Student Loans and Early Employment Outcomes

** WORK IN PROGRESS **

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Abstract

In this paper I investigate the link between student debt and post-graduation job market outcomes. Using a combination of survey and administrative data on graduates in two cohorts, I show that there is a significant negative correlation between the amount of debt upon graduation and the probability of finding a job which matches your education. I use evidence from Equifax to motivate a model of job search and long-term debt where the cost of consumer credit depends on your student loan balance. I successfully calibrate the model to the data and show that this debt constraint mainly binds for high and medium human capital graduates, as it affects the amount of time they are able to spend searching for a good job. I then show that alternative repayment and interest rate policies would have improved labor market outcomes for graduates in 07/08 by allowing extended search times, increasing match quality and possibly lifetime productivity.

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1 Introduction

As the returns to a college degree have risen substantially from the early 90s, the cost of college has also risen rapidly. Rising costs of and returns to college have led to sizeable increases in the demand for student loans. Borrowing for education certainly allows many students who otherwise would not have been able to have the chance for more education. However, the looming need to make loan payments after graduation also complicates the labor market decisions that students make.

Does having high student loans affect post-graduation labor market decisions for young workers? A recent survey conducted by the National Center of Education Statistics (NCES) shows that 51% of student loan borrowers reported that loans altered employment decisions. Specifically, among those people who think that student loans altered their decision, 41% of believe that they took a less desired job due to loans, and 36% claim that they took job outside of their field of study due to their debt burden. The survey suggests that student loans do have a negative effect on young workers' labor market decisions, but in what way? How big is the effect, if any? Can the government help students to alleviate their loan burden through different loan policies? These are the questions that I am investigating in this paper.

Many papers have studied the effects of student loans and evaluated the effectiveness of various student loan policies. Most of the research focuses on the effect on student's earlier schooling decision and educational attainment. For example, Garriga and Keightley (2007) studies the effect of different government student loan policies on enrollment rates and completion rates. Navarro (2011) also investigates how borrowing constraints influence student's college attendance decisions. Chatterjee and Ionescu (2012) proposes insuring student loans against the risk of failing college. There are some also studies on how student loans affect post-graduate outcomes. Cooper, Wang et al. (2014) examines the impact of student loan liabiities on individuals' homeownership states and wealth accumulation and finds that student loans lower the likelihood of homeownership. They also conclude that there is a fairly strong negative correlation between student loan debt and wealth (excluding the student loan debt). Ambrose, Cordell and Ma (2015) investigates the impact of student loan debt on small business formation and finds a significant and economically meaningful negative correlation between changes in student loan debt and net business formation. There are also a few papers which study the correlation between the student loan and post-graduate financial stability (Gicheva and Thompson (2013)), or labor market outcomes (Minicozzi (2005)).

In this paper I investigate the relationship between student loan balance at graduation and early career outcomes among students who newly graduate with a bachelor degree. Young workers are facing low income and high unemployment and underemployment rates[1]. Abel, Deitz and Su (2014) uses various data sources such as the census data, CPS and O*NET to show that many recent college graduates struggle to find jobs especially after the recession. Many workers are underemployed or working part-time. The unemployment rate for recent college graduates is about 2% higher on average from 1990 to 2013 than the unemployment rate for all college graduates. As a result, many prefer to borrow to finance current consumption. However, young workers typically face tight borrowing constraints especially when having high student loan balances. If they are unable to borrow or can only borrow at a very high price, student debt will have first-order effects on early-career consumption, and recent graduates may attempt to minimize these effects through their job choices Rothstein and Rouse (2011).

The paper unfolds as follows. Section 2 provides an overview of the government student loan repayment policies, introduces the data set and shows the result of the empirical analysis. Section 3 presents the economic model and frames the discussion of borrowing constraints in the context of the model. The estimation results and the model fit is also shown in Section 3. Section 4 provides two simple policy experiment using the estimation result of the model, and Section 5 concludes the paper.

2 Government Student Loans and Job Match Quality

This section briefly introduces the relevant government student loan policies as well as the data I am using, then show some empirical results. Section 2.1 introduces the background information about the different GSL Repayment methods. Section 2.2 describes the data I'm using in the paper and presents summary statistics. Section 2.3 analyzes how loan amounts are correlated with job matching quality.

2.1 Government Student Loan Repayment Structure

The percentage of students who borrow for higher education has been growing steadily. In 1993 49% of graduates with bachelor degrees had a student loan. By 2008 this number

[1] this is defined as workers working in a job that typically does not require the degree the worker possesses.

had increased to 66%. The average cumulative debt level is also growing - from $15000 to $24700 in constant 2009 dollars over the same period. After students graduate from college, they have a six month grace period during which those who have loans do not need to start repayment. However, interest still accumulates during the grace period for unsubsidized loans and is added to the principle. All students may choose between different student loan repayment plans and can freely switch their current plan to other plans as long as they are eligible. Two major repayment plans that are widely used are the Standard Repayment Plan and the Income Based Repayment (IBR) Plan. The Standard Repayment Plan requires fixed payments of at least $50 per month for up to 10 years. Under this plan, students pay less interest for their loan over time than they would have paid under any other plans (due primarily to the relative speed at which the loans are repaid). Students who are in the IBR plan pay a fraction (typically 15%) of their discretionary income [2] for a certain number of years. In 2012, the newest Income Based Plan–known as Pay As You Earn (PAYE) was introduced. This has so far been the most attractive income based plan, requiring maximum monthly payments to be just 10% of the discretionary income for up to 20 years. After 20 years the outstanding balance is forgiven, though students may have to pay income tax on any amount that is forgiven. However, neither of the cohorts in my data are eligible for this new plan since they graduated long before 2012.

The IBR lowers the monthly payment, but students will pay more interest in the end. Also, in order to be eligible to enter the IBR, students have to have a partial financial hardship: a circumstance in which the annual amount due on the eligible loans, as calculated under a 10-year Standard Repayment Plan, exceeds 15% (10% for the PAYE) of the difference between the adjusted gross income (AGI) and 150 percent of the poverty line for your family size in the state where you live. i.e. When students' monthly required payment under the IBR is lower than it is required under the 10 years Standard Repayment Plan, they can join the IBR plan. Whichever plan a student signs up for, he/she can always pay more than the required amount without penalty. According to the National Centre of Education Statistics, many individuals pay back their loan more quickly than it is required (Choy, Geis and Carroll (1997)). I also observe this behaviour in my data, and in my calibrated model.

There are several other repayment plans which are less commonly used compared to the two above - the Graduate Repayment Plan, Extended Repayment Plan, and Income Contingent Plan. The first two plans are very similar to the Standard Repayment Plan.

[2] This is defined as the difference between the Adjusted Gross Income (AGI) and 150% of the poverty line for your family size location

Under the Graduate Repayment Plan, students' payments are lower at first and then increase, usually every two years, to a maximum of 10 years. The Extended Repayment Plan requires fixed payments as in the Standard plan, but with a longer time span (up to 25 years). The Income Contingent Plan works like a combination of the standard plan and the IBR, where students pay the lesser of the following: 20 percent of the discretionary income or what they would pay on a repayment plan with a fixed payment over the course of 12 years, adjusted according to their income. In the B&B 07/08 sample (which I detail in the next section), among people who are in repayment in 2009, 78% are in the Standard Repayment Plan and the rest are in the IBR. In the B&B 93/94 sample, among people who are in repayment in 1994, 85% are in the Standard Repayment and the rest are in other repayment plans (The IBR did not come into effect until 2009).

2.2 Data

The data I use is from the Baccalaureate and Beyond Surveys (B&B) from the National Center of Education Statistics (NCES). The B&B was drawn from a nationally representative random sample of all postsecondary students in the US: National Postsecondary Student Aid Study (NPSAS). I use two B&B cohorts in this paper. The first B&B cohort consist of about 11,000 students. It was drawn from the 1993 NPSAS, and is followed-up by further surveys in 1994, 1997, and 2003. The second B&B cohort consists of about 17000 members. It was drawn from the 2008 NPSAS sample, and was followed-up in 2009 and in 2012. The B&B utilizes data from three basic sources: survey data in the original and follow up years; institutional records on college costs and financial aid; and snapshots from student loan administrative records (Choy and Li (2006)). Both surveys have very detailed, extensive information about family background, demographic characteristics, transcripts, major of study, school types, as well as labor market outcomes. Detailed student loan data are also provided. Thus, B&B provides sufficient information and a great opportunity to study how student loan balances are related to student labor market outcomes.

