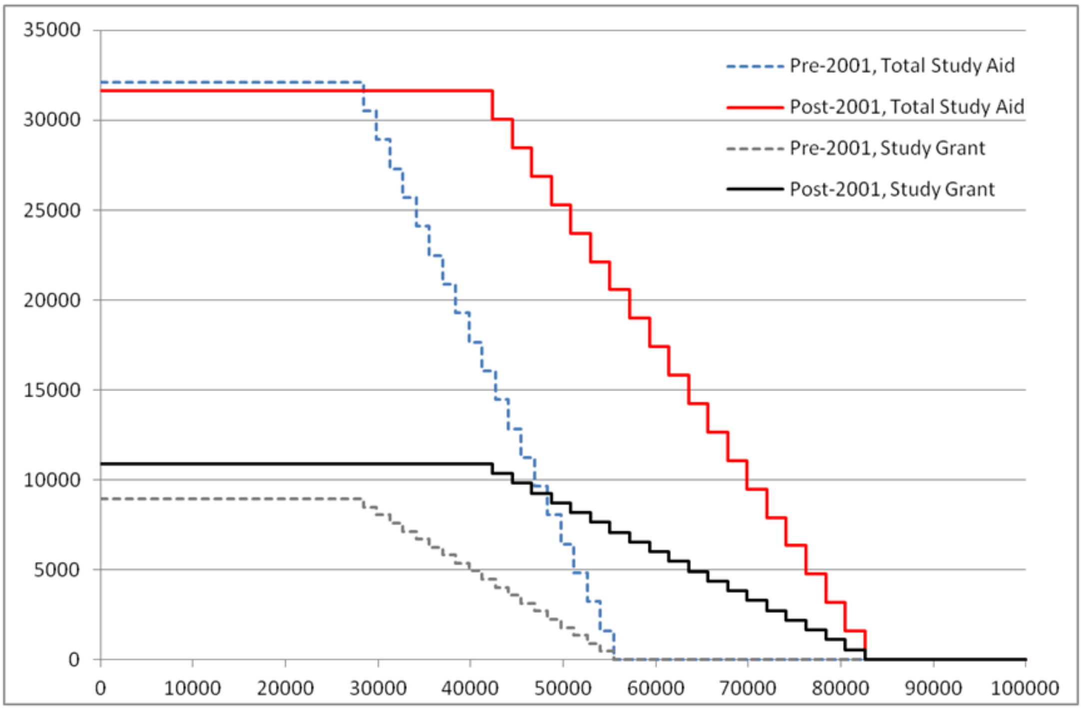
A Figures

Figure 1: Maximum Study Aid, Loan, and Grant.



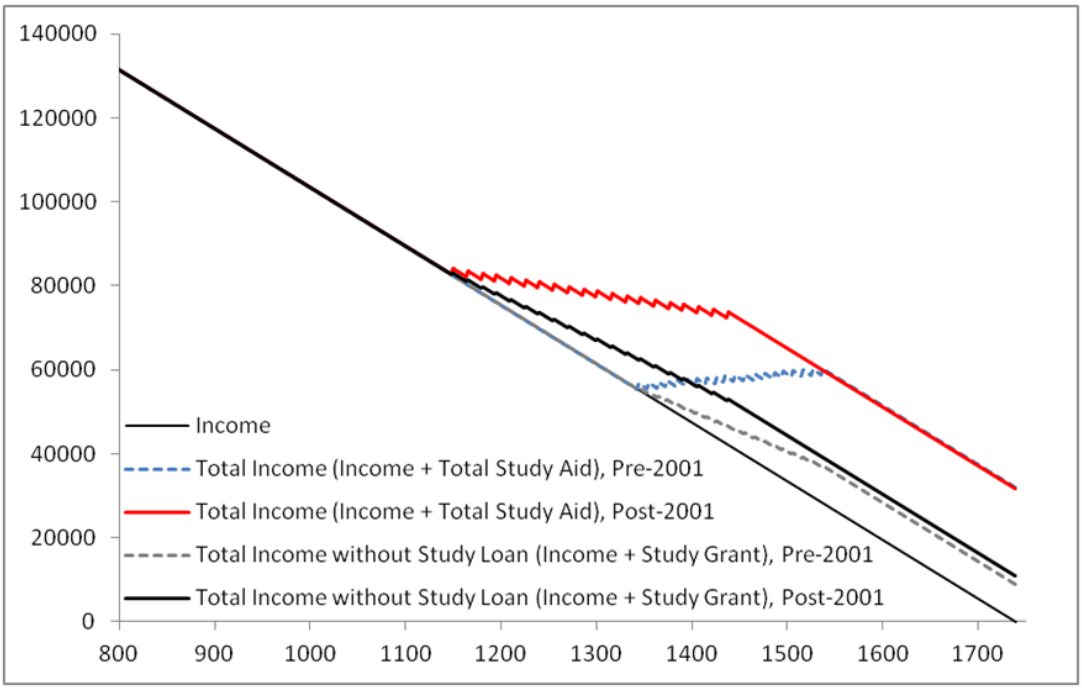
The Figure displays maximum student aid, grant, and loan amounts by semester (half-year). All amounts are in real SEK 2000. The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

Figure 2: Maximum Study Aid and Grant as a function of Student Income, Before and After the Reform.



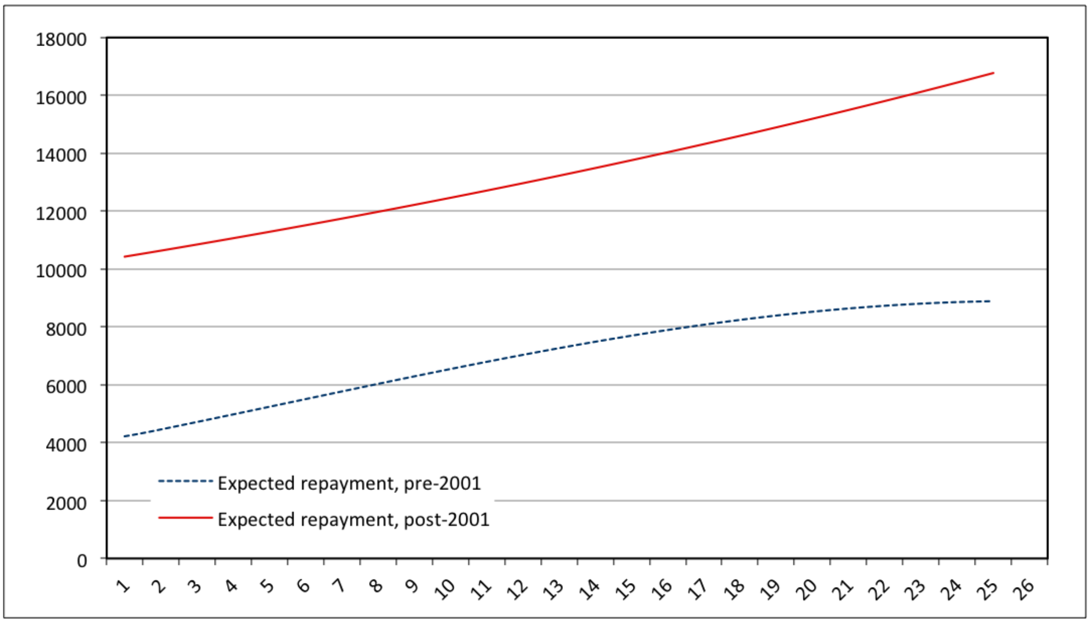
The Figure displays the maximum student aid and grant amount as a function of student income. All amounts are in real SEK 2000. The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

Figure 3: Total Student Income, Before and After the Reform.

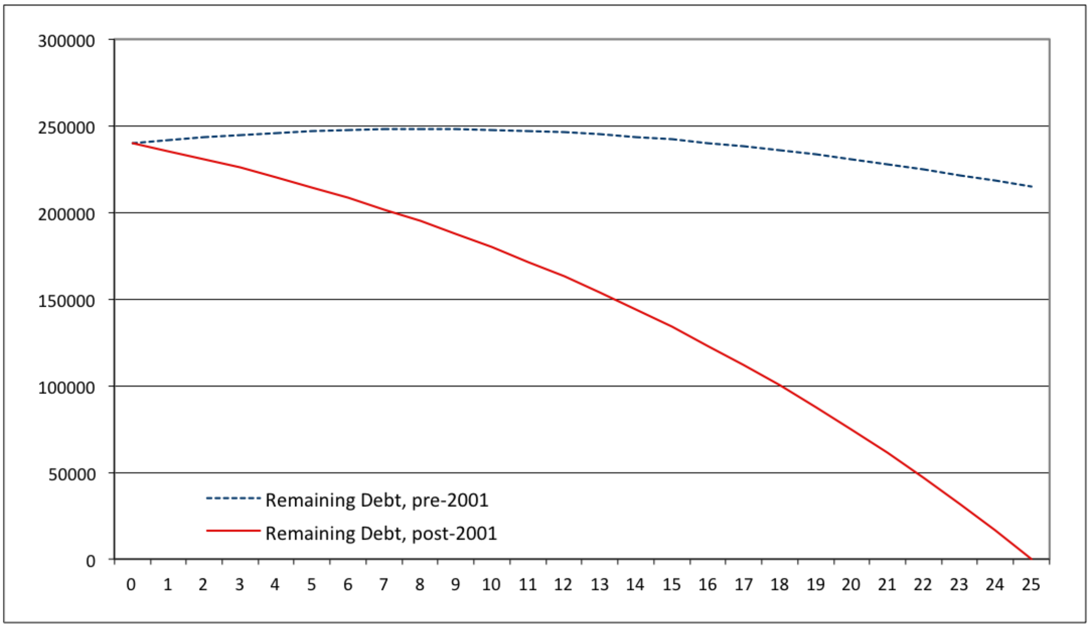


The Figure displays total student income - including the maximum student aid and grant amount - as a function of student leisure hours; i.e. yearly hours not worked. The figure is constructed assuming a non-working student has 1739 leisure hours a year and working students have an hourly wage of 140 SEK. All amounts are in real SEK 2000. The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

Figure 4: Expected repayment schedule and evolution of debt accumulated by a full time student with maximum loan (240 weeks), with starting yearly income equal to the average from the data minus one standard deviation (SEK 105,116), wage equation $\ln(w) = \ln(w_0) + 0.06H_t - 0.0012H_t^2$ and interest rate on loan 2.5%. Pre and post reform.

