Education Economics

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Effects of college educational debt on graduate school attendance and early career and lifestyle choices

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This paper examines how college educational debt affects various post-baccalaureate decisions of bachelor's degree recipients. I employ the Baccalaureate and Beyond 93/97 survey data. Using college-aid policies as instrumental variables to correct for the endogeneity of student college debt level, I find that for public college graduates, college debt has a negative and significant effect on graduate school attendance. This negative effect is concentrated on more costly programs associated with doctoral, MBA, and first professional (FP) degrees, and debt has no effect on the choice of a master's program. For private college students, debt does not have an effect on the overall graduate school attendance, but this absence of effect conceals the differential effects of debt on different graduate programs – debt has a positive and significant effect on the choice of an MBA or an FP program, and a zero effect on other programs. For both public and private college students, debt has no effects on early career choices such as salary, sector of occupation, marital status, and homeownership.

Keywords: college debt; graduate school; early career and lifestyle choices; instrumental variables estimation

JEL codes: H52; I22; I28

1. Introduction

Loans have become increasingly important for financing a college education, and college students are graduating with an increasing amount of debt. In 1993, 49% of bachelor's degree recipients in the USA had borrowed to finance their undergraduate education, while by 1999 this percentage had increased to 65%. Among the borrowers, the average amount borrowed increased from $10,495 in 1993 to $16,740 in 1999 (in constant 1993 dollars, NCES 2005a). College Board (2009) indicates a continued increase in the stock of this debt over the past decade.[1] There have been concerns that students graduating with large amount of debt may avoid low-paid public-interest jobs,[2] or more generally, they may make sub-optimal choices about further education, career path, and family formation. These concerns have led to calls for public programs to relieve the debt burden of college graduates. Despite the general public interest, little rigorous analysis on the effects of college debt has been conducted to provide evidence for policy debates.

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Outstanding debt should have no effect on individuals' future choices in a standard lifetime utility maximization model – it has only an income effect and does not affect prices (interest rates). Two reasons have been raised for debt to possibly have a non-trivial effect. The first is credit constraints. In the presence of credit constraints, prior debt makes further borrowing more difficult: individuals either have to borrow at a higher interest rate or can only borrow a limited amount at the prevailing interest rate. The high cost of borrowing increases the relative desirability of current consumption and reduces the appeal of higher future consumption.[3] Another argument is debt aversion (see, for example, Field 2009). If holding debt lowers utility by itself, college graduates may choose to repay loans more quickly. In so doing, they may choose alternatives with a higher present payoff over ones with a higher long-term payoff.

While there has been an abundance of studies about the effectiveness of *grants* on college attendance (Dynarski 2002 provides a review of the studies), little is known about how *loans* affect college attendance, college completion, and post-baccalaureate decisions. This paper focuses on the last part of these questions. Without addressing the endogeneity of accumulated college educational debt and using earlier cohorts, earlier studies (Bazzoli 1985; Schapiro, O'Malley, and Litten 1991; Fox 1992; Weiler 1994; Minicozzi 2005) find virtually no effect of college debt on graduate school decisions, on college graduates' occupation choices, or on physicians' specialty choices. More recently, Field (2009) and Rothstein and Rouse (2011) made use of natural experiments in two elite universities to isolate the effect of educational debt from other confounding factors. Field (2009) found that students in NYU Law School who received tuition waivers had a higher rate of first job placement in public-interest law; she interprets this as reflecting debt aversion. Rothstein and Rouse (2011), using the introduction of a 'no-loan' policy in a highly selective university, find that debt causes its graduates to choose substantially higher-salary jobs and reduces the probability that students choose low-paid 'public-interest' jobs. Despite the appeal of the natural experiments, experiments like these tend not to occur often and may still not allow researchers to adequately isolate the program; therefore, it is difficult to judge if their findings can be generalized to college graduates at large.

This paper is the first to study the effects of college debt for a representative sample of more recent college graduates while dealing with the endogeneity of debt. I use the Baccalaureate and Beyond 93/97 survey data of the Department of Education, which follows college students receiving a bachelor's degree in 1992–1993 academic year four or five years after degree receipt. I focus on the effects of accumulated college educational debt on individuals' choices of graduate school attendance, early career, and lifestyle. The major challenge in studying the effect of college debt is that the amount borrowed is an endogenous variable. The accumulated debt at college graduation may be a function of unobserved ability, which may also affect an individual's post-baccalaureate decisions. I explicitly deal with this endogeneity problem by using instrumental variables (IVs) for the amount of college debt. The IVs capture variations in college-aid policies: a college's tendency to offer aid and in particular its tendency to offer grants. They provide supply-side variations in the financial-aid options faced by *all* students in a particular college but are not directly related to *each* student's financial need or merit-aid eligibility. Therefore, they are correlated with the amount of debt incurred by a student but not directly related to post-baccalaureate decisions. I control for various college characteristics and conduct sensitivity tests to address the concern that students' choice of college is simultaneous with that of financial-aid availability.

After allowing for endogeneity, college debt is found to have a negative and statistically significant effect on the graduate school decision of students who received a bachelor's degree from public colleges. *Ceteris paribus*, a $1000 increase in college debt reduces the probability that a public college student will attend graduate school by 2.7 percentage points. This negative effect is concentrated on more costly programs associated with doctoral, MBA, and first professional FP degrees. For private college students, debt does not have an effect on the overall graduate school attendance, but this absence of effect conceals the differential effects of debt on different graduate programs – debt has a positive and significant effect on the choice of an MBA or an FP program and no effect on other programs. Once enrolled, debt has no effect on the persistence in a graduate program for both public and private college students. For both public and private college students, debt has no effects on career choices one to two years after receiving a bachelor's degree or family formation decisions in both the very short run and four to five years after the degree receipt.

2. Data

The primary data source is the Baccalaureate and Beyond 93/97 (B&B) Longitudinal Study of the Department of Education. The base-year survey includes a national sample of about 11,000 students who received their bachelor's degrees between July 1992 and June 93 – a majority (63%) started college in 1988 or 1989. The first follow-up was conducted in 1994, and the second in 1997. The base year survey report information on students' demographic characteristics, college admission test scores, college GPA, financial need, and college financial aid for the 1992–1993 academic year, and parents' education and income. The two follow-up surveys contain information on post-baccalaureate activities such as graduate study, employment, and family formation. All three waves contain a self-reported amount of total cumulative debt for undergraduate education, including loans from all sources: federal and state governments, institution, family, friends, and private banks. The dataset is also linked to the National Student Loan Data System (NSLDS) and provides a complete record for each student who has borrowed federal loans.[4] Self-reported and NSLDS-recorded debt amounts for all students are carefully scrutinized to create the variable of total cumulative debt with the highest possible accuracy.