For the analysis in this paper, I mainly use the 07/08 sample but also use the 93/94 sample for comparison purposes. These two cohorts have very different backgrounds in the sense that one cohort graduated during a boom (93/94) and the other one graduated during a recession (07/08). I use the 07/08 sample for my main analysis for two reasons: first, it offers a larger sample with more respondents and many of the interview questions in the survey are more directly related to my research question (and are absent in the earlier sample).

Secondly, the student loan program and the repayment policies have changed greatly since the early 90s, so it is more informative to run policy experiments calibrated to recent cohorts than the earlier cohort. For example, one of the major government student loans, the Federal Supplemental Loans for Students (SLS) program, was eliminated in 1993 by the Omnibus Budget Reconciliation Act (effective July 1, 1994). The SLS program was merged into the unsubsidized Stafford Loan Program. Therefore, unsubsidized Stafford Loans made for periods of enrollment before July 1, 1994 may have benefits and conditions which differ from unsubsidized Stafford Loans made after that date (Department of Education (1997)). In order to make sure that empirical results regarding student loan effects are not simply due to the timing and recession, I do the same empirical analysis with both cohorts for comparison purposes. I use the first two out of three follow ups for the 93/94 B&B data (Since there isn't a third follow up yet for the 07/08 B&B) and the two follow ups for the 07/08 data.

To focus on a typical American student and exclude the outliers, I exclude individuals who are not a US citizen, disabled, or received their bachelor degree later than 30 years old. I also exclude individuals who are enrolled in graduate school since their labor market decisions are strongly influenced by their schooling decisions. For example, students who go to graduate school will probably spend less time in the labor force and do not care about job match quality as much as people who exclusively work and wish to start to build a career. Students in graduate school also do not need to pay back their undergraduate student loans while in school since they are in deferment automatically. Including these people would confound the student loan effect on the labor market outcome that I'm interested in. Furthermore, I exclude people whose student loan is paid by parents or friends, since loans have no effects or smaller effects to these students who get help with paying off their loans compared to students who must pay their loans independently. Altogether, for the B&B 07/08 data, this leaves me 7434 American citizens who received their baccalaureate degree in 07-08 but didn't participate in graduate school after, and paying their own student loans. For the earlier cohort, this leaves me with 5877 observations.

2.3 Empirical Analysis

As student loan balances rise and the proportion of students who borrow for education increases, the question raised is how might student loan balances at graduation affect labor market outcomes, especially immediately after graduation? This is the key question of interest in this paper. One crucial indicator for job market outcomes is occupational matching quality. Guvenen et al. (2015) argues that mismatch is central to the career outcomes of workers and mismatch in occupations held early in life have a strong negative effect on wages in future occupations. There are many different ways to measure/indicate matching quality. One matching quality indicator that is commonly used is underemployment: whether or not the current job requires the highest degree that a worker possess. The B&B 07/08 has information on this: four years after graduation with a bachelor's degree, 40% of borrowers work at jobs which do not require a bachelors degree.

The indicator used in this paper for the main analysis is self reported data on matching quality. The B&B 2003 survey provides self-reported data on job match quality. One year and four years after graduation with a bachelor degree, all the individuals report whether their current job is very relevant, somewhat relevant, or not relevant at all to their major of study in college. Students who answer very relevant or somewhat relevant are further asked if the current job is in their desired industry.[3] I use this as the indicator of job match quality in the analysis of the later cohort. In the earlier cohort, students are asked the first question (how is the job related to the major of study), but not the second. However, in 1994 and 1997 (one and four years after the first cohorts graduation), students are asked what is their current occupation, and what is their expected occupation in long term. For students who report that their current job is somewhat relevant or very relevant to their major of study, and whose current occupation matches the long term expectation, I deem them as having a "good match". The definition of "good match" in two different cohorts are not quite the same, so it may not be completely accurate to compare the magnitude of the loan effect directly between the two cohorts. However, it won't affect the cross-sectional analysis.

I firstly use a simple Probit specification to investigate the relationship between job match quality and student loans. The dependent variable is a dummy variable equal to one if the individual is in a good match and equal to zero otherwise. The independent variable is the log of the student loan balance.

$$Pr(GoodMatch_i) = \beta_0 + \beta_1 \log(DebtAtGraduation_i) + \epsilon_i$$

I used the federal student loan data only because on average, over 90% of the total student loans are federal student loans, and these loans are directly relevant to the policy experiments in the next section. However, excluding other loans potentially biases the result down. The

[3] The question is: Do you consider your current job to be part of a career you are pursuing in your occupation or industry?

Table 1: Regression Results for B&B 07/08 Cohort

	Probit 1	Probit 2	IV Probit 1	IV Probit 2
logowe	-0.01245***	-0.009**	-0.21867***	-0.219226***
	(0.0046)	(0.0047)	(0.02766)	(0.06558)
controls	No	Yes	No	Yes

regression model is as follows and the results for the 07/08 cohort are shown in table 1 column 1.

The coefficient is -0.01245 at 1% significance level. The interpretation of the result is that an 10% increase in student loan level leads to a 5% decrease in probability of a good match. Many other factors which may be related to student debt also play a role in the probability of getting a good match, such as the type of school, major, etc. To ensure an unbiased result, I include these control variables and run the following regression:

$$Pr(GoodMatch_i) = \beta_0 + \beta_1 \log(DebtAtGraduation_i) + X_i\gamma + \epsilon_i$$

X here is a vector of independent variables which include: dependent status dummy, log of family income, school type dummy (public school, private non-for-profit school, and private for-profit school), SAT score quartile dummies, GPA, parents highest education level, and major dummy. Here I grouped all majors into three categories (High, Medium, Low) based on the average income, because I later uses these variables in the model calibration section. The result is shown in column 2 in table 1. Note that the effect is smaller but still significant at 5% significance level. A 10% increase in loan balance is correlated with 3.4% of probability decrease of getting a good matching job.

One natural question when studying the effects of student loans on labor market outcomes is that the loan amount is not plausibly exogeneous. Student characteristics (such as ability, family income and tuition) might be the reason that agents borrow different amount of student loans, which in turn also affect labor market outcomes. Therefore, it is important to carefully separate the effect of the loan and the effect of these other factors. One good news is that students in B&B sample are homogeneous in their educational attainment: all students in the sample have a bachelor degree, so this takes away part of the endogeneity concern. Also, though the B&B doesn't provide much information about the students before they graduate, it does have information about the net tuition (fees minus grants) in the year before graduation which indirectly affects student labor market outcomes only through the student loan balance. I used the net tuition as an instrument for the amount students owe

Table 2: Regression Results for B&B 93/94 Cohort

	Probit 1	Probit 2	IV Probit 1	IV Probit 2
logowe	-0.00187	-0.11917**	-0.03080	-0.08528**
	(0.00386)	(0.00419)	(0.03287)	(0.02791)
controls	No	Yes	No	Yes

upon graduation, as well as controlling for other students' characteristics.

The result for the instrumented Probit regression are shown in column 3 and 4 of table 1. In column 3, only the log of the student loan balance is included, while in column 4, all the other variables (same as the probit regression above) are included. Note that for both of the model specifications, the coefficients are negative and significant at the 1% level, and the value of the coefficients are similar. With the full specification including all the control variables, the interpretation of the result is that a 1% increase in student loan balance is associated with a 6.9% decrease in probability of getting a good matched job. The instrument, however, is weak. The Wald test fails to reject the null hypothesis that the regressor is exogeneous.

I perform exactly the same analysis with the earlier B&B 93/94 cohort, and the results are shown in table 2. The regressions without controls do not produce significant results whether or not the instruments are included. However when the control variables are included (same variables as in the 07/08 cohort), the results become significant at the 5% level for both specifications. Comparing to the 07/08 cohort, the effect of the loan on good match probability is smaller: a 1% loan increase is correlated to a 2.9% decrease in probability of a good match. However, the two results are not directly comparable for the reasons mention before (the dependent variable is defined differently). What is important is that even for a completely different cohort which graduated in a boom, student loans still had a significantly negative correlation with the probability of finding a good job. Considering that the 07/08 cohort's effect is stronger and has more observations, I will focus my subsequent analysis on the 07/08 cohort.

3 Model and Estimation

The empirical results suggest that there is a negative correlation between the amount of student loans an individual has at graduation and their probability of finding a good match.

To understand the mechanism of how student loans affect new graduate's early labor market outcomes, in this section I develop a simple partial equilibrium heterogeneous agents model which can use to better interpret the facts that I observe in the data, and also allow me to do counterfactual policy analysis.

