The Marginal Cost of Redistribution: Lifetime and Annual Perspectives*

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I. Introduction

Approximately 40% of Federal government expenditures are spent on redistributing income from high income households to low income households [20, 293]. Changing income redistribution policies causes distortions which affect the efficiency of resource allocation. Costs caused by these distortions are an important consideration in determining redistribution policies and practices. Previous studies, such as Browning and Johnson [5] looked at the marginal cost of redistribution using annual income data. However, as is shown in this article, using annual rather than lifetime income data greatly understates the marginal cost of redistribution.

The time period is an important consideration when calculating the marginal cost of redistribution. Over a lifetime a person may be a young student expecting a higher future income; be retired having had a higher income in the past; be changing jobs or recently divorced. Lifetime income includes these age and transitory differences in earnings and thus if we are concerned about the cost of decreasing inequality, lifetime income is more accurate.

Also the relevant time period partly depends on the capability of households to even out income fluctuations by spreading income from good to bad times. Upper income groups find it easier to spread income by borrowing or waiting until income rises again while lower income groups find it more difficult to borrow or wait. If we are measuring the number of people in poverty and poor people find it difficult to spread income from good to bad periods, the relevant period of time may be about a week. But using a week for upper income groups would be misleading as many would appear poor but not face the difficulties of the poor.

If most people can average their income, then the annual distribution of income is more appropriate than weekly. However, because of the above mentioned age and transitory differences in income, annual income may also be misleading. People are affected differently in different years by the tax-transfer system, in some years a person may receive transfers and in others pay taxes. Since households live their lives rather than a single year under the tax-transfer system, well-being is more accurately described on a lifetime basis. Lifetime income gives a more accurate picture of households' chances in life and of the degree of economic inequality.

In this article, the annual and lifetime marginal costs of redistribution are calculated by a simulation that uses a lifetime dynamic labor supply model. A linear income tax type of redistri-

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Table I. Lifetime Marginal Cost of Redistribution

HH (1)	Initial Earn. (2)	Change In Earn. (3)	Net Change in Tax Rev. (4)	Trans. (5)	Net Trans. (6)	Change in Disp. Inc. (7)	Change in Real Inc. (8)	Change in Avg. Tax Rate (9)
1	$11,100	−55.50	88.80	159.84	71.04	15.54	48.84	.64%
2	$16,100	−80.50	128.80	159.84	31.04	−49.46	−1.16	.19%
3	$19,100	−95.50	152.80	159.84	7.04	−88.46	−31.16	.04%
4	$22,500	−112.50	180.00	159.84	−20.16	−132.66	−65.16	−.09%
5	$31,100	−155.50	248.80	159.84	−88.96	−244.46	−151.16	−.29%
	$99,900	−499.50	799.20	799.20	0	−499.50	−199.80	

bution policy is used to redistribute income.[1] A linear income tax is where tax revenue from the wage tax is redistributed equally per household.

The marginal cost of redistribution from an increase in the wage tax is defined as the lost real income to the four upper income quintiles divided by the gain in real income to the bottom quintile. The marginal cost of redistribution can be thought of as the additional cost to upper income groups to redistribute $1 to the poor. In calculating the efficiency cost only labor-leisure distortions are included.

The decision to view the marginal cost of redistribution from a lifetime perspective is highly significant. The marginal cost of redistributing income is greater the more equal is the distribution of income. Since the lifetime income distribution is more equal than the annual income distribution, the lifetime marginal cost of redistribution is greater than the annual marginal cost of redistribution.

II. Preliminary Remarks

A numerical example can illustrate why the marginal cost of redistribution is greater if there is a greater degree of income equality. Each quintile in Tables I and II consists of 1 household. The initial earnings in column 2 of Table I, which correspond to the degree of lifetime income inequality, are much more equal than the initial earnings in column 2 of Table II, which correspond to the degree of annual income inequality.[2]

The examples illustrated in Tables I and II assume that (1) there are no capital income taxes and (2) labor supply depends only on a small change in the marginal tax rate and not on the average tax rate, so that income effects are assumed to be zero.[3] The labor supply elasticity is

1. The linear income tax is commonly used in the Optimal Income Tax and Redistribution literatures. Browning and Johnson [5, 180–181] present evidence that a proportional increase in all taxes and transfers would redistribute income in a manner similar to a linear income tax.

