NBER WORKING PAPER SERIES

DOES IT PAY, AT THE MARGIN, TO WORK AND SAVE? -- MEASURING EFFECTIVE MARGINAL TAXES ON AMERICANS' LABOR SUPPLY AND SAVING

Laurence J. Kotlikoff
David Rapson

Working Paper 12533
http://www.nber.org/papers/w12533

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2006

We thank Jane Gravelle, Alexi Sluchynsky, and Adam Looney for critical advice and comments. This paper builds and draws on Gokhale, Kotlikoff, and Sluchynsky (2002).

Does It Pay, at the Margin, to Work and Save? -- Measuring Effective Marginal Taxes on Americans' Labor Supply and Saving

Laurence J. Kotlikoff and David Rapson

NBER Working Paper No. 12533
December 2006
JEL No. H1,H2,H3

ABSTRACT

Building on Gokhale, Kotlikoff, and Sluchynsky's (2002) study of Americans' incentives to work full or part time, this paper uses ESPlanner, a life-cycle financial planning program, in conjunction with detailed modeling of transfer programs to determine a) total marginal net tax rates on current labor supply, b) total net marginal tax rates on life-cycle labor supply, c) total net marginal tax rates on saving, and d) the tax-arbitrage opportunities available from contributing to retirement accounts. In seeking to provide the most comprehensive analysis to date of fiscal incentives, the paper incorporates federal and state personal income taxes, the FICA payroll tax, federal and state corporate income taxes, federal and state sales and excise taxes, Social Security benefits, Medicare benefits, Medicaid benefits, Foods Stamps, welfare (TAFCD) benefits, and other transfer program benefits. The paper offers four main takeaways. First, thanks to the incredible complexity of the U.S. fiscal system, it's impossible for anyone to understand her incentive to work, save, or contribute to retirement accounts absent highly advanced computer technology and software. Second, the U.S. fiscal system provides most households with very strong reasons to limit their labor supply and saving. Third, the system offers very high-income young and middle aged households as well as most older households tremendous opportunities to arbitrage the tax system by contributing to retirement accounts. Fourth, the patterns by age and income of marginal net tax rates on earnings, marginal net tax rates on saving, and tax-arbitrage opportunities can be summarized with one word -- bizarre.

Laurence J. Kotlikoff
Department of Economics
Boston University
270 Bay State Road
Boston, MA 02215
and NBER
kotlikoff@bu.edu

David Rapson
Department of Economics
Boston University
270 Bay State Rd
Boston, MA 02215
rapson@bu.edu

I. Introduction

Households both want and need to understand the incentives they face at the margin for working and saving. Yet any American seeking to understand her total effective net marginal tax on either choice faces a daunting challenge. First, she needs to consider a host of taxes and transfers including federal personal income taxes, federal corporate income taxes, federal payroll taxes, federal excise taxes, state personal income taxes, state corporate income taxes, state sales taxes, state excise taxes, Social Security benefits, welfare benefits (TAFDC), Supplemental Security Income benefits (SSI), Medicaid benefits, Medicare benefit, food stamps, nutrition benefits (WIC), and energy assistance benefits (LIHEAP). Second, she needs to understand in very fine detail how each of these taxes and transfers is calculated. Third, she needs to understand the interactions of the different tax and transfer programs. Fourth, she needs to consider the fact that these taxes and transfers are paid and received over time. And fifth, she needs to have a method for translating all of these interconnected time-dated tax payments and benefit receipts into a simple and comprehensible statement of her marginal reward for working and saving.

This paper uses *ESPlanner*^{TM} (Economic Security Planner^{TM}) in conjunction with detailed modeling of non-Social Security transfer programs (*ESPlanner* incorporates Social Security) to generate total effective (net) marginal taxes on labor supply and saving for stylized American households. It also examines the tax arbitrage opportunity available to households from saving in either a) 401(k), traditional IRA, or other tax-deferred retirement accounts or b) Roth IRAs, Roth 401(k)s, or other Roth accounts.

The paper builds and draws on Gokhale, Kotlikoff, and Sluchynsky (2002) which

studied the incentives of Americans to work full or part time. That study showed that the overall tax/transfer system is progressive, particularly at the very low end of the earnings distribution, that all households face very high marginal taxes on the choice of working full or part time, that many low- and moderate-income households face substantially higher marginal taxes on working full or part time than do high-income households, and that many low-income households face confiscatory taxes on switching from full to part time work or from switching from full-time work by one spouse to full-time work by both spouses.

The value added of this paper relative to Gokhale, Kotlikoff, and Sluchynsky (2002) is that we consider the marginal net taxes on working extra hours in the current year, working extra hours throughout one's career, and increasing one's current saving. We also examine the tax arbitrage opportunity available to different households from contributing to a) 401(k), traditional IRA, or similar tax-deferred accounts or b) Roth IRAs, Roth 401(k)s, or other Roth accounts.

With the exception of certain very low-earning households, we find high to very high marginal net tax rates – ranging from 24 to 45 percent -- on current and life-cycle labor supply. These calculations are made at particular levels of pre-tax and pre-transfer earnings and are based on discrete increments in earnings. As we also demonstrate, marginal net tax rates on current and life-cycle labor supply are astronomical over much smaller increments in gross earnings at particular levels of earnings at which income and asset eligibility tests of particular tax and transfer programs become relevant.

The Congressional Budget Office's (2005) recent study of effective tax rates on labor supply reports much lower marginal rates, particularly for low-income households,

than those we report. The reason is that the CBO ignores transfer payments and federal and state sales and excise taxes.

At low incomes (when transfer benefits are often linked directly to income) our estimates of marginal effective rates are 80 to 100 percentage points higher than the CBO in some cases. For example, 60 year old couples earning $10,000/yr are within the EITC phase-in region, which results in a CBO estimated marginal rate of -40%. However, at this income they also face a one-for-one reduction in food stamps. After accounting for all of the relevant transfer programs, the resulting effective marginal rate is 50%, or 90 percentage points higher than the CBO estimate. Aside from these few extreme cases, the differences are smaller, but still substantial. Our estimates for low- to mid-income households are 30 to 50 points higher than the CBO, and 10 to 25 points higher for mid- to high-income households.

In addition to finding high to very high marginal net taxes on labor supply for virtually all American households, we also find high to very high marginal net tax rates on saving for most households. For some low-income households, we find astronomical net tax rates on saving; for these households higher saving means higher future assets and higher asset income, which can reduce eligibility for transfer payments via asset and income tests. Finally, we find huge arbitrage opportunities for particular households of particular ages and earnings levels from contributing to either tax-deferred retirement accounts or Roth IRAs, Roth 401(k)s, or other Roth accounts.

The paper provides four main takeaways. First, thanks to the incredible complexity of the U.S. fiscal system, it's essentially impossible for anyone to understand her incentive to work, save, or contribute to retirement accounts absent highly advanced

computer technology and software. Second, the U.S. fiscal system provides most households with very strong reasons to limit their labor supply and saving. Third, the system offers very high-income young and middle aged households as well as most older households tremendous opportunities to arbitrage the tax system by contributing to retirement accounts. Fourth, the patterns by age and income of marginal net tax rates on earnings, marginal net tax rates on saving, and tax-arbitrage opportunities can be summarized with one word – bizarre.

We proceed in section II by laying out our methods for measuring total marginal net taxes on working additional hours and on saving. Section III describes *ESPlanner* and its use in this paper. Section IV presents our stylized households. Section V presents results, and Section VI concludes.

II. Measuring Total Effective Marginal Tax Rates and the Tax Arbitrage Opportunities Afforded by Retirement Accounts

Economists measure the gain from extra work or saving in terms of its potential impact on consumption. The gain from extra current work is typically measured in terms of its *maximum* impact on current consumption. Thus, if a worker earns an extra $100 this year, permitting this year's consumption to rise, at most, by $50, we say the worker faces a 50 percent effective marginal tax on her labor supply. The terms "effective" reference marginal taxes paid net of marginal transfer payments received. Since a large component of some households' incomes, particular those of low income households, comes from government transfer programs, including such payments in the analysis of earnings and saving incentives is essential.

Of course working and earning more in the current year is just one potential margin of choice when it comes to expanding labor supply. We say "potential" because some workers may be in jobs in which the hours they work are pre-set by their employer and can't be changed. For such workers, the only way to adjust their annual hours worked is to switch jobs.

In this paper we calculate net marginal tax rates on working additional hours in just the current year. But we also determine the net marginal incentives associated with permanently adjusting annual hours worked by switching from a job with a low fixed-level of annual hours to one with a high fixed-level of annual hours. We refer to such a job change as an increase in *life-cycle* labor supply. To measure this net tax rate we compare the change in the present value lifetime income before any taxes and transfer payments arising from a uniform increase in annual hours (and earnings, since we consider fixed real wages per hour) to the change in the present value of lifetime spending permitted by this additional labor supply.

Our third marginal tax of interest is that on extra saving. The gain from extra saving can be measured in terms of the impact on future consumption of forgoing a fixed amount of current consumption. Consider, for example, a two-period (youth and old age) framework. In the absence of any effective marginal tax on saving, reducing current consumption when young by $100 would lead to an increase in consumption when old, measured in present value, of exactly $100. If consumption when old, measured in present value, rises by only $50, the saver faces a 50 percent marginal net tax on saving.[1]

Our analysis involves, of course, households that live for many years, not just two

1 Alternatively, we can say that the tax on future consumption is 100 percent since the price, measured in present value, of consuming $100 when old has risen from $50 to $100.

periods. When there is more than one period (more than one future year) in which to consume, there is no standard definition of the effective tax rate on saving. One could, for example, consider how much reducing this year's consumption by, say, $100 will increase the present value of future consumption spending assuming the additional future spending power is all allocated to next year's consumption. Alternatively, one could allocate all the future spending power to consumption 10 years out, or 20 years out, or in any future year one chooses. One could also spread the extra spending power uniformly over all future years. Each such choice will generate a different measure of the effective tax rate. The reason is that the longer one pushes out the allocation of the extra spending power, the higher will be the effective tax rate thanks to the nature of compounding.

Our response to this surfeit of computable saving tax rates is to present the saving rate associated with reducing current consumption and raising all future consumption levels by the same percentage. More precisely, we compare the present value increase in future spending that can be financed by a given reduction in current spending assuming that spending in each future year rises by the same percentage.

Our final goal is to illustrate the arbitrage opportunities available to households for saving in either a) 401(k), traditional IRA, or tax-deferred accounts or b) Roth IRAs, Roth 401(k)s, or other Roth accounts. As described below, we arrange this analysis such that one can directly compare the arbitrage the arbitrage opportunities from contribution to tax-deferred accounts with those from contributing to Roth IRAs, Roth 401(k)s, or other Roth accounts.

Accounting for Transfer Payments

Both marginal earnings and marginal saving can alter the amount of transfers received, which will, in turn, affect the calculation of effective tax rates. As is well known, marginal-transfer schedules are highly non-linear. For example, in Massachusetts – the state in which we assume our stylized households reside, a household is eligible to receive welfare (TAFDC) if its assets are below $2500. If this household currently receives welfare and holds $2499 in assets, an additional dollar saved will render it TAFDC-ineligible. As another example, consider a two-parent family that earns $25,736 per year in labor income and has two dependent children. In Massachusetts, this family is eligible to receive nearly $14,000 in transfers, most of which come from Medicaid.[2] Earning an additional dollar or, indeed, an extra penny, causes the family to lose Medicaid eligibility.

Accounting for government transfer programs in the estimation of tax rates raises three issues. One is simply their accurate measurement, which requires taking into account each program's eligibility, income, and asset tests. This is a significant undertaking given that *ESPlanner* does not compute transfer payments apart from Social Security benefits. As described in the Appendix, our transfer benefit calculator assesses household eligibility for each of the transfer programs and applies all applicable income and asset taxes in determining benefit levels.

The second issue is the fungibility of transfer payments. Certain benefits, like Medicare and Medicaid, are in-kind and must be consumed in the year received. Others, like TAFDC and, potentially, Food Stamps are fungible. Ideally, one would want to enter

2 In assuming that eligible households receive average benefits from transfer programs like Medicaid to particular households we are ignoring the insurance value of these programs

fungible benefits as special receipts in *ESPlanner* and treat non-fungible benefits as consumption in the year they are received. But given the time involved in entering a large number of fungible special receipts in a large number of *ESPlanner* profiles, we opted to treat all transfer payments as non-fungible, i.e., as consumed in the year they are received.

A third challenge in incorporating transfer payments is identifying the precise point at which marginal net tax rates spike. As is well known, marginal net tax rates can be extremely high at certain levels of earnings and saving because of the discontinuous nature of tax and transfer schedules.[3] The examples just sighted in which earning extra penny of income trigger major losses in TAFCD and Medicaid benefits are cases in point. Identifying these spikes requires considering very small increments in earnings and saving in the range of earnings and saving where such spikes are known to occur. Our initial analysis uses discreet increments equal to the maximum of $100 or 1 percent of earnings to determine the general pattern of labor supply incentives. We then consider much smaller increments to determine precisely where marginal net tax rates spike.

Calculating Marginal Net Taxes on Current Labor Supply

To calculate marginal net tax rates on current labor supply we simply calculate the marginal income net of taxes and gross of transfer payments that would be generated from earning additional income in the current year and then assume this additional net income is spent in the current year.[4] To determine how much current net income rises for

3 If one could earn infinitesimal amounts, effective marginal net tax rates in these cases would be infinite. But since the smallest increment one can earn is a penny, effective marginal net tax rates, while potentially extremely high, are finite.

4 In maintaining fixed current saving, we're ensuring no change in future incomes and transfer payments

a given increment in current earnings, we run each of our stylized households through *ESPlanner* as well as through our annual transfer benefit calculator twice – first, based on their initial levels of earnings and then based on an incremented level of earnings.

Equation (1) provides a formula for the our net tax rate, τ_c, on current labor supply. In the formula, ΔE stands for the change in current-year labor earnings, ΔT for the change in current-year taxes, ΔX for the change in current-year transfer payments received, θ_s for the state sales tax, and θ_e for the rate of federal excise taxation.[5]

$$(1) \qquad \tau_c = 1 - \frac{\Delta E - \Delta T + \Delta X}{(1 + \theta_s + \theta_e)\Delta E}.$$

Note that the standard formula for the net tax rate on labor supply is $\tau_c = \frac{\Delta T - \Delta X}{\Delta E}$. But the standard formula ignores sales and excise taxes; i.e., it treats both θ_s and θ_e as equaling zero. This is clearly inappropriate since sales and excise taxes, like income and payroll taxes, limit the amount of actual consumption (not consumption expenditure) a worker can enjoy by working more and earning more income.[6] Dividing the change in expenditure associated with additional earnings ($\Delta E - \Delta T - \Delta X$) by the sales- and excise-tax inclusive consumer price of a dollar of expenditure, $(1 + \theta_s + \theta_e)$, determines how

---

with one exception – future Social Security benefits. These benefits are potentially changed due to the presence of higher current earnings in the worker's ultimate earnings record. Including the impact of these Social Security benefit changes on current consumption is a goal of our future research. However, it's important to bear in mind that Social Security benefit changes, to the extent they arise, can only influence current spending insofar as the worker (or household to which the worker belongs) is not liquidity constrained. Many of our stylized households are so constrained.

5 The sales tax in Massachusetts is 5%, and the federal excise tax accounts for approximately 0.9% of aggregate consumption in the U.S. Hence, we set $\theta_s = 0.05$ and $\theta_e = 0.009$.

6 Sales and excise taxes also represent taxes on wealth since, like earnings, when wealth is spent, the spender pays these taxes and ends up getting less actual consumption than would otherwise be the case.

much actual consumption a worker ends up with if she increases her earnings by ΔE.[7]

Calculating Marginal Net Taxes on Life-Cycle Labor Supply

We define the net marginal tax on life-cycle labor supply, τ_l, in (2).

$$(2) \qquad \tau_l = 1 - \frac{PV\Delta C}{(1+\theta_s+\theta_e)PV\Delta E},$$

where *PV⊿C* denotes the change in the present value of total consumption and other "off-the-top" spending (on housing, insurance premiums, and special expenditures) and *PV⊿E* denotes the change in the present value of lifetime earnings arising from a uniform increase in annual earnings. As discussed in more detail shortly, the discount rate used to form these present values is the return before both corporate and individual taxes.

To calculate *PV⊿C* we a) use *ESPlanner* to calculate the present value of total spending (consumption spending, housing spending, special expenditures, and insurance premiums) given base-case annual earnings and b) add to this present value of total spending the present value of transfer payments accruing to the household given *ESPlanner's* calculated annual time path of annual total income and assets. Next we increase annual household earnings by a fixed amount each year (specifically, 1 percent of each household's assumed fixed annual real earnings) through retirement and use *ESPlanner* plus our transfer calculator to obtain new present values of remaining lifetime earnings and total spending. Differencing the new and previously derived present values of total spending provides the numerator in (2). The denominator is determined by

7 In a static setting a worker's budget constraint is $(1+\theta_s+\theta_e)C = w(1-\tau)$, where τ is the sum of income and payroll tax rates and w is the pre-tax wage. But one can rewrite this constraint as $C = w(1-\tau)/(1+\theta_s+\theta_e)$. Letting τ^e stand for the effective tax rate on labor supply, we have $C = w(1-\tau^e)$, where $\tau^e = 1 - (1-\tau)/(1+\theta_s+\theta_e)$, which is the same as equation (1).

simply forming the present value of annual increases in pre-tax and pre-transfer payments earnings.

Since *ESPlanner* smooths households' living standards subject to borrowing constraints, it will spend extra earnings in a given year on consumption in all years provided doing so does not violate the user-specified limit on borrow. For purposes of calculating τ_l we specify this limit at zero. To the extent that borrowing constraints permit, *ESPlanner* will freely spend in one year earnings generated in another. In so doing, the program will alter the time path of regular asset, regular asset income, and taxes levied on regular asset income. Hence, our tax rate τ_l on life-cycle earnings will pick up more than simply taxes levied on earnings. It will also capture marginal taxation of saving. Thus, we don't claim τ_l to represent solely a marginal net tax on life-cycle earnings, but rather a marginal net tax on increased annual earnings that is then subject to as much consumption smoothing as possible.[8]

Calculating Effective Marginal Taxes on Regular Saving

As indicated, we measure the effective tax rate on saving assuming that the reduction in 2005 spending is allocated uniformly to all future periods such that the living standard in all future periods rises by the same percentage. To effect this outcome in *ESPlanner* we do two things. First, we permit all our stylized households to borrow as much as the need in order to fully smooth their living standards as well as to use

8 Roughly two-thirds of young American households appear to be liquidity constrained (see Kotlikoff, Marx, and Rizza, 2006). This doesn't necessarily mean that they have zero current fungible assets. Instead it means that their living standard per person in the future will be higher than it is in the present and that whatever saving they are doing is for purposes of smoothing their living standards in the short or medium runs. Like typical young households, all but the highest earning of our stylized young households are liquidity constrained.

additional current saving to effect a uniform rise in their future living standards.[9] Second, we raise the program's living standard index for all years from 2006 onward by 10 percent and compared the increase in the present value of consumption spending from 2006 onward with the associated reduction in consumption spending in 2005. This second step leads the program to lower current consumption spending, while increasing future consumption spending each year by the same percentage, thus effecting a uniform rise in living standard in all future years.

