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# THE TIMING OF INTERGENERATIONAL TRANSFERS, TAX POLICY, AND AGGREGATE SAVINGS

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## Abstract

We analyze the interest rate and savings effects of fiscal policy in an overlapping generations framework that accommodates two observations: (1) the interest rate on consumption loans exceeds the rate of return to household savings; and (2) private intergenerational transfers are widespread and primarily occur early in the life cycle of recipients. The wedge between borrowing and lending rates in our model arises from the asymmetric tax treatment of interest income and interest payments. Intergenerational transfers in our model are altruistically motivated. We prove the invariance of capital's steady-state marginal product to government expenditures, government debt, the labor income-tax schedules, and the tax rate on capital income when borrowing rates exceed lending rates and at least some families are altruistically connected. In contrast, under the same conditions we find that the tax treatment of interest payments has powerful effects on capital's marginal product.

## 1. Introduction

The interest rate on consumption loans greatly exceeds the rate of return to household savings. As documented in table 1, during selected years over the past two decades the after-tax nominal interest rate on unsecured personal loans averaged 12.4 percent per year, while the after-tax nominal rate of return on government securities averaged only 6.5 percent. The after-tax wedge between household borrowing and lending rates averaged 5.7 percentage points. This wedge increases to a full 8 percentage points if we use the credit-card rate as the measure of household borrowing rates. A wedge of 6 to 8 percentage points is too large to explain away by a simple adjustment for positive default rates on unsecured consumer loans. Thus, households face a kink in their intertemporal budget constraint. We take this simple empirical observation as one stepping-off point for our analysis of how tax and debt policy affect aggregate savings and interest rates.

We develop our analysis in the context of an overlapping generations framework that encompasses a wedge between borrowing and lending rates. We model the source of this wedge as the asymmetric tax treatment of interest income and interest payments on consumption loans. We focus on this source of the wedge for three reasons: (i) this component of the wedge can be directly manipulated by tax policy; (ii) as the positive entries in row (9) of table 1 indicate, asymmetries in the tax code make the wedge larger; and (iii) many past and proposed reforms of the U.S. tax code imply nontrivial changes in the wedge.

As an example of tax policy's impact on the size of the wedge between borrowing and lending rates, consider the Tax Reform Act of 1986. Comparing the 1984 and post-reform entries in table 1 indicates that a direct effect of the Tax Reform Act is to increase the size of the wedge by 3 percentage points.[1] While tax code asymmetries contribute to the wedge between borrowing and lending rates, table 1 also indicates that other features of the economy account for the bulk of the wedge. In this connection, we remark that our framework accommodates (with minor modifications) any capital-market imperfection that amounts to a proportional transactions cost in the consumption-loans market.

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[1] The figures in row (5) of table 1 are not adjusted for provisions in the tax code governing tax-sheltered savings. Since the Tax Reform Act of 1986 greatly restricted the availability of IRAs, table 1 understates the Act's impact on the wedge. Our attempts to adjust the measure of $\rho$ for IRAs suggest that the 1986 Act increased the average after-tax wedge by more than 3.5 percentage points.

TABLE 1

| | Household Borrowing and Savings Rates, Selected Years | | | | | |
|---|---|---|---|---|---|---|
| | 1972 | 1980 | 1983 | 1984 | Post 1986 Tax Reform | Avg |
| 1) **Average Rate on Two-year Personal Loans (credit cards)**$^a$ | .127 (.172) | .155 (.173) | .165 (.188) | .165 (.188) | .147 (.178) | .152 (.180) |
| 2) Average Marginal Subsidy Rate to Borrowing, $\delta^b$ | .181 | .247 | .224 | .249 | 0 | .187 |
| 3) After-tax Borrowing Rate, (1– 6) times (1) | .104 (.141) | .117 (.130) | .128 (.146) | .124 (.141) | .147 (.178) | .124 (.147) |
| 4) Rate on Three-year U.S. Treasury Securities$^c$ | .057 | .116 | .105 | .119 | .083 | .092 |
| 5) Average Marginal Tax Rate on Interest Income, $\rho^d$ | .313 | .346 | .302 | .292 | .217 | .296 |
| 6) After-tax Rate of Return to Savings, (1– p) times (4) | .039 | .076 | .073 | .084 | .065 | .065 |
| 7) Pre-tax Wedge Between Borrowing and Saving Rates, (1) minus (4) | .07 (.115) | .039 (.057) | .060 (.083) | .046 (.069) | .064 (.095) | .060 (.084) |
| 8) After-tax Wedge Between Borrowing and Saving Rates, (3) minus (6) | .065 (.102) | .041 (.054) | .055 (.073) | .040 (.057) | .082 (.113) | .057 .080 |
| 9) Tax Wedge, (p – 6) | .132 | .099 | .078 | .043 | .217 | .109 |

Notes: a. Source: Federal Reserve Bulletin, various issues.

b. Values for 1970, 1972, 1980, 1983, and 1984 were calculated by the authors. The Poet 1986 Tax Reform rate is based on the fully phased-in provisions of the Tax Reform Act of 1986. See Footnote 6.

c. Source: Federal Reserve Bulletin, various issues.

d. Values for 1970, 1972, and 1980 were taken from Estrella and Fuhrer (1983). We calculated the values for 1983 and 1984 using this same procedure. The post-Tax Reform value was taken from Hausman and Poterba (1987).

As a second stepping-off point for our analysis, we note the prevalence and magnitude of intergenerational transfers. Based on a representative cross-section of U.S. households, Cox and Raines (1985) report high incidence rates for the receipt of private transfers over the first eight months of 1979, especially among family units headed by a person less than 25 years old. Cox and Raines also provide evidence that most private transfers are intergenerational, that the overwhelming bulk of intergenerational transfers are from older to younger generations, and that most intergenerational transfers occur inter vivos. Using the same data set as Cox and Raines, Kurz (1984) estimates that private intergenerational transfers amounted to $63 billion in 1979, excluding inheritances.[2]

We do not integrate a full range of transfer motives into our analytical framework. Instead, we focus on intergenerational altruism as a transfer motive and explore its implications in economies with a wedge between borrowing and lending rates. We believe that a complete explanation for the magnitude and prevalence of intergenerational transfers is likely to involve an important role for intergenerational altruism. In any case, several of our chief results require only that altruism motivates some intergenerational transfers, not that it motivates all or even most intergenerational transfers.

Our results provide answers to four questions. First, how does the existence of a wedge between borrowing and lending rates affect the life-cycle timing of altruistically motivated intergenerational transfers? Second, in economies that contain a wedge in the loan market and at least some altruistic family lines, what are the long-run effects of government debt, unfunded social security, and labor income taxation on aggregate savings and capital's marginal product? Third, how do tax policy changes that alter the size of the wedge affect aggregate savings and capital's marginal product? Fourth, what does the existence of a wedge between borrowing and lending rates imply about the relationship of overlapping generations models with altruistic family lines to models with infinitely lived representative

[2] Other empirical approaches bear out the importance of intergenerational transfers. Kotlikoff and Summers (1981) construct age-earnings and age-consumption profiles to compute life-cycle wealth (savings for retirement) for various age cohorts in the United States. By comparing their computation for life-cycle wealth to aggregate wealth, they conclude that intergenerational transfers account for the bulk of aggregate savings. See also Kotlikoff (1988) and Modigliani (1988). Our analysis does not address the aggregate savings puzzle identified by these studies. As we show in the following discussion, intergenerational transfers in our framework occur inter vivos and are used to finance consumption.

agents?

With respect to the first question, the existence of a wedge between borrowing and lending rates pins down the optimal timing of intergenerational transfers. Altruistically motivated intergenerational transfers occur early in the life cycle, when borrowing rates exceed lending rates. This timing result implies that the wedge destroys the fully interconnected set of budget constraints that undergirds standard Ricardian neutrality results. We show, for example, that an increase in the scale of an unfunded social security program causes a short-run reduction in aggregate savings. This outcome occurs in a model in which each generation is linked to its succeeding generation by altruistic transfers early in the life cycle.