2. These figures were obtained from calculations performed by Davies, St-Hilaire, and Whalley [7] for lifetime and annual income inequality for Canada in 1970.

3. The justification for this assumption is as follows: Assuming the income effect to be negligible implies that the compensated labor supply elasticity is equal to the uncompensated elasticity. Although this assumption is not literally true,

Table II. Annual Marginal Cost of Redistribution

HH (1)	Initial Earn. (2)	Change In Earn. (3)	Net Change in Tax Rev. (4)	Trans. (5)	Net Trans. (6)	Change in Disp. Inc. (7)	Change in Real Inc. (8)	Change in Avg. Tax Rate (9)
1	$ 4,400	−22.00	35.20	159.84	124.64	102.64	115.84	2.83%
2	$11,900	−59.50	95.20	159.84	64.64	5.14	40.84	.54%
3	$17,400	−87.00	139.20	159.84	20.64	−66.36	−14.16	.12%
4	$23,200	−116.00	185.60	159.84	−25.76	−141.76	−72.16	−.11%
5	$43,000	−215.00	344.00	159.84	−184.16	−399.16	−270.16	−.43%
	$99,900	−499.50	799.20	799.20	0	−499.50	−199.809	

assumed to be 0.3. The original marginal wage tax rate is assumed to be .40. The marginal increment in the wage tax is 1 percentage point. Since it is assumed that there is no change in the market wage in response to the change in the wage tax, the percentage change in the net wage is equal to .0167 (.01/(1 − .4)). Thus in column 3, the reduction in earnings of .005 is determined by multiplying the percentage change in the net wage (.0167) by the labor supply elasticity (0.3).

The change in tax revenue is shown in column 4. Tax revenue is not just the wage tax increment times initial earnings. Since earnings have decreased because of the increase in the wage tax, the tax revenue from the original 40% wage tax is also reduced. The reduction in tax revenues is determined by multiplying the original wage tax rate times the reduction in earnings in column 3. The additional tax revenue is $799.20 rather than $999. The additional tax revenue of $799.20 is then redistributed equally to each of the 5 households as shown in column 5.[4]

Column 6, the sum of columns 4 and 5, shows the net transfer received or the net tax paid. The change in disposable income is shown in column 7. It is the net transfer received by each household (column 6) minus the reduction in earnings from the tax increment (column 2). In both tables the overall disposable income of the economy is reduced by $499.50.

A better measure of well-being than the change in disposable income is the household's change in real income which is the change in disposable income plus the value of additional leisure as shown in column 8. Assuming that the household values additional leisure at the net wage rate, the value of additional leisure is 1 minus the initial marginal wage tax rate (.6 in this case) times the reduction in earnings in column 3.

Two measures of the marginal cost of redistribution are: (1) the money marginal cost and (2) the real marginal cost.[5] The money marginal cost is the ratio of losses divided by gains of disposable income and the real marginal cost is the ratio of losses divided by gains of real income.[6] In column 7, the money marginal cost of redistributing a dollar to household 1 is $33.14

Browning and Johnson [5] found that the trade-off or marginal loss depended primarily on the compensated elasticity; labor supply reductions were greater at the bottom when income effects are incorporated, and smaller at the top so that income effects had very little impact on the overall results. However, even though the income effect is ignored in these simple examples, it is included in the computer simulation presented in the next section.

4. As mentioned above, this redistributive policy is called a linear income tax.

5. If the concern is to increase the standard of living of the poor, the money marginal cost is most appropriate. If the concern is the real gain to the poor then the real marginal cost is more appropriate.

6. The real (money) marginal cost of redistribution may also be interpreted as the amount of real (money) income lost by upper income households when a redistributive program is expanded to produce a real (monetary) gain of $1 to lower income households.