The discount rate used to determine the present value change in future consumption, all measured in 2005 dollars, is 7.0 percent, which is our assumed pre- all taxes real rate of return. This pre-tax return is the return one would receive before the application of any federal and state personal or corporate income taxes. In using this return, we are, in effect, incorporating marginal effective corporate capital income taxes as well as marginal effective personal capital income taxes.

To see why one needs to discount at the pre- all taxes return, consider a two-period framework with lifetime household budget constraint given by

$$(3) \qquad c_y + c_o/(1+r) = e_y + e_o/(1+r) - T_y - T_o/(1+r).$$

The return r is pre all taxes. The terms c_y and c_o stand for consumption when young and old. The terms e_y, e_o, T_y, and T_c stand, respectively, for pre-tax earnings when young, pre-tax earnings when old, net taxes paid when young, and net taxes paid when old. Net taxes here are comprehensive; for example, taxes when old include, in the U.S. context, corporate income taxes, personal capital income taxes, personal labor income taxes, state

9 In assuming that all of our stylized households are able to borrow, we don't mean to suggest that such borrowing is feasible. Instead, we seek to understand how our tax-transfer system affects the incentive to save were households actually able to do so.

income taxes, payroll taxes, sales taxes, and excise taxes net of all manner of available transfer payments.

Consumption, earnings, and taxes when old are discounted at rate *r*. For a given reduction in current consumption equal, say, to Δc_y, the marginal net tax rate on saving, τ_s, is given by

$$(4) \qquad \tau_s = \frac{\Delta T_y + \Delta T_o/(1+r)}{\Delta c_y}.$$

The formula for τ_s tells us the percentage degree to which the present value of future consumption, $\Delta c_o/(1+r)$, fails to rise by the same amount (in absolute value) that current consumption falls; i.e., were τ_s to equal zero, $\Delta c_o/(1+r)$ would equal - Δc_y according to (3) under our assumption that $e_y + e_o/(1+r)$ don't change.

Note that if one knows *r* and the value of Δc_o, one can compute $\frac{\Delta T_y + \Delta T_o/(1+r)}{\Delta c_y}$ by calculating $\frac{\Delta c_o/(1+r)}{-\Delta c_y}$ and subtracting *1* from the resulting ratio.

Now we know *r*, but how do we determine Δc_o? For purposes of this study, the answer is that we use *ESPlanner* to determine Δc_o (actually, the change in each future year's consumption).

To be clear, *ESPlanner* is operating not off the budget constraint (3), but off the following budget constraint,

$$(4) \qquad c_y + c_o/(1+r^n) = e_y + e_o/(1+r^n) - T_y - T_o^n/(1+r),$$

where r^n is the return households earn pre-individual capital income taxes, but post corporate income taxes and T^n_o are individual income taxes paid when old (i.e., T^n_o does not include corporate income tax payments). Given the assumed linearity of the

corporate income tax, the two budget constraints (3) and (4) are mutually consistent, so there is no problem using (4) to determine Δc_o and then plugging this amount into the formula 1 - $\Delta c_o/(1+r)/$ - Δc_y to form the desired marginal net tax rate on saving. To see this, write $r^n = r(1- \tau_c)$, where τ_c is the corporate income tax rate. If one substitutes this expression for r^n in (4) and notes that $T_o - T^n_o = (e_o - T_y - c_y)\, r\, \tau_c$ (i.e., the two variables differ by the amount of the corporate tax revenue), one arrives at (3).

Return Assumptions Used in Running ESPlanner

In running ESPlanner we enter an 8.33 percent nominal rate of return. Given our 3 percent inflation rate assumption, this translates into a 5.17 percent post-corporate tax real return.[10] We use a 7.0 percent real pre-corporate tax rate of rate (the r in equation (3)) to do the discounting needed to form tax rates on life-cycle labor supply and saving. We arrived at these values based on consultations with Jane Gravelle.

Assessing the Tax-Arbitrage Opportunities in Contributing to Retirement Accounts

So far we've considered only marginal net taxation of regular saving. But much of household saving is currently being done within either 401(k) and other tax-deferred retirement accounts or within Roth IRAs, Roth 401(k)s, or other Roth accounts. Contributing to these accounts does not, however, necessarily entail any reduction in current consumption. Indeed, contributing to these accounts represents a tax arbitrage opportunity if, as we've been assuming, households are not liquidity constrained.

To assess these tax-arbitrage opportunities we measure the increase in the present value of all consumption -- current as well as future – per net dollar contributed to either

10 The formula for the real return is actually (1+i)/(1+π)-1.

type of retirement account. The "net" in "per net dollar" refers to the contribution net of current taxes saved. Thus, if we have a household contribute X to a 401(k) account and it saves the household Y in current taxes, we define the net dollar contribution to be X–Y. This is the amount by which the household's liquid assets are reduced by the transactions. Since Roth contributions are made before tax and do not affect current taxable income, we consider contributions of size X-Y in order to maintain comparability with respect to our analysis of contributions to tax-deferred accounts.

Our analysis here does not include any marginal employer matching contribution. The reason is that we want to understand the pure tax arbitrage incentives presented by retirement "saving" as opposed to the incentive to "save" in retirement accounts presented by employers.

III. Using *ESPlanner* to Measure Total Effective Marginal Tax Rates

The methods discussed above to calculate marginal net taxes on life-cycle labor supply and on saving require the use of a dynamic life-cycle model that jointly calculates all future taxes and transfer payments. *ESPlanner* is clearly one such model. It determines a household's highest sustainable living standard within each non-liquidity constrained interval of its life and the consumption, saving, and term life insurance holdings needed to smooth the household's living standard within each non-constrained interval. The program uses dynamic programming in forming its recommendations. Dynamic programming is needed to deal both with potential borrowing constraints and with non-negativity constraints on life insurance holdings.

The program takes into account the following user-specified inputs: the

household's state of residence, current and future planned children and their years of birth, current and future regular and self-employment earnings, current and future special expenditures and receipts (as well as their tax status), current and future levels of a reserve fund, current regular and retirement account balances, current and future own and employer contributions to retirement accounts (with Roth account contributions treated separately), current and future primary and vacation home values, mortgages, rental expenses, and other housing expenditures, current and future states of residence, ages of retirement account withdrawals, ages of initial Social Security benefit receipt, past and future covered Social Security earnings, desired funeral expenses and bequests, current regular saving and life insurance holdings, the economies of shared living, the relative cost of children, the extent of future changes in Social Security benefits, the extent of future changes in federal income taxes, FICA taxes, and state income taxes, current and future pension and annuities (including lump sum and survivor benefits), the degree to which the household will annuitize its retirement account assets, and values of future earnings, special expenditures, receipts, and other variables in survivor states in which either the head or her spouse/partner is deceased.

The living standard of members of a household is defined by *ESPlanner* as the amount of consumption expenditure an adult would need to make to enjoy as a single person with no children the same living standard she enjoys in the household. The equation relating a household's living standard per member to its total consumption expenditure takes into account economies in shared living and the relative cost of children.[11] Consumption expenditure is defined by *ESPlanner* as all expenditures apart

11 Let C stand for a household's total consumption expenditure, s for its living standard per equivalent adult, k_i for the number of children age i, θ_i for relative cost of a child age i, N for the number of adults, and

from special expenditures, such as college tuition for children, housing expenditures, taxes, life insurance premiums, regular saving, and contributions to retirement accounts.

ESPlanner's Tax Calculations

ESPlanner makes highly detailed federal income, FICA, and state-specific income tax as well as Social Security benefit calculations. These tax and benefit levels are the only non-user specified variables influencing the program's consumption smoothing calculations.

The program's federal and state income-tax calculators determine whether the household should itemize its deductions, compute deductions and exemptions, deduct from taxable income contributions to tax-deferred retirement accounts, include in taxable income withdrawals from such accounts as well as the taxable component of Social Security benefits, check, in the case of federal income taxes, for Alternative Minimum Tax liability, and calculate total tax liabilities after all applicable refundable and non-refundable tax credits including the Earned Income Tax Credit, the Child Credit, and the Saver's credit. These federal and state tax calculations are made separately for each year that the couple is alive as well as for each year a survivor may be alive.

Given the non-linearity of tax functions, one can't determine a household's tax rates in future years without knowing its regular asset and other taxable income in those years. But one can't determine how much a household will consume and save and thus have in asset income in future years without knowing the household's future taxes. Hence, there is a chicken and egg problem -- a simultaneity problem -- that needs to be

---

v for the degree of economies of shared living. The relationship between C and s in a given year is $C = s(N + \Sigma\theta_i k_i)^v$.

resolved to make sure that consumption and saving decisions are consistent with the future tax payments they help engender.

ESPlanner's Social Security Benefit Calculations

In determining Social Security benefits the program takes full account of the earnings test, early retirement reduction factors, the delayed retirement credit, the re-computation of benefits, the family benefit maximum, the phase-in to the system's ultimate age-67 normal retirement age, as well as offset and windfall elimination provisions.

ESPlanner's survivor tax and benefit calculations for surviving wives (husbands) are made separately for each possible date of death of the husband (wife). I.e., *ESPlanner* considers separately each date the husband (wife) might die and calculates the taxes and benefits a surviving wife (husband) and her (his) children would receive each year thereafter. Moreover, in calculating survivor-state specific retirement, survivor, mother, father, and child dependent and survivor Social Security benefits, *ESPlanner* takes account of all the just-mentioned benefit adjustment factors.

Checking the Calculations

Each component of *ESPlanner's* tax code and transfer calculator, whether it be the basics of the 1040 form, the provisions of the Earned Income Tax Credit, the details of the Alternative Minimum Tax, the tax treatment of housing capital gains, the taxation of Social Security benefits, the TAFDC earnings test, the payment in the case of low-income households of Medicare premiums by Medicaid, etc. -- has been rigorously

checked on a component by component basis. This is not to say that no bugs were found. On the contrary, a goodly number were found thanks to independent checking over the years by three software engineers and four economists as well as a large number of *ESPlanner* users, including professional financial planners, who have examined the tax and Social Security benefit calculations with extremely sharp eyes.[12]

ESPlanner's Algorithm

ESPlanner generates recommended levels of annual consumption expenditure, saving, and term life insurance holdings. All recommendations are presented in today's dollars. Consumption in this context is everything the household gets to spend after paying for its "off-the-top" expenditures – its housing expenses, special expenditures, life insurance premiums, special bequests, taxes, and net contributions to tax-favored accounts. Given the household's demographic information, preferences, borrowing constraints, and non-negativity constraints on life insurance, *ESPlanner* calculates the highest sustainable and smoothest possible living standard over time, leaving the household with zero terminal assets (apart from the equity in homes that the user has chosen not to sell) if either the household head, her spouse/partner, or both live to their maximum ages of life.

12 Indeed, in the case of Social Security benefit calculations, a number of individual users and financial planners have double checked *ESPlanner's* Social Security's benefit calculations with those produced by Social Security Administration's detailed ANYPIA calculator. A number have complained that *ESPlanner's* calculated benefits were too high. As they were told, *ESPlanner's* benefit projections accord precisely with those of the ANYPIA calculator in the case of users whose covered earnings all lie in the past. But in the case of users with projected future covered earnings, *ESPlanner's* projection of future benefits differ from the ANYPIA's projection for a simple reason. The ANYPIA calculator assumes no future rise in the U.S. price level and no future real wage growth. This seems remarkable until one realizes that the government doesn't want to be in a position of implicitly promising higher benefits than it knows for sure it will pay.

The amount of recommended consumption expenditures needed to achieve a given living standard varies from year to year in response to changes in the household's composition. Moreover, the relationship between consumption and living standard in a given year is non-linear for two reasons. First, a non-linear function governs the program's assumed economies of shared living, with the function depending on the number of equivalent adults. Second, the program permits users to specify that children are less or more expensive than adults in terms of delivering a given living standard. The default setting is that a child is 70 percent as expensive as an adult. Hence a household with 2 adults and 2 children is specified, under the default assumptions, to entail 3.4 equivalent adults.

The program's recommended consumption also rises when the household moves from a situation of being liquidity constrained to one of being unconstrained. Finally, recommended household consumption will change over time if users intentionally specify, via the program's standard of living index, that they want their living standard to change.

Dealing with the simultaneity issues as well as the borrowing and non-negative life insurance constraints all within a single dynamic program appears impossible given the large number of state variables such an approach entails.[13] To overcome this

13 The simultaneity issue with respect to taxes mentioned above is just one of two such issues that need to be considered. The second is the joint determination of life insurance holdings of potential decedents and survivors. *ESPlanner* recognizes that widows and widowers may need to hold life insurance in order to protect their children's living standard through adulthood and to cover bequests, funeral expenses, and debts (including mortgages) that exceed the survivor's net worth inclusive of the equity on her/his house. Accordingly, the software calculates these life insurance requirements and reports them in its survivor reports. However, the more life insurance is purchased by the potential decedent, the less life insurance survivors will need to purchase, assuming they have such a need. But this means survivors will pay less in life insurance premiums and have less need for insurance protection from their decedent spouse/partner. Hence, one can't determine the potential decedent's life insurance holdings until one determines the survivor's holdings. But one can't determine the survivor's holdings until one determines the decedent's holdings.

problem, *ESPlanner* uses an iterative method of dynamic programming. Specifically, the program has two dynamic programs that pass data to one another on an iterative basis until they both converge to a single mutually consistent solution to many decimal points of accuracy.

One program takes age-specific life insurance premium payments as given and calculates the household's consumption smoothing conditional on these payments. The other program takes the output of this consumption smoothing program -- the living standard in each year that needs to be protected – as given. This second program calculates how much life insurance is needed by both potential decedents and their surviving spouses/partners.

This iterative procedure also deals with our two simultaneity issues. The trick here is to form initial guesses of future taxes and survivor life insurance holdings and update these guesses across successive iterations based on values of these variables endogenously generated by the program in the previous iteration. When the program concludes its calculations, current spending is fully consistent with future taxes and vice versa, and the recommended life insurance holdings of heads and spouses/partners are fully consistent with the recommended life insurance holdings of survivors.

Accounting for Employer-Paid FICA Taxes and Corporate Income Taxes

Since users enter their earnings net of employer-paid FICA taxes *ESPlanner* does not explicitly calculate these taxes. Nor does it explicitly calculate corporate income taxes since users enter their expected returns net of such taxes. From an economics perspective, employer-paid payroll taxes are no less of a burden or a work or saving

disincentive than are those paid directly by employees. Indeed, there is only one economic difference between employer-paid and employee-paid payroll taxes; employer-paid payroll taxes are excludable from the calculation of adjusted gross income in determining federal personal income tax liability, whereas employee-paid payroll taxes are not.

Our procedure for including the employer FICA tax is to input into *ESPlanner* a given increase in earnings, say X (where X is either an increase in current earnings or an increase in the present value of future earnings), and compare the associated increase in spending not with X, but with X plus the additional FICA tax paid on X. This sum represents the full pre-tax compensation being paid to the household.

Like employer-paid payroll taxes, corporate income taxes, both federal and state, also reduce the return to input suppliers. But unlike payroll taxes, where the input supply is labor, the input supply relevant to the corporate income tax is household saving. This saving helps finance corporations, and when corporations have to pay taxes, they can't pay as high a return to their investors. To capture this discrepancy between the pre- and post-corporate tax rates of return, we use the pre-corporate tax discussed above in all the discounting used to form present values. However, in actually running *ESPlanner*, we enter the post-corporate return as an input in the program since, to repeat, *ESPlanner* doesn't calculate corporate taxes.

Non-Social Security Transfers

As indicated, our transfer calculator determines the level of benefits of seven

government programs available to residents of Massachusetts: Transitional Aid to Families with Dependent Children (TAFDC), Supplemental Security Income (SSI), Food Stamps, Special Supplemental Nutrition Program for Women with Infants and Children (WIC), Medicare, Medicaid, and Low Income Home Energy Assistance Program (LIHEAP). For each year of potential life of our stylized households, we consider whether the household is eligible for the transfer based on it demographics, income, and assets and, if eligible, compute the appropriate benefit level taking into account any relevant earnings and asset tests. These provisions can include earnings deductions, net income adjustments (such as non-reimbursed out-of-pocket medical expenses), child deductions, and housing deductions. Often the earnings tests are tied explicitly to the federal poverty lines, which vary by the number of household members.

IV. Our Stylized Households

Our stylized households consist of either single individuals or married couples, whose spouses are the same age. We consider households age 30, 45, and 60. Both the single-headed households and the married households have two children to whom they gave birth at ages 27 and 29. Table 1 lists key assumptions about the seven single and seven married households we consider. The single households have initial labor earnings ranging from $0 to $250,000. For the married couples, the spread is double that of the singles, i.e., it ranges from $0 to $500,000. All household heads and spouses retire and start collecting Social Security benefits at age 65. Earnings between the household's current (2005) age and retirement at the beginning of age 65 are assumed to remain fixed in real terms.

Each household is assumed to have a home, a mortgage, and non-mortgage housing expenses. The 30 year-old households have initial assets equal to a quarter of a year's earnings. The older households are assumed to have the same assets that *ESPlanner* determines the 30 year-olds to have at the age at which we consider the older households. The households are also assumed to incur non-housing expenses, the most significant component of which is annual college tuition. For ease of implementation, and to avoid unrealistic profiles, tuition is assumed to be a quarter of a year's earnings, subject to a ceiling of $50,000 per child. The households pay these amounts each year for four years for each child when the child is age 19 to 22.

The final assumption to discuss concerns longevity. The default assumption in *ESPlanner* is that users have maximum ages of life of 100. Since the program is focused on economic security, this seems appropriate; users may live this long and need to plan for this eventuality. But for purposes of understanding the marginal net taxes households pay, on average, the appropriate longevity assumption is expected, rather than maximum lifespan. Hence, for this analysis, we run the stylized households through *ESPlanner* under the assumption that household heads and their spouses or partners live to age 85. This is greater than current life expectancy at birth, but seems appropriate given that we are considering households age 30, 45, and 60.

V. Results

Tables 2 and 3 present our calculated marginal net tax rates on current labor supply for couples and singles, respectively. The increment we consider in current earnings is the maximum of $100 or 1 percent of current earnings. Consequently, the

marginal net tax rates we compute are relative to this increment. We discuss below marginal net tax rates over 1 penny increments in earnings.

The first impression one gets from glancing at these tables is that marginal rates calculated with respect to the aforementioned discrete earnings increments are either moderate or high for essentially all households except for very low-earning young and middle age couples as well as middle aged singles. For all households with $20,000 or more in annual earnings, marginal net tax rates range from 24 percent to 45 percent.

The relationship of marginal rates to income is anything but monotonic in earnings. Nor does it take on the U-shaped pattern suggested by optimal income tax theory (see Diamond, 1998). Take couples age 30. The marginal rate is –14 percent at $10,000 in earnings, 42 percent at $20,000, 24 percent at $50,000, 37 percent at $75,000, 46 percent at $150,000, 37 percent at $200,000, and 44 percent at $500,000.

In addition to anomalous patterns of marginal rates with income, holding age constant, there are also unusual patterns with respect to age, holding income fixed. Take singles earning $10,000. Thirty-year old members of this group face a marginal net tax rate of 72 percent. Were they age 45, their marginal rate would be –10 percent. And were they 60, their marginal rate would be 39 percent. As another example of the surprising relationships between age and marginal rates, note that rates fall with age for couples with $30,000 in earnings, but rise with age for couples with $75,000 in earnings.

