Ricardian Equivalence Holds in a Dynamic Model with Strategic Behavior

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Abstract

The absence of strategic interaction between generations has been identified as important for Ricardian equivalence but receives little attention in the literature. This paper uses simulations to show Ricardian equivalence is not negated by intergenerational strategic behavior. This result is robust to different possible sequences of choices by parent and child. I then introduce capital gains and inheritance taxes and show the crowding out effect of government debt is notably smaller in models with strategic behavior. In spite of the neutrality of debt under lump sum taxes, including intergenerational strategic behavior can significantly influence the outcome of government tax policies.

Keywords: Ricardian equivalence, strategic behavior, intergenerational altruism, crowding out

JEL Classifications: C73, D64, D91, E62

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1 Introduction

The absence of strategic interactions between members of different generations is believed required for Ricardian equivalence but little explored in the literature.¹ This paper presents an overlapping generations model in which a child attempts to manipulate the size of the bequest given him by his parent. The child subsequently becomes a parent, potentially manipulated by his child, and so on. I evaluate Ricardian equivalence by considering the effects of a deficit financed tax cut followed by a tax increase to retire the debt. Numerical results indicate Ricardian equivalence holds in this framework.² Next I use the simulations to assess the effect of allowing strategic behavior on the crowding out of private savings by government debt. I introduce capital gains and inheritance taxes and find crowding out to be significantly smaller in models with strategic behavior than in the model without strategic behavior.

Previous works present mixed results on the effect of intergenerational strategic behavior on Ricardian equivalence. Bruce and Waldman (1990) and Kotlikoff, Razin and Rosenthal (1990) conclude government debt is not neutral in their respective static environments. Seater (1993) writes that when strategic behavior is included in parent-child interactions “a debt-for-tax swap alters the threat point of the parents and/or the children and therefore has real effects, negating Ricardian equivalence.” (p. 148). In his review of Ricardian equivalence literature he finds only a handful of authors who attempt to connect strategic behavior and Ricardian equivalence.

Most existing general equilibrium studies of Ricardian equivalence generally avoid intrafamily strategic behavior. Laitner (1993) points out the difficulty of incorporating such

¹See Barro (1989) and Seater (1993) for surveys of the conditions believed necessary for Ricardian equivalence and their respective significance. Each also provides reviews of the micro and macroeconomic studies that test for empirical evidence of Ricardian equivalence.

²I show Ricardian equivalence holds in the presence of one possible form of intergenerational strategic behavior. The intent is not to assert strategic behavior never negates Ricardian equivalence, but rather to demonstrate that intergenerational strategic behavior does not necessarily cause Ricardian equivalence to fail.
behavior in dynamic models with intergenerational transfers (p. 70). Common techniques include assuming two-sided altruism (Altig and Davis (1993) and Laitner (1993) and (1992)) and assuming parents make some decisions for their children (Batina (1987) and Caballé (1995)). General equilibrium analyses that do include strategic behavior focus on other issues and don’t evaluate Ricardian equivalence (Coate (1995)). Two exceptions are Smetters (1999) and Bernheim and Bagwell (1988). Smetters demonstrates the neutrality of some types of strategic behavior, but omits discussion of the form studied in this paper. Bernheim and Bagwell extend Barro’s dynastic framework to extremes by asserting everyone is in fact connected through possible future marriages and through transfers to siblings, cousins, and charities (fn. 23). Their result that “everything is neutral” is certainly untenable (as they point out) and may stem in part from their assertion that uncertainty about potential future connections is irrelevant. However, given the extremes to which they take their assumptions it is difficult to be certain what is driving their result. This paper examines a specific type of strategic behavior to assess its impact on Ricardian equivalence and on one aspect of the effect of certain distortionary taxes.