($515.04/15.54) in the more equal distribution of income in Table I and $5.87 in the less equal distribution of income in Table II. In column 8, the real marginal cost of redistributing $1 to household 1 is $5.09 in the more equal distribution of income in Table I and $2.73 in the less equal distribution of income in Table II. Thus the marginal cost of redistribution increases when the inequality of earnings decreases.

The changes in the average tax rates are determined by dividing the households' net transfers (column 6) by the households' initial earnings (column 2). The changes in the average tax rates show the amount of additional transfer income paid or received by each household while the marginal tax rate causes the efficiency loss. The changes in the average tax rates are larger in the less equal annual distribution (Table II) because more income is redistributed.

The lifetime marginal cost of redistribution (Table I) is greater than the annual marginal cost of redistribution (Table II) because the lifetime earnings distribution is more equal than the annual earnings distribution. When the distribution of earnings is more equal and the mean is constant, there is less tax revenue but the efficiency loss is the same. In other words, the efficiency losses are the same but less is redistributed, consequently the per dollar marginal cost of redistribution increases.[7]

These simple numerical examples demonstrate that the annual marginal cost of redistribution is likely to be less than the lifetime marginal cost of redistribution. However, they are not conclusive. The numerical examples do not include intertemporal aspects that are included in a dynamic model. That is, households will change the amount of labor they provide at different ages because of the change in the tax-transfer system.

III. The Simulation

This study develops a discrete time simulation using an extension of the dynamic labor supply model developed by Heckman [9], Heckman and MaCurdy [10], MaCurdy [14], and Killingsworth [12] to compare the lifetime and the annual marginal costs of redistribution.

Data on the average wage rates for heads of households were taken from the Survey Research Center's *A Panel Study of Income Dynamics* [16] to determine values for the wage rates used in the simulation.[8] The wage data are used to calculate 50 lifetime wage profiles. A lifetime wage profile consists of the wages that a household earns in each of 11 age periods that the household lives. These age periods last 5 years each and start at the beginning of age 20 and end at the conclusion of age 74 for a total of 55 years. Each household uses the wage profile that it confronts to decide on the optimal amount of labor to supply to the market during each of the 11 age periods. In the simulation, only age and wage differences cause incomes to differ. These wage differences are caused by both age and transitory factors.

One household is assumed to be in each of the 11 age periods that make up a lifetime wage profile with a new household starting and an old household ending their economic lives every 5 years. The households which follow the same wage profile have exactly the same lifetime income

7. Implicit in the optimal taxation literature is the calculation of the marginal cost of redistribution. According to Mirrlees [15] the reason the amount of inequality affects the marginal cost of redistribution is that the "labor-discouraging effects of the tax are more important, relative to the redistributive benefits." In his article differences in inequality were created by changing the distribution of skills.

8. The average wage rate was determined by the Panel Study staff by taking the amount of labor income reported for 1982 by the head of each household studied in 1983 and dividing this labor income by the hours of work he/she reported for 1982.

though they will have different yearly incomes because there are different wage rates in different age periods. Since there are 50 of these wage profiles and 11 households in each profile, there are a total of 550 households in the simulation. For simplicity, there is one wage earner per household and all households are equivalent except for age and wage differences.

To determine the distribution of wage rates in each of the 11 age groups, the head of household's wage rates and the Panel Study's weighting factor were sorted by age into the 11 age groups.[9] The wage rates and weighting factors were then used to calculate the relative frequencies with which the wages appeared in each age group.[10]

Once these Panel Study relative frequencies were calculated for each age group, they were used as a frequency distribution to which a random number generator was applied to randomly assign wage rates to each of the 11 age groups in the 50 lifetime wage profiles. The wage rates in the wage profiles were then adjusted until the degree of income inequality calculated in the simulation approximated the degree of income inequality calculated by Lillard [11], Blinder [1], and Davies, St-Hilaire, and Whalley [7].[11]

IV. Labor Supply and Consumption Functions

To derive equations for the household's optimal amount of consumption and leisure, the assumption is made that each household gains satisfaction from consumption goods $C(t)$ and leisure time $L(t)$ and that the household maximizes a log-additive Cobb-Douglas utility function of the form $u[C(t), L(t)] = \alpha \ln C(t) + \beta \ln L(t)$ at each time t.

