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Ricardian Consumers with Keynesian Propensities

By ROBERT B. BARSKY, N. GREGORY MANKIW, AND STEPHEN P. ZELDES*

This paper examines Ricardian equivalence in a world in which taxes are not lump sum, but are levied on risky labor income. It shows that the marginal propensity to consume out of a tax cut, coupled with a future income tax increase, can be substantial under plausible assumptions. Indeed, the MPC out of a tax cut 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.

In conventional Keynesian macroeconomic models, a debt-financed tax cut stimulates aggregate demand. An alternative view, first noted by David Ricardo and revived by Robert Barro (1974), is that a tax cut merely replaces current taxes with future taxes of equal present value. If taxes are lump sum, capital markets are perfect, and all individuals have operative altruistic bequest motives, debt and tax finance are equivalent, and tax cuts are inconsequential.

Barro (1974, 1978) and James Tobin (1980) discuss a large number of deviations from Ricardian 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. Hence, he claims,

Ricardian equivalence is the appropriate benchmark.

In this paper we examine one particular deviation from Ricardian equivalence (discussed by both Barro and Tobin) and argue that it has both determinate sign and potentially major quantitative significance. Barro 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" (1974, p. 1115). 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, for example, Robert Lucas, 1977, and documented later in this paper) that variation in individual fortunes is large relative to aggregate uncertainty. A general, though not universal, feature of optimal consumption plans is a precautionary demand for saving (Hayne 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.¹

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¹Our examination is a partial equilibrium one, in that we consider only the decision of a consumer in the

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 (*MPC*) 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 incorporate the life cycle (permanent income) view of consumption, but ignore the future tax liabilities implied by debt finance. Of course, the mechanism we highlight is very different from the usual "bonds are net wealth" channel, since individuals fully perceive all future tax liabilities. 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.

Much of this paper is aimed at demonstrating the quantitative importance of the risk-sharing effect on consumption. This effect clearly depends on the nature and amount of individual uncertainty about future labor income. Interpreting the model on Barro's own turf, where operative intergenerational bequests are central, we consider not just uncertainty about one's own income, but uncertainty about the fortunes of future generations as well. Evidence from the available studies of income dynamics suggests that the degree of such uncertainty is likely to be 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.

Out of necessity, our simulations are highly stylized. The available panel data are not sufficiently detailed to permit estimation and simulation of a complete model of income dynamics with heterogeneous agents. The only tractable strategy is to choose a simple and suggestive specification characterized by a minimal number of parameters, and then to calibrate the model by requiring conformity with the available evidence. The simplicity of our specification allows extensive analysis of the sensitivity of the results to changes in the underlying parameter values.

I. The Model

In this section we show analytically how a tax cut coupled with a future income tax increase can stimulate consumer spending through the precautionary motive for saving. Our development follows that of Louis Kuo Chi Chan (1983), who provides a careful discussion of the importance of missing markets for various deviations from Ricardian equivalence. We examine here just one of these deviations using a two-period model. All individuals in the model are identical *ex ante*. Their labor income in the second period is uncertain and there do not exist markets through which they can insure against this risk.² We 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:

$$(1) \quad EU(C_1, C_2),$$

where C_1 = first-period consumption, C_2 = second-period consumption, E = the expectation operator conditional on information

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.

²That 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.

available in the first period, and $U(\cdot) =$ 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 a risk-free interest rate. Wealth after the first period is

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

Let R be one plus the real interest rate. Second-period consumption is

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

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

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

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.³ That is, an individual with income Y_2 must pay

$$(4) \quad tY_2$$

in additional taxes, where $t =$ the tax rate.

³Note 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. Since our goal is to examine only the risk-sharing effect, we do not include capital taxation. We also do not examine the human capital decision, which in principle is also affected by the policy intervention (Jonathan Eaton and Harvey Rosen, 1980).