Explaining Patterns of Work Incentives by Age and Earnings

How does one make sense of these findings? Well, the size of each marginal net tax rate is easily traced to underlying marginal changes in particular taxes or transfer

payments. Take, for example, married households age 30 that earn $10,000 per year. Their –14 percent net tax rate reflects the major marginal subsidy being provided to them by the Earned Income Tax Credit; this subsidy significantly exceeds the marginal payroll and sales and excise taxes they pay on additional earnings.[14] If this same household were to earn $20,000, rather than $10,000, its marginal net tax rate would be 42 percent rather than -14 percent. The reason is that at this higher earnings level, the EITC is being clawed back at a rate of more than 20 cents on the dollar. In addition, the household pays, at the margin, FICA and state income taxes and also gets hit by sales and excise taxes.

Next consider the $10,000 couple, but at age 60. Unlike their younger counterparts, this couple is no longer eligible for the EITC because it no longer has young children and its earnings exceed the income cutoff. On the other hand, the couple does receive Food Stamps. But because it has no young children, the couple is in the Food Stamps claw back range, where it loses 24 cents in Food Stamps per dollar earned. This marginal tax in conjunction with the 15.3 employer and employee FICA, the Massachusetts 5.3 percent income tax, the Massachusetts 5.0 percent sales tax, and the .9 percent assumed federal excise tax rate delivers a net marginal rate of 51 percent.[15]

As a third example of one's ability to precisely trace the anomalous nature of these marginal net taxes, consider 30 year old singles who earn only $10,000 per year. Unlike their married counterparts who face a 14 percent subsidy on additional current earnings, these single households face a 72 percent marginal net tax. The major difference between the two cases involves the clawback of TADFC. Because the single

14 This household pays no state income tax at the margin.

15 To be clear, there are interactions in the separate marginal net tax provisions, so these rates are not simply additive for this or any other household.

household's family size is smaller, it faces the TADFC clawback of 100 cents on the dollar when it earns $10,000, whereas the married household faces this effective marginal tax only at a higher earnings level.

Surprisingly, if the $10,000 single household is age 45 rather than age 30, the marginal net tax is –10 percent rather than 72 percent. What explains this huge difference? The answer has to do with the TAFDC benefit. Because the 45 year-old single household has older children, it no longer qualifies for the TAFDC daycare allowance or, consequently, any TAFDC benefits. At the margin it therefore faces no TAFDC clawback tax. On the other hand, its earnings are so low that it's in the Earned Income Tax Credit's positive subsidy range. This subsidy is sufficiently high to produce a negative net marginal tax on labor supply notwithstanding the state, FICA, sales, and excise taxes this household must pay on marginal earnings.

If we advance this household's age by another 15 years and consider it at age 60, we find it again faces a very high, positive marginal net tax, in this case 39 percent. Because this household's children are now grown, it finds itself in the EITC clawback range, which contributes significantly to the total net marginal tax it faces.

Tracing each household's marginal net tax on supplying more current earnings is one thing. Understanding why anyone would intentionally design a fiscal system with such a bizarre pattern of work incentives by age and earnings is another. The explanation is that these patterns are unintended. Indeed, for federal and state government officials to have intentionally designed these incentives would have required them to know what they were doing. But, to our understanding, this is the very first study to have incorporated *all*

of the major federal and state tax-transfer programs.[16] Thus, those who designed this sausage could literally not have known what they were doing.

But why didn't they try to find out? The answer is that no single government body is responsible for the overall structure of our fiscal incentives. Instead, the twenty or so major tax-transfer programs/provisions that combine to produce these bizarre incentives are being set by various federal and state governmental committees/bodies each of whom ignore, for the most part, the workings of the others and focus only on the details of the program/provision over which they have responsibility.

Marginal Net Tax Rates on Life-Cycle Labor Supply

Table 4 presents marginal life-cycle net tax rates for our 30-year old households. In these calculations, the increment in annual earnings is the maximum of $100 or 1 percent of each year's earnings. First consider couples. Their net tax rates are generally similar to the current marginal tax rates reported in Table 2 for 30 year-old couples. The main differences occur at $10,000, $50,000, and $500,000 in income. At these income rates the life-cycle net tax rates are significantly higher than the current-year rates. This is not to suggestion that life-cycle rates are always higher for given income levels. There are several income levels in tables 2 and 4 at which the life-cycle rates are lower.

For single households age 30, life-cycle and current-year marginal rates are very different for earnings below $125,000, but quite similar at that level of earnings and above. Take the $10,000 earnings case. The current-year marginal net tax rate is 72

16 To its credit, the Congressional Budget Office has been providing Congress with detailed studies of marginal effective federal income tax rates. But Congressional Budget Office (2005) and prior studies do not include state income taxes, sales or excise taxes, or any of the seven major transfer programs included here. Moreover, these studies do not use a dynamic/intertemporal model and, consequently, can not address saving or life-cycle labor supply incentives.

percent, whereas the life-cycle rate is only 2 percent. At $75,000 in earnings, the life-cycle rate is 76 percent, whereas the current-year rate is 37 percent. Part of what is going on here is that low-income households that are eligible for Medicaid, TAFDC, and other welfare benefits in the current year will not be receiving these benefits throughout their lives because of changes in their household demographics and levels of non-labor income.

Budget Constraints

Now that we've provided a broad brush overview of marginal net tax rates measured over discrete intervals, we turn to a more detailed analysis of the highly non-linear and complex budget constraints facing typical earners. The figures at the end of the paper show current year and lifetime budget constraints. The current year budget constraints relate current year net income to current year gross income. The slope of this constraint determines the current year marginal net tax rate. The lifetime budget constraints show how the present value of lifetime spending varies with annual real earnings, where we're assuming the same annual earnings in all years of work.[17] The slope of this budget constraint determines what we've been referring to as the life-cycle marginal net tax rate. We also present figures indicating marginal net tax rates on current labor supply as well as the marginal net tax rates on life-cycle labor supply confronting 30 year-old households.

Take, as an example, the figure relating current net income to current gross income for 45 year-old couples. And consider a $25,000 initial total household earnings

17 The present value of lifetime spending includes here the present value of non-Social Security transfer payments, which, to recall, we are treating as being consumed/spent in the year received.

level, which is close to what the head and spouse would collectively earn were they to work full time at the minimum wage. This income places the couple about 30 percent above the federal poverty line, but is low enough that the whole family is eligible for Medicaid benefits in Massachusetts. Recall that this household has two dependent children, both of whom are college bound. It also has a $75,000 house with a fifteen year remaining mortgage whose balance is just over $30,000.

Because of the Earned Income Tax Credit (EITC), Medicaid, and other benefits provided by federal and state transfer programs, this household has net income of just over $40,000 per year. If the couple earns additional wage income, several things will happen. First, every additional dollar earned will generate a clawback of the EITC at the rate of 21 cents per dollar earned. More importantly, if the couple earns enough additional income, it will lose eligibility for roughly $15,000 in Medicaid benefits. The figure showing marginal net tax rates levied on this household's current labor supply identify where these rates become extremely high. This occurs at points where the households' incomes exceed income-test thresholds for the various transfer programs.

One way to appreciate the size of work disincentives facing this household is to ask how much more it must earn, after losing all its benefits, to achieve the same living standard it enjoys when earning $25,000 and receiving all its benefits. The answer is roughly $50,000. I.e., the couple has to double its earnings simply to break even with respect to maintaining its living standard. Such high net taxes apply to all low-income households, regardless of age or marital status.

The life-cycle labor supply budget figures as well as their associate marginal net tax-rate diagrams also indicate kinks and high rates of marginal net taxes but these kinks

and high rates don't necessarily line up with those associated with current labor supply. These life-cycle figures tell us not just about the incentives to work more each year, but also about the incentives to take costly steps, such as enhancing one's education or switching to a more demanding job, that will raise one's annual earnings for a given level of labor supply by raising one's hourly wage rate.

To further appreciate the nature of life-cycle labor supply disincentives, consider our 60 year-old couple earning only $10,000. For this couple earning $55,000 a year for the duration of its working life is only marginally better than earning $10,000. The $10,000/yr household has remaining lifetime spending of $473,000 whereas the $55,000/yr household will spend $480,000. As can be seen in the figure below, all households with incomes between $10,000 and $55,000 will have lower remaining lifetime spending than the $10,000 household. The reason is simple: between $12,000 and $13,000/yr in income, the couple loses its Medicaid benefits in retirement, thanks to the Medicaid asset test, and between $17,000 and $18,000/yr in income it loses Medicaid benefits from age 60-65. These losses (which occur every year between age 60 and death) amount to hundreds of thousands of dollars in present value.

Younger households face similar life-cycle budget constraints, but the life-cycle labor supply disincentives are considerably smaller. This is because Medicaid expenditures comprise a larger fraction of remaining lifetime consumption at age 60 than age 30 or 45. Discounting these future losses to present value and recognizing that younger couples have far more years of working over which to make up the transfer losses makes clear why younger households are not as adversely affected. For 30 year old couples and singles, they must earn $10,000 to $15,000/yr more to overcome their loss of

Medicaid when it occurs; 45 year olds must earn $15,000-25,000/yr more; and, to repeat, 60 year olds must earn $25,000-$45,000/yr more.

Measuring Marginal Net Taxes on Saving

Tables 5 and 6 present our marginal net tax rates on regular and retirement account saving by age and earnings levels. The increment in current saving we consider ranges from $500 to $5,500 depending on the household's earnings level. Consider first the regular saving findings for couples. Most of the net tax rates fall in the range of 20 to 40 percent. The highest rate is 52 percent, which applies to 30 year-old households making $500,000 per year. This is part of a pattern for young and middle-aged households in which the net tax rate on regular saving rises with income. But for 60 year-old couples, the rate is 39 percent at the lowest earnings level, then falls to 22 percent and then climbs to 36 percent for households with $500,000 in earnings.

The regular saving net tax rates for singles are far a-field from those for couples. For very low-earning, young and middle aged singles, the rates are astronomical reflecting the impact of asset tests on various transfer benefits. At higher incomes and at older ages, the rates range from around 20 percent to around 40 percent. Above $34,000 in annual earnings these rates generally rise.

Measuring Retirement Account Tax Arbitrage Opportunities

Tables 5 and 6 present our findings on tax arbitrage via contributions to tax-deferred retirement accounts, which we reference as "401(k)"-type accounts and Roth accounts. As indicated above, the results are presented in terms of cents of arbitrage gain

per dollar of net contribution.

Take, as an example, the 401(k) results for our 45 year-old couples with $70,000 in total annual household earnings. At the margin, these households can increase the present value of their lifetime consumption by 23.3 cents for every dollar they contribute on net (net of their immediate tax savings) to a tax-deferred retirement account. This is a significant money machine. But it's de minimis compared with the 154.7 cent money machine available to 30 year-old couples with $500,000 in annual earnings. On the other hand, it's huge compared with the .7 cent money machine available to 30-year old single households with earnings of $15,000.

As the two tables indicate, the arbitrage opportunities are greatest for high-earning young and middle-aged households and for older households. That said, the pattern of arbitrage opportunities by age and earnings is far from monotonic with respect to either age or by earnings. Take singles households with $35,000 in annual earnings. The size of their 401(k) money machine is 16.3 cents at age 30, 64.9 cents at age 45, and 32.0 cents at age 60. Or consider couples age 60. If they earn $20,000 per year in total, their 401(k) money machine generates 171.1 cent per net dollar contributed. With $70,000 in annual earnings, their 401(k) machine produces only 28.0 cents per net dollar contributed. But at $500,000 in annual earnings, the machine has improved. It now produces 49.2 cents per net dollar contributed.

The Roth arbitrage opportunities are uniformly smaller than the 401(k)-type arbitrage opportunities.[18] Nonetheless, they can be quite substantial. For example, 45-year old singles earning $100,000 per year stand to receive 32.1 cents per dollar placed in

18 This analysis abstracts from potential future tax hikes that could significantly limit the marginal arbitrage gain available from contributing to tax-deferred retirement accounts.

a Roth account.[19] The top Roth arbitrage opportunity is that of couples age 30 with $500,000 in annual earnings. Their money machine generates 121.9 cents for free for each dollar they place in a Roth account.

As in the case of marginal net tax rates on labor supply and saving, one can decipher the reason a particular arbitrage opportunity is of a given size. In this regard, the 5.7 cent and 171.1 cent respective arbitrage opportunities of 30 and 60 year-old couples earning $20,000 are worth comparing. The 30 year-olds have zero (or very small positive) federal tax obligations at age 30, before considering the EITC. To take advantage of the federal Saver's Credit, they must be paying positive federal taxes.

The Saver's Credit, enacted in 2001, matches low-income households' retirement account contributions by as much as dollar for dollar, but it does so by reducing their tax payments *to the extent these payments are positive*; i.e., the Saver's Credit is not refundable, making many low-income households ineligible for it.

Our 60 year-old couple with $20,000 is low-income, but is eligible for the Saver's Credit. The reason is that the couple no longer has dependent children. With fewer deductions, its adjusted gross income is higher than that of its 30 year-old analogue, resulting in a higher (positive) federal tax liability. So when these households contribute to a 401(k) vehicle, they not only reduce their current taxes by exempting their contribution to the 401(k) from their taxable income; they also reduce them because of the Saver's Credit. These factors, in combination with the fact that these households will be in very low tax brackets in the future, explain the fantastic size of this arbitrage opportunity.

19 Note that all contributions to Roth accounts are on a net basis because there is no reduction in current taxes associated with adding to one's Roth account.

Interestingly, the same age-60 couple has a much smaller arbitrage potential if it contributes not to a 401(k)-type vehicle, but to a Roth account. In this case, the money machine spews forth only 47.5 cents per dollar contributed. The reasons this machine does so poorly compared to the 401(k) machine number two. First, the Roth contributions generate no immediate reduction in taxes. Hence, there is no ability, as there is with the 401(k) contribution, to arbitrage between current high and future low marginal tax brackets. Second, each dollar of net contribution to a 401(k) entails a larger gross contribution than in the case of a contribution to a Roth account. Since the Saver's Credit is paid on the basis of the gross contribution, not the net contribution, a given net contribution to a 401(k)-type account generates a much larger Saver's Credit than does the same size net contribution made to a Roth account.

Another comparison between arbitrage incentives that's worth making is that between 45 year-old 401(k) contributing couples who earn $25,000 per year and those who earn $35,000. The lower-earning couple is again not eligible to receive the Saver's Credit because of its negligible federal tax obligations, whereas the higher earning couple is so eligible.

A final arbitrage opportunity worth highlighting is that of 30 year-old couples with $500 in total annual earnings. These couples can earn 154.7 cents for free per net dollar placed in a 401(k)-type account. This reflects the value of their current tax saving, the fact that they are in much lower tax brackets in the future, and their ability to benefit from tax-deferral (the ability to earn capital income on a tax-free basis). As the size of the corresponding Roth arbitrage opportunity makes clear, the deferral advantage for this household is significant.

V. Conclusion

The study of effective marginal tax rates is hardly new.[20] Nor is the observation that transfer programs can dramatically affect effective marginal tax rate calculations, and that marginal rates depend critically and sensitively on household demographic and economic circumstances. But what is new here is the inclusion in one study of all the major tax and transfer programs/elements that materially affect incentives to work and save. On the tax side, this list includes federal and state personal income, corporate income, sales and excise, and payroll taxes. On the transfer side, the list includes Social Security, Medicare, Medicaid, Food Stamps, and TAFDC benefits.

America's tax-transfer system confronts the vast majority of American households with either high, very high, or astronomically high total effective marginal tax rates on labor supply and saving. It also provides very substantial tax arbitrage opportunities to a subset of households, particularly those with high incomes or advanced ages.

The pattern of net marginal tax rates and arbitrage opportunities with respect to age, marital status, and earnings is quite simply all over the map. But this is what one would expect given the amazing complexity of the fiscal system, the fact that the various components of the system are being developed with little or no thought to their interaction, and that the various governmental bodies responsible for the different elements of our tax-transfer system appear to make little or no attempt to understand the overall work and saving disincentives as well as arbitrage opportunities they are

20 Recent contributions to the literature on marginal net tax rates include CBO (2005) and Feenberg and Poterba (2003).

producing.

References

Congressional Budget Office, "Effective Marginal Taxes on Labor Income," November 2005.

Diamond, Peter, "Optimal Income Taxation: An Example with a U-Shaped Pattern for the Optimal Marginal Rates," *American Economic Review*, 88 (1), March 1998, 83-95.

Feenberg, Daniel and James Poterba, "The Alternative Minimum Tax and Effective Marginal Tax Rates," NBER Working Paper No. 10072, April 2003.

Gokhale, Jagadeesh, Laurence J. Kotlikoff, and Alexi Sluchynsky, "Does It Pay to Work," NBER Working Paper no. 9095, August 2002.