How do student loans affect students' post-graduation outcomes? One possible mechanisms is that many students are credit constrained after graduation, especially students with high student debt. Young workers have low wages and the beginning of their career is relatively unstable. They would want to borrow to smooth consumption, especially in situations when they have lost their job or looking for work. If recent graduates are unable to do this, student debt will have first-order effects on early career decisions (Rothstein and Rouse (2011)). There are other mechanisms that have been proposed in previous research, such as direct income effects and negative utility from debt. However, Minicozzi (2005) suggested that the income effect is minimal since the amount of debt is very small compared to the present value of students' life time income, and Rothstein and Rouse (2011) conclude that the negative preference hypothesis is unlikely to be true.

In this model all agents are searching for jobs and are making student loan repayment decisions. Additionally, they may borrow or save to maximize present value of the stream of utility from consumption. The decision they make is conditional on the type of job offer they get and their different states, specifically their debt levels and human capital level. Considering that new graduates only account for a small proportion of the entire labor market, students take wage as given. When an offer lands, they decide to take the job or wait for a better job. Student decisions have no influence on the wage setting (this is a partial equilibrium model). The model incorporates the different government student loan repayment policies and illustrates how having the option to choose different repayment method can affect students' early career outcomes through the repayment method. The availability of different repayment methods allows students to alleviate their debt burden especially earlier in life.

3.1 Simple Model of Debt and Career Choice

Time is discrete and runs forever, $t = 0, 1, 2, ...$ The economy is filled with heterogeneous agents that differ in their human capital (h) level, initial student loan balance (D), current student loan balance (d), asset position (b), and employment status (e). Each agent has one unit of labor and supplies it inelastically. Agents live forever and discount the future with the discount rate β. The objective of an agent then is to maximize the expected lifetime flow utility from consumption.

$$\mathbb{E}\Big[\sum_{t=0}^{\infty} \beta^t u(c_t)\Big]$$

c_t is the period consumption flow at time t. Period utility has the Constant Relative Risk Aversion (CRRA) form.

$$u(c_t) = \begin{cases} \frac{c_t^{1-\sigma}}{1-\sigma} & \sigma > 0 \\ \log(c_t) & \sigma = 0 \end{cases}$$

where σ is the coefficient of relative risk aversion. All agents graduate in $t = 0$ with zero assets ($b_0 = 0$). When they graduate ($t = 0$), the current student loan balance (d_0) is equal to the initial student loan balance (D_0), which is drawn from distribution $F(D) \subseteq \mathbb{R}_-$. If the agent has a positive student loan balance, he can choose how much to pay back each period subject to the minimum payment required by the government repayment program the agent is in. Agents can choose freely between the repayment programs, and can switch from one to the other at any time. I use two of the most common repayment methods in the model: the regular repayment which requires a fixed amount of payment for up to 10 years:

$$P_S(d, D) = \frac{\max\{|d|, |D|\}}{\sum_{t=1}^{10} \left(\frac{1}{1+r}\right)^{t-1}}$$

Here r is the student loan interest rate set by the government. The income based repayment plan requires that agents pay a fraction of discretionary income (Adjusted Gross Income (AGI) subtract the 150% of the poverty line) at minimum:

$$P_I(y) = \max\{\lambda(y - \underline{w} \times 150\%), 0\}$$

Here y is the agent's income and $\underline{w}$ is the poverty line. Note that y is dependent on the human capital level. Combining the two repayment methods, the minimum required payment can be written as:

$$P_{min}(d, D, y) = \min\{P_S(d, D),\ P_I(y),\ |d|\}$$

Agents can pay any amount in the student loan repayment above this lower bound.

All agents can borrow or save to smooth consumption between periods. When saving, the price is equal to $\frac{1}{1+r_{rf}}$, where r_{rf} is the risk free interest rate. Agents' borrowing price differ based on their current state. Agents can borrow at price $Q(d, y)$, so the price depends on both the balance of student loans and the amount of borrowing, as well as the income level.

For each human capital level there are two types of jobs: good match jobs and bad match jobs. Good job and bad job offers arrive randomly, conditional on agents' level of human capital. Every period, agents with human capital h receive a good match job offer with probability $p^G(h)$ and a bad match job offer with probability $p^B(h)$. With probability $(1 - p^G(h) - p^B(h))$ no offer arrives. Agents who get a good offer will accept it immediately while agents who get a bad offer can choose to accept or wait. Agents' income depend on both their human capital level and job matching quality.

Every period, working agents are separated from their current employer and become unemployed at exogenous rate δ_E where $E \in \{G, B\}$. An employed agent works at the same wage forever unless exogenously separated, and good match jobs have different separation rates from bad match jobs. In this simple set up of the model, I assume human capital doesn't change, because the main interest of this paper is the labor market outcomes of agents a few years after graduation. Human capital change wouldn't affect the analysis significantly for the purpose of this paper.

Altogether, an agent with a good match job chooses the amount of payment to student loans and also chooses the next period asset level to maximize the period utility and the expected continuation value. The agent solves the following problem:

$$V^G(h, d, D, b) = \max_{p,\ b'} \Big\{ u(c) + \beta(1 - \delta_G)V^G(h, d', D, b') + \beta\delta_G V^U(h, d'D, b') \Big\}$$

$$\begin{aligned}
s.t. \qquad & c + q(b', d, y^G(h)) \times b' + p = y^G(h) + b \\
& d' = (d + p) \times (1 + r), \qquad d, d' \leq 0 \\
& p \geq P_{min}(d, D, y^G(h)) \\
& P_{min}(d, D, y) = \min \left\{ \frac{\max\{|d|, |D|\}}{\sum_{t=1}^{10} \left(\frac{1}{1+r}\right)^{t-1}},\ \max\{\lambda(y - \underline{w} \times 150\%), 0\},\ |d| \right\} \\
& q(b', d, y^G(h)) = \begin{cases} \frac{1}{1+r_{rf}} & \text{when } b' \geq 0 \text{ (saving)} \\ Q(d, y^G(h)) & \text{when } b' < 0 \text{ (borrowing)} \end{cases}
\end{aligned}$$

The borrowing price $Q(d, y^G(h))$ is a pricing function of the asset, which is a function of the wage level and current student loan level. The assumption in the model is that when the total debt to income ratio increases, the cost of debt increases. This assumption is well justified. For students who are otherwise the same, those with high student loans are more credit constrained than those with smaller student loan balances or have no loans. Ceteris peribus, the student with a high loan balance faces higher borrowing costs. Many researches have shown similar results that high student debt is associated with higher probability of being credit constrained and in financial hardship. Gicheva and Thompson (2013) uses both the Equifax and SCF data to show that outstanding student loans increase the probability of being denied credit: with \$10000 in debt raising the probability by six percentage points. Thompson and Bricker (2014) uses the SCF and shows a similar correlation between student debt balance and financial distress. Chan and Xu (2015) uses Equifax data to shows that from 1999 to 2014, the average FICO score[4] for people without student loans is persistently higher than for people with student loans among 25-30 years old. The result is shown in Figure 1: the difference between the FICO scores for borrowers and not-borrowers diminishes gradually up until right before the recession and starts to split widely. Similar results have been shown using TransUnion (Wise (2015)), and the TransUnion report further shows that the effect of student loans on credit profiles is not unique to the recession. This justifies the assumption that correlation between the cost of debt and student debt balances applies not only to the B&B 07/08 data, but also to the 93/94 data.

The badly matched agents solve a similar problem to the good matched agents. However, when an agent is working at a bad match job (either because the major of the study doesn't match the occupation or the current occupation is not part of a career), the probability of being separated from the job is very different (potentially much higher) than for a good match job. This is intuitive and well supported, for example, Guvenen et al. (2015) suggests that skill mismatch significantly increases the probability of an occupational switch. In the calibration of the model, I show that this assumption is well justified and that the probability of separating from a bad match job is much higher than it is for a good match job. Use δ_B to denote the probability of separation, and the problem the agents are solving is as follows:

[4] A FICO score is a credit score developed by FICO, a company that specializes in what's known as predictive analytics, which means they take information and analyze it to predict what's likely to happen.