The analysis focuses on individuals between 20 and 24 years of age at the end of 1992 who received a bachelor's degree from a college located within one of the 50 US states (plus the District of Columbia) between July 1992 and June 1993. This selection reduces the sample size to 7279, with 4724 (65%) receiving a bachelor's degree from public colleges and 2555 (35%) from private colleges. This distribution is almost identical to the overall distribution of college students between public and private colleges.

As summarized in Table 1A, public and private college students are similar in race and gender compositions, but private college students tend to have higher SAT scores and to come from families with higher income. Private college students are more likely to have attended a graduate program within four years of receiving a bachelor's degree (40% as opposed to 32%). Among those who have attended graduate school, private college graduates are more likely to have enrolled in a doctoral, an MBA, or an FP program, and are less likely to have enrolled in a master's program. For both public and private college students, almost 50% of those who have attended graduate school did so within 12 months of receiving a bachelor's degree. Almost the same percentage of public and private college students worked in public/non-profit sector or taught in

Table 1A. Characteristics of 1992–1993 BA/BS recipients.

	Public	Private
No. of observations	4724	2555
Female	55.9%	56.7%
White	86.2%	85.8%
Black	5.3%	6.3%
Hispanic	3.7%	3.9%
Asian	4.1%	3.6%
SAT percentile	60.7%	64.4%
College GPA	3.0	3.1
Family income	$49,039	$61,198
Attended graduate school by 1997	1527 (32.4%)	1018 (40.0%)
Attended master's programs	66.1%	60.8%
Attended doctoral programs	10.9%	12.3%
Attended MBA or FP programs	23.0%	26.9%
Annual salary in 1994	$21,415	$20,905
Work in public/non-profit sector in 1994	34.4%	35.3%
Teach in 1994	13.3%	13.9%
Have been married by 1997	35.7%	27.7%
Own house/condo in 1997	29.4%	18.5%

1994, and they in general had similar earnings. However, public college students were significantly more likely to have married and own a house or condo in 1997.

Table 1B summarizes the amount of accumulated undergraduate educational debt for public and private college students separately.[5] Slightly less than half of public college students (46%) borrowed for their undergraduate study. The average amount of debt at college graduation for all students was $4130, of this, $2750 (67%) was federal loans.[6] By comparison, more of private college students (58%) borrowed, and the average amount of debt was higher ($8101), but a similar proportion (69%) was federal loans. This difference is expected and largely reflects the cost difference between the two types of college. For both public and private college students, those who attended graduate school by 1997 had borrowed less than those who did not, although the difference is only significant for private college students. Public college students who attended doctoral, MBA, or FP programs by 1997 had borrowed significantly less than those who attended master's programs, but similar difference is not present for private college students. Debt amount also differs by other outcome measures, but the differences are insignificant in most comparisons. These differences suggest a potential link between cumulative college educational debt and post-baccalaureate decisions; however, these could also reflect differences in measured and unmeasured abilities across students. Regression analysis controlling for ability differences is necessary.

3. Empirical strategy

We are interested in the effect of accumulated college debt on a college graduate's post-baccalaureate decision. The relationship can be expressed in the following reduced form Equation (1):

Table 1B.   Undergraduate educational debt by outcome categories.

	Public	Private
Total undergraduate educational debt	$4130	$8101
No graduate school by 1997	$4205	$8554
Attended graduate school by 1997	$3975	$7438
Attended master's programs	$4253	$7347
Attended doctoral programs	$3419	$7594
Attended MBA or FP programs	$3425	$7516
Work in public/non-profit sector in 1994	$4450	$8945
Work in private for-profit sector in 1994	$4050	$8226
Teach in 1994	$4110	$8458
Not teach in 1994	$4600	$8527
Have been married by 1997	$3852	$8403
Never married by 1997	$4062	$8006
Own house/condo in 1997	$3789	$8523
Not own house/condo in 1997	$4077	$8034
Federal loans	$2752	$5569
Percentage with total debt > 0	46%	58%
Average debt if total debt > 0	$8955	$13,943

Note: Author's calculation based on Baccalaureate and Beyond 93/97 survey. Statistics for 1994 salary, occupation sector, and debt of those worked in different sectors are based on the sub-sample of individuals working more than 30 hours a week and having an annual salary between $5000 and $100,000. Statistics related to marital status are for individuals who were never married in 1992–1993 academic year; individuals are defined as 'have been married by 1997' if they are married, separated, divorced, or widowed.

$$Y_i = \alpha + \beta D_i + X_i \cdot \gamma + \upsilon_i \qquad (1)$$

Here, Y_i is a measure of post-baccalaureate choice such as graduate school attendance status or earnings a certain period after receiving a bachelor's degree, D_i is the amount of debt an individual has borrowed during undergraduate study, and X_i is a vector of individual covariates.

In order to obtain an unbiased estimate of the causal effect of debt, the regression analysis must include in X_i all of the individual characteristics that affect both post-baccalaureate decisions and amount borrowed in college. Unfortunately, many of these covariates are usually unavailable to the econometrician; this makes D_i an endogenous variable, and OLS estimate of Equation (1) will generate a biased estimate of β. The bias could go in either direction. Take graduate school decision as an example. On the one hand, a college student with higher unmeasured ability may borrow more if he expects higher future earnings. If he is also more likely to attend graduate school, OLS will underestimate the effect of debt. On the other hand, a college student with higher unmeasured ability may borrow less if he can obtain more grants.[7] If he is also more likely to attend graduate school, OLS will overestimate the effect of debt. In either case, the bias could go in the opposite direction if college students with higher unmeasured ability are less likely to attend graduate school because they will have higher earnings regardless.[8]

I deal with this endogeneity problem by identifying IVs for individuals' college educational debt. The IVs are variables that capture the aid policy of an individual's

undergraduate college.[9] They provide supply-side variations in the financial-aid options faced by *all* students in a particular college but are not directly related to *each* student's financial need or merit-aid eligibility. The amount of college debt is thus modeled as an outcome of individual demand for debt and other shocks including these supply-side variations, represented by the first-stage regression:

$$D = \delta_0 + Aid\ Policies \cdot \delta_1 + X \cdot \delta_2 + \varepsilon \tag{2}$$

where X represents covariates from Equation (1).