Kotlikoff, Laurence J., Ben Marx, and Pietro Rizza, "Americans' Dependency on Social Security," Boston University, 2006. posted at http://people.bu.edu/kotlikof/Americans%27%20Dependency%20on%20Social%20Security1.pdf

Table 1

Characteristics of Stylized Households

Single Households							
Total Annual Household Earnings	**Assets at Age 30**	**Annual College Expense**	**House Value**	**Mortgage**	**Monthly Mortgage Payment**	**Annual Property Taxes**	**Annual Home Maintenance**
$10,000	$2,500	$2,500	$30,000	$24,000	$300	$300	$150
$15,000	$3,750	$3,750	$45,000	$36,000	$450	$450	$225
$25,000	$6,250	$6,250	$75,000	$60,000	$750	$750	$375
$35,000	$8,750	$8,750	$105,000	$84,000	$1,050	$1,050	$525
$50,000	$12,500	$12,500	$150,000	$120,000	$1,500	$1,500	$750
$100,000	$25,000	$25,000	$300,000	$240,000	$3,000	$3,000	$1,500
$250,000	$62,500	$50,000	$750,000	$600,000	$7,500	$7,500	$3,750
Married Households							
Total Annual Household Earnings	**Assets at Age 30**	**Annual College Expense**	**House Value**	**Mortgage**	**Monthly Mortgage Payment**	**Annual Property Taxes**	**Annual Home Maintenance**
$20,000	$5,000	$10,000	$60,000	$48,000	$600	$600	$300
$30,000	$7,500	$15,000	$90,000	$72,000	$900	$900	$450
$50,000	$12,500	$25,000	$150,000	$120,000	$1,500	$1,500	$750
$70,000	$17,500	$35,000	$210,000	$168,000	$2,100	$2,100	$1,050
$100,000	$25,000	$50,000	$300,000	$240,000	$3,000	$3,000	$1,500
$200,000	$50,000	$50,000	$600,000	$480,000	$6,000	$6,000	$3,000
$500,000	$125,000	$50,000	$1,500,000	$1,200,000	$15,000	$15,000	$7,500

Table 2

Marginal Net Tax Rates on Current-Year Labor Supply (Couples)

	Total Annual Household Earnings ($000s)									
Age	10	20	30	50	75	100	150	200	300	500
30	-14.2%	42.5%	42.3%	24.4%	36.9%	37.0%	45.9%	36.8%	43.9%	44.0%
45	-11.4%	41.7%	41.8%	35.8%	36.1%	36.1%	45.1%	35.9%	40.9%	43.2%
60	50.9%	32.0%	36.3%	36.5%	45.5%	45.5%	47.7%	43.2%	45.8%	45.0%

Table 3

Marginal Net Tax Rates on Current-Year Labor Supply (Singles)

	Total Annual Household Earnings ($000s)									
Age	10	20	30	50	75	100	125	150	200	250
30	72.3%	42.9%	42.9%	37.0%	37.0%	36.1%	36.2%	36.9%	42.0%	41.5%
45	-9.8%	42.9%	42.6%	37.0%	36.9%	36.1%	36.1%	36.9%	42.0%	41.5%
60	39.5%	37.3%	37.7%	46.4%	45.5%	38.8%	38.8%	44.0%	45.0%	44.0%

Table 4

Marginal Net Tax Rates on Life-Cycle Labor Supply

Couples Total Annual Household Earnings ($000s)									
10	20	30	50	75	100	150	200	300	500
2.1%	40.2%	40.1%	32.3%	36.6%	33.3%	42.2%	41.6%	42.8%	49.6%
Singles **Total Annual Household Earnings ($000s)**									
10	20	30	50	75	100	125	150	200	250
0.8%	34.7%	36.7%	32.6%	34.6%	39.5%	37.3%	37.7%	40.3%	41.3%

Table 5

The Marginal Net Taxation of Saving

Couples

Marginal Effective Tax on Regular Saving							
Total Household Annual Income ($000s)							
Age	20	30	50	70	100	200	500
30	20.5%	20.1%	20.5%	23.3%	24.9%	32.0%	51.5%
45	20.1%	21.4%	22.0%	22.6%	25.9%	30.3%	43.4%
60	38.6%	22.1%	22.0%	27.9%	34.1%	34.3%	36.5%
401(k) Arbitrage Opportunity							
Total Household Annual Income ($000s)							
Age	20	30	50	70	100	200	500
30	5.7¢	5.6¢	5.9¢	8.6¢	20.4¢	53.9 ¢	154.7¢
45	6.2¢	7.5¢	24.1¢	23.3¢	21.4¢	44.1¢	79.9¢
60	171.1¢	183.9¢	46.4¢	28.0¢	36.1¢	47.7¢	49.2%
Roth Arbitrage Opportunity							
Total Household Annual Income ($000s)							
Age	20	30	50	70	100	200	500
30	1.1¢	0.9¢	1.2¢	3.9¢	19.1¢	33.4¢	121.9¢
45	1.1¢	2.9¢	4.0¢	4.4¢	17.6¢	30.8¢	57.0¢
60	47.5¢	48.0¢	16.2¢	15.6¢	25.3¢	23.9¢	27.8¢

Table 6

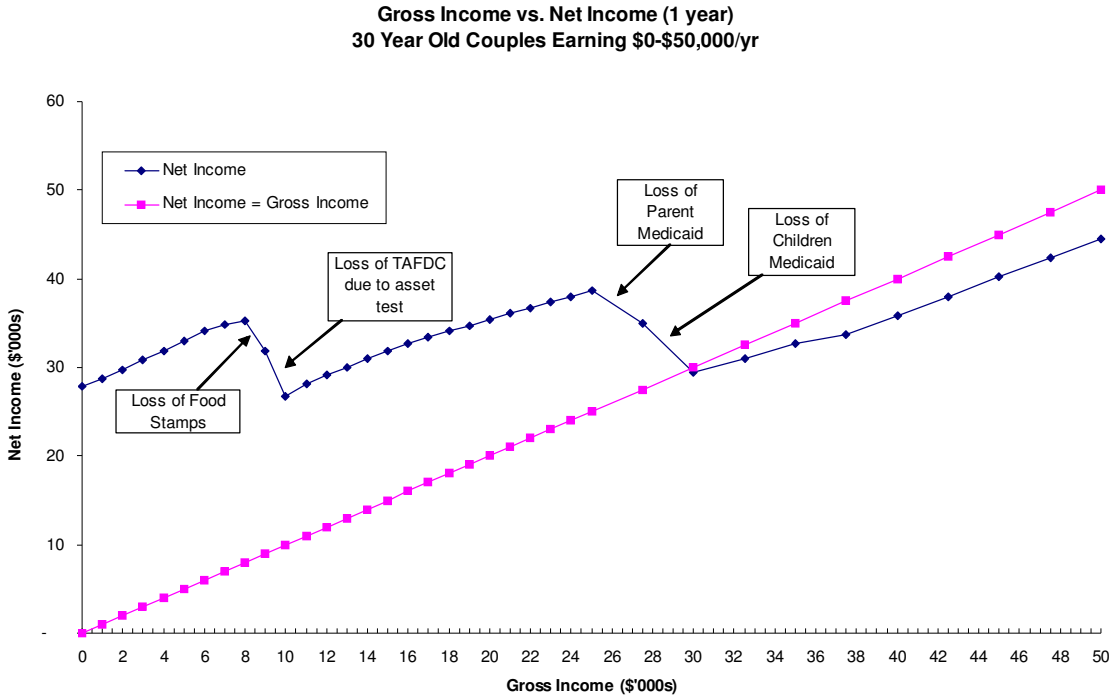
The Marginal Net Taxation of Saving

Singles

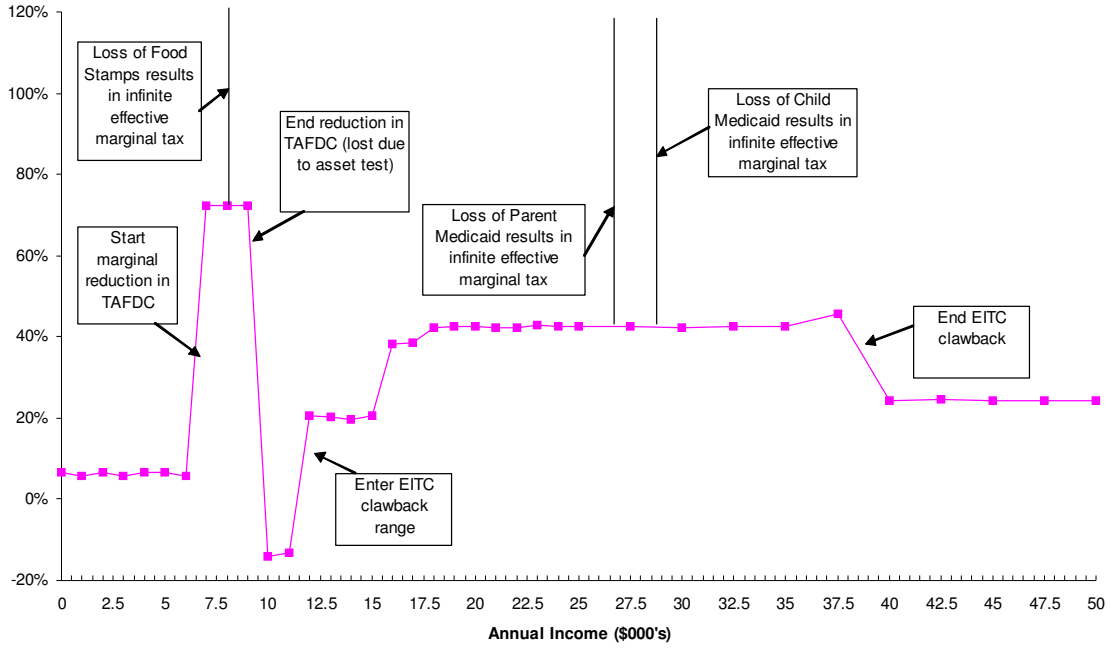
Marginal Effective Tax on Regular Saving							
Total Household Annual Income ($000s)							
Age	10	15	25	35	50	100	250
30	82.7%	260.4%	18.8%	18.7%	20.4%	25.5%	30.6%
45	109.4%	19.6%	19.7%	20.1%	20.2%	30.7%	39.2%
60	20.5%	41.4%	22.0%	23.4%	30.3%	37.6%	35.8%
401(k) Arbitrage Opportunity							
Total Household Annual Income ($000s)							
Age	10	15	25	35	50	100	250
30	1.0¢	0.7¢	5.5¢	16.4¢	5.4¢	31.0¢	73.4¢
45	5.8¢	5.9¢	6.6¢	64.9¢	18.0¢	33.8¢	69.4¢
60	47.7¢	76.2¢	64.1¢	32.0¢	42.0¢	33.6¢	55.4¢
Roth Arbitrage Opportunity							
Total Household Annual Income ($000s)							
Age	10	15	25	35	50	100	250
30	1.0¢	0.7¢	0.6¢	0.6¢	2.2¢	28.6¢	53.3¢
45	1.3¢	0.9¢	1.7¢	9.6¢	1.4¢	32.1¢	50.6¢
60	7.1¢	23.9¢	35.0¢	9.6¢	18.2¢	28.0¢	26.5¢

Summary Graphs:

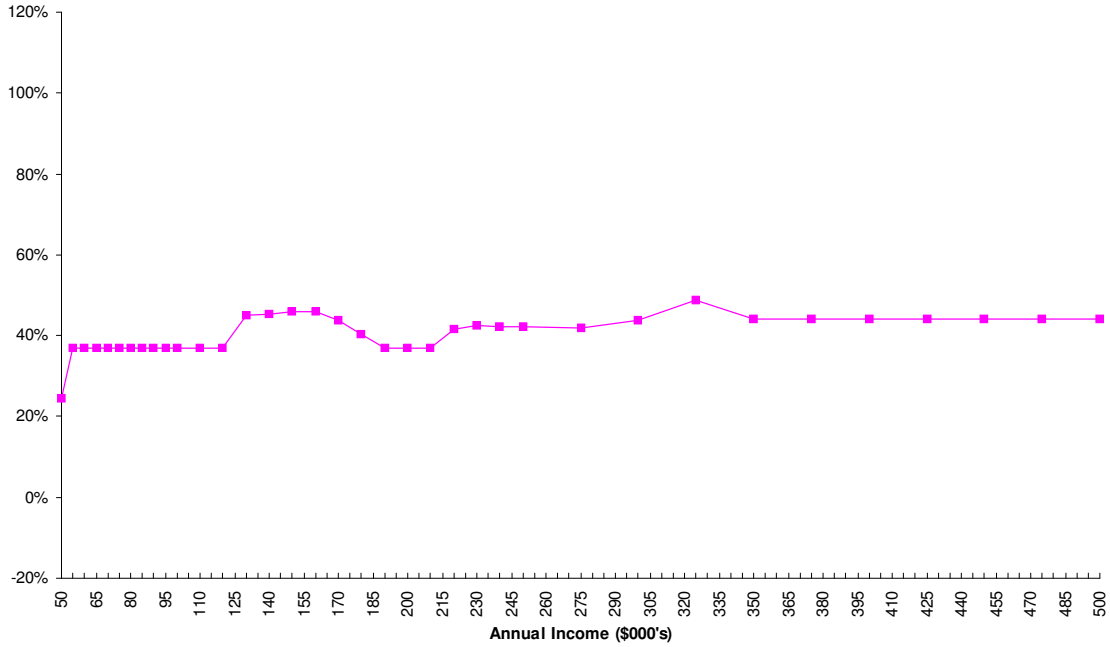
COUPLES

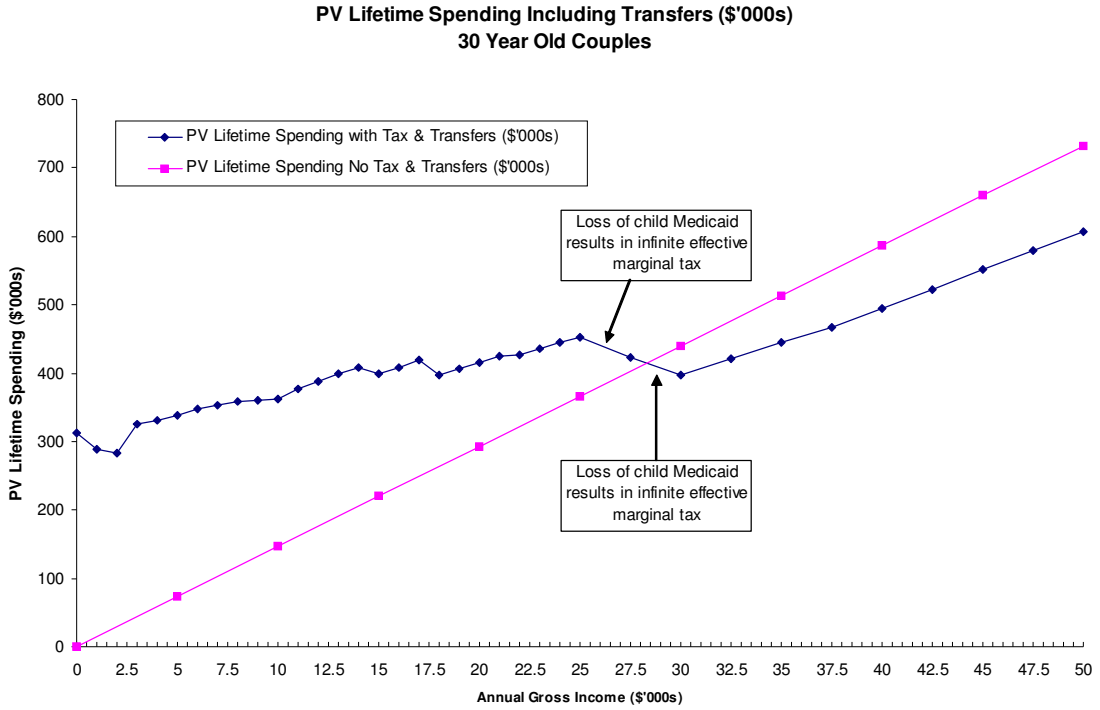


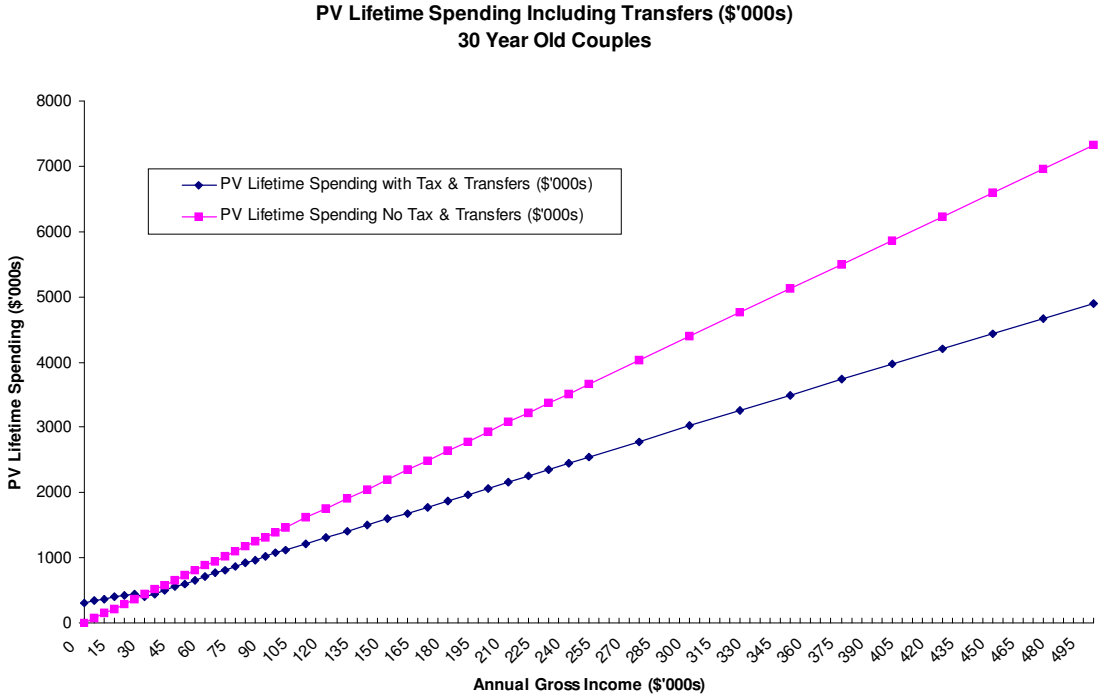
Marginal Effective Tax Rate
30 Year Old Couples Earning $0-$50,000/yr



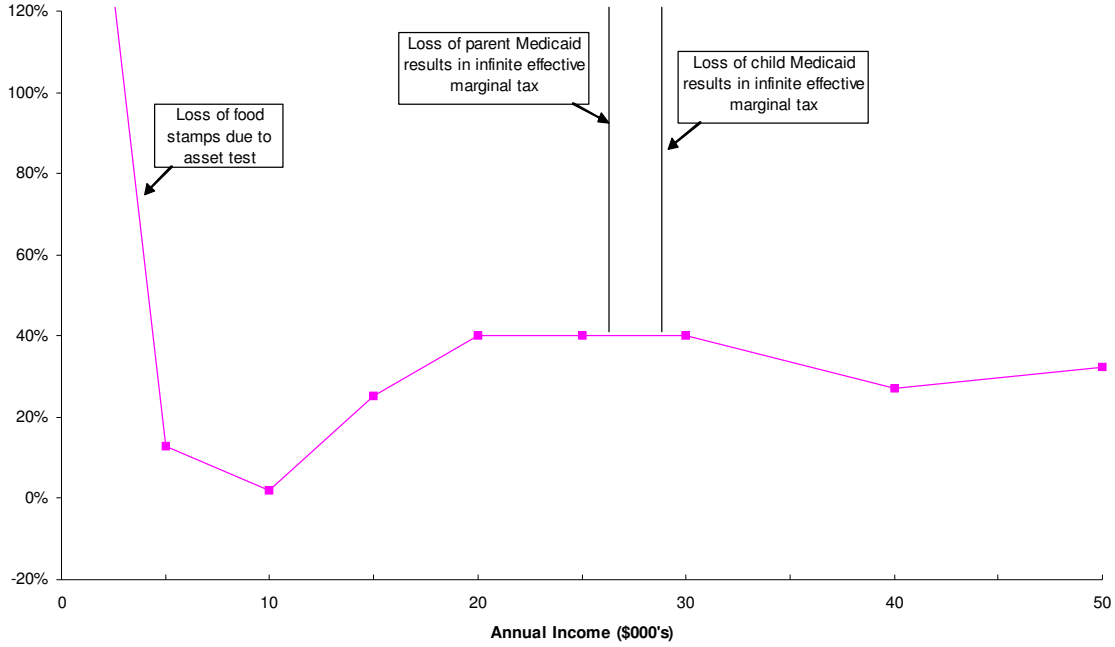
Marginal Effective Tax Rate
30 Year Old Couples $50,000-$500,000/yr



