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**GUARANTEED VERSUS DIRECT LENDING:
THE CASE OF STUDENT LOANS**

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Abstract

The federal government makes low-cost financing for higher education widely available through its fast-growing direct and guaranteed student loan programs. Both programs offer borrowers similar loan products and terms. From the perspective of other key stakeholders, including educational institutions, commercial lenders, and state guaranty agencies, the programs differ significantly. The programs also report widely divergent budgetary costs. In this study, we propose and implement a methodology to estimate the cost of the two programs in market-value terms. In doing so, we address the question of how much of the difference in reported subsidy rates can be attributed to real cost differences and how much is due to idiosyncrasies in the rules that govern the budgeting of federal credit. We find that budgetary costs for both programs are well below their market value. This is mostly attributable to budget rules requiring that expected net cash flows be discounted at Treasury rates. Understatement of the market cost of capital also is the reason that some direct loans appear to make money for the government, despite the favorable terms offered to borrowers. Administrative costs are accounted for inconsistently across programs, complicating cost comparisons. Nevertheless, it appears that the guaranteed program is fundamentally more expensive than the direct program. Guaranteed lenders are paid more than is required to induce them to lend at statutory terms. The excess funds are largely absorbed in competition for borrowers, which occurs through various discounts, marketing activities, and higher service levels and subsidies to educational institutions.

1. Introduction

The federal government makes low-cost financing for higher education widely available to borrowers through its fast-growing student loan programs. The existence of two competing government programs provides a unique opportunity to compare the cost to the government of direct federal lending versus loan guarantees.

The direct and guaranteed student loan programs offer borrowers similar loan products and terms. From the perspective of other key stakeholders, including educational institutions, commercial lenders, and state guaranty agencies, the programs differ significantly. The programs also report widely divergent budgetary costs: The FY2007 budget records a 2 percent subsidy rate on direct loans, versus a subsidy rate of 10 percent for loans provided through the guaranteed program. The subsidy rate captures the expected present value of the lifetime shortfall of net federal cash flows for each dollar of credit extended.

In this study, we propose and implement a methodology to estimate the cost of the two programs in market-value terms. In doing so, we address the question of how much of the difference in reported subsidy rates can be attributed to measurable cost differences and how much is due to idiosyncrasies in the rules for budgeting for federal credit. A potential source of a real cost differential is in the cost of capital. Data from the secondary market for guaranteed student loans provide some interesting evidence on the size of this effect.

To preview the main results, we find that budgetary costs for both programs are well below costs measured at their market value. This is mostly attributable to budget rules that require the discounting of expected net cash flows at Treasury rates. Understatement of the market cost of capital also is the reason that some direct loans appear to make money for the government, despite the favorable terms offered to borrowers. Administrative costs are accounted for inconsistently across programs, complicating cost comparisons. Nevertheless, it appears that the guaranteed program is fundamentally more expensive than the direct program. Guaranteed lenders are paid more than is required to induce them to lend at statutory terms. The excess funds are largely absorbed in competition for borrowers, which occurs through various discounts, marketing activities, and higher service levels and subsidies to educational institutions. To the extent that the market is not perfectly competitive, guaranteed lenders presumably retain some of the surplus as above normal profit. This suggests that reductions in government payments to guaranteed lenders could result in reduced benefits to borrowers and schools, as well as affect profitability.

The rest of the paper is organized as follows: Section 2 provides an overview of federal student loan programs—their size, their product offerings, the roles of various stakeholders, and their market structure. Section 3 describes how the government budgets for student loans and guarantees, how these rules have influenced structural changes in the programs over time, and the decomposition of costs in the budget. In Section 4, we

discuss the private market for student loans and the information it provides on the market cost of capital and administrative costs.

In Section 5, we turn to the central problem of estimating the market value of federal student loans and loan guarantees. The exercise requires modeling loan cash flows, which under the direct loan program are affected by defaults, deferrals, forbearance, prepayments, and other embedded options. For the guaranteed program, government cash flows are also affected by payments to and fees from private lenders. Identifying financing versus administrative costs is important both for assessing total cost and for understanding the cost differential between programs. Rates on private student loans are used as a starting point for risk adjustment. The resulting market-value estimates are presented and subjected to sensitivity analysis. Section 6 concludes with a discussion of some of the broader policy questions that the analysis raises.

2. Overview

The Department of Education (ED) oversees two competing student loan programs: the Federal Family Education Loan (FFEL), or guaranteed, program; and the William D. Ford Federal Direct Loan, or direct loan, program. In the guaranteed program, which dates back to the mid-1960s, the government guarantees loans originated by private lenders against losses from default and makes supplemental payments to lenders. In the direct program, which began operation much more recently, in 1994, the government directly lends to qualifying students.

2.1 Program Size

The federal student loan program is one of the largest credit programs operated by the U.S. government. Table 1 shows the rapid growth in the value of outstanding federally backed student loans, which in 2005 totaled over \$380 billion. Statistics compiled by the ED indicate that, in the same year, about 6.8 million students, and 750,000 parents of students, borrowed \$56 billion in new federally backed loans (and that an additional \$69.6 billion in old loans was consolidated). The guaranteed program was responsible for 77 percent of this new-loan volume. Another 2.5 million borrowers took advantage of the option to convert their outstanding Stafford loans into more favorable consolidation loans.

2.2 Product Offerings

Both programs offer three basic types of loans, with loan terms set by statute under the Higher Education Act:

Stafford. These 10- to 30-year loans are available to students enrolled in eligible educational institutions, which includes most U.S. colleges and universities, trade schools, and for-profit schools. Between 1998 and July 2006, these loans carried a floating rate that reset annually, based on the three-month Treasury rate plus a fixed spread. Since July 2006, Stafford loans have carried a fixed 6.8 percent per annum interest rate, with flexible repayment plans that begin when a student completes or drops

out of a course of study. Stafford loans may be “subsidized” or “unsubsidized”; the difference is that the federal government pays all of the accrued interest on subsidized Stafford loans while a borrower is in school, grace or deferment, whereas the interest accrues on unsubsidized loans. Both types carry a below-market interest rate. Eligibility for subsidized loans is based on income. Borrowers are assessed a one-time 3 percent origination fee, although this may be paid by the lender in the guaranteed program or reduced in the direct program. Recent legislation gradually phases out the origination fee.

Parent Loan for Undergraduate Students (PLUS). Traditionally, these were loans made to parents of students attending eligible institutions. In July 2006, borrowers began paying a fixed 8.5 percent per annum rate for PLUS loans, and students attending graduate schools became eligible to take out PLUS loans.¹ For parent borrowers, loan repayment begins immediately. Student borrowers begin repayment upon completion of their studies or if their course load drops below 50 percent of full-time status. All PLUS loans are unsubsidized but still carry interest rates that are generally below those available in private credit markets.

Consolidation. Borrowers with one or more Stafford or PLUS loans may replace them with a single consolidation loan anytime after completing their course of study. Consolidation loans offer a new repayment plan and an interest rate equal to the weighted average of interest rates on the underlying Stafford or PLUS loans rounded up to the nearest eighth of a percentage point. Thus, the portion of post-July 2006 Stafford loans that are consolidated will carry a rate slightly above 6.8 percent. Consolidation loans offer a similar set of flexible repayment terms as Stafford loans, including forbearance and in-school deferment.

Although guaranteed lenders receive lower compensation from the government for Consolidation loans than they do for Stafford loans, the returns are still positive, and competition to offer these loans is brisk. An exception is that guaranteed lenders often avoid consolidating distressed loans, which are more expensive to administer and have a lower expected income stream. As a result, a disproportionate share of distressed loans is consolidated into the direct loan program.

2.3 Stakeholders

Students and parents of students pursuing postsecondary degrees clearly benefit from these programs, which lower the cost and increase the availability of funding for higher education. From an economic perspective, such assistance can be welfare improving when imperfections in private credit markets limit access to education or when education has significant positive externalities.² However, some students may borrow excessively to

¹ Because of an administrative oversight, Direct PLUS loans began carrying a 7.9 percent rate as of June 2006.

² Several studies question the effectiveness of such policies, for example, De Fraja (2002), Dynarski (2002), Edlin (1993), Hanushek (1989), and Keane (2002). Gale (1991) points out that many federal credit programs probably have a small real effect on the allocation of credit, in many cases simply crowding out private borrowing and lending.

pay for degrees that add little to their earning potential. Unsubsidized Stafford loans are not means-tested, and borrowing limits are tied to years of educational attainment.

Educational institutions also depend on federal student loan programs for financial support. Without assistance, many students would be unable or unwilling to pay the high tuition charges at many schools.³ To a lesser extent, schools benefit directly if they elect to participate in the guaranteed loan program. Guaranteed lenders offer schools various types of support in exchange for featuring their loans, including educational grants and administrative, educational, and systems support to financial aid offices. In “school as lender” programs, where the educational institution itself takes on the origination role, the school retains the excess of government payments over its cost of extending credit.

Providing financing for guaranteed student loans has been a profitable line of business for private lenders, even as competition in the industry has intensified over time and with the liberalization of interstate banking. Although over 3,500 lenders originate, service, and finance federally guaranteed loans, the market is dominated by a few large lenders, including the leading commercial banks and Sallie Mae. Sallie Mae, by far the largest guaranteed lender, began as a government-sponsored enterprise but now is fully privatized.

State and private nonprofit guaranty agencies are another constituency that benefits financially from the guaranteed loan program. These entities administer the federal guarantee and provide services to schools and lenders. As of 2006, there were 35 active guaranty agencies, some operating in multiple states. Each guarantee agency maintains an account in federal trust, which is used to pay out claims from lenders. Those funds are replenished by the federal government. Guaranty agencies also receive federal funds for performing collection activities, currently 22 percent of the recovered amounts or 8 percent if the recovery is achieved via a consolidation loan. The agencies may use their share of collections to fund scholarships and educational outreach programs and for default-aversion activities.

2.4 Market Structure

Schools have a choice of whether to participate in the direct or guaranteed loan program. Simultaneous participation in both programs is not permitted, but a school can elect to switch programs, and some choose to do so.⁴ Competition for volume between the two programs therefore centers on school administrators, particularly financial aid officers. Recall that both programs offer students nearly identical loan terms, so differentiation occurs along other dimensions. The direct program offers greater administrative simplicity, which initially attracted many schools to the program. Guaranteed lenders responded by offering schools and borrowers improved service and other inducements,

³ Some analysts have argued that the generous borrowing limits in the federal student loan program have accommodated the growth in college tuition, which has exceeded the growth of the overall economy. (Add citation)

⁴ A single university may have some schools participating in the direct program and others using the guaranteed program.

and since the late 1990s the guaranteed program has slowly regained market share (see Figure 1).

Competition also takes place at each FFEL school between guaranteed lenders. Although there are thousands of lenders potentially competing for borrowers' business, at the school level, competition is much more limited. The financial aid office serves as a gatekeeper, counseling students who seek advice and including only a limited number of lenders on its "preferred lender list." Most students have little financial experience and rely on the advice of the school, although direct-to-student marketing of loan products is becoming more common and some students venture beyond the preferred lender list. Northwestern University provides a fairly typical example close to home. It includes five major lenders on its preferred list for undergraduate students. It does not officially rank them, but Citibank holds the coveted first position on the (nonalphabetical) list. The preferred lender lists for Northwestern's various graduate and professional schools are shorter. The business, law, and medical schools offer just three options, with the first one being Northwestern University itself. Only two lenders are recommended to students pursuing part-time MBAs.

Understanding the competitive structure of guaranteed lending is important for identifying the likely disposition of rents that arise from federal payments to lenders in excess of production costs. Although we do not model these interactions formally, it is a reasonable first approximation to assume that competition among the large players for access to borrowers leaves guaranteed lenders with only very low levels of above normal profit. The gatekeeper role of schools suggests that they capture a large portion of rents, but those may be passed on to students through scholarships, expanded program offerings, or other means. The common practice of lenders paying the origination fee for students is evidence that some of the rent goes directly to students. Some rents are also absorbed by marketing costs and inducements to schools and financial aid officers that are unlikely to provide much benefit to students.

