The Insurance Value of Financial Aid

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Abstract

Financial aid programs exist to enable students with fewer financial resources to pay less to attend college than other students with greater financial resources. When income is uncertain, a financial aid formula that requires more of an Expected Family Contribution (EFC) when income and assets are high and less of an EFC when income and assets are low provides insurance against that uncertainty. Using a stochastic, life-cycle model of consumption, we show that the insurance value of financial aid is substantial. Under our preferred parameters, a household that was receiving financial aid equal to one third of tuition on average under the current formula would require financial aid equal to two thirds of tuition if offered regardless of income and assets to have the same lifetime expected utility. That is, a dollar of financial aid given through the income- and asset-contingent financial aid formula is equivalent to two dollars of aid given without regard to the household financial resources. We then consider the possibility of making households better off by eliminating the dependence of the financial aid formula on household assets, as some prior studies have suggested. In general, removing the “asset tax” makes the household worse off, because household assets are a good indicator for the household’s average income. The ability to redistribute based on average income is sufficiently valuable that removing the “asset tax” would require colleges to offer more aid on average – approximately 7 percent for the same household described above.

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I. Introduction

Attending college is an important pathway to higher earnings. Unconditional estimates of the gap in median earnings between year-round, full-time workers with bachelor’s degrees and those with only high school diplomas are about 60 percent, or about 12 percent per year of college, for both men and women.¹ Careful estimation of the marginal returns to a year of college by Carneiro, Heckman, and Vytlacil (2011) suggest an earnings premium of 8 percent per year of college.²

The high returns to college have made the financing of college an important topic for both academic research and public policy over the last several decades. High returns to college have been accompanied by high and rising costs of college attendance. Launched as part of the Great Society programs of the 1960s, the federal financial aid system has grown in scale and complexity to help ever more students from low- and middle-income families afford college and the access to higher earnings it can provide. Most states and institutions of higher education also operate financial aid programs.³ For all families, and particularly for those who have higher incomes or who aspire to more expensive institutions, how to pay for college is often a savings decision that begins when the child is born.

Financial aid programs exist to enable students with fewer financial resources to pay less to attend college than other students with greater financial resources. As implemented through both federal and institutional formulas, the amount of financial aid a student receives declines with both the income and assets of his or her family at the time of enrollment. The inclusion of family assets in the formulas to determine a student’s “Expected Family Contribution” (EFC) toward college expenses has attracted considerable attention from economists, who have highlighted the resulting disincentive for families to save for college expenses and have produced varying estimates of its impact on household saving. The concept of the “financial aid tax” dates back to Case and McPherson (1986). Edlin (1993) provided an early, readable discussion of the financial aid tax, and Feldstein’s (1995) estimates of a large crowding out of saving due to this tax spawned a small literature testing the robustness of those initial results.⁴

Omitted from this literature is the recognition that the saving disincentives due to the financial aid tax comprise only the incentives side of a standard incentives-insurance tradeoff. In general, providing insurance against risks beyond a household’s control will distort incentives along margins that the household can control. When income is uncertain, a financial aid formula that requires more of an EFC when income and assets are high and less of an EFC when income and assets are low provides insurance against that uncertainty. The incentives-insurance tradeoff is well understood in the literature on

² See Oreopoulos and Petronijevic (2013) for a recent review of estimates to the returns to college and a discussion of how and why the college earnings premium has changed over time.
³ See Dynarski and Scott-Clayton (2013) for an evaluation of financial aid policy today.
⁴ The implicit tax on assets also figures prominently into practitioner guidance on saving for college. See, for example, http://www.forbes.com/sites/troyonink/2014/02/14/how-assets-hurt-college-aid-eligibility-on-fafsa-and-css-profile/.
optimal redistributive taxation. What has not yet been recognized is that, as redistributive mechanisms based on assets and income, an analogous tradeoff is present in financial aid formulas.

The contribution of our paper is to estimate the insurance value of financial aid using a stochastic, life-cycle model of consumption in which households save in anticipation of a planned retirement, uncertain income, and the college education of their children. The main results show that the insurance value of financial aid is substantial. We calculate the insurance value of financial aid by comparing lifetime expected utility under two financial aid systems – one in which there is a stylized version of the current financial aid formula and one in which colleges give aid by simply discounting their tuition, regardless of a household’s income or assets. Under our preferred parameters, a household that was receiving financial aid equal to one third of tuition on average under the current formula would require financial aid equal to two thirds of tuition if offered regardless of income and assets to have the same lifetime expected utility. That is, a dollar of financial aid given through the current income- and asset-contingent financial aid formula is equivalent to two dollars of aid given without regard to the household financial resources.

We then consider the possibility of making households better off by eliminating the dependence of the financial aid formula on household assets, as some prior studies have suggested. We implement this by increasing the dependence of financial aid on current income. This change could make the household better off by removing the saving disincentive and by offering greater scope for redistribution based on current income. However, for a broad range of parameterizations, removing this financial aid tax makes the household worse off. The reason for this surprising result is that household assets are a good indicator for the household’s average income in the years prior to the student’s enrollment in college. The ability to redistribute based on average income is sufficiently valuable that removing the this financial aid tax would require colleges to offer more aid on average – approximately 7 percent for the same household described above to be compensated for the loss of the financial aid tax.

The remainder of the paper is organized as follows. Section II describes the key features of the financial aid system and briefly reviews the literature on the relationship between financial aid and household saving. Section III develops the stochastic life-cycle model of consumption that will be used to simulate consumption and saving decisions and thus measure the insurance value of financial aid. The main results on the insurance value of financial aid are presented in Section IV, along with sensitivity analyses. Section V considers the case of a financial aid formula without an asset tax, and Section VI discusses avenues for further research and concludes.

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5 See Eaton and Rosen (1980) and Varian (1980) for early analyses of this tradeoff in optimal income tax systems.
6 In this respect, the analysis is similar to prior papers that have examined the insurance aspects of other tax and expenditure policies. See Hubbard, Skinner, and Zeldes (1995) for precautionary saving and social insurance, Engen and Gruber (2001) regarding precautionary saving and the unemployment insurance system, and a recent paper by Athreya, Reilly, and Simpson (2014) on the insurance value of the Earned Income Tax Credit.
II. The Financial Aid Tax

Most need-based financial aid is governed by either of two formulas: a “Federal Methodology” set by Congress that determines eligibility for federal financial aid and an “Institutional Methodology” set by the College Scholarship Service that is used by many selective colleges and universities to determine eligibility for institutionally provided aid. While both require information on income and assets, they differ principally in that the Institutional Methodology considers more sources of income and assets. The key omission from both formulas is assets held in retirement accounts like 401(k) plans and IRAs.

Aid awarded under the Federal Methodology is based on information reported on the Free Application for Federal Student Aid (FAFSA). The FAFSA combines information on family structure, income, and assets to generate the Expected Family Contribution (EFC), and financial need is calculated by subtracting the EFC from the student’s cost of attendance at a given school. The components of the formula are presented in the EFC Guide published each year and form the basis of the algorithm used in this paper to calculate financial aid. Students who are unmarried and sufficiently young apply as dependents of their parents. Those who are older, married, veterans, or have dependents of their own apply under the more favorable status of independent students.

As our focus is the parents’ saving decisions, we consider students as dependents and simplify the calculations by zeroing out the student’s contributions. We further simplify the modeling of financial aid by using the formula in the Federal Methodology for combining assets and income to calculate the EFC but a fully general measure of assets and income that is more consistent with the Institutional Methodology. In the absence of this simplification, each different type of asset in the formula would necessitate both a state variable and a choice variable in the model below. To address the omission of retirement account assets, we consider a test of robustness below in which no assets are included – all of the insurance is provided by treatment of income by the formula.

