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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

[1] See the tabulations of total money earnings for 2010 in the Current Population Survey, 2011 Annual Social and Economic Supplement. See http://www.census.gov/hhes/www/cpstables/032011/perinc/new03_154.htm and http://www.census.gov/hhes/www/cpstables/032011/perinc/new03_280.htm for data on men and women, respectively.

[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.[5] 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.[6] 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.

[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.[7] 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.[8] 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.[9]

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:

$$AI = \text{Adjusted Gross Income - (Federal Income Tax Paid + State and Other Tax Allowance + Social Security Tax Allowance + Income Protection Allowance + Employment Expense Allowance)} \quad (1)$$

[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.

(2) $CA = Max(0, 0.12*(Assets - Asset\ Protection\ Allowance))$

(3) $AAI = k*AI + j*CA$

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:

$$\begin{aligned} EFC = \; & 0.22*min(14600, max(AAI, -3409)) + 0.25*max(0, min(AAI, 18400) - 14600) + \\ & 0.29*max(0, min(AAI, 22100) - 18400) + 0.34*max(0, min(AAI, 25900) - 22100) + \\ & 0.40*max(0, min(AAI, 29600) - 25900) + 0.47*max(0, AAI - 29600) \end{aligned} \quad (4)$$

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

[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*(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*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*0.04*(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 $0.07 + 0.07*(1-0.07) + 0.07*(1-0.07)^2 + 0.07*(1-0.07)^3 = 0.252$, or about

[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.[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.

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:

[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.

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

such that :

(5)

$$a)\ u(C) = \frac{C^{1-\gamma}}{1-\gamma}$$

$$b)\ X_s = A_s + Y_s - h(Y_s) - z_s(A_s, Y_s)$$

$$c)\ A_{s+1} = (1+r)(X_s - C_s) - g(Y_s, X_s - C_s)$$

$$d)\ A_s \geq 0 \ \ \forall s$$

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 β 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: $u(C) = C^{1-\gamma}/(1-\gamma)$, where γ 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

[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:

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

(6) At retirement:

$$e)\ Y_{s+1} = RR * Y_s$$

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 σ^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:

$$(7) \qquad V_{T-1}(A_{T-1}, Y_{T-1}) \equiv \max_{\{C_{T-1}\}} \; u(C_{T-1}) + \beta E_{T-1}[V_T(A_T, Y_T)]$$

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:

$$(8) \qquad V_t(A_t, Y_t) \equiv \max_{\{C_t\}} \; u(C_t) + \beta E_t[V_{t+1}(A_{t+1}, Y_{t+1})]$$

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

$$(9) \qquad u'(C_t) - \beta(1 + r(1 - g_2(Y_t, X_t - C_t)))E_t[V_{t+1}^A(A_{t+1}, Y_{t+1})] = 0$$

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, $r^*g_2(Y_t, X_t - C_t)$ 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 β. 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, ρ = 0.95, and σ = 0.15. The interest rate, r, is 0.03, and the coefficient of relative risk aversion, γ, 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, β, 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.[22] Over the life cycle, consumption rises slightly – with β*(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 β = 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

[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, $E[z(A_s,Y_s)] - \delta$, that makes $E[V_1(A_1,Y_1)]$ equal to its value under the current system. If δ 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.[23]

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.

[23] 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 δ – 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, δ (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 $C(A_t,Y_t,W_t)$ and $m(A_t,Y_t,W_t)$ 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.[24] With no Contribution from Assets, average financial aid is higher. The additional aid needed to

[24] 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.[25]

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

[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 (ρ= 0.99). When shocks to income become more permanent, then the degree of additional information in assets relative to current income gets smaller.