3. Budget Estimates

Most analyses of the cost difference between the direct and guaranteed loan programs rely on budget estimates prepared by the Congressional Budget Office (CBO) and the Office of Management and Budget (OMB). Budget estimates are systematically lower than the market-based costs described in Section 4. An interpretation of a market-based cost estimate for a program is the up-front price a competitive private entity would charge to assume the federal government's role in the program. Such prices reflect the market's valuation of risk, whereas current budget estimates assume that the cost of risk to the government is zero. Because budget measures call for the use of risk-free discount rates for government credit programs, programs structured so that the government instead of private entities bears risk will always report a lower budget cost.⁵

⁵ Lucas and Phaup (2007) discuss the pros and cons of using market-based estimates in federal budgeting.

The current budget treatment provides a useful starting point for evaluating the cost of the student loan program. In this section we describe the rules governing budgeting for credit, how changes in budget rules over time have affected the federal student loan program, and what budget estimates reveal about the breakdown of costs for the two programs.

3.1 Budgeting for Federal Credit Programs

Before fiscal year 1992, credit programs, like most other government programs, were accounted for on a cash basis. For a new direct loan program, this implied a large up-front cost equal to the principal borrowed, with no offset for expected future repayments. An economically equivalent credit guarantee program had a much lower, or even negative, up-front budget cost. For credit guarantees, few defaults occur in the first year, and guarantee fees are collected up front. This accounting favored new guaranteed loan programs over almost all alternative policies, including direct loan programs.

The Federal Credit Reform Act of 1990 (FCRA) effectively put credit on an accrual basis, with cost measured as the net present value of current and future cash flows associated with the current-year commitment. Although FCRA moved the budget toward making credit and other forms of assistance comparable, the subsidy estimates do not measure cost in terms completely equivalent to cash spending. The biggest discrepancy arises from the mandated use of interest rates on maturity-matched U.S. Treasury securities for discounting, rather than a market-based cost of capital that includes the cost of market risk. It also treats administrative costs inconsistently across programs, with some costs included in subsidy rates and others recorded elsewhere on a cash basis.

3.2 Effects of Budget Rules on Student Loans

Accounting conventions have had a significant effect on the structure and evolution of the federal student loan programs. Most notably, the direct student loan program appears to have been made feasible from a budgetary perspective by FCRA. Although such a program was proposed on several occasions in the late 1980s, its high initial cash cost was a decisive obstacle. The direct loan program was enacted in 1993 shortly after the FCRA went into effect.

As for other credit programs, the mandated use of maturity-matched Treasury rates without risk adjustment and the inconsistent treatment of administrative costs drive a wedge between budget estimates and the market-value estimates of program cost. The inconsistent treatment of costs across programs is particularly pronounced for student loans. Unlike with many credit programs, administrative costs are included in the subsidy rate reported for guaranteed loans. This occurs because the federal government makes supplementary allowance payments to private lenders to cover the lender's administrative and other expenses in excess of the amounts collected from borrowers. Inasmuch as those payments continue for the life of the guaranteed student loan, they are capitalized and included in subsidy costs. By contrast, administrative costs in the direct program are accounted for separately on a cash basis and are not included in subsidy estimates. The

extent to which this inconsistency affects the difference in subsidy rates has been estimated to be no more than 1.5 percentage points (CBO, 2005).

A discrepancy between budget and market-value cost also arises from the budgetary treatment of floating-rate loans. Through June 2006, the only large federal direct lending program with floating rates was the direct student loan program. The FCRA is interpreted as requiring the use of long-term Treasury rates for discounting, whereas market values reflect the shorter effective maturity of floating-rate loans. Because of the term premium in long-term rates, this tends to bias down federal estimates of direct loan value. This undervaluation has potential real effects. For instance, it prompted the Department of Education to propose a sale of direct loans in 2003. The plan was to sell the loans, apply some of the proceeds to paying off Treasury debt, and use the net gain to provide additional assistance to students. In fact, the sale would have entailed additional administrative costs without generating any real savings. Although switching to fixed rates for new student loans after June 2006 mitigated this effect, the payments to guaranteed lenders still depend on short-term interest rates and will continue to be misvalued.

3.3 Budget Cost Decomposition

The Credit Supplement to the Budget, prepared by OMB, provides a breakdown of subsidy cost across four cost components (defaults, interest, fees, and “other”) for four loan categories (Stafford Subsidized, Stafford Unsubsidized, PLUS, and Consolidated). Table 2 reproduces this data from the 2007 Credit Supplement in terms of subsidy rates. The subsidy rate is the present value of net losses divided by the underlying loan principal at origination.

Both programs report a similar, but small, subsidy cost component for defaults. As discussed below, this component of cost appears inexplicably low for both programs. For the remaining components, the breakdown of subsidy costs is markedly different across the two programs.

First, the direct program reports large interest income, whereas the guaranteed program reports large interest costs. In the direct program, the government reports interest income as the present value of any interest paid by borrowers in excess of the cost of financing, which is taken to be a Treasury rate. Because the borrower interest rate on most loans typically exceeds the Treasury rate, this item reduces the subsidy cost. In contrast, the interest component in the guaranteed program represents the present value of the net payments paid to private guaranteed lenders (the difference between the lenders’ rate, which is indexed to the 3-month commercial paper rate, and the borrowers’ rate), which is positive on average. Although classified as interest, these payments are more accurately described as covering administrative costs because the borrower rate typically exceeds lenders’ cost of funds. Administrative costs in the direct program that are paid directly by the federal government, however, are excluded from subsidy estimates. Direct lending administrative costs that entail payments to third parties for tasks such as collecting on loans appear in the category “other.”

Fees levied on borrowers, guaranteed lenders, and guaranty agencies reduce subsidy costs. These fees include the up-front application fee on Stafford and PLUS loans in both programs, as well as the 1.05 percent per annum consolidation fee paid by private lenders to the federal government in the guaranteed program. The remaining category, other, largely includes the subsidy cost contribution associated with collecting loans and payments to third parties for performing administrative tasks.

The last two columns of Table 2 show expected cumulative lifetime default and recovery rates (the latter is the expected cash flow recovered as a percentage of defaulted principal).⁶ Default rates are similar in the two programs, reflecting the similar borrower populations. The exception is for consolidation loans, which experience much higher default rates in the direct program. As noted earlier, the higher default rate can be explained by the reluctance of guaranteed lenders to consolidate loans on the brink of default, while the direct program accepts those loans for consolidation.

4. Inferences from the Private Loan Market

A systematic way of identifying the market value of the federal government's credit commitments is to use the prices of comparable securities offered in private markets. For student loans, we propose to use rates quoted to borrowers in the private market for student loans.

Limits on federal borrowing and increasing educational expenses have contributed to the development and rapid growth of a competitive private market for student loans. The market primarily serves students who have exceeded federal lending limits, which currently are set at a cumulative amount of \$23,000 for undergraduates and at a combined limit of \$65,500 for undergraduate and graduate study.⁷

The main players in the private loan market are the largest guaranteed lenders—Sallie Mae and major national and regional commercial banks. Economies of scale in marketing, systems administration, and funding, and the experience gained from guaranteed lending, give these institutions a competitive advantage over other potential entrants. Although students can obtain private loans on their own, as with guaranteed lending, students often rely on the financial aid office for recommendations, which tends to limit direct competition between lenders.

⁶ The surprisingly high reported recovery rates arise from two idiosyncrasies in budget reporting: The recovery amounts are not discounted, and not all collection costs are deducted. As shown in the next section, adjusting for these factors yields recovery rates that are in line with experience in the private student loan market.

⁷ There are also various annual limits on federal borrowing. For independent students and those whose parents have been denied a PLUS loan, the current cumulative limits are \$46,000 and \$138,500, respectively. Some medical school students may be able to borrow up to \$40,500 a year (up from \$38,500) and \$189,125 total.

4.1 Federal-Private Differences

Although the private loan market provides data that are useful in estimating the market value of government loans and loan guarantees, various differences make direct cost comparisons problematic. Here we describe the main differences between private and government-backed loans and propose some adjustments to account for the resulting cost differentials.

Borrowers: Federal programs serve a much broader population of students than do private lenders. Because private loans appeal to students who have hit federal borrowing limits, they tend to be used by students at high-cost undergraduate institutions and by students preparing to enter such professions as medicine, law, and business. Several factors suggest that federal borrowers are likely poorer credit risks. The eligibility of borrowers for federal loans or subsidies does not depend on a credit score, whereas private lenders use credit scores to assess borrowers' creditworthiness, refusing credit entirely below a certain cutoff. Private lenders also can avoid originating loans at schools whose graduates' employment prospects are weak. Conversely, private lenders extend credit to students who already have high federal loan balances and who start work with much higher levels of total indebtedness.

Default Losses: Federal and private lenders report quite similar losses from default (net of recoveries and collection costs) of approximately 1 percent per annum, but the composition of default losses is starkly different. Default rates in the federal programs are approximately 2 percent of outstanding principal per annum, whereas they are only 1 percent per annum for typical private loans. The lower default rates in the private program are offset by lower recovery rates because private lenders do not have access to federal collection remedies, such as the Treasury offset program and administrative wage garnishment. The recovery rate is computed by discounting the cash flow stream of loans in default over their remaining life. Because many defaulted federal loans are only partially recovered and recovery is an expensive process, federal recovery rates are about 50 percent of the defaulted sum (this estimate is discussed in more detail in the next section).

Loan Terms and Fees: Apart from carrying higher interest rates, private loan terms are less favorable than those for Stafford loans along a number of dimensions. Private loans lack the valuable consolidation option, repayment options are more limited, and lenders may be less generous with forbearance. There are no grace or deferment periods, and in contrast with federal loans, death or disability does not trigger forgiveness. Private loans do offer long loan maturities of up to 20 years, and the mechanisms to collect on defaulted loans are weaker (see Section 5.1.2). As on guaranteed loans (but not with direct loans), lenders often offer incentives for on-time and electronic payments, etc. Among these nonrate differences, the consolidation option is likely to be the biggest advantage of the federal programs. In Lucas and Moore (2006), we estimate that in every year since 2001 the consolidation option has added more than 2 percent to the market-value subsidy rate on new loans. (With the switch to fixed rates, the consolidation option will have less value going forward, but borrowers with fixed rates will have the valuable

option to speed up repayment when rates are low or to slow down repayment when rates are high.)

Competitive pressures have reduced or eliminated origination fees on private loans, hence administrative costs are covered by higher rate spreads. Similarly, most guaranteed lenders pay the federal origination fee on behalf of borrowers. On direct loans, however, borrowers still are required to pay 1.5 percent up front and the entire fee if they fail to make a timely first payment.

Administrative Costs: The task of identifying administrative costs and allocating them across activities is complicated by the lack of either government or private data. Common administrative functions include origination, servicing, collection, and general overhead.

Origination costs are probably somewhat higher for private loans because of fees paid to obtain credit scores (including those paid for students who ultimately borrow elsewhere or don't qualify). Private loans also involve higher contracting costs (legal expenses, for instance) than do direct loans. Loan servicing is a competitive industry, and it is safe to assume that servicing costs are similar for all lenders. Loan collection services can also be obtained at competitive prices, although guaranty agencies are paid a statutory amount that appears to exceed their cost of providing services. We assume similar collection costs for private and direct loans, and adjust for the subsidy component of payments to guarantee agencies in the guaranteed program.

Additional administrative cost arises for guaranteed and private loans because of higher service levels and marketing expenses. Such expenses include information systems, marketing personnel, phone center staff, conference sponsorship, travel to schools, and so on.