Following the Federal Methodology, the EFC is obtained by considering a family’s “Adjusted Available Income,” (AAI) which is the sum of “Available Income” (AI) and the “Contribution from Assets” (CA), defined as follows:

\[
AI = \text{Adjusted Gross Income} - (\text{Federal Income Tax Paid} + \text{State and Other Tax Allowance} + \text{Social Security Tax Allowance} + \text{Income Protection Allowance} + \text{Employment Expense Allowance})
\]

7 See https://professionals.collegeboard.com/profdownload/FM%20&%20IM%20Differences.pdf for a summary of the key differences between the two methodologies.

8 The methodology for determining the EFC is found in Part F of Title IV of the Higher Education Act of 1965, as amended, and governs awards for federal Pell grants, subsidized Stafford loans, Perkins loans, federal work-study programs, and other opportunities. For the latest and archived “EFC Guide” publications, see: http://ifap.ed.gov/ifap/byAwardYear.jsp?type=efcformulaguide.

9 Other alternatives are possible. For example, all assets could be treated as 529 plan assets that accumulate tax free.
Available Income begins with the parents’ adjusted gross income (AGI) from their tax return and subtracts allowances based on other payments a household would make in order to earn that income. As implemented below, AGI is just the sum of labor income and asset income, and taxes paid are approximated by a simplified version of the federal tax schedule based on that income. Marginal tax rates under this schedule range from 10 percent at very low levels of income to 39.6 percent at the highest income levels. Each of the other allowances is as specified in the EFC Guide, with a state tax allowance of 4.5 percent chosen to reflect the middle of the distribution of state tax rates.10

The Contribution from Assets is zero if assets do not exceed the Asset Protection Allowance specified in the EFC Guide and 12 percent of any excess of Assets over that allowance otherwise. These two components are added together in Equation (3) to obtain AAI. In Equation (3), the scalars $k$ and $j$ are both equal to 1 but will be altered in simulations of alternative financial aid formulas in Section V. Given AAI, the EFC is calculated as:

$$EFC = 0.22 \times \min(14600, \max(AAI, -3409)) + 0.25 \times \max(0, \min(AAI, 18400) - 14600) + 0.29 \times \max(0, \min(AAI, 22100) - 18400) + 0.34 \times \max(0, \min(AAI, 25900) - 22100) + 0.40 \times \max(0, \min(AAI, 29600) - 25900) + 0.47 \times \max(0, AAI - 29600)$$

The EFC is a piecewise-linear spline in AAI with marginal conversion rates that increase progressively from 22 to 47 percent. Two aspects of these formulas are noteworthy. First, the top marginal conversion rate of 0.47 is reached at a fairly low level of AAI, or $29,600 in the 2012-2013 formula used below. Second, while the marginal conversion rates of 12 percent in Equation (2) and 22 – 47 percent in Equation (4) have stayed the same over the years, the various nominal amounts in Equation (4) and the dollar values in the allowances in Equations (1) and (2) have increased over time. The modeling framework below fixes these dollar values in real terms based on the 2012-2013 formula.

Table 1 shows the EFCs that result from these formulas for a range of income and assets. For illustrative purposes, these calculations use the allowances for a married couple with one parent working and one child in college in which the older parent is 45 years old. The table shows that the EFC is monotonically increasing in both assets and income. The EFC remains at zero for combinations of income and assets that do not exceed the various allowances.11 At any college using the Federal Methodology to allocate aid, any EFC that fell below the costs of attendance would make the student eligible for financial aid, potentially up to the difference between those costs and the EFC if the institution committed to meet

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10 The payroll tax is based on the formula in place in 2013. A payroll tax of 6.2 percent for the employee’s share of Social Security is levied on pre-tax labor income up to a maximum taxable earnings limit of $113,700, and an analogous Medicare payroll tax of 1.45 percent is levied on all such income.

11 The formula used to generate the table ignores the Simplified Needs Analysis in the Federal Methodology that excludes assets from the EFC calculation for low-income households. This likely understates the insurance value of financial aid for households with low permanent income.
full demonstrated need. For the highest values of income and assets, the EFCs exceed the costs of attendance at the most expensive colleges, resulting in no financial aid.12

Table 2 presents the implied marginal tax rates on income inherent in the EFC amounts in Table 1. Each cell holds the asset level constant (at the value specified in the row heading) and then calculates the incremental change in the EFC for a $15,000 increase in labor income. At low levels of income and assets, at which the EFC is zero, the implied marginal tax rates are also zero. Once they become positive, marginal tax rates can be as high as 40 percent. The intuition from Equations (1) and (4) is that the implied marginal tax rate is the conversion rate, up to 0.47, multiplied by one minus the marginal income tax rate on labor income. Recognizing that the marginal tax rate includes Social Security and Medicare payroll tax rates, the numbers in the table might be $0.47 \times (1-0.35) = 0.3055$, or about 30 percent. Lower rates obtain at higher income levels for which the combined state and federal taxes are higher, despite the decline in the payroll tax at the maximum taxable earnings limit. Higher or lower rates may occur at lower income levels for which the marginal labor income tax rates may be lower but the marginal conversion rates are also lower.

These marginal tax rates are in addition to the marginal income tax rates from the payroll tax, federal income taxes, and state income taxes, implying potentially high combined tax rates on labor income during the years in which parents have children in college. This possibility is noted but not explored in Feldstein (1995). Using cross-sectional regressions of actual financial aid awards, Dick and Edlin (1997) estimate lower income-sensitivity of financial aid than these theoretical predictions, noting that actual awards are typically not as progressive as the formulas imply.

Table 3 shows the implied marginal tax rates on assets inherent in the EFC formula. Analogous to Table 2, each cell of Table 2 holds labor income constant (at the value specified in the column heading) and then calculates the incremental change in the EFC for a given (here, $20,0000) increase in assets. Over most of the table, the implied marginal tax rate on assets is about 7 percent. This "asset tax" comes from two sources. The first is in Equations (2) and (4), in which 12 percent of assets are available and are converted at rates up to 47 percent: $0.47 \times 0.12 = 0.0564$. The second is in Equations (1) and (4), in which the assets generate income, net of taxes on that income at the federal and state levels, and then are converted at rates up to 47 percent. With a 3 percent rate of return and a 30 percent combined marginal income tax rate on asset income, this would yield an additional $0.47 \times 0.04 \times (1 - 0.3) = 0.0099$. Combining these two components gives approximately the 7 percent figure found in much of the table. Lower rates obtain at higher income levels for which the combined state and federal taxes are higher and at lower income levels for which the marginal tax rates may be lower but the marginal conversion rates are also lower.

An implied marginal tax rate of 7 percent may not seem too high, but it is important to note that it applies in each successive year of college attendance to the remaining assets. Thus, a dollar of assets at the start of college is reduced by $0.07 + 0.07 \times (1-0.07) + 0.07 \times (1-0.07)^2 + 0.07 \times (1-0.07)^3 = 0.252$, or about

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12 The EFC is divided by the number of children in college, so with more children in college (and adjusting for the impact of more children on the income allowance) there would be the possibility of financial aid even at these income and asset levels.
25 percent over four years in college. Thus, the financial aid formula levies a substantial tax on assets over a broad range of income and asset combinations.\textsuperscript{13}

These implied marginal tax rates on assets are the impetus for the empirical literature that has estimated whether households respond to the asset tax by saving less. The literature starts with Feldstein (1995), who estimated a reduction of about 50 percent in asset accumulation due to the financial aid tax. His estimation sample was a cross-section of 161 households in the Survey of Consumer Finances 1986. Long (2003) argues that a household’s estimate of the implicit tax on assets that would discourage saving is more complicated than suggested in Feldstein (1995) and in Table 3, noting that it depends on factors such as the likelihood of children going to college, the expected cost of college (since the marginal tax rate is zero if the EFC exceeds the cost of attendance), and the possibility that the college does not meet all need, in which case an additional dollar of assets will reduce unmet need rather than financial aid. His methodology generates smaller taxes at the margin and no correlation between those marginal tax rates and asset accumulation. Later studies by Monks (2004) using the National Longitudinal Study of Youth and Reyes (2008) using the Panel Study of Income Dynamics find weak evidence consistent with lower asset accumulation, but at magnitudes much less than Feldstein (1995).