I model the interaction between an altruistic parent and a selfish child as a form of the Samaritan’s dilemma. An altruistic parent makes an end-of-life transfer to a selfish child. The child can attempt to elicit as large a transfer as possible from the parent by overconsuming when young, so as to be relatively poor when the parent is choosing the bequest amount. The parent faces the problem of the good Samaritan: how to help the

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3The literature analyzing Ricardian equivalence, intergenerational transfers, and intergenerational strategic behavior is quite substantial, but these three elements are seldom combined. Laitner (1993) and (1992), Altig and Davis (1993), and O’Connell and Zekles (1993) each consider intergenerational transfers in a general equilibrium environment, and each mentions the potential significance of intergenerational strategic behavior, but chooses to forgo its inclusion in their analysis. Veall (1986) and Cremer, Kessler and Pestieau (1992) include intergenerational strategic behavior in their respective general equilibrium analyses but make no reference to Ricardian equivalence.

4The Samaritan’s dilemma was first presented by James M. Buchanan (1975). Coate (1995), Bruce and Waldman (1991), and Lindbeck and Weibull (1988) provide examples of other applications to policy analysis.

5Bernheim, Shleifer and Summers (1985) suggest a desire for child-to-parent services (e.g. phone calls, frequent visits, etc.), rather than altruism, motivates parental transfers. The true motivation for parent-to-child transfers remains an open question in economics and is not an issue addressed in this paper. Bernheim (1991) offers additional discussion on this question. Altruism receives substantial attention in the literature hence it is the motivation used in this paper.
selfish individual without compromising his own consumption too much. Since successful manipulation by the child alters the margins at which decisions are made, the parent saves and transfers different amounts than he would without the strategic behavior. Consider the effect of a subsequent government substitution of debt for taxes. It seems unlikely the parent increases his transfer by the amount of a tax decrease when confronted with a manipulative child, causing Ricardian equivalence to fail. I show that, in spite of the altered decision margins, Ricardian equivalence continues to hold in this framework.

The intuition for this result relies on a simple, revealed preference argument. The policy change is analogous to a redistribution of wealth from child to parent. The child faces a new tax and the parent’s wealth has increased by the amount of the tax. The redistribution causes the parent to increase his bequest by the amount of the redistribution. Since the child effectively perceives the same resource constraint as before the policy change, by the axiom of revealed preference, his initial choices continue to be optimal. The parent similarly recognizes that the policy change has no effect on the family’s total wealth. Again the axiom of revealed preference dictates that the initial choice is still the optimal choice.

I consider three distinct specifications of this model. These specifications differ with respect to the timing of choices within the model. The goal is to contrast two specifications that allow potential strategic behavior with a specification commonly used in the literature (which omits strategic behavior).

The first model specification assumes individuals alive in a period choose their respective consumption, savings, and bequest amounts for the period simultaneously, taking the others’ choices as fixed. The second specification assumes individuals alive in a period make their respective choices for the period sequentially within the period, with the eldest individuals choosing first and the youngest individuals choosing last. The third assumes individuals choose consumption and savings amounts for all periods of life, and a bequest amount, in their first period of life. The first two of these specifications are referred to as manipulative
since a parent’s bequest choice is conditional on his child’s actions. The third specification is non-manipulative since a bequest amount is chosen at the beginning of an individual’s life and cannot later be changed.

I construct a computer simulation for each specification and examine the impact of a temporary substitution of debt for lump sum taxes. I consider a wide variety of possible parameter configurations. Numerical results indicate Ricardian equivalence holds in all cases considered.