In practice, college students usually receive an aid package that is determined by college financial-aid officers. It includes grants and scholarships (gift aid) and loans (self-help aid). Since gift aid does not require repayment, it is preferred to loans and is the first to be added into an aid package. Loans are therefore the marginal source of funds to most students.[10] Measures of college financial-aid policies are obtained from Peterson's (1989), which are provided to the Peterson's by college admission and financial-aid officers or registrars. The 1989 Peterson's provides a summary for academic year 1988 of undergraduate financial aid for each college in the USA that offers four- or five-year baccalaureate degree programs, including both need-based and non-need-based aid, for both undergraduates in general and freshmen in particular.

I focus on two variables: the percentage of undergraduate students that receive financial aid (*Aid*%) and the percentage of gift aid relative to total need-based aid per student for freshmen (*Gift*%).[11] *Aid*% counts both need-based and non-need-based aid. *Gift*% includes both the gift aid awarded by the college and the gift aid students obtained from other sources, including federal Pell grants, so it reflects both a college's resources available for financial aid and the capability of a college's freshmen to obtain outside financial support. The hypothesis is that, *ceteris paribus*, if a college aids more students, then it tends to offer more loans in an aid package; if a college is more inclined to 'offer' gift aid, then students in general will have to borrow less. On average, 70% of students in private colleges receive financial aid, and 62% of average need-based aid received by freshmen in private colleges is gift aid. In public colleges, these proportions are 56% and 52%, respectively.[12]

For these variables to qualify as IVs they have to satisfy two conditions. First, controlling for other individual characteristics, they are correlated with the amount of accumulated college debt. This condition is tested by the first-stage regression in the next section.

Second, they are correlated with post-baccalaureate decision only through their correlations with the amount of debt. In other words, they are uncorrelated with the error terms in Equation (1). This orthogonality condition may not hold if a college's aid policies are correlated with other college characteristics that may have a direct impact on its students' post-baccalaureate decisions. This may happen because students are not randomly assigned to a set of aid policies; instead, they choose which college to go to. Therefore, they simultaneously choose a bundle of college characteristics including financial-aid availability as well as peer quality, faculty quality, and so forth. These two sets of variables can be related for various reasons. For example, a wealthier college has potentially more resources available for student financial aid. At the same time, the college could also use its resources to provide a better learning environment by attracting better students (in part through more attractive aid package) and better faculty, and providing better physical facilities. Better

college learning experience may better motivate and prepare students to pursue graduate education.

To address this concern, I include in *X* college characteristics that are traditionally considered as good summary measures of a college's resources and learning environment. The first is college selectivity; it is derived from Barron's Profiles of American Colleges (Barron 1989), which groups colleges into six categories on the basis of entering students' class rank, high school grade point average, average SAT scores, and the percentage of applicants admitted. I divide institutions into three groups: low selectivity, including non- and less-competitive colleges; medium selectivity, including competitive and very competitive colleges; high selectivity, including highly and most competitive colleges. The selectivity measure captures most directly the quality of incoming students, but it is strongly correlated with other college inputs; for example, the high selectivity category includes most of the elite private institutions and flag-ship public universities. The second is the Carnegie Classification of colleges, which groups colleges into research, liberal arts, and comprehensive categories based on program offering, types and quantities of degrees conferred, and research activities. Research universities are doctorate-granting institutions and engage in significant research activities measured by research staff and expenditure. Liberal arts colleges concentrate on undergraduate education and are highly residential. Comprehensive universities offer undergraduate education and confer a large number of master's degrees.[13]

Table 2A shows how graduate school attendance status by 1997 and annual salary in 1994, two important outcome measures, vary with college categories. For both public and private colleges, students graduating from high selectivity colleges are significantly more likely to have attended graduate school by 1997 and have higher earnings in 1994 than students from other types of colleges. Students graduating from public research universities and students graduating from both private research universities and private liberal arts colleges are more likely to attend graduate school by 1997. For both public and private colleges, students graduating from research universities have significantly higher earnings in 1994 than students graduating from other types of colleges. Table 2B shows how values of the two IVs, *Aid*% and *Gift*%, vary across college categories. For public colleges, the two IVs do not vary systematically with either college type; *t*-tests do not show significant differences in the IVs across college categories. There are, however, significant differences across different types of private colleges. In particular, liberal arts colleges and the high selectivity colleges tend to have a smaller proportion of students on aid and to offer more gift aid to freshmen.

While it is inherently impossible to completely address the issue of exclusion restrictions, it is plausible that including the two summary measures described above as control variables can help considerably mitigate the concern. Additionally, following the main regression, I conduct multiple sensitivity analyses to provide further support for the IV estimation.

4. Results

This section reports the IV estimate of the effect of total amount of debt for undergraduate education on various measures of graduate school attendance choices, on early career choices, and on family formation and homeownership for students receiving a bachelor's degree from public colleges and private colleges separately.

Table 2A. Graduate school attendance, by college type.

	Public college students			Private college students		
	#Students	% Attending grad school by 1997	Annual salary in 1994	#Students	% Attending grad school by 1997	Annual salary in 1994
High selectivity	227	46.7	$24,084	649	52.4	$22,356
Medium selectivity	3349	33.1	$21,390	1487	37.1	$20,772
Low selectivity	957	27.4	$20,040	314	30.9	$20,049
Research universities	2780	35.9	$22,010	694	47.8	$23,370
Liberal arts	32	28.1	$21,115	705	44.8	$19,531
Comprehensive	1907	27.5	$20,592	1151	32.2	$20,410

Note: # is the number of students in each type of college based on the B&B sample of students between 20 and 24 by December 1992. Annual salary in 1994 is calculated for individuals working more than 30 hours a week and having an annual salary between $5000 and $100,000.

Table 2B. Summary of college aid policies, by college type.

	Public colleges			Private colleges		
	#Colleges	Aid%	Gift%	#Colleges	Aid%	Gift%
High selectivity	11	53.3	55.7	37	57.3	71.8
Medium selectivity	167	55.4	52.3	174	71.2	61.1
Low selectivity	93	58.8	50.7	53	74.7	54.6
Research universities	108	53.3	51	53	66.5	63.9
Liberal arts	5	55	58.6	50	63.4	68
Comprehensive	183	58.5	52.3	182	72.9	59

Note: # is the number of colleges in each category; Aid% is the percentage of undergraduate students that receive financial aid; Gift% is the percentage of freshman need-based aid in the form of gift aid. Low selectivity are non-competitive and less competitive colleges in Barron's College Profile; mid selectivity are competitive and very competitive colleges, high selectivity are highly and most competitive colleges.