The implied marginal tax rates on both income and assets in Tables 2 and 3 are also the source of the insurance value of financial aid. As Eaton and Rosen (1980) note, even a simple proportional income tax in which the proceeds are redistributed as a lump sum will raise welfare when income is uncertain. As with the prior literature on the disincentive effects of the asset tax, the degree of insurance in the financial aid formula depends on whether the college commits to provide financial aid equal to the difference between the costs of attendance and the EFC. This is assumed in the analysis below and is true of the most well funded colleges and universities, for which the analysis in general is most applicable. However, this issue is not as critical for the insurance value of financial aid as it is for the disincentives of the asset tax. Even if there may be some income or asset ranges over which an institution may not boost financial aid dollar-for-dollar with demonstrated need, generating lower marginal tax rates than in Tables 2 and 3, the insurance provided on the inframarginal need is still present.

\section*{III. Stochastic Life-Cycle Model of Consumption}

This section presents a stochastic, life-cycle model of consumption in which the traditional retirement motive for saving is augmented by a precautionary motive to save against income uncertainty and a need to pre-fund a child’s college education. The basic structure of the model is that in each period of life, $s$, the household chooses a value of consumption, $C_s$, as a function of the two state variables in the model, current assets, $A_s$, and labor income, $Y_s$. The individual’s value function in period $t$, $V_t(A_t, Y_t)$, is defined as:

\textsuperscript{13} These estimates for the asset tax are broadly consistent with those of Dick and Edlin (1997), who estimated marginal asset tax rates of up to 30 percent using cross-sectional data from the 1987 National Postsecondary Student Aid Survey.
The value function is equal to the sum of the expected utility of consumption in each period from the current period \( t \) to the final period \( T \), discounted by a factor of \( \beta \) each period.\(^{14} \) The discount factor governs the utility tradeoff across periods – values closer to 1 reflect greater patience. The utility of consumption each period shown in (5a) is assumed to take the Constant Relative Risk Aversion (CRRA) form: \( u(C) = \frac{C^{1-\gamma}}{1-\gamma} \), where \( \gamma \) is the coefficient of relative risk aversion. With a utility function such as CRRA that has a convex marginal utility function (i.e. \( u'''(C) > 0 \)), there is a precautionary motive for saving, and greater uncertainty in the income process will induce greater saving.\(^ {15} \)

Equation (5b) defines the concept of “cash on hand” that is available to finance consumption and income taxes each period. To obtain cash on hand, \( X_s \) assets are augmented by labor income but reduced by payroll taxes, \( h(Y_s) \), and costs of college attendance, \( z_s(A_s, Y_s) \), which may depend on assets and income through the financial aid formula.\(^ {16} \)

Equation (5c) shows how assets accumulate from one period to the next. Cash on hand is used to finance consumption and the income taxes, \( g(\cdot, \cdot) \), that are due based on labor and non-labor income. To avoid the complexity of an additional state and choice variable, the portfolio decision is restricted to a single riskless asset paying a return, \( r \), each period. Thus, the amount of saving is \( X_s - C_s \), and capital income is just \( r(X_s - C_s) \). The household’s taxes are calculated based on the 2013 tax schedule for a married couple with one child who does not itemize deductions and receives all capital income as interest or dividends rather than capital gains. Payroll taxes are assumed to be paid as the labor income is earned, prior to the consumption decision each period. Since income taxes depend on capital income

\( V_t(A_t, Y_t) \equiv \max_{\{C_s\}} E_t \sum_{s=t}^{T} \beta^{t-s} u(C_s) \)

such that:
\begin{enumerate}
  \item \( u(C) = \frac{C^{1-\gamma}}{1-\gamma} \)
  \item \( X_s = A_s + Y_s - h(Y_s) - z_s(A_s, Y_s) \)
  \item \( A_{sv} = (1 + r)(X_s - C_s) - g(Y_s, X_s - C_s) \)
  \item \( A_s \geq 0 \ \forall s \)
\end{enumerate}

\(^{14} \) The specification for the value function and the within-period utility make several simplifications. The first is that consumption is assumed to be additively separable in consumption and all other factors that affect utility, so that these factors can be omitted from the optimization problem. The second is that there is no adjustment to the argument of the utility function for the size of the household, even after the child has left for college. The third is that there is no mortality risk and thus no accidental bequests. Further, there is no planned bequest motive. See Samwick (2010) for a similar model that includes mortality risk and bequest motives.

\(^{15} \) The use of the CRRA utility function is standard in both the empirical and theoretical literature on precautionary saving. CRRA utility means that a consumer remains equally willing to engage in gambles over a constant proportion of current wealth as wealth increases. An alternative, and perhaps more realistic assumption, might be that the consumer will accept larger proportional risks as wealth increases. See Kimball (1990) for a discussion and derivation of the key results for precautionary saving.

\(^{16} \) The payroll tax includes coverage for disability insurance, but the impact of disability is not modeled in this paper. See Chandra and Samwick (2008) for a similar model that incorporates the risk of disability.
and thus the outcome of the consumption decision during the period, they are assumed to be paid at
the end of the period.

The last part of Equation (5) is the liquidity constraint. Equation (5d) requires assets to be positive in
each period – the individual cannot borrow against future income to finance current consumption. This
is a simplification that nonetheless acknowledges the credit constraints that prevent individuals from
borrowing too heavily against future income outside of a secured or collateralized relationship.17

The processes that describe income uncertainty and the evolution of labor income are as follows:

Before retirement:

a) \( \ln(Y_s) = \ln(P_s) + u_s \)
b) \( \ln(P_{s+1}) = g + \ln(P_s) \)
c) \( u_{s+1} = \rho u_s + \varepsilon_{s+1} \)
d) \( \varepsilon_s \sim i.i.d. N(0, \sigma^2) \)

At retirement:

e) \( Y_{s+1} = RR \cdot Y_s \)

After retirement:

f) \( Y_{s+1} = Y_s \)

Prior to retirement, the natural log of labor income is equal to the natural log of permanent income \( (P_s) \)
plus a shock to income \( (u_s) \) that follows an AR(1) process. Permanent income is assumed to grow at a
constant annual rate of \( g \). The innovations to that AR(1) process are assumed to be independently and
identically drawn from a normal distribution with mean zero and variance \( \sigma^2 \).18 In this model, the
individual retires at a planned date that is known from the beginning of the working life. At retirement,
labor income falls by a factor \( (1 – RR) \), where \( RR \) is the replacement rate. This replacement rate is meant
to capture the income from Social Security and employer-provided pensions. After retirement, income is
unchanged at this new level and is no longer uncertain.19

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17 The outcomes of the model are not greatly affected by allowing a fixed amount of unsecured borrowing. It also
imposes the liquidity constraint directly, rather than including a much higher rate for borrowing that would
discourage but not prohibit large amounts of unsecured borrowing. See Hurst and Willen (2007) for an analysis of
consumption with a richer modeling of credit constraints.