The simulations also offer the opportunity to examine the extent to which government debt crowds out private savings when taxes are distortionary. We know Ricardian equivalence fails when taxes are distortionary. Given the restrictive nature of the conditions required for Ricardian equivalence to hold, some authors suggest Ricardian equivalence may be more useful as a benchmark rather than as an absolute measure. Seater (1993) concludes that “despite its nearly certain invalidity as a literal description of public debt in the economy, Ricardian equivalence holds as a close approximation.” (p.143) Barro (1989) closes with the prediction that “the Ricardian approach will become the benchmark model for assessing fiscal policy.” (p.52)

In light of these assertions I measure the extent to which Ricardian equivalence holds using the ratio of private savings crowded out to public debt. I evaluate the effect of several different combinations of inheritance, capital gains, and lump sum taxes. The portion of public debt crowded out of private savings is substantially smaller when strategic behavior is present than when it is absent. However, differences between the portions crowded out in the two manipulative specifications are quite small. This result is consistent with the fact that the strategic behavior considered here encourages larger bequests which require large savings amounts.

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6Lucas (1986) suggests distortionary taxes may be the primary source of deviations from Ricardian equivalence. (p.121)
2 The Model

This section briefly describes the model and the manipulative specifications. A more complete description of this model can be found in Rebelein (2001).

2.1 The Environment

The basic framework is a model with overlapping generations of three-period lived consumers. Consumers are homogeneous and there is no aggregate or individual uncertainty. Individuals are intertemporally linked by one-sided intergenerational altruism (parent to child). There is no population growth. Each consumer has one child, born at the beginning of the parent’s second period of life. In the third period of life a parent may transfer any nonnegative amount of resources to his child.\textsuperscript{7} The use of three-period lived consumers provides both members of adjacent generations the opportunity to behave strategically. Only when the individuals are both alive for two overlapping periods can both make potentially manipulative choices in one period while still having a subsequent period of interaction.

The government finances production of a public good by levying lump sum taxes, by issuing debt, or both. The amount of the public good and the financing method are exogenously specified. The public good enters consumers’ utility functions in an additively separable manner.

The economy has the following additional characteristics:

- A large finite number (N) of identical consumers is born at each time period.

\textsuperscript{7}In a more general version of this model I allow inter vivos transfers in addition to end-of-life bequests. Because strategic behavior leads consumers to squander resources when young, parents always do best by not giving an inter vivos transfer. Thus prohibiting inter vivos transfers has no effect on the results of this model.
• Each consumer is endowed with one unit of time in each period of life. This time is inelastically supplied as labor.

• A consumer born at time $t$ may save (or borrow) an amount $a^t_j$ at age $j$ ($j = 1, 2$). The net return on saving (cost of borrowing) initiated at time $t$ is $r_{t+1}$. A consumer is not allowed to borrow against a possible future bequest he may receive, but may borrow against future wage income.

• There is a government that collects per capita lump-sum taxes ($\tau_t$), produces a public good ($x_t$), and can issue debt ($D_t$) in each period $t$. The government must eventually retire any debt it issues.

• The aggregate capital stock is the sum of private and public savings.

$$K_t = Na_1^{t-1} + Na_2^{t-2} - D_t$$  \hspace{1cm} (1)

• Consumers born at time $t$ have preferences over their own consumption, their child’s utility, and the public good as follows:

$$U^t_t = \left( [u(c^t_1) + v(x_t)] + \beta [u(c^t_2) + v(x_{t+1})] + \beta^2 [u(c^t_3) + v(x_{t+2})] \right) + \rho U^{t+1}$$  \hspace{1cm} (2)

where $c^t_j$ ($j = 1, 2, 3$) is the age $j$ consumption of a consumer born at time $t$. $\beta \in (0, 1]$ is the intertemporal discount factor. $\rho \geq 0$ is the intergenerational discount rate.\footnote{The intergenerational discount rate indicates the weight put on the child’s utility in the parent’s utility function. For example, a value of 0.5 indicates the parent values his child’s utility only 50% as much as the parent values his own utility from consumption. Then, in equilibrium, the parent seeks to equate his child’s marginal utility of consumption to twice his own marginal utility of consumption.}

Assume $u(\cdot)$ is strictly increasing and concave, $\lim_{c \to 0} u'(c) = \infty$, and $v(\cdot)$ is increasing.