With respect to the second question, we derive a powerful long-run neutrality result relating changes in government expenditures, government debt, the scale of social security programs, and the labor income tax schedule to capital's marginal product: If at least some family lines are characterized by (a) an operative transfer motive and (b) young persons who are at an interior solution with respect to their borrowing or saving decision, then capital's steady-state marginal product is invariant to each of these government interventions.

Unlike neutrality results in the tradition of Barro (1974), Becker (1974), and Bernheim and Bagwell (1988), the proof of our neutrality result does not rest upon a network of interconnected budget constraints. Thus, our neutrality result is both far more robust and far less comprehensive than the Ricardian Equivalence Theorem. Our result applies to a wider class of interventions, it does not require perfect capital markets, and it does not rest upon pervasive intergenerational altruism. It is less comprehensive in the sense that it applies only to the steady-state marginal product of capital.

With respect to tax policy interventions that affect the size of the wedge, we show the following. First, if conditions (a) and (b) hold for at least some family lines, and if the household borrowing rate exceeds the rate of return to saving (as in table 1), then changes in the proportional tax rate on capital income have no long-run effect on capital's marginal product. It follows that for a plausible elasticity of aggregate labor supply, aggregate savings is highly inelastic with respect to changes in the tax rate on capital income. Second, under the same conditions, capital's long-run marginal product is highly sensitive to changes in the proportional subsidy rate on household borrowing. It follows that aggregate savings is highly elastic with respect to changes in the subsidy rate on household borrowing, regardless of whether the labor supply is elastic. Thus, our analysis indicates that the subsidy to household borrowing is a much more potent tool for influencing aggregate savings than is the tax rate on capital income.

Finally, with respect to the fourth question, our analysis highlights the sharp distinctions between overlapping generations models with altruistic linkages and representative agent models. Since even a small wedge between borrowing and lending rates pins down the optimal timing of intergenerational transfers, altruistic linkage models are generally not isomorphic to representative agent models. The distinct fiscal policy implications of these two models, and the life-cycle model, emerge clearly in some numerical simulations reported in section 6. The simulations focus on the long-run response of aggregate savings to changes in the tax rate on capital income and changes in the subsidy rate on interest payments.

We turn now to a description of our analytical framework.

## 2. An Overlapping Generations Framework with Capital Income Taxation

Consider an overlapping generations production economy populated by persons who live for three periods. Each member of generation $t$ supplies homogeneous labor services $(L_{1t}, L_{2t}, L_{3t})$ over the life cycle according to a lifetime productivity profile $(\alpha_1, \alpha_2, \alpha_3)$ and a labor-leisure choice spelled out below. Aggregate period-$t$ labor supply is given by

$$(1+n)^t L_t = \left[\alpha_1 L_{1t} + \frac{\alpha_2 L_{2,t-1}}{1+n} + \frac{\alpha_3 L_{3,t-2}}{(1+n)^2}\right](1+n)^t, \tag{1}$$

where n is the population growth rate, and we have normalized population so that generation 0 has one member.

Defining $k = \frac{K}{L}$ as the capital-labor ratio, we write the aggregate production function as

$$Y_t = F[K_t, (1+n)^t L_t] \equiv (1+n)^t L_t f(k_t), \tag{2}$$

where $f'(\cdot) > 0$, $f''(\cdot) < 0$, $\lim_{k\to 0} f(k) = \infty$, and $\lim_{k\to\infty} f'(k) = 0$. The representative firm's competitive profit-maximization conditions are

$$W_t = f(k_t) - k_t f'(k_t) \tag{3}$$

and

$$r_t = f'(k_t), \tag{4}$$

where $W_t$ is the period-t wage in units of the produced good and $r_t$ is the rate of return on physical capital held from time $t - 1$ to time t.

The representative member of generation t chooses a sequence over consumption, labor supply, and intergenerational transfers to maximize

$$U_t = \sum_{i=1}^{3} \beta^{i-1} u(C_{it}) + \sum_{i=1}^{3} \beta^{i-1} v(L_{it}) + \beta\gamma U^*_{t+1}, \tag{5}$$

where

$C_{it}$ = consumption by a member of generation t in the ith period of life;

$L_{it}$ = labor supply by a member of generation t in the ith period of life;

$\beta$ = intertemporal discount factor, $0 < \beta < 1$;

$\gamma$ = interpersonal discount factor, $0 < 7 \leq (1+n)/\beta$ (insures a positive steady-state interest rate when transfer motives operate and capital markets are perfect);

$u(\cdot)$ = period utility function (over consumption), satisfying $u'(\cdot) > 0$, $u''(\cdot) < 0$, $\lim_{C\to 0} u'(C) = \infty$, and $\lim_{C\to\infty} u'(C) = 0$;

$v(\cdot)$ = period utility function (over labor supply), satisfying $v'(\cdot) < 0$, $v''(\cdot) < 0$, $\lim_{L\to 0} v'(L) = 0$, and $\lim_{L\to\overline{L}} v'(L) = -\infty$, where $\overline{L}$ is a positive upper bound on labor supply; and

$U^*_{t+1}$ = maximum utility attainable by a generation $t + 1$ agent as a function of intergenerational transfers received.

The specification of altruistic preferences in equation (5) mirrors the specification in Barro (1974) and many other analyses. We allow for operative and inoperative transfer motives, so that equation (5) also encompasses pure life-cycle economies.

Turning to the household budget constraints, we consider lifetime productivity profiles such that the middle-aged individuals choose to save and the young individuals choose to save or borrow. A key feature of our model is a wedge between household borrowing and lending rates. We explicitly model the source of this wedge as distortionary taxation of interest income that is not (fully) matched by the subsidy applied to interest payments on consumption loans. Alternatively, we could interpret the wedge as arising from any capital-market imperfection that amounts to a proportional transaction cost in the consumption-loans market. Although we focus on the tax interpretation of the wedge between borrowing and lending rates, our results apply with little or no modification when proportional transaction costs exist in the loan market.

It is worthwhile to observe that, for a sufficiently large wedge between borrowing and savings rates, young households may choose a corner position at which they neither save nor borrow. A wedge economy with a corner outcome is (locally) equivalent to an economy with binding borrowing constraints that stem from the absence of ex post enforcement mechanisms in the consumption-loans market, or any other capital-market imperfection severe enough to shut down the consumption-loans market. Thus, our overlapping generations framework encompasses capital-market imperfections that take the form of borrowing constraints. In this paper, we focus primarily on equilibria in which the young are at an interior solution with respect to either their savings or their borrowing decision. However, corner outcomes arise in some of our numerical simulation exercises. For a complete analysis of corner equilibria, see Altig and Davis (1989a,b).

With these remarks in mind, we write the budget equations for a representative member of generation t as

$$C_{1t} + a_{1t} + T_{1t} = \alpha_1 L_{1t} W_t + b_{1t} + x_t, \tag{6}$$

$$C_{2t} + (1+n) b_{1,t+1} + \psi_{t+1} x_t + a_{2t} + d_{t+1} + T_{2t} = \phi_{t+1} a_{1t} + \alpha_2 L_{2t} W_{t+1} + b_{2t}, \tag{7}$$

$$C_{3t} + (1+n) b_{3,t+1} + T_{3t} = \phi_{t+2}(a_{2t} + b_{3t} + d_{t+1}) + \alpha_3 L_{3t} W_{t+2}, \tag{8}$$

where

$x_t =$ borrowings by generation t when young;

$a_{1t} =$ savings (claims to capital) by generation t when young;

$a_{2t} =$ savings (in the form of claims to capital or repayment of consumption loans) by generation t when middle-aged;

$b_{i,t+1} =$ transfers made by a generation-t parent to each $(1+n)$ offspring in the children's ith period of life (an inter vivos transfer for $i = 1, 2$, a bequest for $i = 3$);

$T_{it} =$ lump-sum taxes (subsidies if negative) levied on a member of generation t during the ith period of life;

$d_{t+1} =$ government debt issued at time t $+ 1$ per middle-aged person;

$r_t =$ the pre-tax rate of return from t $- 1$ to $t$ on claims to physical capital, government debt, and the repayment of consumption loans;

$\phi_t = 1 + r_t(1 - p)$ where $p =$ proportional tax rate on interest income; and

$\psi_t = 1 + r_t(1 - 6)$ where $6 =$ the proportional subsidy rate applied to interest payments on consumption loans.