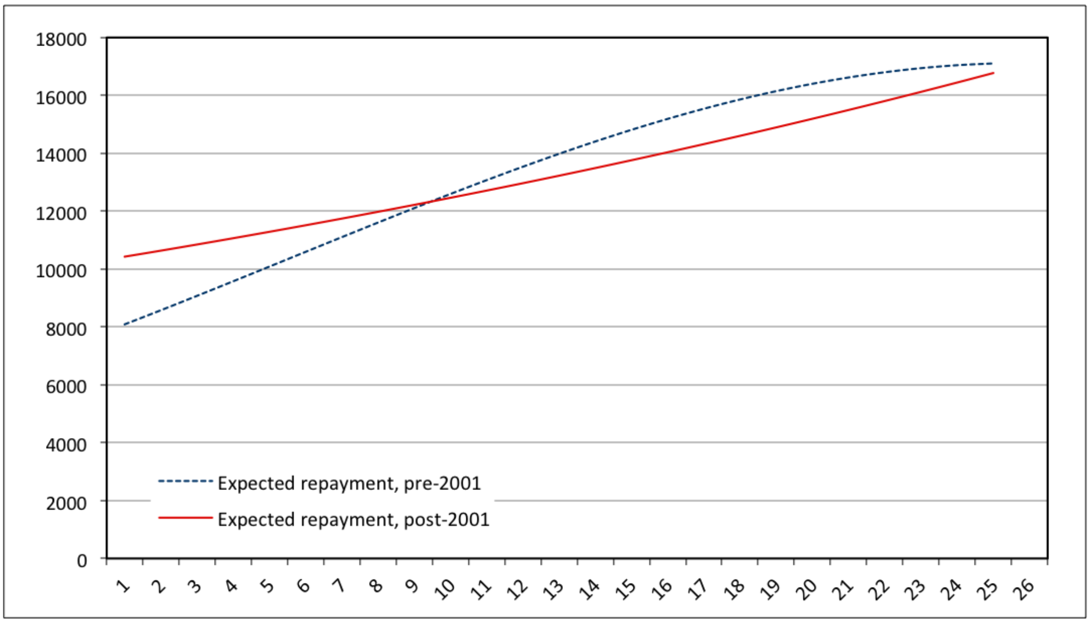


(a) Expected repayment schedule.

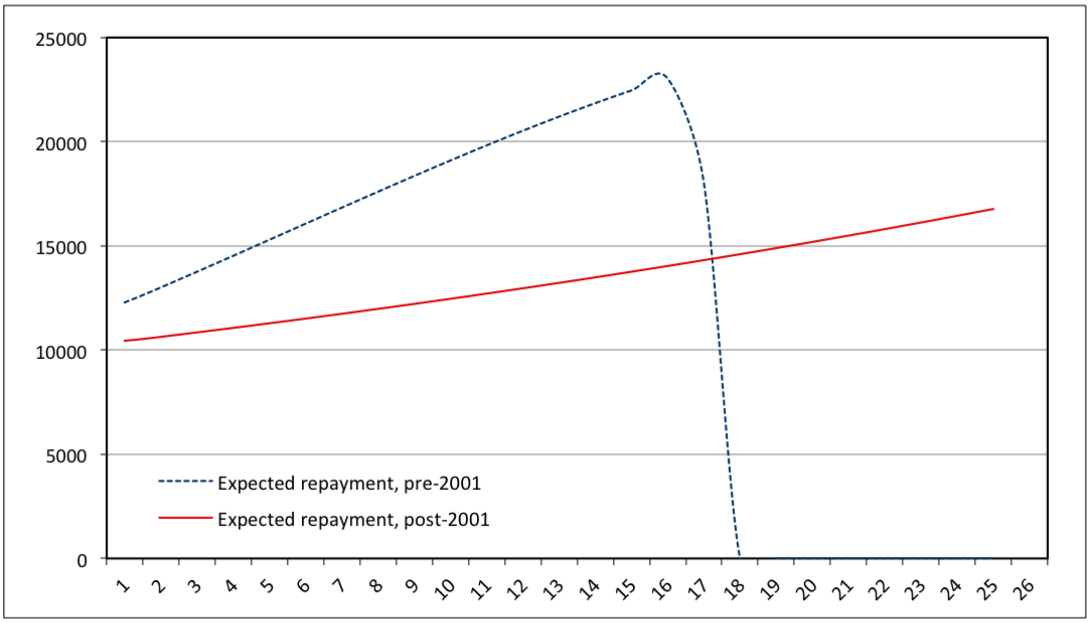


(b) Evolution of debt.

Figure 5: Expected repayment schedule for a full time student with maximum loan (240 weeks), with starting yearly income equal to the average from the data (SEK 202,229) (a) and to the average from the data plus one standard deviation (SEK 306,678) (b), wage equation $\ln(w) = \ln(w_0) + 0.06H_t - 0.0012H_t^2$ and interest rate on loan 2.5%. Pre and post reform.

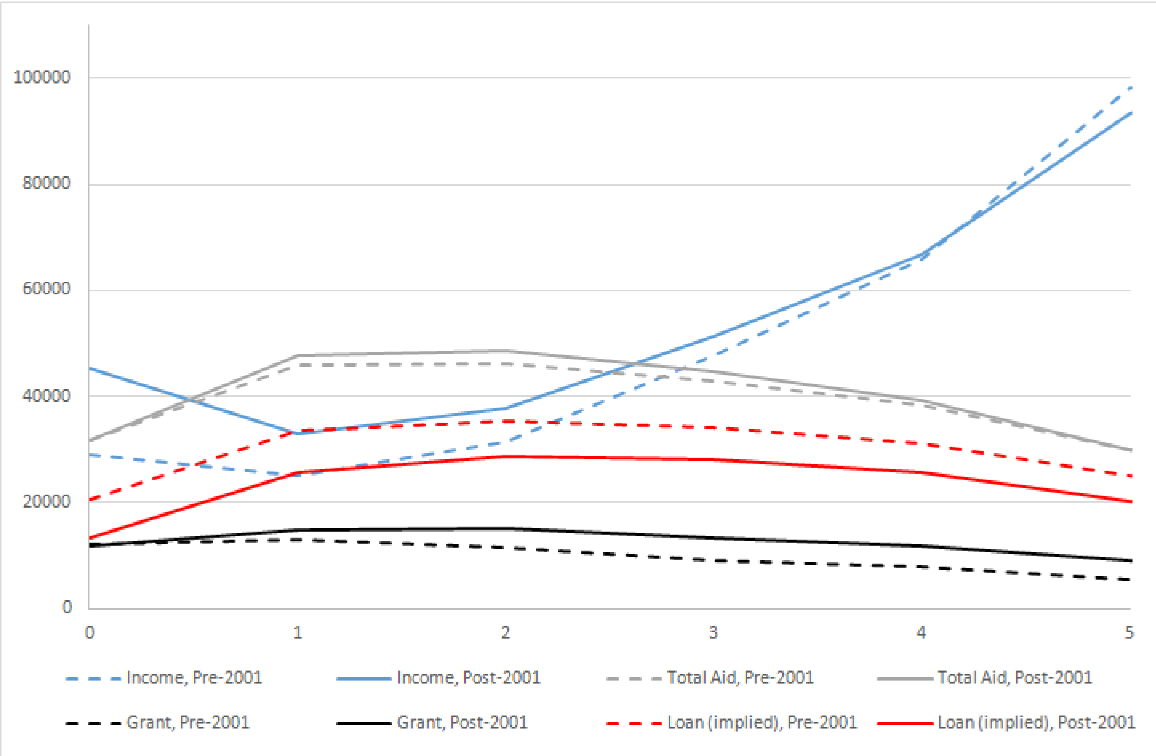


(a) Expected repayment schedule - starting salary SEK 202,229.



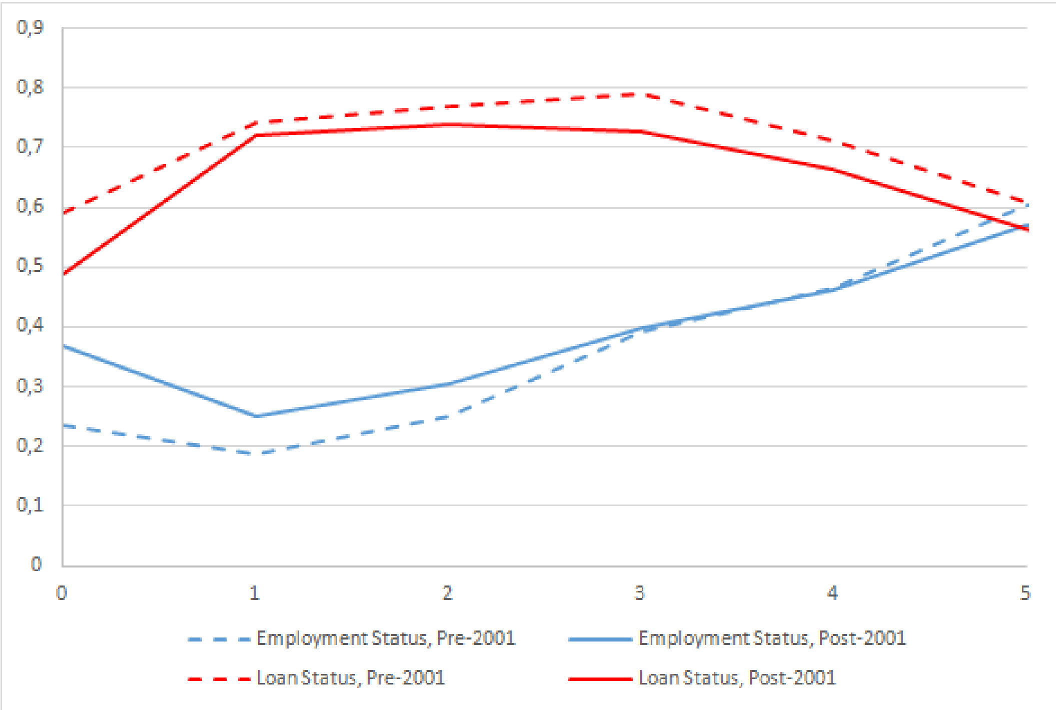
(b) Expected repayment schedule - starting salary SEK 306,678.

Figure 6: Immediate Impact of Reform on Student Income and Aid.



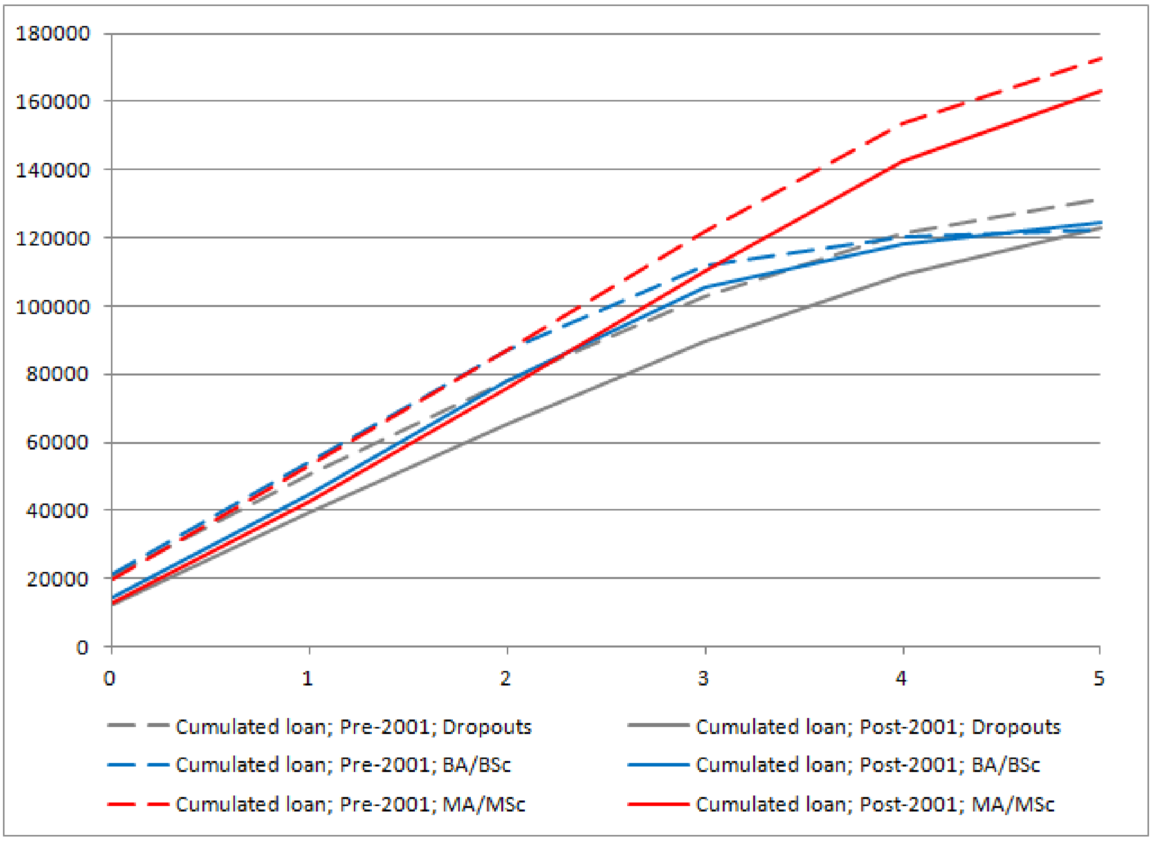
The Figure displays student income, total aid, grant, and loan amounts before and after the 2001 reform. All amounts are in real SEK 2000 and displayed separately by years since initial college enrollment (on the x-axis). The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

Figure 7: Immediate Impact of Reform on Student Employment and Loan Status.