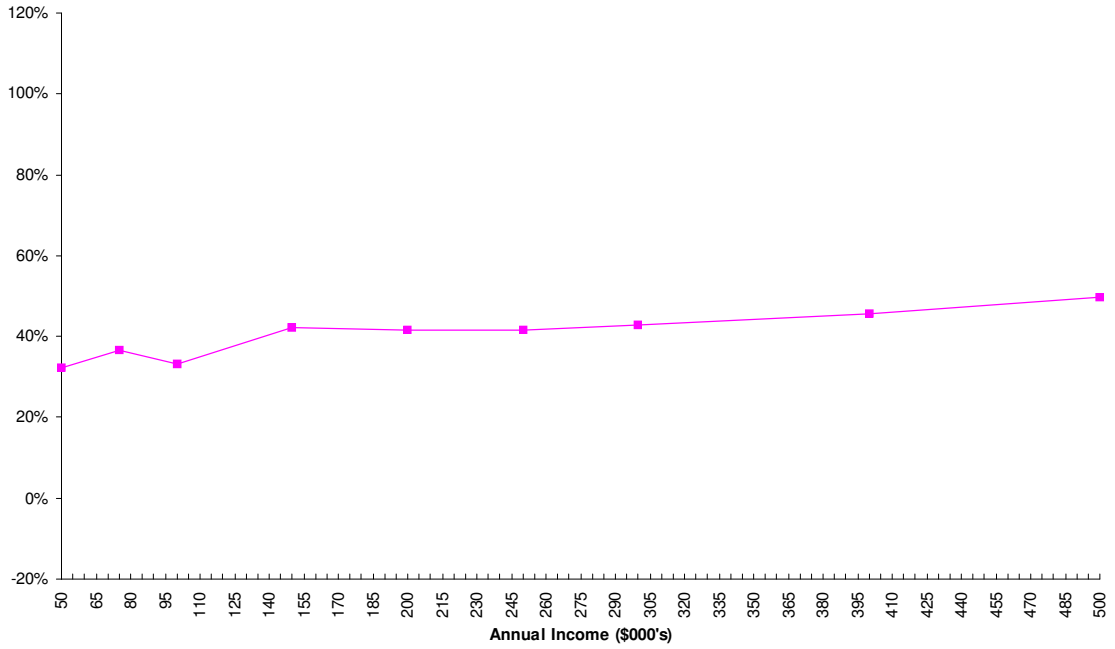

PV Lifetime Spending Including Transfers ($'000s)
30 Year Old Couples
PV Lifetime Spending with Tax & Transfers ($'000s)
PV Lifetime Spending No Tax & Transfers ($'000s)
Loss of child Medicaid results in infinite effective marginal tax
Loss of child Medicaid results in infinite effective marginal tax
PV Lifetime Spending ($'000s)
Annual Gross Income ($'000s)
0
100
200
300
400
500
600
700
800
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50


PV Lifetime Spending Including Transfers ($'000s)
30 Year Old Couples
PV Lifetime Spending with Tax & Transfers ($'000s)
PV Lifetime Spending No Tax & Transfers ($'000s)
PV Lifetime Spending ($'000s)
Annual Gross Income ($'000s)
0
1000
2000
3000
4000
5000
6000
7000
8000
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
270
285
300
315
330
345
360
375
390
405
420
435
450
465
480
495

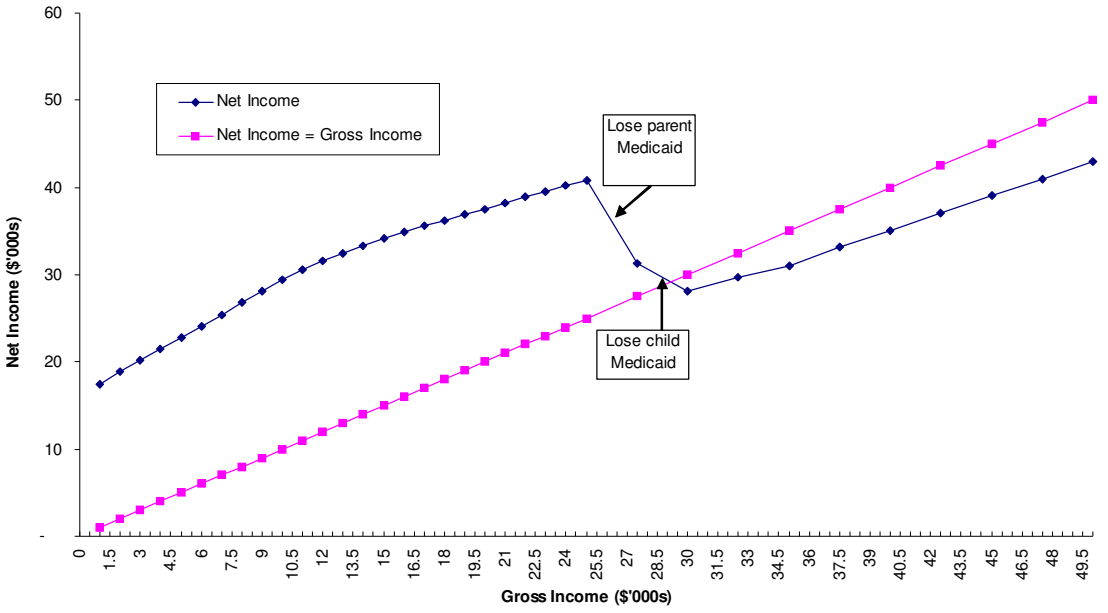
Marginal Lifetime Effective Tax Rate
30 Year Old Couples $0-$50,000/yr



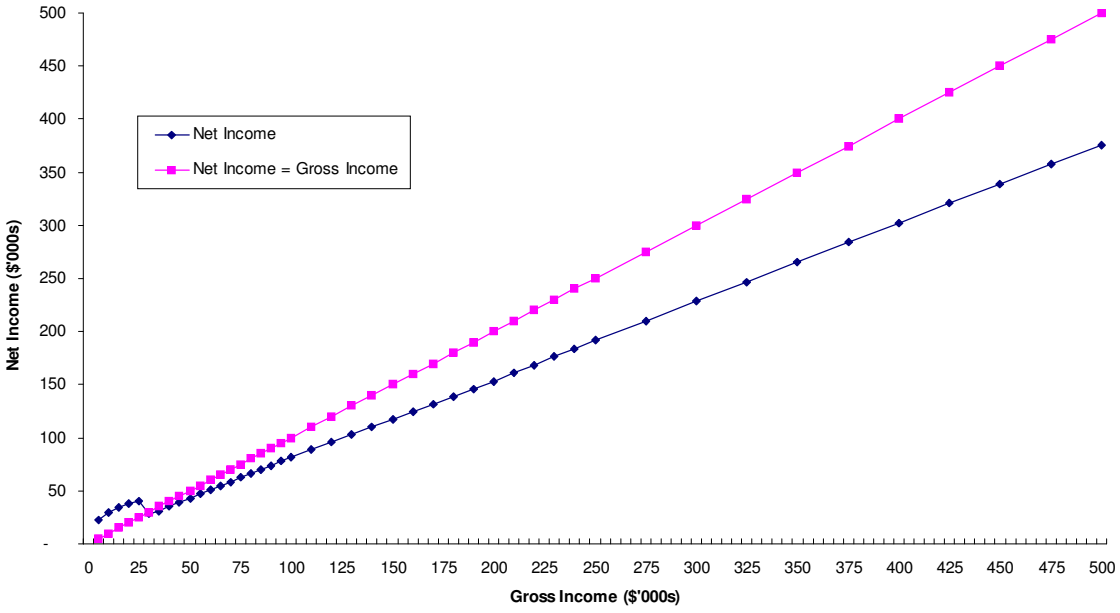
Marginal Lifetime Effective Tax Rate
30 Year Old Couples $50,000-$500,000/yr



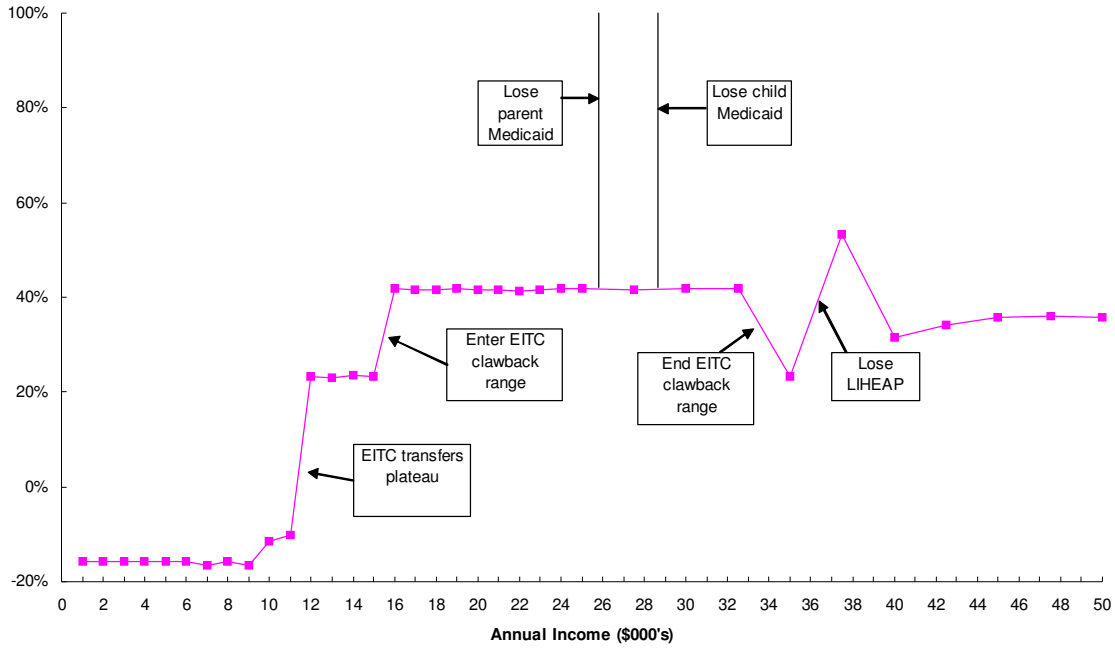
Gross Income vs. Net Income (1 year)
45 Year Old Couples Earning $0-$50,000/yr



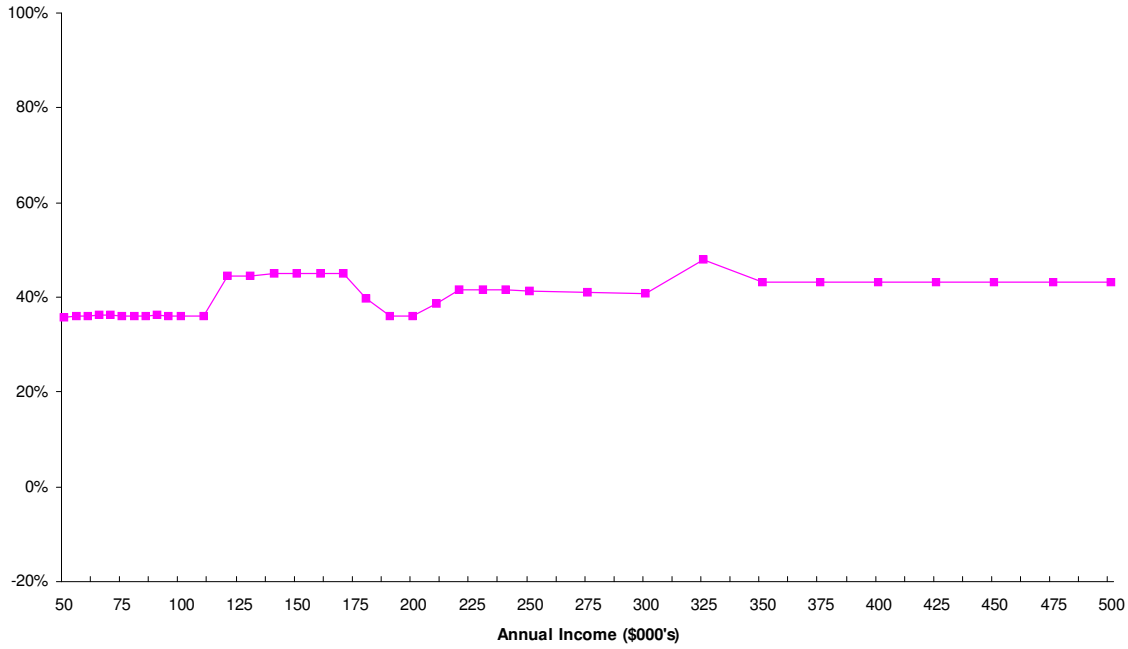
Gross Income vs. Net Income (1 year)
45 Year Old Couples Earning $0-$50,000/yr

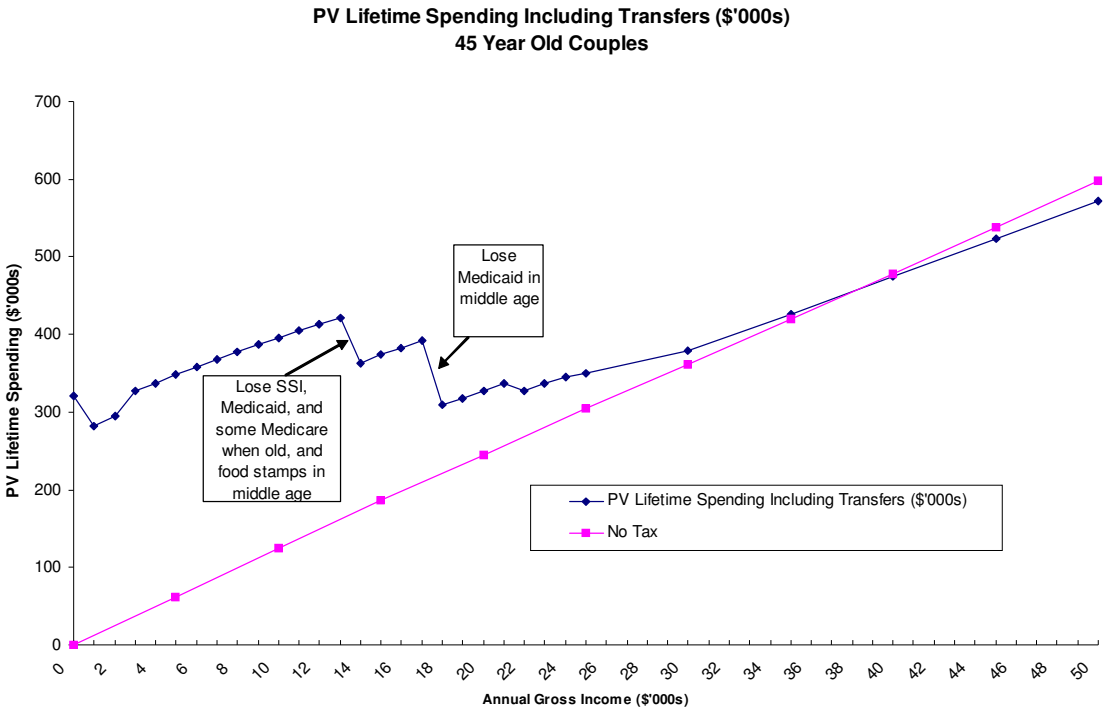


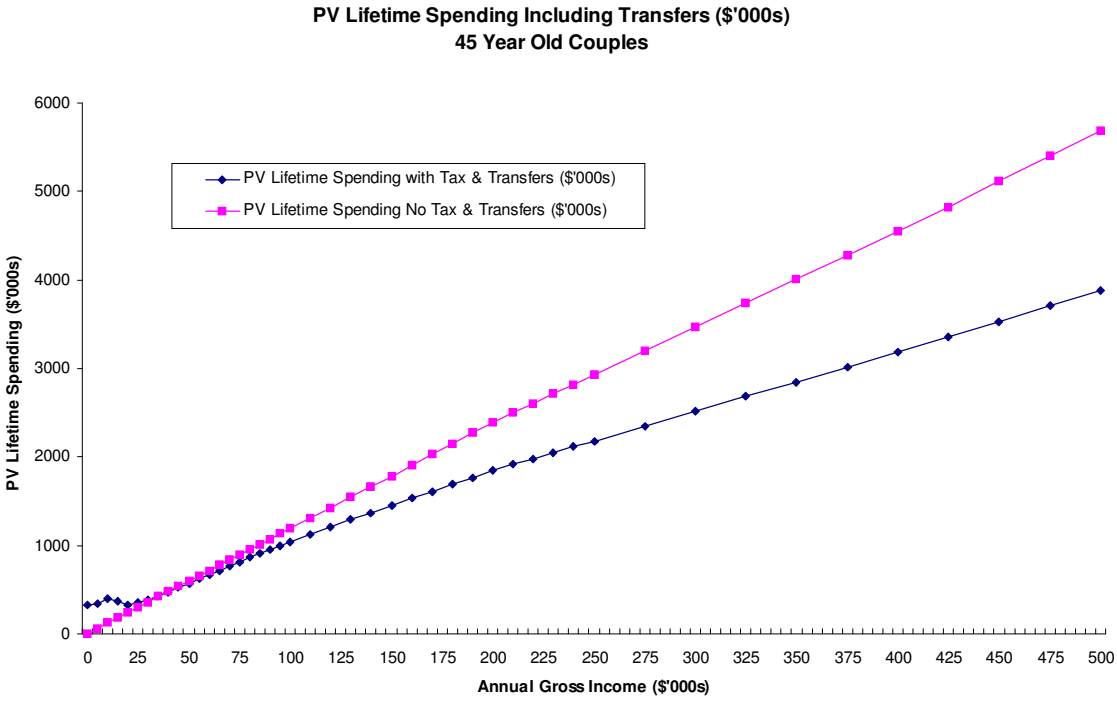
Marginal Effective Tax Rate
45 Year Old Couples Earning $0-$50,000/yr