A major implication of using a log-additive Cobb-Douglas utility function is that the elasticity of substitution between consumption and leisure is always equal to 1. For this reason, the substitution effect between consumption and leisure and the compensated elasticity calculated by the simulation will probably be greater than would be calculated in a model with a smaller elasticity of substitution. However, as shown below, the compensated and uncompensated elasticities which result from the simulation calculations are in the ranges calculated in empirical labor supply studies.

Lifetime utility is the sum of each household's discounted utility from the beginning to the end of its life. Each household continues for 11 periods of five years each; the first period is 0 and the last is 10. The household's utility in each of the 11 time periods is discounted to time 0 by the household's discount rate (δ). In discrete time, lifetime utility is:

$$U = \sum_{t=0}^{10} (1 + \delta)^{-t} [\alpha \ln C(t) + \beta \ln L(t)]. \quad (1)$$

As in the continuous case, $U_c(t) > 0$, $U_L(t) > 0$, $U_{cc}(t) < 0$, $U_{LL}(t) < 0$, and $U_{cL} = U_{Lc}$. The household prefers more consumption and leisure to less and as more is consumed, satisfaction increases at a decreasing rate.

9. Since the panel study has relatively more poor households than there are in American society, the weighting factor is used to adjust the wage rates to be representative of the wage rates received in society.

10. The relative frequencies are calculated for $0, $0 to $1, $1 to $2, and so on by $1 increments until $20. After $20 the relative frequencies are calculated for $20 to $25, $25 to $30, $30 to $35, $35 to $40, $40 to $50 and above $50.

11. These studies suggest that the coefficient of variation is between .75 to .90 for annual income and between .40 to .50 for lifetime income and that the Gini Coefficient is between .35 to .43 for annual income and between .20 to .35 for lifetime income.

Assuming zero inheritances, each household over its lifetime gains income from wage earnings and government transfers. Assuming zero bequests, gross income will be spent on consumption goods and taxes. Thus the lifetime budget constraint in discrete time is:

$$\sum_{t=0}^{10}(1+r)^{-t}[(1-\tau_w)W(t)H(t)+G_y(t)-C(t)]. \tag{2}$$

Net wage earnings are represented by $(1-\tau_w)W(t)H(t)$ where τ_w is the wage tax, $W(t)$ is the wage rate and $H(t)$ is the number of hours worked in each period. The letter r stands for the market interest rate. The lump sum government transfer $G_y(t)$ is determined by adding up all tax revenue at time t and dividing the revenue by the number of households.

To attain the greatest possible satisfaction, the household optimizes lifetime utility subject to the lifetime budget constraint. To find the optimal solutions for consumption and leisure, substitute $\alpha/C(t)$, the Cobb-Douglas marginal utility of consumption, for $U_c(t)$ in the first order condition $e^{-\delta t}U_c(t)=e^{-rt}\mu$ and $\beta/L(t)$, the Cobb-Douglas marginal utility of leisure, for $U_L(t)$ in the first order condition $e^{-\delta t}U_L(t)=e^{-rt}(1-\tau_w)W(t)\mu$. Also, let the interest rate r equal the time preference rate δ; then rearrange terms until equations (3) and (4) are derived. Equations (3) and (4) equate the marginal benefits and costs of consumption and leisure time at each time t.

$$C(t)=\alpha/\mu \tag{3}$$

$$(1-\tau_w)W(t)L(t)=\beta/\mu \tag{4}$$

To solve for the demand functions for consumption and leisure at each time t, it is necessary to find the optimal value for the marginal utility of initial wealth (μ). This is done by substituting equations (3) and (4) into equation (2), the lifetime budget constraint and solving for μ.

$$\mu=\{(\alpha+\beta)\sum_{t=0}^{10}(1+\delta)^{-t}\}/\{\sum_{t=0}^{10}(1+r)^{-t}[(1-\tau_w)W(t)Hrs+G_y]\} \tag{5}$$

where Hrs is the maximum time in each period that the household has available for work and leisure.