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Figure 1

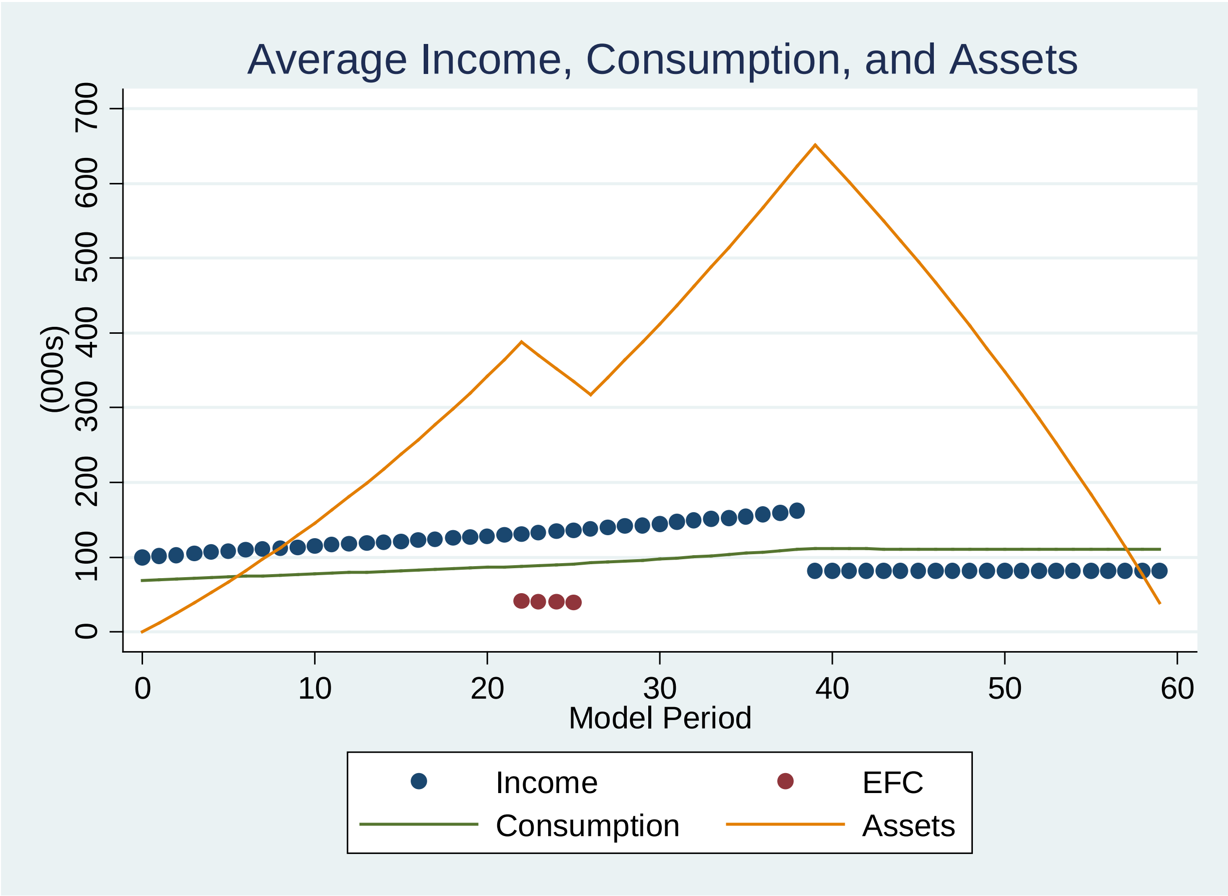
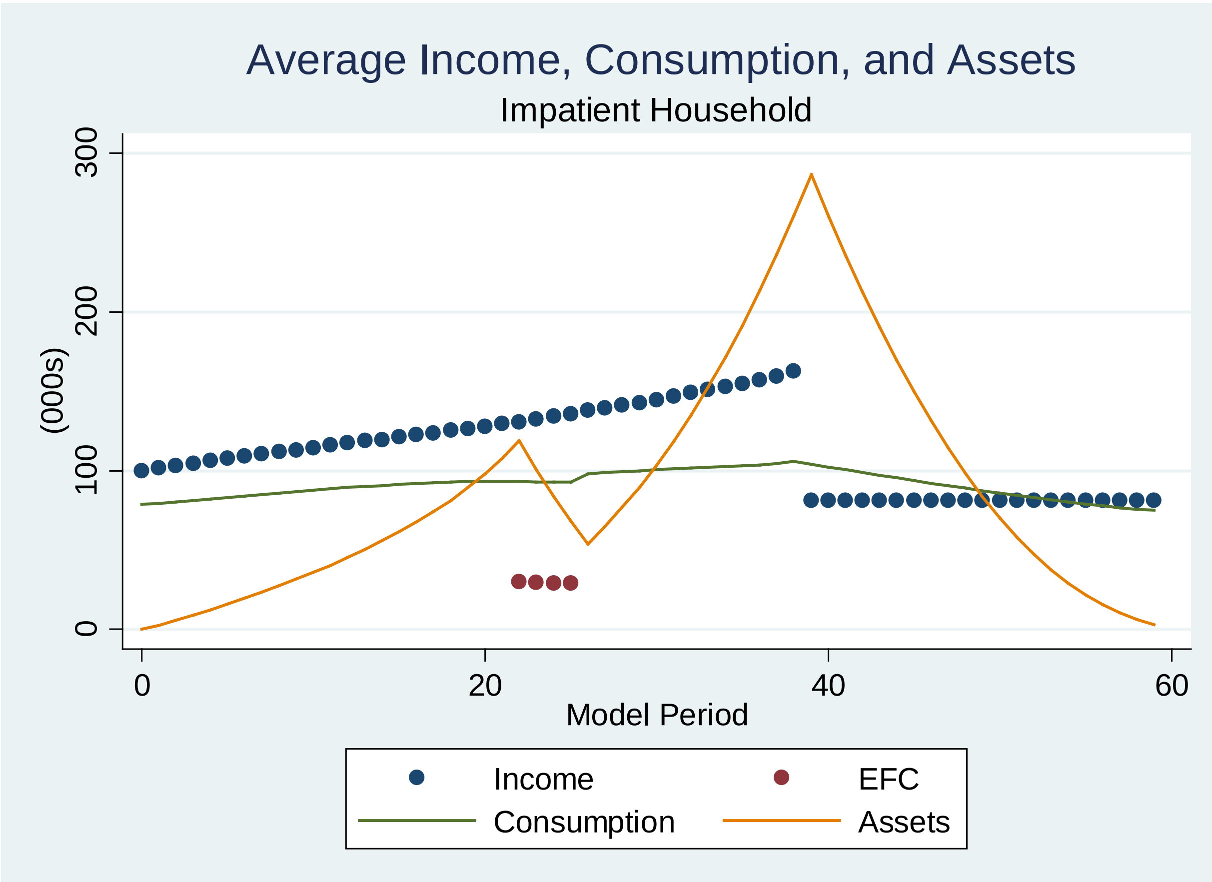