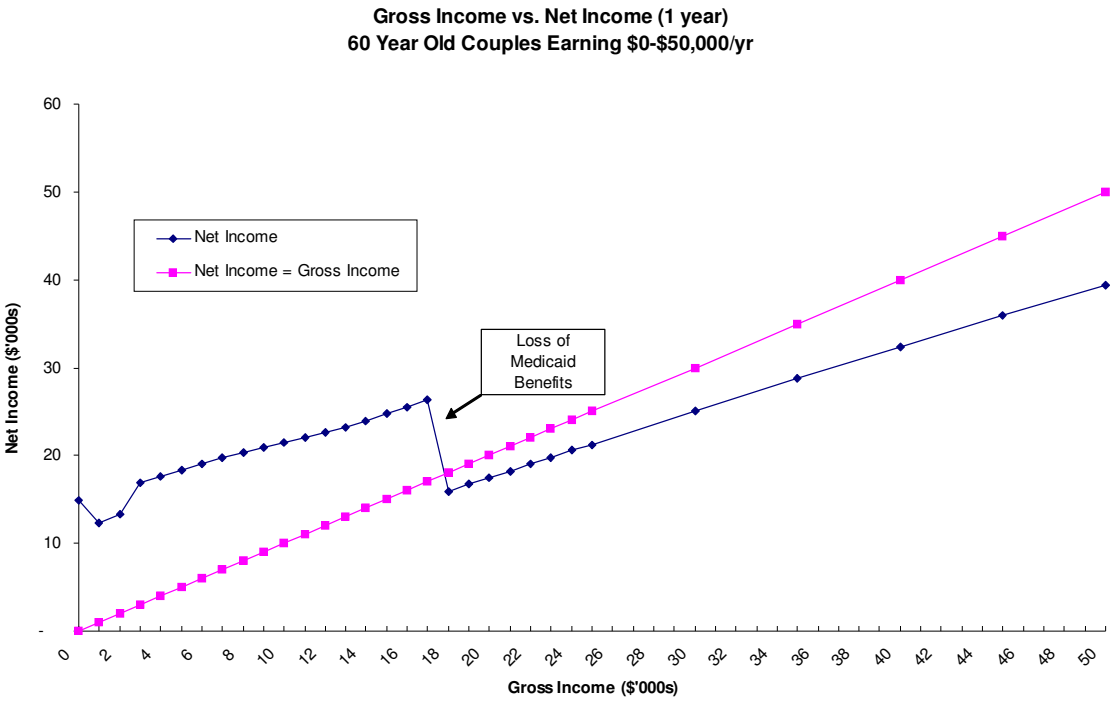


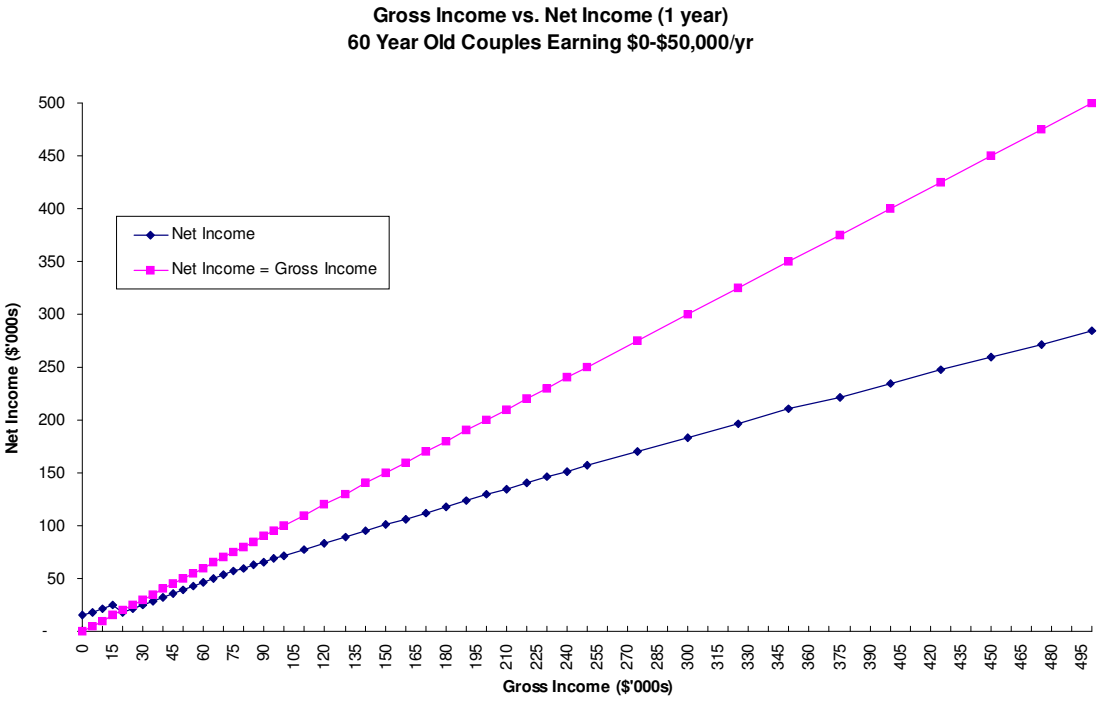
Marginal Effective Tax Rate
45 Year Old Couples $50,000-$500,000/yr



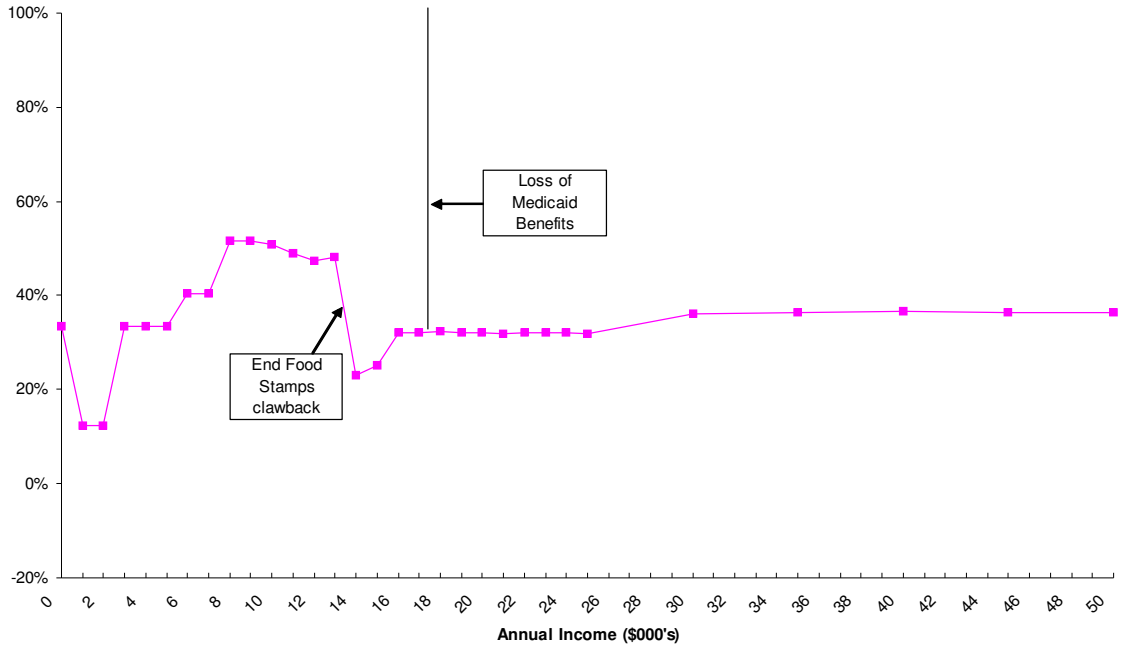

PV Lifetime Spending Including Transfers ($'000s)
45 Year Old Couples
PV Lifetime Spending ($'000s)
Annual Gross Income ($'000s)
Lose Medicaid in middle age
Lose SSI, Medicaid, and some Medicare when old, and food stamps in middle age
PV Lifetime Spending Including Transfers ($'000s)
No Tax


PV Lifetime Spending Including Transfers ($'000s)
45 Year Old Couples
PV Lifetime Spending ($'000s)
Annual Gross Income ($'000s)
PV Lifetime Spending with Tax & Transfers ($'000s)
PV Lifetime Spending No Tax & Transfers ($'000s)

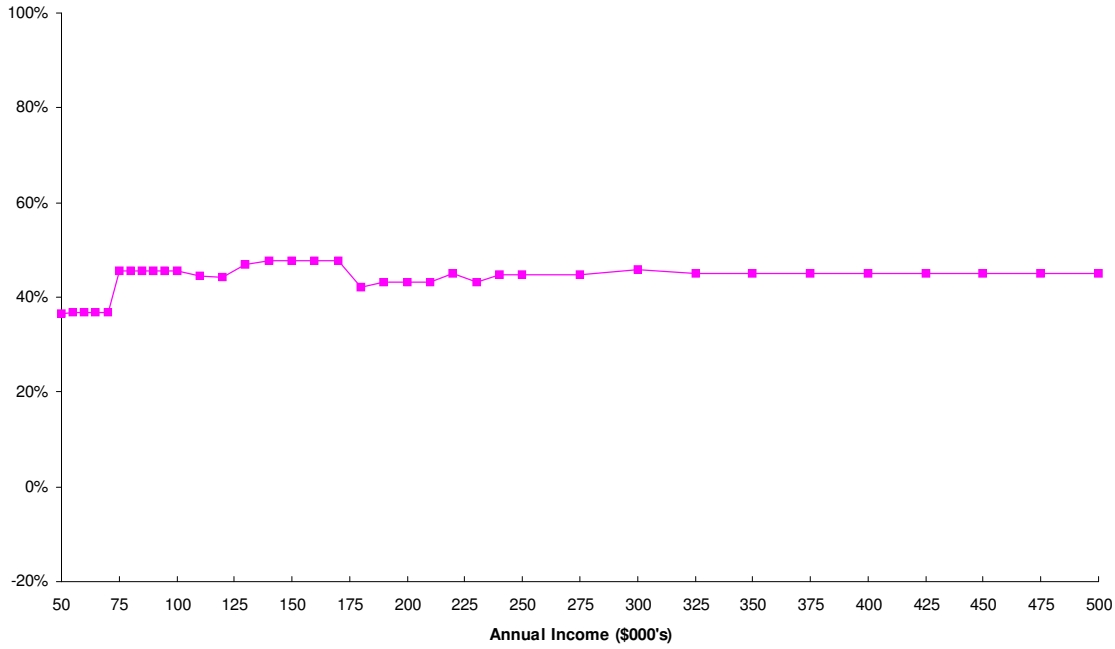

Gross Income vs. Net Income (1 year)
60 Year Old Couples Earning $0-$50,000/yr
Net Income ($'000s)
Gross Income ($'000s)
Net Income
Net Income = Gross Income
Loss of Medicaid Benefits

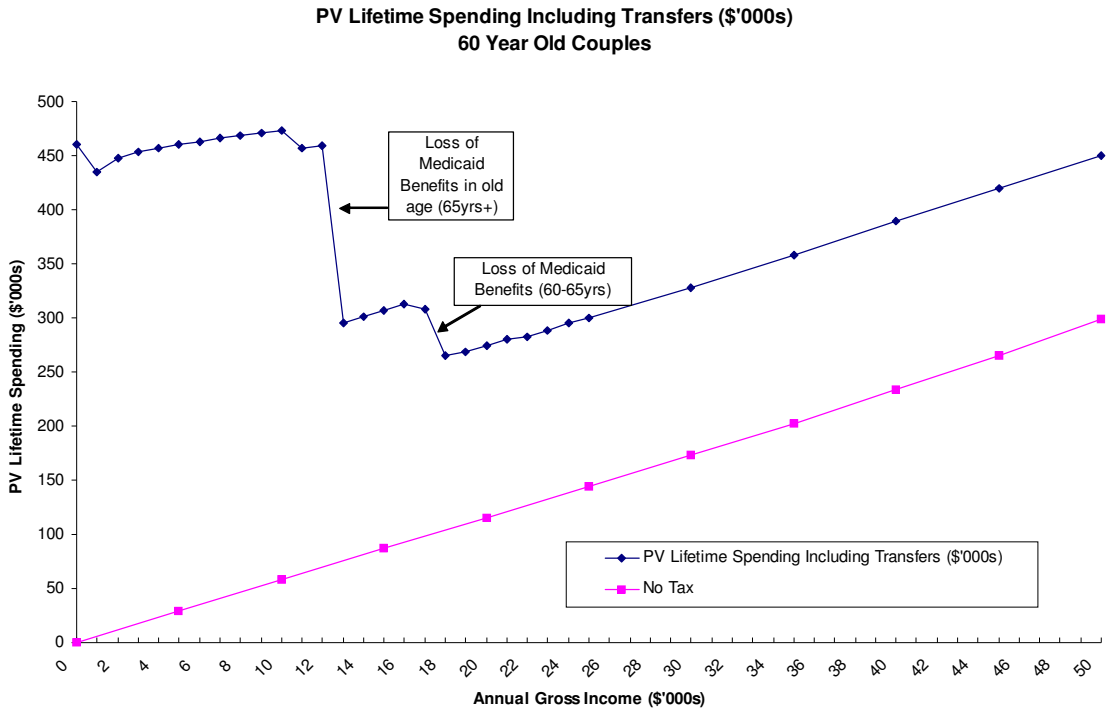

Gross Income vs. Net Income (1 year)
60 Year Old Couples Earning $0-$50,000/yr
Net Income ($'000s)
Gross Income ($'000s)
Net Income
Net Income = Gross Income

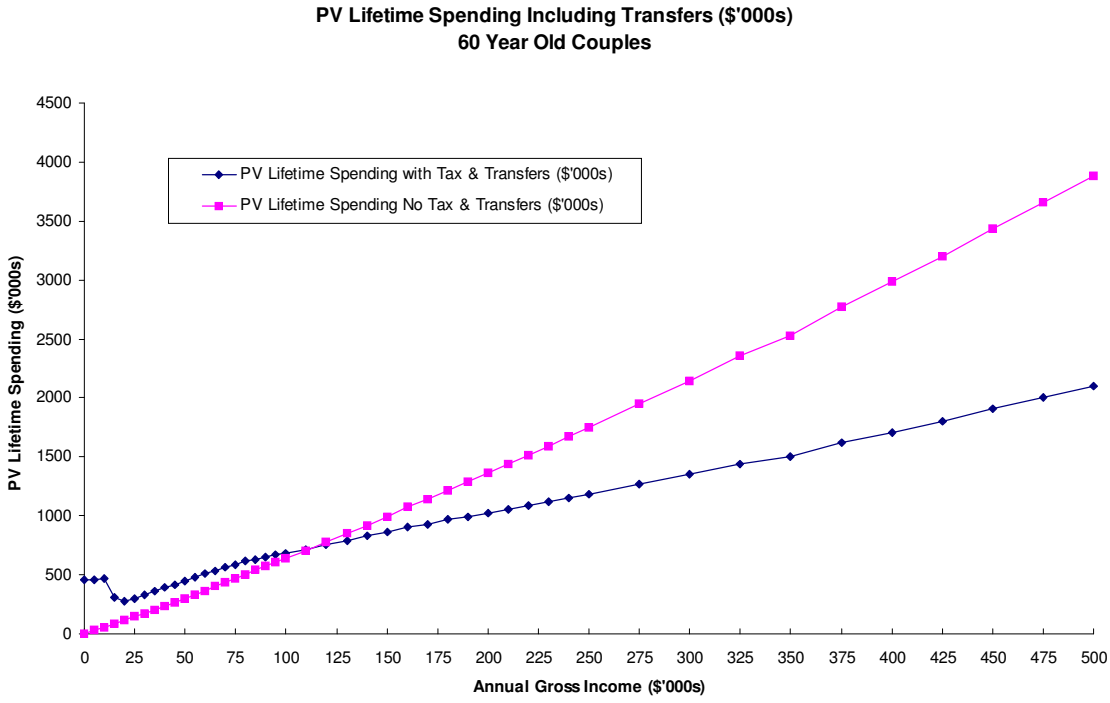
Marginal Effective Tax Rate
60 Year Old Couples Earning $0-$50,000/yr



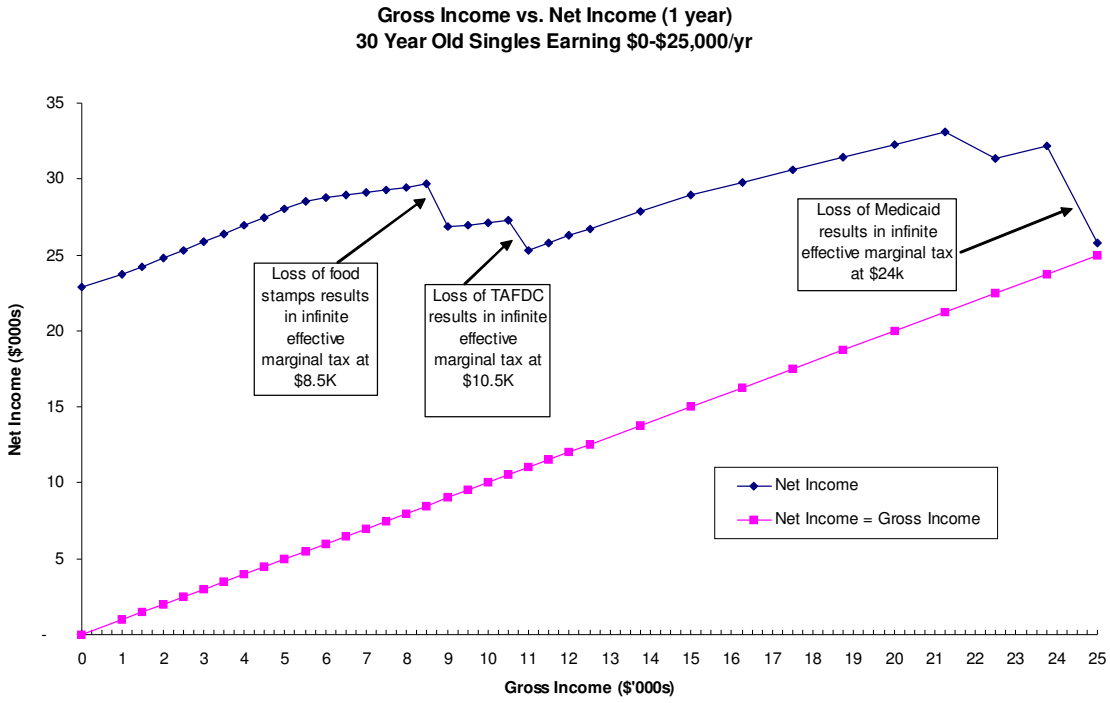
Marginal Effective Tax Rate
60 Year Old Couples $50,000-$500,000/yr

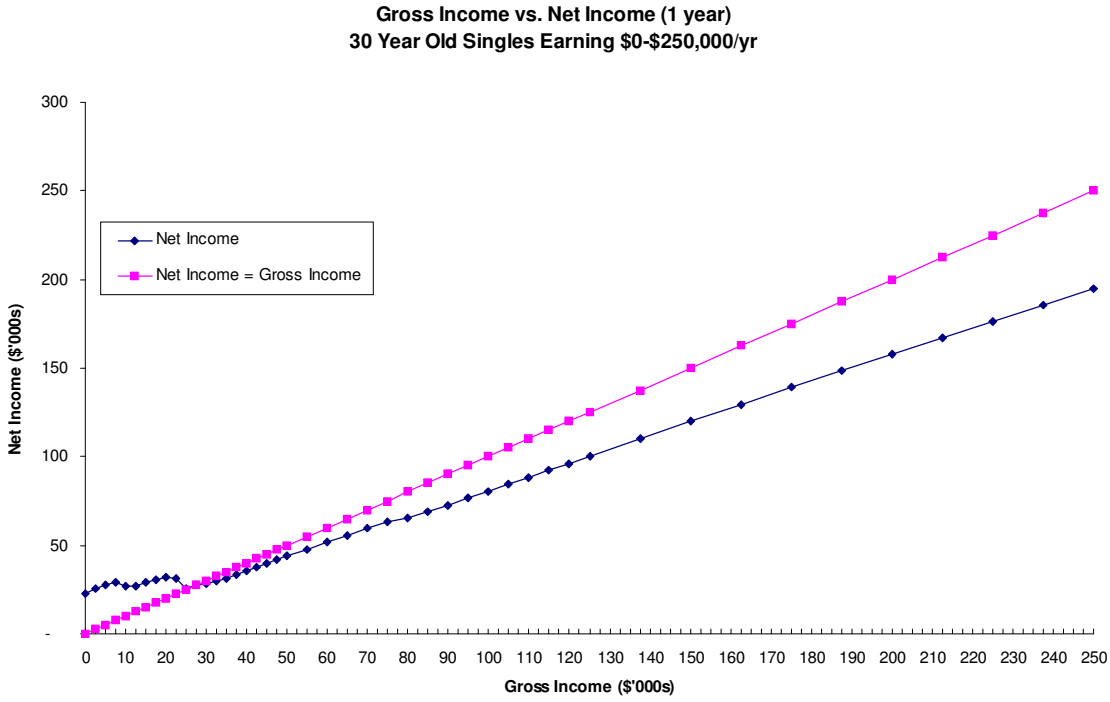



PV Lifetime Spending Including Transfers ($'000s)
60 Year Old Couples
PV Lifetime Spending ($'000s)
Annual Gross Income ($'000s)
Loss of Medicaid Benefits in old age (65yrs+)
Loss of Medicaid Benefits (60-65yrs)
PV Lifetime Spending Including Transfers ($'000s)
No Tax

