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ABSTRACT

In this paper, we examine Ricardian equivalence of debt and tax finance in a world in which taxes are not lump-sum but are levied on risky labor income. First, we show that the marginal propensity to consume out of a tax cut, coupled with a future income tax increase, is positive under reasonable assumptions regarding preferences toward risk. Second, we document that the degree of income uncertainty facing the typical individual or family is large. Third, we show that, for plausible utility function parameters and distributions of future income, the MPC out of a tax cut is quantitatively large. Indeed, the MPC out of a tax cut, coupled with a future income tax increase, can be closer to the Keynesian value that ignores the future tax liabilities than to the Ricardian value that treats future taxes as if they were lump-sum.

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I. Introduction

In conventional Keynesian macroeconomic models, a debt-financed tax cut stimulates aggregate demand. As Tobin [1980] discusses, this effect is central to the traditional conclusions that tax changes might have a useful role in short-run stabilization policy and that persistent government deficits reduce the steady-state capital stock. This view of debt finance is implicit in many policy discussions regarding the large current Federal deficits.

One possible objection to this conventional view, first noted by Ricardo, is that it ignores the future tax liabilities implicit in debt finance. In any finite horizon model, for example, the government must at some point levy taxes to repay the debt. The present value of the future taxes exactly equals the value of the debt. If the planning horizon of individuals is at least as long as the horizon over which the debt is repaid, then the replacement of current taxes with future taxes could not increase individuals' perceived wealth. In this world, therefore, government bonds do not stimulate consumer spending.[1]

The argument for the equivalence of tax and debt finance would have little force in the absence of some account as to why mortal individuals might plan over an horizon as long as that of the government. In an ingenious paper, Barro [1974] builds upon Becker's [1974] theory of the family to provide such an account. Barro envisions a

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[1]In this paper, we work in finite horizon models. As Bryant [1983] makes clear, the important issues are apparent even in two-period models. For discussion of Ricardian equivalence in infinite horizon models, however, see Feldstein [1976], Barro [1976], and Carmichael [1982].

continuing family linked by intergenerational altruism; each generation has the utility of the immediately succeeding generation as an argument in its own utility function. This plausible assumption implies that saving behavior depends in part on the intent of parents to leave bequests to their offspring. Because of the nesting of the utility functions, the family behaves as one immortal consumer.

The equivalence of debt and tax finance results from noting that, as long as bequests are positive, no one's budget constraint is altered by a tax cut. Only if parents are at a corner solution, in which they would like to leave negative bequests but cannot, will they choose to take advantage of the opportunity afforded by debt finance to increase their consumption at the expense of their children. Otherwise, the dissaving of the government is exactly offset by increased household saving aimed at helping the young meet their increased future tax liability. In this sense, the Barro result is a fundamental Modigliani-Miller theorem asserting that overall saving in each period is determined independently of the government's financing decision.

Barro [1974, 1980] and Tobin [1980] discuss a large number of deviations from the conclusion of debt-tax equivalence as various assumptions of the formal theorem are relaxed. Childless couples, alternative models of the bequest motive, corner solutions, imperfect capital markets, and several effects arising from the non-lump-sum nature of taxation and from uncertainty receive consideration. Tobin argues that all these effects imply that the replacement of current taxes with a package of debt and concomitant future taxes has a positive effect on aggregate demand. He says nothing, however, about either the relative importance of the various arguments or the quantitative significance of all of them taken together. Barro, on the other hand, while acknowledging deviations from the original hypothesis, concludes that they have indeterminate sign. Thus, he claims, Ricardian equivalence is the appropriate benchmark case.

In this paper, we examine one particular deviation from the Barro hypothesis (discussed by both Barro and Tobin) and argue that it has both determinate sign and potentially major quantitative significance. Barro [1974, p. 1115] writes, "It seems clear that, either in the sense of effects on perceived total wealth, or in the sense of risk composition of household portfolios, the impact of changes in government debt cannot be satisfactorily analyzed without an explicit treatment of the associated tax liabilities." Taking Barro seriously, we offer such an explicit treatment, noting that taxes are not lump-sum, but are positively related to income (indeed, progressively so), and that uncertainty about future income is substantial.

We emphasize the stylized fact (noted by, e.g., Lucas [1977] and documented later in this paper) that variation in individual fortunes is very large relative to aggregate uncertainty. Thus, the principal effect of a tax cut and debt issue may be an increase in risk-sharing, leading to a reduction in individual uncertainty about after-tax income. A general, though not universal, feature of optimal consumption plans is a precautionary demand for saving (Leland [1968]). In this case, as long as claims on human capital cannot be traded, a tax cut leads to increased consumption. The reason for this stimulatory effect is that the tax cut provides certain wealth while the future tax increase is contingent upon future income. Taken together, these effects reduce income uncertainty without changing the present value of expected tax payments.[2]