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 requires⁴

$$(5) \quad RT = t(\mu_2),$$

or, equivalently,

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

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

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

An individual's consumption in the second period is now

$$(3') \quad C_2 = RW + \mu_2 + \varepsilon - RT(\mu_2 + \varepsilon)/\mu_2 \\ = RW + \mu_2 - RT + (1 - RT/\mu_2)\varepsilon.$$

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

$$(6) \quad E[U_1(C_1, C_2)] = RE[U_2(C_1, C_2)].$$

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 intractable except in simple examples. We can solve 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 find⁵

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

⁴More 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').

⁵Equation (7) is parallel to Chan's equation (11).

The *MPC* is not generally zero. A sufficient condition of the *MPC* to be positive is that $RU_{222} - U_{122}$ be uniformly positive.⁶ 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 nonincreasing absolute risk aversion. Leland and Agnar 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 Warren Smith (1969) and Robert 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 decision cannot be analyzed by reference to any summary wealth statistic.⁷

The positive marginal propensity to consume out of a tax cut relies on the absence of contingent claims markets through which an individual can privately diversify away his individual human capital risk. This assump-

tion appears a reasonable starting point for our analysis, since these contingent claims markets do not in fact appear to exist. Future research could integrate this analysis with an explicit model of missing markets. One way would be to assume that individuals have greater information on the distribution of their future income than is publicly available. It is well-known that the government can provide insurance through mandatory coverage even if adverse selection makes private insurance infeasible.

The model could be made more realistic, as well as greatly more complicated, by including moral hazard.⁸ 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, a tax cut that provides insurance will still affect the optimal consumption level of individuals. Following the analysis of Jacques Drèze and Franco 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 effect continues to stimulate current consumption.⁹ More generally, we believe that incorporating an explicit model of missing markets will not qualitatively alter the conclusions of this analysis.

The sign of the *MPC* would be affected by altering the risk characteristics of the future tax liabilities. For example, Barro (1974) and Chan point out that if taxes are levied on individuals at random, then a substitution of certain current taxes with random future taxes increases perceived risk and decreases current consumption. We sus-

⁶This result is demonstrated by noting that, for any nondegenerate random variable X and function $F(\cdot)$, if F' is uniformly positive, then $\text{Cov}(X, F(X)) > 0$.

⁷An 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. Such liquidity constraints are not present in our model.

⁸As the model stands, a 100 percent tax rate with lump sum rebates is optimal. Our purpose, however, is to examine the positive, and not the normative, implications of the risk-sharing effect. Hal Varian (1980) discusses the possible optimality of redistributive taxation as social insurance.

⁹Of course, this will not hold more generally and, in particular, if the marginal tax rate depends on other considerations, such as the need to fund public expenditure.

pect that the risk-creating effect of capricious taxation is empirically less important than the risk-sharing effect of income taxation. Similarly, to the extent that the future tax liabilities fall more heavily on the poor, possibly through reductions in transfer payments, government debt would again be risk-creating. Future research could address these issues more fully.

II. 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 is consistent with the view that the degree of uncertainty is substantial.

We consider two interpretations of our model. In the first, 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. 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 (PSID)*, Daniel Hill and Saul Hoffman 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" (1977, p. 30). In terms of the "income/needs ratio" discussed by Greg Duncan and James Morgan, "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" (1977, p. 30).¹⁰

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

Robert Hall and Frederic 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 the *PSID* data, 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 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 0.55.¹¹

¹⁰Hill and Hoffman (p. 33) also report that the largest share of variation in the income/needs ratio comes from income rather than needs.

¹¹Alternatively, one might look at the uncertainty concerning average income in the second half (30 years) of life. If the individual is half way through the first

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 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" (p. 480). Thus, the observed degree of uncertainty is correctly interpreted as a measure of individual rather than aggregate risk.