• Production is done by a single representative firm using a constant returns-to-scale technology. Solving the firm’s maximization problem assures labor and capital are paid their marginal products.
2.2 Manipulation in an Overlapping Generations Model

The main issue here is specification of when the transfer amount is chosen. Two possibilities exist:

1. The parent chooses a bequest amount at the beginning of his life and is unable to deviate from that choice.\(^9\)

2. The parent chooses the bequest amount in the final period of his lifetime.

To date, researchers using an overlapping generations model have consistently chosen some form of the first approach. We refer to this approach as one of ‘precommitment’ (to the future bequest amount) or as non-manipulative. The bequest amount is chosen during the parent’s first period of life and cannot later be changed. While easier to compute, this approach introduces time consistency problems on the part of the parent. For example, a parent may wish to provide additional resources to a child who squandered resources when young or to give less to a child who saved a large amount when young, but is constrained from doing so.\(^10\) The unrealistic nature of this restriction, combined with the time consistency problem, makes precommitment a difficult assumption to defend in practice.\(^11\)

In the second approach the child’s first period actions may influence the size of the bequest he receives. This gives both individuals the opportunity to behave strategically and is the primary focus of this paper. The strategy available to the child is to overconsume when young (in contrast to smoothing consumption over his lifetime.) Later, when the parent chooses the bequest amount, the child presents himself as a relatively poor individual and

\(^9\)Some authors have chosen a modification of this approach. For example, Caballé (1995), Batina (1987), and Cremer and Pestieau (1993) each use a three-period overlapping generations model and assume a parent makes all of his child’s decisions for the child’s first period of life, thus effectively removing the child’s opportunity for manipulation.

\(^10\)Parents may appear to precommit to a bequest amount by writing a will. In fact a parent is also free to subsequently change the will, and thus is not really committing to a bequest amount.

\(^11\)Kockerlakota (2001) finds no evidence that consumers have time-inconsistent preferences in his examination of asset prices.
asks for a larger bequest. The child’s ability to successfully manipulate the parent depends on the parent’s affinity for the child and on the parent’s wealth and income levels. The child’s interest in being manipulative depends primarily on his substitution rate between current and future consumption.

The parent may anticipate the possible manipulation by his child and may decrease his savings amount in order to reduce his future assets. This diminishes the child’s ability to elicit a larger bequest from the parent. The parent’s success in mitigating the child’s potential manipulation depends in part on the timing of their decisions within a period. One possibility is simultaneous choices of consumption, savings and bequests by all consumers alive in a period. A second possibility is sequential choices by the consumers alive in a period: oldest to youngest. When the parent chooses his consumption and savings amounts first he is more successful at reducing the effect of the child’s manipulation than he is when their choices are simultaneous.\(^{12}\)

I consider both of these specifications because it is not at all clear one is preferable to the other. The simultaneous choices approach is certainly more common but, as O’Connell and Zeldes (1993) point out, “In reality, of course, parents are born before children and make a large fraction of their consumption decisions before their children become independent adults. A more natural modeling approach would therefore be to make parents the ‘leaders’ in a sequential game.” (p.364) Consideration of both specifications also helps demonstrate the robustness of the Ricardian equivalence result.

\(^{12}\)A third possibility exists in that the child could chose before the parent. I omit this case because it seems highly unlikely a parent considering a bequest would wait to make his savings decisions until the child made all of his pre-bequest decisions.
2.3 Simultaneous Choices in a Period

This section briefly describes the model specification arising from the assumption of simultaneous consumption, savings, and bequest choices by the individuals alive in a period. A more complete description is available in Rebelein (2001).

2.3.1 The Elderly Consumer

A consumer who is elderly at time $t$ chooses consumption, $c_{3t-2}$, and a bequest, $B_{t-2}$, to maximize his utility from current consumption plus the discounted utility of his middle-aged child. His budget constraint is

$$c_{3t-2} + B_{t-2} \leq w_t + a_{t-2}^2 (1 + r_t) - \tau_t. \quad (3)$$

Combining first order conditions allows specification of a parent’s bequest as a function of the parent’s second period savings and his child’s first period savings.$^{13}$ That is,

$$B_{t-2} \equiv B(a_{t-2}^1, a_{t-1}^t). \quad (4)$$

A young consumer may consider her parent’s bequest function when choosing her own savings amount.