The principal result of this paper is that in a stylized but highly suggestive model with plausible estimates of the parameter values, the marginal propensity to consume out of a tax cut, with associated future income taxes, is likely to be large. Indeed, the MPC is in the neighborhood of neo-Keynesian values of the MPC that ignore the future tax liability implied by debt finance. Of course, the mechanism we highlight is very different from the usual "bonds are net wealth" channel. In our model, the positive MPC is due to the reduction in precautionary saving when the government, by reducing the variance of future income, provides insurance to individuals that is not available in the private market.[3]

Much of this paper is aimed at demonstrating the quantitative importance of the risk-sharing effect on consumption. This effect

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[2]Our examination is a partial equilibrium one, in that we consider only the decision of a consumer in the face of a tax cut. Of course, this partial equilibrium effect of a tax cut on consumer spending is a prerequisite for the conventional general equilibrium conclusions.

[3]Chan [1983] provides a careful discussion of the importance of missing markets for various deviations from the Barro hypothesis. Varian [1980] discusses the possible optimality of redistributive taxation as social insurance. In this paper, we examine only the positive, and not the normative, implications of the risk-sharing effect.

clearly depends upon the amount of individual uncertainty about future labor income. Interpreting the model on Barro's own turf, where operative intergenerational bequests are central, we need to consider not just uncertainty about one's own income, but uncertainty about the fortunes of future generations as well. We offer evidence from the available studies of income dynamics to show that the variance of the forecast error is in line with that required for a large marginal propensity to consume.

As is well known, solving for the decision rule of a consumer facing uncertain future income is intractable except in some simple cases. Therefore, to show the potential importance of the risk-sharing effect of a tax cut, we rely on the use of simulations. In particular, we use the technique of stochastic dynamic programming to examine the response of optimal consumption to the income tax cut and future tax increase. Previous authors consider at most the sign of the risk-sharing effect. Through the use of simulation, we are able also to examine its quantitative importance.

II. The Model

We begin by examining the effects of a tax cut in a two period model. All individuals in the model are identical *ex ante*. Their labor income in the second period is, however, uncertain and there do not exist markets through which they can insure against this risk.[4] We

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[4]That is, we exclude markets through which human capital returns can be explicitly traded and also securities with which individual-specific income risk can be hedged.

consider a policy under which the government cuts taxes in the first period, issues bonds to finance the tax cut, and increases income taxes in the second period to repay the debt.

Each individual maximizes expected utility:

(1) $$E\ U(C_1, C_2)$$

where C_1 = first period consumption,

C_2 = second period consumption,

E = the expectation operator conditional on information available in the first period,

$U(\cdot)$ = the von Neumann-Morgenstern utility function.

Before the policy intervention, each individual has first period labor income μ_1 and second period labor income $Y_2 = \mu_2 + \varepsilon$, where ε is a random variable that has zero mean and is uncorrelated across individuals. Although each individual faces uncertainty regarding his future income, there is no aggregate uncertainty.

Each individual can borrow and lend at the certain gross real return R. Wealth after the first period is

(2) $$W = \mu_1 - C_1.$$

Second period consumption is

(3) $$C_2 = RW + \mu_2 + \varepsilon.$$

In the absence of any government intervention, each individual maximizes expected utility (1) subject to the constraints (2) and (3).

Suppose the government gives each individual a tax cut T in the first period. Since all individuals in the model are identical *ex ante*, the form of the tax cut is irrelevant. Wealth after the first period is

$$(2') \qquad W = \mu_1 + T - C_1.$$

The government raises taxes to repay the debt in the second period. Suppose it obtains the extra revenue by an increase in a labor income tax.[5] That is, an individual with income Y_2 must pay

$$(4) \qquad t\,Y_2$$

in additional taxes, where t = the tax rate.

The government sets the tax rate t so that the total amount raised equals the debt, which is RT per person in the second period. This government budget constraint requires[6]

$$(5) \qquad RT = t(\mu_2)$$

or, equivalently,

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[5]Note that capital income is not taxed. If it were, then the policy intervention would lower the after-tax real interest rate, which would also affect consumption. Summers [1983] forcefully argues that a lower after-tax real interest rate raises consumption. Since our goal is to examine only the risk-sharing effect, we do not include capital taxation.

[6]More formally, the budget constraint requires that the tax rate times income per capita equals debt per capita. As the size of the population approaches infinity, the tax rate implied by this budget constraint converges in probability to the tax rate implied by (5').

(5') $t = RT/\mu_2.$

The amount of tax an individual with income Y_2 pays is therefore

(4') $RT\ (Y_2/\mu_2).$

An individual's consumption in the second period is now

$$(3') \qquad C_2 = RW + \mu_2 + \varepsilon - RT(\mu_2 + \varepsilon)/\mu_2$$

$$= RW + \mu_2 - RT + (1 - RT/\mu_2)\varepsilon.$$

Each individual maximizes expected utility (1) subject to the constraints (2') and (3'). The first-order condition is

$$(6) \qquad E[U_1(C_1,C_2)] = R\ E[U_2(C_1,C_2)]$$

The three equations (2'), (3') and (6) jointly determine the three variables C_1, C_2 and W.