While the results from these studies are consistent with the view that there is substantial income uncertainty, this interpretation is certainly not free of problems. Not all of the measured variation reflects true uncertainty about lifetime earnings. Measurement error is one problem that arises when using panel data.¹² In the Hall and Mishkin study, however, the measurement error is likely to be included in the transitory component of income and thus should not affect the estimated conditional variance of the lifetime component.

A second problem of these studies is that the individual agents may have greater information than the econometrician. That is, what is "news" to the econometrician may not be news to the individual. Benjamin Eden and Ariel Pakes (1981) develop a methodology that can deal with this problem, as well as the measurement error problem, using the restrictions imposed by the permanent income hypothesis (Hall, 1978). In particular, only genuine news about permanent income should affect consumption. Unfortunately, the data Eden and Pakes use are not of high quality, resulting in a large confidence inter-

val for the variance of the innovation in permanent income. Nevertheless, this methodology may provide an avenue through which future research can resolve this difficulty.

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 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 status is Christopher 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 (pp. 219-20).

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

(30-year) period and assuming income follows a random walk (i.e., ignoring the transitory component), the coefficient of variation of the forecast of second period average income is 0.50, close to the 0.55 of the text. Thomas MaCurdy (1982) estimates an earnings equation with a different stochastic specification using the same data. Calculations based on his estimates imply a similar coefficient of variation.

¹²See, for example, Joseph Altonji and Aloysius Siow (1984).

compare men who are identical in all these respects, 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 (p. 236).

	Uncon- ditional 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 lifetime earnings. In summary, "luck has far more influence on income than successful people admit" (p. 227).

Some studies, such as that of John 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 Paul Taubman's (1977) volume indicate, repeating Jencks's exercise with actual data on brothers and with more advanced statistical techniques leads to almost identical conclusions. For instance, Michael Olnick writes, "The average difference between brothers on earnings is 87 percent as large as the difference between random individuals" (1977, p. 137). Thus no parent can feel assured of even roughly predicting his children's future earnings.

III. Two-Period Simulations

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. The simulation method is explained in the Appendix.

A major difficulty in attempting to quantify the risk-sharing effect arises when deciding on an appropriate way to use the limited, though suggestive, evidence on income uncertainty reviewed in Section II. In principle, one approach would be to construct a multi-point distribution that would mimic the uncertainty regarding lifetime income faced by a typical family. We do not adopt this approach because the available evidence is much too scanty to allow us to pin down such a distribution. Instead, we choose a simple, symmetric three-point distribution, which is characterized by two parameters. We then calibrate these parameters by requiring that the implied coefficient of variation (standard deviation divided by mean) be consistent with the results of Hall and Mishkin and others.

We assume throughout that the utility function is time-separable. 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 one-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:

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

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-paying industry because of technological innovation or foreign competition. Or he simply could turn out less successful in his chosen occupation than he anticipated. The first outcome in our three-point distribution 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 above distribution.

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.) 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.¹³ 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.¹⁴

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 pro-

grams. We assume that this income floor is not affected by the policy intervention.¹⁵

Our three-point distribution exhibits a coefficient of variation (σ) equal to $x(2p)^{1/2}$. As a conservative summary of the estimated coefficient of variation from the empirical literature, we take σ to be at least $1/3$ but no larger than $1/2$. Of course, many combinations of p and x are consistent with a given value of σ . Moreover, the marginal propensity to consume out of a tax cut depends on the entire distribution of income, not just its second moment. It is therefore important to examine the various combinations of the two parameters to ensure that any conclusion is robust.

Table 1 presents the results of the simulations for two scenarios. The real interest rate is zero ($R = 1$) and the utility function of the consumer is additively separable through time with no time preference. The single-period utility function exhibits constant relative risk aversion.¹⁶ For the results in panel A, the coefficient of relative risk aversion is one, while for the results in panel B, the coefficient of relative risk aversion is three.¹⁷ The region for which $1/3 \leq \sigma \leq 1/2$ is marked in each panel.