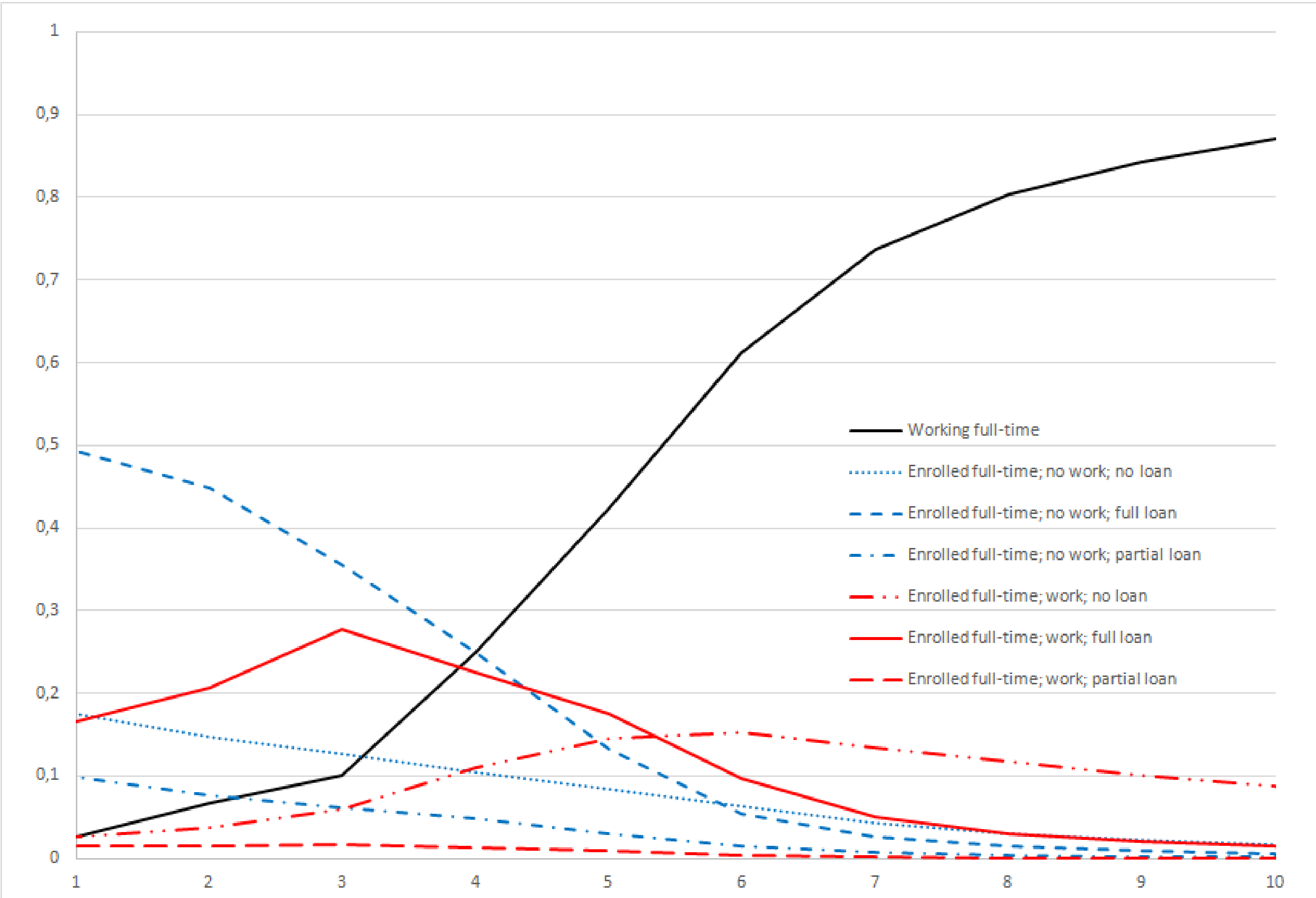
The Figure displays student employment and loan take-up choices before and after the 2001 reform. All numbers are displayed separately by years since initial college enrollment (on the x-axis).

Figure 8: Immediate Impact of Reform on Cumulated Loan by College Degree.



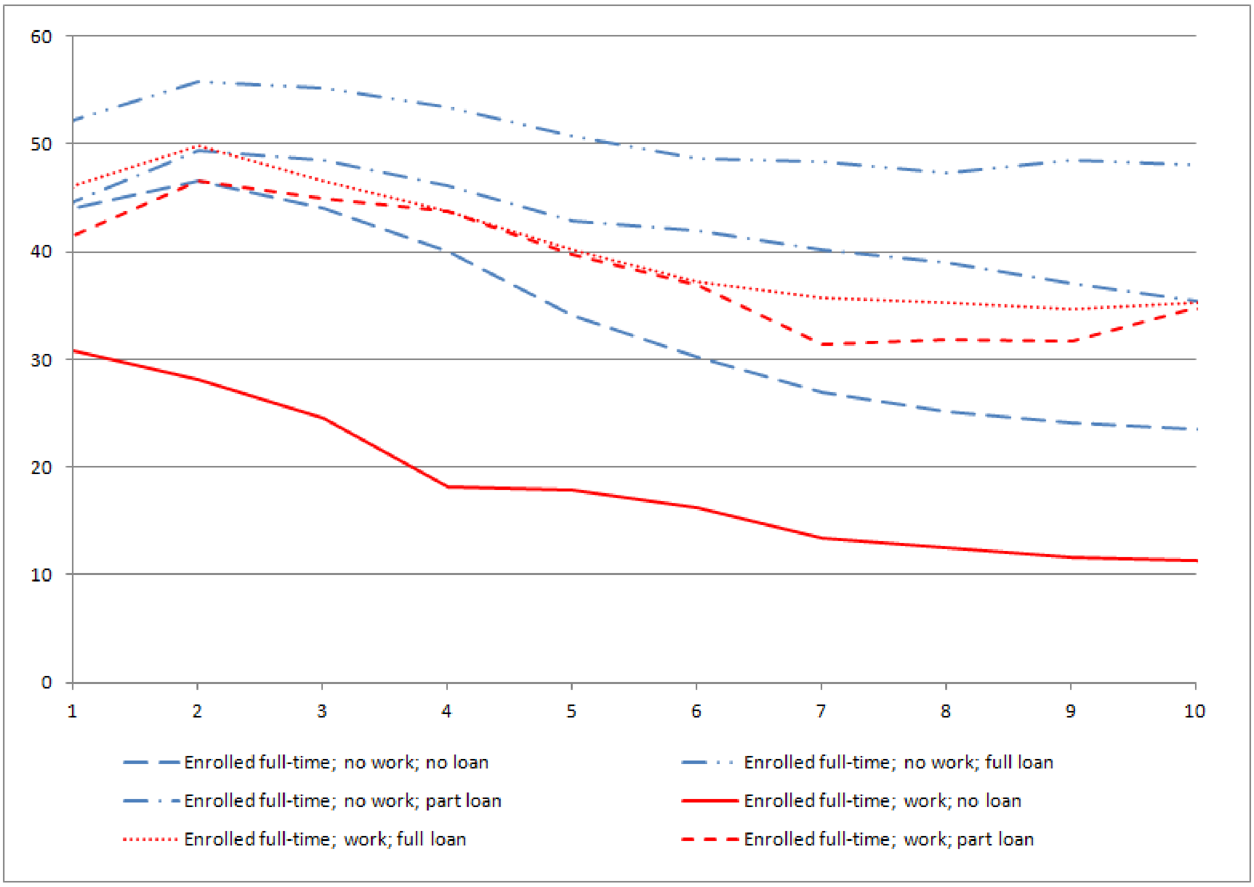
The Figure displays the loan cumulated before and after the 2001 reform. All amounts are in real SEK 2000 and displayed separately by years since initial college enrollment (on the x-axis). The exchange rate ultimo December 2000 was 9.3955 SEK/USD and 8.8263 SEK/EUR.

Figure 9: College-to-Work Transition.



The Figure displays the college-to-work transition over the years since initial enrollment (on the x-axis). The fraction of individuals making each feasible model choice of college enrollment, employment and loan status, $k = 0, \ldots, 6$, is displayed separately.

Figure 10: Course Credit Production over time since initial enrollment.



The Figure displays actual course credit production per year since initial enrollment (on the x-axis). Average course credit production is displayed separately by the model choices; i.e. by student employment and loan status. One year of full-time studies corresponds to 60 ECTS (on the y-axis).

B Tables

Table 7: Observed and Predicted Academic and Labor Market Outcomes, Choices and Transitions (a).

	Observed	**Predicted**
Course Credits		
$P(g_t = 0)$	0,49	0,49
$P(g_t = 1)$	0,05	0,05
$P(g_t = 2)$	0,09	0,09
$P(g_t = 3)$	0,06	0,06
$P(g_t = 4)$	0,05	0,05
$P(g_t = 5)$	0,10	0,10
$P(g_t = 6)$	0,09	0,09
$P(g_t = 7)$	0,07	0,07
Across alternatives:		
g_t given $d_t^1 = 1$	3,59	4,31
g_t given $d_t^2 = 1$	5,01	4,39
g_t given $d_t^3 = 1$	3,66	4,41
g_t given $d_t^4 = 1$	1,73	2,90
g_t given $d_t^5 = 1$	4,13	3,32
g_t given $d_t^6 = 1$	3,58	3,36
Each time period:		
g_1	4,67	4,05
g_2	4,71	3,84
g_3	4,26	3,63
g_4	3,16	2,97
g_5	2,07	2,15
g_6	1,15	1,35
g_7	0,64	0,83
g_8	0,43	0,56
g_9	0,31	0,41
g_{10}	0,24	0,30
Total in last time period:		
G_{11}	23,79	24,05
Highest acquired degree:		
$E_{11} = 0$	0,34	0,05
$E_{11} = 1$	0,28	0,44
$E_{11} = 2$	0,38	0,50

Table 8: Observed and Predicted Academic and Labor Market Outcomes, Choices and Transitions (b).