In equation (5), let A be the numerator and B the denominator so that $\mu=A/B$. Notice that B is the discounted lifetime net earnings of the household, and A is proportional to discounted lifetime utility.

The demand functions for consumption and leisure at each time t are found by substituting μ into equations (3) and (4) and solving for $C(t)$ and $L(t)$. The functions for consumption and leisure at each time t can be written:

$$C(t)=\alpha B/A \tag{6}$$

$$L(t)=\beta B/[A(1-\tau_w)W(t)]. \tag{7}$$

The numerical value for available hours (Hrs) is arbitrary because the idea of what is to be included in leisure is not precisely defined. Phlips [18, 253–259], using a Stone-Geary utility function subject to a budget constraint, calculated that the maximum number of hours an individual is willing to work is about 2,600 hours a year or 50 hours a week. Since in the simulation, a period is 5 years long, 2,600 hours a year corresponds to 13,000 hours in each period.

To test how sensitive the simulation results are to changes in available hours, the simulation was calculated for 13,000 hours 18,200 hours, and 29,120 hours in each period. 18,200 is calculated by assuming that a household has 10 hours a day, 7 days a week, and 52 weeks a year for 5 years and 29,120 is calculated by assuming a household has 16 hours a day, 7 days a week, and 52 weeks a year for 5 years. I consider 18,200 to be the best estimate and use it in my central case calculation of the marginal cost of redistribution.

In this simulation 3% is considered most representative of the interest rate.[12] The simulation is also run for real interest rates of 0% and 6% to test the sensitivity of the model.

The values for alpha and beta in equations (6) and (7) are chosen so that the simulation results approximate the values calculated in other studies. The value of alpha is 0.7 and beta is 0.3 for all households in the simulation.

In the simulation the assumption is that the reduction in income inequality is caused by a 1 percentage point increment in a flat rate wage tax with the revenue from the tax being redistributed equally per household. This wage tax can be thought of as a weighted average marginal tax rate for all taxes that fall on earnings. The simulation is calculated for various initial values of the wage tax. These values are 0.38, 0.43, and 0.48. These figures are estimates of the marginal tax rates on wage earnings. A marginal wage tax rate of 43 percent was considered by Browning [3, 15] as the amount of taxes a typical household in the U.S. will pay on each additional dollar of earned income. In the simulation, 43% is used as the best estimate of the value of the marginal tax rate.[13]

Before the 1 percentage point increment in the marginal wage tax, 40% of tax revenue is used for transfers and the remaining portion is used for other government expenditures such as defense while the tax revenue from the 1 percentage point increment in the marginal wage tax is used solely for transfers [20, 293].[14] The percentage of government expenditures that are used for the government transfer payments before the marginal wage tax increase is assumed to be constant over all the lifetimes.

The linear income tax program used in the simulation imposes a balanced budget constraint on government transfer payments in each period. In each period, before the increase in the marginal wage tax rate, each household receives government transfer payments equal to the total government tax revenue that is to be used for government transfer payments divided by 550 where 550 is the number of households in the simulation. After the increase in the marginal wage tax, each household receives government transfer payments equal to the tax revenue divided by 550. Transfers payments are calculated both before and after the increase in the marginal wage tax rate in each period.

V. Net Benefit or Loss from the Increase in the Tax-Transfer System

Each household's net benefit or net loss from a marginal increment in the tax-transfer system is the additional amount received from the new transfer minus the additional amount paid in taxes to

12. In models with perfect capital markets, the interest rate is the rate of return on savings, the cost of borrowing, and the rate at which future streams of wealth are discounted. Though strong, this assumption greatly reduces the complexity of the simulation.

13. Because of the increase in the standard deduction and the phasing out of exemptions at higher income levels the Tax Reform Act of 1986 may have made the marginal tax rates more progressive even though the statutory tax rates were reduced.