Implicit in much neo-Keynesian analysis of tax cuts, such as that of Alan Blinder (1981), are two assumptions. First, consumers set their consumption in proportion to the present value of expected income. In other words, their behavior is based on the life cycle (permanent income) theory of con-

¹⁵Alternatively, 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.

¹⁶One property of this iso-elastic utility function is that a proportionate change in income, wealth, and the distribution of future income does not affect the marginal propensity to consume. Heterogeneity regarding current (certain) wealth relative to future (uncertain) income is ignored here but is discussed in Zeldes (1986). Zeldes's simulations suggest that the *MPC* is decreasing in the level of certain wealth relative to uncertain income.

¹⁷Recent studies that estimate the coefficient of relative risk aversion find values in this range. See, for example, Lars Hansen and Kenneth Singleton (1983) or Mankiw (1985).

¹³The *MPC*s reported for these two-period examples are for an infinitesimal T ; these are very close to the *MPC*s calculated for a T of 5 percent of first-period income.

¹⁴That is, $RT = E[t(Y_2 - (1-x)100)]$.

TABLE 1—THE MARGINAL PROPENSITY TO CONSUME

	$x = 1/4$	$x = 1/2$	$x = 3/4$	$x = 1$
A. Logarithmic Utility^a				
$p = 1/128$	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]
B. Relative Risk Aversion of Three^b				
$p = 1/128$	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]

Notes: The top number is the *MPC* out of tax cut alone; the number below in brackets is the *MPC* out of a tax cut coupled with a future income tax increase.

^aAssumptions: $U(C_1, C_2) = \log(C_1) + \log(C_2)$.

^bAssumptions: $U(C_1, C_2) = (C_1^{1-A})/(1-A) + (C_2^{1-A})/(1-A)$; $A = 3$.

$$R = 1.0; Y_1 = 100; Y_2 = (1-x)100 \quad \text{with prob. } p \\ \quad \quad \quad 100 \quad \quad \quad \text{with prob. } 1-2p \\ \quad \quad \quad (1+x)100 \quad \text{with prob. } p$$

sumption and on certainty equivalence. Second, the future tax liabilities implied by debt finance are ignored, presumably because they fall on some future generation. 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 Marjorie Flavin (1981), Hall and Mishkin, and Ben Bernanke (1985), 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, certainty equivalence implies an *MPC* out of wealth of 0.5 in our two-period example.

As Zeldes shows, utility functions with positive third derivatives can exhibit “excess sensitivity,” even though consumption is set optimally and there are no borrowing constraints.¹⁸ The top numbers in Table 1 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.

¹⁸Another and very different explanation of excess sensitivity is suggested by Ron Michener (1984): in general equilibrium, rates of return may vary to make consumption more closely track income.

B. *A Bird in the Hand*

The numbers in brackets in Table 1 are the *MPCs* 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.

If we assume $1/2 \leq \sigma \leq 1/3$, then the *MPC* is never smaller than 0.28 with logarithmic utility and 0.45 with relative risk aversion of three. The individual's marginal propensity to consume out of a one dollar tax cut is high, even though he will, on average, have to repay the dollar to the government in the second period.¹⁹ 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.

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 distributions with $1/3 \leq \sigma \leq 1/2$, which appear to fit the stylized facts we discuss above, the future tax increase provides only a small mitigating effect. Because the individual pays no taxes if "times are bad" for him, the future liability has little effect on current consumption. 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 *MPCs* 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 indi-

vidual 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 unlikely ($p=1/128$), the uncertainty is sufficient to generate a large *MPC*: 0.56 in panel A and 0.73 in panel B. 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

$$U(C) = (C - C_s)^{1-A} / (1 - A).$$

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 2 presents results that relax these assumptions. Since the two periods represent two halves of a single life, we use a real interest rate of 50 percent and a comparable discount rate. We see that a higher real interest rate lowers the *MPCs*, while a higher rate of time preference raises the *MPCs*. 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. *Growth in Income*

The simulation results above assume no growth in expected income. In reality, the growth of per capita real income is not zero

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

TABLE 2—THE MARGINAL PROPENSITY TO CONSUME: ALTERNATIVE RATES OF INTEREST AND TIME PREFERENCE^a

	$x = 1/4$	$x = 1/2$	$x = 3/4$	$x = 1$
$R = \beta = 1.0$	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]

Notes: See Table 1.