	Observed	**Predicted**
Cumulated loan at University Exit		
D_t	$148,647$	$144,625$
Wages after University Exit		
Y_t	$224,799$	$329,537$
Across highest acquired degree:		
Y_t given $E_t = 0$	$85,691$	$111,698$
Y_t given $E_t = 1$	$193,878$	$270,235$
Y_t given $E_t = 2$	$252,416$	$369,211$
Distribution over alternatives		
$P(d_t^0 = 1)$	0,44	0,44
$P(d_t^1 = 1)$	0,09	0,08
$P(d_t^2 = 1)$	0,18	0,15
$P(d_t^3 = 1)$	0,05	0,04
$P(d_t^4 = 1)$	0,09	0,08
$P(d_t^5 = 1)$	0,13	0,17
$P(d_t^6 = 1)$	0,01	0,04
Transitions over time		
Full-time work:		
k=0, t=0	0,00	0,02
k=0, t=1	0,03	0,03
k=0, t=2	0,07	0,07
k=0, t=3	0,10	0,14
k=0, t=4	0,25	0,27
k=0, t=5	0,42	0,40
k=0, t=6	0,61	0,57
k=0, t=7	0,74	0,68
k=0, t=8	0,80	0,77
k=0, t=9	0,84	0,84
k=0, t=10	0,87	0,89

Table 9: Observed and Predicted Academic and Labor Market Outcomes, Choices and Transitions (c).

	Observed	**Predicted**
Transitions over time		
Enrolled full-time; no work; no loan:		
k=1, t=0	0,24	0,16
k=1, t=1	0,17	0,15
k=1, t=2	0,15	0,14
k=1, t=3	0,13	0,12
k=1, t=4	0,10	0,10
k=1, t=5	0,08	0,08
k=1, t=6	0,06	0,05
k=1, t=7	0,04	0,04
k=1, t=8	0,03	0,03
k=1, t=9	0,02	0,02
k=1, t=10	0,02	0,01
Enrolled full-time; no work; full loan:		
k=2, t=0	0,23	0,29
k=2, t=1	0,49	0,29
k=2, t=2	0,45	0,27
k=2, t=3	0,36	0,24
k=2, t=4	0,25	0,20
k=2, t=5	0,13	0,16
k=2, t=6	0,05	0,11
k=2, t=7	0,03	0,08
k=2, t=8	0,02	0,05
k=2, t=9	0,01	0,04
k=2, t=10	0,01	0,02
Enrolled full-time; no work; partial loan:		
k=3, t=0	0,25	0,09
k=3, t=1	0,10	0,07
k=3, t=2	0,08	0,06
k=3, t=3	0,06	0,05
k=3, t=4	0,05	0,04
k=3, t=5	0,03	0,03
k=3, t=6	0,02	0,02
k=3, t=7	0,01	0,02
k=3, t=8	0,00	0,01
k=3, t=9	0,00	0,01
k=3, t=10	0,00	0,00

Table 10: Observed and Predicted Academic and Labor Market Outcomes, Choices and Transitions (d).

	Observed	**Predicted**
Transitions over time		
Enrolled full-time; work; no loan:		
k=4, t=0	0,05	0,13
k=4, t=1	0,03	0,14
k=4, t=2	0,04	0,14
k=4, t=3	0,06	0,13
k=4, t=4	0,11	0,11
k=4, t=5	0,15	0,10
k=4, t=6	0,15	0,07
k=4, t=7	0,13	0,06
k=4, t=8	0,12	0,04
k=4, t=9	0,10	0,03
k=4, t=10	0,09	0,02
Enrolled full-time; work; full loan:		
k=5, t=0	0,19	0,24
k=5, t=1	0,17	0,26
k=5, t=2	0,21	0,27
k=5, t=3	0,28	0,26
k=5, t=4	0,22	0,23
k=5, t=5	0,18	0,19
k=5, t=6	0,10	0,14
k=5, t=7	0,05	0,11
k=5, t=8	0,03	0,08
k=5, t=9	0,02	0,06
k=5, t=10	0,02	0,04
Enrolled full-time; work; partial loan:		
k=6, t=0	0,04	0,07
k=6, t=1	0,02	0,06
k=6, t=2	0,02	0,06
k=6, t=3	0,02	0,06
k=6, t=4	0,01	0,05
k=6, t=5	0,01	0,04
k=6, t=6	0,00	0,03
k=6, t=7	0,00	0,02
k=6, t=8	0,00	0,02
k=6, t=9	0,00	0,01
k=6, t=10	0,00	0,01

Table 11: Observed and Predicted Academic and Labor Market Outcomes, by Field of University Education (a).

	Education		Humanities and Arts		Social Sciences, Law, Business, Services		Math, Natural, Life and Computer Sciences		Technical Sciences, Engineering		Health Sciences, Health and Social Care	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Course Credits												
$P(g_t = 0)$	0.54	0.54	0.49	0.48	0.50	0.50	0.50	0.49	0.49	0.48	0.53	0.55
$P(g_t = 1)$	0.04	0.05	0.05	0.05	0.04	0.04	0.05	0.05	0.06	0.05	0.04	0.05
$P(g_t = 2)$	0.08	0.08	0.09	0.09	0.09	0.08	0.08	0.09	0.08	0.09	0.08	0.08
$P(g_t = 3)$	0.04	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.08	0.06	0.04	0.06
$P(g_t = 4)$	0.04	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05
$P(g_t = 5)$	0.09	0.09	0.10	0.10	0.11	0.10	0.10	0.10	0.09	0.10	0.10	0.08
$P(g_t = 6)$	0.09	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.08	0.09	0.09	0.07
$P(g_t = 7)$	0.08	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06
Across alternatives:												
g_t given $d_t^1 = 1$	3.95	4.31	3.36	4.21	3.67	4.34	3.39	4.25	3.49	4.30	4.07	4.35
g_t given $d_t^2 = 1$	5.22	4.37	4.87	4.35	5.02	4.43	4.87	4.35	4.87	4.37	5.20	4.45
g_t given $d_t^3 = 1$	3.86	4.38	3.54	4.39	3.80	4.45	3.39	4.38	3.52	4.41	4.07	4.46
g_t given $d_t^4 = 1$	1.61	2.77	1.66	2.88	1.74	3.02	1.71	2.92	1.73	2.95	1.78	2.57
g_t given $d_t^5 = 1$	4.45	3.30	3.88	3.26	4.25	3.38	3.91	3.26	3.89	3.30	4.41	3.25
g_t given $d_t^6 = 1$	3.81	3.33	3.53	3.32	3.74	3.40	3.40	3.32	3.49	3.35	3.72	3.34

Table 12: Observed and Predicted Academic and Labor Market Outcomes, by Field of University Education (b).

	Education		Humanities and Arts		Social Sciences, Law, Business, Services		Math, Natural, Life and Computer Sciences		Technical Sciences, Engineering		Health Sciences, Health and Social Care	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Course Credits												
Each time period:												
g_1	4.93	4.00	4.56	4.05	4.85	4.08	4.35	4.08	4.40	4.11	4.93	3.99
g_2	5.15	3.83	4.22	3.72	4.71	3.91	4.43	3.83	4.64	3.88	4.76	3.77
g_3	4.65	3.56	3.75	3.45	4.42	3.76	4.24	3.63	4.23	3.70	3.77	3.30
g_4	2.71	2.52	2.90	2.88	3.55	3.27	3.44	3.21	3.44	3.24	2.07	2.01
g_5	1.44	1.58	2.12	2.24	2.03	2.21	2.27	2.37	2.51	2.58	1.61	1.50
g_6	0.73	0.92	1.40	1.57	1.04	1.27	1.33	1.53	1.43	1.67	1.06	1.10
g_7	0.48	0.67	0.96	1.12	0.56	0.75	0.79	0.98	0.73	0.96	0.64	0.67
g_8	0.38	0.53	0.71	0.82	0.35	0.50	0.52	0.67	0.43	0.59	0.48	0.48
g_9	0.32	0.42	0.55	0.65	0.26	0.36	0.36	0.47	0.29	0.40	0.38	0.37
g_{10}	0.27	0.33	0.42	0.51	0.20	0.27	0.28	0.35	0.21	0.28	0.31	0.28
Total in last time period:												
G_{11}	23.74	22.61	24.17	25.17	24.62	24.47	23.99	25.35	24.33	25.62	23.05	21.61
Highest acquired degree:												
$E_{11} = 0$	0.22	0.19	0.51	0.11	0.36	0.11	0.38	0.13	0.36	0.13	0.12	0.31
$E_{11} = 1$	0.50	0.81	0.24	0.49	0.19	0.62	0.14	0.58	0.20	0.68	0.55	0.80
$E_{11} = 2$	0.28	0.78	0.26	0.81	0.44	0.66	0.48	0.71	0.44	0.86	0.33	0.69
Cumulated loan at University Exit												
D_t	144,444	142,230	166,857	159,662	159,403	155,603	153,551	146,766	145,893	141,880	136,082	133,552
Wages after University Exit												
Y_t	170,289	338,635	173,097	314,521	242,078	351,075	215,046	317,666	264,015	331,004	195,989	328,362
Across highest acquired degree:												
Y_t given $E_t = 0$	164,715	269,421	161,584	269,028	212,576	288,142	194,348	251,968	225,804	255,476	150,808	230,229
Y_t given $E_t = 1$	163,646	336,418	184,074	327,579	232,878	339,094	231,030	309,205	276,184	320,239	180,921	306,949
Y_t given $E_t = 2$	199,252	463,945	199,096	450,698	282,897	434,461	234,899	401,030	306,432	435,323	271,046	460,937

Table 13: Observed and Predicted Choices and Transitions, by Field of University Education (a).

	Education		Humanities and Arts		Social Sciences, Law, Business, Services		Math, Natural, Life and Computer Sciences		Technical Sciences, Engineering		Health Sciences, Health and Social Care	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Distribution over alternatives												
$P(d_t^0 = 1)$	0.49	0.48	0.43	0.46	0.46	0.45	0.44	0.46	0.44	0.46	0.50	0.46
$P(d_t^1 = 1)$	0.06	0.07	0.09	0.07	0.08	0.08	0.11	0.08	0.11	0.08	0.06	0.08
$P(d_t^2 = 1)$	0.16	0.14	0.20	0.15	0.18	0.15	0.19	0.15	0.18	0.15	0.15	0.15
$P(d_t^3 = 1)$	0.04	0.03	0.06	0.03	0.05	0.04	0.06	0.03	0.06	0.04	0.04	0.03
$P(d_t^4 = 1)$	0.11	0.08	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.11	0.08
$P(d_t^5 = 1)$	0.13	0.16	0.13	0.17	0.13	0.16	0.10	0.16	0.11	0.16	0.13	0.16
$P(d_t^6 = 1)$	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04
Transitions over time												
Full-time work:												
k=0, t=0	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=0, t=1	0.03	0.04	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.03	0.04	0.03
k=0, t=2	0.06	0.08	0.10	0.07	0.06	0.07	0.07	0.07	0.06	0.07	0.09	0.07
k=0, t=3	0.10	0.14	0.15	0.14	0.09	0.13	0.11	0.13	0.09	0.13	0.15	0.14
k=0, t=4	0.35	0.29	0.27	0.27	0.18	0.26	0.20	0.26	0.19	0.26	0.47	0.29
k=0, t=5	0.56	0.43	0.41	0.41	0.42	0.40	0.38	0.40	0.32	0.39	0.57	0.42
k=0, t=6	0.72	0.58	0.56	0.58	0.64	0.56	0.57	0.57	0.53	0.56	0.65	0.57
k=0, t=7	0.77	0.69	0.66	0.68	0.77	0.67	0.70	0.68	0.71	0.67	0.75	0.67
k=0, t=8	0.80	0.78	0.73	0.77	0.83	0.77	0.78	0.77	0.80	0.77	0.79	0.77
k=0, t=9	0.82	0.84	0.77	0.84	0.87	0.84	0.83	0.84	0.85	0.84	0.82	0.84
k=0, t=10	0.84	0.89	0.80	0.89	0.89	0.89	0.86	0.89	0.89	0.89	0.85	0.89

Table 14: Observed and Predicted Choices and Transitions, by Field of University Education (b).