4.1. *Effects on graduate school attendance*

The first outcome measure is an indicator variable of whether an individual has attended graduate school by the end of 1997 since the receipt of a bachelor's degree; it takes the value one if one has attended and zero otherwise. I first estimate Equation (1) by OLS in a linear probability model whose estimates can be directly compared to those in the previous literature; I then estimate it by IV, using percentage of undergraduate students aided and percentage of grants in all need-based aid for freshmen of a college as IVs.[14]

Columns 1 and 4 of Table 3 report the OLS estimates. For both public and private college students, the coefficient estimate on total debt is close to zero, but in neither case is it precisely estimated. This result is similar to findings in the previous work. In both regressions, I control for individual, college, and local labor market characteristics. There are some common patterns between public and private college students. Students with higher academic ability, as measured by SAT scores and college GPA, are more likely to attend graduate school, likely reflecting their better preparation and

Table 3.   College educational debt and graduate school attendance.

	Public college students			Private college students		
	(1) OLS	(2) IV	(3) First stage	(4) OLS	(5) IV	(6) First stage
Total college education debt ($1000)	−0.001 [0.001]	−0.027 [0.013]**		−0.001 [0.001]	0.004 [0.012]	
Percentage of students aided			0.038 [0.006]***			0.002 [0.019]
Percentage of gift aid			−0.021 [0.008]***			−0.098 [0.028]***
Female	−0.027 [0.016]*	−0.023 [0.017]	0.212 [0.236]	−0.028 [0.024]	−0.024 [0.026]	−1.149 [0.540]**
Black	0.133 [0.035]***	0.16 [0.040]***	0.898 [0.508]*	0.157 [0.047]***	0.15 [0.050]***	0.246 [1.176]
Hispanic	0.147 [0.046]***	0.139 [0.048]***	0.291 [0.653]	−0.015 [0.058]	−0.02 [0.059]	0.243 [1.201]
Asian	0.028 [0.039]	−0.004 [0.044]	−0.592 [0.584]	0.109 [0.061]*	0.107 [0.063]*	1.283 [1.841]
Other	−0.081 [0.086]	−0.084 [0.100]	−0.105 [1.444]	0.124 [0.158]	0.117 [0.166]	0.458 [3.730]
SAT percentile	0.355 [0.081]***	0.332 [0.085]***	−0.531 [1.074]	0.453 [0.116]***	0.484 [0.137]***	−8.181 [2.540]***
No SAT score	0.186 [0.054]***	0.192 [0.058]***	0.276 [0.765]	0.26 [0.093]***	0.28 [0.104]***	−3.889 [2.366]
College GPA (1–4)	0.197 [0.019]***	0.177 [0.022]***	−0.921 [0.242]***	0.147 [0.023]***	0.15 [0.025]***	−0.574 [0.424]

Table 3. (*Continued*).

	Public college students			Private college students		
	(1) OLS	(2) IV	(3) First stage	(4) OLS	(5) IV	(6) First stage
Instate student	−0.022	−0.024	−0.172	0.011	0.008	0.643
	[0.019]	[0.020]	[0.300]	[0.024]	[0.025]	[0.558]
Attended two-year college	−0.014	−0.029	−0.446	−0.024	−0.021	−0.649
	[0.017]	[0.020]	[0.238]*	[0.032]	[0.034]	[0.842]
Education major	0.188	0.206	0.698	0.253	0.252	−0.144
	[0.027]***	[0.030]***	[0.391]*	[0.042]***	[0.042]***	[1.117]
Engineering major	0.085	0.119	1.205	0.173	0.159	1
	[0.032]***	[0.039]***	[0.500]**	[0.059]***	[0.067]**	[1.446]
Health major	0.061	0.095	1.573	0.071	0.058	1.349
	[0.034]*	[0.041]**	[0.578]***	[0.050]	[0.059]	[1.418]
Social service/public affair major	0.077	0.082	−0.058	0.122	0.117	−0.239
	[0.040]*	[0.042]*	[0.563]	[0.067]*	[0.068]*	[1.766]
Science major	0.207	0.213	0.239	0.277	0.273	0.134
	[0.030]***	[0.032]***	[0.399]	[0.039]***	[0.041]***	[1.030]
Social science major	0.12	0.109	−0.529	0.205	0.204	−0.477
	[0.027]***	[0.029]***	[0.367]	[0.039]***	[0.039]***	[1.007]
Humanities major	0.066	0.071	0.446	0.169	0.17	−0.761
	[0.029]**	[0.031]**	[0.436]	[0.038]***	[0.039]***	[1.017]
Other major	0.043	0.04	0.031	0.133	0.135	−1.272
	[0.024]*	[0.026]	[0.409]	[0.041]***	[0.041]***	[1.024]
Family income ($1000)	0	0	−0.025	0	0	−0.035
	[0.000]**	[0.000]	[0.003]***	[0.000]	[0.000]	[0.004]***
Research university	0.046	0.046	0.177	0.05	0.044	1.548
	[0.017]***	[0.018]**	[0.250]	[0.033]	[0.036]	[0.775]**

Table 3.　(*Continued*).

	Public college students			Private college students		
	(1) OLS	(2) IV	(3) First stage	(4) OLS	(5) IV	(6) First stage
Liberal arts college	−0.097	−0.095	0.028	0.042	0.036	2.401
	[0.086]	[0.092]	[2.015]	[0.029]	[0.033]	[0.776]***
Medium selectivity college	0.042	0.031	−0.491	0.033	0.025	0.398
	[0.020]**	[0.022]	[0.331]	[0.036]	[0.041]	[1.192]
High selectivity college	0.08	0.095	0.075	0.082	0.074	1.259
	[0.046]*	[0.049]*	[0.690]	[0.049]*	[0.050]	[1.542]
% College graduates, 1992	0.001	0.001	0.021	−0.001	−0.002	0.074
	[0.002]	[0.002]	[0.026]	[0.003]	[0.003]	[0.066]
% Unemployment rate, 1992	0.013	0.012	0.003	0.016	0.016	−0.03
	[0.005]**	[0.006]**	[0.078]	[0.010]	[0.010]	[0.224]
Constant	−0.746	−0.531	6.953	−0.679	−0.743	21.005
	[0.077]***	[0.135]***	[1.227]***	[0.122]***	[0.194]***	[3.870]***
Sargan statistic		0.471			0.035	
		p = 0.493			*p* = 0.852	
Test of joint significance of IVs			*F*(2, 3444) =20			*F*(2, 1784) =8.5
Number of observations	3472	3472	3472	1812	1812	1812