For simplicity, and without loss, the budget constraints incorporate the assumption that all government debt is purchased by the middle-aged.

The representative consumer maximizes equation (5) subject to equations (6)-(8) and the non-negativity constraints on period consumption, labor supply and transfers. Assuming nonpositive savings by the young $(a_{1t} = 0)$, the consumer's intertemporal first-order conditions can be written

$$u'(C_{1t}) \geq \beta(1 + r_{t+1}(1 - \delta))u'(C_{2t}) \quad \text{and} \tag{9}$$

$$u'(C_{2t}) = \beta(1 + r_{t+2}(1 - \rho))u'(C_{3t}). \tag{10}$$

Equation *(9)* holds *as* an equality when the loan market is active; it holds as an inequality when the loan market is inactive and when the young are at a corner.

Using the envelope theorem, the first-order conditions governing intergenerational transfers are

$$u'(C_{2t}) \geq \frac{\gamma}{1+n}u'(C_{1,t+1}) \quad \text{with equality if } b_{1,t+1} > 0, \tag{11}$$

$$u'(C_{3t}) \geq \frac{\gamma}{1+n}u'(C_{2,t+1}) \quad \text{with equality if } b_{2,t+1} > 0, \tag{12}$$

for inter vivos transfers and

$$u'(C_{3t}) \geq \frac{\gamma\beta}{1+n}(1 + r_{t+2}(1 - \rho))u'(C_{3,t+1}) \quad \text{with equality if } b_{3,t+1} > 0 \tag{13}$$

for bequests. Equations *(11)* and *(12)* state that, when an inter vivos transfer motive operates, the discounted marginal rate of substitution of parents' consumption for children's consumption equals the (population growth) deflated interpersonal discount factor. Equation *(13)* has a similar interpretation.

The static first-order conditions characterizing the labor-leisure trade-off for a member of generation t are given by

$$v'(L_{it}) = -\alpha_i W_{t+i-1} u'(C_{it}), \quad \text{for } i=1,2,3. \tag{14}$$

To complete the framework, we specify the government budget constraint, the goods-market-clearing condition, and the capital-market- clearing condition:

$$g_t + \frac{(1+r_t)}{1+n} d_{t-1} = (1+n)\Gamma_{1t} + \Gamma_{2,t-1} + \frac{\Gamma_{3,t-2}}{1+n} + d_t, \tag{15}$$

$$(1+n)L_{t+1}k_{t+1} - L_t k_t + C_{1t} + \frac{C_{2,t-1}}{1+n} + \frac{C_{3,t-2}}{(1+n)^2} + g_t = L_t f(k_t), \tag{16}$$

$$L_t k_t + (1+n)x_{t-1} = (1+n)a_{1,t-1} + a_{2,t-2} + b_{3,t-2}, \tag{17}$$

where

$g_t =$ government expenditures on goods and services at time t per middle-aged person,

$\Gamma_{1t} = T_{1t}$,

$\Gamma_{2,t-1} = T_{2,t-1} - \delta r_t x_{t-1} + \rho r_t a_{1,t-1}$, and

$\Gamma_{3,t-2} = T_{3,t-2} + \rho r_t (a_{2,t-2} + b_{3,t-2} + d_{t-1})$.

We assume that, on the margin, government expenditures are unproductive and do not substitute for private consumption. For our purposes, nothing essential is altered by relaxing these assumptions.

For economies that fit within this framework, an equilibrium is a sequence $\{C_{1t}, C_{2,t-1}, C_{3,t-2}, L_{1t}, L_{2,t-1}, L_{3,t-2}, x_t, a_{1t}, a_{2,t-1}, b_{1t}, b_{2,t-1}, b_{3,t-2}, W_t, r_{t+1}, k_t, g_t, d_t, T_{1t}, T_{2,t-1}, T_{3,t-2}\}_{t=0}^{\infty}$ that satisfies equations (3) through (14), the non-negativity constraints, the market-clearing conditions, and the government budget constraint for all t, given the initial condition $(x_{-1}, a_{1,-1}, a_{2,-2}, k_0, d_0)$.

## 3. The Optimal Timing of Altruistic Intergenerational Transfers

In Barro's (1974) Ricardian environment, the optimal timing of altruistic intergenerational transfers is indeterminate. Since capital markets are perfect, children and parents care only about the present value of intergenerational transfers, and not about their exact timing. This timing indeterminacy supports an extensive set of intergenerational linkages, which in turn play a key role in neutralizing certain fiscal policies. A straightforward, but central, result that emerges from our framework is the knife-edge character of this timing indeterminacy.

The slightest friction in the consumption-loans market in the form of a wedge between borrowing and lending rates–or a strong friction like binding borrowing constraints–pins down the optimal timing of altruistically motivated intergenerational transfers. Once the timing of intergenerational transfers is pinned down, the extensive set of intergenerational linkages in Ricardian environments breaks down. Despite this general observation, the fiscal policy implications of pinning down the timing of intergenerational transfers depend very much on whether capital-market imperfections drive potential borrowers to a corner solution, whether capital-market imperfections arise from transaction costs or tax considerations, and on the elasticity of labor supply.

We now state two **proposit**ions that characterize the optimal timing of altruistically motivated transfers. The first proposition applies when borrowing rates exceed lending rates in an active consumption-loans market or when the wedge between borrowing and lending rates is large enough to drive young persons to a corner with respect to their borrowing decision. The second proposition applies when lending rates exceed borrowing rates.

***Proposition 1:*** Assume that borrowing rates exceed lending rates *($p > 6$)* in the consumption-loans market and that the non-negativity constraint binds on $a_1$. Then, if intergenerational transfers are positive, $b_1 > 0$ and $b_2 = b_3 = 0$.

***Proof:***

***Interior solution for $x$:***

Suppose that $b_2 > 0$, so that equation (12) holds with equality. Combining equations *(12)* and *(10)* yields

$$r = \frac{1+n-\beta\gamma}{\beta\gamma(1-\rho)}. \tag{18}$$

Substituting into equation (9) yields

$$u'(C_1) = \beta[1 + (\frac{1+n}{\gamma\beta} - 1)(\frac{1-\delta}{1-\rho})]u'(C_2).$$

Equation *(11)* requires that $u'(C_1) \leq (\frac{1+n}{\gamma})u'(C_2)$. This condition holds if and only if

$$\beta[1 + (\frac{1+n}{\gamma\beta} - 1)(\frac{1-\delta}{1-\rho})]u'(C_2) \leq \frac{1+n}{\gamma}u'(C_2)$$

$$\Rightarrow (\frac{1+n}{\gamma\beta} - 1)(\frac{1-\delta}{1-\rho}) \leq \frac{1+n}{\gamma\beta} - 1$$

$$\Rightarrow 1-\delta \leq 1-\rho,$$

which implies $6 \geq$ p, violating the hypothesis (a). Thus, $b_2$ cannot be positive.

Now suppose that $b_3 > 0$. Then equation (13) leads to (18), and we obtain a contradiction in the same way as before. Thus, $b_3$ cannot be positive.

Finally, when $b_1 > 0$, equations (9) and (11) imply

$$r = \frac{1+n-\beta\gamma}{\beta\gamma(1-\delta)}. \tag{19}$$

It is straightforward to verify that equations (12) and (13) are consistent with (19) when $b_2 = b_3 = 0$. Thus, if intergenerational transfers are positive, only $b_1 > 0$.

***Corner solution for $x$:***

As before, suppose that $b_2 > 0$ or $b_3 > 0$. Then equation (12) or (13) in combination with equations (9) and (10) yield

$$u'(C_1) > \beta[1 + (\frac{1+n}{\gamma\beta} - 1)(\frac{1-\delta}{1-\rho})]u'(C_2).$$

Substituting this expression into equation (11) yields a contradiction. Thus, $b_2 = b_3 = 0$. Furthermore, $b_1 > 0$ is consistent with equations (9) through (13).