We do not solve for the level of consumption C_1, as doing so is an intractible task except in very simple examples. We can solve, however, for the marginal propensity to consume (MPC) out of the tax cut as a function of optimal consumption. By implicitly differentiating the equations (2'), (3') and (6), we solve for dC_1/dT. We find

$$(7) \qquad MPC = \frac{R\ Cov[(R\ U_{22} - U_{12}),\varepsilon]}{-\mu_2[EU_{11} - 2R\ EU_{12} + R^2\ EU_{22}]} .$$

The MPC is not generally zero. A sufficient condition of the MPC to be positive is that $R\, U_{222} - U_{122}$ be uniformly positive.[7] In the additively separable case, the third derivative of the utility function must be positive. In other words, marginal utility must be a convex function of consumption. This condition is even weaker than the condition of non-increasing absolute risk aversion. Leland [1968] and Sandmo [1970] discuss the more general case and conclude that one should typically expect this condition to hold. Hence, the marginal propensity to consume out of a tax cut is presumptively greater than zero.

A common argument, made by Smith [1969] and Mundell [1971] among others, is that bonds are net wealth because individuals discount the associated future tax liabilities at an interest rate higher than the rate on government bonds. One cannot interpret our analysis in this way. A discount rate for human capital that includes a risk premium and thus exceeds the government bond rate is not sufficient to generate our results. For example, in the case of quadratic utility, optimal consumption decisions display certainty equivalence, despite the risk aversion of the consumer. In this case, the amount the individual would pay today to avoid his tax liabilities is less than their present value computed using the risk-free rate. Nonetheless, the MPC out of a tax cut is zero, since the third derivatives of the utility function are zero. The effects of debt and future taxes on the consumption

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[7]This result is demonstrated by noting that, for any non-degenerate random variable X and function $F(\cdot)$, if F' is uniformly positive, then $Cov(X,F(X)) > 0$.

decision cannot be analyzed by reference to any summary wealth statistic.[8]

III. The Extent of Income Uncertainty

The model and the effect we highlight rely on the existence of individual uncertainty regarding future income. Before turning to our simulation results, we examine the evidence on the extent of uncertainty regarding future income. As becomes clear below, this task is not a simple one. In this section, we attempt to use existing analyses of income dynamics to shed some light on the nature of this distribution. The available evidence does suggest that the degree of uncertainty is substantial.

We consider two interpretations of our model. In the first interpretation, the uncertainty concerns the income of an individual within his lifetime. In the second interpretation, the uncertainty concerns the performance of future generations of the family. We begin with the former.

A. Individual Uncertainty

One interpretation of the model, analogous to many interpretations of overlapping generations models, is that the two periods correspond to the two halves of a single person's life. That is, we can consider each period as corresponding to roughly thirty years.

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[8] An alternative reason that the future taxes might be discounted at an interest rate higher than that paid on the government debt might be that individuals borrow and lend at different interest rates. See Rotemberg [1984] for a model of liquidity constraints along these

The policy intervention then entails a tax cut during a person's youth coupled with a tax increase during his old age. Under this view, the relevant measure of the uncertainty is that of a young person regarding his income during the second half of his life.

In their analysis of the Michigan Panel Study of Income Dynamics, Hill and Hoffman [1977] pose the question, "Does an individual's economic status remain relatively constant over time or is there widespread change in economic standing?" Their conclusion is that "change in status is not only quite common but often quite dramatic as well." [p.30] In terms of the "income/needs ratio" discussed by Duncan and Morgan [1977], "less than a quarter of married men were in the same decile position in both 1967 and 1974, about 30 percent changed by one decile, and about 45 percent shifted by two deciles or more." [p.30][9] Not all of these transitions reflect genuine "news" about lifetime earnings. Some are probably transitory, reflect choices regarding change in occupation or labor supply, or were forecastable by the individual. It appears unlikely, however, that one can explain away the bulk of the variation in this fashion.

Another finding from analysis of the PSID is that individual incomes are highly vulnerable to disability, which includes medical,

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lines. Such liquidity constraints, however, are not present in our model.

[9]Hill and Hoffman also report that the largest share of variation in the income/needs ratio comes from income rather than needs. [p. 33]

psychiatric, and other factors limiting hours of work or precluding work entirely. It is a mistake to conclude that individuals largely insure themselves against income loss from disability. "Even when transfers offset some of the impact, there was a $3000 to $5000 a year difference in the family head's income associated with his or her disability." [Morgan, 1980, p.285]

Taubman [1975] calculates a "transition probability matrix" for individuals in his sample who reported earnings in both 1955 and 1969. His numbers indicate substantial fluidity with respect to transition from one economic status to another.[10] For example, an individual who is in the 70th to 80th percentile range in 1955 had a nine percent chance of finding himself below the 30th percentile in 1969, and a better than fifteen percent chance of falling below the 40th percentile. The probability that an individual beginning in the top ten percent made a transition to the bottom half exceeded nine percent.