	Education		Humanities and Arts		Social Sciences, Law, Business, Services		Math, Natural, Life and Computer Sciences		Technical Sciences, Engineering		Health Sciences, Health and Social Care	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Transitions over time												
Enrolled full-time; no work; no loan:												
k=1, t=0	0.21	0.15	0.17	0.16	0.21	0.16	0.25	0.16	0.29	0.16	0.18	0.16
k=1, t=1	0.14	0.14	0.13	0.15	0.14	0.15	0.19	0.15	0.21	0.15	0.14	0.15
k=1, t=2	0.12	0.13	0.11	0.13	0.12	0.14	0.16	0.14	0.18	0.14	0.12	0.14
k=1, t=3	0.09	0.11	0.11	0.12	0.11	0.12	0.14	0.12	0.15	0.12	0.08	0.12
k=1, t=4	0.05	0.09	0.11	0.10	0.11	0.10	0.14	0.10	0.13	0.10	0.06	0.10
k=1, t=5	0.04	0.07	0.09	0.08	0.08	0.08	0.12	0.08	0.11	0.08	0.04	0.08
k=1, t=6	0.03	0.05	0.07	0.05	0.06	0.06	0.09	0.05	0.09	0.05	0.03	0.06
k=1, t=7	0.02	0.03	0.06	0.04	0.04	0.04	0.06	0.04	0.06	0.04	0.02	0.04
k=1, t=8	0.02	0.02	0.05	0.03	0.03	0.03	0.05	0.03	0.04	0.03	0.02	0.03
k=1, t=9	0.01	0.02	0.04	0.02	0.02	0.02	0.03	0.02	0.03	0.02	0.02	0.02
k=1, t=10	0.01	0.01	0.03	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01
Enrolled full-time; no work; full loan:												
k=2, t=0	0.25	0.28	0.31	0.29	0.26	0.30	0.23	0.28	0.20	0.28	0.32	0.30
k=2, t=1	0.49	0.27	0.55	0.29	0.51	0.29	0.52	0.28	0.49	0.29	0.47	0.30
k=2, t=2	0.46	0.26	0.46	0.27	0.48	0.28	0.47	0.27	0.45	0.27	0.42	0.28
k=2, t=3	0.34	0.23	0.35	0.24	0.41	0.25	0.41	0.24	0.37	0.25	0.22	0.25
k=2, t=4	0.20	0.18	0.25	0.20	0.26	0.21	0.29	0.20	0.31	0.20	0.15	0.20
k=2, t=5	0.07	0.14	0.16	0.15	0.12	0.16	0.15	0.16	0.18	0.16	0.10	0.16
k=2, t=6	0.03	0.10	0.09	0.10	0.05	0.11	0.07	0.11	0.07	0.11	0.04	0.11
k=2, t=7	0.02	0.07	0.06	0.07	0.02	0.08	0.04	0.08	0.03	0.08	0.02	0.08
k=2, t=8	0.01	0.05	0.03	0.05	0.01	0.06	0.02	0.05	0.02	0.05	0.01	0.06
k=2, t=9	0.01	0.03	0.02	0.03	0.01	0.04	0.01	0.03	0.01	0.04	0.01	0.04
k=2, t=10	0.01	0.02	0.01	0.02	0.00	0.02	0.01	0.02	0.01	0.02	0.00	0.02

Table 15: Observed and Predicted Choices and Transitions, by Field of University Education (c).

	Education		Humanities and Arts		Social Sciences, Law, Business, Services		Math, Natural, Life and Computer Sciences		Technical Sciences, Engineering		Health Sciences, Health and Social Care	
	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.
Transitions over time												
Enrolled full-time; no work; partial loan:												
k=3, t=0	0.24	0.08	0.29	0.08	0.25	0.08	0.31	0.09	0.31	0.09	0.19	0.08
k=3, t=1	0.09	0.07	0.09	0.07	0.09	0.07	0.11	0.07	0.12	0.07	0.09	0.07
k=3, t=2	0.07	0.06	0.08	0.06	0.07	0.06	0.09	0.06	0.09	0.06	0.06	0.06
k=3, t=3	0.04	0.05	0.07	0.05	0.07	0.05	0.08	0.05	0.07	0.05	0.04	0.05
k=3, t=4	0.02	0.04	0.05	0.04	0.05	0.04	0.07	0.04	0.06	0.04	0.03	0.04
k=3, t=5	0.01	0.03	0.04	0.03	0.03	0.03	0.05	0.03	0.04	0.03	0.02	0.03
k=3, t=6	0.01	0.02	0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02
k=3, t=7	0.00	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.00	0.02
k=3, t=8	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01
k=3, t=9	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
k=3, t=10	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Enrolled full-time; work; no loan:												
k=4, t=0	0.06	0.14	0.04	0.14	0.05	0.13	0.04	0.14	0.04	0.13	0.05	0.13
k=4, t=1	0.03	0.14	0.03	0.14	0.03	0.13	0.03	0.14	0.02	0.14	0.03	0.13
k=4, t=2	0.03	0.14	0.04	0.14	0.04	0.13	0.04	0.14	0.04	0.14	0.04	0.13
k=4, t=3	0.05	0.14	0.06	0.13	0.05	0.13	0.05	0.13	0.05	0.13	0.15	0.13
k=4, t=4	0.16	0.12	0.09	0.12	0.09	0.11	0.08	0.12	0.09	0.12	0.15	0.11
k=4, t=5	0.16	0.10	0.11	0.10	0.15	0.10	0.14	0.10	0.14	0.10	0.14	0.09
k=4, t=6	0.15	0.07	0.13	0.07	0.14	0.07	0.15	0.07	0.16	0.07	0.17	0.07
k=4, t=7	0.14	0.06	0.13	0.06	0.12	0.06	0.13	0.06	0.14	0.06	0.15	0.05
k=4, t=8	0.14	0.04	0.13	0.04	0.10	0.04	0.11	0.04	0.11	0.04	0.13	0.04
k=4, t=9	0.13	0.03	0.13	0.03	0.09	0.03	0.10	0.03	0.09	0.03	0.12	0.03
k=4, t=10	0.12	0.02	0.12	0.02	0.07	0.02	0.09	0.02	0.08	0.02	0.10	0.02

Table 16: Observed and Predicted Choices and Transitions, by Field of University Education (d).

	Education		Humanities and Arts		Social Sciences, Law, Business, Services		Math, Natural, Life and Computer Sciences		Technical Sciences, Engineering		Health Sciences, Health and Social Care	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Transitions over time												
Enrolled full-time; work; full loan:												
k=5, t=0	0.20	0.26	0.15	0.25	0.19	0.24	0.14	0.25	0.13	0.24	0.22	0.24
k=5, t=1	0.20	0.28	0.15	0.27	0.18	0.26	0.12	0.27	0.12	0.26	0.21	0.26
k=5, t=2	0.25	0.28	0.20	0.27	0.22	0.26	0.16	0.27	0.16	0.27	0.25	0.26
k=5, t=3	0.35	0.27	0.25	0.26	0.22	0.26	0.19	0.26	0.25	0.26	0.35	0.25
k=5, t=4	0.20	0.23	0.22	0.23	0.26	0.23	0.21	0.23	0.21	0.23	0.14	0.21
k=5, t=5	0.15	0.19	0.17	0.19	0.29	0.19	0.16	0.20	0.19	0.20	0.14	0.18
k=5, t=6	0.06	0.15	0.12	0.14	0.19	0.14	0.09	0.15	0.12	0.14	0.10	0.14
k=5, t=7	0.04	0.11	0.08	0.11	0.09	0.11	0.06	0.11	0.06	0.11	0.06	0.11
k=5, t=8	0.03	0.08	0.05	0.08	0.04	0.08	0.03	0.08	0.03	0.08	0.04	0.08
k=5, t=9	0.02	0.06	0.03	0.06	0.03	0.06	0.02	0.06	0.02	0.06	0.03	0.06
k=5, t=10	0.02	0.04	0.03	0.04	0.02	0.04	0.02	0.04	0.01	0.04	0.03	0.04
Enrolled full-time; work; partial loan:												
k=6, t=0	0.05	0.07	0.04	0.07	0.04	0.07	0.03	0.07	0.03	0.08	0.05	0.07
k=6, t=1	0.02	0.07	0.02	0.06	0.02	0.06	0.01	0.06	0.01	0.07	0.02	0.06
k=6, t=2	0.02	0.06	0.02	0.06	0.02	0.06	0.01	0.06	0.02	0.06	0.02	0.06
k=6, t=3	0.02	0.06	0.02	0.06	0.02	0.06	0.01	0.06	0.02	0.06	0.02	0.05
k=6, t=4	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05
k=6, t=5	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04
k=6, t=6	0.00	0.03	0.01	0.03	0.00	0.03	0.01	0.03	0.01	0.03	0.00	0.03
k=6, t=7	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=6, t=8	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=6, t=9	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
k=6, t=10	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01

Table 17: Observed and Predicted Academic and Labor Market Outcomes, by Parental Education Level (a).

	Basic Schooling, High School				Higher Education ≤ 2 years				Higher Education ≥ 3 years				Postgraduate Education			
	Mother		Father		Mother		Father		Mother		Father		Mother		Father	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Course Credits																
$P(g_t = 0)$	0.51	0.05	0.51	0.05	0.47	0.05	0.47	0.05	0.47	0.05	0.46	0.05	0.42	0.04	0.44	0.05
$P(g_t = 1)$	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.05
$P(g_t = 2)$	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.09	0.08	0.09	0.08	0.09
$P(g_t = 3)$	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07	0.08	0.07
$P(g_t = 4)$	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.06	0.06
$P(g_t = 5)$	0.10	0.09	0.10	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.12	0.11	0.11
$P(g_t = 6)$	0.08	0.08	0.09	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.11	0.11	0.10	0.10
$P(g_t = 7)$	0.07	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09
Across alternatives:																
g_t given $d_t^1 = 1$	3.54	4.29	3.57	4.29	3.41	4.28	3.54	4.31	3.62	4.33	3.61	4.33	3.79	4.38	3.67	4.35
g_t given $d_t^2 = 1$	4.99	4.37	5.00	4.37	4.95	4.38	4.99	4.38	5.02	4.41	5.01	4.42	5.04	4.47	5.02	4.44
g_t given $d_t^3 = 1$	3.61	4.39	3.65	4.39	3.57	4.40	3.67	4.40	3.73	4.43	3.70	4.43	3.93	4.47	3.89	4.46
g_t given $d_t^4 = 1$	1.67	2.84	1.68	2.84	1.75	2.93	1.75	2.94	1.78	2.96	1.78	2.97	2.08	3.16	1.93	3.07
g_t given $d_t^5 = 1$	4.11	3.30	4.13	3.30	4.13	3.32	4.12	3.31	4.16	3.34	4.15	3.34	4.23	3.44	4.16	3.38
g_t given $d_t^6 = 1$	3.52	3.34	3.56	3.35	3.48	3.34	3.50	3.36	3.63	3.37	3.60	3.38	3.78	3.47	3.81	3.42

Table 18: Observed and Predicted Academic and Labor Market Outcomes, by Parental Education Level (b).