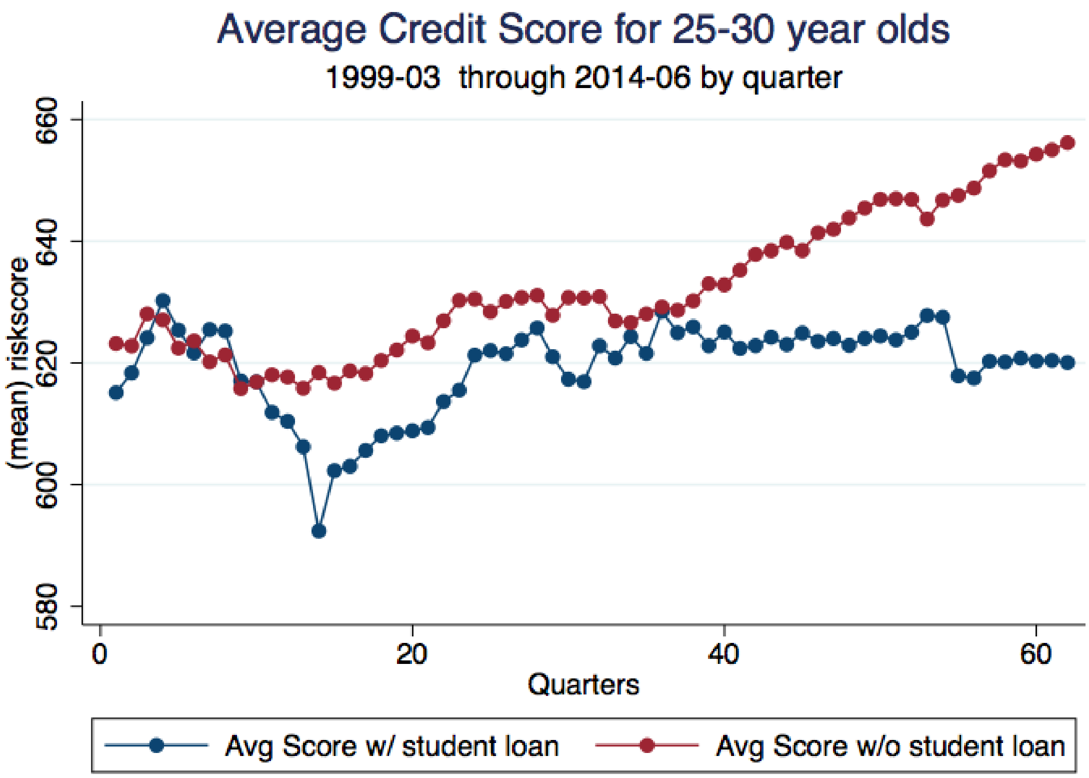
Average Credit Score for 25-30 year olds
1999-03 through 2014-06 by quarter
(mean) riskscore
580
600
620
640
660
0
20
40
60
Quarters
Avg Score w/ student loan
Avg Score w/o student loan

Figure 1

$$V^B(h,d,D,b) = \max_{p,\ b'} \left\{ u(c) + \beta(1-\delta_B)V^B(h,d',D,b') + \beta\delta_B V^U(h,d'D,b') \right\}$$

$$\begin{aligned}
s.t. \qquad & c + q(b',d,y^B(h)) \times b' + p = y^B(h) + b \\
& d' = (d+p)\times(1+r), \qquad d,d' \leq 0 \\
& p \geq P_{min}(d,D,y^B(h)) \\
& P_{min}(d,D,y) = \min\left\{ \frac{\max\{|d|,|D|\}}{\sum_{t=1}^{10}\left(\frac{1}{1+r}\right)^{t-1}},\ \ \max\{\lambda(y - \underline{w}\times 150\%),0\},\ \ |d| \right\} \\
& q(b',d,y^B(h)) = \begin{cases} \frac{1}{1+r_{rf}} & \text{when } b' \geq 0 \text{ (saving)} \\ Q(d,y^B(h)) & \text{when } b' < 0 \text{ (borrowing)} \end{cases}
\end{aligned}$$

Compared to workers with both good matches and bad matches, the unemployed workers are making one additional decision. Besides making optimal repayment decisions and borrowing/saving decisions, unemployed workers also need to decide whether or not to accept a bad match job when a bad match offer arrives. If the unemployed worker decides to accept the offer, he transit to the bad worker's problem next period, and if he decides to keep waiting, he stays at the unemployed worker's problem next period. As before, the worker makes all decisions to maximize their period utility and continuation value:

$$V^U(h,d,D,b) = \max_{p,\ b'} \Big\{ u(c) + \beta \Big(p^G(h) V^G(h,d',D,b') + (1 - p^G(h) - p^B(h)) V^U(h, d'D, b') + p^B(h) \max\{V^U(h,d'D,b'), V^B(h,d'D,b')\} \Big) \Big\}$$

$$\begin{aligned}
s.t. \qquad & c + q(b',d,y^U) \times b' + p = y^U + b \\
& d' = (d+p) \times (1+r), \qquad d, d' \leq 0 \\
& p \geq P_{min}(d,D,y^U) \\
& P_{min}(d,D,y^U) = \min \left\{ \frac{\max\{|d|,|D|\}}{\sum_{t=1}^{10} \left(\frac{1}{1+r}\right)^{t-1}},\ \ \max\{\lambda(y^U - \underline{w} \times 150\%), 0\},\ \ |d| \right\} \\
& q(b',d,y^U) = \begin{cases} \frac{1}{1+r_{rf}} & \text{when } b' \geq 0 \text{ (saving)} \\ Q(d,y^U) & \text{when } b' < 0 \text{ (borrowing)} \end{cases}
\end{aligned}$$

I now turn to the discussion of optimal repayment and optimal asset choice for the agents. Assuming that both the price function and the value functions for agents with all employment status are first order differentiable, the envelope conditions for optimal asset choices when employed (good match and bad match) and unemployed can be written as:

$$u'(c) = V_4^G(h,d,D,b) \tag{1}$$
$$u'(c) = V_4^B(h,d,D,b) \tag{2}$$
$$u'(c) = V_4^U(h,d,D,b) \tag{3}$$

Equation (1) (2) and (3) require the marginal utility flow of consumption to be equal to the marginal value of assets, both when employed (in good match or bad match jobs) and unemployed. This result is standard - expected utility can't be increased or decreased by additional savings or borrowing.

Similarly, the envelope condition for optimal repayment choice in different employment status' can be written as:

$$u'(c)(1 - Q'(d)b') = V_2^G(h,d,D,b) \tag{4}$$
$$u'(c)(1 - Q'(d)b') = V_2^B(h,d,D,b) \tag{5}$$
$$u'(c)(1 - Q'(d)b') = V_2^U(h,d,D,b) \tag{6}$$

Equation (4) (5) and (6) hold under the condition that $b' < 0$. When $b' \geq 0$, i.e. consumers choose to save, the left hand side of all three becomes $u'(c)$. These three envelope conditions are similar with (1) (2) and (3) which require the marginal utility flow of consumption to be equal to the marginal value of student loans for all three employment status. Note that if $b' < 0$ the value of $(1 - Q'(d)b')$ is greater than 1, since Q is increasing in d. This is intuitive: when $b' < 0$, i.e. when agents are borrowing, the price of borrowing depends on the student loan level d. So the marginal value of student loans is greater than the marginal utility flow of consumption because of its additional marginal value from the asset price change. However, when $b' >= 0$, the left hand side becomes $u'(c)$, which means that the marginal value of student loan is equal to the marginal utility of consumption. This is because when agents are saving, the student loan level d has no effect on the price of asset so there isn't the additional marginal value from student loan. Note in this case, the marginal value of student loan is also equal to marginal value of asset.

The first order necessary conditions further characterized the agents optimal asset and repayment choices. For agents with good jobs, the FOCs are:

$$u'(c)q(b', d) = \beta(1-\delta)V_4^G(h, d', D, b') + \beta\delta V_4^U(h, d', D, b') \tag{7}$$

$$u'(c)\frac{1}{1+r} = \beta(1-\delta)V_2^G(h, d', D, b') + \beta\delta V_2^U(h, d', D, b') + \frac{\mu}{1+r} \tag{8}$$

$$\mu(p - P_{min}(d, D, y)) = 0 \tag{9}$$

This standard inter-temporal result states that the marginal utility of consumption loss/gain today is equal to both the marginal value gain/loss of student loan and asset tomorrow in today's present value. This is true for agents with bad matching job, and unemployed agents also (the FOCs for V^B and V^U are omitted here because of the similarity with V^G). Note that μ is the Lagrange multiplier for the minimum payment constraint and it is equal to zero when the constraint is slack. When the constraint is binding, $\mu \neq 0$, and the agent pays the minimum payment required: $p = P_{min}(d, D, y)$.

3.2 Estimation

Solving the model requires knowledge of the agents' initial student loan distribution $F(D)$, wage offer rates for agents in different human capital levels with different employment states $y^E(h)$, the agent's discount factor β and CRRA preference parameter σ, the interest rates r, r_{rf} and the pricing function $Q(d, y)$, the probability of getting a good match offer for different group of people $p^G(h)$, probability of not getting an offer $P^U(h)$, probability of being fired or job destruction for both well matched and bad matched agents δ_G and δ_B. The key interest of this paper is agents early labor market outcome, so the parameters are calibrated so that the models simulated early career outcome is consistent with the career outcome in B&B 07/08 one (2009) and four years (2012) after the agents graduate.