^aAssumptions: $U(C_1, C_2) = \log(C_1) + \beta \log(C_2)$.

$$\begin{array}{ll}
 Y_1 = 100; Y_2 = (1-x)100 & \text{with prob. } 1/4 \\
 100 & \text{with prob. } 1/2 \\
 (1+x)100 & \text{with prob. } 1/4
 \end{array}$$

but has averaged about 2.2 percent annually since 1960. Taking into account such growth strengthens our conclusions by making a higher fraction of lifetime income uncertain. In particular, if we scale up each of the possible outcomes by a constant growth factor $(1+g)$ and assume the same tax structure (proportional to income in excess of the floor income), the new *MPC* is the same as if we had increased the parameter x by a factor of $(2+2g)/(2+g)$. For a value of $1+g$ of $1.92 = (1.022)^{30}$, the *MPC* for any x_0 is the same as the *MPC* without growth for $x = 1.31x_0$. If $p = 1/4$, $x = 1/2$, $g = 0.92$, the *MPC* out of a tax cut with logarithmic utility would be 0.38, as opposed to a *MPC* of 0.28 in an economy without growth.

F. A Multipoint Income Distribution

As a final two-period simulation, we try a multipoint 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 (p. 213). In particular, the son's income distribution is²⁰

²⁰This distribution, which has a coefficient of varia-

\$12 with prob. 0.047	\$105 with prob. 0.179
35 0.082	146 0.195
58 0.171	204 0.063
82 0.244	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 0.41.²¹ 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 multipoint distribution using a constant *absolute* risk-

tion of about 0.6, overestimates the uncertainty by including some transitory and life cycle variation in income, but underestimates the uncertainty by excluding all disability and chronic unemployment.

²¹The 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 Laurence Kotlikoff and Lawrence Summers (1981). Interestingly, the family in this example would pay 36 percent of its first-period income to eliminate second-period income uncertainty entirely (keeping the mean constant).

aversion utility function. We 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).²² 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.

IV. Multiperiod Simulations

In this section, we investigate how our results are affected by extending the number of periods in the model.²³ 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. In a certainty or certainty equivalent model with no future taxes, the *MPC* equals 0.2. Thus, 0.2 is the benchmark "Keynesian" estimate.²⁴ Table 3 presents the *MPC*s implied by a utility function with constant relative risk aversion of three and no dis-

²² Thus, the utility function is $-\exp(-aC)$, and a is $3/100$.

²³ It is not the case that increasing the number of time periods diversifies away identical and independently distributed income. Numerical examples in Zeldes demonstrate that, for a given income process and initial wealth, precautionary saving does not decrease when the number of periods increases. This result is closely related to Paul Samuelson's (1963) discussion of repeated gambles.

²⁴ The low value of the Keynesian benchmark is in part due to the absence of any discounting in our example.

TABLE 3—THE MARGINAL PROPENSITY TO CONSUME: ALTERNATIVE DEBT REPAYMENT HORIZONS^a

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

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

$$^a\text{Assumptions: } U(C_1, C_2, C_3, C_4, C_5) = \sum_1^5 \frac{C_i^{1-A}}{1-A};$$

$$A = 3.$$

$$R = 1.0; Y_1 = 100;$$

$$Y_i = \begin{cases} (1-x)100 & \text{with prob. } 1/8 \\ 100 & \text{with prob. } 3/4 \\ (1+x)100 & \text{with prob. } 1/8 \end{cases} \quad i = 2, 3, 4, 5$$

counting of any sort. The *MPC* for the case in which there is no future tax increase can exceed 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 *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 5, 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 0.2.²⁵

²⁵ We also tried an intervention in which the government announces a tax cut in period 1 to go into effect in period 2, coupled with a tax increase in period 5. The *MPC*s were 0.03 for $x = 1$, 0.13 for $x = 3/4$, and 0.10

The results in Table 3 assume that income is independently distributed in each period. More realistically, income might be modeled as containing both permanent and transitory components. In this case, the uncertainty regarding income in later 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 3 might thus understate the importance of the repayment horizon.