	Basic Schooling, High School				Higher Education ≤ 2 years				Higher Education ≥ 3 years				Postgraduate Education			
	Mother		Father		Mother		Father		Mother		Father		Mother		Father	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Course Credits																
Each time period:																
g_1	4.60	4.00	4.63	4.00	4.60	4.05	4.70	4.03	4.73	4.10	4.71	4.12	4.83	4.22	4.68	4.19
g_2	4.67	3.76	4.69	3.76	4.59	3.82	4.72	3.84	4.75	3.92	4.73	3.94	4.86	4.12	4.72	4.05
g_3	4.16	3.49	4.18	3.50	4.20	3.64	4.30	3.66	4.34	3.74	4.34	3.77	4.48	4.01	4.37	3.91
g_4	2.85	2.71	2.85	2.70	3.23	3.08	3.23	3.02	3.46	3.21	3.53	3.27	3.99	3.67	3.91	3.60
g_5	1.73	1.86	1.73	1.85	2.21	2.31	2.09	2.20	2.39	2.44	2.47	2.51	3.08	3.01	2.93	2.91
g_6	0.95	1.14	0.95	1.13	1.24	1.47	1.16	1.37	1.35	1.55	1.39	1.60	1.80	2.08	1.80	2.01
g_7	0.55	0.72	0.55	0.71	0.72	0.91	0.63	0.83	0.74	0.94	0.76	0.96	1.00	1.25	0.98	1.23
g_8	0.38	0.50	0.38	0.50	0.49	0.63	0.43	0.56	0.48	0.63	0.49	0.64	0.58	0.76	0.61	0.77
g_9	0.29	0.37	0.29	0.37	0.38	0.48	0.31	0.40	0.34	0.44	0.33	0.44	0.37	0.50	0.40	0.51
g_{10}	0.23	0.27	0.23	0.28	0.29	0.37	0.23	0.29	0.26	0.33	0.26	0.33	0.31	0.39	0.32	0.41
Total in last time period:																
G_{11}	22.55	22.79	22.66	22.78	23.92	24.65	23.73	24.06	24.99	25.25	25.18	25.54	27.44	28.00	26.97	27.60
Highest acquired degree:																
$E_{11} = 0$	0.36	0.17	0.35	0.17	0.38	0.12	0.37	0.12	0.33	0.11	0.33	0.10	0.30	0.07	0.30	0.07
$E_{11} = 1$	0.33	0.77	0.33	0.77	0.23	0.71	0.26	0.74	0.23	0.70	0.21	0.68	0.12	0.58	0.14	0.57
$E_{11} = 2$	0.31	0.71	0.32	0.71	0.39	0.75	0.37	0.73	0.44	0.78	0.45	0.78	0.59	0.82	0.56	0.81
Cumulated loan at University Exit																
D_t	141,612	138,405	141,703	138,534	152,714	146,854	147,905	143,565	156,221	151,434	158,595	153,595	158,528	153,294	161,149	154,784
Wages after University Exit																
Y_t	217,545	320,477	217,427	321,923	229,783	325,707	228,776	324,896	232,526	340,216	236,654	342,493	243,667	356,064	239,677	353,830
Across highest acquired degree:																
Y_t given $E_t = 0$	199,496	257,220	200,476	258,275	205,187	256,611	206,020	261,423	202,931	265,712	204,202	266,884	195,775	261,774	190,490	258,076
Y_t given $E_t = 1$	205,020	321,498	204,652	322,043	214,932	317,806	216,513	318,794	211,926	322,269	214,111	321,241	207,069	308,323	212,888	324,901
Y_t given $E_t = 2$	268,433	434,273	266,346	435,795	276,099	430,119	274,577	426,657	278,854	433,618	283,746	433,269	281,390	425,503	282,920	430,887

Table 19: Observed and Predicted Choices and Transitions, by Parental Education Level (a).

	Basic Schooling, High School				**Higher Education ≤ 2 years**				**Higher Education ≥ 3 years**				**Postgraduate Education**			
	Mother		**Father**		**Mother**		**Father**		**Mother**		**Father**		**Mother**		**Father**	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Distribution over alternatives																
$P(d_t^0 = 1)$	0.47	0.45	0.47	0.45	0.42	0.43	0.42	0.43	0.42	0.44	0.42	0.44	0.37	0.42	0.39	0.43
$P(d_t^1 = 1)$	0.08	0.08	0.08	0.08	0.10	0.08	0.10	0.08	0.10	0.08	0.10	0.08	0.15	0.09	0.14	0.09
$P(d_t^2 = 1)$	0.17	0.15	0.17	0.15	0.19	0.16	0.18	0.16	0.19	0.16	0.20	0.16	0.20	0.17	0.20	0.17
$P(d_t^3 = 1)$	0.05	0.03	0.05	0.03	0.06	0.04	0.05	0.04	0.06	0.04	0.06	0.04	0.06	0.04	0.06	0.04
$P(d_t^4 = 1)$	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.08
$P(d_t^5 = 1)$	0.13	0.17	0.13	0.17	0.13	0.17	0.14	0.17	0.13	0.16	0.13	0.16	0.12	0.16	0.11	0.16
$P(d_t^6 = 1)$	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04
Transitions over time																
Full-time work:																
k=0, t=0	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=0, t=1	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.03	0.01	0.03	0.02	0.03
k=0, t=2	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.07	0.06	0.07	0.05	0.07	0.03	0.06	0.04	0.06
k=0, t=3	0.12	0.14	0.12	0.14	0.10	0.13	0.09	0.13	0.08	0.13	0.08	0.13	0.05	0.12	0.07	0.12
k=0, t=4	0.30	0.28	0.30	0.28	0.22	0.26	0.23	0.27	0.20	0.26	0.19	0.25	0.12	0.23	0.13	0.24
k=0, t=5	0.49	0.42	0.49	0.42	0.38	0.40	0.41	0.40	0.36	0.39	0.34	0.39	0.25	0.36	0.27	0.37
k=0, t=6	0.66	0.57	0.66	0.57	0.58	0.57	0.60	0.57	0.56	0.56	0.55	0.56	0.45	0.55	0.46	0.55
k=0, t=7	0.76	0.68	0.77	0.68	0.71	0.68	0.74	0.68	0.71	0.67	0.71	0.67	0.64	0.66	0.64	0.66
k=0, t=8	0.82	0.77	0.82	0.77	0.79	0.77	0.80	0.77	0.79	0.77	0.79	0.77	0.77	0.75	0.75	0.76
k=0, t=9	0.85	0.84	0.85	0.84	0.82	0.84	0.84	0.84	0.83	0.84	0.84	0.84	0.84	0.83	0.82	0.83
k=0, t=10	0.88	0.89	0.87	0.89	0.85	0.89	0.87	0.89	0.86	0.89	0.87	0.89	0.86	0.88	0.85	0.89

Table 20: Observed and Predicted Choices and Transitions, by Parental Education Level (b).

	Basic Schooling, High School				**Higher Education $\leq$ 2 years**				**Higher Education $\geq$ 3 years**				**Postgraduate Education**			
	Mother		**Father**		**Mother**		**Father**		**Mother**		**Father**		**Mother**		**Father**	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Transitions over time																
Enrolled full-time; no work; no loan:																
k=1, t=0	0.23	0.16	0.23	0.16	0.25	0.16	0.25	0.16	0.25	0.16	0.25	0.16	0.34	0.17	0.32	0.17
k=1, t=1	0.17	0.14	0.16	0.15	0.18	0.15	0.18	0.15	0.18	0.15	0.18	0.15	0.25	0.16	0.24	0.16
k=1, t=2	0.14	0.13	0.14	0.13	0.15	0.14	0.15	0.14	0.15	0.14	0.15	0.14	0.23	0.15	0.21	0.15
k=1, t=3	0.11	0.12	0.11	0.12	0.14	0.12	0.13	0.12	0.14	0.13	0.14	0.13	0.21	0.14	0.18	0.13
k=1, t=4	0.09	0.10	0.09	0.10	0.11	0.10	0.11	0.10	0.11	0.10	0.12	0.10	0.18	0.11	0.17	0.11
k=1, t=5	0.07	0.07	0.07	0.07	0.10	0.08	0.08	0.08	0.09	0.08	0.10	0.08	0.14	0.09	0.14	0.09
k=1, t=6	0.05	0.05	0.05	0.05	0.07	0.05	0.06	0.05	0.07	0.06	0.08	0.06	0.12	0.06	0.12	0.06
k=1, t=7	0.03	0.04	0.03	0.04	0.05	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.09	0.05	0.08	0.04
k=1, t=8	0.02	0.03	0.02	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.06	0.03	0.05	0.03
k=1, t=9	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.02	0.04	0.02	0.04	0.02
k=1, t=10	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.03	0.01
Enrolled full-time; no work; full loan:																
k=2, t=0	0.23	0.28	0.23	0.28	0.23	0.29	0.22	0.28	0.23	0.29	0.24	0.29	0.24	0.30	0.24	0.29
k=2, t=1	0.48	0.28	0.48	0.28	0.49	0.29	0.48	0.28	0.50	0.29	0.51	0.29	0.47	0.30	0.47	0.30
k=2, t=2	0.44	0.26	0.44	0.26	0.44	0.27	0.44	0.27	0.46	0.28	0.47	0.28	0.43	0.29	0.45	0.29
k=2, t=3	0.33	0.24	0.33	0.24	0.36	0.24	0.35	0.24	0.38	0.25	0.39	0.25	0.39	0.27	0.40	0.26
k=2, t=4	0.21	0.19	0.21	0.19	0.26	0.20	0.25	0.20	0.29	0.21	0.30	0.21	0.34	0.23	0.35	0.22
k=2, t=5	0.10	0.15	0.10	0.15	0.15	0.16	0.14	0.15	0.16	0.16	0.17	0.16	0.21	0.18	0.21	0.18
k=2, t=6	0.04	0.10	0.04	0.10	0.06	0.11	0.06	0.11	0.06	0.11	0.07	0.11	0.09	0.12	0.09	0.12
k=2, t=7	0.02	0.07	0.02	0.07	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.04	0.09	0.04	0.09
k=2, t=8	0.01	0.05	0.01	0.05	0.02	0.05	0.01	0.05	0.02	0.06	0.02	0.06	0.01	0.06	0.02	0.06
k=2, t=9	0.01	0.03	0.01	0.03	0.02	0.04	0.01	0.03	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04
k=2, t=10	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.03

Table 21: Observed and Predicted Choices and Transitions, by Parental Education Level (c).