Following the same line of argument as in the preceding proof, we have

***Proposition 2:*** Assume that lending rates exceed borrowing rates in the consumption loans market and that the non-negativity constraint binds on $a_1$. Then, if intergenerational transfers are positive, $b_2 > 0$ or $b_3 > 0$, or both, and $b_1 = 0$.

The intuition behind these timing propositions is straightforward. Parents choose the timing of intergenerational transfers to exploit the wedge between the after-tax borrowing rate faced by the child and the after-tax rate of return on their own savings. More generally, in the cases covered by Proposition 1 (2), the marginal rate of substitution of current for future consumption is higher (lower) for children than for parents. Thus, transfers early (late) in the life cycle dominate transfers late (early) in the life cycle. As we show in the following section, this timing result has important implications for fiscal policy.

## 4. Lump-Sum Fiscal Policy in the Altruistic Linkage Model

We turn now to the analysis of **lump-sum** fiscal policy in economies with altruistic family lines and a wedge between borrowing and lending rates. We prove two results under the assumption of an active loan market. First, all lump-sum social security **and** government debt interventions are fully neutral in their effect on steady-state equilibrium. Second, we show by way of a simple example that these same fiscal policies are typically non-neutral in their short-run impact.

### A. Long-Run Neutrality

Proposition *3:* If (a) the consumption-loans market is active, (b) the altruistic transfer motive operates, and (c) the level of government expenditures is constant, then all fiscal policies that redistribute resources between generations in a lump-sum manner have no effect on steady-state values of interest rates, the capital stock, and the lifetime consumption profile.

Proof:

Case (i): p > 6:

By hypothesis (a),

$$u'(C_1) = \beta[1 + r(1 - \delta)]u'(C_2).$$

By hypothesis (b), p > 6, and applying proposition 1,

$$u'(C_2) = \frac{\gamma}{1+n} u'(C_1).$$

Combining these two equations yields equation (19). The parameters on the right side of equation (19) are independent of **lump-sum** fiscal policies. Thus, the capital-labor ratio is also independent of lump-sum fiscal policies.

Use the first-order conditions (9) and (10) to rewrite the goods-market-clearing condition as

$$G(C_2, k, \delta, \rho) = L[f(k) - nk] - g,$$

where $\frac{\partial G(\cdot)}{\partial C_2} > 0$. By condition (19), the term in square brackets is a constant.

Now suppose that the capital stock rises following the fiscal intervention. k and g constant imply that L rises, which implies that $C_2$ rises. But an increase in $C_2$ implies that L falls by equation (14), a contradiction. We also obtain a contradiction when we suppose the capital stock falls. Thus, the capital stock does not change.

It follows that L, W, and aggregate consumption are also unchanged. Finally, since aggregate consumption and the interest rates are unchanged, it follows from equations (9) and (10) that the lifetime consumption profile is unchanged.

***Case (ii), $\rho \leq 6$:***

The proof proceeds along lines parallel to case *(i).* Note that the steady-state interest rate is now given by equation (18).

The main distinguishing feature of proposition 3 is the line of proof. To develop this point, consider the nature of the neutrality results that appear in the literature. Fiscal-policy neutrality results in the tradition of Barro (1974), Becker (1974), and Bernheim and Bagwell (1988) exploit the interconnectedness of budget constraints implied by operative altruistic transfers. (Bernheim and Bagwell refer to the interconnectedness of budget constraints as the linkage hypothesis.) Neutrality theorems in this tradition basically state that a government-imposed transfer between two persons or generations who are directly or indirectly linked by altruistic transfers (before and after the government action) is neutral in its impact on consumption patterns and prices.

In contrast, the proof of proposition 3 does not exploit the interconnectedness of budget constraints implied by operative altruistic transfer motives. Instead, the proof combines an intertemporal first-order condition with the first-order condition governing altruistic transfers to pin down the interest rate in terms of preference, growth rate, and tax parameters. The remainder of the proof then follows from the intertemporal first-order conditions and the goods-market-clearing condition. Thus, our proof exploits the implications of altruistic preferences for the transfer motive first-order condition, whereas proofs in the Barro/Becker/Bernheim-Bagwell tradition exploit the implications of altruistic preferences for the interconnectedness of budget constraints. As we show in the following section, this aspect of our proof carries powerful implications for the interest rate and savings response to distortionary tax policy interventions as well.

The substance of proposition 3 differs in two respects from the Ricardian Equivalence Theorem as proved by Barro (1974) and as reformulated many times in the subsequent literature. First, the neutrality result in proposition 3 holds despite distortionary capital income taxation and, more generally, despite the asymmetric tax treatment of interest income and interest payments on consumption loans. Second, proposition 3 applies only to the steady-state effects of debt and social security interventions. When borrowing and lending rates differ (p $\neq \delta$), lump-sum interventions typically imply non-neutralities along the transition path.

### *B. Short-run Non-neutrality*

We now demonstrate that a wedge between borrowing and lending rates implies the short-run non-neutrality of **lump-sum** fiscal policies in the altruistic linkage model. Our discussion focuses on the impact effects of a surprise increase in lump-sum payments to older individuals, financed by an increase in **lump-sum** taxes on middle-aged individuals. Thus, the experiment represents a surprise increase in the size of an unfunded social security system.

To make the argument transparent, we adopt several simplifying assumptions: no population growth, inelastic labor supply, no labor supply by the old, no government expenditures, and the redistribution of all distortionary taxes to the affected generations via lump-sum transfers. We further assume that the economy is in a steady-state equilibrium at time t, prior to the intervention at time t $+$ 1.

Let $T_{2t}$ denote the additional **lump-sum** tax levied on middle-aged persons at time t $+$ 1. Normalizing so that $\alpha_1 + \alpha_2 = 1$, write the goods-market-clearing condition as

$$f(k_{t+1}) + k_{t+1} - C_{3,t-1} = C_{1,t+1} + C_{2t} + k_{t+2}.$$

Given p $>$ 6, proposition 1 informs us that the marginal utility of consumption of the older generation exceeds the y-discounted marginal utility of their middle-aged children's consumption. Hence, individuals who are old at time t $+$ 1 will choose to increase $C_{3,t-1}$ by the full amount of a small, surprise increase in social security payments. This is the key observation.

Now use the budget constraint (8) and the government budget constraint to rewrite the goods-market-clearing condition as

$$f(k_{t+1}) + k_{t+1} - (1 + r_{t+1})a_{2,t-1} - T_{2t} = C_{1,t+1} + C_{2t} + k_{t+2}. \qquad (20)$$

Except for $T_{2t}$, every term on the left side of equation (20) is predetermined. It follows from the key observation in the preceding paragraph that the social security payment to the old translates dollar-for-dollar as reductions in the sum of consumption by the young, consumption by the middle-aged, and aggregate savings. The impact effect is non-neutral.

Consumption-smoothing incentives (both between persons and over time) imply that part of the decline takes the form of a reduction in aggregate savings. Thus, the capital stock falls and the interest rate rises. Since equation (9) holds with equality, consumption falls for both the young and the middle-aged. If we allow for an elastic labor supply, the impact effects also include increased aggregate output and a reduction in the wage. Because the middle-aged reduce savings by more if they anticipate higher future social security benefits, the impact effects on the capital stock are smaller for a transitory increase in old-age benefits than for an increase expected to persist for two or more periods. By the same token, the impact effects on labor supply, output, the wage, and consumption by the middle-aged and the young are larger in response to a transitory increase in old-age benefits.

These remarks show that altruistic linkage models lead to short-run non-neutrality and long-run neutrality in response to small **lump-sum** interventions. The wedge between borrowing and lending rates is essential for this dichotomy between long-run and short-run responses. If borrowing rates equal lending rates in a model with homogenous family lines and altruistic intergenerational transfers, then adjacent generations are connected at the margin by intergenerational transfers at all stages of the life cycle. In this case, arguments based on the interconnectedness of budget constraints apply, and full neutrality prevails.