I fix the CRRA risk aversion parameter at the standard level: $\sigma = 2$. For the initial student loan distribution and initial wage level distribution, it is possible to directly identify from the data. Initial wage level differs across human capital level and employment status. I use agents' major as a proxy of human capital. Specifically, I firstly ranked all majors based on the average wage within the major, and then for the group of majors which the average wage of the major is greater than the 75 percentile of total average wage, I label them as high human capital group, Similarly, for majors which the average wage within the major is below 25 percentile of the total average wage, I label them as low human capital. The rest of majors are grouped into middle-human capital. Inside each major group, I separate agents into sub-groups based on their employment status. I use the average sub-group wage in B&B 07/08 directly and get six different wages for each sub-group: $y^G(h)$ and $y^B(h)$,where $h \in \{H, M, L\}$. In this simple baseline model, I assume that once an agent is matched his wage doesn't change. The poverty line is set to be \$11200 annually which is from the census definition of poverty line. The pre-calibrated parameters are summarized in table 3.

One challenge of the calibration is to define function $Q(d, y)$. Though it is well supported that a high balance student loan and debt to income ratio is negatively correlated with agents' credit scores and borrowing ability, it is not clear to what magnitude the student loan affects the borrowing price. The ideal way of setting the price is to make it endogenous, so that agents risk factor and default probability endogenously decide what the borrowing price is. However, this will make the problem much more complicated and greatly increase the computational burden – It requires value functions of good credit and bad credit for all agents with different employment status. To capture the effect of credit constraints without making the model too complicated to solve, I assumed that the borrowing price agents face depends on the agent's debt to income ratio. Specifically, I combine individual student loan payments and balance of assets (if borrowing) as the debt obligation, and calculate the ratio of this debt obligation over the discretionary income. I use the discretionary income because I do not model agents' housing decision, but rent or mortgage is a big proportion when debt to income ratio is calculated in the real world. When this ratio is below 40%, the borrowing price is at average credit card rate, 21% annually. When the ratio is above 40%, it

Table 3: Pre-Calibrated Parameters

Variable	Value	Description
σ	0.2	Risk Aversion
r_{rf}	0.04	Annualized Risk Free Rate
$\underline{w}$	11200	Poverty Line
λ	0.15	Repayment Fraction of IBR
r	0.068	Avg. GSL Interest Rate
$y^G(H)$	47500	Avg. Annual Income for GM High HC
$y^G(M)$	37600	Avg. Annual Income for GM Medium HC
$y^G(L)$	30700	Avg. Annual Income for GM Low HC
$y^B(H)$	33900	Avg. Annual Income for BM High HC
$y^B(M)$	28800	Avg. Annual Income for BM Medium HC
$y^B(L)$	27600	Avg. Annual Income for BM Low HC

becomes very difficult for agents to borrow–agent can only borrow at some very high interest rates such as the loan shark rate (which I set to 100%). The cutoff 40$ is chosen because 40% debt to income ratio is used by many mortgage provider as a cutoff, and I assume a similar cutoff rule in this paper. Given these assumptions, the result may not be as accurate quantitatively, but it is qualitatively effective because it is sufficient to capture the main mechanism–high debt to income ratio agents are more credit constrained, and it generally matches the data well. However, I do not match consumer debt in the model to the data since firstly there isn't much information about student credit card borrowing decision, and secondly the assumptions in the model about the borrowing price is limited and restrictive.

The annualized risk free rate r_{rf} is set to be 4% and the annualized student loan interest rate is set to be 6.8% to match the average interest rate of the government student loan policy. I assume that the probability of getting a bad match job offer is the same for all human capital level groups: p^B, since no matter what level of human capital, agents can always find some temporary bad match job (this is more likely to be true given that all agents in B&B data have a bachelor degree). This reduces to two parameters which need to be estimated. Therefore the probability of not getting a job offer is simply $1-p^G(h)-p^B$. For high human capital agents, the probability of not getting any job offer is smaller than other groups (this is shown in the calibration result). The remaining eight parameters include the probability of getting a good job for each human capital group: $p^G(H)$, $p^G(M)$ and $p^G(L)$, the probability of getting a bad offer p^B, agent's discount factor β, unemployment benefits y^U, and finally the probability of separation for good match and bad match jobs: δ^G and δ^B. The parameters are calibrated jointly to match eight moments: the share of agents in

Table 4: Jointly Estimated Parameters

Variable	Value	Description
β	0.96239	Discount Factor
$P^G(H)$	0.2359	Probability of Good Match for High HC
$P^G(M)$	0.1711	Probability of Good Match for Medium HC
$P^G(L)$	0.13335	Probability of Good Match for Low HC
P^B	0.18192	Probability of Bad Match
Y^U	16134	Unemployment Income
δ^G	0.023017	Separation Rate of Good Match
δ^B	0.14841	Separation Rate of Bad Match

good matched jobs for each human capital group one year after graduation; the share of all agents that are unemployed one year after graduation; the average student loan balance one year after graduation conditional on having a positive loan at graduation; average time to find the first job; the transition probability from good job to good job between one year and four years after graduation, and the transition probability from bad job to good job between one year and four years after graduation.

Table 4 summarizes the parameters and Table 5 summarizes the model's fit relative to the targeted moments. The first five moments are all evaluated at the target period (t = 7)[5], while the last two moments captures the transition probability between one year after graduation and four years after graduation. The model matches most of the moments well while it is unable to match some moments. Firstly, the model doesn't match the unemployment rate very well since there is no on the job search or wage growth in the model. This decreased the incentive for people to take a bad job because once they are matched, they can't move to a better job unless being exogenously separated. So more agents would wait for good match jobs and the unemployment rate in the model is higher than it is in the data. For the same reason, the time to find the first job is longer than it is in the data, and the transition probability of moving from a bad match job to a good match job is smaller than it is showed in the data (due to no on the job search).

Using the calibrated parameters, the model can be fully solved. Figure 2, 3 , and 4 show the value functions for agents with high, medium, and low human capital level respectively in the beginning of the first period. In the first period, the initial debt level equal to the current debt level, and consumer asset level is equal to zero. From all three figures it is clear that the value of good match (V^G) is superior to both the value of bad match (V^B)

[5] In B&B 07/08, Some students graduated in fall 2007 and some graduated in spring 2008. I took the average time between graduation and the first interview.

Table 5: Targeted Moments

Moments	Target Value	Model Value
Share of Good Match for High HC	0.7220	0.7248
Share of Good Match for Medium HC	0.5291	0.5490
Share of Good Match for Low HC	0.4285	0.4321
Unemployment Rate	0.088	0.1127
Average Student Debt	-11100	-10064
Time to 1st Job (in Quarters)	1.985	2.150
Transition Rate G to G	0.883	0.884
Transition Rate B to G	0.6378	0.5770

and unemployment (V^U). Thus whenever a good match offer arrives the agent will accept without doubt. However, how V^B compares to V^U is different across human capital groups. For both high human capital and medium human capital agents, there is an intersection between V^B and V^U, which gives a cutoff level of initial debt. If the initial student loan level is below the cutoff, V^U is greater than V^B, so the student would not accept a bad match offer when it arrives. Instead, the agent chooses to wait for a better offer since V^U is greater. Note the level of the cutoff is different when having different levels of human capital: the higher human capital you have, the more debt you can ”handle” (waiting for a better job). This is because that the probability of finding a good job is higher for high human capital, and the wage difference between good match jobs and bad match jobs is bigger for high human capital individuals so it is worthwhile to wait. For low human capital agents, V^B is higher than V^U for all level of initial debt. Therefore agents with low human capital would not choose to wait no matter what debt level they initially have because waiting is not worthwhile due to the low probability of finding a good job as well as the small difference between the wages from good and bad match job. The result from the value functions illustrate the key mechanism of the student loan effect: when bad job offer arrives, agent who has no student loans or low balance of student loans can choose to reject and wait for good match job while agent with high student loan balance choose to take the job, ceteris paribus.