*Significance at 10%; **significance at 5%; and ***significance at 1%.
Note: Robust standard errors in brackets. The omitted category of major is business major.

higher expected gains from further education. Females are not significantly less likely to attend graduate school than their male classmates. Blacks are more likely to attend graduate school than Whites, so are Hispanic students from public colleges. Relative to business majors, all other majors are more likely to attend graduate school, likely reflecting relative differences in labor market opportunities for different majors with a bachelor's degree and a graduate degree. College types appear to influence students' choice: students from more selective colleges and from research or private liberal arts colleges are more likely to attend graduate school; the impacts, however, are sometimes insignificant given that other individual characteristics have been controlled for. Local labor market conditions were measured by unemployment rate and percentage of labor force with at least a bachelor's degree in 1992 for the state where an individual received a bachelor's degree. When unemployment is high, individuals tend to return to school.[15]

IV estimates and the associated first-stage results are reported in the remaining columns of Table 3. I include the same set of covariates as in the OLS model, and they have broadly similar effects on graduate school attendance as in the OLS model.

The IV estimate of the effect of debt is strikingly different between public and private college students. For a public college student, *ceteris paribus*, a $1000 increase in total debt for undergraduate education reduces the probability of attending graduate school by 1997 by 2.7 percentage points, and the effect is significant at 5% level.[16] The Hausman test of exogeneity of the debt variable is rejected at the conventional significance level.[17] For private college students, in contrast, the estimate of debt's effect is still almost zero and statistically insignificant.

The first-stage results are reported in Columns 3 and 6. For an average public college student, a 10-percentage point increase in undergraduate students aided leads to $380 more debt, and a 10-percentage point increase in grants offered leads to $210 less debt. Both relationships are statistically significant, and F-statistic on the joint significance of IVs is $F(2, 3444) = 20$. For an average private college student, a 10-percentage point increase in grants offered leads to almost $1000 less debt and this effect is significant. However, the percentage of students aided does not appear to have a significant effect on debt amount. The F-statistic on the joint significance of IVs is $F(2, 1784) = 8.5$. This is a borderline case according to the criterion of Bound, Jaeger, and Baker (1995); therefore, for private college student, there may be a finite-sample bias in the IV estimate of the debt effect. Results from tests of over-identifying restrictions are also reported at the bottom of Table 3. Exogeneity of IVs is not rejected at the 10% significance level for both public and private college students.

The validity of the IV estimate hinges on the assumption that IVs are uncorrelated with unmeasured college characteristics that may affect graduate school decisions once college selectivity and Carnegie type are controlled for. I conduct several robustness tests to provide support for the validity of the main results. First, I include as control variables several college characteristics that directly contribute to education experience, which, following Epple, Romano, and Sieg (2006), are peer quality, expenditure on student, and diversity. These are measured by average SAT score of freshmen, per student total current expenditure, faculty–student ratio, and percentage of minority students.[18] The results for public and private college students are respectively reported in Columns 1 and 5 of Table 4. For both, the estimate of the debt's effect on graduate school attendance is almost identical, so are the estimates on the two IVs in the first stage. Public college students tend to borrow more and are more likely to go to graduate school when their peers have higher SAT scores, but the magnitude of estimates is

Table 4. College educational debt and graduate school attendance: robustness tests.

	Public college students				Private college students			
	1	2	3	4	5	6	7	8
Total college educaion debt ($1000)	−0.028	−0.03	−0.048	−0.022	0.009	0.007	0.017	0.035
	[0.012]*	[0.013]*	[0.015]***	[0.013]*	[0.013]	[0.013]	[0.015]	[0.021]
Average SAT of freshmen	0.0003	0.0003			0.0001	0.0001		
	[0.0001]**	[0.001]**			[0.0001]	[0.0002]		
Percentage of non-White, non-Asian students	0.001	0.001			0.002	0.002		
	[0.001]	[0.001]			[0.001]*	[0.001]*		
Per student endowment ($1000)			0.0002				0.002	
			[0.001]				[0.001]**	
First stage								
Average SAT of freshmen	0.003	0.003			−0.002	−0.001		
	[0.002]*	[0.002]*			[0.003]	[0.003]		
Percentage of non-White, non-Asian students	−0.014	−0.013			−0.073	−0.069		
	[0.012]	[0.012]			[0.018]***	[0.018]***		
Per student endowment ($1000)			0.003				−0.021	
			[0.013]				[0.010]**	
Percentage of students aided	0.04	0.039	0.041	0.037	0.021	0.019	0.015	0.035
	[0.006]***	[0.007]***	[0.007]***	[0.007]***	[0.016]	[0.016]	[0.015]	[0.021]
Percentage of gift aid	−0.016	−0.015	−0.016	−0.026	−0.093	−0.096	−0.089	−0.1
	[0.009]*	[0.009]*	[0.010]	[0.008]***	[0.025]***	[0.025]***	[0.026]***	[0.031]***
Number of observations	3439	3426	2869	2736	1737	1713	1701	1020

*significance at 10%; **significance at 5%; and ***significance at 1%.
Note: Robust standard error in brackets. Columns 1 and 5 also control for per student total current expenditure and faculty to student ratio; Columns 2 and 6 also control for per student current expenditure on student-related activities (including instruction, academic support, and student services) and 9- and 10-month faculty to student ratio. Columns 4 and 8 include in-state students only; other columns include both in-state and out-of-state students.

small. For private college students, the presence of a larger share of minority students reduces the borrowing and increases the likelihood of going to graduate school; however, the magnitude again is small. For both types of colleges, per student expenditure and faculty–student ratio have no effect on debt level or graduate school decision, in part due to the inaccuracy of the measures. In Columns 2 and 6, I use per-student current expenditure on student-related activities (instruction, academic support, and student services) and 9- and 10-month faculty to student ratio instead, and the results are unchanged.

Second, I include a university's endowment as a control variable. Endowment is directly related to a university's financial resources, especially for private universities; it may also be indirectly related to education experience and quality. I construct endowment per full-time equivalent student for 1989 from Integrated Postsecondary Education Data System (IPEDS); including this variable however considerably reduces the sample size. Based on this sub-sample, for both public and private colleges, endowment per-student is positively correlated with *Gift*%, and students who have attended graduate school are more likely to receive a bachelor's degree from colleges with larger endowment. The estimation results are shown in Columns 3 and 7 of Table 4. For public college students, endowment has no significant impact on either debt amount or graduate school decision; while this does not change the first-stage estimate on the IVs, debt now has a more negative effect on graduate school decision for this reduced sample. Students of private colleges with more endowment tend to borrow less and are more likely to go to graduate school, but adding the endowment in the equation does not change debt's effect on graduation school decision.