## 5. Long-Run Interest-Rate Neutrality in the Altruistic Linkage Model

We now turn our attention to the long-run effects of the tax policy parameters, p and 6, on interest rates and aggregate savings in the altruistic linkage model. We first build on the analysis in section 4 to obtain a strong neutrality result. We then show that the proportional subsidy rate on interest payments has powerful effects on aggregate savings when borrowing rates exceed lending rates.

### *A. Interest-Rate Neutrality*

Consider a version of the altruistic linkage model in which borrowing rates exceed lending rates in an active consumption-loans market. Retracing the first part of the proof to proposition 3 yields equation **(19),** reproduced here for convenience:

$$r = \frac{1 + n - \beta\gamma}{\beta\gamma(1 - \delta)}. \tag{19}$$

Equation (19) states that the pre-tax interest rate (that is, capital's marginal product) is unaffected by changes in the proportional tax rate on income from investments in physical capital or consumption **loans.**[3]

This interest-rate neutrality result is even stronger than it appears. Since the derivation of equation (19) does not play off of the interconnectedness of budget constraints, it does not require pervasive altruistic preferences. Provided there exist at least some family lines characterized by *(i)* an operative altruistic transfer motive and *(ii)* young members who are at an interior solution with respect to their borrowing (or saving) decision, then equation (19) (or [18]) holds at a steady-state equilibrium. Hence, this interest-rate neutrality result is consistent with the following observations: some family lines behave as pure life-cycle consumers; a broad range of motives contributes to observed patterns and magnitudes of intergenerational transfers; and many persons are at a corner with respect to their borrowing and saving **decisions.**[4]

We make three other straightforward observations about this neutrality result. First, if p $<$ 6, then a similar argument establishes that equation (18) holds in the steady-state equilibrium, provided that at least some family lines have an operative altruistic transfer motive. Second, when conditions *(i)* and *(ii)* hold for at least some family lines, all **lump**-sum interventions involving government expenditures and/or government debt also have zero effect on capital's steady-state marginal product. Finally, equation (4) implies that interest-rate neutrality is equivalent to aggregate-savings neutrality when the aggregate labor supply is inelastic.

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[3] **This** neutrality result requires, of course, a restriction on the size of the change in p. For a decrease in p, the restriction is that the after-tax lending rate not be pushed to a point where condition (11) fails to hold with equality. For an increase in p, the restriction is that the young not be pushed to a corner with respect to their borrowing decision.

[4] **Thus,** interest-rate neutrality is compatible with the existence of borrowing-constrained consumers as in the economies analyzed by Altig and Davis **(1989a,b)** and with the accumulating empirical evidence on the importance of borrowing constraints; see Zeldes (1989) and the references therein.

We summarize these results in

***Proposition 4:*** If borrowing rates exceed lending rates and at least some family lines are characterized by (a) positive intergenerational transfers motivated by a preference specification of the form (5) and (b) young persons who are at an interior solution with respect to their borrowing or saving decision, then *(i)* changes in the level of government expenditures, *(ii)* fiscal policies that redistribute resources between generations or over time in a lump-sum manner, and *(iii)* changes in the tax rate on interest income have no effect on capital's marginal product. Furthermore, if the aggregate labor supply is inelastic, then these interventions have no effect on steady-state aggregate savings.

We are aware of two previous analyses that use a line of proof similar to the one underlying proposition 4. In Altig and Davis (1989a) we prove an interest-rate neutrality result in the context of a model with borrowing constraints and child-to-parent altruistic gift motives. We also discuss the role played by the separability assumptions embedded in the preference specification (5) in this line of proof. Summers (1982) derives an interest-rate neutrality result in an overlapping generations model with capital income taxation, but with no wedge between borrowing and lending rates. Summers stresses the infinite elasticity of savings with respect to the after-tax rate of return implied by the neutrality result in his setting.

In sharp contrast, depending on the elasticity of labor supply, we obtain a zero long-run elasticity of savings with respect to the after-tax rate of return on savings. The difference between our results and those of Summers reflects the wedge between borrowing and lending rates in our framework as compared to the absence of a wedge in his framework.

### *B. The Long-Run Effect of the Subsidy on Interest Payments*

In contrast to the neutrality of capital's marginal product with respect to the proportional tax rate on capital income, capital's marginal product is highly sensitive to changes in the proportional subsidy rate on interest payments. This result, too, follows directly from equation (19). Thus, we have

***Proposition 5:*** Under the hypotheses of proposition 4, the steady-state marginal product of capital, given by equation (19), is an increasing function of the proportional subsidy rate applied to interest payments on consumption loans.

Consider a simple numerical example in which $n = .641$ and $\beta = .778$. Interpreting a period as 25 years, these values correspond to an annual population growth rate of 2 percent and an annual time discount factor of .99. Assume that parents weight each child's utility one-half as heavily as their own utility. Now consider the impact of a reduction in 6 from .25 to 0, which corresponds to the estimated effect of the 1986 tax reform in table 1. From equation (19), this reduction in the subsidy rate on interest payments implies a reduction in the steady-state value of $r$ from 4.29 to 3.22. In annualized terms, this change corresponds to a reduction in the pre-tax rate of return on capital from 6.89 percent to 5.92 percent. Thus, the recent tax policy change governing the proportional subsidy rate on interest payments implies a 14 percent decline in the steady-state marginal product of capital in this partial parameterization of the altruistic linkage model. This sizable reduction in the marginal product of capital implies that the elimination of interest payment deductibility causes a sizable increase in the steady-state capital stock, even if aggregate labor supply is inelastic in the long run.

### *C. A Remark on the Existence of Equilibrium*

We close this section with a brief remark on the existence of equilibrium. All of our novel fiscal policy results hypothesize an equilibrium in which some or all family lines are characterized by both operative intergenerational transfers and young members who borrow in the consumption-loans market. The reader may well ask whether such equilibrium configurations are likely outcomes in our overlapping generations framework. Altig and Davis (1989b) address this issue at length in versions of the framework with $p = 6 = 0$, inelastic labor supply, and homogeneous family lines. Given reasonable and conventional specifications of preferences, the production technology, and the lifetime productivity profile, we show that it is quite easy to obtain equilibria with operative transfers and an active loan market for small values of the interpersonal discount factor. With allowance for heterogeneous family lines, there is even more scope for equilibria that satisfy the hypotheses of our propositions.

## 6. Tax Policy and Aggregate Savings: Experiments in Three Models

With respect to the effects of tax policy on aggregate savings, two basic points emerge from the analytical results in section 5. First, in the altruistic linkage model, aggregate savings is considerably more sensitive to changes in the subsidy rate on interest payments (6) than to changes in the tax rate on interest income (p). Second, the aggregate savings response to changes in 6 or $\rho$ in the altruistic linkage model differs from the response in life-cycle and **dynastic/representative** agent models.

Our objective here is to develop these points more fully by quantifying the long-run aggregate savings response to tax policy changes in the three models. The three models we consider are the altruistic linkage (AL) model with operative transfers and differential borrowing and lending rates, the life-cycle (LC) model with no transfers but differential borrowing and lending rates, and the **dynastic/representative** agent (DRA) model. Since the **dynastic/representative** agent model does not admit differential borrowing and lending rates, we assume that $\rho = 6$ in our simulations of this **model.**[5] Using each of these models in turn, we calculate the percentage change in the steady-state capital stock associated with permanent changes in the tax policy parameters.

### *A. Parameterization*

In conducting our simulations, we interpret a period as 25 years and use the following parameterization:

Technology:

$$y_t = k_t^{\theta}, \ \theta = .25$$

Productivity profile:

$$(\alpha_1, \alpha_2, \alpha_3) = (1.5, 6.0, 2.5)$$

Population growth:

$$n' = .01, \ n = (1 + n')^{25} - 1$$

Time preference:

$$\beta' = .99, \ \beta = (\beta')^{25}$$

Interpersonal discount factor (altruistic linkage model):

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[5] **Propositions** 1 and 2 imply that Barro-type dynasties do not exist when borrowing and lending rates differ in an active consumption-loans market. Thus, the standard motivation for the infinitely lived representative-agent framework, as described by Judd (1987) and elaborated by Aiyagari (1987), breaks down. Nonetheless, we can still ask how the response to changes in the proportional tax rate on capital income in the representative agent model compare to responses in the life-cycle model and generalized altruistic linkage model.