Average Income, Consumption, and Assets
(000s)
0
100
200
300
400
500
600
700
0
10
20
30
40
50
60
Model Period
Income
EFC
Consumption
Assets

Figure 2



Average Income, Consumption, and Assets
Impatient Household
(000s)
0
100
200
300
0
20
40
60
Model Period
Income
EFC
Consumption
Assets

Figure 3

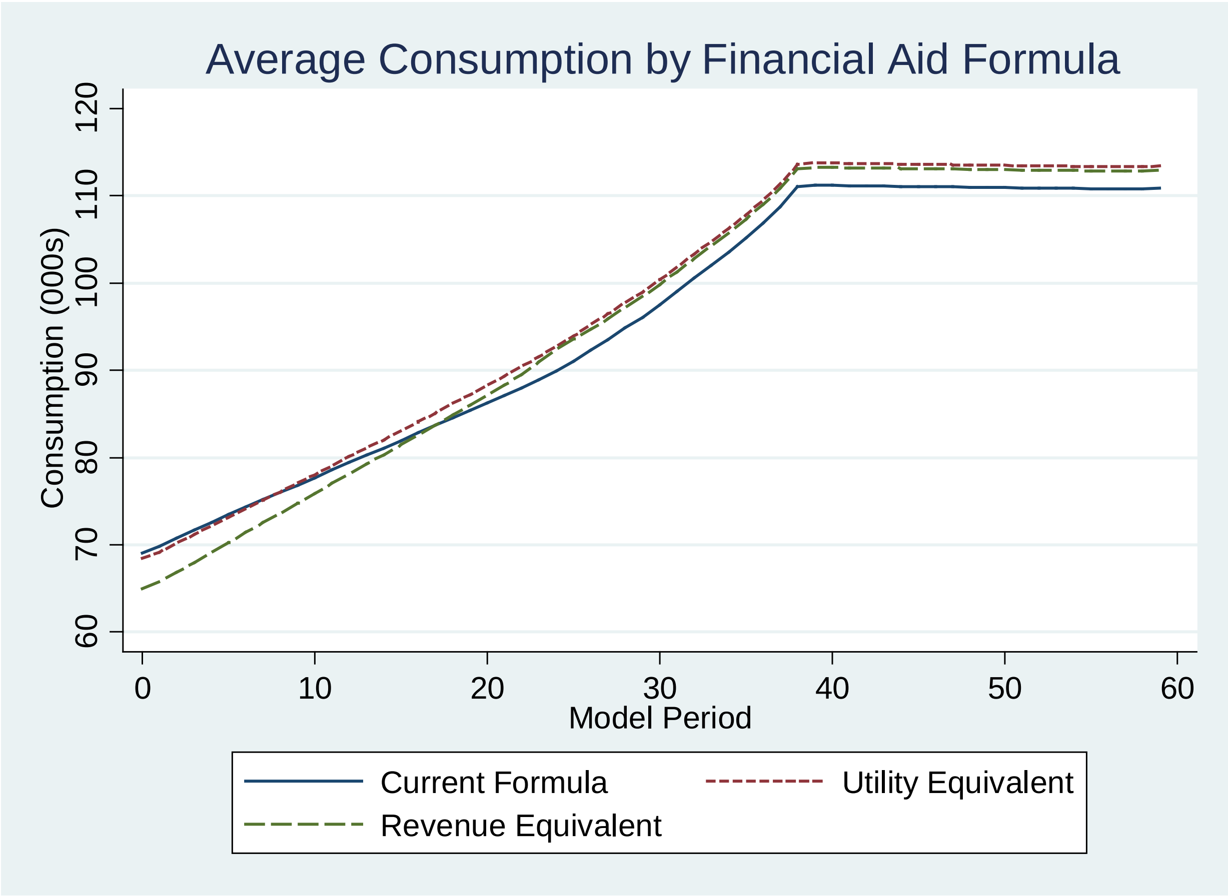

Average Consumption by Financial Aid Formula
Consumption (000s)
60
70
80
90
100
110
120
0
10
20
30
40
50
60
Model Period
Current Formula
Utility Equivalent
Revenue Equivalent