The financial statements of private and guaranteed lenders provide some data on administrative costs. Noninterest expense, broken into various categories, is reported on an annual basis. Some costs, such as servicing, apply to the portion of the outstanding loan portfolio in repayment, while other costs are incurred for origination activity, but financial reports do not allocate costs by activity. Data from one lender for 2006 are used to make some rough imputations.⁸ We attribute 80 percent of personnel, consulting, and occupancy expenses to origination, 100 percent of promotional expenses to origination, and 50 percent of computer and other expenses to origination. Total origination expenses, divided by total volume of Stafford and private originations, is 0.95 percent. Representing this as an annual rate spread on a 10-year amortizing loan implies an origination cost of 22 basis points (bps). The remaining noninterest expenses, divided by the portfolio of loans in repayment, gives an annual cost of 45 bps. Thus, private lenders bear an amortized cost of 67 bps, excluding collection costs, which we account for separately in default losses.

⁸ Simply dividing total noninterest expense over the loan portfolio would be misleading because a large portion of the total is current originations.

Administrative per-dollar costs for outstanding loans in the direct program appear to be lower than per-dollar costs for private loans. An annual appropriation to the Department of Education covers the administrative costs of the direct program, although some of these costs are attributable to administering both the direct and guaranteed programs. That appropriation was approximately \$600 million in 2006. At that time, the outstanding direct program portfolio was approximately \$100 billion and the guaranteed portfolio approximately \$300 billion. In disclosures to CBO, the department reported allocating approximately \$200 million of the appropriation to direct program servicing contracts, \$30 million to direct program origination contracts, and \$200 million to direct and guaranteed program recovery contracts. We assume the remaining unallocated \$170 million is attributable to servicing and origination functions of the direct and guaranteed programs in proportion to the size of each program. The amounts attributable to the direct program divided by the \$100 billion outstanding yield an estimate of amortized direct program origination and servicing cost of 30 bps.⁹

4.2 Estimating the Cost of Capital from Private Market Rates

In a competitive private lending market, the rate charged by private lenders should recover all costs associated with making the loan, including administrative costs, losses from default, and the cost of capital. A broad measure of the market cost of federal credit includes all of these components because that is what the government would have to pay private lenders to provide this service to students.

Although we can infer loans' losses and administrative costs directly from Department of Education records, we have no way of directly estimating the loans' cost of capital because federal loans are not traded without their guarantee. Thus, we estimate the cost of capital for federal student loans from the cost of capital for private student loans. That cost of capital includes a charge for the systematic risk in student loans losses, the risk premium for student loans.

Private lenders charge students floating rates tied to the London Interbank Offered Rate (LIBOR). Quoted rates range from LIBOR+2 percent to LIBOR+7 percent. The rate offered varies by credit score and educational institution, but LIBOR+4 percent is typical. Assuming a 30 basis-point spread between one-year LIBOR and one-year Treasury, the interest rate spread over Treasury is 4.3 percent.

The risk premium on student loans—the difference between the loan cost of capital and the Treasury rate—can be estimated by starting with this 4.3 percent spread and subtracting estimates of other cost components. As discussed above, administrative costs are on the order of 72 bps,¹⁰ and the annual default loss rate from federal student loan data is approximately 1 percent per annum. This leaves 2.58 percent attributable to a

⁹ We assume that the federal program is close to a steady state, so dividing total costs by total loans is a reasonable approximation of annual costs.

¹⁰ Private administrative costs for collections of 5 bps are added to the 67 bps for the servicing, origination, and general administration of loans.

market-risk premium, an estimate we use in the cost analysis in the next section. Because of the many reasons the private and federal risk premiums differ, in our sensitivity analysis, we consider lower and higher levels of the risk premium.

The special allowance payments to lenders have significantly lower risk than do the student loans. The payments are based on commercial paper rates, which typically are about 30 bps over Treasury rates. Hence, these payments are discounted at Treasury rates plus a spread of 30 bps.

An alternative approach would be to approximate private lenders' cost of capital by looking at the weighted average cost of debt and equity capital for public firms in this business. This turns out to be impractical because there are few publicly traded companies whose primary business is making and self-funding private student loans. Further, the few publicly traded companies that specialize in private loans have a short history. They also tend to repackage the risk, for instance through securitization structures. Hence, the cost of capital for private student loans cannot be accurately inferred from traded debt and equity returns.

5. Estimating Federal Program Costs

The main cost analysis involves projecting the distribution of future cash flows to and from the government over the life of a loan or guarantee obligation and discounting at risk-adjusted rates. We start by modeling the cash flows associated with the underlying loans, taking into account program rules, borrower behavior, and the various options affecting payment patterns. These cash flows, in combination with rules for payments between guaranteed lenders and the government, also determine the cash flows associated with guaranteed loans.

A subsample of student records from the Department of Education's National Student Loan Database System (NSLDS) provides information on historical borrower payment patterns, which is used to parameterize the model. In particular, we derive new estimates of default and recovery, which are critical inputs into the subsidy rate. We use a sample from the database drawn in January 2006, which contains historical information on loans and borrowers dating back to 1980, although we used the older data only where absolutely necessary. The sample consists of over 10 million loan records and 1 million borrowers. We use Monte Carlo simulation to project future cash flows that depend on stochastic interest rates and borrower behavior. Discounting projected cash flows at the risk-adjusted rates (derived as described above) yields cost estimates for both programs. In addition, we present alternative estimates based on a simple comparison of private and government student loan rates.

5.1 Cash flows

On direct loans, a net outflow of principal occurs when the borrower takes a new loan (less the 1.5 percent origination fee paid by the borrower). Subsequently, net inflows of repaid principal and outstanding interest flow to the government over time, including

amounts recovered from default less any recovery costs. The government also incurs ongoing administrative costs, which we allocate to individual loans on a per annum basis in proportion to their outstanding amount.

In the guaranteed program, government cash flows include net transfers to and from lenders (indirectly via guaranty agencies) on each outstanding loan, equal to the difference between the borrower's interest payment (if any) and the three-month commercial paper rate plus a spread. This is referred to as a Special Allowance Payment, or SAP. Currently the spread is equal to 1.74 percent per annum for Stafford loans when the borrower is in school, 2.34 percent for Stafford loans when the borrower is in repayment, and 2.64 percent (less the 1.05 percent per annum lender consolidation fee) for consolidation loans. The government also makes guarantee payments to lenders for claims on defaulted loans and pays "retention" fees to guaranty agencies in proportion to their recoveries on defaulted loans.

5.1.1 Effective Maturity and Repayment Status

The repayment horizon for federally backed loans varies from less than a year to over 30 years. Borrowers may prepay their federal loans, which can significantly shorten loan terms, without penalty. For example, approximately 8 percent of originated loans close in fewer than five years, and approximately 60 percent close within 15 years.¹¹ Historical data may understate the future distribution of loan lifetimes because closure rates at long horizons are estimated from loans originated when the federal loan program offered less favorable terms to borrowers.

While they are in school and for a few months after graduating, borrowers do not need to make payments on federally backed student loans. During this grace period, the federal government pays the interest for subsidized loans, whereas interest accrues on unsubsidized loans. Periods of grace necessarily raise the market-based subsidy cost even for unsubsidized loans because the interest rate is typically lower than the rate a private lender would charge. Over 95 percent of loans by originated value are in an in-school or grace period in the year of origination, but fewer than 10 percent of loans were in a grace period four years after origination. The average time in school is approximately 2.5 years (excluding time in loan deferral for subsequent schooling, which is discussed next).

Borrowers are entitled to lengthy payment deferral in times of financial hardship or, in the case of Stafford loans, when borrowers want to pursue further studies. Stafford loans are also forgiven in the event of the death or disability of the borrower (parent loans are forgiven upon the death, but not disability, of the student). An effect of these provisions is that they may lower reported default rates. Periods of in-school deferment last as long as the borrower remains in school, whereas a borrower who experiences financial hardship may elect a three-year payment deferment or a payment forbearance period (the former is available only under more restrictive conditions). Analysis of loans in the NSLDS suggests that borrowers with outstanding loans in repayment enter deferment or

¹¹ These estimates treat loan consolidations as an extension of the original loan rather than as a new loan. Stafford loan lifetimes would otherwise appear to be much shorter than this.

forbearance at a rate of approximately 6 percent per annum for a typical term of three years.

The effect of these repayment options is shown in Figure 3, which illustrates the breakdown of outstanding loan principal by loan status in January 2006 for both the direct and guaranteed program. Overall, only about half of the loans are in repayment, while grace, deferral, forbearance, and default account for the remainder.

Borrowers have standard options to extend Stafford loans beyond the basic 10-year maturity even without consolidation. Stafford borrowers with a balance of \$30,000 or more from a single lender (whether a single guaranteed lender or a loan from the direct program) may choose an extended repayment plan of up to 25 years. Income-contingent and graduated repayment plans are also available. The right to consolidate Stafford loans also allows borrowers to extend the term of their original loans, as well as to convert floating-rate loans to a fixed rate. For some borrowers, consolidation allows them to extend for up to 30 years. Eligibility for term extension depends on the size of the consolidated loan, as shown in Table 3.

The OMB treats consolidation loans as new loans rather than as extensions of existing loans. This paper treats consolidation as an extension of existing loans. Treating a consolidation loan as an extension of an original loan avoids double counting of loan volumes and default rates. This approach also ensures that the subsidy cost includes the value of the option to consolidate.

5.1.2 Default and Recovery

Borrower default is an ongoing source of costs in both the direct and guaranteed lending programs, despite the strong loan enforcement mechanisms that the government has at its disposal.¹² Before direct lending, the guaranteed lending program reported very high default rates. In response, the Congress made a number of changes to the Higher Education Act. Chief among them was the use of cohort default rates as a performance measure and as a criterion for schools to retain access to federal student loans and grant funding. Since the adoption of these measures, new default claims in both the direct and guaranteed lending programs have more than halved.

The strength of the U.S. economy and the increased use of deferment, forbearance, and consolidation have also contributed to the lowering of default rates. Offering more generous terms to students is costly, however, since it may delay an inevitable default and make recovery more difficult. Table 4 below reports default claims as a percentage of outstanding balance for 1990, 1996, and 2005.

Figure 4 shows the average annual default rate of loans by the number of years that have elapsed since the loans entered repayment for the four classes of loans (guaranteed Stafford, guaranteed Consolidated, direct Stafford, and direct Consolidated). Average

¹² Student loans are not dismissed in bankruptcy. The government can collect through the Treasury Offset Program.

default rates are about 2 percent per annum. Stafford loans experience higher levels shortly after entering repayment, which may in part reflect the cumulative effect of in-school grace periods (since a borrower cannot default while he or she remains in school even though adverse circumstances may arise that impair a borrower's current and future ability to repay his or her loan). Consolidated direct loans report strongly higher default rates than consolidated Stafford loans because the Education Department frequently consolidates loans for borrowers that guaranteed lenders consider too risky. Even though guaranteed lenders bear virtually no credit risk, the administrative expense of consolidating a borrower's loans and resolving default is a sufficient disincentive to consolidate risky borrowers. Data confirm that borrowers who consolidate defaulted loans are more likely to default on their consolidation loans than are other borrowers. We attribute the cost of these defaults to the program in which the original loans were originated rather than to the program that consolidated them.

OMB reports recovery rates on student loans that far exceed those on other forms of unsecured consumer credit, but as discussed in Section 3.3, that agency's measure neglects collection costs and time value. Relying instead on NSLDS data, we find that individual loans exhibit significant variability in recoveries, with some defaulted loans resolved quickly and others remaining uncollected for more than 10 years. The typical pattern suggests that collection rates diminish over time. Applying a risk-adjusted discount rate (equal to the average interest rate over the data period plus our assumed 2.58 percent risk premium) and subtracting a 16 percent recovery cost suggests a recovery rate of about 50 percent of the defaulted principal. Combining this with the annual default rate of 2 percent per annum implies losses from default equal to 1 percent of principal outstanding per annum.

5.2 Simulating Cash Flows

Cash flows for both programs depend on the stochastic path of future interest rates, program rules, and borrower behavior. These are modeled using Monte Carlo simulation. Each month, a random draw from a normal distribution determines the innovation in the short-term interest rate, and the corresponding term structure is derived from the Cox Ingersoll Ross (CIR) model (see Appendix 2 for a complete description of the interest rate model and the parameters used in estimation). Variation in interest rates affects the discount rate and guaranteed lender payments.