Hall and Mishkin [1982], in their study of the sensitivity of consumption to income, provide statistical estimates of the income process that allows us to infer the degree of uncertainty. Using panel data on households, they first use regression to correct family income for life-cycle and other demographic effects. They then divide the residual into a lifetime component, which follows a random walk, and a transitory component, which follows a second-order moving-average process. Over a forecast horizon of thirty years, the variance of the

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[10]Because Taubman's sample is more homogeneous than the general population and he reports his transitions as movements between deciles, these numbers do not correspond to transition probabilities between deciles in the overall income distribution. The mean income in

lifetime component far exceeds the variance of the transitory component. Hall and Mishkin report that the annual innovation to the lifetime component has a standard deviation of about $1200. The standard error of a forecast over a thirty year horizon is thus $6600. Since the median family income during their time period (1972) was roughly $12,000, the implied coefficient of variation is 0.55.

The uncertainty in our model is individual rather than aggregate. This assumption is important, since the government cannot provide insurance against aggregate shocks to income. It is, however, also empirically valid. Hall and Mishkin [p. 480] report that the "overwhelming bulk of movements in income that give rise to our inference from the data are unrelated to the behavior of the national economy; most are probably highly personal." Thus, the observed degree of uncertainty is correctly interpreted as a measure of individual rather than aggregate risk.

B. Intergenerational Uncertainty

A second interpretation of the model is that the two periods represent two generations. The relevant measure of uncertainty is that of a person forecasting the income of his child. Perhaps surprisingly, it is easier to glean evidence on the conditional distributions of

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Taubman's top quintile is between three and four times the mean in the bottom qunitile, as compared to a ratio between seven and eight for full-time male workers in general.

sons' and grandsons' incomes than on the conditional distribution of own income. The distribution of a descendant's income presumably depends on a small number of identifiable characteristics.

A classic reference for the distribution of earnings conditional on family background, educational attainment, and occupational stutus is Jencks [1972]. Among his striking findings are:

1) Upper-middle-class parents are unable to ensure that their children will maintain their privileged position. Among men born into the most affluent fifth of the population, only 40 percent will be in this top quintile as adults. [p. 215]

2) Correlation between parents' and son's permanent incomes is only about 0.3. [p.236]

3) Family background explains about 15 percent of the variation in earnings. The earnings of brothers raised in the same home would vary radically. "In 1968, for example, if we had compared random pairs of individuals, we would have found that their earnings differed by an average of about $6,200. If we had had data on brothers, our best guess is that they would have differed by at least $5,600." If the earnings of the general population exhibited only the degree of inequality characteristic of brothers, the best-paid fifth of all male workers would still earn six times the pay of the lowest quintile. [p.219-220]

4) "Neither family background, cognitive skill, educational attainment, nor occupational status explains much of the variation in men's incomes.

Indeed, when we compare men who are identical in all these repects, we find only 12 to 15 percent less inequality than among random individuals." [p.226]

The following table compares several parameters of the conditional distribution of earnings given father's education and occupational status with the corresponding parameters of the unconditional distribution. The underlying data are earnings of full-time, year-round, male workers in 1968. [Jencks, p.236]

	Unconditional Distribution	Conditional Distribution Given Father's Education and Occupational Status
Standard Deviation	$5,508	$5,232
Ratio of Mean of Top 5th to Mean of Bottom 5th	7.7	6.5

Jencks interprets these numbers as evidence indicating a large random component in the determination of life-time earnings. In summary, "luck has far more influence on income than successful people admit." [p. 227]

Some studies, such as Brittain [1977], criticize Jencks on a variety of grounds: for not using actual data on brothers, for underestimating the correlation of income within families, and for jumping to excessively strong conclusions given his evidence. But, as the sophisticated studies in Taubman [1977] indicate, repeating Jencks's exercise with actual data on brothers and with more advanced statistical techniques leads to almost identical conlusions. For instance, Olneck writes, "The average difference between brothers on earnings is 87 percent as large as the difference between random individuals." [p.137]. Thus no parent can feel assured of even roughly predicting his children's future earnings.

IV. Simulation Method

The theory shows that, under plausible conditions, the marginal propensity to consume out of a tax cut is positive because of the risk-sharing effect. Examination of the degree of income uncertainty suggests that human capital returns are indeed risky and undiversifiable through contingent claims markets. We now turn to the question of whether the risk-sharing effect is quantitatively large. We answer this question by simulating the consumer's optimization problem for reasonable parameter values.

We try both two-period and multi-period examples, and we assume throughout that the utility function is time-separable. For the two-period examples, equation (7) gives the analytical expression for the MPC out of a tax cut in period one.[11] The right hand side of equation (7), however, must be evaluated at the optimal choice of consumption, which in general cannot be calculated analytically. We therefore use

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[11]For some of the simulations, the tax increase is not proportional to second period income. In these cases, an expression analogous to (7) is derived.

numerical methods to calculate the optimal level of consumption and then use this value in equation (7) is arrive at the MPC's.