2.3.2 The Middle-Aged Consumer

A consumer who is middle-aged at time $t$ chooses consumption, $c_{2t-1}$, and savings, $a_{2t-1}^t$, to maximize his utility from present and future consumption plus the discounted utility of his young child. His budget constraint is:

$$c_{2t-1} + a_{2t-1}^t \leq w_t + a_{1t-1}^1 (1 + r_t) + B_{t-2} - \tau_t. \quad (5)$$

$^{13}$By assumption we are only interested in the case of positive bequests. Then, since individuals can borrow or save and $\lim_{c \to 0} u'(c) = \infty$, all first order conditions will be satisfied with equality.
2.3.3 The Young Consumer

A consumer who is young at time $t$, chooses consumption, $c^t_1$, and savings, $a^t_1$, to maximize her utility from present and future consumption plus the discounted utility of her as-yet-unborn child. Her budget constraint is:

$$c^t_1 + a^t_1 \leq w_t - \tau_t$$  \hspace{1cm} (6)

The young consumer may use information about her parent’s resources ($a^{t-1}_2$) to attempt to manipulate the bequest her parent will choose next period. Her first order conditions can be combined to give\textsuperscript{14}

$$-u'(c^t_1) + \beta u'(c^t_2) \left[1 + r_{t+1} + \frac{\partial B^{t-1}}{\partial a^t_1} \right] \leq 0. \hspace{1cm} (7)$$

where $\frac{\partial B^{t-1}}{\partial a^t_1}$ is obtained from equation (4).

2.4 Sequential Choices in a Period

Uncertainty regarding the true nature of parent-child interactions, coupled with the fact that the sequential-choice specification produces different allocations than does the simultaneous-choice specification, strongly indicates we should evaluate it as well. However, since this specification is structurally identical to the sequential-choice specification I omit a detailed description of it here.

The primary difference between the simultaneous- and sequential-choice regimes is that here a middle-aged consumer does not treat the young consumer’s savings choice as given. Analysis of the problem facing the young child allows us to formulate her savings choice as a function of the savings choice of today’s middle-aged consumer. Recognizing the impact his savings choice will have on the child’s savings choice increases the parent’s ability to reduce

\textsuperscript{14}An appendix, available from the author upon request, offers additional information on derivation of this result.
3 Computer Simulations

This section first presents the specific functional forms used in the computer simulations. A brief numerical example follows.

Functional Forms

- **Utility of Consumption** is given by

\[ u(c) + v(x) = \frac{c^\gamma}{\gamma} + x \]  

with \( \gamma < 1, \gamma \neq 0. \)

- **Production Function** is given by:

\[ F(K_t, L_t) = AK_t^\alpha L_t^{(1-\alpha)} \]  

where \( L_t \) is aggregate labor supplied at time \( t \) and \( 0 < \alpha < 1. \)

An Example

To illustrate the differences between the equilibria of the different specifications I arbitrarily chose a set of parameter values and computed the equilibrium of each specification. The values chosen are given in Table I with the following exception. To facilitate comparisons between the specifications the output of the sequential-choices specification was scaled up by setting \( A = 2.7162. \) This exception occurs because the sequential-choices specification inherently produces a lower output level than do the other two specifications when using the same parameter values.

Table II compares the steady state equilibria of the three specifications. As expected, the parent gives the smallest bequest in the non-manipulative specification. Under simultaneous choices the young consumers achieve the greatest manipulation of their parents: first
period consumption is greatest, second period consumption least, and bequests largest. Under sequential choices a parent is able to somewhat mitigate his child’s manipulation. This is evidenced by the lower bequest amount than that for simultaneous choices. Note both manipulative specifications produce higher utilities than does the non-manipulative specification. This suggests the parent is not maximizing the ‘family’s utility.’ These results are representative of the many different parameter configurations studied.