18 In the simulations, the mean of the shock to the level (not log) of income is normalized to be one in all periods.

19 These modeling choices for income are designed to avoid additional state variables and choices unrelated to the
college savings decision. A richer model would include a disutility of work (if not the risk of involuntary retirement
due to health or other reasons) and a choice over the retirement age based on economic factors. It would also be
possible to include a better approximation of the Social Security benefit formula, at the cost of additional
complexity in the model.
The solution method for stochastic optimization problems with multiple state and control variables is discussed in detail in Carroll (2001). The solution begins in the last period of life, T, when the problem is trivial because the household simply consumes all of its assets and after-tax income, yielding an optimal value for \( C_T \) as a function of the state variables \( A_T \) and \( Y_T \). These solutions generate the value function, \( V_T(A_T, Y_T) \), and the partial derivative, \( V_T^A(A_T, Y_T) \), which represents the marginal value of an additional dollar in assets at the beginning of period T. Moving back to the period T-1 problem, we can rewrite the objective function as:

\[
V_{T-1}(A_{T-1}, Y_{T-1}) \equiv \max_{\{C_{T-1}\}} u(C_{T-1}) + \beta E_{T-1}[V_T(A_T, Y_T)]
\]

More generally, given the function \( V_{t+1}(A_{t+1}, Y_{t+1}) \) and the associated partial derivative, the problem at period \( t \) is:

\[
V_t(A_t, Y_t) \equiv \max_{\{C_t\}} u(C_t) + \beta E_t[V_{t+1}(A_{t+1}, Y_{t+1})]
\]

These one-period problems have first-order conditions given by:

\[
u'(C_t) - \beta(1 + r(1-g_2(Y_t, X_t - C_t)))E_t[V_{t+1}(A_{t+1}, Y_{t+1})] = 0
\]

The first term in the first-order condition is the marginal utility of an additional dollar of consumption in period \( t \). The second term is the expected discounted value of saving that dollar to be used in period \( t+1 \). The dollar grows by the after-tax interest rate and has a marginal value of \( V^A \) at that time. In this expression, \( r*\hat{g}_2(Y_t, X_t - C_t) \) is the marginal tax on another dollar of saving, i.e. the derivative of the tax liability function with respect to its second argument. The expected marginal utility of a dollar of assets at time \( t+1 \) is discounted back to period \( t \) utility by a factor of \( \beta \). The difference between the marginal utility of consumption and the expected marginal utility of assets in the next period is zero at the optimal level of consumption.\(^{20}\)

The solution of the optimization problem is a series of consumption rules that determine consumption in each period as a function of assets and labor income. Once the optimal consumption rules have been obtained, the model can be simulated forward by specifying initial values of the state variables, drawing random shocks to income, and applying the consumption rules to generate distributions of asset balances in each period. In the simulations below, the model is evaluated using the distributions generated based on 1,000 independent random draws of the income profile.\(^{21}\) The key outcome of the

\(^{20}\) The solution method is complicated by the liquidity constraint. The constraint that \( A_{t+1} \) cannot be negative implies that the maximum amount of consumption in the prior period is \( X_t - g(Y_t, 0) \).

\(^{21}\) The closest antecedent in the literature is the model of Dick, Edlin, and Emch (2003), who estimate preference parameters for education and saving to determine the asset reductions due to the financial aid system and simulate the asset and welfare changes that would result from changes to that system. The saving framework in that paper is based on a non-stochastic life-cycle model and thus cannot measure the insurance value of financial aid.
model is a value for the expected value of \( V_1(A_1, Y_1) \), computed as the average value of this term across the 1,000 income profiles and a starting asset value of zero at the beginning of the work life. This expected value is a metric by which different financial aid systems can be compared, as those with higher values of \( E[V_1(A_1, Y_1)] \) are the ones in which the household is better off.

Figure 1 summarizes the age profiles of average income, consumption, assets, and college costs for our preferred parameters in Equations (5) and (6). Economic life lasts 60 periods, with retirement in the 40th period. The child is born in the fourth period of economic life, with college starting in the 22nd period. The parameters of the income process are \( g = 0.015 \), \( RR = 0.5 \), \( \rho = 0.95 \), and \( \sigma = 0.15 \). The interest rate, \( r \), is 0.03, and the coefficient of relative risk aversion, \( \gamma \), is set to 3. Tuition, which serves as the maximum value of the EFC, is $60,000. In Equation (3), \( k = j = 1 \). For a patient household, the discount factor, \( \beta \), is 0.97. Initial assets \( A_1 \), are set to 0. In the simulations below, results will be presented for a range of \( Y_1 \) from $25,000 to $400,000.

In Figure 1, \( Y_1 = $100,000 \). Income starts at this amount and grows by 1.5 percent per year before retirement, at which time it falls by 50 percent. Consumption is smoothed from working years into retirement – consumption is below income before retirement and then above income in retirement. Asset accumulation makes this possible, as assets rise to a peak of roughly 4 times pre-retirement income on the eve of retirement. Assets are depleted over the years in which the child is in college and then again, to zero, in the retirement period. Average consumption does not decrease during the college years. Over the life cycle, consumption rises slightly – with \( \beta^*(1+r) \) approximately 1, it is the need for precautionary saving that generates the upward-sloping profile.

Figure 2 shows the analogous figure for the impatient household, with \( \beta = 0.92 \). The average income profile is the same as in Figure 1. Due to impatience, asset accumulation is less rapid early in the life cycle. This generates a lower EFC but a decline in assets during the college years nonetheless. Assets peak at less than 2 times pre-retirement income and are more rapidly spent down in retirement, even as the consumption profile in retirement slopes downward.

Table 4 shows the differences in average EFCs by patience and replacement rates, for the baseline parameters and the case of no uncertainty. The first two columns show that the difference for the parameters in Figures 1 and 2 is about $10,000 per year for a household with initial income of $100,000. Impatient households save less and thus receive more financial aid. The difference is comparable in magnitude for income levels between $50,000 and $150,000. The right panel of the table repeats the comparisons when there is no income uncertainty. Without uncertainty, the patient household has a lower EFC at low income levels and a higher EFC at high income levels. With no uncertainty, there is no chance that low initial incomes become unusually high in mid-career and result in higher EFCs. Similarly, there is no chance that high initial incomes become unusually low in mid-career and result in lower

\[ \text{22 The smoothness of consumption around the years of college attendance is consistent with the evidence in Souleles (2000), who shows in the Consumer Expenditure Survey that households’ non-education consumption does not decrease over the academic year in proportion to college expenditures in the fall. That is, at least over short horizons, the household is able to smooth consumption.} \]
EFCs. Given the importance of precautionary saving early in the life cycle, disparities in EFCs between
the patient and impatient are minimal in the absence of income uncertainty.

Table 4 also shows the impact of lowering the replacement rate from 50 to 25 percent. This change
increases the household’s need for life-cycle saving and raises asset accumulation during the working
life. Greater assets at the time of college-going generate a higher EFC, as shown in the third column in
each panel. The higher EFCs occur both when there is income uncertainty and when income is certain.
These higher EFCs are contrary to the intent of the financial aid system, as the decline in lifetime income
due to the lower replacement rate has made the household poorer. The exclusion of retirement
accounts from the definition of assets can be justified in part to avoid this outcome. As will be shown in
Section V, however, excluding assets may have other, negative consequences for expected utility.

IV. Model Results

This section calculates the insurance value of financial aid by solving the model described in Section III
under the current financial aid formula and an alternative in which financial aid does not depend on
income or assets. Instead, the college simply lowers the cost of attendance. This is equivalent to setting
the EFC in all states of the world equal to the expected EFC under the current system minus some
compensation, \( E[z(A_n Y_n)] - \delta \), that makes \( E[V_1(A_n Y_n)] \) equal to its value under the current system. If \( \delta \) is
positive, then the alternative system is more costly for the college to implement to achieve a given level
of household welfare.