14. This percentage is calculated by assuming that government transfer expenditures include Income Security expenditures less Federal Employees Retirement and Disability expenditures plus Social Security, Medicare, and Social Services expenditures. The sum of the Federal Government transfer payments from these sources are then divided by total Federal Government expenditures.

pay for the additional transfers minus the marginal welfare cost. In the simulation the net benefit or loss in each age period from the increase in the tax-transfer system is calculated by:

$$\Delta NL = \Delta G_y(t) - \Delta \tau_w W(t)H(t) - \Delta WL(t) \tag{8}$$

where $\Delta G_y(t)$ is the change in government transfers, $\Delta \tau_w W(t)H(t)$ is the change in tax payments, and $\Delta WL(t)$ is the additional welfare cost.[15]

If the change in government transfers is greater than the increased tax payments plus the additional welfare cost, then the household is a net gainer from the increase in the tax-transfer program. The lifetime net gain or loss for each household from the increase in the tax-transfer system is calculated by discounting the net benefits or losses in each of the 11 age periods to age zero.

In the simulation the additional welfare cost is calculated using the methodology developed by Browning [2; 3; 4]. The additional welfare cost is measured by equation (9) and is used to calculate the marginal welfare loss for each household in each of the 11 age periods in the simulation.

$$\Delta WL(t) = [(.5\Delta\tau_w + \tau_w 1)(W(t)H_2\cap)/(1 - \tau_w 1)]\Delta\tau_w. \tag{9}$$

In equation (9), $\tau_w 1$ is the wage tax rate before the marginal increase; $\Delta\tau_w$ is the increment in the wage tax which will be .01; $W(t)$ is the wage rate at age t without any taxes; H_2 is the quantity of labor supplied to the market before the increase in the wage tax; $\cap$ is the compensated elasticity.[16]

To calculate the marginal welfare cost, the compensated labor supply elasticity is needed. The compensated labor supply elasticity equals the uncompensated labor supply elasticity plus the income elasticity multiplied by the wage rate. In the simulation, for simplicity, the average uncompensated elasticity is calculated for the percentage change in total labor supply divided by the percentage change in wages for all households in a single time period.[17] Since the income effect must be multiplied by the wage rate in each period, the income elasticity is calculated for each household. The individual income elasticities are then averaged together to determine the overall income elasticity. The income elasticity and the uncompensated elasticity are then added together to determine the compensated elasticity. This compensated elasticity is used to calculate the marginal welfare cost for each household at each period of time.[18]

Since the marginal cost of redistribution is the ratio of the average net loss to the upper four quintiles to the average net gain to the bottom quintile, lifetime and annual quintiles are needed.

15. For each period the simulation calculates and compares the steady state values for transfer payments, tax revenue, labor supply, and income both before and after the 1 percentage point increase in the marginal wage tax.

16. Equation (9) is calculated by assuming that the compensated labor supply curve between the original and new labor supplies is a straight line. The change in the welfare cost is then directly calculated as $\Delta WL(t) = \{.5[W(t)\Delta\tau_w] + W(t)\tau_w 1\}\Delta H_2(t)$. To determine $\Delta H_2(t)$, multiply $\Delta H_2(t) = \Delta H_2(t)$ by $H_2(t)/H_2(t)$, $(1 - \tau_w 1)/(1 - \tau_w 1)$, and $W(t)\Delta\tau_w/\Delta W(t)$ where $W(t)\Delta\tau_w = \Delta W(t)$ and rearrange terms until $\Delta H_2(t) = (\cap H_2(t)/(1 - \tau_w 1))\Delta\tau_w$. Then substitute $\Delta H_2(t)$ into $\Delta WL(t)$.

17. The simulation was also run using disaggregated uncompensated labor supply elasticities for marginal wage tax rates of .39, .44, and .48. Using disaggregated elasticities, the simulation results were within approximately $0.51 of the simulation results using the aggregated uncompensated elasticities. However, the simulation results were more stable when the aggregated elasticities were used.

18. Even though an explicit utility function is assumed, Browning's method was used to calculate the marginal deadweight loss because it greatly reduced the number of calculations and saved programming space thus making the simulation more efficient.