In the multi-period examples, we do not use an analytic expression to compute the MPC's. We use numerical methods to calculate the optimal level of consumption in each example both before and after the tax cut. The MPC out of the tax cut is the difference in consumption divided by the size of the tax cut.

The technique used to calculate the optimal consumption levels is stochastic dynamic programming.[12] First, the problem is formulated as a stochastic control problem with one state variable (current wealth), one control variable (consumption) and one disturbance (income). The state space is discretized using a technique suggested by Bertsekas [1976]. For the last period of life, optimal consumption is equal to wealth, and the value function is equal to the utility function. In all prior periods, the computer searches, for each level of the state variable, for the choice of consumption that maximizes the sum of current utility and the discounted expected value of next period's value function.[13]

While the numbers are an approximation to the actual solution, we can make the approximation errors arbitrarily small by narrowing the

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[12]Zeldes [1983] describes this technique in more detail, and uses the technique to investigate some the the properties of optimal consumption in the presence of non-traded labor income.

[13]While there are simpler methods for calculating the two-period results (such as numerically approximating the solution to the single Euler equation), the advantage of this method is that the same technique can be used regardless of the number of the periods in the model.

width of the grid used for the discretization.[14] We tested our grid against some simple examples that can be solved analytically. The results were very close. We believe that our calculated MPC's are accurate to ± 0.03.

V. Two-Period Simulations

We begin with two-period simulations. As discussed above, one can interpret the simulations in two ways. The first interpretation is that each period represents a half of a single life.

During the first half of the individual's life, he earns \$100. During the second half, he also expects to earn \$100. This latter income, however, is uncertain. We assume that second period income follows the distribution:

$$Y_2 = \begin{cases} (1-x)100 & \text{with probability } p, \\ 100 & \text{with probability } 1-2p, \text{ and} \\ (1+x)100 & \text{with probability } p. \end{cases}$$

With some probability p, his income falls below its mean value of 100. One can view this unlucky event as a variety of possible outcomes. As discussed above, the degree of income uncertainty is great for the typical individual. The individual could become disabled, losing much of his earning power. The individual might lose his job in a high-

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[14] See Bertsekas [1976].

paying industry because of technological innovation or foreign competition. (The steel and auto industries come to mind here.) Or he simply could turn out less successful in his chosen occupation than he anticipated. The first outcome in the list above represents the "bad" event which, although possibly unlikely, may be sufficiently worrisome to generate a precautionary demand for saving.

The distribution of the individual's future income is symmetric, so that there is also a probability p of an extraordinarily good event. Individuals find themselves more successful in their careers than they expected. This sort of event is represented in the third outcome in the list above.

The second interpretation of the model is that the first period represents an individual's life, while the second represents the life of his child. Under this view, the individual is relatively certain of his own lifetime income, but his child's lifetime income is unknown. Indeed, his child may not even be born yet. He expects his child to earn the same as he does ($100), but, as documented above, one's child's lifetime performance in the labor market is highly variable. His child may be less able or simply "unlucky" in one of the ways mentioned above. Alternatively, his child may be extraordinarily lucky and find himself with the favorable outcome. Thus, either interpretation of the example is fully appropriate. For concreteness, we discuss the simulation as if it were two periods of a single life.

We consider a tax cut that gives the individual T in the first period along with a contingent tax liability in the second period.[15] In the bad state, the individual pays no tax. In the two other states, he pays a tax proportional to his income in excess of the floor income (1-x)100. In expectation, the present value of his tax liability equals his tax cut.[16]

The policy intervention we consider is a marginal tax change for an economy in which taxes and transfers already exist. Therefore, Y_2 is income net of these existing taxes and transfers. The income floor of (1-x)100 is possibly due to existing government programs. We assume that this income floor is not affected by the policy intervention.[17]

Tables 1 and 2 present the result of the simulations for two scenarios. In both, the real interest rate is zero (R = 1) and the utility function of the consumer is additively separable through time with no time preference. In both, the single-period utility function exhibits constant relative risk aversion. For the results in Table 1, the coefficient of relative risk aversion is one, while for the results in Table 2, the coefficient of relative risk aversion is three.[18]

Implicit in much neo-Keynesian analysis of tax cuts, such as that

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[15] The MPC's reported are for an infinitesimal T; these are very close to the MPC's calculated for a T of five percent of first period income.

[16] That is, $RT = E[t(Y_2 - (1-x)100)]$.

[17] Alternatively, one could assume that the tax increase is strictly proportional, rather than progressive. In this case, the MPC is exactly the product of x and the MPC as we compute it.