Figure 4

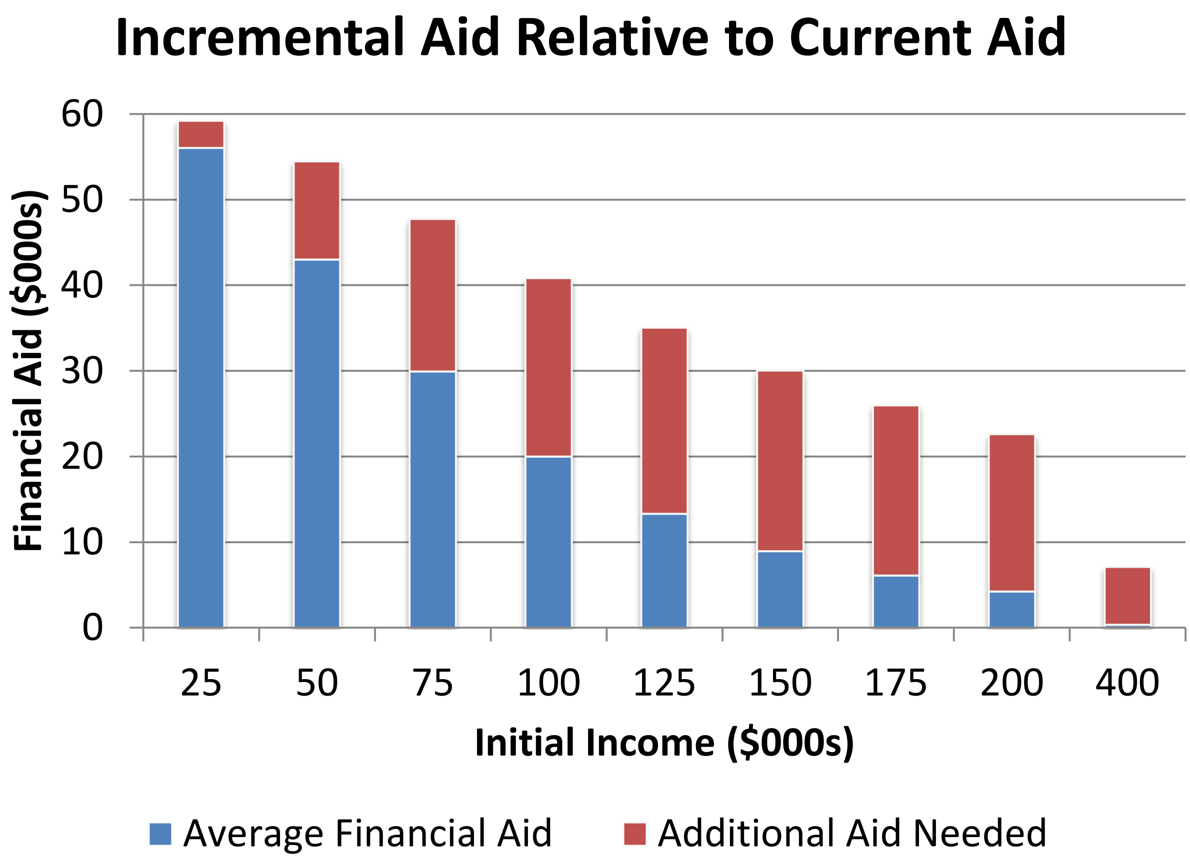

Incremental Aid Relative to Current Aid
Financial Aid ($000s)
0
10
20
30
40
50
60
25
50
75
100
125
150
175
200
400
Initial Income ($000s)
Average Financial Aid
Additional Aid Needed

Table 1

Expected Family Contributions by Assets and Income, 2012-2013

	Labor Income									
Assets	15000	30000	45000	60000	75000	90000	120000	150000	180000	240000
20000	-	-	-	6,165	10,749	15,180	24,225	33,899	43,212	61,421
40000	-	-	-	6,384	11,014	15,445	24,490	34,153	43,466	61,656
60000	-	-	3,922	7,244	12,334	16,765	25,810	35,462	44,775	62,946
80000	-	-	4,767	8,859	13,727	18,158	27,203	36,843	46,156	64,309
100000	-	-	5,721	10,290	15,120	19,551	28,596	38,225	47,538	65,672
120000	-	3,473	6,526	11,720	16,513	20,944	29,989	39,607	48,920	67,035
140000	-	4,246	8,015	13,151	17,906	22,337	31,382	40,989	50,302	68,398
160000	-	5,129	9,446	14,582	19,299	23,730	32,776	42,371	51,684	69,761
180000	-	6,145	10,876	16,012	20,692	25,123	34,169	43,752	53,065	71,124
200000	3,786	7,026	12,307	17,443	22,085	26,516	35,562	45,134	54,447	72,487
300000	9,189	14,325	19,460	24,596	29,051	33,482	42,527	52,043	61,356	79,302
400000	16,342	21,478	26,614	31,585	36,016	40,447	49,493	58,952	68,265	86,117