$\gamma = .35$

Period utility (over consumption):

$$u(C_{it}) = \frac{C_{it}^{1-\frac{1}{\sigma_C}}}{1-\frac{1}{\sigma_C}}$$

Period utility (over labor supply):

$$v(L_{it}) = \frac{-L_{it}^{1+\frac{1}{\sigma_N}}}{1+\frac{1}{\sigma_N}}.$$

A priori, the magnitude of the aggregate savings response to changes in the tax policy parameters seems likely to be sensitive to the intertemporal substitution elasticities, $\sigma_C$ and $\sigma_N$, as the following remarks suggest. First, it is well known that the intertemporal elasticity of substitution in consumption strongly influences the savings response to changes in the after-tax interest rate in the LC and DRA models. Second, in models with altruistic linkages, Altig and Davis (1989b) show that small changes in the willingness to substitute consumption intertemporally have powerful effects on the magnitude of intergenerational transfers and on the scale of activity in the consumption-loansmarket. Finally, the analysis in section 5 shows that, at least for the AL model, the aggregate savings response to changes in the marginal tax rate on interest income depends critically on the elasticity of labor supply.

These observations prompt us to simulate the long-run response to tax policy interventions under several sets of values for the intertemporal substitution elasticities. We consider values of $\sigma_N$ in the set $\{.1, .3, 1\}$ and values of $\sigma_C$ in the set $\{.33, .5, 1\}$.

MaCurdy's (1981) study of men's labor supply behavior suggests values of $\sigma_N$ in the range $(.1, .45)$, a finding largely confirmed in related studies (see Pencavel [1986]). Our midpoint value of $\sigma_N$ is near the midpoint of MaCurdy's range, while our lower value corresponds to to the lower end of his range. Despite much greater disparity in the estimates of the labor supply elasticity of women, there is broad agreement among labor economists that the elasticity is higher for women than for men (see Killingsworth and Heckman [1986]). Thus, evidence on the labor supply behavior of women points to a larger value for the aggregate labor supply elasticity. In addition, Hansen (1985) shows that indivisibilities in labor supply behavior can lead to an aggregate intertemporal substitution elasticity much larger than the elasticity of individuals. These considerations lead us to consider unit elasticity as an upper value for $\sigma_N$.

Turning to the intertemporal elasticity of substitution in consumption, Hall's (1988) empirical study suggests a value of $\sigma_C$ near .1. Hall's estimates of $\sigma_C$ (as well as most other estimates in the literature) are based on short-run consumption growth responses to anticipated movements in real returns on financial assets. However, given the three-period-lived agents in our analytical framework and our focus on the long-run response to tax policy changes, it is more appropriate to parameterize the model in terms of the willingness to substitute consumption over broad epochs of life. We are unaware of formal econometric attempts to estimate this notion of an intertemporal substitution elasticity, although descriptive work suggests that the elasticity is large. For example, Carroll and Summers (1989) show that the shape of the lifetime consumption profile differs greatly across educational and occupational groups, and that the shape of group average consumption profiles closely mirrors the shape of group average income profiles. Aside from pointing to important departures from perfect capital markets, these patterns indicate that consumers exhibit considerable willingness to substitute consumption intertemporally over broad epochs of life. These factors lead us to consider a fairly broad range for $\sigma_C$ as well.

Other notable features of our parameterization include a lifetime productivity profile with a sharp peak during the middle years of life and an interpersonal discount factor in the AL model for which parents weight their children's utility 35 percent as heavily as their own.

All of our tax policy experiments maintain a balanced budget for the government by adjusting lump-sum taxes and subsidies. In the AL and LC models, the generational incidence of lump-sum taxes matters. For simplicity, we assume that all distortionary taxes are returned to the affected generation via lump-sum subsidies, and we treat distortionary subsidies analogously.

We report the results of two types of experiments.

Experiment 1: The subsidy rate, 6, is fixed and the marginal tax rate on interest income, p, is varied.

Experiment 2: $\rho$ is fixed and 6 is varied.

In our simulations, we measure the capital-stock response relative to a benchmark tax structure with $\delta = 0$ and $\rho = 22$. These values closely reflect the fully phased-in provisions of the Tax Reform Act of 1986.[6,7]

### *B. The Savings Response to Changes in the Tax Rate on Interest Income*

Tables 2 through 4 report the results of our simulation experiments in the LC, AL, and DRA models, respectively. The table entries report the percentage change in the steady-state capital stock under experiments 1 and 2 relative to the benchmark specification of the tax policy parameters. Column headings indicate the value of p and/or $\delta$ in the new equilibrium, while the leftmost columns describe the parameterization of the consumption and labor supply elasticities. Note that we include the inelastic labor supply case as well.

Table 2 shows that changes in the marginal tax rate on interest income have significant effects on the steady-state capital stock in the LC model. For example, assuming $\sigma_C = .33$ and $\sigma_N = .3$, an increase in p from .22 to .33 causes the capital stock to decline by 6.7 percent. Elimination of interest income taxation causes the capital stock to rise by 12.6 percent. Similar results hold for other parameterizations of $\sigma_C$ and $\sigma_N$. Turning to Table 4, equal increases or decreases in p and $\delta$ have significant effectson the steady-state capital stock in the DRA model. Assuming $\sigma_C = .33$ and $\sigma_N = .3$, an increase in p from .22 to .33 causes the capital stock to decline by 17 percent. Elimination of interest income taxation (and interest expense subsidies) causes the capital stock to rise by 36 percent. Thus, simulations in both the LC and DRA models indicate that long-run aggregate savings shows significant sensitivity to the tax rate on interest income. These results are similar to previous results in the literature; see Summers (1982).

The simulated effect of changes in p differ sharply for the AL model. We know from proposition 5 that changes in $\rho$ have zero effect on the steady-state capital stock when the labor supply is inelastic. Table 3 reveals qualitatively similar responses when the labor

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'Interest expense on pure consumption loans will no longer be deductible as of 1991. The effect of eliminating deductions of interest payments on nonmortgage consumer debt may be muted for many households by the availability of home-equity lines of credit. In fact, lending in the form of home equity lines of credit has expanded dramatically since 1986. The extent to which this type of debt instrument will eventually substitute for traditional, non-tax-favored forms of consumption loans is not yet clear. See Canner and Luckett (1989).

[7]The benchmark value of p is taken from Hausman and Poterba (1987), who estimate the marginal tax rate on interest income in 1988 to be 21.7 percent, based on the NBER's TAXSIM model.

TABLE 2

The Effects of Tax Policy on the Steady State

Capital Stock Life Cycle Model

| | | $\rho = .33$ | $\rho = .11$ | $\rho = 0$ | $\delta = 11$ | $\delta = .22$ |
|---|---|---|---|---|---|---|
| $\sigma_c = .33$ | Inelastic | -8.95 | 8.65 | 17.01 | -9.53 | -19.19 |
| | $\sigma_N = .15$ | -7.63 | 7.31 | 14.37 | -9.55 | -19.25 |
| | $\sigma_N = .3$ | -6.74 | 6.41 | 12.57 | -9.65 | -19.47 |
| | $\sigma_N = 1$ | -4.46 | 4.17 | 8.11 | -10.26 | -20.06 |
| $\sigma_c = .5$ | Inelastic | -9.16 | 8.89 | 17.54 | -8.73 | -17.77 |
| | $\sigma_N = .15$ | -8.41 | 8.14 | 16.04 | -8.72 | -17.74 |
| | $\sigma_N = .3$ | -7.85 | 7.58 | 14.93 | -8.82 | -17.94 |
| | $\sigma_N = 1$ | -6.11 | 5.86 | 11.52 | -9.58 | -19.40 |
| $\sigma_c = 1$ | Inelastic | -8.18 | 7.85 | 15.40 | -6.38 | -13.20 |
| | $\sigma_N = .15$ | -8.31 | 8.01 | 15.77 | -6.60 | -13.63 |
| | $\sigma_N = .3$ | -8.42 | 8.15 | 16.07 | -6.79 | -14.00 |
| | $\sigma_N = 1$ | -8.67 | 8.51 | 16.90 | -7.53 | -15.43 |

Notes: Each entry reports the percentage change in the steady state capital stock as a result of altering one of the tax parameters $\rho$ or 6. At the initial steady state, $\rho = .22$ **and** $6 = 0$. Column headings indicate the value of the altered tax parameter in the new steady state.