Lastly, I focus on in-state students. Students going to college within their home states are likely to be more sensitive to college cost and less sensitive to college quality; therefore, college-aid policy, while affecting the amount of debt, is less likely to be correlated with unmeasured college quality that may affect graduate school decisions. As shown in Columns 4 and 8 of Table 4, using the sub-sample of in-state students does not alter the main results. Indeed, the IVs have slightly larger effects on total debt in the first-stage regression.

Overall, debt has an economically important effect on the graduate school decision of public college students. In 1993, an average public college student accumulated $4130 in debt upon receiving a bachelor's degree, causing his probability of attending graduate school by 1997 to be 11 percentage points lower than an otherwise similar student with no debt. Given that the average graduate school attendance rate of public college student in 1997 is 32%, this translates into a gap of about a third in graduate school attendance rate between an average borrower and one with no debt. To close this gap for college students as a whole through public policies such as debt relieving can be quite costly.

In contrast, private college students' graduate school decision is in general not responsive to debt. This may be because private college students are individuals who are more willing to bear the cost of obtaining a suitable education. By choosing to attend a private school in the first place, they already revealed their willingness to pay a higher price in order to receive an education that may fit better their preferences. In addition, as shown in the next section, private college students do respond to debt when choosing among different graduate programs, and the response is generally consistent with the conjecture above.

Table 5 reports the IV estimates of debt effects on a few other measures of graduate school attendance. For comparison, estimates from Table 3 are reported in the first

Table 5. College educational debt and graduate school, attendance timing, length of enrollment (IV Estimates).

	Public college students	Private college students
Dependent variable		
Attended grad school by 1997	−0.027	0.004
	[0.013]**	[0.012]
Attended grad school by 1994	−0.029	0.004
	[0.010]***	[0.010]
Attended grad school between 1994 and 1997	0.002	0
	[0.010]	[0.011]
Among students attending grad school by 1997		
Attended grad school 12 months after BA/BS receipt	−0.06	−0.011
	[0.038]	[0.022]
Length of enrollment	−0.822	−0.202
	[0.812]	[0.514]

*Significance at 10%; ** significance at 5%; and *** significance at 1%.
Note: Robust standard error in brackets.

row. The dependent variable in the second row is an indicator variable for whether an individual has attended graduate school by 1994 and equals one if he/she has and zero otherwise. It can be interpreted as a measure of the very short-term outcome, whereas attendance by 1997 a measure of the medium-term outcome. For public college students, a $1000 increase in total debt for undergraduate student reduces the probability of attending graduate school by 1994 by 2.9 percentage points, and the effect is significant at 1% level. The effects of debt on graduate school attendance by 1994 and 1997 together suggest that the harmful effect of debt almost completely occurs within the first two years after college degree. Indeed, graduate school attendance between 1994 and 1997 is not at all affected by total debt for undergraduate education. It is likely that students with large amount of debt are hindered from attending graduate school in the short-run, but once they have paid off at least part of their debt or even have saved some funds, they become more comfortable financially to pursue further education. However, because of this delay, some of them will never return to college for more education. We can reasonably conclude that the estimate (0.027) also reflects the long-term effect of debt on graduate school attendance. Again, debt has no effect on private college students' graduate school attendance, for both short-run and long-run.

The remainder of Table 5 focuses on students who have attended graduate school by 1997. The first variable measures the timing of attendance, defined as one if a student has attended graduate school within one year of receiving a bachelor's degree and zero otherwise. For public college students, *ceteris paribus*, a $1000 increase in total debt reduces the probability of attending within one year by six percentage points, and the estimate is marginally significant ($p = 0.11$). This result is qualitatively consistent with the debt effects on attendance by 1994 and 1997, and suggests that not only have fewer college graduates attended graduate school when they have higher accumulated debt, but, among those who have attended graduate school, those with more debt are also likely to have attended with a larger gap after receiving a bachelor's

degree. For private college students who have attended graduate school, debt has no effect on attendance timing.

I next consider the length of graduate program enrollment for those who have attended graduate school, measured as number of months of graduate study since receiving a bachelor's degree. Longer enrollment indicates students' persistence in graduate school and increases the probability of eventual receipt of an advanced degree. For both public and private college students who have attended graduate school, debt has a negative effect, but it is not statistically significant.[19] This may in part reflect the continued availability of financial aid to graduate students.

Taken together, the results in Table 5 suggest that college educational debt can be an important initial barrier to graduate school attendance for public college students, but it does not affect their persistence in a program once they have enrolled. For private college students, debt has no adverse effects on either initial enrollment or persistence toward a degree.

4.2. *Effects on graduate program choice*

Individuals with a bachelor's degree can choose to attend different graduate programs, which are associated with different direct and opportunity costs and availability of financial support in the forms of scholarships or assistantships. College debt may have a larger adverse effect on the attendance of programs that are more expensive and that are less likely to offer financial support such as programs associated with an MBA or an FP degree, and a smaller adverse effect on a master's program (shorter and less expensive). For a doctoral program, debt's effect can go either way: it takes longer time hence more costly but it also tends to support students with scholarships or assistantships.

I explore the possibility that debt has differential effects on the decision to enter different graduate programs. Let Y_{ij} equal one if a college graduate has attended graduate program j, and zero otherwise; j equals one for a master's program, two for a doctoral program, and three for an MBA or an FP degree program. The differential effects are estimated in a simultaneous equation system:

$$Y_{ij} = \alpha_j + \beta_j D_{ij} + X_{ij} \cdot \gamma_j + \upsilon_{ij} \tag{3}$$

where corr $(\upsilon_{ik}, \upsilon_{il}) \neq 0$ for $k \neq l$.

Equation (3) is estimated in a three-stage least squares (3SLS) framework, where the endogenous variables are indicators for whether or not to choose a master's program, a doctoral program, an MBA or FP degree program (Y_{ij}), and the amount of debt accumulated for college education (D_i). The excluded variables are the two IVs (*Aid*% and *Gift*%). Of all the public college students, 68% have not attended any graduate program; 21%, 3.5%, and 7.4% have attended a master's, a doctoral, and an MBA or FP program, respectively. The percentages for private college students are 60%, 24%, 4.9%, and 10.8%.