Monthly loan repayment cash flows depend on various borrower behaviors: whether the student is in-school; the borrower's repayment plan; consolidation; default, recovery, prepayment; and an administrative charge. Appendix 2 contains a description of how we simulate the cash flows that depend on stochastic borrower behavior. It also describes the aggregation of cash flows across representative loan groupings.

The cash flow model is calibrated under the following base-case assumptions:

Borrower Interest Rates: As of June 2006, borrowers began paying a fixed rate of 6.8 percent per annum on all new Stafford loans. The interest rate on consolidation loans is a

weighted average of the interest rates prevailing on the loans consolidated rounded up to the nearest 1/16th of a percentage point. For a student whose original loans all have a 6.8 percent rate, the consolidation loan interest rate will be 6.875 percent per annum.

Repayment Horizons: A typical loan repays over a 20-year term, but any individual loan can be repaid over shorter or longer horizons. The probability of longer repayment is positively correlated with the borrower's balance. For borrowers entering repayment, approximately one-third of all loan value is in each of three balance categories, and respectively 15 percent, 40 percent, and 60 percent of borrowers in each category take up the maximum extension options.

Default Losses: The value of default losses each year is equal to 1 percent of outstanding balances in both the direct program and guaranteed program. Although there are reasons that default losses for the two programs differ,¹³ the available historical data did not contain information on direct program recoveries to estimate the direction or magnitude of the difference.

Noncollection-Related Federal Administrative Expenses: The federal government incurs direct administrative expenses for both programs. These costs are not included in official budget subsidy estimates, but they are included in the more comprehensive estimates here. We assume that, each year, the department directly spends 0.3 percent of outstanding principal administering the direct program and 0.1 percent administering the guaranteed program. The administrative costs borne by guaranteed lenders in the guaranteed program do not directly affect subsidy rates.

Guaranteed Lender Payments: The federal government pays guaranteed lenders a spread above the quarterly reset three-month commercial paper rate. That spread varies with the type of loan and its payment status as described earlier and terminates upon default.

Loan Origination Fee Receipts: The government charges borrowers a 3 percent origination fee in both programs, which reduces the subsidy cost by a corresponding amount. In the guaranteed program, guaranteed lenders often pay this fee for the borrower. In the direct program, the Department of Education charges half of the 3 percent fee up front and levies the remaining 1.5 percent only if borrowers fail to enter repayment on time. For simplicity, we assume one-half of borrowers enter repayment on time, reducing the total fee (in present value) to 2.25 percent.

Adjustments for Federal Revenue Effects: The companies that serve the direct and guaranteed programs pay federal corporate income taxes. Ideally, the corporate income taxes paid should be taken into account in calculating the net federal outlay. However, current budget practice does not recognize income tax receipts in subsidy estimates. A recent study by Price Waterhouse Coopers (2005) estimated that the guaranteed lending program generates corporate income tax with a present value of 1.5 cents per dollar of loans originated, which translates to an approximate per annum tax receipt of 20 basis

¹³ For example, the direct program reports slightly higher default rates, and the guaranty agencies in the guaranteed program are paid a higher collection fee than are contract collectors in the direct program.

points per dollar outstanding. The direct program also generates corporate income taxes from information technology, servicing and collections contracts with private companies. We assume this generates no more than 5 basis points of tax revenue, leaving a 15 basis-point per annum tax differential between the direct and guaranteed programs. In our base-case subsidy estimates, we ignore this differential.

5.3 Discounting Risky Cash Flows

Under current budgetary treatment of credit programs, expected net federal outlays are forecast using a simulation model. Those expected cash flows are then discounted using maturity matched zero-coupon Treasury bond yields to produce subsidy estimates.¹⁴ In a market-based valuation of the federal exposure, we adopt a similar simulation approach, but we additionally categorize cash flows by their exposure to market risk and discount them using risk-adjusted rates.

To incorporate the effect of interest rate and credit risks on the value of direct and guaranteed loans, we overlay a simple two-state model of default on a model of interest rates to provide state-dependent discount rates (or state prices). Each state of the model corresponds to an interest rate and a borrower default state (in other words, whether default has occurred or not) allowing us to specify cash flows in each of those states and discount them accordingly. The appropriate discount rates for default and nondefault states is inferred from the credit-risk premium derived in Section 4 (and justified by a no-arbitrage argument). Interest rates are calibrated to prices of long- and short-term Treasury securities.¹⁵ Appendix 2 explains the model in detail.

Despite the apparent differences between the cash flows of the two programs (as described in Section 5.1), using market-based discount rates ensures that program subsidy rates are consistent whether programs are publicly or privately financed. In particular, a direct program whose administration is competitively outsourced to a private lender will have a market-based subsidy identical to that of a guaranteed loan program with a 100 percent credit guarantee and a competitively determined private lender yield. That is, in a market-based approach, it is irrelevant whether public or private entities raise capital for the program because the cost of capital is determined by the underlying assets. In contrast, current budget practice will not produce equal direct and guaranteed subsidy rates in this case because lender yields in the guaranteed program include compensation for the credit-risk premium (required to ensure the participation of lenders), which is implicitly excluded from the subsidy rate of the direct program due to the use of Treasury discount rates for all cash flows.

¹⁴ Using a full schedule of Treasury maturities captures the interest rate term premium inherent in longer-term cash flows.

¹⁵ For simplicity, we assume that the risk factors driving interest rates are independent of the risk factors driving credit spreads. We also ignore the well-documented term premium in credit spreads and assume that a constant credit-risk premium applies to the underlying loans irrespective of their term.

5.4 Base-Case Subsidy Estimates

Table 5 presents subsidy estimates for newly originated loans in academic year 2006–2007 (July 1, 2006, to June 30, 2007) under the base-case assumptions outlined above. The overall subsidy estimate for each program is computed by averaging over representative groupings of loans by subsidized status and maximum available repayment horizon. The difference between subsidized and unsubsidized loans is the present value of in-grace and in-deferment interest paid by borrowers with unsubsidized loans that is not paid by borrowers with subsidized loans. Considering that a typical subsidized borrower will spend about three years in grace and in deferment, the 6.8 percent per annum forgone interest adds up to a subsidy of about 12 percent of the loan amount.

Subsidy rates vary with the term of loan repayment. Allowing borrowers to extend a 10-year Stafford loan to 20-years raises the subsidy cost for that loan by about \$3 per \$100 originated. This increase would be even higher, but many borrowers fail to take advantage of term-extension options and frequently pay off their loans early.

Guaranteed loans have a consistently higher subsidy rate than do direct loans. Subsidies for both programs are computed under the assumption that actual administrative and capital costs are similar across both programs. But the net income payments to guaranteed lenders and guaranty agency collection fees are significantly more than is required to cover those costs in the guaranteed program.

Looking to the future, subsidy rates for new loans may be considerably different from the estimates for 2006 reported in Table 5. The most obvious cause of future variation in new-loan subsidy rates is changes in interest rate conditions. This is because borrower interest rates are fixed at 6.8 percent per annum for all new Stafford loans, whereas the government's opportunity cost moves with prevailing interest rates. Thus, if interest rates go up next year, subsidy rates will rise; if interest rates decline, so will subsidy rates. Figure 5 shows average, 10th and 90th percentiles of subsidy estimates for each of the next 10 years. To make these forecasts, we use the interest rate model combined with current yield curve information to provide simulated paths of future interest rates to determine starting conditions for each year. We assume loan cash flow performance is consistent with the assumptions of the base case (but appropriate to interest rate conditions). As the horizon lengthens, the course of future interest rates becomes more uncertain, so the band of subsidy values widens in both programs.

5.5 Sensitivity Analysis

Aggregate subsidy estimates under alternative assumptions are shown in Table 6. Subsidy estimates are quite sensitive to the assumed risk premium. A one-percent higher (lower) risk premium than that assumed in the base case raises (lowers) subsidy rates by \$7 per \$100. For the direct program, this is most easily understood as the higher discount rate reducing the value of future repayments. On the guaranteed loans, the effect of market risk is to raise the present value of guarantee payments made on defaulted loans. The credit-risk premium has a small effect on the present value of net income payments to

guaranteed lenders, as discussed in Section 5.3. The effective duration of the loans also affects value, with loan extension generally increasing cost. Table 6 also reports subsidy costs with 25 percent faster and slower loan repayment rates, which serves to lengthen or shorten the average loan term by approximately four years. The increase (decrease) raises (lowers) subsidy costs by about \$2 per \$100.

To compare the cost of the two programs, it is useful to break subsidy costs into their component parts. Table 7 reports a breakdown into market risk, default losses, up-front fees, and other administrative expenses. The cost attributable to each component is found by sequentially removing each cost element from cash flows or discount rates, computing the new subsidy cost and then reporting the difference.¹⁶ Any residual subsidy cost is driven by the difference between the student interest rate and risk-free rate of return. Market risk and default losses are the most important elements of the direct loan subsidy. The guaranteed lender payments add significantly to the guaranteed program's subsidy cost.

Finally, Table 8 reports subsidy costs for the direct and guaranteed programs for a variety of policy alternatives. One option is to lower the guaranteed lender payments to bring the guaranteed subsidy closer to the direct loan subsidy rate. The first two rows of Table 7 report the predicted subsidy estimates after lowering lenders payments by 0.5 percent and 1.0 percent per annum, respectively. The effect of the 1.0 percent reduction is to bring the subsidy in the guaranteed program to within 3 percent of the direct program. Another set of alternatives relates to the interest rate paid by borrowers. Switching from variable to fixed interest rates on Stafford loans has increased the subsidy cost for 2006 by approximately \$2 per \$100, in part because fixed rate loans should have a premium above variable-rate loans and in part because our long-term interest rate projections imply that the variable-rate loan will be above 6.8 percent. If market interest rates continue to increase, subsidy costs on loans originated after 2006 could be significantly higher than they would be under the variable-rate policy. Several proposals to lower borrower rates are being discussed by members of the Congress. One proposal would cut the borrower rate in half over the entire life of the loan, which would increase the subsidy cost by approximately \$15 per \$100. (In fact, the subsidy cost could increase by even more than this if the lower rates caused borrowers to lower their rate of prepayment and switch to longer-term repayment plans).

5.6 Alternative Estimates

A ballpark market-value estimate of the cost to the government of direct lending is obtained by comparing the rate charged to students on private loans with the rate charged by the government and discounting the annual savings. Although such an estimate does not control for the differences between private and direct loans and greatly oversimplifies the pattern of cash flows, it provides a useful comparison point and confirms that the low

¹⁶ The order that different cost elements are removed has a modest impact on the cost attribution to different components.

subsidy cost for direct loans in the budget is probably well below the true cost to taxpayers.

Like the earlier calculation of the cost of capital, the estimate is based on typical terms for floating-rate Stafford loans and private loans made in recent years, where LIBOR+4 percent approximates the average rate. Stafford loans carry a rate based on a three-month Treasury rate that resets annually, plus a spread. The spread equals 1.7 percent when the student is in school, in grace, or in deferment, and 2.3 percent otherwise. Approximating the difference between LIBOR and three-month Treasury at 30 bps, and assuming a 2 percent average spread on federal loans, students typically pay 2.3 percent more per annum on private loans than on federal loans. We assume further that both types of loans amortize over 10 years, abstract from the effects of prepayment and default, set LIBOR to 5 percent, and discount at LIBOR + 4 percent. This yields an estimated present value interest savings to students of \$10,463 per \$100,000 borrowed, or a 9.8 percent subsidy rate. The higher subsidy rate in the more complete analysis can be attributed to the value of the various extension and deferral options.

6. Discussion and Conclusions

This paper presents two main findings: First, the market-value estimates developed here indicate that the cost to taxpayers of both programs is significantly understated in the budget. Second, even under a market-based valuation methodology, the guaranteed program reports a significantly higher subsidy rate than does the direct program. We conclude with further discussion of the government's apparent cost advantage over the private sector in funding fully guaranteed student loans.