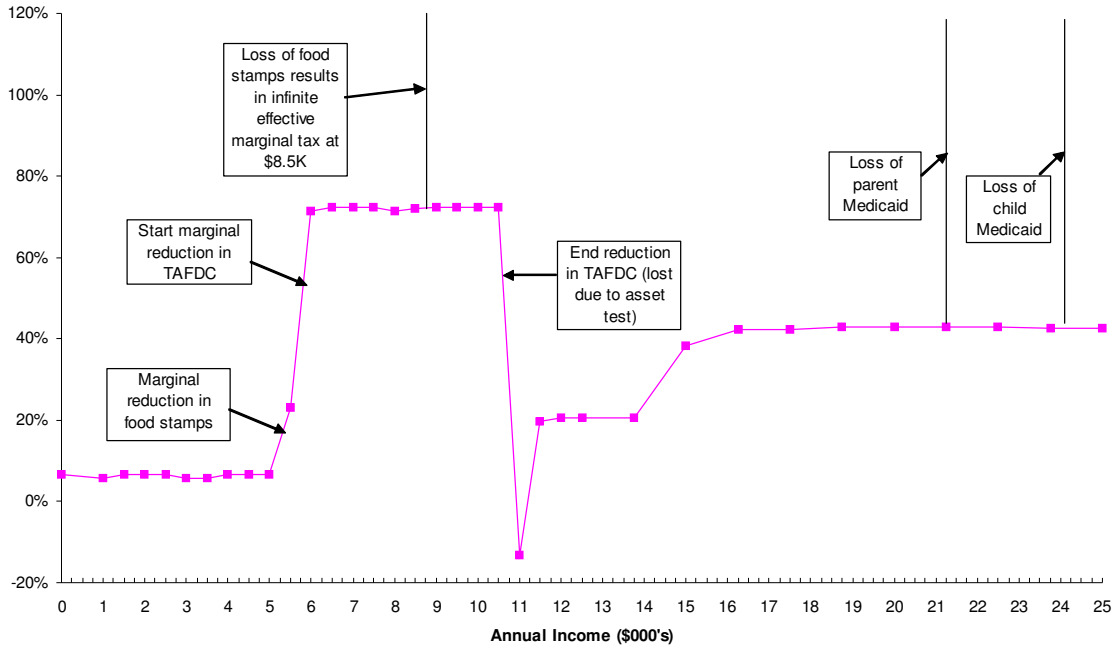

PV Lifetime Spending Including Transfers ($'000s)
60 Year Old Couples
PV Lifetime Spending ($'000s)
Annual Gross Income ($'000s)
PV Lifetime Spending with Tax & Transfers ($'000s)
PV Lifetime Spending No Tax & Transfers ($'000s)

SINGLES

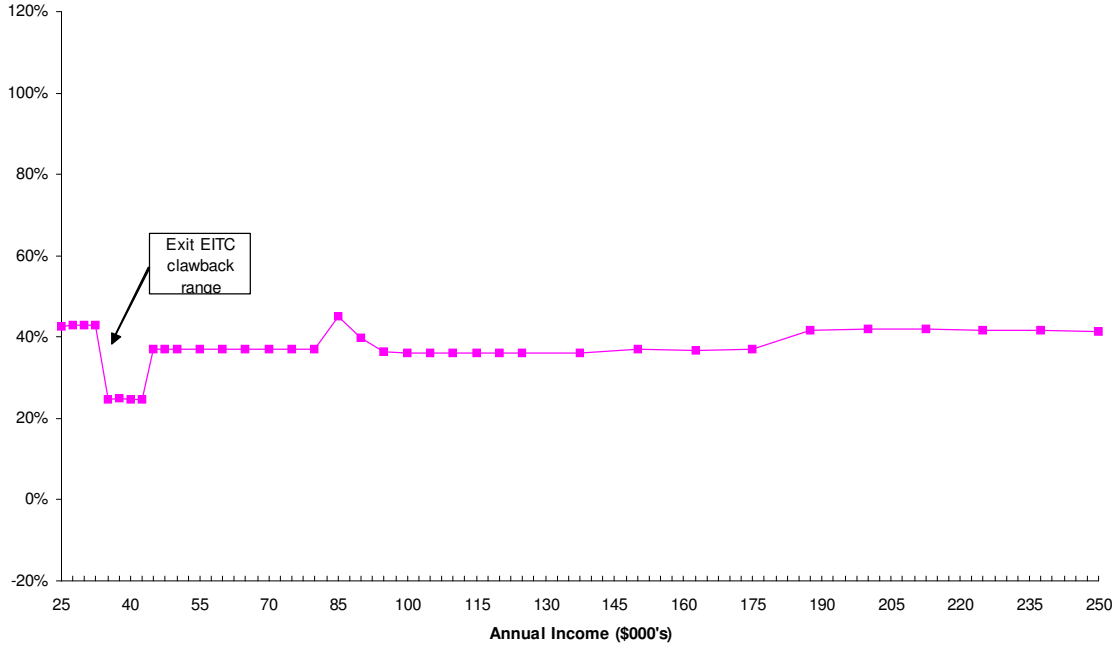

Gross Income vs. Net Income (1 year)
30 Year Old Singles Earning $0-$25,000/yr
Net Income ($'000s)
Gross Income ($'000s)
Loss of food stamps results in infinite effective marginal tax at $8.5K
Loss of TAFDC results in infinite effective marginal tax at $10.5K
Loss of Medicaid results in infinite effective marginal tax at $24k
Net Income
Net Income = Gross Income

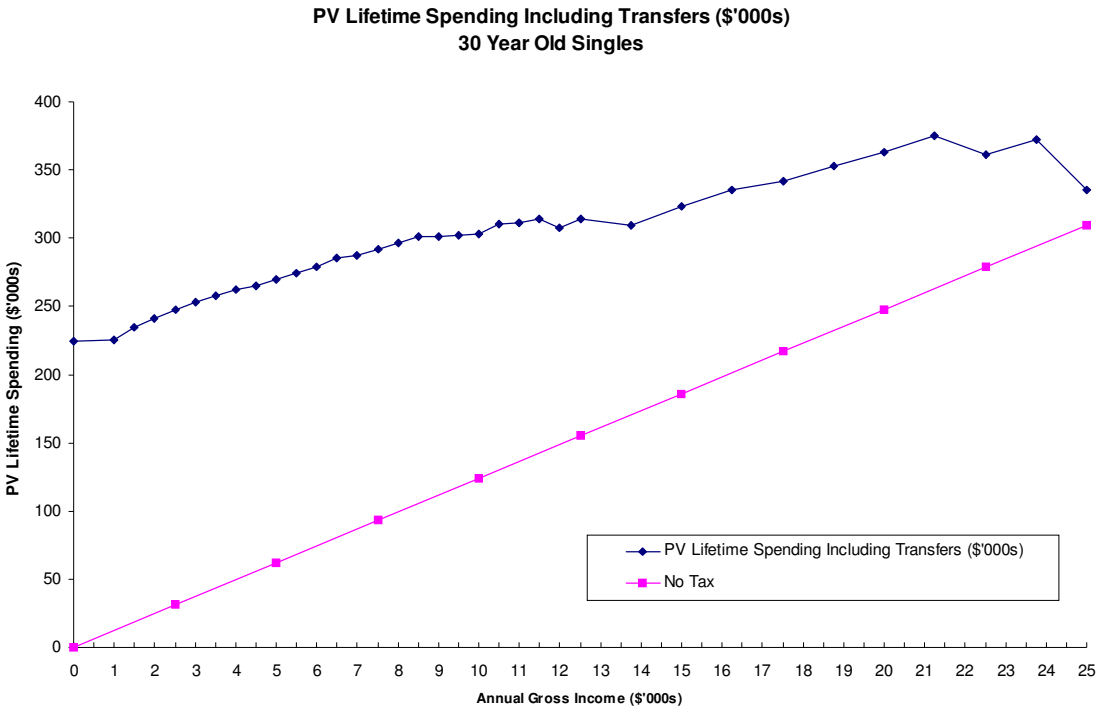

Gross Income vs. Net Income (1 year)
30 Year Old Singles Earning $0-$250,000/yr
Net Income ($'000s)
Gross Income ($'000s)
Net Income
Net Income = Gross Income

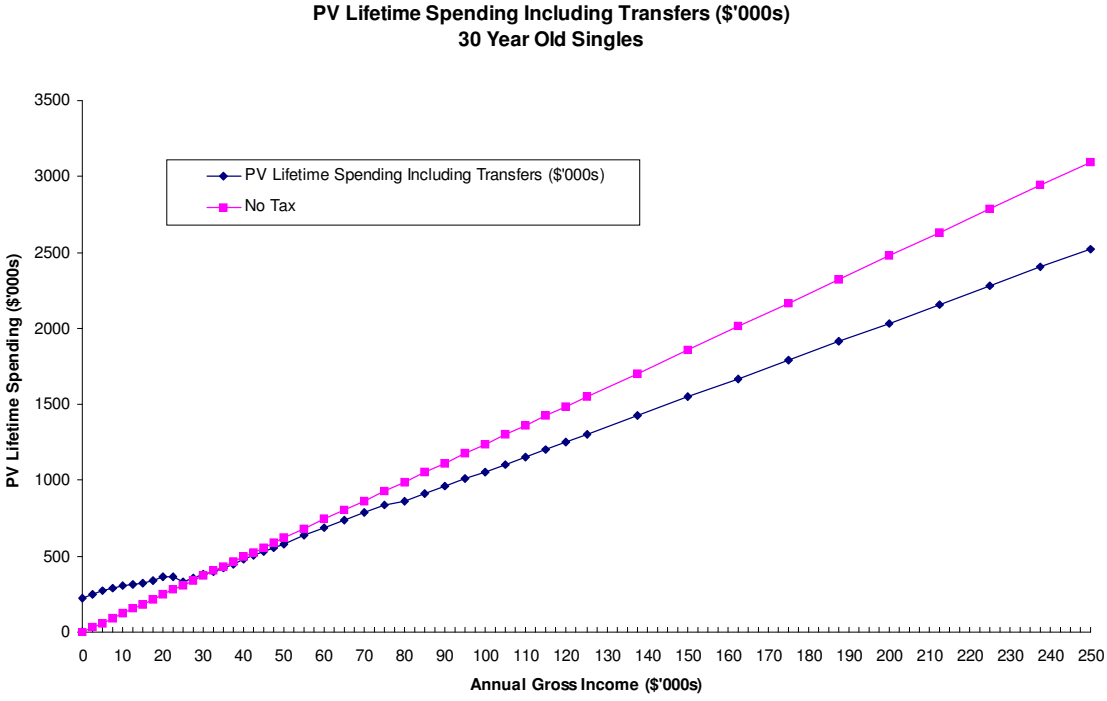
Marginal Effective Tax Rate
30 Year Old Singles Earning $0-$25,000/yr



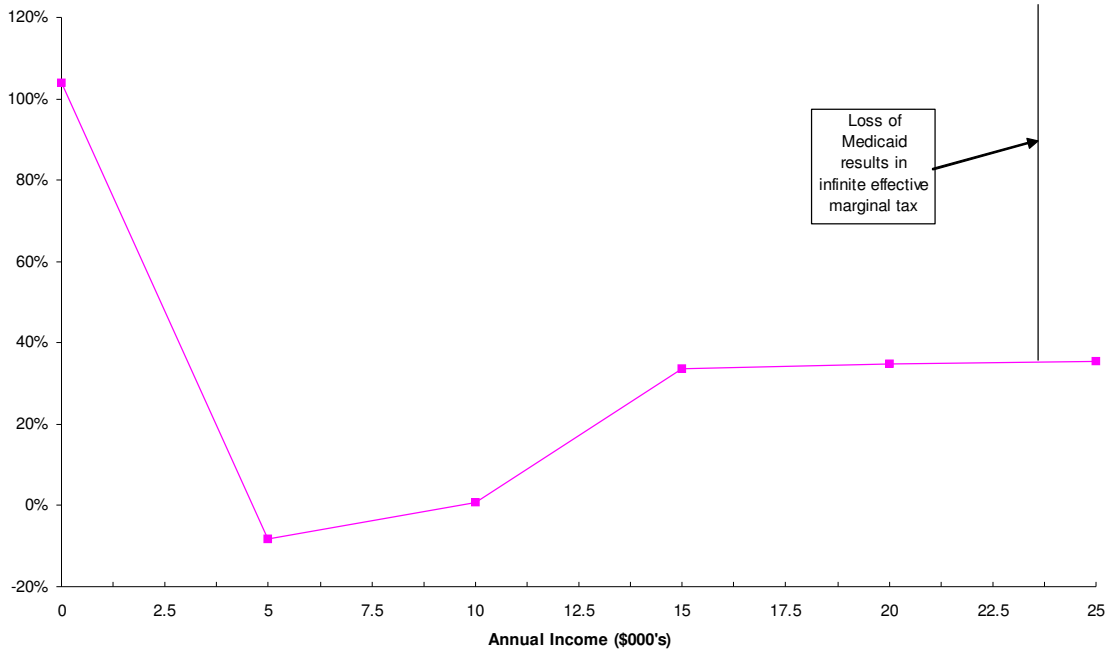
Marginal Effective Tax Rate
30 Year Old Singles $25,000-$250,000/yr



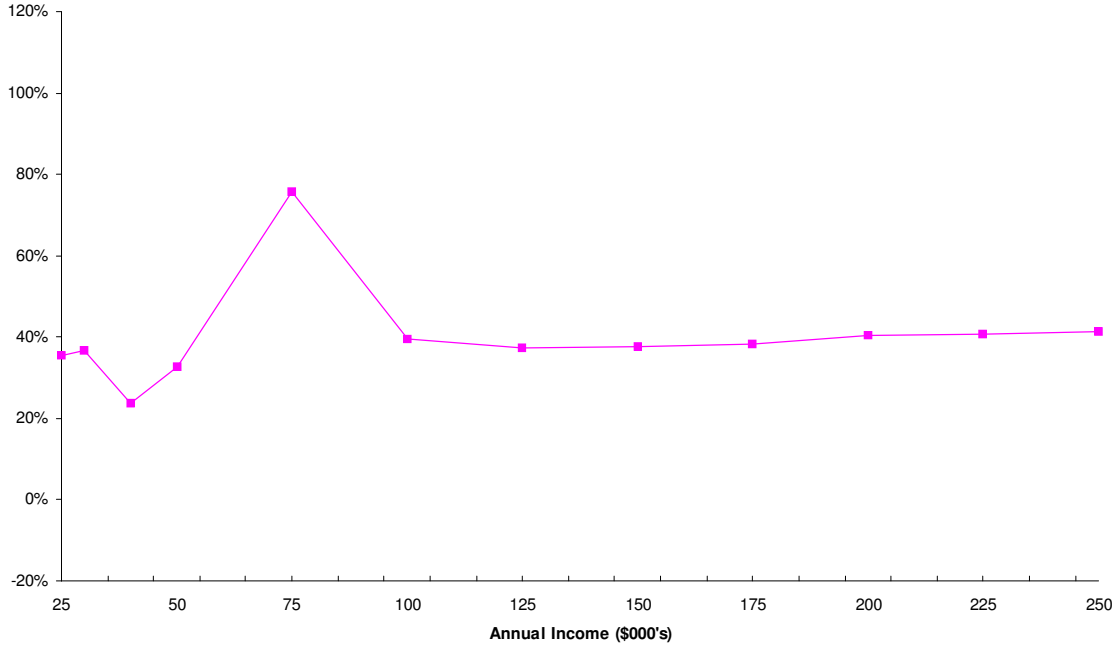

PV Lifetime Spending Including Transfers ($'000s)
30 Year Old Singles
PV Lifetime Spending ($'000s)
400
350
300
250
200
150
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Annual Gross Income ($'000s)
PV Lifetime Spending Including Transfers ($'000s)
No Tax


PV Lifetime Spending Including Transfers ($'000s)
30 Year Old Singles
PV Lifetime Spending ($'000s)
3500
3000
2500
2000
1500
1000
500
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Annual Gross Income ($'000s)
PV Lifetime Spending Including Transfers ($'000s)
No Tax

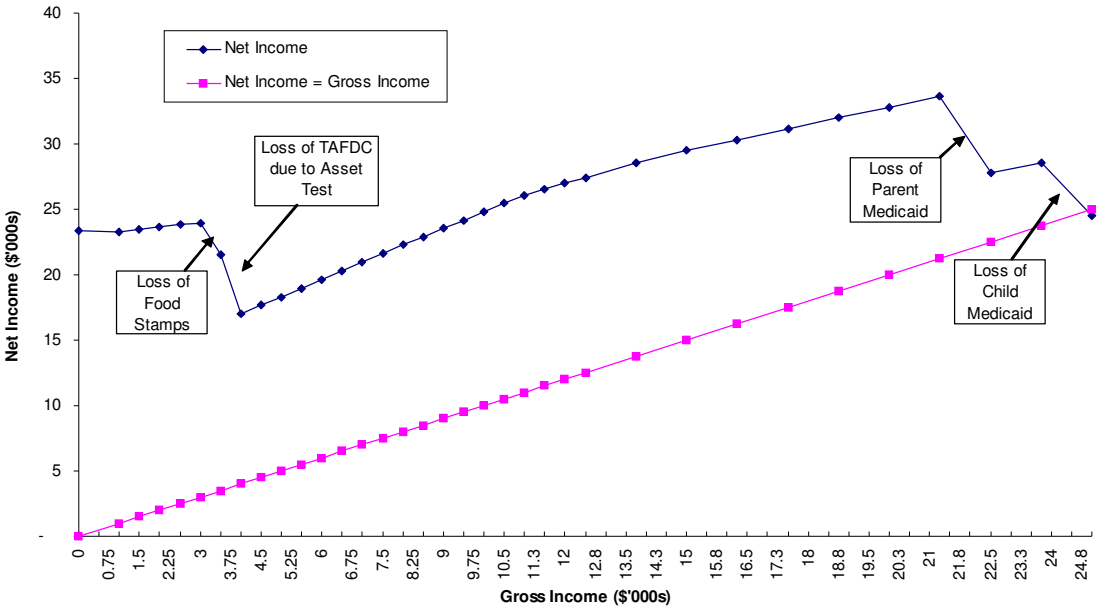
Marginal Lifetime Effective Tax Rate
30 Year Old Singles $0-$25,000/yr