In each period, a household gains income from gross wage earnings, capital, and net government transfer payments. Annual income is the period income divided by 5. Lifetime income, because of the assumption of perfect capital markets, is discounted lifetime gross earnings and net transfer payments. Annual and lifetime income are then ranked from the highest income household to the lowest. Because there are 550 households in the simulation, each quintile consists of 110 households. The highest income group is the fifth quintile, and the lowest income group is the first quintile, and so on.

Previously, the net benefit or loss for each household from the increase in the tax-transfer program was calculated. After the quintiles have been formed, the average net benefit or loss for each quintile is calculated. The marginal cost of redistribution is then calculated as the ratio of the average net losses to the upper four quintiles to the average net gain to the bottom quintile. These ratios can be interpreted as the amount of real income given up by upper income households to redistribute one dollar to the poor.

VI. Results

As shown in cases 1 and 2 in Table III, using the simulation's central case assumptions, the marginal cost of redistributing $1 of real income to the lowest income quintile is calculated to be $2.52 using the annual income distribution, and $4.31 using the lifetime income distribution. The marginal cost of redistributing $1 of disposable income is $4.45 using the annual distribution, and $10.97 using the lifetime income distribution.[19]

The elasticities average values are 0.20 for the uncompensated elasticity, 0.36 for the compensated elasticity and 0.23 for the intertemporal elasticity. The estimated uncompensated, compensated, and intertemporal elasticities are within the range of previous estimates.[20]

The degree of income inequality in the simulation, as measured by the coefficient of variation, is 0.85 for the annual income distribution and 0.45 for the lifetime income distribution, while the Gini coefficients are 0.41 for the annual income distribution and 0.26 for the lifetime income distribution.[21] These estimates show slightly more income inequality than Lillard's [11] values for the coefficient of variation and Gini coefficients. The lifetime Gini coefficient of 0.26 is within the 0.2 to 0.35 range estimated by Blinder [1].

As shown in cases 3 and 4, the lower the marginal wage tax, the lower the marginal cost of redistribution and at higher tax rates the marginal cost of redistribution increases. When the marginal wage tax increases from 38% to 39% (case 3), the marginal cost of redistribution is $2.12

19. The marginal cost of redistribution in terms of disposable income is higher relative to the marginal cost of redistribution in terms of real income because leisure has value to households and the marginal cost of redistribution using disposable income does not include the value of leisure.

20. Pencavel [17] reviewing the labor supply literature for men, finds the central tendency for uncompensated elasticities is between −0.17 and −0.08 and for compensated elasticities is between 0.0 and 0.12. While Killingsworth and Heckman [13], reviewing the labor supply literature for women, find the central tendency for uncompensated labor supply elasticities is between 0.41 and 2.45 and for compensated elasticities is between 0.34 and 2.64.

The intertemporal elasticity shows the percentage change in labor supply given the percentage change in wages from one period to another. The intertemporal substitution elasticity is estimated to be between 0.01 and 0.05 by MaCurdy [14], between −0.068 and 0.44 by Ghez and Becker [8], and 0.32 by Smith [19].

21. The Gini coefficient is calculated by the following formula: $G = 1 + (1/n) - (2/(n^2\overline{y})[y_1 + 2y_2 + 3y_3 + \cdots + ny_n])$ where n = the number of people $\overline{y}$ = the average income, y is the highest income, y_2 is the next highest, and y_n is the lowest income household [6, 116].

Table III. Summary of the Simulation Results

	Case (1)	Annual Marg. Cost (2)	Life. Marg. Cost (3)	Uncomp. Elast. (4)	Comp. Elast. (5)	Inter-Temp. Elast. (6)
1	Real MC Central Case	\$2.52	\$4.31	0.20	0.36	0.23
2	Money MC Central Case	\$4.44	\$11.61	0.20	0.36	0.23
3	Real MC 39% Wage Tax	\$2.12	\$3.37	0.15	0.33	0.19
4	Real MC 49% Wage Tax	\$2.87	\$5.17	0.24	0.38	0.22
5	Real MC 13,000 Hours	\$2.52	\$4.31	0.20	0.36	0.23
6	Real MC 29,120 Hours	\$2.52	\$4.31	0.20	0.36	0.23
7	Real MC 0% Interest	\$2.52	\$3.87	0.20	0.37	0.22
8	Real MC 6% Interest	\$2.65	\$3.66	0.20	0.36	0.22
9	Real MC Less Inc. Equal.	\$2.50	\$3.18	0.20	0.36	0.34
10	Real MC More Inc. Equal.	\$2.77	\$18.79	0.19	0.34	0.27