Guaranteed lenders routinely obtain funding by securitizing parcels of previously originated federal loans and selling these asset-backed securities to investors at a weighted average rate slightly over LIBOR. This suggests that private investors do not view guaranteed loans as perfect substitutes for Treasury securities, despite the 97 percent to 99 percent credit guarantee.¹⁷ In addition, lenders bear underwriting, SEC filing, and other administrative fees that add to the total cost of capital. In comparison with the cost of Treasury funding for direct loans, it appears that guaranteed lenders pay 25 to 35 basis points more to borrow. What accounts for the higher cost? One factor is that a guaranteed loan is not completely risk-free—lenders who fail to administer loans according to ED policy and regulations may have the guarantee voided for those loans. The exemption of Treasury interest from state and local taxes also lowers Treasury rates relative to LIBOR. Further, securitized student loans are less liquid than Treasury securities. The prepayment and extension options add uncertainty about maturity, also increasing funding cost (as evidenced by higher spreads on the tranches of securitizations that absorb the maturity risk). However, these options also increase the cost of funding direct loans and, as with the risk premium, should be included in a market-value cost estimate for either program.

¹⁷ This discussion is based on securitizations of floating-rate loans and prospectus data from Sallie Mae on recent issues.

Prior to the mid-1970s, individual federal agencies raised funds separately, but recognition of the cost advantage of centralized borrowing led to a policy of consolidating federal borrowing through the Treasury, via the Federal Financing Bank. Since that time, growth in federally guaranteed loan programs has reduced some of this advantage. There may be instances when private intermediation adds value, for instance through better screening or monitoring of borrowers. However, in the case of student loans, which have categorical entitlement and an almost full credit guarantee, it is not clear that the value added by private intermediation justifies the significantly higher cost.

Table 1: Federal Student Loans Outstanding, 1998-2005								
(Millions of dollars)								
	1998	1999	2000	2001	2002	2003	2004	2005
Family Federal Education Loan Program								
Unconsolidated (Stafford & PLUS)	74,727	92,760	106,220	122,423	129,757	130,455	142,405	148,391
Consolidated	9,675	20,008	27,891	32,384	49,434	79,017	100,176	138,457
Subtotal	84,402	112,768	134,111	154,807	179,191	209,472	242,581	286,848
Ford Federal Direct Loan Program								
Unconsolidated (Stafford & PLUS)	26,937	33,763	43,091	47,958	50,264	51,013	52,090	47,679
Consolidated	4,733	12,067	14,622	22,526	29,807	33,507	37,155	47,027
Subtotal	31,670	45,830	57,713	70,484	80,071	84,520	89,245	94,706
Total	116,072	158,598	191,824	225,291	259,262	293,992	331,826	381,554

Source: Office of Management and Budget, as reported in the budget appendix.

Table 2: Composition of Subsidy Costs (Percent)							
	Subsidy Rate	Composition of Subsidy				Default Rate	Recovery Rate
		Defaults (net of recovery)	Interest	Fees	All other		
Ford Direct Loan Program							
Weighted Average of Total Obligations	2.05	1.31	-2.66	-1.67	5.07	14.00	118.29
Subsidized Stafford	9.83	0.67	6.44	-3.00	5.72	12.04	118.93
Unsubsidized Stafford	-8.28	0.82	-12.59	-3.00	6.49	12.09	116.57
PLUS	-6.37	0.89	-11.97	-4.00	8.71	5.50	101.51
Consolidation	4.37	1.92	-0.99	n/a	3.44	17.20	119.56
Family Federal Education Loan Program							
Weighted Average of Total Obligations	9.87	0.89	11.12	-5.54	3.40	12.04	117.65
Subsidized Stafford	17.78	0.86	17.62	-3.25	2.55	12.04	118.99
Unsubsidized Stafford	1.12	0.96	0.79	-3.25	2.62	11.15	116.27
PLUS	-0.01	0.88	-1.73	-3.25	4.09	5.38	101.08
Consolidated	12.20	0.88	15.46	-8.26	4.12	13.27	118.64

Source: *Federal Credit Supplement 2006*.

Table 3: Allowable Term by Balance	
Term (years)	Balance Must Be at Least:
10	-
12	\$7,500
15	\$10,000
20	\$20,000
25	\$40,000
30	\$60,000

Note: Allowable term for extended and graduated repayment plans in the direct program and for newly consolidated loans in both programs. Balance refers to total balance of loans in the direct program for direct program extensions and total balance of loans consolidated for consolidation term extension. In the guaranteed program, borrowers with balances of more than \$30,000 can elect a 25-year extended repayment term on their original loans.

Budget Year	1990	1996	2005
Outstanding Loan Portfolio (millions of dollars)	49,890	57,557	242,581
Default Claims (millions of dollars)	2,384	1,428	3,818
Loans in Default (percent)	4.8	2.5	1.6

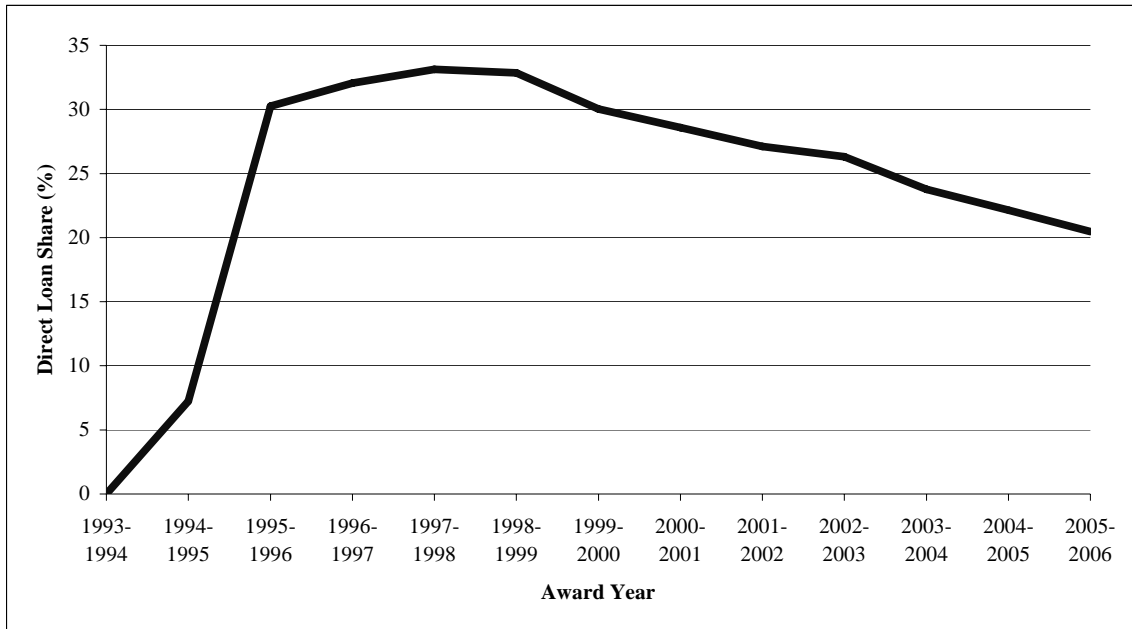
	Direct	Guaranteed	Difference
Unsubsidized Loans			
\$0- 20,000	17.6	25.8	8.2
\$20,000 – 60,000	19.6	28.7	9.1
\$60,000 +	21.2	30.8	9.5
Weighted Average Subsidy of Unsubsidized Loans	19.5	28.4	8.9
Subsidized Loans			
\$0- 20,000	30.0	37.0	7.1
\$20,000 – 60,000	32.6	40.3	7.8
\$60,000 +	34.2	42.3	8.1
Weighted Average Subsidy of Subsidized Loans	32.2	39.9	7.6
Program Average	25.9	34.1	8.3

Table 6: Parameter Sensitivity of Subsidy Rates			
(Percent)			
	Direct	Guaranteed	Difference
Base-Case Subsidy Rate	25.9	34.1	8.3
<i>Varying Credit Risk and Credit-Risk Premium</i>			
High Credit-Risk Premium (3.58% p.a.)	31.8	39.1	7.3
Low Credit-Risk Premium (1.58% p.a.)	19.1	28.5	9.4
No Credit-Risk Premium	6.8	18.8	12.0
No Default or Credit-Risk Premium			
<i>Speed of Repayment</i>			
25% Faster than Base Case	22.2	29.5	7.3
25% Slower than Base Case	29.0	38.0	9.0
Not Sensitive to Interest Rates	25.3	33.6	8.3
<i>Other</i>			
Longer Stafford Repayments/Reduced Consolidation	26.0	36.5	10.5

Table 7: Components of Subsidy Rate		
(Percent)		
	Direct	Guaranteed
Base-Case Subsidy Rate	25.9	34.1
Up-Front Fees	-2.3	-3
Federal Noncollection Administrative Expenses	2.2	0.4
Lenders Spread Above CP Rates	-	12.1
2% Guarantee Shortfall		-0.5
Liquidity Charge	2.1	2.1
Default Losses net of Recovery and Collections Costs	7.2	7.2
Risk Premium for Credit Risk	12.9	12.9
Residual: Net Interest	3.7	3.7

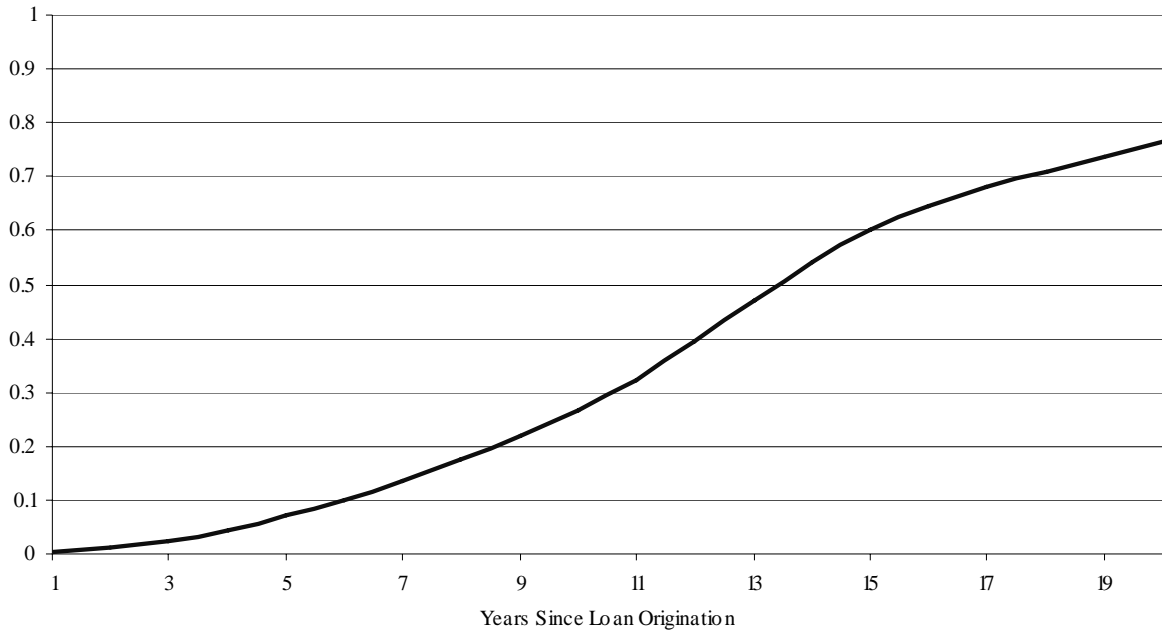
Table 8: Subsidy Rates Under Alternative Policies			
(Percent)			
	Direct	Guaranteed	Difference
Base Case	25.9	34.1	10.5
Current Commercial Paper Spreads less 0.5%	25.9	31.3	5.5
Current Commercial Paper Spreads less 1.0%	25.9	28.6	2.8
Floating Rates, as Under 1998-2006 Law	23.4	32.7	9.3
Floating Rates but Without Special Allowances Floor	20.1	27.9	7.8
3.4% Interest Rate on Loans—Without Interest Rate Response	42.1	49.7	7.6
3.4% Interest Rate on Loans—With Interest Rate Response	44.9	52.4	7.5
90% Federal Guarantee	25.9	32.1	6.1
75% Federal Guarantee	25.9	28.0	2.1