The results of this comparison are shown in Figure 3 for the average consumption profile of the patient
household under the baseline parameters. The solid curve shows the same average consumption profile
from Figure 1. Financial aid is approximately $20,000 on average. The long-dashed curve pertains to the
alternative in which financial aid is $20,000 regardless of income and assets. The present value of
lifetime resources, and therefore consumption, is the same in this “Revenue Equivalent” alternative.
That the latter starts out lower and ends higher is due to the need for additional precautionary saving in
the absence of the insurance provided by the financial aid formula. With that insurance under the
current system, the household can spend more early in life when consumption is relatively low. The
effect on asset accumulation is noticeable: households accumulate about 11 percent less under the
current system on the eve of college-going compared to the “Revenue Equivalent” alternative.\(^2\)

The short-dashed curve in Figure 3 is the average consumption profile that obtains when enough
additional financial aid is provided to allow the household to achieve the same lifetime expected utility
as under the current financial aid formula. After the first few years, average consumption must be
higher under the “Utility Equivalent” alternative than under the current system. Comparing the full
distribution of consumption outcomes for the current system and this “Utility Equivalent” alternative,
the standard deviation of consumption is lower by about 6 percent at the time of college-going due to
the insurance provided by the financial aid system.

\(^2\) Note that this reduction is due to both incentives, in the form of the implicit tax on assets, and insurance, with a
lessened need to save for precautionary reasons.
Table 5 shows just how much this additional aid must be. The table presents the differences in average EFCs and financial aid for patient households facing the baseline parameters. The first column is the average EFC under the current financial aid formula, by level of initial income, repeated from the first column of Table 4. The next two columns subtract this average EFC from the $60,000 cost of attendance to get average financial aid and then scale this financial aid as a percent of the costs of attendance (referred to as Gross Tuition in the table). Financial aid is half or more of the costs of attendance for initial incomes of $75,000 and below but under 15 percent for initial incomes of $150,000 or more.

The remaining columns of the table describe the “Utility Equivalent” alternative, starting with the value of $\delta$ – the additional amount of financial aid needed to make the household as well off under this alternative as under the current system. The second-to-last column shows that these additional amounts are about 30 – 36 percent of costs of attendance for households with initial incomes between $75,000 and $200,000. The last column of the table shows that financial aid would have to increase by about 80 percent of the Average EFC for the lowest-income household, falling monotonically to about 11 percent for the highest-income household. For the household with initial income of $100,000, the additional financial aid needed is $20,846, roughly the same as the average financial aid of $20,004 under the current system. Thus, in order to make the household as well off under an alternative in which financial aid is not income- or asset-contingent, the average amount of financial aid would have to double. This is the insurance value of financial aid, and it is shown graphically in Figure 4. Each column in the graph stacks the incremental aid, $\delta$ (Column 4 in Table 5), on the average amount of financial aid (Column 2 in Table 5).

Table 6 presents the analogous calculations for the impatient household under the baseline parameters. The additional aid needed to compensate for the loss of the insurance in the current formula is quite similar to that of the patient households. As a share of the $60,000 cost of attendance, the incremental aid is slightly lower for households with initial incomes below $150,000 and slightly higher for households with higher initial incomes. Because impatient households accumulate fewer assets and consequently receive more financial aid, the incremental aid offsets a larger percentage of the current Average EFC at all initial income levels compared to the patient household.

As noted above, not all assets are included in the measure of assets used in the financial aid formula. Retirement accounts are excluded from both the Federal and Institutional Methodologies, and home equity is also excluded from the Federal Methodology. A more general model of saving decisions in the presence of financial aid would include a state variable, say $W$, to represent excluded assets and a choice variable, say $m$, reflect net saving in these excluded assets. The household’s problem would then be to maximize the same objective function as in Equation (5) by choosing both $C(A,Y,W)$ and $m(A,Y,W)$ each period. This is a considerably more complicated problem.

To get an indication of what this might do to the insurance value of financial aid, Table 7 presents the analogous calculations to Table 5 assuming that the Contribution from Assets in Equation (2) is set to zero. With no Contribution from Assets, average financial aid is higher. The additional aid needed to

\[^{24}\text{Income from Assets is still included in Equation (1), however.}\]
compensate for the loss of the remaining income-contingent part of the financial aid formula is lower in dollar terms and thus as a share of costs of attendance for initial income levels below $200,000, particularly for the lowest income levels. This shows that the presence of a Contribution from Assets increases the insurance value of financial aid, a point to which we will return in Section V. However, as shown in the last column, the additional aid as a share of the Average EFC is just as high without the Contribution from Assets as under the current system.

Tables 8 and 9 present a sensitivity analysis of the key metric for the insurance value of financial aid—the incremental aid needed to maintain welfare as a share of costs of attendance—as baseline parameters are changed in isolation. The first column in each table repeats Column 6 from Table 5. The remaining columns in Table 8 focus on the amount of risk in the income profile or the household’s risk aversion. Changing these parameters should have a noticeable impact on the insurance value of financial aid. When the amount of persistence in the AR(1) income process is higher ($\rho = 0.99$) or the degree of risk aversion is higher ($\gamma = 5$), the insurance value of financial aid is also higher. When the persistence in the AR(1) process is lower ($\rho = 0.90$), the standard deviation of income shocks is lower ($\sigma = 0.10$), or risk aversion is lower ($\gamma = 1$), the insurance value of financial aid is also lower. These parameters retain the property from the main results in Table 5 that the insurance value of financial aid tends to be highest for intermediate values of initial income, at which the likelihood of either the EFC or financial aid being zero is low.

The parameterizations in Table 9 include four that vary the predictable aspects of the budget constraint and two that change an aspect of the timing or amount of college costs. The first two columns after the baseline show the results when the replacement rate is lowered to 25 percent and raised to 75 percent, respectively. At low initial income levels, the insurance value of financial aid is higher than the baseline for the lower replacement rate. This pattern reverses for initial income levels above $100,000. The next column lowers the growth rate of real income from 1.5 percent to 0. This lowers the insurance value of financial aid at all initial income levels.

The next three columns raise the amount of lifetime wealth relative to the costs of attending college—by starting out with $100,000 in assets, by having costs of attendance equal to only $30,000, or by delaying college attendance and thus allowing permanent income to grow over more years. In all cases, this raises the insurance value of financial aid at low levels of initial income and lowers it at higher levels of initial income. The greater wealth or lower costs raise the likelihood that low-income households will have non-zero EFCs and thus experience variation that can be insured. Analogously, the higher wealth relative to costs reduce the likelihood that high-income households will have EFCs less than the costs of attendance and thus experience variation that can be insured. The effects are most pronounced for the lower tuition case, followed by the delayed entry, and the increase in initial assets. Across all of these different parameterizations, however, the insurance value of financial aid for the household with initial income of $100,000 varies very little around its baseline amount of about 35 percent.
V. Welfare Impact of Eliminating the Contribution from Assets

The potentially large implicit taxes on assets inherent in the Federal and Institutional Methodologies for calculating financial aid, along with some evidence that these taxes may discourage saving, have prompted some economists to suggest alternative means of determining financial aid. For example, Dick and Edlin (1997) suggest either that actual assets be replaced by a measure of permanent income derived from a full earnings history or by an imputed asset amount derived from earnings. The critical feature of these alternatives is that a household’s decision to increase its assets relative to its earnings does not reduce its financial aid eligibility.

To analyze the implications of alternative formulas that provide less disincentive to save, we consider a modification of the current system that eliminates the Contribution from Assets and raises the tax rate on Available Income. Specifically, we set $j = 0$ in Equation (3) and adjust $k$ upward from 1 until expected utility, $E[V_1(A_1,Y_1)]$, is the same as under the current system. The amount by which the average EFC, $E[z(A_s,Y_s)]$, is lower (higher) under this alternative system indicates how much more (less) the college has to pay in financial aid when the Contribution from Assets is eliminated. There are four aspects of this change that could affect household welfare:

1. Welfare could increase due to the reduced distortion on the saving for retirement margin in the absence of the implicit tax on assets.
2. Welfare could increase due to the additional insurance against fluctuations in current income via the higher implicit taxes on income in the financial aid formula.
3. Welfare could decrease due to the loss of insurance against income fluctuations that lead to higher or lower asset accumulation.
4. Welfare could decrease due to the higher distortion on the labor supply margin due to the higher implicit taxes on income.