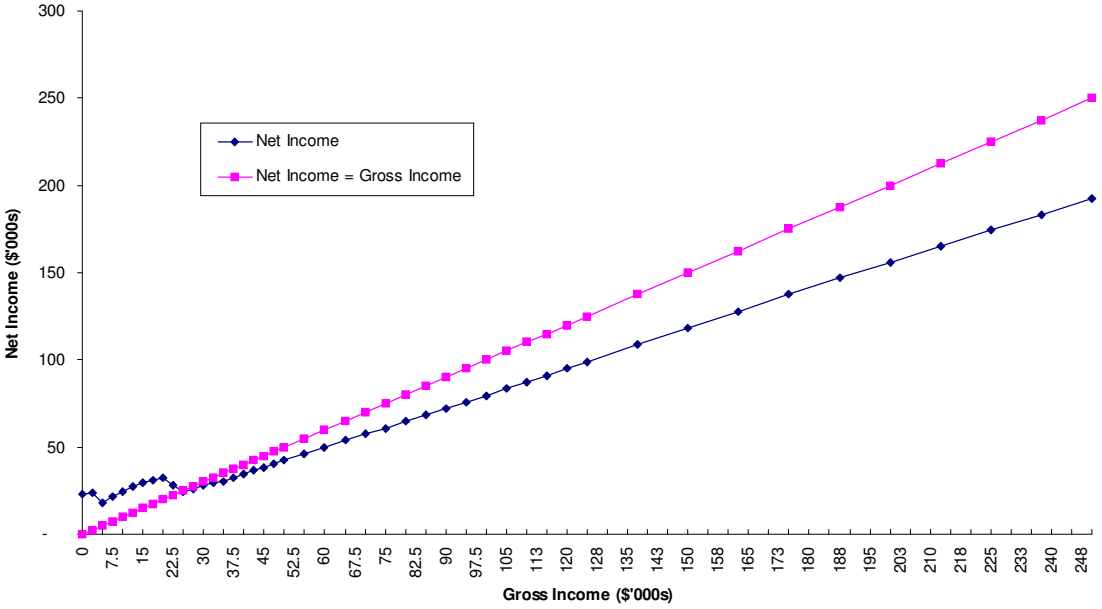
Marginal Lifetime Effective Tax Rate
30 Year Old Singles $25,000-$250,000/yr



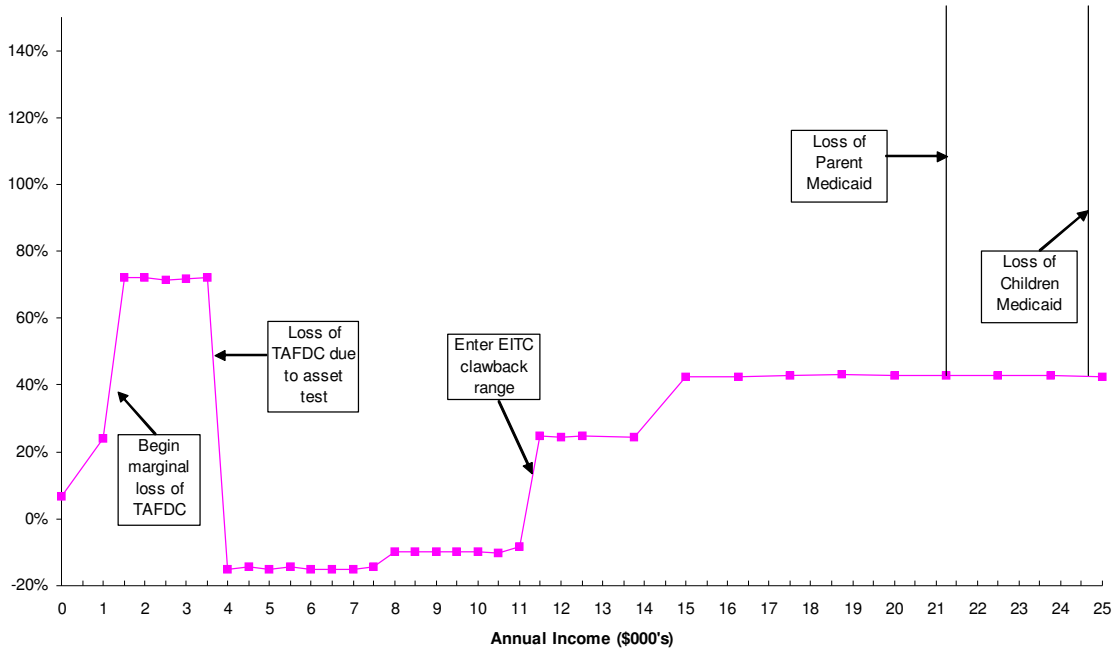
Gross Income vs. Net Income (1 year)
45 Year Old Singles Earning $0-$25,000/yr



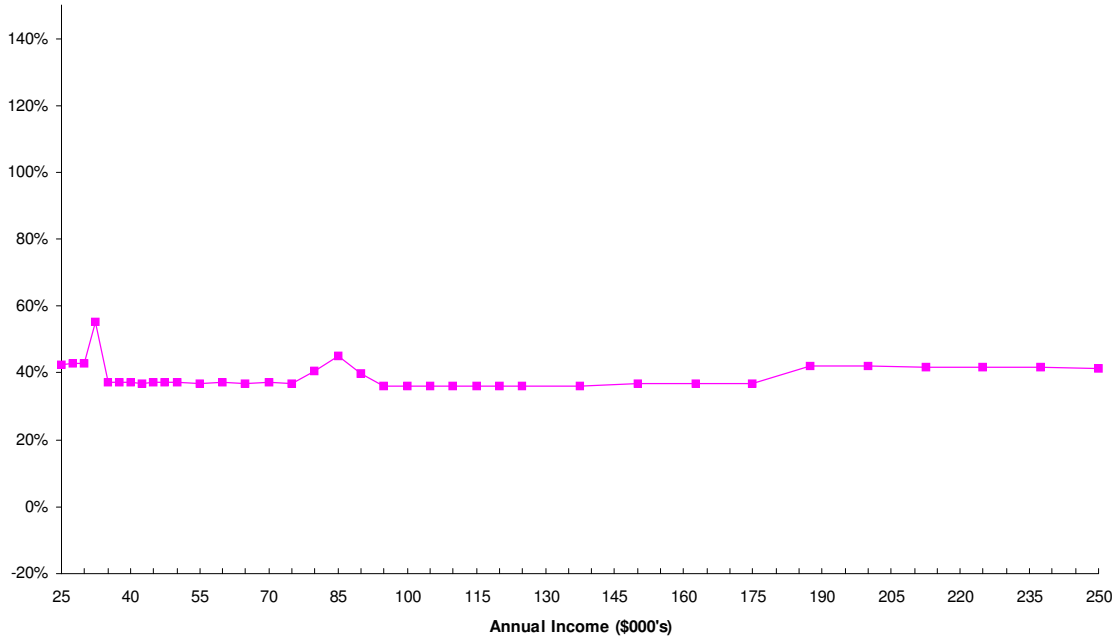
Gross Income vs. Net Income (1 year)
45 Year Old Singles Earning $0-$250,000/yr

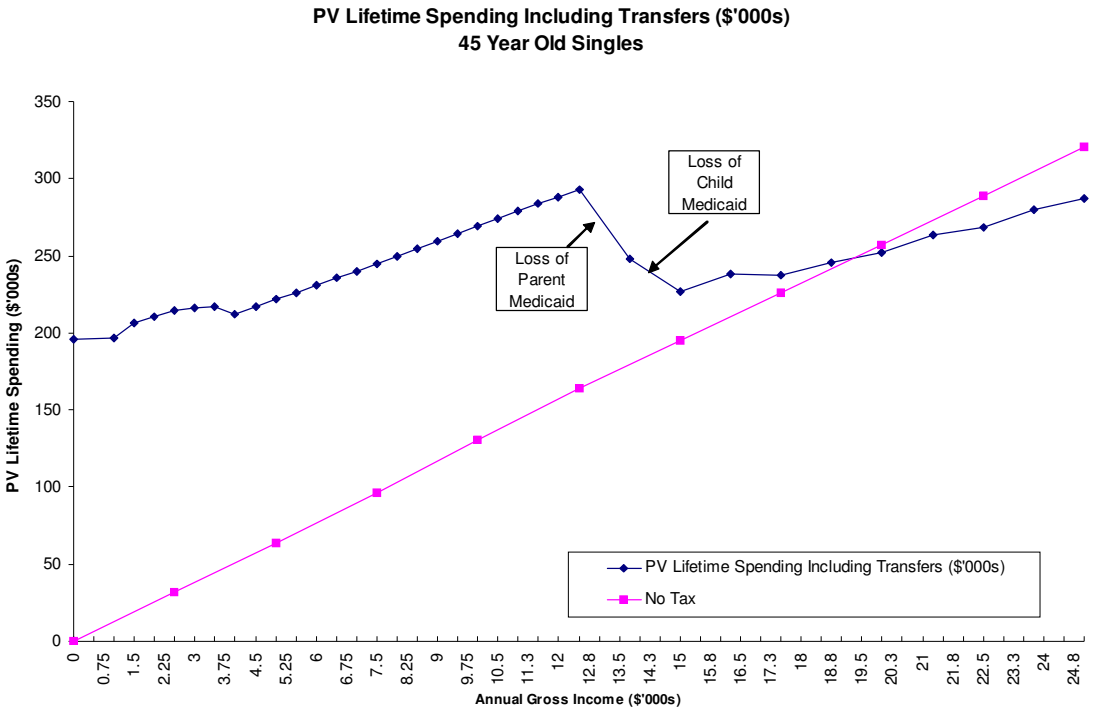


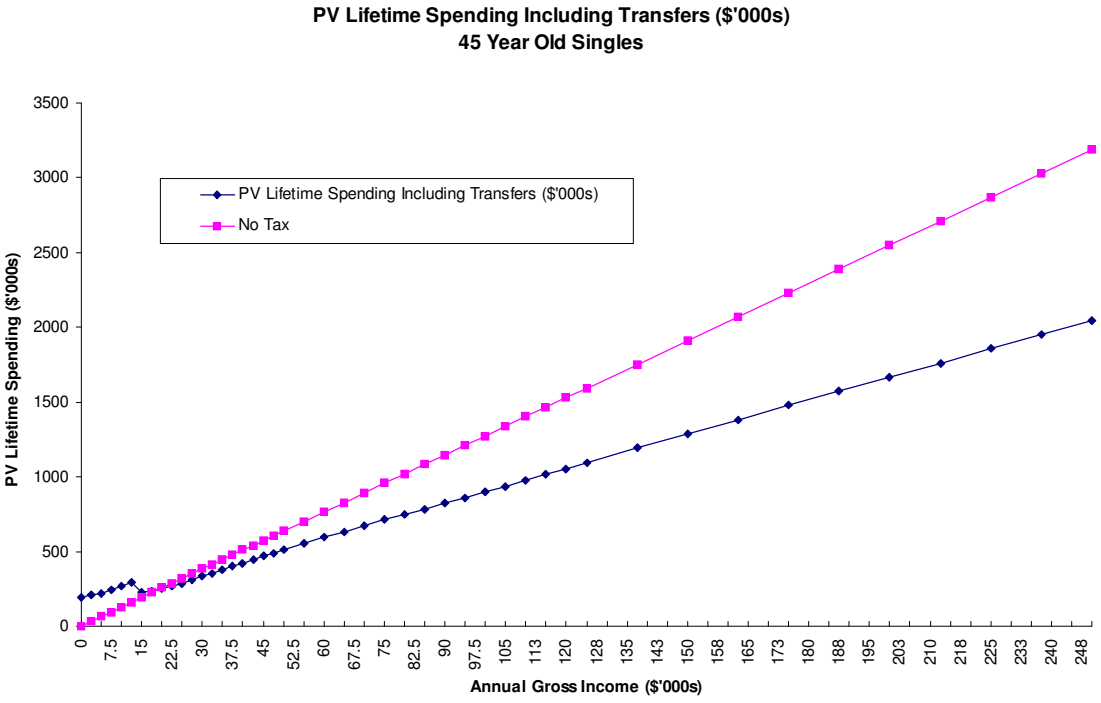
Marginal Effective Tax Rate
45 Year Old Singles Earning $0-$25,000/yr



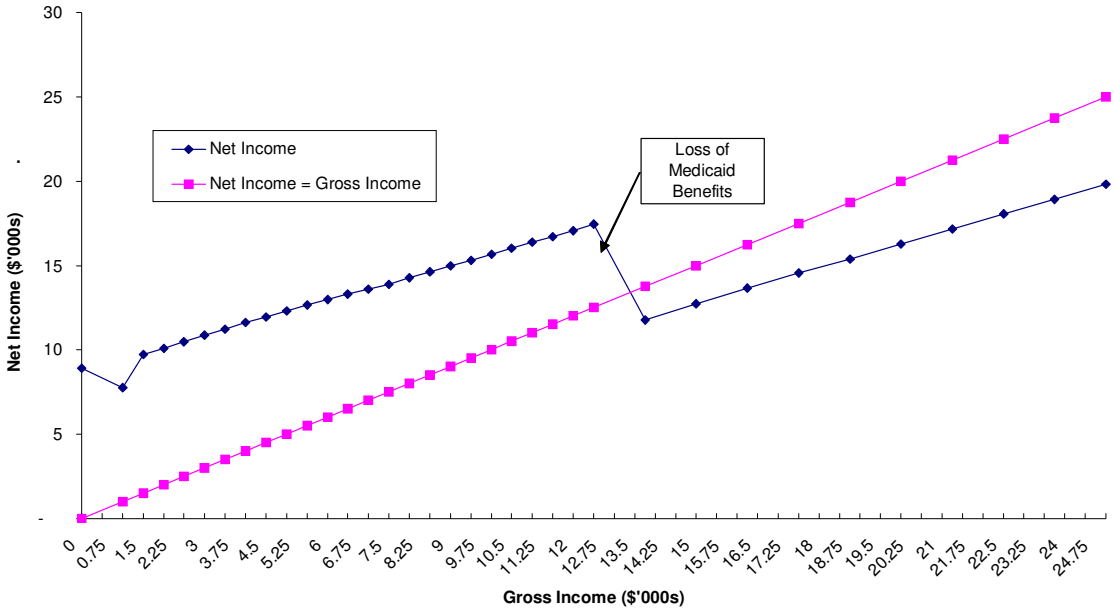
Marginal Effective Tax Rate
45 Year Old Singles $25,000-$250,000/yr



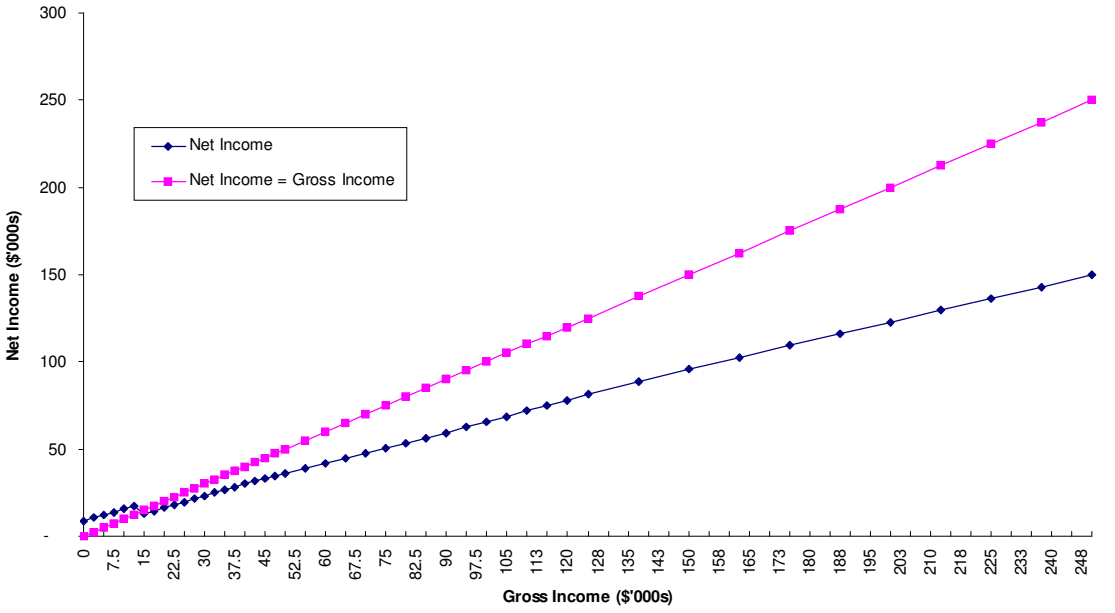

PV Lifetime Spending Including Transfers ($'000s)
45 Year Old Singles
PV Lifetime Spending ($'000s)
Annual Gross Income ($'000s)
Loss of Child Medicaid
Loss of Parent Medicaid
PV Lifetime Spending Including Transfers ($'000s)
No Tax


PV Lifetime Spending Including Transfers ($'000s)
45 Year Old Singles
PV Lifetime Spending ($'000s)
Annual Gross Income ($'000s)
PV Lifetime Spending Including Transfers ($'000s)
No Tax

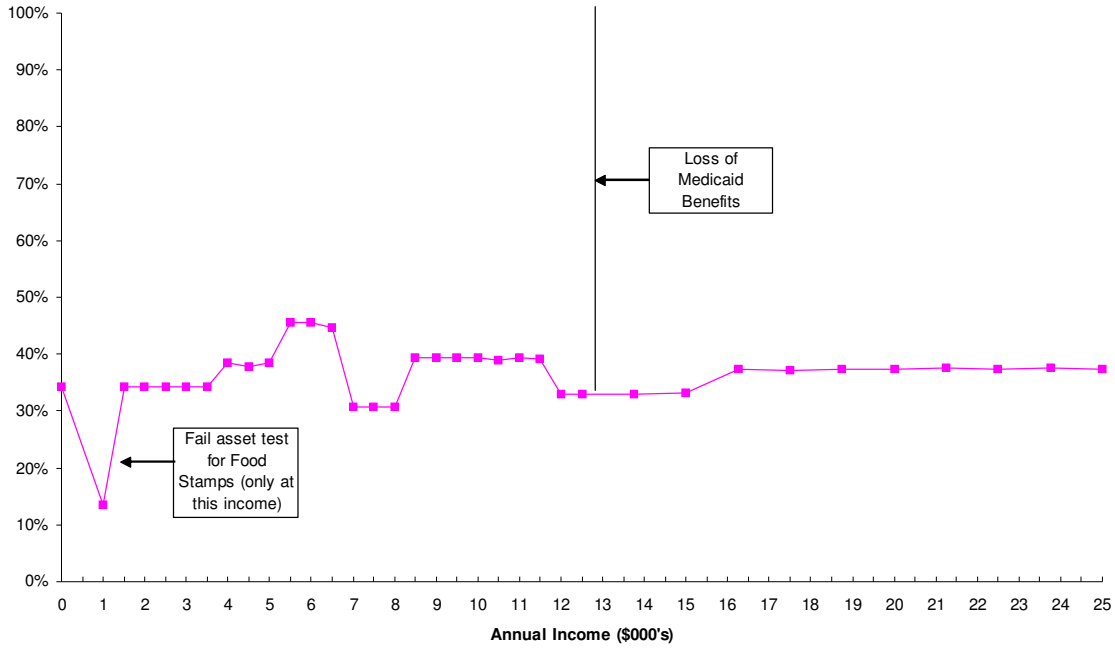
Gross Income vs. Net Income (1 year)
60 Year Old Singles Earning $0-$50,000/yr



Gross Income vs. Net Income (1 year)
60 Year Old Singles Earning $0-$50,000/yr



Marginal Effective Tax Rate
60 Year Old Singles Earning $0-$25,000/yr



Marginal Effective Tax Rate
60 Year Old Singles $50,000-$500,000/yr