Table 6 reports the estimated effects of total college debt on the choices of different graduate programs relative to not attending graduate school at all. For public college students, as expected, debt has virtually no effect on the choice of a master's program, a small and marginally significant negative effect on the choice of a doctoral program, and an economically and statistically significant negative effect on the choice of an MBA or FP program. *Ceteris paribus,* a $1000 increase in college debt

Table 6.   College educational debt and graduate program choice estimation method: 3SLS.

	Public college students	Private college students
Dependent variable		
Attended master's programs	0.008	−0.011
	[0.011]	[0.014]
Attended doctoral programs	−0.009	−0.005
	[0.005]*	[0.007]
Attended MBA/FP programs	−0.021	0.022
	[0.008]**	[0.012]*
Number of observations	3472	1812

*Significance at 10%; **significance at 5%; and ***significance at 1%.
Note: Robust standard error in brackets. Dependent variables are indicators for attending 'master's program,' 'doctoral program,' and 'MBA or FP program'; they take value of one if a student has attended a respective program, zero otherwise.

reduces the probability of attending a doctoral program by 0.9 percentage points and the probability of attending an MBA or FP program by 2.1 percentage points. The negative effect of debt reported in Table 3 appears to be mostly driven by the negative effect on the choice of a doctoral, an MBA, or an FP program.

For private college students, debt has virtually no effect on the choice of either a master's or a doctoral program, but a positive and significant effect on the choice of an MBA or an FP program. *Ceteris paribus*, a $1000 increase in college debt indeed increases the probability of enrolling in an MBA or FP program by an economically significant 2.2 percentage points. The absence of debt effect on overall graduate school attendance conceals its differential effects on different graduate programs. Private college students with large amount of college debt appear to be willing to incur extra cost and bear extra debt to attend a graduate program that may increase considerably their future earnings.[20]

4.3.   Effects on early career choices

Higher outstanding debt may induce students to choose more lucrative occupations in the short-term. This may lead to slower growth of earnings in the long term, or, more to the interest of the society, to an inefficient allocation of college graduates to private for-profit jobs at the expense of public-interest jobs such as teaching because of their lower payment.

I focus on the effects of debt on career outcomes in 1994 of students who work at least 30 hours a week and earn an annual salary between $5000 and $100,000.[21] Because some students may have attended or finished a graduate program by 1994, their career outcomes will also be affected by their graduate school decision. Therefore, debt's effect on each career outcome is jointly estimated with its effect on graduate school attendance, where graduate school attendance status also enters the career outcome equation. Each simultaneous equation system is estimated by 3SLS. Same control variables as in Table 3 are included. The top panel of Table 7 reports the estimates of debt effects on three career outcomes. For both the public and private college students, debt has no effect on their annual salary in 1994, on the probability of their working in the public/non-profit sector, or their probability of teaching in K-12 schools. The estimates are insignificant economically as well as statistically.

Table 7.   College educational debt and career and life style choice estimation method: 3SLS.

	Public college students	Private college students
Career choices in 1994		
Logarithm of annual salary in 1994	0.006	0.014
	[0.025]	[0.013]
Work in public/non-profit sector in 1994	0.033	0.009
	[0.027]	[0.019]
Teach in 1994	0.008	0.017
	[0.016]	[0.020]
Family formation and home ownership in 1994 and 1997		
Have been married by 1994	0.003	0.002
	[0.011]	[0.005]
Own house/condo in 1994	0.028	−0.007
	[0.016]*	[0.010]
Have been married by 1997	−0.016	0.020
	[0.018]	[0.017]
Own house/condo in 1997	−0.008	0.002
	[0.016]	[0.017]

*Significance at 10%; **significance at 5%; and ***significance at 1%.
Note: Robust standard error in brackets. Coefficient estimates in each cell are obtained from a separate simultaneous equation system, where the dependent variables are a function of and are jointly estimated with a graduate school attendance variable. Career choice equations are estimated for individuals working more than 30 hours a week and having annual salary between $5000 and $100,000. Family formation equations are estimated for individuals who were never married by 1992–1993 academic year.

4.4.   *Effects on marriage and homeownership*

Accumulated college debt may also deter individuals from buying homes, getting married, or other responsibilities typically associated with full-fledged adulthood (Chiteji 2007). I consider the effects of debt on the likelihood of marriage and home-ownership in both the very short term (1994) and in the medium term (1997). Since individuals tend to buy homes when they get married, the two outcomes are jointly estimated. Because these lifestyle choices may also respond to the education outcome, graduate school attendance status in 1994 or 1997 also enters the 1994 or 1997 outcome equations respectively, and is jointly estimated with the outcome equations by 3SLS.

The equation systems are estimated for individuals who were never married by 1992–1993 academic year. An individual is defined to 'have been married by 1994 (1997)' if he/she was married, separated, divorced, or widowed in 1994 (1997). Homeownership is measured by an indicator of whether one owns a house or condo. The bottom panel of Table 7 reports the estimates. For both public and private college students, and in both the short term and medium term, debt has no effect on virtually all the outcome measures. It has a marginally (10% level) significant effect on home-ownership in 1994 for public college students, but the sign is opposite to expectation.

5.   Conclusion

In this paper, I estimate the causal effects of college educational debt on post-baccalaureate decisions within four to five years after receiving a bachelor's degree

for a nationally representative sample of recent bachelor's degree recipients. Using variables reflecting college-aid policies as IVs to correct for the endogeneity of college debt, I find that, for public college students, the accumulated college educational debt has a negative and significant effect on graduate school attendance, and the negative effect concentrates on the choice of a doctoral, MBA or FP programs. For private college students, debt does not have an effect on the overall graduate school attendance, but this absence of effect masks the differential effects of debt on different graduate programs. Debt has a positive and significant effect on the choice of an MBA or an FP program, and zero effect on other programs. The different responses to debt by public and private college students likely reflect underlying difference in their willingness to incur cost and bear the debt burden for human capital investment, revealed by their choice into these two types of colleges in the first place. These findings are in sharp contrast to earlier studies that do not take into account the endogeneity of college debt and find no effect of debt. Once enrolled, debt has no effect on the persistence in a graduate program; this holds for students receiving a bachelor's degree from both public and private colleges. Debt has no effect on early career choices or family formation decisions for both public and private college students.