In our model, #4 is not a consideration because labor is assumed to be supplied inelastically. Thus, the impact on household welfare will be negative only if #3 is important enough to outweigh the combined benefits of #1 and #2.  

The calculations in Table 10 show that this is exactly what occurs. The two panels of the table correspond to the patient and impatient households. The first column in each panel shows the Average EFC by initial income, repeating the main results from Tables 5 and 6. The second columns show the Average EFCs under the alternative formula in which the Contribution from Assets has been zeroed out and Available Income has been scaled up (by the factor in the fourth columns of each panel) to keep household welfare unchanged. When the new Average EFC is lower, this means that the college must give more financial aid on average. The third columns show how much average financial aid must increase. It is positive in all cases but patient households with the lowest initial incomes. For the patient households with the lowest initial incomes, welfare could increase due to the reduced distortion on the saving for retirement margin in the absence of the implicit tax on assets.

25 In addition, social welfare might be reduced because the absence of an implicit tax on assets reduces the ability of the financial aid formula to redistribute from those with high initial assets to those with low initial assets. This is not a concern here, as welfare comparisons are done at the household level only.
household with initial income of $100,000, the increase is about 7 percent of financial aid. For the impatient household, the increases are less – about 4 percent over most of the initial incomes.

These results show that including the Contribution from Assets allows for more efficient insurance against income risk in the financial aid formula. As suggested by Dick and Edlin (1997), assets are reflecting lifetime income – information beyond what is available in current income. For a given level of current income, a low level of assets indicates that prior income shocks were sufficiently low that the household found it optimal to consume most of its income. Including assets in the financial aid formula allows the formula to partially insure against those prior shocks as well. Table 10 shows that this added insurance is important – it is enough to outweigh the benefits of the reduced distortions on the saving margin and greater insurance on current income.26

VI. Conclusion

Our analysis is the first to recognize that the financial aid tax discussed prominently by practitioners and academics is merely one component of a standard incentives-insurance tradeoff. Using a stochastic, life-cycle model in which households have precautionary, retirement, and college motives for saving, we show that the insurance value of a financial aid formula based on the current Federal and Institutional Methodologies is substantial. Across a range of parameterizations, we calculate that financial aid would have to increase by about a third of the costs of attendance to compensate households for the loss of the income- and asset-contingent elements of the formula. We further show that because assets provide incremental information about the history of income shocks relative to current income, eliminating the implicit tax on assets can leave a household worse off, despite the improvement in incentives for saving.

There are several possible directions for further research, most of which would expand the complexity of the model beyond the framework of one choice variable and two state variables used here. First, we do not consider the choice on the labor supply margin, even though the implicit tax rates on current income can be quite high. Second, we do not consider the real growth in the cost of attending college or the uncertainty surrounding it, even though this cost growth and uncertainty are prominent in policy discussions regarding access to higher education. Incorporating this growth and uncertainty would likely increase the insurance value of financial aid, since the EFC that comes from the Federal Methodology does not depend on college costs except as a maximum. Third, we do not consider other margins along which substitution would be possible, such as attending a cheaper institution or taking on student loans. Incorporating these other choices would likely reduce the insurance value of financial aid. Fourth, along these lines, we do not consider parents’ payments for college in a more general context of intergenerational transfers to children, where payments for college could be replaced by direct payments of cash if the value proposition in college becomes less favorable. Finally, we do not consider the growing industry of tax-advantaged college saving vehicles, like 529 plans and Coverdell accounts, that make saving for college relatively cheaper than in our model.

26 In tabulations not shown, the only parameterization in Tables 8 and 9 that did not generate higher welfare is the one in which the income process is nearly a random walk ($\rho = 0.99$). When shocks to income become more permanent, then the degree of additional information in assets relative to current income gets smaller.
References


Figure 1

Average Income, Consumption, and Assets

Model Period

Income
Consumption
EFC
Assets
Figure 2

Average Income, Consumption, and Assets

Impatient Household

Model Period

Income
Consumption
EFC
Assets

(000s)

0
100
200
300

0
20
40
60

0
10
20
30

0
10
20
30

0
10
20
30

0
10
20
30
Figure 3

Average Consumption by Financial Aid Formula

- Current Formula
- Utility Equivalent
- Revenue Equivalent
Figure 4

Incremental Aid Relative to Current Aid

- **Average Financial Aid**
- **Additional Aid Needed**
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Notes: Author's calculations for a married couple, with one parent working, the older parent 45 years old, and one child.
Table 2
Implied Marginal Tax Rates on Income by Assets and Income, 2012 - 2013

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Notes: Author's calculations for a married couple, with one parent working, the older parent 45 years old, and one child. Marginal tax rates are for an increase of $15,000 in income.
### Table 3
Implied Marginal Tax Rates on Assets by Assets and Income, 2012 - 2013

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<td>7.0%</td>
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<td>7.0%</td>
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<td>6.9%</td>
<td>6.8%</td>
</tr>
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<td>4.8%</td>
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<td>7.0%</td>
<td>7.0%</td>
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<td>7.0%</td>
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<td>7.0%</td>
<td>7.0%</td>
<td>7.0%</td>
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<td>6.9%</td>
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<td>7.0%</td>
<td>7.0%</td>
<td>7.0%</td>
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</tr>
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<td>7.2%</td>
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<td>7.0%</td>
<td>7.0%</td>
<td>6.9%</td>
<td>6.9%</td>
<td>6.8%</td>
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<td>7.0%</td>
<td>7.0%</td>
<td>6.9%</td>
<td>6.9%</td>
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<tr>
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<td>7.2%</td>
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<td>6.9%</td>
<td>6.8%</td>
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<td>7.2%</td>
<td>7.0%</td>
<td>7.0%</td>
<td>7.0%</td>
<td>7.0%</td>
<td>6.9%</td>
<td>6.9%</td>
<td>6.8%</td>
</tr>
</tbody>
</table>

Notes: Author's calculations for a married couple, with one parent working, the older parent 45 years old, and one child. Marginal tax rates are for an increase of $20,000 in assets and apply successively in each year of college attendance.
**Table 4**

Impact of Saving on Average EFC, by Uncertainty, Patience, and Replacement Rate

<table>
<thead>
<tr>
<th>Initial Income</th>
<th>$\sigma = 0.15$</th>
<th>No Income Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patient, RR = 0.50</td>
<td>Patient, RR = 0.50</td>
</tr>
<tr>
<td>25</td>
<td>3.958</td>
<td>1.503</td>
</tr>
<tr>
<td>50</td>
<td>17.005</td>
<td>9.470</td>
</tr>
<tr>
<td>75</td>
<td>30.073</td>
<td>19.784</td>
</tr>
<tr>
<td>100</td>
<td>39.996</td>
<td>29.424</td>
</tr>
<tr>
<td>125</td>
<td>46.675</td>
<td>37.225</td>
</tr>
<tr>
<td>150</td>
<td>51.061</td>
<td>43.151</td>
</tr>
<tr>
<td>175</td>
<td>53.895</td>
<td>47.721</td>
</tr>
<tr>
<td>200</td>
<td>55.759</td>
<td>51.097</td>
</tr>
<tr>
<td>400</td>
<td>59.666</td>
<td>59.258</td>
</tr>
</tbody>
</table>