Figure 5 shows the dynamics of good match rate changes for each human capital level group over time. As the graph shows, the good match rate increases sharply after the graduation and then gradually slows down. Specifically, a bit over one year after graduation (the dotted vertical line shows the target period), the average good match rate is 72.48%, 54.9% and 43.21% for high, medium and low human capital levels respectively. Figure 7 shows the student loan repayment dynamic. Agents payoff the student loan rather quickly earlier in life to avoid interest rate accumulation. By the target period, the average student's

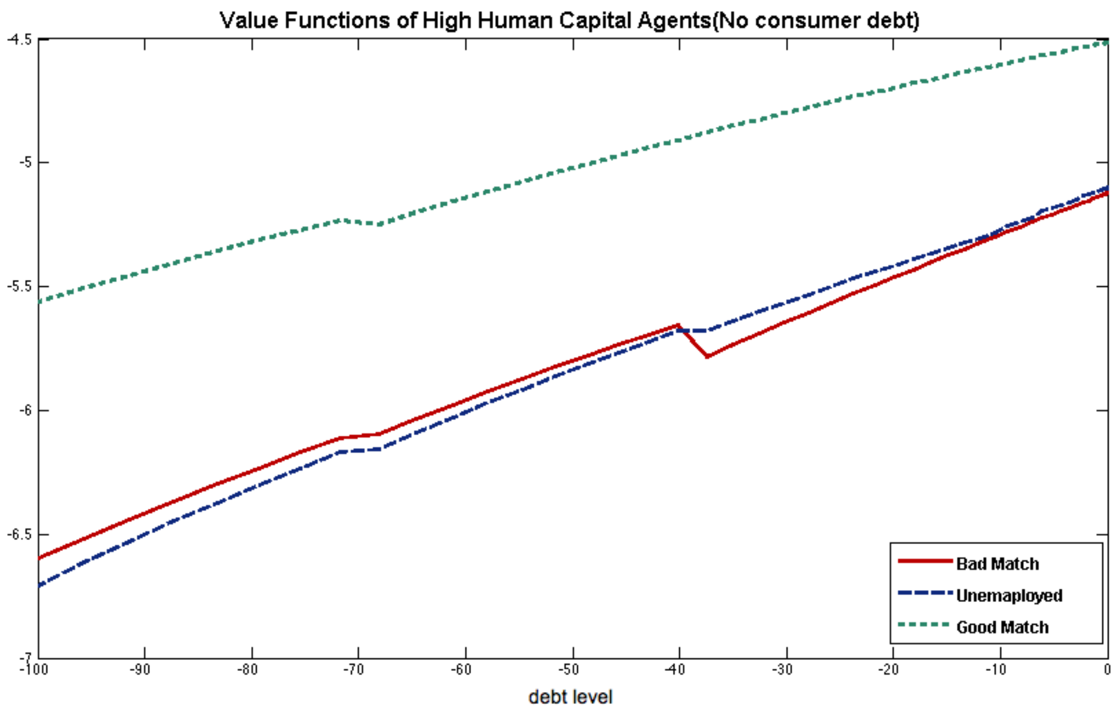

Figure 2

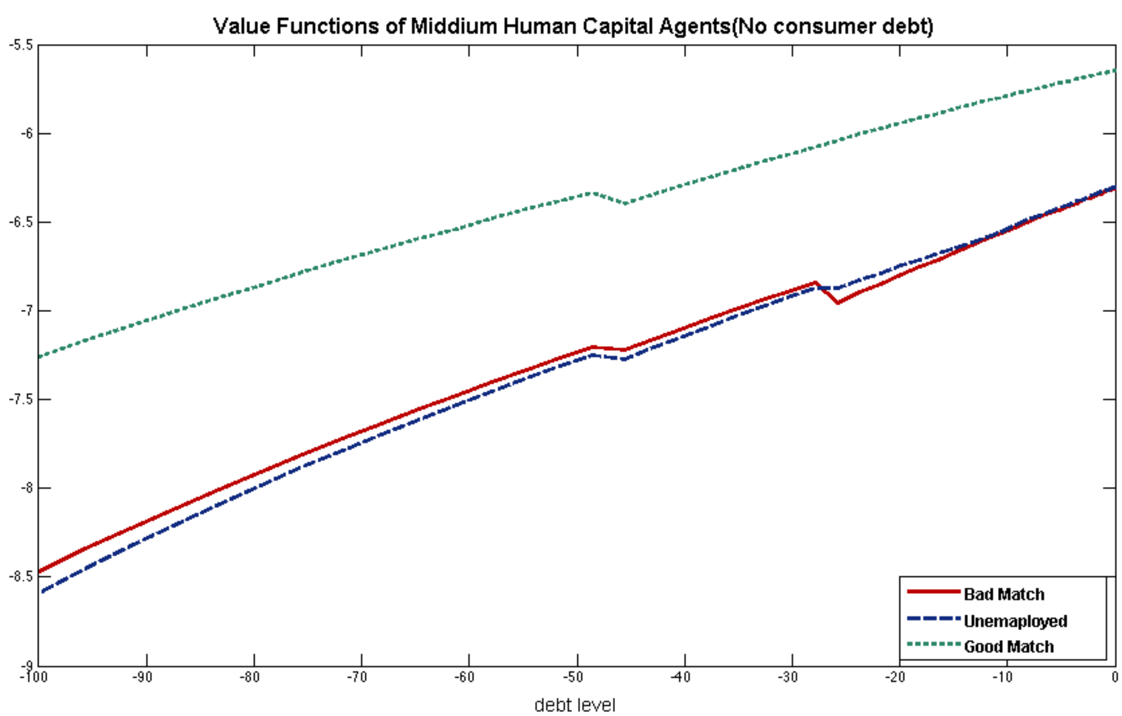

Figure 3

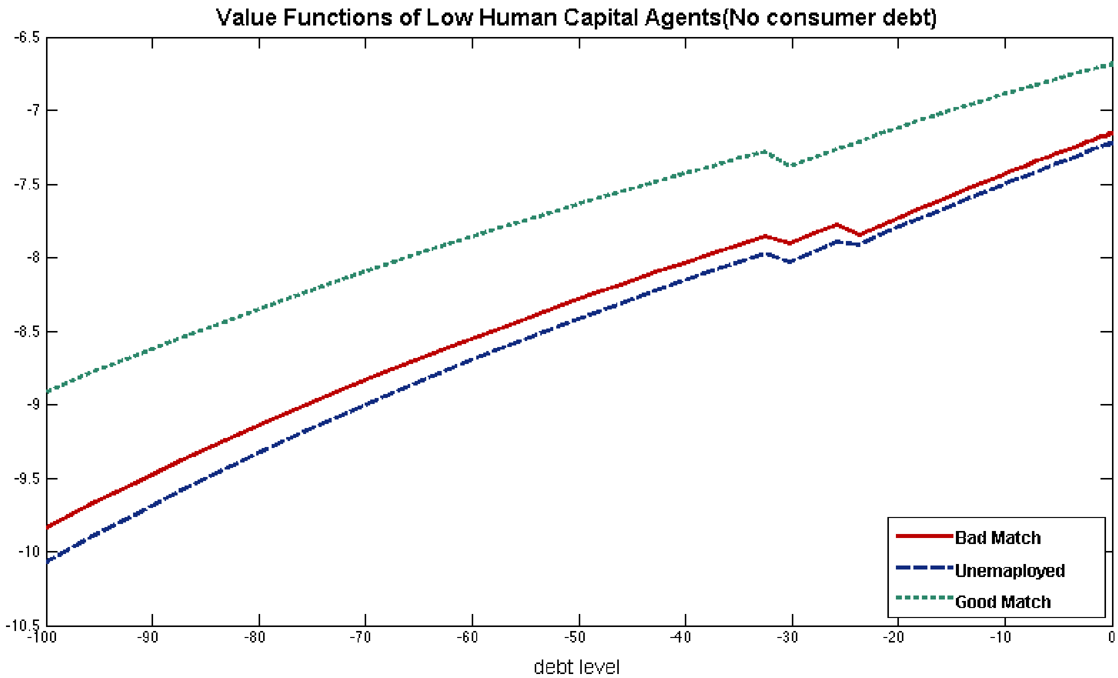

Figure 4

loan debt level is \$10064, so the model predicts a slightly faster repayment speed than in the data. Figure 8 illustrates the dynamic of average good match rates (for all human capital groups), as well as the bad match rate and unemployment over time. Good match rate increases as shown in figure 5, and bad match rate increases at the beginning then gradually decreases. This is because some agents may choose to work at a bad matched job to alleviate the debt burden earlier in life, then can afford to wait for better matched job (when separated) once the debt burden is low. The limitation of the model is that agents with bad match can't choose to move to better jobs unless exogenously separated. This reduces the transition probability from bad job to good job so that the model's prediction is lower than it is in the data. For a similar reason, the unemployment rate that the model predicts is also higher than it is in the data – bad matched (less stable job, separation rate is high) workers can only transit to good job (stable job, separation rate is low) through the unemployment stage.