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

	Labor Income								
Assets	15000	30000	45000	60000	75000	90000	120000	180000	240000
20000		0.0%	0.0%	41.1%	30.6%	29.5%	30.8%	31.0%	28.7%
40000		0.0%	0.0%	42.6%	30.9%	29.5%	30.8%	31.0%	28.7%
60000		0.0%	26.2%	22.2%	33.9%	29.5%	30.8%	31.0%	28.7%
80000		0.0%	31.8%	27.3%	32.5%	29.5%	30.8%	31.0%	28.7%
100000		0.0%	38.1%	30.5%	32.2%	29.5%	30.8%	31.0%	28.7%
120000		23.2%	20.4%	34.6%	32.0%	29.5%	30.8%	31.0%	28.7%
140000		28.3%	25.1%	34.2%	31.7%	29.5%	30.8%	31.0%	28.7%
160000		34.2%	28.8%	34.2%	31.5%	29.5%	30.8%	31.0%	28.7%
180000		41.0%	31.5%	34.2%	31.2%	29.5%	30.8%	31.0%	28.7%
200000		21.6%	35.2%	34.2%	31.0%	29.5%	30.8%	31.0%	28.7%
300000		34.2%	34.2%	34.2%	29.7%	29.5%	30.8%	31.0%	28.7%
400000		34.2%	34.2%	33.1%	29.5%	29.5%	30.8%	31.0%	28.7%

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

	Labor Income									
Assets	15000	30000	45000	60000	75000	90000	120000	150000	180000	240000
20000										
40000	0.0%	0.0%	0.0%	1.1%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%
60000	0.0%	0.0%	19.6%	4.3%	6.6%	6.6%	6.6%	6.5%	6.5%	6.5%
80000	0.0%	0.0%	4.2%	8.1%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%
100000	0.0%	0.0%	4.8%	7.2%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%
120000	0.0%	17.4%	4.0%	7.2%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%
140000	0.0%	3.9%	7.4%	7.2%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%
160000	0.0%	4.4%	7.2%	7.2%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%
180000	0.0%	5.1%	7.2%	7.2%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%
200000	18.9%	4.4%	7.2%	7.2%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%
300000	8.3%	7.2%	7.2%	7.2%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%
400000	7.2%	7.2%	7.2%	7.0%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%

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

Initial Income	σ = 0.15 Patient, RR = 0.50	σ = 0.15 Impatient, RR = 0.50	σ = 0.15 Patient, RR = 0.25	No Income Uncertainty Patient, RR = 0.50	No Income Uncertainty Impatient, RR = 0.50	No Income Uncertainty Patient, RR = 0.25
25	3.958	1.503	5.222	0.153	0.114	0.430
50	17.005	9.470	20.757	8.231	8.175	11.245
75	30.073	19.784	34.961	20.036	19.915	25.924
100	39.996	29.424	44.635	31.102	30.481	38.434
125	46.675	37.225	50.552	42.399	41.186	51.459
150	51.061	43.151	54.093	53.114	51.546	60.000
175	53.895	47.721	56.231	60.000	60.000	60.000
200	55.759	51.097	57.538	60.000	60.000	60.000
400	59.666	59.258	59.881	60.000	60.000	60.000

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

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

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 uniforma amount, regardless of income and assets.