**Notes:**

1) Calculations are done for the baseline parameters, as discussed in the text, except as noted.
2) All dollar values are in thousands of constant 2013 dollars.
3) Each cell is the Average Expected Family Contribution for a couple with one child.
### Table 5

Additional Aid Required to Compensate for Loss of EFC Formula -- Baseline Parameters

<table>
<thead>
<tr>
<th>Initial Income</th>
<th>Average EFC</th>
<th>Average Financial Aid</th>
<th>Aid as a % of Tuition</th>
<th>Additional Aid Needed</th>
<th>New Average Financial Aid</th>
<th>As a Share of Gross Tuition</th>
<th>As a Share of Net Tuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>3.958</td>
<td>56.042</td>
<td>93.4%</td>
<td>3.180</td>
<td>59.223</td>
<td>5.3%</td>
<td>80.4%</td>
</tr>
<tr>
<td>50</td>
<td>17.005</td>
<td>42.995</td>
<td>71.7%</td>
<td>11.480</td>
<td>54.474</td>
<td>19.1%</td>
<td>67.5%</td>
</tr>
<tr>
<td>75</td>
<td>30.073</td>
<td>29.927</td>
<td>49.9%</td>
<td>17.833</td>
<td>47.760</td>
<td>29.7%</td>
<td>59.3%</td>
</tr>
<tr>
<td>100</td>
<td>39.996</td>
<td>20.004</td>
<td>33.3%</td>
<td>20.846</td>
<td>40.850</td>
<td>34.7%</td>
<td>52.1%</td>
</tr>
<tr>
<td>125</td>
<td>46.675</td>
<td>13.325</td>
<td>22.2%</td>
<td>21.711</td>
<td>35.035</td>
<td>36.2%</td>
<td>46.5%</td>
</tr>
<tr>
<td>150</td>
<td>51.061</td>
<td>8.939</td>
<td>14.9%</td>
<td>21.092</td>
<td>30.031</td>
<td>35.2%</td>
<td>41.3%</td>
</tr>
<tr>
<td>175</td>
<td>53.895</td>
<td>6.105</td>
<td>10.2%</td>
<td>19.872</td>
<td>25.977</td>
<td>33.1%</td>
<td>36.9%</td>
</tr>
<tr>
<td>200</td>
<td>55.759</td>
<td>4.241</td>
<td>7.1%</td>
<td>18.351</td>
<td>22.592</td>
<td>30.6%</td>
<td>32.9%</td>
</tr>
<tr>
<td>400</td>
<td>59.666</td>
<td>0.334</td>
<td>0.6%</td>
<td>6.777</td>
<td>7.111</td>
<td>11.3%</td>
<td>11.4%</td>
</tr>
</tbody>
</table>

Notes:
1) Calculations are done for the baseline parameters.
2) All dollar values are in thousands of constant 2013 dollars.
3) The left panel is for the current financial aid formula. The right panel is for an alternative in which tuition is simply discounted by a uniform amount, regardless of income and assets.
### Table 6
Additional Aid Required to Compensate for Loss of EFC Formula -- Impatient Household

<table>
<thead>
<tr>
<th>Initial Income</th>
<th>Average EFC</th>
<th>Average Financial Aid</th>
<th>Aid as a % of Tuition</th>
<th>Additional Aid Needed</th>
<th>New Average Financial Aid</th>
<th>As a Share of Gross Tuition</th>
<th>As a Share of Net Tuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1.503</td>
<td>58.497</td>
<td>97.5%</td>
<td>1.303</td>
<td>59.800</td>
<td>2.2%</td>
<td>86.7%</td>
</tr>
<tr>
<td>50</td>
<td>9.470</td>
<td>50.530</td>
<td>84.2%</td>
<td>7.302</td>
<td>57.831</td>
<td>12.2%</td>
<td>77.1%</td>
</tr>
<tr>
<td>75</td>
<td>19.784</td>
<td>40.216</td>
<td>67.0%</td>
<td>13.577</td>
<td>53.793</td>
<td>22.6%</td>
<td>68.6%</td>
</tr>
<tr>
<td>100</td>
<td>29.424</td>
<td>30.576</td>
<td>51.0%</td>
<td>18.270</td>
<td>48.846</td>
<td>30.4%</td>
<td>62.1%</td>
</tr>
<tr>
<td>125</td>
<td>37.225</td>
<td>22.775</td>
<td>38.0%</td>
<td>21.144</td>
<td>43.918</td>
<td>35.2%</td>
<td>56.8%</td>
</tr>
<tr>
<td>150</td>
<td>43.151</td>
<td>16.849</td>
<td>28.1%</td>
<td>23.201</td>
<td>40.050</td>
<td>38.7%</td>
<td>53.8%</td>
</tr>
<tr>
<td>175</td>
<td>47.721</td>
<td>12.279</td>
<td>20.5%</td>
<td>23.150</td>
<td>35.429</td>
<td>38.6%</td>
<td>48.5%</td>
</tr>
<tr>
<td>200</td>
<td>51.097</td>
<td>8.903</td>
<td>14.8%</td>
<td>21.854</td>
<td>30.758</td>
<td>36.4%</td>
<td>42.8%</td>
</tr>
<tr>
<td>400</td>
<td>59.258</td>
<td>0.742</td>
<td>1.2%</td>
<td>7.673</td>
<td>8.415</td>
<td>12.8%</td>
<td>12.9%</td>
</tr>
</tbody>
</table>

Notes:
1) Calculations are done for the baseline parameters, but with a lower discount factor.
2) All dollar values are in thousands of constant 2013 dollars.
3) The left panel is for the current financial aid formula. The right panel is for an alternative in which tuition is simply discounted by a uniforma amount, regardless of income and assets.
<table>
<thead>
<tr>
<th>Initial Income</th>
<th>Average EFC</th>
<th>Average Financial Aid</th>
<th>Aid as a % of Tuition</th>
<th>Additional Aid Needed</th>
<th>New Average Financial Aid</th>
<th>As a Share of Gross Tuition</th>
<th>As a Share of Net Tuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1.554</td>
<td>58.446</td>
<td>97.4%</td>
<td>1.327</td>
<td>59.772</td>
<td>2.2%</td>
<td>85.4%</td>
</tr>
<tr>
<td>50</td>
<td>9.727</td>
<td>50.273</td>
<td>83.8%</td>
<td>6.620</td>
<td>56.893</td>
<td>11.0%</td>
<td>68.1%</td>
</tr>
<tr>
<td>75</td>
<td>19.926</td>
<td>40.074</td>
<td>66.8%</td>
<td>11.822</td>
<td>51.897</td>
<td>19.7%</td>
<td>59.3%</td>
</tr>
<tr>
<td>100</td>
<td>29.481</td>
<td>30.519</td>
<td>50.9%</td>
<td>15.765</td>
<td>46.284</td>
<td>26.3%</td>
<td>53.5%</td>
</tr>
<tr>
<td>125</td>
<td>37.542</td>
<td>22.458</td>
<td>37.4%</td>
<td>18.392</td>
<td>40.850</td>
<td>30.7%</td>
<td>49.0%</td>
</tr>
<tr>
<td>150</td>
<td>43.826</td>
<td>16.174</td>
<td>27.0%</td>
<td>19.601</td>
<td>35.775</td>
<td>32.7%</td>
<td>44.7%</td>
</tr>
<tr>
<td>175</td>
<td>48.459</td>
<td>11.541</td>
<td>19.2%</td>
<td>19.781</td>
<td>31.322</td>
<td>33.0%</td>
<td>40.8%</td>
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<tr>
<td>200</td>
<td>51.787</td>
<td>8.213</td>
<td>13.7%</td>
<td>19.139</td>
<td>27.352</td>
<td>31.9%</td>
<td>37.0%</td>
</tr>
<tr>
<td>400</td>
<td>59.353</td>
<td>0.647</td>
<td>1.1%</td>
<td>7.802</td>
<td>8.449</td>
<td>13.0%</td>
<td>13.1%</td>
</tr>
</tbody>
</table>