Finally, figure 6 shows the average student debt level over time given the eventual matching quality (the matching quality at ($t = 40$)). Specifically, I put all agents in two groups based on their eventual outcome, and plot the average loan level over time for each group. The graph supports the main idea of the paper that agents who end up at a good match job on average have lower student loan level initially.

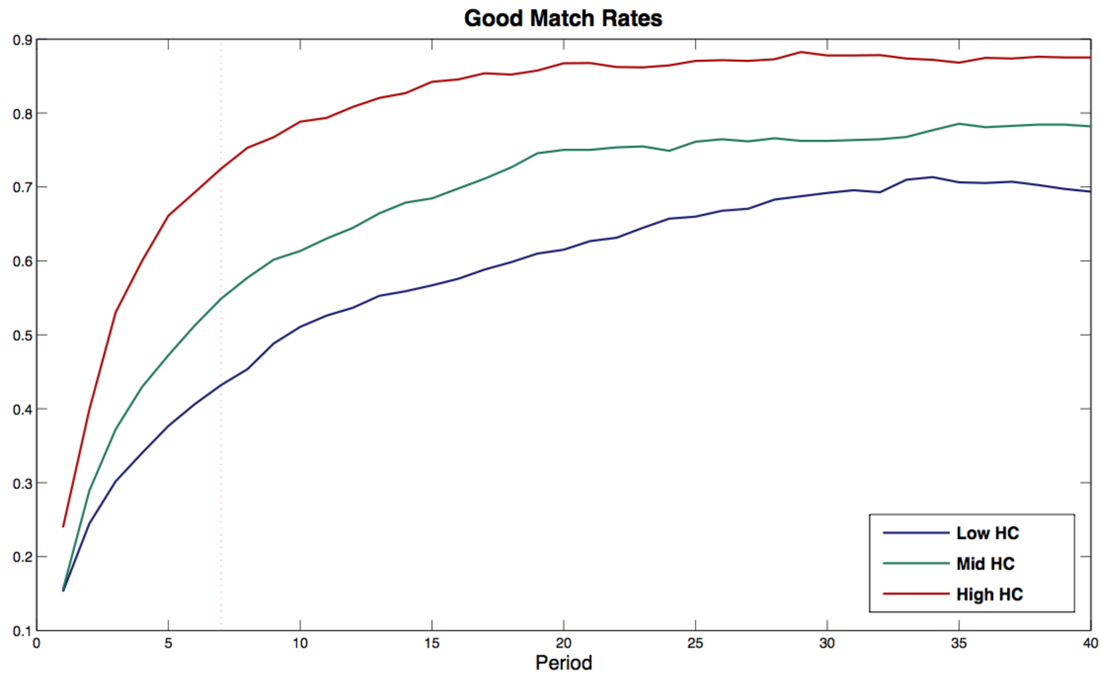

Figure 5

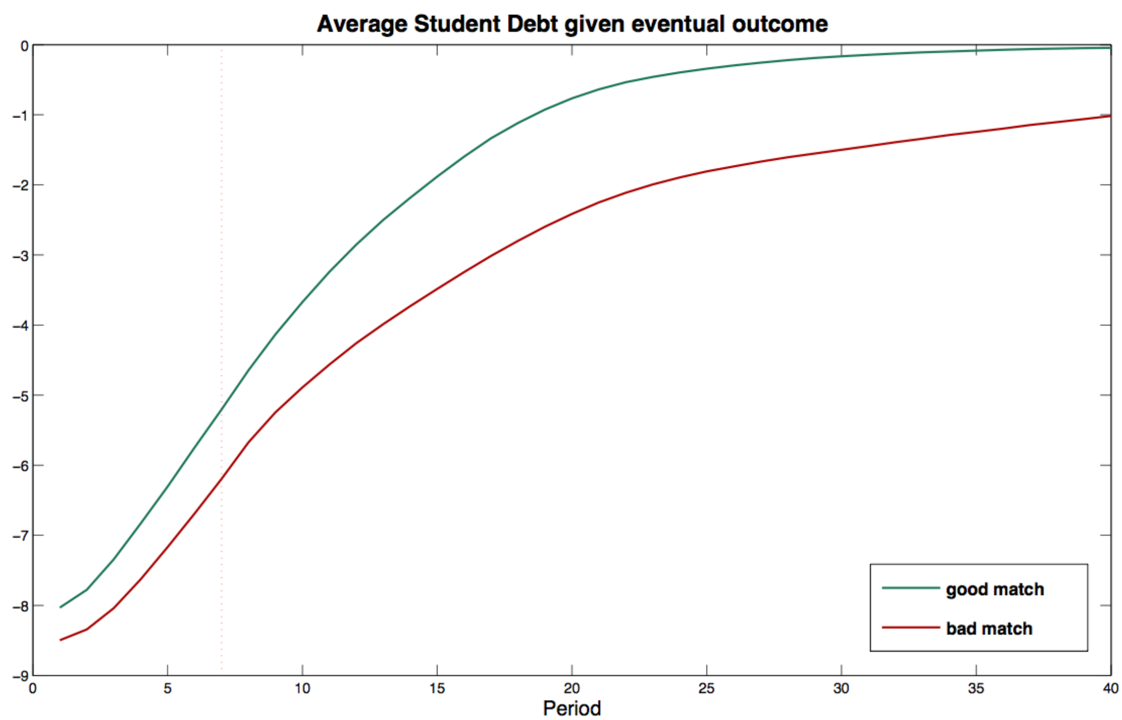

Figure 6

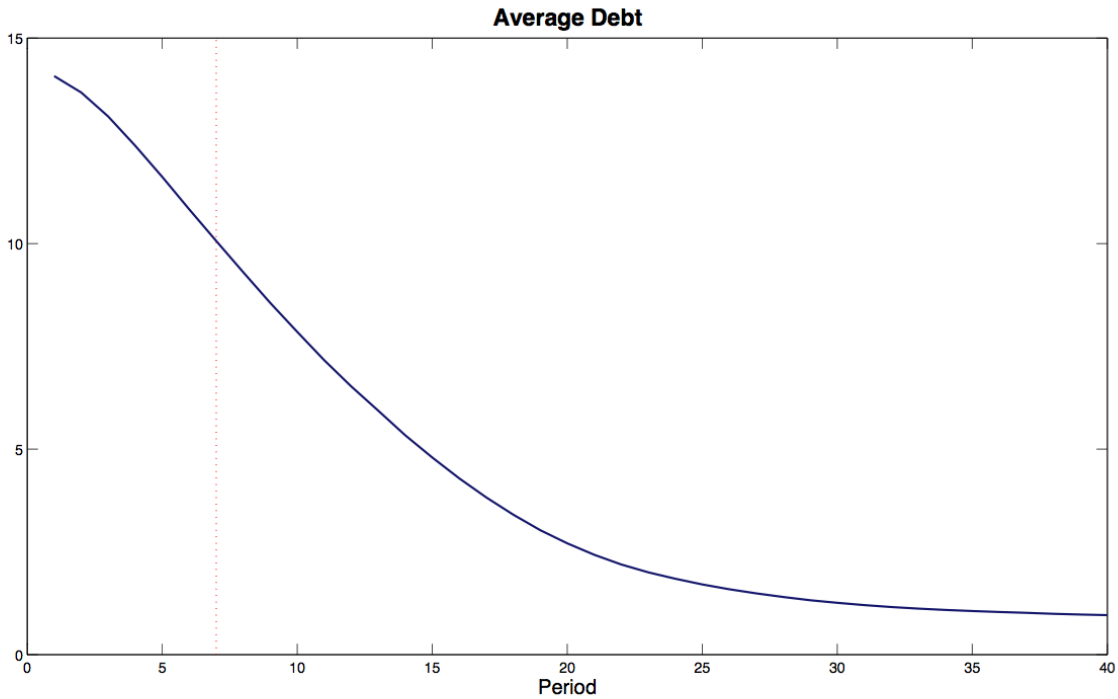

Figure 7

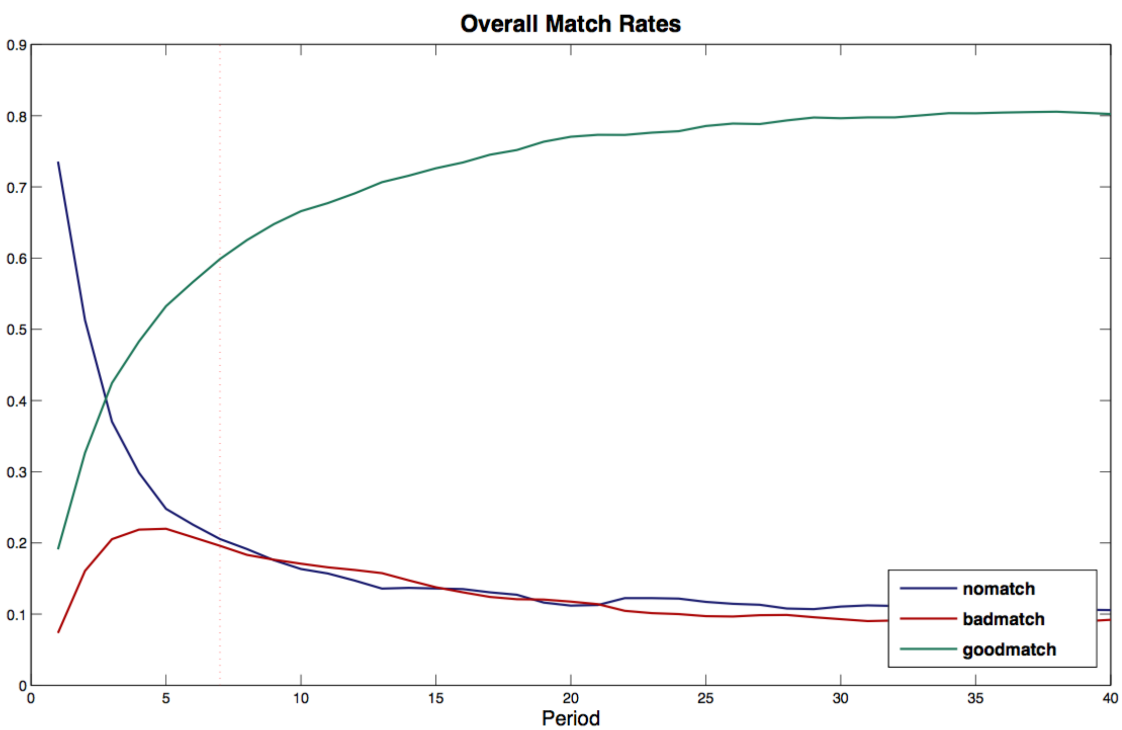

Figure 8

Table 6: None Targeted Moments—Four Years After Graduation

Moments	Data Value	Model Value
Share of Good Match for High HC	0.7991	0.8575
Share of Good Match for Medium HC	0.7012	0.7455
Share of Good Match for Low HC	0.6090	0.6098
Average Student Debt	-7401	-3027

3.3 Comparing the Model and Empirical Result and Other Non-Targeted Moments:

To further check how the model fits the data, I calculated some other moments which I am not directly targeting in the estimation: the average good matching rate four years after graduation for agents with different human capital level (may not be close since human capital neither advances nor depreciates), and the average student loan balance four years after graduation. Table 6 shows the non-targeted model results. The model captures the share of good match jobs pretty well even though these moments are not targeted. The share of good matches for high and low human capital are slightly lower in the model than in data. This is mainly due to the limitation of the model: the model doesn't capture human capital growth and on the job search, which can greatly increase the share of good matches. The average student debt level that is generated from the model is much lower than it is in the data. This can largely be due to the limitations of the grid search method I use – agents in the model are forced to pay on the grids, so it is more than the minimum amount. In order to match these moments four years after graduation, I would need a model which better captures the dynamics of job change and wage growth.

The model is also successful at replicating the empirical result that the balance of student loan is negatively correlated to the job matching quality. I run the Probit regression on the simulated data to see how is the initial debt level correlated to the probability of good match, and the coefficient β of log of initial debt is negative and significant. The value of β is equal to -0.223073, which can be translated to a 8% decrease in probability of good match correspond to a 10% debt level increase. However, there isn't a comparable instrument in the model and the model also is missing many controls, so the magnitude of the result from simulated data is not directly comparable to the empirical result.

4 Counterfactual Analysis and Policy Experiment

The government amends student loan policy frequently to help students to afford higher education. It has been effective in the prospect of college attendance: during the last decade, between 2002 and 2012, post-baccalaureate enrollment rose 24 percent, from 2.4 million to 2.9 million. Many research studies the government policy impact on students decisions before entering college. Caucutt and Kumar (2003) investigate how three different subsidy policies contribute to the efficiency of the utilization of education resources and the welfare gain/loss. Ionescu (2009) quantifies the effects of alternative student loan policies on college enrollment, borrowing behavior, and default rates. Lochner and Monge-Naranjo (2011) uses the borrowing constraint from government student loan (GSL) programs and private lending to explain the persistent strong positive correlation between ability and schooling and college attendance. Cameron and Taber (2004) studies the borrowing constraint before school and concludes that none of the methods produces evidence that borrowing constraints generate inefficiencies in the market for schooling in the current policy environment.

While the impact of government policy on the pre-school decision is well studied, less research focus on how can different policy alleviate students debt burden after graduation. Though it is true that the changes in policy can affect students earlier decision before entering, many already graduated young workers are no longer facing the same decision and are experience financial hardship at the same time. There are many new policies intended to help students with student loan repayment and help them to go through financial difficulties, however, these policies are generally not applicable to earlier borrowers. For example, PAYE repayment eligibility requires the time of the loan must be on or after Oct. 1, 2007.