[18] Recent studies that estimate the coefficient of relative risk aversion find values in this range. See, for example, Hansen and Singleton [1983] or Mankiw [1983].

of Blinder [1981], are two assumptions. First, consumers set their consumption in proportion to the present value of expected income. In other words, their behavior exhibits certainty equivalence. Second, the future tax liabilities implied by debt finance are ignored. Under these two assumptions, the MPC out of a tax cut in a two period model with no discounting is 0.5. Thus, we take 0.5 to be the benchmark "Keynesian" estimate.

A. Excess Sensitivity

The first important observation is that consumption exhibits "excess sensitivity" to current income. Much work on consumption, not only that of Blinder on tax cuts but also that of Flavin [1981], Hall and Mishkin [1982] and Bernanke [1982], rests on the assumption that optimal consumption exhibits certainty equivalence. In this case, one need look only at the first moment of income to determine the optimal level of consumption. As pointed out above, under our other assumptions, certainty equivalence implies an MPC out of wealth of 0.5.

As Zeldes [1983] forcefully shows, utility functions with positive third derivatives can exhibit "excess sensitivity" in Flavin's sense, even though consumption is set optimally and there are no borrowing constraints. The top numbers in Tables 1 and 2 show the MPC out of a tax cut with no associated future tax increase for various degrees of uncertainty. These MPC's are greater than 0.5, the value one would obtain assuming certainty equivalence.

B. A Bird in the Hand

The bottom numbers in Tables 1 and 2 are the MPC's out of a tax cut coupled with a future income tax increase. The tax change has no effect on the individual's permanent income as defined by, for example, Flavin. Yet the tax change can often have very large effects on consumption.

For example, suppose the individual has a one in eight chance of obtaining only half his expected income and an equal chance of receiving fifty percent more than his expected income ($p = 1/8$, $x = 1/2$). We see in Table 2 that his marginal propensity to consume out of a one dollar tax cut is 0.36, even though he will, on average, have to repay the dollar to the government in the second period.[19] Thus, the consumer is Ricardian in taking into account the future tax liabilities implied by debt finance and is Keynesian in increasing his spending in response to the tax cut.[20]

A comparison of the top and bottom numbers demonstrates the importance of the future tax increase as a factor mitigating the stimulative effect of the tax cut. For distributions with little uncertainty (small x and p), the tax increase almost fully eliminates the effect of the tax cut on spending. For moderate amounts of uncertainty, the future tax increase eliminates only half of the stimulative effect.

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[19]The optimal level of saving in this example is 7.5 percent of first period income.

[20]If income in the second period were scaled up by a constant growth factor, the MPC's would be even larger than those we report. The reason is that a higher fraction of life-time resources would be uncertain.

For distributions with large amounts of uncertainty, which appear to fit the stylized facts we discuss above, the future tax increase provides only a small mitigating effect. The tax cut, like a bird in the hand, stimulates spending, despite the contingent tax increase. Indeed, a naive observer might wonder if the consumer simply ignores his future tax liability altogether.

C. Unlikely and Unlucky Events

It is particularly interesting to compare the two MPC's for the $x = 1$ column. With these distributions, there is a small but non-zero probability of zero income in the second period. In this unlucky event, the individual consumes only what he saved from the first period.

The MPC out of a tax cut, along with the future income tax increase, is very large for all these distributions. Even if the unlucky event is very unlikely ($p = 1/128$), the uncertainty is sufficient to generate a large MPC: 0.56 in Table 1 and 0.73 in Table 2. Remember that if p were equal to zero, the MPC would also be zero. It appears that consumption and saving behavior can be greatly affected by small probability events.

One might argue that a second period income of zero is unrealistic, since various institutions in society provide a floor on income. Although the existence of such a floor is undeniable, it is also true that there is some consumption level below which survival is impossible. Suppose that society provides a floor on income at the survival level, C_s, and that utility is defined in excess of this survival level as:

$$U(C) = \frac{(C - C_s)^{1-A}}{1-A}$$

In this case, the results in the x = 1 column continue to apply, regardless of the level of the income floor.

D. The Rates of Interest and Time Preference

In the above simulations, we assume that the real interest rate between the two periods is zero and that individuals do not discount future relative to present utility. Table 3 presents results that relax these assumptions. Since the two periods represent two halves of a single life, we use a real interest rate of fifty percent and a comparable discount rate. We find that a higher real interest rate lowers the MPC's, while a higher rate of time preference raises the MPC's. Our primary conclusion--that a tax cut can have a large impact on consumer spending despite the future tax liabilities--is not affected by alternative rates of interest and time preference.

E. A Multi-point Income Distribution

As a final two-period simulation, we try a multi-point income distribution. Again, there is no discounting of any sort. We consider the two periods as two generations. The father earns $100 with certainty in the first period. The son also expects to earn $100. We base the distribution for the son on the distribution of the earnings of full-time, year-round male workers in 1970, as reported by Jencks [1972, p. 213]. In particular, the son's income distribution is:[21]

$12	with probability	0.047
35		0.082
58		0.171
82		0.244
105		0.179
146		0.195
204		0.063
350		0.019

We compute the MPC for the utility function exhibiting constant relative risk aversion of three. The MPC out of a tax cut with no future tax liability is 0.60, while the MPC out of a tax cut with a future proportional income tax increase is 0.41.[22] This latter value of the MPC out of a tax cut is closer to the Keynesian benchmark of 0.5 than to the Ricardian benchmark of zero.