for the annual income distribution and \$3.37 for the lifetime distribution. When the marginal wage tax is increased from .48 to .49 (case 4), the marginal cost of redistribution is \$2.87 for the annual income distribution and \$5.17 for the lifetime income distribution. This is because, as shown by equation (9), when the marginal wage tax rate is lower (higher), the marginal welfare cost is also lower (higher). Also, since the leisure demand curves are linear, with a lower tax rate, households are on a lower portion of the leisure demand curves and a movement up the curve will increase the elasticities.

As shown in cases 1, 5, and 6, when the number of available hours is changed there is no effect on the simulation results. This is because only the magnitude of the numbers has changed, not their relative standings.

When the interest rate decreases to zero percent (case 7), the lifetime marginal cost of redistribution is \$.44 lower than the central case. This slight decrease is because, as shown by equation (5), when there is a lower interest rate the marginal utility of initial wealth (μ) increases. The increase in the marginal utility of initial wealth causes households to increase lifetime labor supply when their wages are above the new lower reservation wage. Since households are earning more, the degree of income inequality increases and the lifetime marginal cost of redistribution decreases.

With a 6% interest rate (case 8), the lifetime marginal cost of redistribution is \$.65 lower than in the central case. Since some transfers are received while a household is young and most taxes are paid in the middle-age years, because of the higher interest rate, the value of the transfers received in the beginning periods become greater relative to the net taxes paid in the middle-age periods and the marginal cost of redistribution decreases.

As shown in case 9, when incomes are less equally distributed the marginal cost of redistributing income is lower. As incomes become more equally distributed (case 10), the greater the marginal cost of redistribution. In case 9, the marginal cost of redistribution is \$2.50 for the annual distribution of income and \$3.18 for the lifetime distribution of income. In case 10, the marginal cost of redistribution is \$2.77 for the annual distribution of income and \$18.79 for the lifetime distribution of income.

The simulation results of the marginal cost of redistribution are sensitive to the degree of income inequality, the original wage tax rate, the interest rate, and, as shown in Browning [4], the labor supply elasticity. The parameters used in the simulation are only estimates of the "true" values of these parameters and the literature contains various estimates for these "true" values. Since the simulation results are sensitive to the values of these parameters, the lifetime and annual marginal costs of redistribution reported above should not be thought of as precise values of the marginal costs of redistribution but as estimates that are of the correct order of magnitude.

The lifetime and annual marginal costs of redistribution calculated here are also only for a distortion in labor supply caused by a marginal change in the wage tax and do not include the administrative or compliance costs of collecting and redistributing income nor does the simulation include the effect of the increase in the wage tax on saving or the choice of occupation. Including these effects would increase the marginal cost of redistribution.

VII. Summary

Viewing the marginal cost of redistribution from a lifetime approach is highly significant. Redistribution costs are an important consideration in determining redistribution policies and practices. Previous studies, such as Browning and Johnson [5], used only annual income distributions. However, age and transitory differences cause the lifetime income distribution to be more equal than the annual income distribution. Because of the greater income equality the cost of redistributing income is approximately twice as expensive using lifetime data relative to annual data.

Using the simulation's central case assumptions, the marginal cost of redistribution, which is defined as the ratio of the real net losses to the upper four quintiles divided by the real net gains to the bottom quintile, is estimated to be \$2.52 using the annual income distribution, and \$4.31 using the lifetime income distribution. The marginal cost of redistribution in terms of disposable income is estimated to be \$4.45 using the annual distribution, and \$10.97 using the lifetime income distribution.

Another interesting result from this study is that the simple tables shown in section 1 provide results that are close to those provided by the much more complicated simulation.

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