The analysis employs the sample of students who finished college in 1992–1993 academic year, a time in which some dramatic changes in federal student-aid policies were made. Federal loans to students, particularly federal unsubsidized loans (unsubsidized Stafford loans and Parent Loans for Undergraduate Students [PLUS]), have increased significantly since then. In addition, private sector loans have been more widely available and have been used by college-aid offices as a part of students' aid packages (McPherson and Schapiro 1998; Kane 1999; College Board 2005). Loans have become increasingly more important in college financing. Recent years have seen much higher levels of indebtedness of college graduates than in the early 1990s. If the effect of debt on individual choices is non-linear, then we might expect a larger effect of debt on post-baccalaureate decisions now than in the past. This will be explored in future research.

That said, findings of the paper suggest that one should be cautious in making policy recommendations of relieving the debt burden of recent college graduates. While the benefits of this public assistance will largely go to the college graduates themselves, its burden will be born by all the tax payers. The redistribution implication is apparent.

Notes

1. NCES (2005) data are based on the Baccalaureate and Beyond 1993/1994 and 2000/2001 student surveys, while College Board (2009) data are based on a survey of colleges. The numbers from these two different types of surveys are not comparable, but both indicate an upward trend in the percentage of college graduates with debt and the amount of debt at graduation.

2. This concern prompted the Clinton administration to introduce an income contingent loans option in the USA in 1993 (Chapman 2006).

3. Recent empirical studies, such as Cameron and Taber (2004), suggest that in the current policy environment with large government subsidies to college students, liquidity constraints do not prevent high school graduates from going to college. However, it is plausible that liquidity constraints are present for college graduates.

4. All federal loans carry two subsidies compared to loans from other sources: lower interest rates and a lower cost of default (no forfeiture of collateral, such as one's house). Students passing a means test are eligible for federally subsidized loans, which have an extra in-school interest subsidy that pays the interest on the loans while an individual is enrolled in post-secondary school at least half-time. This extra subsidy may induce individuals with federally subsidized loans to attend graduate school immediately. During the period of study, federally subsidized loans included Stafford and Perkins loans. Undergraduate students could borrow Stafford loan up to $2625 for each of the first two years in college and $4000 for the third through the fifth year; the amount of Perkins loan was more flexible, but fewer students received it. Federally (unsubsidized) loans included Supplemental Loans for Students for independent students and Parent Loans for Undergraduate Students (PLUS) for parents of dependent students. Both had an upper limit of $4000 for each year. For recent changes in federal loan programs, see Kane (1999) and the Federal Student Financial Aid Handbook published by the US Department of Education at http://ifap.ed.gov/IFAPWebApp/currentSFAHandbooksPag.jsp.

5. PLUS are not included in this variable.

6. Given the subsidies of the federal loans, it is desirable to examine separately the effect of federal loans and other loans on student behavior; the B&B dataset, however, does not have sufficient observations to allow this breakdown.

7. Higher ability students may be able to obtain more merit-based grants, but they may also receive more need-based grants and smaller loans in their aid package. McPherson and Schapiro (1998) argue that colleges tend to behave strategically in offering financial aid in order to maximize the quality of enrolled students and to gain as much revenue from them as possible. This is manifested by differential Expected Family Contributions (EFCs) calculated by different colleges for the same student and even more so by the different amounts of gift aid, hence loans, received by students of similar EFC in the same college. This is termed as 'merit within need' in McPherson and Schapiro, that is, awarding different need-based aid package based on merit, and is a major factor in student-aid practices at a great many institutions that have no explicit merit or non-need aid. Epple, Romano, and Sieg (2006) build a general equilibrium model of the higher-education market from the behavioral assumptions that colleges admit students and offer financial aid to maximize education quality, which is jointly determined by peer quality, expenditure on students, and diversity. Their empirical findings suggest that the model based on these behavioral assumptions explains reasonably well the observed admission and financial-aid policies.

8. There can be other reasons that debt is endogenous. For example, a college student expecting to go to graduate school may borrow less because he is debt averse. If he/she is more likely to *actually* attend graduate school, OLS will overestimate the effect of debt.

9. An individual's undergraduate college is the college where one received the bachelor's degree. Some students transferred, but most of them spent the longest time in the college of degree conferral.

10. Students also receive self-help aid in the form of campus job, which is usually sponsored by the Federal Work Study program. Given the small size of this program (College Board 2005), loans account for the majority of self-help aid.

11. *Aid*% and *Gift*% thus created are indeed functions of college-aid policies and characteristics of students in the college. Although the student body on which the two variables are based does not necessarily correspond to the B&B sample, correlation of student quality over time suggests that it is important to adequately control for the quality of a college's student body in the main regression. This is done as described in the next few paragraphs.

12. When the information for 1989 is not reported, information for 1988 is used. Comparison of randomly drawn colleges between the two years shows that the values of these two aid variables changed little. Other college-aid policy variables, such as numbers of undergraduate students receiving need-based and merit-based scholarships and their amounts, are

available, but these two variables preserve the largest number of observations. In addition, when using other variables as IVs, the main results are quite similar.

13. The Carnegie categories used here are based on the 2000 Classification. The new 2005 Classification has made a few changes in the basic categories and has also classified colleges in many other dimensions. For details, see http://classifications.carnegiefoundation.org/details/index.php

14. The marginal effects of debt estimated at the sample means from a probit model and a probit model adjusting for the endogeneity of debt are almost identical.

15. Local labor market conditions are also measured by unemployment rate and percentage with at least a bachelor's degree averaged over 1992 to 1995 for a state where an individual received a bachelor's degree or where one lived since receiving bachelor's degree. Main results are unchanged. Data are from US Census and NCES.

16. Debt does not appear to have a non-linear effect on graduate school attendance. Adding a quadratic term of debt does not change the estimate.

17. I use the test suggested by Davidson and MacKinnon (1993). The main regression is augmented by the predicted value of debt from the first-stage regression; the coefficient on the predicted debt variable is significantly different from zero at 3% level, rejecting the null hypothesis that the debt variable is exogenous.

18. Total number of students, including both undergraduates and graduates, is used to calculate per student expenditure and faculty–student ratio; minority students are non-white and non-Asian undergraduate students. Data are obtained from the Integrated Postsecondary Education Data System (IPEDS), 1989. Average SAT of freshmen is calculated from National Postsecondary Student Aid Study, 1989 and 1993.

19. Because the sample students received their bachelor's degrees in a 12-month period, their choices at the survey time may reflect this sampling difference. Including dummy variables for months of degree receipt does not alter any of the estimation results.

20. Without controlling for the endogeneity of debt, simultaneous estimation of Equation (3) generates no effect of debt on graduate program choices, for both public and private college students.

21. The effects of debt on longer-term career outcomes are also of interest. But modeling a complicated dynamic system of career and education choices is beyond the scope of the present paper and will be left for future work.

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