Figure 1: The Direct Program Share of New-Loan Volume



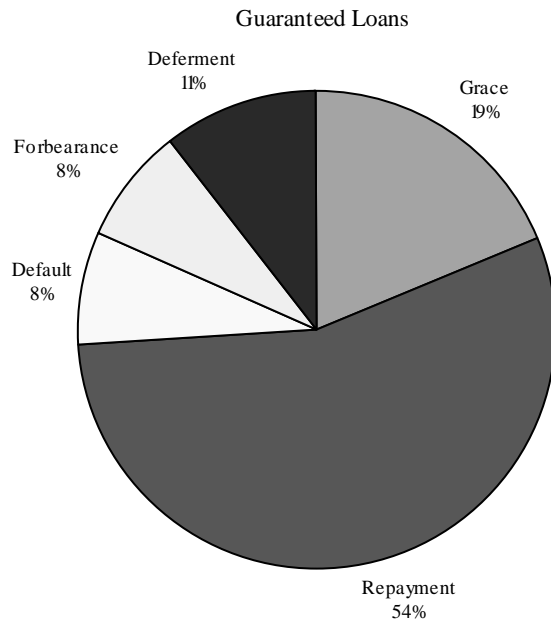
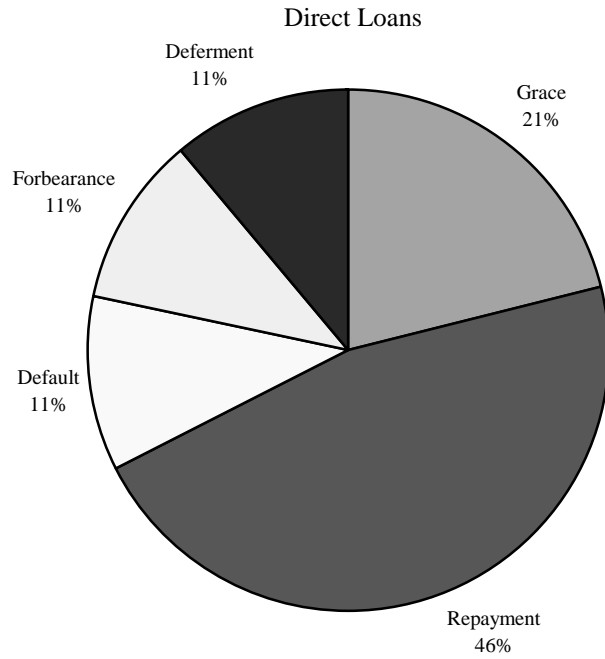
Source: The Department of Education.

Figure 2: Distribution of Loan Lifetimes



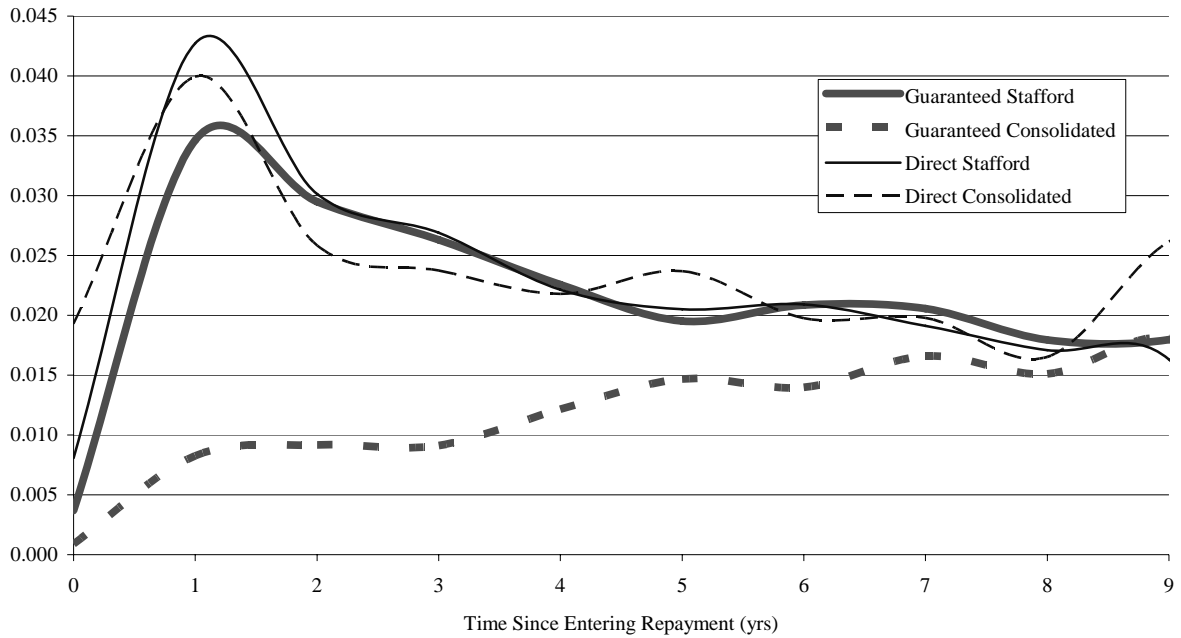
Source: Estimates from 2006 sample of the National Student Loan Database.

Figure 3: Status of Direct and Guaranteed Loan Portfolio, January 2006



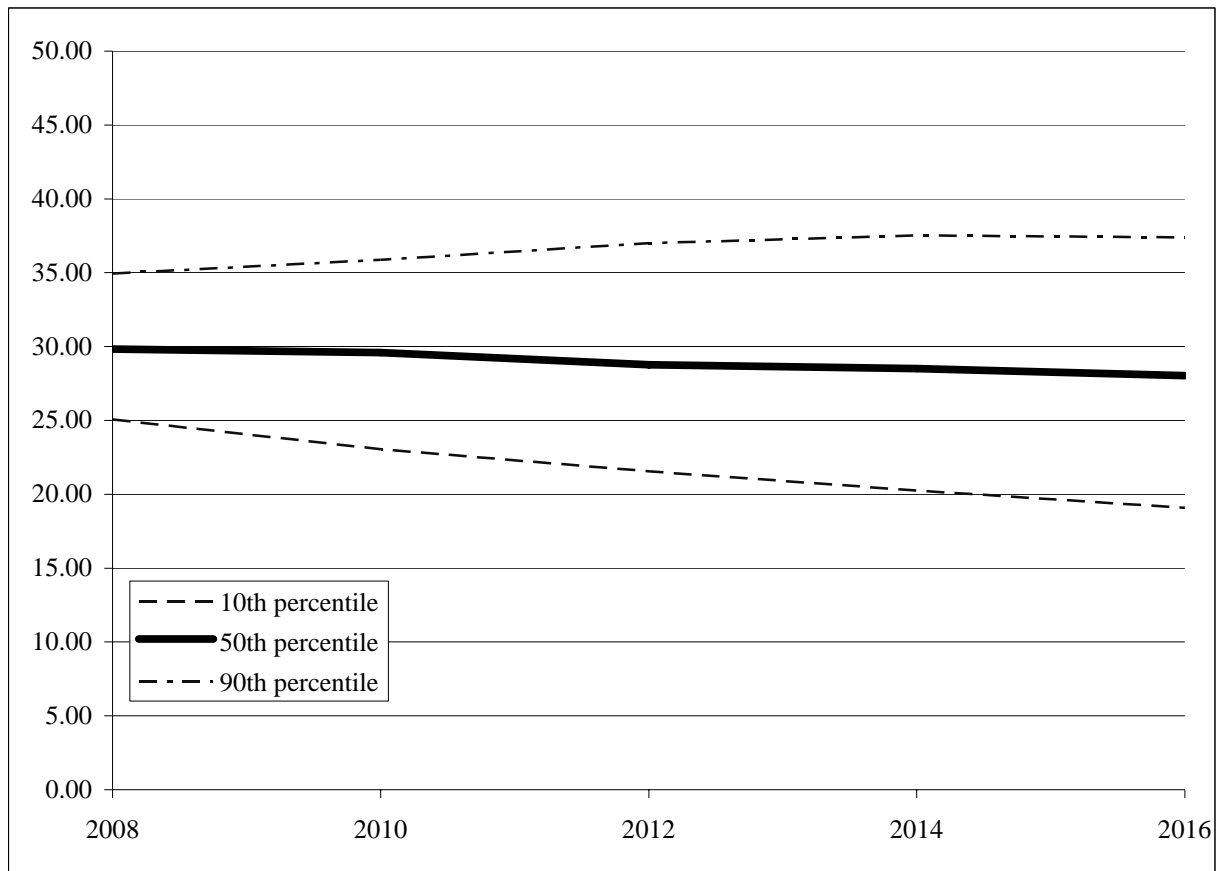
Source: Estimates from 2006 sample of the National Student Loan Database.

Figure 4: Default Rates (Weighted by Loan Value) by Years Since Borrower Entered Repayment



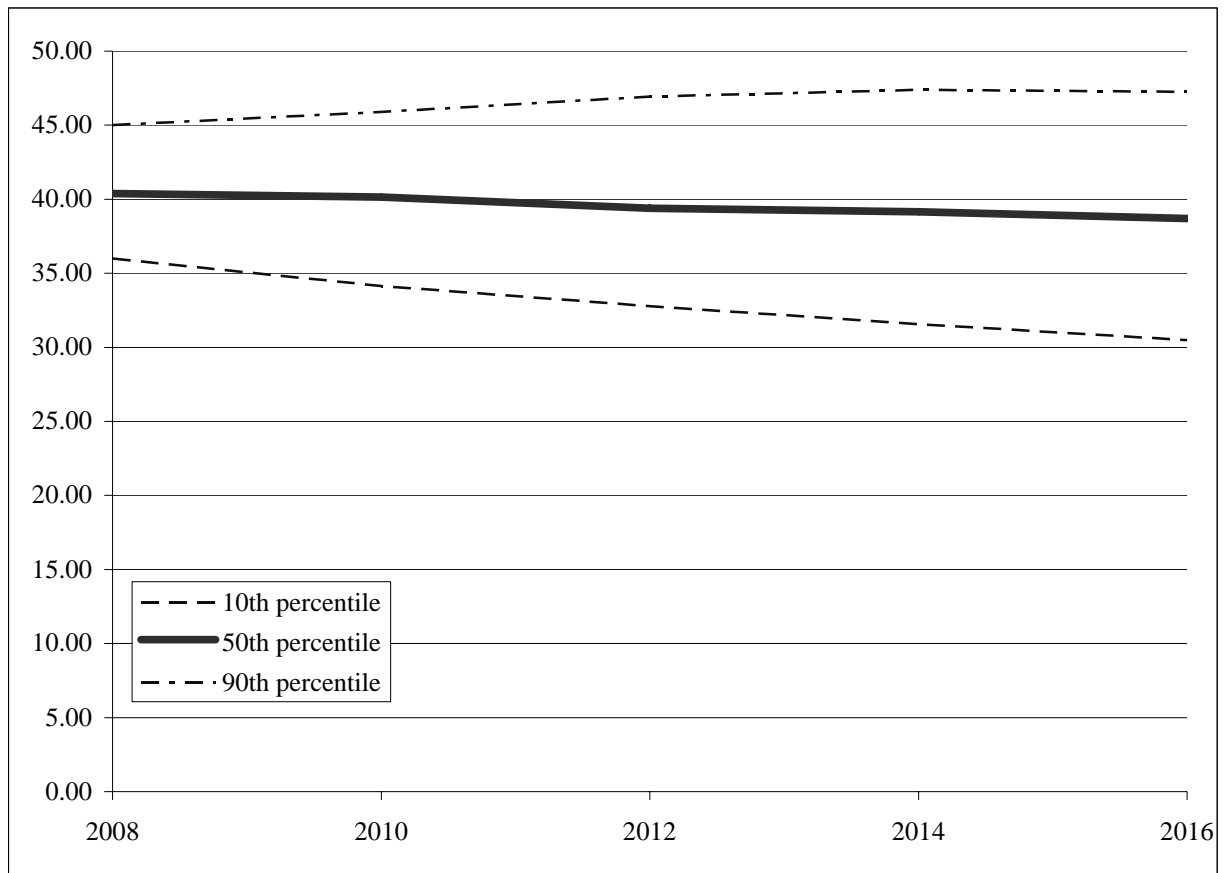
Source: Estimates from 2006 sample of the National Student Loan Database.