Source: Authors' calculations.

TABLE **3[a]**

The Effects of **Tax** Policy on the Steady State Capital Stock

Altruistic Linkage Model

| | | $\rho = .33$ | $\rho = .11$ | $\rho = 0$ | $\delta = 11$ | $\delta = .22$ |
|---|---|---|---|---|---|---|
| $\sigma_c = .33^b$ | Inelastic | 0.00 | 0.00 | 0.00 | -14.39 | -28.20 |
| | $\sigma_N = .15$ | -0.33 | 0.31 | 0.60 | -13.50 | -26.58 |
| | $\sigma_N = .3$ | -0.58 | 0.54 | 1.05 | -12.98 | -25.62 |
| | $\sigma_N = 1$ | -1.18 | 1.10 | 2.12 | -11.96 | -23.74 |
| $\sigma_c = .5$ | Inelastic[c] | 0.00 | 0.00 | 0.00 | -14.39 | -28.20 |
| | $\sigma_N = .15$ | **-6.69[d]** | 0.35 | 0.68 | -13.79 | -27.09 |
| | $\sigma_N = .3$ | -0.66 | 0.63 | 1.23 | -13.36 | -26.30 |
| | $\sigma_N = 1$ | -1.49 | 1.41 | 2.77 | -12.32 | -24.37 |
| $\sigma_c = 1^e$ | Inelastic | 0.00 | **6.28[f]** | **13.72[f]** | -7.741 | **-14.47[f]** |
| | $\sigma_N = .15$ | **-10.63[d]** | **3.03[f]** | **10.42[f]** | **-10.91[f]** | -17.62 |
| | $\sigma_N = .3$ | -0.79 | **5.91[f]** | **13.67[f]** | **-8.72[f]** | **-15.78[f]** |
| | $\sigma_N = 1$ | -2.08 | **7.48[f]** | **15.78[f]** | **-8.41[f]** | **-16.24[f]** |

Notes:

a: See note to table 2. Unless otherwise noted, calculations in this table are based on 7 = **.35.**

b: Savings by the young are positive in the initial steady state for $\sigma_c = .33$ and the benchmark tax parameters when 7 = **.35.** All entries corresponding to $\sigma_c = .33$ assume 7 = .25 except for the inelastic labor supply case, which assumes 7 = **.15.**

c: Savings by the young are positive in the initial steady state for $\sigma_c = .5$, inelastic labor supply and the benchmark tax parameters when 7 = **.35.** All entries in this row assume 7 = **.25.**

d: The young are at a corner with respect to their **saving/dissaving** decision in the new steady state.

e: The transfer motive is inoperative in the initial steady state for $\sigma_c = 1$ and the benchmark tax parameters when 7 = **.35.** All entries corresponding to $\sigma_c = 1$ assume 7 = .52 except the inelastic labor supply case, which assumes 7 = **.50.**

f: The transfer motive is inoperative in the new steady state.

Source: Authors' calculations.

TABLE 4[a]

The Effects of Tax Policy on the Steady State Capital Stock

**Dynastic/Representative** Agent Model

| | | $\rho = .33$ | $\rho = .ll$ | $\rho = 0$ |
|---|---|---|---|---|
| $\sigma_c = .33^b$ | Inelastic | -18.35 | 19.23 | 39.28 |
| | $\sigma_N = .15$ | -17.52 | 18.20 | 37.03 |
| | $\sigma_N = .3$ | -17.08 | 17.67 | 35.86 |
| | $\sigma_N = 1$ | -16.34 | 16.76 | 33.91 |
| $\sigma_c = .5$ | Inelastic[c] | -18.35 | 19.23 | 39.28 |
| | $\sigma_N = .15$ | -17.91 | 18.69 | 38.09 |
| | $\sigma_N = .3$ | -17.63 | 18.35 | 37.35 |
| | $\sigma_N = 1$ | -17.07 | 17.67 | 35.87 |
| $\sigma_c = l^d$ | Inelastic | -17.78[e] | 19.23 | 39.28 |
| | $\sigma_N = .15$ | -18.40 | 19.30 | 39.44 |
| | $\sigma_N = .3$ | -18.43 | 19.36 | 39.57 |
| | $\sigma_N = 1$ | -18.53 | 19.51 | 39.92 |

Notes:

a: Each entry reports the percentage change in the steady-state capital stock as a result of simultaneously changing $\rho$ and $\delta$ by the same amount. Unless otherwise noted, calculations are based on $7 = .35$.

b: See note b, table 3.

c: See note c, table 3.

d: The transfer motive is inoperative in the initial steady state for $\sigma_c = 1$ and the benchmark tax parameters when $7 = .35$ <u>and</u> when $7 = .52$ as **in** table 2. All entries **corresponding** to $\sigma_c = 1$ assume $\gamma = .60$ except the inelastic labor supply case, which assumes $7 = .50$.

e: See note e, table 3.

Source: Authors' calculations.

supply is elastic. The effects of changes in p in the AL model are of roughly an order of magnitude smaller than in the LC and DRA models. The only exceptions occur when the tax policy change either pushes the middle-aged to a corner with respect to their transfer decision or pushes the young to a corner with respect to their saving/borrowing decision. The contrast between the aggregate savings effects in the AL and DRA models is especially striking. Assuming $\sigma_C = .33$ and $\sigma_N = .3$, elimination of interest income taxation causes the steady-state capital stock to rise by a mere 1 percent in the AL model, compared to the 36 percent rise in the DRA model.

### *C. The Savings Response to Changes in the Subsidy Rate on Interest Expense*

In the LC model, changes in p and 6 have roughly symmetric effects on the steady-state capital stock. For example, again focusing on $\sigma_C = .33$ and $\sigma_N = .3$, an increase in $\delta$ from 0 to .11 causes the capital stock to fall by 9.7 percent. An increase in $\delta$ from 0 to .22 causes the capital stock to fall by 19.5 percent. Thus, aggregate savings also shows significant sensitivity to the subsidy rate on interest expenses in the LC model.

In the AL model, the aggregate savings effects of changes in 6 are even larger. This result holds for all parameterizations we considered in tables 2 and 3, Provided that an interior solution holds at the new steady state, the capital stock effects are considerably larger in the AL model. For example, when $\sigma_C = .33$ and $\sigma_N = .3$, an increase in 6 from 0 to .11 causes the capital stock to fall by 13 percent, and an increase in 6 from 0 to .22 causes the capital stock to fall by 25.6 percent.

In sum, the simulations point to powerful long-run effects of the interest subsidy on aggregate savings in the LC and, especially, AL models. With respect to the 1986 Tax Reform Act's elimination of interest-expense deductibility (on consumer loans), the simulations support the view that this reform will lead to an eventual 10- to 25-percent increase in the capital stock.

## 7. Some Extensions

In this section, we extend our previous results regarding the long-run neutrality of capital's marginal product in the face of various fiscal policy interventions. We briefly consider the implications of distortionary labor income taxes and the distortionary effects of inflation when the capital income tax base involves nominal variable's.

### *A. Distortionary Labor Income Taxes*

Provided that there exist at least some family lines characterized by an operative altruistic transfer motive and young persons who choose an interior solution with respect to borrowing or saving, arbitrary labor income tax schedules have no effect on the steady-state marginal product of capital. Under these circumstances, equation (19) describes the marginal product of capital when the after-tax borrowing rate exceeds the after-tax lending rate. (Alternatively, if the lending rate exceeds the borrowing rate or the young are net savers, then equation [18] describes the marginal product of capital.)