The first experiment I run with the model is allowing the PAYE repayment method for the individuals in my sample. This allows the agents to pay a lower fraction of their income, which can help to reduce the debt burden. This change is not very large, so in the short period it doesn't change the share of good matches. It does allow students to pay down the debt slower–the average student debt in $t = 7$ is \$10630 comparing to \$10064 when PAYE is not allowed, and also the average time to find first job increased from 2.15 quarters to 2.35 quarters, so students spend more time on average to wait for good offers. In a longer time span this repayment method does increase the share of agents in a good job, though the effect is not very big. The result is shown in the first column of table 7

The interest rate and fees of student loans are also changing frequently at a yearly or sometimes bi-yearly basis. However, similar to the new repayment method, the new interest

Table 7: Policy Experiment

Moments	PAYE	Standard IBR	Low Interest Rate
Share of Good Match for High HC	0.8580	0.8575	0.8607
Share of Good Match for Medium HC	0.7461	0.7455	0.7505
Share of Good Match for Low HC	0.6190	0.6098	0.6139
Average Student Debt	-4691	-3027	-2926

rates also do not apply to the earlier borrowers. Students who graduated in 07/08 are facing 6.8% interest rates on average, while students who graduate more recently in 12/13 have half of the earlier interest rate–3.4%.

I run the second experiment such that the government lowers the interest rate to the newer level, after the student graduates (so students do not anticipate this change, therefore not changing the decision of entering). The result of this experiment is shown in column 3 of table7. Similar with the previous experiment, agents take longer to find a first job (2.299 quarters in stead of 2.15), and four years after graduation, the share of agents in good match increased, though by a small amount.

The two experiments I do above are preliminary, and don't generate a big change in agents' early labor outcome. However, it is a first step to show that there is indeed room for the government to help students to alleviate the debt burden which in turn can lead students to better matched jobs and higher productivity. However, the caveat here would be the general equilibrium effect. For example, the PAYE does increase the share of people with good match but it decreases students repayment amount which impacts the government's budget constraint, so more thorough research with a general equilibrium model analyzing the social welfare would be required.

5 Conclusion

In this paper I have documented some empirical relationships between student debt levels and post-graduation job market outcomes. Specifically, I've shown that for both graduates in the early 1990s and more recently during the great recession, higher amounts of student debt are associated with lower probability of finding a good or well-matched job after you graduate. I use a model of job search and long-term debt to explore this relationship, which I show is possibly related to debt constraints - the higher your student debt balance, the higher your cost of consumer debt. This higher debt cost reduces your ability to wait for a good job, forcing those who have large debts to take poorly matched jobs which potentially affect all of their subsequent job market outcomes and lifetime productivity. Using the calibrated model, I show that those with higher human capital likely get more good job offers than those with lower human capital, and that the debt constraint mainly binds for high and medium human capital graduates, since those with lower human capital will always take the first job offer regardless of debt status. I then run some counterfactual policy analysis to show that both lower payment limits and lower interest rates (such as those enjoyed by graduates today) would have improved the outcomes for graduates in 07/08 in terms of job match quality by allowing them to search longer before accepting a job. The next step is to take this analysis to a general equilibrium lifecycle model to look at how changes in these policies might affect education and borrowing decisions prior to graduation.

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