Table 6

Additional Aid Required to Compensate for Loss of EFC Formula -- Impatient Household

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

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 7

Additional Aid Required to Compensate for Loss of EFC Formula -- No Asset Tax

Initial Income	Average EFC	Average Financial Aid	Aid as a % of Tuition	Additional Aid Needed	New Average Financial Aid	As a Share of Gross Tuition	As a Share of Net Tuition
25	1.554	58.446	97.4%	1.327	59.772	2.2%	85.4%
50	9.727	50.273	83.8%	6.620	56.893	11.0%	68.1%
75	19.926	40.074	66.8%	11.822	51.897	19.7%	59.3%
100	29.481	30.519	50.9%	15.765	46.284	26.3%	53.5%
125	37.542	22.458	37.4%	18.392	40.850	30.7%	49.0%
150	43.826	16.174	27.0%	19.601	35.775	32.7%	44.7%
175	48.459	11.541	19.2%	19.781	31.322	33.0%	40.8%
200	51.787	8.213	13.7%	19.139	27.352	31.9%	37.0%
400	59.353	0.647	1.1%	7.802	8.449	13.0%	13.1%

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 uniforma amount, regardless of income and assets.

Table 8

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

Initial Income	Baseline	$\rho = 0.99$	$\rho = 0.90$	$\sigma = 0.10$	$\gamma = 1$	$\gamma = 5$
25	5.3%	10.2%	2.6%	1.9%	2.0%	8.3%
50	19.1%	29.8%	10.9%	9.2%	7.2%	29.0%
75	29.7%	41.3%	18.7%	16.2%	11.6%	44.2%
100	34.7%	44.5%	23.9%	21.2%	14.2%	51.2%
125	36.2%	42.9%	25.9%	23.5%	15.0%	52.4%
150	35.2%	39.0%	25.2%	25.9%	14.7%	51.0%
175	33.1%	34.4%	26.4%	25.1%	15.5%	48.3%
200	30.6%	29.6%	24.9%	20.9%	14.8%	45.3%
400	11.3%	6.8%	1.8%	1.2%	2.6%	27.5%

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 9

Additional Aid Required to Compensate for Loss of EFC Formula -- Sensitivity Checks

Initial Income	Baseline	Replacement Rate = 25%	Replacement Rate = 75%	Income Growth = 0%	Initial Assets = $100,000	Tuition = $30,000	Delay College by 8 Years
25	5.3%	7.0%	4.4%	4.2%	7.2%	10.4%	9.1%
50	19.1%	21.7%	17.2%	16.3%	20.2%	30.9%	27.0%
75	29.7%	30.5%	28.6%	25.4%	29.3%	37.1%	36.4%
100	34.7%	32.4%	35.5%	29.3%	33.3%	35.0%	37.6%
125	36.2%	31.0%	38.5%	29.3%	34.1%	30.7%	35.1%
150	35.2%	28.5%	38.7%	27.5%	33.0%	26.2%	31.5%
175	33.1%	25.8%	37.2%	24.6%	31.0%	21.7%	28.0%
200	30.6%	22.9%	34.7%	21.5%	28.7%	18.0%	24.5%
400	11.3%	8.9%	12.6%	7.0%	10.9%	3.7%	8.4%

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

	Patient Household				Impatient Household			
Initial Income	Average EFC	New Average EFC	% Increase in Aid	AI Multiplier	Average EFC	New Average EFC	% Increase in Aid	AI Multiplier
25	3.958	4.365	-0.7%	2.05	1.503	1.445	0.1%	1.12
50	17.005	16.516	1.1%	1.52	9.470	8.962	1.0%	1.05
75	30.073	28.798	4.3%	1.41	19.784	18.816	2.4%	1.04
100	39.996	38.608	6.9%	1.35	29.424	28.275	3.8%	1.04
125	46.675	45.439	9.3%	1.31	37.225	36.224	4.4%	1.03
150	51.061	50.086	10.9%	1.28	43.151	42.403	4.4%	1.03
175	53.895	53.139	12.4%	1.24	47.721	47.175	4.4%	1.02
200	55.759	55.187	13.5%	1.22	51.097	50.704	4.4%	1.02
400	59.666	59.585	24.4%	1.09	59.258	59.250	1.1%	1.01

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.