As before, this result follows directly by combining the intertemporal consumption first-order condition for the young individuals with the transfer-motive first-order condition for the middle-aged individuals.[8] Hence, the results stated in propositions 3 through 5 carry over without alteration to economies with distortionary labor income taxation. In addition to the long-run neutrality results in these propositions, we add

***Proposition 6:*** Under the hypotheses of proposition 4, the steady-state marginal product of capital is invariant to arbitrary changes in the labor income tax schedule.

### *B. Inflation and Nominal Taxation*

We model inflation by introducing an exogenously determined unit of account. This device enables us to capture the distortion arising from the interaction between inflation and the tax structure without explicitly modeling the inflationary mechanism. We continue to assume a proportional tax rate on interest income and a proportional subsidy rate on interest payments. In contrast to our previous analysis, however, we assume that tax calculations are based on nominal interest rates. Denote the rate of inflation (the growth rate of the unit of account) from time $t$ to $t+1$, as $\pi_{t+1}$. Approximating the nominal interest rate as the sum of the real rate of return to capital and the rate of inflation, the first-order conditions (9) and (10) become

$$u'(C_{1t}) \geq \beta(1 + r_{t+1}(1-\delta) - \delta\pi_{t+1})u'(C_{2t}), \tag{9'}$$

[8] The steady-state invariance of capital's marginal product with respect to the labor income tax schedule does not require separability between consumption and leisure in the utility function. This observation is easily verified by relaxing the intraperiod separability assumption embodied in equation (5) and retracing the derivation of equations (18) and (19).

$$u'(C_{2t}) = \beta(1 + r_{t+2}(1-\rho) - \rho\pi_{t+1})u'(C_{3t}). \tag{10'}$$

Using equations (9') and (10') to argue along familiar lines, we have

Proposition *7:* Assume that interest income taxes and interest payment subsidies are calculated on nominal rates. Then *(i)* If after-tax borrowing rates exceed after-tax lending rates and conditions (a) and (b) of proposition 4 hold for at least some family lines, the steady-state marginal product of capital is given by

$$r = \frac{1 + n + \gamma\beta\delta\pi - \gamma\beta}{\gamma\beta(1-\delta)} \tag{21}$$

*(ii)* If after-tax lending rates exceed after-tax borrowing rates, and conditions (a) and (b) of proposition 4 hold for at least some family lines, the steady-state marginal product of capital is given by

$$r = \frac{1 + n + \gamma\beta\rho\pi - \gamma\beta}{\gamma\beta(1-\rho)}. \tag{22}$$

Three interesting results follow directly from proposition 7. First, for a fixed inflation rate, the neutrality results in propositions 3 through 6 extend to economies with nominal interest income taxation.[9] Second, the long-run sensitivity of capital's marginal product to the tax parameters, $\rho$ or $\delta$, is an increasing function of the inflation rate. To see this point when, for example, borrowing rates exceed lending rates, differentiate equation (21) to obtain

$$\frac{dr}{d\delta} = \frac{\pi + r}{1-\delta}.$$

Third, when borrowing rates exceed lending rates, the effect of inflation on capital's steady-state marginal product hinges crucially on the interest payment subsidy rate, $\delta$, and is independent of the interest income tax rate, $\rho$. From equation (21),

$$\frac{dr}{d\pi} = \frac{\delta\pi}{1-\delta}.$$

[9] In an explicit monetary model, the government's budget constraint implies a relationship between the growth rate of the money supply and fiscal policy instruments. A higher level of government debt, for example, would be associated with a higher inflation rate, if the interest payments on government debt were financed by money creation. In this scenario, and under the assumptions of proposition 8, changes in the steady-state level of government debt would be associated with changes in the marginal product of capital. Alternatively, if interest payments on the higher level of government debt were financed by an increase in labor income taxes, the steady-state marginal product of capital would be unaffected.

Thus, the inflation effect on capital's marginal product is an increasing function of the proportional subsidy rate on interest payments. Furthermore, eliminating the subsidy to interest payments eliminates the effect of inflation on capital's marginal product.

The implication of these observations for aggregate savings can be summarized as follows. When borrowing rates exceed lending rates in the altruistic linkage model, the magnitude of any inflation-induced decline in aggregate savings is much more sensitive to the subsidy rate on nominal interest payments than to the tax rate on nominal interest income. If the aggregate labor supply is inelastic, then the long-run response of aggregate savings to inflation is independent of the tax rate on nominal interest income.

## 8. Concluding Remarks

The results in this paper do not conform neatly to any of the prominent positions in the vigorous debate over the aggregate savings effects of fiscal policy. On the one hand, we prove the invariance of capital's steady-state marginal product to government debt and social security policies and to the labor income-tax schedule under weak conditions. For reasonable parameterizations of consumption and labor supply elasticities, the effects of these government interventions on the steady-state capital stock are also small.

Notably, our long-run invariance theorem does not rest upon an extensive network of interconnected budget constraints, either within family lines or across family lines. Nor does it rest upon the assumed absence of binding borrowing constraints or otherwise perfect capital markets. Thus, our invariance theorem is immune to the most frequently invoked arguments against the Ricardian position.

On the other hand, the scope of our invariance theorem is narrower than the Ricardian Equivalence Theorem in many respects. The invariance of capital's steady-state marginal product (and the approximate invariance of steady-state aggregate savings) in our altruistic linkage model is consistent with important short-run effects of lump-sum government debt and social security policies and with distortionary labor income taxation on capital's marginal product and aggregate savings. Our invariance theorem is also fully consistent with the view that these fiscal policies have important long-run and short-run consequences for the distribution of consumption across age groups and among heterogeneous individuals within age cohorts.

Furthermore, our analysis points to powerful long-run effects of certain types of tax policy on aggregate savings, regardless of whether intergenerational altruism plays an important role. For example, our simulations suggest that the elimination of interest expense deductibility by the Tax Reform Act of 1986 will lead to an eventual 10- to 25-percent increase in aggregate savings.

We interpret the sharply asymmetric response of aggregate savings to changes in the tax treatment of interest income and interest payments in our altruistic linkage model as a caveat to the use of representative agent models for tax policy analysis. While representative agent models offer useful insights about intertemporal substitution effects, they do not permit one to pose interesting questions about the effects of unequal-size changes in the interest-income-tax rate and the interest-payment- subsidy rate. As the empirical evidence in table 1 and the theoretical results for the altruistic linkage model indicate, this restriction is a severe one.

Most of our novel results follow from proposition 1, which describes the optimal timing of altruistically motivated intergenerational transfers when borrowing rates exceed lending rates. While we doubt that our simple altruistic linkage model–and the optimal timing proposition, in particular-completely characterizes real-world savings and transfer behavior, we are willing to entertain the hypothesis that the model captures an element of truth for a significant fraction of the population. This hypothesis suggests two interesting and testable implications that we plan to pursue in future empirical work.

The first testable implication follows directly from the optimal timing proposition and involves the connection between the age distribution of resources and the age distribution of consumption. (See Boskin and Kotlikoff [1985], Abel and Kotlikoff [1988], and Altonji, Hayashi, and Kotlikoff [1989] for related empirical work.) According to proposition 1, shocks that redistribute income between middle-aged and young persons imply no change in the age distribution of consumption, whereas shocks that redistribute income from middle-aged (or young) persons to old persons lead to increased consumption by the old. This strict testable implication follows when all family lines exhibit nonstrategic altruistic behavior. More plausibly, in our view, when some family lines operate as pure life cyclers and other family lines operate as altruists, the testable implication becomes this: a one-dollar redistribution of resources from middle-aged individuals to old individuals leads to a larger decline in consumption by the middle-aged than would a one-dollar redistribution of income from the middle-aged individuals to young individuals. This implication can be tested with time-series data on age-consumption and age-income (or age-wealth) profiles. It can also be reformulated as holding on average (across families) in panel data.

A second testable implication follows from propositions 4 and 5, which describe the long-run aggregate savings response to the tax treatment of interest income and interest expense in the altruistic linkage model. If our analysis captures an important element of real-world behavior, then cross-country differences in the tax treatment of consumer loan interest expenses will help to explain differences in aggregate savings rates. At a minimum, the subsidy rate on consumer loans will have more explanatory power than the tax rate on interest income.

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