Figure 5: Distribution of Future Subsidy Costs Given Interest Rate Uncertainty in the Direct Lending Program



Source: Estimates from 2006 sample of the National Student Loan Database.

Figure 6: Distribution of Future Subsidy Costs Given Interest Rate Uncertainty in the Guaranteed Lending Program



Source: Estimates from 2006 sample of the National Student Loan Database.

Appendix 1

Description of NSLDS Data

The Department of Education administers the National Student Loan Database System (NSLDS), a recordkeeping system that tracks the status of individual loans and borrowers. The Congressional Budget Office receives an annual subsample of loan and borrower records each January, which it uses to make cost estimates. The database consists of multiple linked files containing current and historical information about borrowers and their loans. The files used to produce market-based subsidy estimates in this paper are as follows:

Loan File: The file consists of one record per loan on the type of loan (direct or guaranteed, consolidated or original), the date the loan was taken, the amount disbursed, the principal outstanding at the time the sample was drawn, the current status of the loan, and the academic level of the student when the loan was taken. Each loan record also contains a unique identifier for the borrower, school, and guaranty agency associated with the loan, making aggregation of loans by borrower possible. The file contains 5.42m loan records on 1.30m distinct borrowers.

Loan Status History File: The file contains a sequence of records with dates and codes for each loan's status changes. A status change occurs for various reasons, including: entering repayment, default, deferment, forbearance, consolidation and payment in full. The historical timing of status changes provides a basis for estimating the probability that new loans transition through the various statuses over their lifetime. The file contains 25.60 million status change records on 5.42 million distinct loans.

IRS and Guaranty Agency Collections Files: These files track the timing and amount of payments collected by the Internal Revenue Service, guaranty agencies, the Department of Education, and their contracted agents from borrowers whose guaranteed loans are in default. No recovery information is available on direct program loans in default. The files contain the amount collected and date of collection for each defaulted loan. The amounts recovered by issuing the borrower with a consolidation loan are treated inconsistently. Collection amounts are combined with historical loan status changes of defaulted loans in the loan status history file to compute a recovery rate on defaulted guaranteed loans, which we assume is very similar to that in the direct program. The IRS offset file contains 340,000 IRS collection records on 156,000 loans (the file contains few collections per loan owing to the short history of the IRS offset program). The combined guaranty agency and departmental collection file contains 4.05 million collection records on 355,000 distinct borrowers.

Several features limit the usefulness of this data set for estimating loan cash flows over time. Except for the collections on defaulted loans, the CBO sample of NSLDS loans does not contain a record of borrower payments over time. Similarly, when the sample is drawn each January, only the current level of outstanding principal is recorded. Another problem is that repayment plans are not reported, making it difficult to infer loan lifetimes and to distinguish on-time repayment from prepayment.

Appendix 2 Modeling Assumptions¹⁸

Interest Rates

We adopt the Cox-Ingersoll-Ross (CIR) model to simulate future paths of Treasury rates. In the CIR model, the instantaneous interest rate, $R(t)$, is the sum of a constant and n factors, $z_i(t)$, $i = 1, \dots, n$, the state variables in the model:

$$R(t) = \bar{R} + \sum_{i=1}^n z_i(t) \quad (1)$$

Each factor obeys a mean reverting square root process:

$$dz_i(t) = \kappa_i [\theta_i - z_i(t)] dt + \sigma_i \sqrt{z_i(t)} dZ_i(t) \quad (2)$$

where θ_i is the mean reverting rate, κ_i is the speed of mean reversion, σ_i is the volatility, and $dZ_i(t)$ is a standard Weiner process independent across factors.

Under the risk-neutral (or equivalent martingale) measure

$$dz_i(t) = \bar{\kappa}_i [\bar{\theta}_i - z_i(t)] dt + \sigma_i \sqrt{z_i(t)} dZ_i(t) \quad (3)$$

where

$$\bar{\kappa}_i = \kappa_i + \lambda_i \quad (4)$$

and

$$\bar{\theta}_i = \frac{\kappa_i \theta_i}{\kappa_i + \lambda_i} \quad (5)$$

λ_i is the constant market price of risk for factor i . The time t price of a zero coupon bond with unit coupon and expiring at T is

$$p(t, T) = e^{-\bar{R}(T-t)} \prod_{i=1}^n A_i(t, T) e^{-B_i(t, T) y_i(t)} \quad (6)$$

where

¹⁸ This appendix uses some of the text, figures, and equations contained in Appendix 2 of Lucas and Moore (2007).

$$A_i(t, T) = \left[\frac{2\gamma_i \exp[(\gamma_i + \bar{\kappa}_i)(T-t)/2]}{(\gamma_i + \bar{\kappa}_i)[\exp[\gamma_i(T-t)] - 1] + 2\gamma_i} \right]^{2\bar{\kappa}_i\bar{\theta}_i/\sigma_i^2} \quad (7)$$

$$B_i(t, T) = \frac{2 \exp[\gamma_i(T-t) - 1]}{(\gamma_i + \bar{\kappa}_i)[\exp[\gamma_i(T-t)] - 1] + 2\gamma_i} \quad (8)$$

and

$$\gamma_i = \sqrt{\bar{\kappa}_i^2 + \sigma_i^2} \quad (9)$$

The yield to maturity, y , of a zero-coupon bond maturing at T is

$$y(t, T) = \frac{-\ln p(t, T)}{T - t} \quad (10)$$

Jagannathan, Kaplin, and Sun (2001) estimate the following factors from the two-factor model using weekly LIBOR rates of various maturities from 1995 through 1999:

Factor	κ	θ	σ	λ
1	0.392	0.272	0.0153	-0.00038
2	0.0532	0.0162	0.0430	-0.0592
$\bar{R} = -0.229$				

Under these parameters, factor 1, with the stronger degree of mean reversion, drives the gap between long- and short-term rates, whereas factor 2 determines long-term rates. We subtract 20 basis points from \bar{R} to reflect the average spread between three-month Treasury and LIBOR yields. With these parameters, the Model implies a long-run average three-month Treasury bill rate of 3.57 percent (standard deviation, 1.57 percent) and 10-year zero-coupon rate of 3.98 percent (standard deviation 1.79 percent).

For each Monte Carlo run, initial levels of the states variables are calibrated to fairly price an initial three-month T-bill and 10-year Treasury bond rate. For each simulation, the instantaneous rate is sampled monthly for as many months as the maximum maturity of the student loan, using a discrete approximation of the risk-neutral process in equation (3). For each sample path of interest rates, the monthly discount rate d_t used to discount interest-rate-sensitive cash flows from month $t + 1$ back to month t is:

$$d_t^j = -\ln p\left(\frac{t}{12}, \frac{t+1}{12}\right) \quad (11)$$

Averaging the discounted value of the set of cash flows over all sample interest rate paths provides the net present value of any interest-rate-sensitive stream of cash flows.

Cash Flows

Loans originate at time 0, begin repayment at time T^R , and have a maturity of T^M so the loan is repaid in T^R+T^M months. T^M depends on whether the consolidation option is exercised or, in the counterfactual case, the loan term is extended. The original maturity of Stafford loans is 10 years. Figure 2-3 of this appendix describes the stochastic rules governing consolidation and extension.

Interest accrues on outstanding principal every month, except for in cases in which the borrower of a subsidized loan is in school, deferment, or default. The borrower interest rate in period t , denoted $R_{S,t}^j$, is either 0, 6.8 percent, or 6.875 percent, depending on the type and status of the loan.¹⁹

The variable P_t^j denotes the evolution of principal (prior to default) over time in each simulation j . Given an initial principal of $P_0^j = P_0$, principal evolves according to:

$$P_{t+1}^j = P_t^j [1 + r_{S,t}^j] - A_{t+1}^j \quad (12)$$

where

$$r_{S,t}^j = (1 + R_{S,t}^j)^{\frac{1}{12}} - 1 \quad (13)$$

is the monthly compounding student rate. The prescribed monthly payment, A_t^j , depends on the loan's status and is based on amortizing the principal at the current interest rate over the remaining life of the loan:

$$A_{t+1}^j = \begin{cases} \frac{P_t^j r_{S,t}^j}{1 - (1 + r_{S,t}^j)^{-k}}, & t \geq T^R \\ 0, & t < T^R \end{cases} \quad (14)$$

Borrowers may pay more or less than this prescribed amount in instances of default, prepayment, consolidation, deferment, or forbearance. Because we do not have reliable data on actual payments, we assume that borrowers make the prescribed payment unless they default on their loans, prepay their loans in their entirety, defer, or receive forbearance on their loans. In the direct program, the government's cash flows on performing loans are the student loan payments less an administrative charge:

¹⁹ The numerical implementation of the model is flexible enough to accommodate floating interest rates tied to particular rates on the yield curve.

$$A_t^j - fP_t^j \quad (15)$$

where f is the proportional administrative fee. The fee is 0.50 percent per annum in the benchmark calibration, reflecting typical servicing and other administrative costs of the direct program. In cases of default, the government recovers in proportion to the present value of remaining payments.

In the guaranteed lending program, the government cash flows are the quarterly payments to lenders—the SAP less any consolidation fee paid by lenders to the government—while the loan is in good standing, and the lump-sum payment of outstanding principal and accrued interest in the event of default. We ignore administrative costs because they are largely borne by the guaranteed lender.

The quarterly SAP is the difference between the student rate and the three-month commercial paper rate plus a spread but has a floor of zero. We assume that the annualized three-month commercial paper rate, R_C , tracks the T-bill rate with a 20 basis-point spread:

$$R_{C,t}^j = \exp\left[4y^j(3k, 3k + 3/12)\right] + .002 - 1, \forall t = 1, 2, \dots, T \quad (16)$$

Absent default, the government cash flow in each month is the SAP less any consolidation fee paid from lenders to the government (1.05 percent of principal). The net guarantee payment to the government is

$$G_t^j = \begin{cases} -P_{3k}^j \left[R_{C,3k}^j + 1.74\% - R_{S,3k}^j \right] / 4, & 3k < T^R \text{ and } 3k < T^C \quad \forall k = 0, 1, 2, \dots \\ -P_{3k}^j \left[R_{C,3k}^j + 2.34\% - R_{S,3k}^j \right] / 4, & 3k \geq T^R \text{ and } 3k < t^C \quad \forall k = 0, 1, 2, \dots \\ -P_{3k}^j \left(\left[R_{C,3k}^j + 2.64\% - R_{S,3k}^j \right] - 1.05\% \right) / 4, & 3k \geq t^C \quad \forall k = 0, 1, 2, \dots \\ 0, & \textit{otherwise} \end{cases} \quad (17)$$

In cases of default, the government pays the outstanding principal, P_t^j , to the lender, assumes the loan, and recovers in proportion to the present value of the remaining outstanding payments. The default and recovery rates used in the calibration are described in Section 2.5 of the paper.

Stochastic Rules Governing Borrower Behavior

Borrowers make a variety of decisions that can dramatically shorten or lengthen the life of their loans and correspondingly raise or lower their monthly payments. A borrower does not enter repayment until six months after completing his or her course of study, so loans taken early in a borrower's degree will have longer periods of nonrepayment than loans taken later. Some students shorten or extend the duration of their studies, which

adds an uncertain element to the time until a borrower begins repayment. Upon entering repayment, a borrower typically opts for a standard 10-year repayment plan. But a borrower with a larger balance can choose a longer repayment plan of 25 years or consolidate multiple loans into a new loan with term as long as 30 years. Some borrowers who have left school but decide to take further studies are entitled to payment deferment. Those borrowers experiencing financial hardship are entitled to loan forbearance. We model the take-up of these options using a sample of loans from the NSLDS (as described in Appendix 1).