	Basic Schooling, High School				Higher Education $\leq$ 2 years				Higher Education $\geq$ 3 years				Postgraduate Education			
	Mother		Father		Mother		Father		Mother		Father		Mother		Father	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Transitions over time																
Enrolled full-time; no work; partial loan:																
k=3, t=0	0.24	0.08	0.24	0.08	0.26	0.09	0.24	0.09	0.26	0.09	0.27	0.09	0.24	0.10	0.26	0.10
k=3, t=1	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.08	0.11	0.08
k=3, t=2	0.07	0.06	0.07	0.06	0.07	0.06	0.08	0.06	0.08	0.06	0.08	0.06	0.09	0.07	0.09	0.07
k=3, t=3	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05	0.07	0.05	0.07	0.05	0.08	0.06	0.08	0.06
k=3, t=4	0.04	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.06	0.04	0.06	0.04	0.08	0.05	0.07	0.05
k=3, t=5	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.03	0.06	0.04	0.05	0.04
k=3, t=6	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
k=3, t=7	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02
k=3, t=8	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
k=3, t=9	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01
k=3, t=10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
Enrolled full-time; work; no loan:																
k=4, t=0	0.05	0.14	0.05	0.14	0.05	0.13	0.05	0.14	0.04	0.13	0.04	0.13	0.04	0.12	0.04	0.13
k=4, t=1	0.03	0.14	0.03	0.14	0.03	0.14	0.03	0.14	0.03	0.13	0.02	0.13	0.03	0.13	0.03	0.13
k=4, t=2	0.04	0.14	0.04	0.14	0.04	0.13	0.04	0.14	0.04	0.13	0.04	0.13	0.05	0.13	0.03	0.13
k=4, t=3	0.06	0.13	0.06	0.13	0.06	0.13	0.06	0.13	0.06	0.13	0.05	0.13	0.05	0.12	0.05	0.12
k=4, t=4	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.12	0.10	0.11	0.10	0.11	0.07	0.11	0.08	0.11
k=4, t=5	0.14	0.10	0.15	0.10	0.15	0.10	0.15	0.10	0.15	0.10	0.14	0.10	0.12	0.09	0.12	0.09
k=4, t=6	0.14	0.07	0.15	0.07	0.16	0.07	0.16	0.07	0.16	0.07	0.16	0.07	0.16	0.07	0.17	0.07
k=4, t=7	0.13	0.06	0.13	0.06	0.14	0.06	0.13	0.06	0.14	0.06	0.15	0.06	0.16	0.05	0.15	0.05
k=4, t=8	0.11	0.04	0.11	0.04	0.12	0.04	0.11	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.13	0.04
k=4, t=9	0.10	0.03	0.10	0.03	0.11	0.03	0.10	0.03	0.10	0.03	0.10	0.03	0.09	0.03	0.10	0.03
k=4, t=10	0.09	0.02	0.09	0.02	0.10	0.02	0.09	0.02	0.09	0.02	0.09	0.02	0.09	0.02	0.09	0.02

Table 22: Observed and Predicted Choices and Transitions, by Parental Education Level (d).

	Basic Schooling, High School				Higher Education $\leq$ 2 years				Higher Education $\geq$ 3 years				Postgraduate Education			
	Mother		Father		Mother		Father		Mother		Father		Mother		Father	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Transitions over time																
Enrolled full-time; work; full loan:																
k=5, t=0	0.20	0.25	0.21	0.25	0.18	0.24	0.19	0.24	0.17	0.24	0.16	0.24	0.11	0.21	0.12	0.22
k=5, t=1	0.18	0.27	0.18	0.27	0.16	0.26	0.17	0.26	0.16	0.26	0.15	0.26	0.12	0.23	0.12	0.24
k=5, t=2	0.22	0.27	0.22	0.27	0.20	0.27	0.21	0.27	0.20	0.26	0.20	0.26	0.16	0.24	0.16	0.25
k=5, t=3	0.30	0.26	0.30	0.26	0.26	0.26	0.29	0.26	0.26	0.26	0.25	0.26	0.21	0.24	0.20	0.24
k=5, t=4	0.22	0.23	0.22	0.23	0.24	0.23	0.25	0.23	0.23	0.23	0.23	0.23	0.20	0.22	0.20	0.22
k=5, t=5	0.16	0.19	0.16	0.19	0.18	0.19	0.18	0.19	0.19	0.19	0.20	0.19	0.22	0.19	0.20	0.19
k=5, t=6	0.08	0.15	0.08	0.14	0.11	0.14	0.11	0.15	0.11	0.14	0.11	0.14	0.13	0.14	0.13	0.14
k=5, t=7	0.05	0.11	0.04	0.11	0.05	0.11	0.05	0.11	0.06	0.11	0.06	0.11	0.06	0.11	0.07	0.11
k=5, t=8	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.04	0.08	0.04	0.08
k=5, t=9	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.03	0.06
k=5, t=10	0.02	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.01	0.04	0.02	0.04
Enrolled full-time; work; partial loan:																
k=6, t=0	0.04	0.07	0.04	0.07	0.05	0.07	0.04	0.07	0.04	0.07	0.04	0.07	0.04	0.07	0.03	0.07
k=6, t=1	0.02	0.06	0.02	0.06	0.01	0.06	0.02	0.06	0.01	0.06	0.01	0.06	0.02	0.06	0.01	0.06
k=6, t=2	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.01	0.06	0.01	0.06	0.01	0.06
k=6, t=3	0.02	0.06	0.02	0.06	0.01	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.05	0.02	0.05
k=6, t=4	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05
k=6, t=5	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04
k=6, t=6	0.00	0.03	0.00	0.03	0.01	0.03	0.00	0.03	0.00	0.03	0.01	0.03	0.00	0.03	0.01	0.03
k=6, t=7	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=6, t=8	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=6, t=9	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
k=6, t=10	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01

Table 23: Observed and Predicted Academic and Labor Market Outcomes, by Parental Income (a).

	Parental Income < p10						**Parental Income > p90**					
	Mother		**Father**		**Total**		**Mother**		**Father**		**Total**	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Course Credits												
$P(g_t = 0)$	0.50	0.05	0.51	0.05	0.51	0.05	0.41	0.05	0.46	0.05	0.42	0.05
$P(g_t = 1)$	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05
$P(g_t = 2)$	0.09	0.09	0.09	0.09	0.09	0.08	0.09	0.10	0.09	0.09	0.09	0.09
$P(g_t = 3)$	0.06	0.06	0.06	0.06	0.06	0.06	0.08	0.07	0.08	0.07	0.08	0.07
$P(g_t = 4)$	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.07	0.06	0.06	0.06
$P(g_t = 5)$	0.10	0.10	0.10	0.10	0.09	0.09	0.11	0.11	0.12	0.11	0.11	0.11
$P(g_t = 6)$	0.08	0.09	0.08	0.09	0.08	0.08	0.10	0.10	0.11	0.10	0.10	0.10
$P(g_t = 7)$	0.07	0.07	0.07	0.07	0.06	0.07	0.09	0.09	0.09	0.08	0.09	0.09
Across alternatives:												
g_t given $d_t^1 = 1$	3.49	4.28	3.46	4.27	3.43	4.25	3.74	4.37	3.82	4.38	3.82	4.39
g_t given $d_t^2 = 1$	4.95	4.37	4.95	4.37	4.92	4.36	5.05	4.44	5.05	4.43	5.05	4.44
g_t given $d_t^3 = 1$	3.46	4.39	3.56	4.39	3.46	4.38	3.87	4.45	3.87	4.45	3.94	4.46
g_t given $d_t^4 = 1$	1.69	2.84	1.70	2.84	1.67	2.80	2.01	3.12	1.98	3.10	2.02	3.14
g_t given $d_t^5 = 1$	4.06	3.29	4.12	3.29	4.06	3.27	4.18	3.38	4.18	3.37	4.17	3.38
g_t given $d_t^6 = 1$	3.40	3.32	3.50	3.33	3.47	3.32	3.71	3.40	3.72	3.40	3.67	3.41

Table 24: Observed and Predicted Academic and Labor Market Outcomes, by Parental Income (b).

	Parental Income < p10						**Parental Income > p90**					
	Mother		**Father**		**Total**		**Mother**		**Father**		**Total**	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Course Credits												
Each time period:												
g_1	4.49	4.02	4.54	4.02	4.45	4.02	4.80	4.10	4.78	4.12	4.79	4.13
g_2	4.57	3.76	4.59	3.77	4.53	3.75	4.74	3.93	4.77	3.97	4.78	3.98
g_3	4.10	3.52	4.11	3.51	4.04	3.48	4.35	3.81	4.40	3.85	4.40	3.86
g_4	2.94	2.81	2.95	2.80	2.87	2.76	3.73	3.41	3.79	3.43	3.84	3.48
g_5	1.90	2.01	1.90	2.01	1.84	1.96	2.71	2.67	2.69	2.68	2.77	2.75
g_6	1.09	1.28	1.08	1.26	1.06	1.25	1.53	1.72	1.46	1.66	1.53	1.71
g_7	0.64	0.82	0.63	0.81	0.64	0.82	0.82	1.01	0.75	0.94	0.78	0.97
g_8	0.45	0.57	0.45	0.58	0.45	0.58	0.49	0.65	0.46	0.61	0.46	0.62
g_9	0.34	0.43	0.33	0.43	0.35	0.43	0.34	0.47	0.31	0.41	0.31	0.42
g_{10}	0.27	0.33	0.26	0.32	0.26	0.33	0.27	0.34	0.24	0.32	0.23	0.31
Total in last time period:												
G_{11}	22.89	23.54	23.02	23.53	22.68	23.42	25.55	25.76	25.60	25.76	25.78	25.95
Highest acquired degree:												
$E_{11} = 0$	0.37	0.16	0.37	0.16	0.37	0.16	0.36	0.09	0.34	0.08	0.34	0.09
$E_{11} = 1$	0.30	0.74	0.30	0.73	0.31	0.73	0.16	0.69	0.17	0.68	0.15	0.68
$E_{11} = 2$	0.33	0.74	0.34	0.75	0.32	0.74	0.48	0.78	0.50	0.76	0.51	0.77
Cumulated loan at University Exit												
D_t	145,725	142,098	145,990	141,968	145,167	141,685	152,043	146,564	148,421	143,679	148,974	144,174
Wages after University Exit												
Y_t	212,851	314,924	213,764	320,631	207,875	314,086	250,823	341,443	257,555	344,026	260,890	345,370
Across highest acquired degree:												
Y_t given $E_t = 0$	190,931	248,532	193,094	254,637	186,239	248,676	211,986	263800.8	216,030	267,106	218,094	267,036
Y_t given $E_t = 1$	203,398	316,223	201,527	322,042	199,494	318,544	226,851	318152.8	228,492	318,667	230,910	316,697
Y_t given $E_t = 2$	262,806	429,080	263,857	432,001	259,181	429,481	298,450	427230.8	306,609	423,339	308,834	423,986

Table 25: Observed and Predicted Choices and Transitions, by Parental Income (a).