Notes:
1) Calculations are done for the baseline parameters, but with no Contribution from Assets.
2) All dollar values are in thousands of constant 2013 dollars.
3) The left panel is for the current financial aid formula. The right panel is for an alternative in which tuition is simply discounted by a uniform amount, regardless of income and assets.
### Table 8
Additional Aid Required to Compensate for Loss of EFC Formula -- Sensitivity to Risk Parameters

<table>
<thead>
<tr>
<th>Initial Income</th>
<th>Baseline</th>
<th>$\rho = 0.99$</th>
<th>$\rho = 0.90$</th>
<th>$\sigma = 0.10$</th>
<th>$\gamma = 1$</th>
<th>$\gamma = 5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>5.3%</td>
<td>10.2%</td>
<td>2.6%</td>
<td>1.9%</td>
<td>2.0%</td>
<td>8.3%</td>
</tr>
<tr>
<td>50</td>
<td>19.1%</td>
<td>29.8%</td>
<td>10.9%</td>
<td>9.2%</td>
<td>7.2%</td>
<td>29.0%</td>
</tr>
<tr>
<td>75</td>
<td>29.7%</td>
<td>41.3%</td>
<td>18.7%</td>
<td>16.2%</td>
<td>11.6%</td>
<td>44.2%</td>
</tr>
<tr>
<td>100</td>
<td>34.7%</td>
<td>44.5%</td>
<td>23.9%</td>
<td>21.2%</td>
<td>14.2%</td>
<td>51.2%</td>
</tr>
<tr>
<td>125</td>
<td>36.2%</td>
<td>42.9%</td>
<td>25.9%</td>
<td>23.5%</td>
<td>15.0%</td>
<td>52.4%</td>
</tr>
<tr>
<td>150</td>
<td>35.2%</td>
<td>39.0%</td>
<td>25.2%</td>
<td>25.9%</td>
<td>14.7%</td>
<td>51.0%</td>
</tr>
<tr>
<td>175</td>
<td>33.1%</td>
<td>34.0%</td>
<td>26.4%</td>
<td>25.1%</td>
<td>15.5%</td>
<td>48.3%</td>
</tr>
<tr>
<td>200</td>
<td>30.6%</td>
<td>29.6%</td>
<td>24.9%</td>
<td>20.9%</td>
<td>14.8%</td>
<td>45.3%</td>
</tr>
<tr>
<td>400</td>
<td>11.3%</td>
<td>6.8%</td>
<td>1.8%</td>
<td>1.2%</td>
<td>2.6%</td>
<td>27.5%</td>
</tr>
</tbody>
</table>

**Notes:**

1) Calculations are done for the baseline parameters, as discussed in the text, except as noted.

2) Each cell is the Incremental Financial Aid Required in the alternative model, as a share of gross tuition.
<table>
<thead>
<tr>
<th>Initial Income</th>
<th>Baseline</th>
<th>Replacement Rate = 25%</th>
<th>Replacement Rate = 75%</th>
<th>Income Growth = 0%</th>
<th>Initial Assets = $100,000</th>
<th>Tuition = $30,000</th>
<th>Delay College by 8 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>5.3%</td>
<td>7.0%</td>
<td>4.4%</td>
<td>4.2%</td>
<td>7.2%</td>
<td>10.4%</td>
<td>9.1%</td>
</tr>
<tr>
<td>50</td>
<td>19.1%</td>
<td>21.7%</td>
<td>17.2%</td>
<td>16.3%</td>
<td>20.2%</td>
<td>30.9%</td>
<td>27.0%</td>
</tr>
<tr>
<td>75</td>
<td>29.7%</td>
<td>30.5%</td>
<td>28.6%</td>
<td>25.4%</td>
<td>29.3%</td>
<td>37.1%</td>
<td>36.4%</td>
</tr>
<tr>
<td>100</td>
<td>34.7%</td>
<td>32.4%</td>
<td>35.5%</td>
<td>29.3%</td>
<td>33.3%</td>
<td>35.0%</td>
<td>37.6%</td>
</tr>
<tr>
<td>125</td>
<td>36.2%</td>
<td>31.0%</td>
<td>38.5%</td>
<td>29.3%</td>
<td>34.1%</td>
<td>30.7%</td>
<td>35.1%</td>
</tr>
<tr>
<td>150</td>
<td>35.2%</td>
<td>28.5%</td>
<td>38.7%</td>
<td>27.5%</td>
<td>33.0%</td>
<td>26.2%</td>
<td>31.5%</td>
</tr>
<tr>
<td>175</td>
<td>33.1%</td>
<td>25.8%</td>
<td>37.2%</td>
<td>24.6%</td>
<td>31.0%</td>
<td>21.7%</td>
<td>28.0%</td>
</tr>
<tr>
<td>200</td>
<td>30.6%</td>
<td>22.9%</td>
<td>34.7%</td>
<td>21.5%</td>
<td>28.7%</td>
<td>18.0%</td>
<td>24.5%</td>
</tr>
<tr>
<td>400</td>
<td>11.3%</td>
<td>8.9%</td>
<td>12.6%</td>
<td>7.0%</td>
<td>10.9%</td>
<td>3.7%</td>
<td>8.4%</td>
</tr>
</tbody>
</table>

Notes:
1) Calculations are done for the baseline parameters, as discussed in the text, except as noted.
2) Each cell is the Incremental Financial Aid Required in the alternative model, as a share of gross tuition.
Table 10
Additional Aid Required to Compensate for Loss of the Asset Tax, by Patience

<table>
<thead>
<tr>
<th>Initial Income</th>
<th>Patient Household</th>
<th></th>
<th></th>
<th></th>
<th>Impatient Household</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average EFC</td>
<td>New Average EFC</td>
<td>% Increase in Aid</td>
<td>AI Multiplier</td>
<td>Average EFC</td>
<td>New Average EFC</td>
<td>% Increase in Aid</td>
</tr>
<tr>
<td>25</td>
<td>3.958</td>
<td>4.365</td>
<td>-0.7%</td>
<td>2.05</td>
<td>1.503</td>
<td>1.445</td>
<td>0.1%</td>
</tr>
<tr>
<td>50</td>
<td>17.005</td>
<td>16.516</td>
<td>1.1%</td>
<td>1.52</td>
<td>9.470</td>
<td>8.962</td>
<td>1.0%</td>
</tr>
<tr>
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<td>30.073</td>
<td>28.798</td>
<td>4.3%</td>
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<td>18.816</td>
<td>2.4%</td>
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<tr>
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<td>39.996</td>
<td>38.608</td>
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<td>1.35</td>
<td>29.424</td>
<td>28.275</td>
<td>3.8%</td>
</tr>
<tr>
<td>125</td>
<td>46.675</td>
<td>45.439</td>
<td>9.3%</td>
<td>1.31</td>
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<td>36.224</td>
<td>4.4%</td>
</tr>
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<td>51.061</td>
<td>50.086</td>
<td>10.9%</td>
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<td>43.151</td>
<td>42.403</td>
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</tr>
<tr>
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<td>53.139</td>
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<td>55.187</td>
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<td>50.704</td>
<td>4.4%</td>
</tr>
<tr>
<td>400</td>
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<td>59.585</td>
<td>24.4%</td>
<td>1.09</td>
<td>59.258</td>
<td>59.250</td>
<td>1.1%</td>
</tr>
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</table>

Notes:
1) Calculations are done for the baseline parameters.
2) All dollar values are in thousands of constant 2013 dollars.
3) The alternative model is one in which there is no Contribution from Assets, but Available Income (AI) has been scaled by the factor shown in the last column of each panel.