In estimating the time that elapses before a borrower enters repayment, we abstract from the uncertainty and simply assume that all loans experience an in-school plus grace period of two years.²⁰ Conversely, we assume that loan consolidation and loan prepayment behavior are random and sensitive to prevailing interest rates. Prepayment and consolidation may also be related to default rates but, for simplicity, we ignore this. Default rates are discussed in the next section of this appendix.

We posit a rule for the intensity of consolidation for a given loan that is consistent with the Probit model described in Appendix 1. Specifically, the probability of consolidation is decreasing in the student interest rate and decreasing in the elapsed time since repayment began. We assume that borrowers consolidate loans during the grace period at a level consistent with the rule for consolidation at other times, but that they cannot consolidate at all while they are in school.²¹ Thus, the annualized probability of consolidation, $q_{C,t}$, at month t is

$$q_{C,t}^j = \begin{cases} 0, & t < T^R - 6 \\ \Phi(\beta_1 + \beta_2 \max([\frac{t - T^R}{12}, 0])), & t \geq T^R \end{cases} \quad (18)$$

where Φ is the cumulative standard normal distribution function and β_1 and β_2 are loan-type-specific parameters based on Probit regression estimates as reported in Lucas and Moore (2007). Table 2-2 summarizes these parameters for loan type.

Forbearance and deferment rates are likely to exhibit correlation with both interest rates and borrower default rates as well as with the borrower's cumulative loan balance. For simplicity, we ignore these correlations and just assume that, each year, a loan has a 6 percent chance of entering deferment or forbearance for a fixed duration of three years. Under that assumption, each loan enters deferment or forbearance one time at most, which results in a cumulative 10-year rate of deferment and forbearance of approximately 0.55 in base-case calibrations. During this period, borrowers do not make payments, hence $A_t = 0$ for each period t .

²⁰ Averaging the subsidy costs over a distribution of repayment start dates yields similar results when the mean of the distribution is the same as that used for the fixed repayment rate.

²¹ For the 2006 academic year, borrowers were allowed to consolidate during their in-school period.

Table 2-2: Parameters Determining the Annual Frequency of Consolidation			
Maximum Eligible Consolidation Loan Term (Loan type)	Model Coefficient Estimates		Proportion of Loans Consolidating over 10 years
	β_1	β_2	
10 years	-1.94	-0.03	0.16
20 years	-0.6	-0.09	0.55
30 years	-0.43	-0.16	0.51

Adjusting Discount Rates for Default Risk

Under the CIR model, the risk-neutral monthly compounded discount rate, d_t , for default-free but possibly interest-rate-contingent monthly cash flows is

$$d_t = \frac{1}{p(t, t+1/12)} - 1 \quad \forall t = 0, 1, 2, \dots \quad (19)$$

In both the direct and guaranteed lending programs, the underlying payments between parties are contingent on default. We assume that default occurs with probability q in each month until the borrower completely repays the loan and that default risk is orthogonal to interest rate risk. To establish a simple no-arbitrage pricing mechanism for interest rate and default sensitive cash flows, we suppose that there is a pair of simple one-period securities traded in every period. The first is risk-free and offers a certain payoff of \$1 in one period's time. The second is a risky claim that pays \$1 if the borrower does not default and α if the borrower does default. The fair price of the default-free claim along a particular interest-rate-simulation path is:²²

$$\frac{1}{1 + d_t} \quad (20)$$

With a constant monthly risk premium of π and a default probability of q , the fair price of the risky claim is:²³

$$\frac{1 - q(1 - \alpha)}{(1 + d_t)(1 + \pi)} \quad (21)$$

²² We omit the subscript j in the remainder of this appendix.

²³ The probability of default and the risk premium can be time-varying, but this is suppressed for simplicity.

More conveniently, we can define state price deflators to value cash flows in $t+1$ paid if the borrower defaults:

$$\frac{h}{1+d_t} \quad (22)$$

and if the borrower does not default:

$$\frac{1-h}{1+d_t} \quad (23)$$

where h is the risk-neutral probability of default:

$$h = \frac{\pi + q(1-\alpha)}{(1+\pi)(1-\alpha)} \quad (24)$$

Calibrating State Prices for Default-Contingent Prices

Data from the NSLDS suggest a cumulative default rate over the life of a typical Stafford loan of 15 percent. Default rates vary over the life of a loan, with the rate decreasing as the loan ages. Abstracting from the time pattern, an annual default rate of 2 percent is consistent with this cumulative experience. Hence, the quarterly default rate, q , is set to 0.25 percent. Estimates from the NSLDS suggest a recovery rate on defaulted loans in the range of 40 percent to 60 percent. We assume the midpoint of 50 percent in the computation of subsidy cost for the two programs.

Present Value of Program Cash Flows

For a given sequence of interest rates, the transition of a loan through defaulting and non-defaulting states can be represented as a binomial tree. Figure 2-1 shows borrower payments on a direct loan in a two-period binomial tree. The tree tracks the status of the loan over time, with discrete intervals of time indicated on the horizontal axis. From a given node, each upward move indicates the borrower does not default in the subsequent period, and each downward move corresponds to a borrower's default. To ensure a stationary representation, rather than terminate the loan after default, we assume that the borrower and lender agree to a new loan with payments reduced to fraction α of the originally prescribed payments (reflecting failed collections and collection costs).²⁴ That is, the lender recovers a lump sum proportional to the present value of remaining payments. Cash flows in each state can be priced back to the previous period by using the default and nondefault state prices in equations (26) and (27) and to earlier periods by applying (26) and (27) recursively. The present value of loan cash flows is then:

²⁴ This makes it possible to calibrate the risk premium using the observed loan spread above the risk-free rate (s) and the recovery adjusted default rate $q(1-\alpha)$, as in equation (30).

$$\sum_{t=0}^{\infty} \frac{A_t}{\left(\prod_{k=0}^{t-1} (1+d_k) \right) (1+s)^t} \quad (25)$$

where

$$s = \frac{1+\pi}{1-q(1-\alpha)} - 1 \quad (26)$$

The variable s has an interpretation as the monthly credit spread, which depends on the rate of default (q), the rate of recovery (α), and the risk premium for credit risk (π).

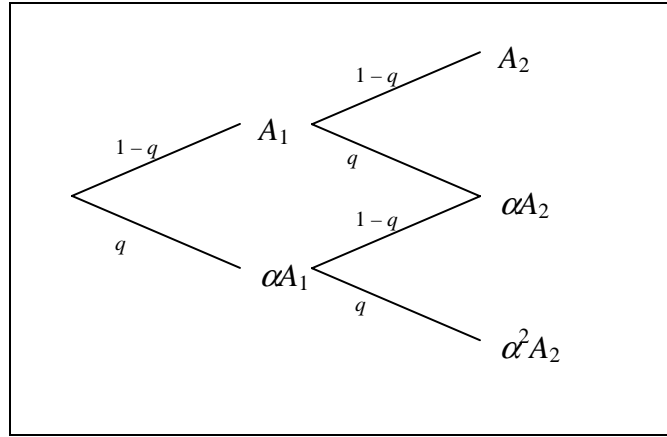


Figure 2-1: Binomial representation for the cash flows of a two-period student loan for a given simulation of interest rates.

Assuming that the administrative fee is paid only as long as the loan is not in default (only along the uppermost branches of the binomial tree), the present value of administrative fees is:

$$\sum_{t=0}^{\infty} \frac{(1-h)^t f P_t^j}{\left(\prod_{k=0}^{t-1} (1+d_k) \right)} \quad (27)$$

Thus the present value of a direct loan is the difference between (25) and (27). The cash flows for the guarantee also have a binomial tree representation, as shown in Figure 2-2 for the two-period case.

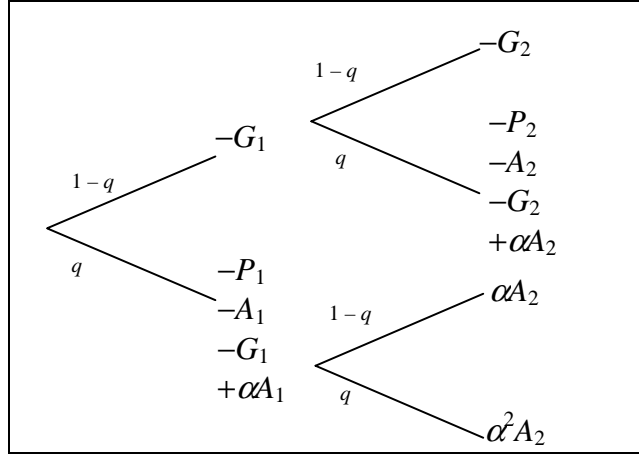


Figure 2-2: Binomial representation for the cash flows of a two-period loan guarantee for a given simulation of interest rates.

These cash flows can be decomposed into two simpler binomial trees, as displayed in Figure 2-3. The first is just the binomial tree for the student loan, and the second is a residual that captures the net payments to lenders as described in Section 5.3. Those lender payments have only two nonzero branches in each period because the loan is assumed to become federal property following default.

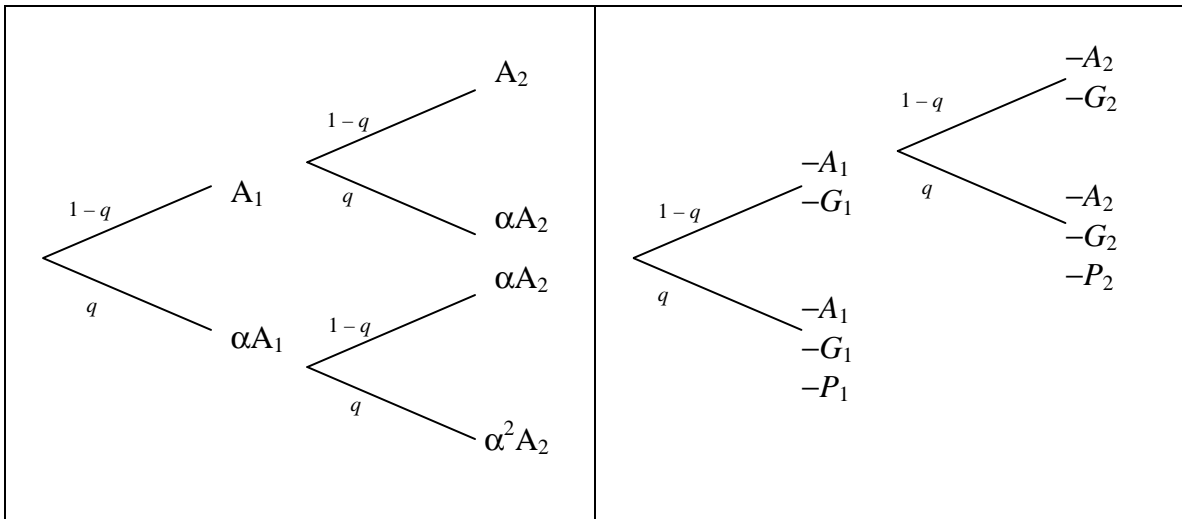


Figure 2-3.

Valuing the two components using the risk-neutral discount rates and probabilities of default gives the following present value of cash flows in the FFEL program (excluding federal administrative expenses and guaranty agency payments):

$$\sum_{t=0}^{\infty} \frac{A_t}{\left(\prod_{k=0}^{t-1} (1+d_k) \right) (1+s)^t} - \sum_{t=0}^{\infty} \frac{(1-h)^t (G_t + A_t)}{\left(\prod_{k=0}^{t-1} (1+d_k) \right)} - \sum_{t=0}^{\infty} \frac{(1-h)^{t-1} h (P_t + G_t + A_t)}{\left(\prod_{k=0}^{t-1} (1+d_k) \right)} \quad (28)$$

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