To test the robustness of our result to alternative forms of the utility function, we also compute the MPC for this multi-point distribution using a constant absolute risk aversion utility function. We

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[21]This distribution overestimates the uncertainty by including transitory and life-cycle variation in income, but underestimates the uncertainty by excluding disability and chronic unemployment.

[22]The level of saving in this example is 23 percent of first period income. This finding suggests that the precautionary motive for saving may be an important explanation for the high level of bequests reported by Kotlikoff and Summers [1981]. Interestingly, the individual in this

choose the coefficient of absolute risk aversion so that the coefficient of relative risk aversion at the mean of second period income is equal to three (the value we use above).[23] In this case, the MPC out of a tax cut alone is 0.50, while the MPC out of a tax cut with the future tax increase is 0.24. Thus, the risk-sharing effect continues to be important with this alternative specification of preferences.

VI. Multi-Period Simulations

In this section, we investigate how our results are affected by extending the number of periods in the model.[24] In particular, we explore how the MPC out of a tax cut is affected by the horizon over which the debt is to be repaid. The model includes five periods and there is no discounting of any sort. Each period here represents a generation. Income is independently and identically distributed in each generation. Because family characteristics have little value in predicting earnings, it seems a reasonable approximation to assume that the uncertainty about the fate of one's grandchildren is not greater than the uncertainty about one's children.

In a world of the type Barro describes, the MPC out of tax cut equals zero regardless of the timing of the corresponding tax increase.

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example would pay 36 percent of his first period income to eliminate second period income uncertainty entirely (keeping the mean constant).

[23]Thus, the utility function is -exp(-aC), and a is 3/100.

[24]It is not the case that increasing the number of time period diversifies away i.i.d. income. Numerical examples in Zeldes [1983] demonstrate that, for a given income process and initial wealth, precautionary saving increases when the number of periods increases. This result is closely related to Samuelson's [1963] discussion of repeated

In a certainty or certainty equivalent model with no future taxes, the MPC equals 0.2. Thus, 0.2 is the benchmark "Keynesian" estimate.[25] Table 4 presents the MPC's implied by a utility function with constant relative risk aversion of three and no discounting of any sort. The MPC for the case in which there is no future tax increase exceeds 0.2 by large amounts. Again, this effect is the "excess sensitivity" of consumption to current income.

The results that include the future tax liability are dramatic. We find that the repayment horizon is critical to the effect of the tax cut on consumption. The farther in the future is the tax increase, the higher is the the MPC out of the current tax cut. Risk-sharing in a later period has greater effect on consumption than risk-sharing in an early period. This result is due to the fact that a tax increase in a later period implies an earlier resolution of uncertainty. Indeed, if the taxes are not raised until period five, the MPC's are almost as large as if the taxes are not raised at all. Consumers have MPC's that are very close to being "Keynesian," even though they fully incorporate all future tax liabilities in their plans. Indeed, the MPC's we find sometimes exceed the Keynesian benchmark of 0.2.[26]

The results in Table 4 assume that income is independently distri-

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gambles.

[25]The low value of the Keynesian benchmark is in part due to the absence of any discounting in our example.

[26]We also tried an intervention in which the government announces a tax cut in period one to go into effect in period two, coupled with a tax increase in period five. The MPC's were 0.03 for $x = 1$, 0.13 for $x = 3/4$, and 0.10 for $x = 1/2$. For a tax cut effective in periods one and two, coupled with a tax increase in periods four and five, the

buted in each period. More realistically, income might be modeled as containing both permanent and transitory components. In this case, the uncertainty regarding income in latter periods is greater than the uncertainty regarding income in earlier periods. The length of the repayment horizon would be even more important in this case. The results in Table 4 might thus understate the importance of the repayment horizon.

VII. Conclusion

In this paper, we examine the interaction between individual income uncertainty and income taxation in the face of a debt-financed tax cut. Under plausible assumptions regarding preferences toward risk, the marginal propensity to consume out of a tax cut, coupled with a future income tax increase, is positive because of an increase in risk-sharing. An examination of the degree of income uncertainty suggests that this uncertainty is substantial, suggesting that the risk-sharing effect may be important. Numerical simulations show that this effect is potentially large. Indeed, the MPC out of a tax cut, coupled with a future income tax increase, appears closer to the Keynesian value that ignores the future taxes than to the Ricardian value that treats the future taxes as if they were lump-sum.

MPC's are 0.46 for $x = 1$, 0.32 for $x = 3/4$, and 0.16 for $x = 1/2$.