V. 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, indicating 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.

The final question to address is whether the risk-sharing effect provides an intuitively appealing reason to believe that tax cuts stimulate consumer spending. To hone one's intuition, it is useful to envision two policy interventions. In both, the government gives a tax cut of \$2000 now to every living individual and will raise the \$2000 and accumulated interest by a tax on the next generation in thirty years.

In the first intervention, which probably corresponds best to what we experience, the

future tax increase takes the form of a marginal change in income tax rates. This change will raise the necessary revenue in total, but not necessarily the same from each individual's child.

In the second intervention, the government levies a lump sum tax. That is, from each child, the government will collect the \$2000 and accumulated interest, regardless of how impoverished the child happens to be and regardless of how dire the consequences. While it is difficult to envision such a tax increase, it seems clear that this prospect, if credible, would cause more concern among parents than a mere change in income tax rates. In particular, a prospective lump sum tax would plausibly seem to call forth greater saving to meet the future liability. While Ricardian equivalence may be the appropriate benchmark for a world in which taxes are lump sum, it is probably not the appropriate benchmark for the world in which we live.

APPENDIX: SIMULATION METHOD

For the two-period examples, equation (7) gives the analytical expression for the *MPC* out of a tax cut in period one.²⁶ 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 numerical methods to calculate the optimal level of consumption and then use this value in equation (7) to arrive at the *MPC*s.

In the multiperiod 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 dynam-

for $x = 1/2$. For a tax cut effective in periods 1 and 2, coupled with a tax increase in periods 4 and 5, the *MPC*s are 0.46 for $x = 1$, 0.32 for $x = 3/4$, and 0.16 for $x = 1/2$.

²⁶For most of the simulations, the tax increase is not proportional to second-period income. In these cases, an expression analogous to (7) is derived.

ic programming.²⁷ 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 made discrete using a technique suggested by Dimitri Bertsekas (1976). The first step is to determine the upper and lower bounds for wealth (W). If there is a positive floor on income in future periods, we can, without loss of generality, redefine income as the amount in excess of the floor and redefine wealth to include the present value of all future income floors. In this new problem, there is positive probability of receiving an income of zero in each period. Since we use utility functions for which $U'(0) = \text{infinity}$, we know that individuals will always carry positive "wealth," that is, they will never borrow against risky labor income. For this new problem, then, W must always be greater than zero, so we choose $W_{\min} = 0$.

We next need to determine an upper bound for wealth, that is, a W_{\max} that wealth never exceeds at any point during life. One choice would be the wealth that would be accumulated if income turned out to be its maximum in each period and consumption equalled zero in each period.

Next, we divide the range (W_{\min}, W_{\max}) into G equal intervals. For our two-period examples, we use $G = 1000$. In other words, the state variable W can take on any of the 1000 discrete values between W_{\min} and W_{\max} . 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.²⁸

²⁷Zeldes describes this technique in more detail, and uses the technique to investigate some of the properties of optimal consumption in the presence of nontraded labor income.

²⁸While 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.

While the numbers are an approximation to the actual solution, we can make the approximation errors arbitrarily small by narrowing the width of the grid used for the discretization (see Bertsekas). We tested our grid against some simple examples that can be solved analytically. The results were very close. We believe that our calculated MPCs are accurate to ± 0.03 .

The examples used here took little computer time to run. Yet as the number of time periods increases, W_{\max} must also increase, implying that the required memory and CPU time increases dramatically.

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