	Parental Income < p10						Parental Income > p90					
	Mother		Father		Total		Mother		Father		Total	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Distribution over alternatives												
$P(d_t^0 = 1)$	0.45	0.45	0.46	0.45	0.46	0.46	0.37	0.40	38.55	0.41	0.37	0.40
$P(d_t^1 = 1)$	0.09	0.08	0.09	0.08	0.09	0.08	0.13	0.09	13.34	0.09	0.14	0.09
$P(d_t^2 = 1)$	0.17	0.15	0.17	0.15	0.17	0.15	0.19	0.17	19.27	0.17	0.19	0.17
$P(d_t^3 = 1)$	0.05	0.04	0.05	0.04	0.05	0.03	0.06	0.04	5.69	0.04	0.06	0.04
$P(d_t^4 = 1)$	0.09	0.09	0.09	0.08	0.09	0.08	0.09	0.09	8.84	0.09	0.09	0.09
$P(d_t^5 = 1)$	0.12	0.17	0.12	0.17	0.12	0.16	0.15	0.17	13.21	0.17	0.14	0.17
$P(d_t^6 = 1)$	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	1.11	0.04	0.01	0.04
Transitions over time												
Full-time work:												
k=0, t=0	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=0, t=1	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.03	0.02	0.03
k=0, t=2	0.08	0.07	0.08	0.07	0.09	0.07	0.05	0.07	0.05	0.07	0.05	0.07
k=0, t=3	0.12	0.14	0.12	0.14	0.13	0.14	0.07	0.13	0.07	0.13	0.07	0.13
k=0, t=4	0.28	0.27	0.28	0.27	0.29	0.27	0.16	0.25	0.15	0.25	0.14	0.25
k=0, t=5	0.46	0.41	0.46	0.41	0.47	0.41	0.31	0.39	0.31	0.38	0.29	0.38
k=0, t=6	0.63	0.57	0.63	0.57	0.63	0.57	0.53	0.56	0.54	0.56	0.53	0.56
k=0, t=7	0.74	0.68	0.74	0.68	0.73	0.68	0.70	0.67	0.72	0.67	0.71	0.67
k=0, t=8	0.80	0.77	0.79	0.77	0.79	0.77	0.79	0.76	0.80	0.76	0.80	0.76
k=0, t=9	0.83	0.84	0.83	0.84	0.83	0.84	0.84	0.83	0.85	0.83	0.85	0.83
k=0, t=10	0.86	0.89	0.86	0.89	0.86	0.89	0.87	0.89	0.88	0.89	0.88	0.89

Table 26: Observed and Predicted Choices and Transitions, by Parental Income (b).

	Parental Income < p10						Parental Income > p90					
	Mother		Father		Total		Mother		Father		Total	
	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.
Transitionsover time												
Enrolled full-time;												
no work; no loan:												
k=1, t=0	0.24	0.16	0.23	0.16	0.24	0.16	0.30	0.17	0.31	0.17	0.31	0.17
k=1, t=1	0.17	0.15	0.17	0.15	0.17	0.15	0.22	0.16	0.24	0.16	0.24	0.16
k=1, t=2	0.14	0.13	0.14	0.13	0.14	0.13	0.19	0.14	0.21	0.14	0.20	0.14
k=1, t=3	0.13	0.12	0.12	0.12	0.12	0.12	0.17	0.13	0.19	0.13	0.19	0.13
k=1, t=4	0.10	0.10	0.10	0.10	0.10	0.10	0.15	0.11	0.15	0.11	0.15	0.11
k=1, t=5	0.08	0.08	0.08	0.08	0.08	0.08	0.11	0.08	0.12	0.08	0.12	0.09
k=1, t=6	0.06	0.05	0.06	0.05	0.07	0.05	0.09	0.06	0.08	0.06	0.09	0.06
k=1, t=7	0.05	0.04	0.04	0.04	0.05	0.04	0.06	0.04	0.05	0.04	0.06	0.04
k=1, t=8	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03
k=1, t=9	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.02	0.03	0.02
k=1, t=10	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
Enrolled full-time;												
no work; full loan:												
k=2, t=0	0.23	0.28	0.23	0.29	0.23	0.28	0.21	0.29	0.22	0.29	0.21	0.29
k=2, t=1	0.50	0.28	0.50	0.28	0.49	0.28	0.44	0.30	0.45	0.29	0.44	0.30
k=2, t=2	0.45	0.26	0.44	0.26	0.44	0.26	0.41	0.28	0.42	0.28	0.42	0.28
k=2, t=3	0.34	0.24	0.33	0.24	0.33	0.24	0.36	0.25	0.37	0.25	0.37	0.26
k=2, t=4	0.23	0.19	0.23	0.19	0.22	0.19	0.29	0.21	0.30	0.21	0.30	0.21
k=2, t=5	0.12	0.15	0.12	0.15	0.11	0.15	0.17	0.17	0.17	0.17	0.17	0.17
k=2, t=6	0.05	0.11	0.05	0.11	0.05	0.10	0.07	0.12	0.07	0.12	0.07	0.12
k=2, t=7	0.03	0.08	0.03	0.08	0.03	0.07	0.03	0.08	0.03	0.08	0.02	0.08
k=2, t=8	0.02	0.05	0.01	0.05	0.02	0.05	0.01	0.06	0.02	0.06	0.01	0.06
k=2, t=9	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.04	0.01	0.04	0.01	0.04
k=2, t=10	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.03	0.01	0.03

Table 27: Observed and Predicted Choices and Transitions, by Parental Income (c).

	Parental Income < p10						**Parental Income > p90**					
	Mother		**Father**		**Total**		**Mother**		**Father**		**Total**	
	Obs.	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**	**Obs.**	**Pred.**
Transitions over time												
Enrolled full-time;												
no work; partial loan:												
k=3, t=0	0.27	0.08	0.27	0.08	0.28	0.08	0.21	0.09	0.22	0.10	0.22	0.10
k=3, t=1	0.10	0.07	0.10	0.07	0.10	0.07	0.09	0.08	0.10	0.08	0.10	0.08
k=3, t=2	0.07	0.06	0.08	0.06	0.08	0.06	0.08	0.07	0.08	0.07	0.08	0.07
k=3, t=3	0.06	0.05	0.06	0.05	0.06	0.05	0.07	0.06	0.07	0.06	0.07	0.06
k=3, t=4	0.05	0.04	0.04	0.04	0.05	0.04	0.06	0.05	0.06	0.05	0.06	0.05
k=3, t=5	0.03	0.03	0.03	0.03	0.03	0.03	0.06	0.04	0.04	0.04	0.04	0.04
k=3, t=6	0.01	0.02	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.03	0.02	0.03
k=3, t=7	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.01	0.02
k=3, t=8	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01
k=3 t=9	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
k=3, t=10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01
Enrolled full-time;												
work; no loan:												
k=4, t=0	0.05	0.14	0.04	0.14	0.04	0.14	0.06	0.13	0.05	0.13	0.06	0.13
k=4, t=1	0.03	0.14	0.03	0.14	0.03	0.14	0.03	0.13	0.03	0.13	0.03	0.13
k=4, t=2	0.04	0.14	0.04	0.14	0.04	0.14	0.04	0.13	0.04	0.13	0.04	0.13
k=4, t=3	0.06	0.13	0.07	0.13	0.07	0.13	0.06	0.13	0.06	0.13	0.06	0.12
k=4, t=4	0.11	0.12	0.12	0.11	0.12	0.12	0.09	0.11	0.08	0.11	0.08	0.11
k=4, t=5	0.14	0.10	0.14	0.10	0.14	0.10	0.14	0.09	0.14	0.10	0.14	0.09
k=4, t=6	0.14	0.07	0.15	0.07	0.14	0.07	0.17	0.07	0.17	0.07	0.17	0.07
k=4, t=7	0.13	0.06	0.13	0.06	0.13	0.06	0.15	0.05	0.14	0.05	0.14	0.05
k=4, t=8	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.11	0.04	0.12	0.04
k=4, t=9	0.10	0.03	0.11	0.03	0.11	0.03	0.10	0.03	0.09	0.03	0.09	0.03
k=4, t=10	0.09	0.02	0.10	0.02	0.10	0.02	0.08	0.02	0.09	0.02	0.08	0.02

Table 28: Observed and Predicted Choices and Transitions, by Parental Income (d).

	Parental Income < p10						Parental Income > p90					
	Mother		Father		Total		Mother		Father		Total	
	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.
Transitions over time												
Enrolled full-time; work; full loan:												
k=5, t=0	0.17	0.25	0.18	0.25	0.18	0.25	0.18	0.23	0.16	0.23	0.17	0.22
k=5, t=1	0.16	0.27	0.17	0.27	0.16	0.27	0.17	0.25	0.15	0.25	0.15	0.25
k=5, t=2	0.20	0.27	0.21	0.27	0.20	0.27	0.21	0.25	0.19	0.25	0.19	0.25
k=5, t=3	0.28	0.26	0.28	0.26	0.27	0.26	0.26	0.25	0.23	0.25	0.23	0.25
k=5, t=4	0.21	0.23	0.21	0.23	0.21	0.23	0.25	0.22	0.24	0.22	0.24	0.22
k=5, t=5	0.16	0.19	0.17	0.19	0.16	0.19	0.22	0.19	0.21	0.19	0.22	0.19
k=5, t=6	0.09	0.14	0.09	0.14	0.09	0.14	0.12	0.14	0.12	0.14	0.12	0.14
k=5, t=7	0.05	0.11	0.05	0.11	0.05	0.11	0.06	0.11	0.05	0.11	0.06	0.11
k=5, t=8	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08
k=5, t=9	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06
k=5, t=10	0.02	0.04	0.02	0.04	0.02	0.04	0.01	0.04	0.01	0.04	0.01	0.04
Enrolled full-time; work; partial loan:												
k=6, t=0	0.04	0.07	0.04	0.07	0.04	0.07	0.04	0.07	0.03	0.07	0.04	0.07
k=6, t=1	0.02	0.06	0.01	0.06	0.04	0.07	0.02	0.06	0.02	0.06	0.02	0.06
k=6, t=2	0.01	0.06	0.02	0.06	0.01	0.06	0.02	0.06	0.02	0.06	0.02	0.06
k=6, t=3	0.02	0.06	0.02	0.06	0.02	0.06	0.01	0.06	0.02	0.06	0.02	0.06
k=6, t=4	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.02	0.05
k=6, t=5	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04
k=6, t=6	0.00	0.03	0.01	0.03	0.00	0.03	0.00	0.03	0.00	0.03	0.00	0.03
k=6, t=7	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=6, t=8	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
k=6, t=9	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
k=6, t=10	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01

Table 29: Academic Outcomes, Debt, Parental and Family Background.

	Wald tests (p-value)			Pseudo R^2		
	Parental and Family background			**Parental and Family background**		
All University Entrants						
Dropout	45.47	46.81	35.36	0,00	0,01	0,01
	0.00 ***	0.00 ***	0.00 ***			
Bachelor Graduation	216.34	240.08	152.96	0,01	0,03	0,03
	0.00 ***	0.00 ***	0.00 ***			
Master Graduation	388.62	339.45	219.92	0,02	0,04	0,05
	0.00 ***	0.00 ***	0.00 ***			
Time (t) of university exit						
Dropout	8.58	39.93	25.63	0,00	0,02	0,02
	0.00 ***	0.00 ***	0.00 ***			
Bachelor Graduation	8.35	29.47	21.02	0,00	0,01	0,02
	0.00 ***	0.00 ***	0.00 ***			
Master Graduation	9.90	13.65	10.51	0,00	0,00	0,01
	0.00 ***	0.00 ***	0.00 ***			
Cumulated loan at university exit						
All	91.73	147.40	180.57	0,00	0,02	0,04
	0.00 ***	0.00 ***	0.00 ***			
Dropout	21.96	34.20	30.13	0,00	0,02	0,03
	0.00 ***	0.00 ***	0.00 ***			
Bachelor Graduation	67.04	45.16	75.62	0,01	0,02	0,05
	0.00 ***	0.00 ***	0.00 ***			
Master Graduation	64.01	38.17	109.23	0,01	0,01	0,05
	0.00 ***	0.00 ***	0.00 ***			
Control variables:						
Parental Income (real 2000 SEK)	+	+	+	+	+	+
Parental Education and Employment		+	+		+	+
Family Composition			+			+

Wald tests of joint significance of parental and family background variables (p-value)
Control variables included are: number of siblings, birth order, sibling age composition, parental marital status, parental age at birth, parental education level and field, parental employment status and financial variables in real 2000 SEK (including income, disposable income both personal and of the family, first and last percentiles.