A variety of issues remain open. We assume in this paper the absence of contingent claims markets through which an individual can privately diversify away his individual human capital risk. This assumption appears a reasonable starting point for our analysis, since these contingent claims markets do not in fact appear to exist. Future research, however, could integrate our analysis with an explicit model of missing markets. We suspect that the explanation involves some combination of moral hazard and adverse selection. When incentive effects on labor supply are admitted, the increase in insurance achieved through tax cuts may or may not be optimal. Even if government insurance is not optimal, however, a tax cut that provides insurance may still affect the optimal consumption level of individuals.[27] We believe that, even after the explanation for missing markets is incorporated into the analysis, the risk-sharing effect of a tax cut will continue to provide a substantial stimulus to consumer spending.

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[27]Along the lines of Dreze and Modigliani [1972], one can decompose the risk-sharing effect into an income effect and a substitution effect. We suspect that at the optimal level of government insurance, the marginal deadweight losses exactly balance the income effect, while the substitution would continue to stimulate current consumption.

Table 1

The Marginal Propensity to Consume: Logarithmic Utility

The top number is the MPC out of tax cut alone. The bottom number is the MPC out of a tax cut coupled with a future income tax increase.

	x = 1/4	x = 1/2	x = 3/4	x = 1
p = 1/128	0.50 0.00	0.50 0.01	0.52 0.06	0.76 0.56
p = 1/32	0.50 0.02	0.51 0.05	0.55 0.16	0.73 0.56
p = 1/8	0.51 0.07	0.53 0.17	0.58 0.34	0.68 0.57
p = 1/4	0.51 0.13	0.54 0.28	0.59 0.44	0.65 0.58
p = 1/2	0.52 0.24	0.55 0.41	0.58 0.52	0.61 0.58

Assumptions: $U(C_1,C_2) = \log(C_1) + \log(C_2)$

$R = 1.0$

$Y_1 = 100$

$Y_2 = (1-x)100$ with prob. p

100 with prob. $1-2p$

$(1+x)100$ with prob. p

Table 2

The Marginal Propensity to Consume: Relative Risk Aversion of Three

The top number is the MPC out of tax cut alone. The bottom number is the MPC out of a tax cut coupled with a future income tax increase.

	x = 1/4	x = 1/2	x = 3/4	x = 1
p = 1/128	0.50 0.01	0.51 0.06	0.61 0.34	0.78 0.73
p = 1/32	0.50 0.04	0.53 0.17	0.63 0.48	0.73 0.69
p = 1/8	0.51 0.14	0.55 0.36	0.61 0.55	0.66 0.64
p = 1/4	0.52 0.25	0.56 0.45	0.59 0.56	0.62 0.61
p = 1/2	0.52 0.39	0.55 0.52	0.56 0.55	0.57 0.57

Assumptions: $U(C_1,C_2) = \frac{C_1^{1-A}}{1-A} + \frac{C_2^{1-A}}{1-A}$ $A = 3$

$R = 1.0$

$Y_1 = 100$

$Y_2 = (1-x)100$ with prob. p

100 with prob. $1-2p$

$(1+x)100$ with prob. p

Table 3

The Marginal Propensity to Consume:

Alternative Rates of Interest and Time Preference

The top number is the MPC out of tax cut alone. The bottom number is the MPC out of a tax cut coupled with a future income tax increase.

	$x = 1/4$	$x = 1/2$	$x = 3/4$	$x = 1$
$R = \beta = 1.0$	0.51 0.13	0.54 0.28	0.59 0.44	0.65 0.58
$R = \beta^{-1} = 1.5$	0.61 0.15	0.63 0.32	0.68 0.49	0.73 0.63
$R = 1.0$ $\beta^{-1} = 1.5$	0.61 0.19	0.66 0.41	0.72 0.60	0.77 0.73
$R = 1.5$ $\beta^{-1} = 1.0$	0.51 0.10	0.52 0.21	0.56 0.34	0.61 0.47

Assumptions: $U(C_1,C_2) = \log(C_1) + \beta \log(C_2)$

$$Y_1 = 100$$

$$Y_2 = \begin{cases} (1-x)100 & \text{with prob. } 1/4 \\ 100 & \text{with prob. } 1/2 \\ (1+x)100 & \text{with prob. } 1/4 \end{cases}$$

Table 4

The Marginal Propensity to Consume:

Alternative Debt Repayment Horizons

This table shows the MPC out of a first period tax cut, varying the period during which the future tax increase occurs.

Taxes Repaid In Period:	x = 1/2	x = 3/4	x = 1
2	0.03	0.10	0.35
3	0.04	0.15	0.39
4	0.07	0.20	0.41
5	0.14	0.25	0.42
never	0.22	0.27	0.42

Assumptions: $U(C_1,C_2,C_3,C_4,C_5) = \sum_{1}^{5} \frac{C_i^{1-A}}{1-A}$ $A = 3$

$R = 1.0$

$Y_1 = 100$

$Y_i = (1-x)100$ with prob. 1/8 $i = 2,3,4,5$

100 with prob. 3/4

$(1+x)100$ with prob. 1/8

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