4 Testing Ricardian Equivalence with Lump Sum Taxes

The overlapping generations framework allows for straightforward evaluation of Ricardian equivalence. In some time period $T_D$, the government substitutes debt for a portion of current taxes. To simulate a government issuing debt, simultaneously reduce the aggregate capital stock by the amount of debt issued. When the debt is retired, increase the lump sum taxes by the amount required to retire the entire debt plus accumulated interest. This process can easily be modified to allow multiple periods of deficit financing and to allow multiple periods for gradual retirement of the debt.

Ricardian equivalence predicts that, when facing a reduction of his own taxes and a corresponding increase in the taxes his child (or other descendant) will bear, the altruistic parent increases the size of his transfer to help the child (or other descendant) with his new tax burden.

Using a wide variety of parameter values, I examine each specification to discern the effects of government substitution of debt for lump sum taxes. I find this substitution to have no real effects. Savings and bequests increase temporarily as the proceeds of the tax cut are saved and passed on to future generations. This result is independent of the sequence of choices within a period.\footnote{This is true in spite of the fact that altering the sequence of choices does change the resulting allocations.}
Table I: Parameters for Sensitivity Studies

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta$</th>
<th>$\gamma$</th>
<th>$\rho$</th>
<th>$A$</th>
<th>$\tau_t$</th>
<th>$x_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>0.442</td>
<td>-2.0</td>
<td>0.15</td>
<td>2.5</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table II: Steady State Comparison Across Specifications

<table>
<thead>
<tr>
<th></th>
<th>Non-Manipulative Choices</th>
<th>Simultaneous Choices</th>
<th>Sequential Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>period 1 consumption</td>
<td>0.7022</td>
<td>0.8772</td>
<td>0.8276</td>
</tr>
<tr>
<td>period 2 consumption</td>
<td>1.0068</td>
<td>0.9350</td>
<td>0.9554</td>
</tr>
<tr>
<td>period 3 consumption</td>
<td>1.4434</td>
<td>1.3404</td>
<td>1.3697</td>
</tr>
<tr>
<td>bequest</td>
<td>0.1824</td>
<td>1.4519</td>
<td>1.2173</td>
</tr>
<tr>
<td>period 1 savings</td>
<td>0.0334</td>
<td>-0.1416</td>
<td>-0.0920</td>
</tr>
<tr>
<td>period 2 savings</td>
<td>0.1335</td>
<td>0.3085</td>
<td>0.2185</td>
</tr>
<tr>
<td>utility</td>
<td>-1.2789</td>
<td>-0.9570</td>
<td>-1.0242</td>
</tr>
</tbody>
</table>
Figures 1 - 6 present time series plots for selected variables of the simultaneous-choice specification. Each pair of figures contains time series plots for a single variable. The figure on the left of a pair plots the variable for the case without deficit financing. The figure on the right of each pair plots the variable for the case with deficit financing for one period ($T_D = 50$). After a one period tax increase, at time $t = 51$, to retire the debt, taxes return to their initial level.

The figures show aggregate savings increases at time $t = 50$, as does bequests. To understand the behavior of these three variables at time $t = 51$, consider the effect of deficit financing on each cohort alive when debt is issued. An elderly individual consumes nothing out of the accompanying tax cut – he increases his bequest by the amount of the tax cut. A middle-aged individual receives both the proceeds of the tax cut and a larger bequest. He saves both of these amounts, 1/2 to pay the tax that will be imposed on him next period and 1/2 to increase the bequest he will give to his child next period. Thus second period savings ($a_2$) increases at time $t = 50$. This individual increases his next period bequest by 1/2 of the additional amount saved (equal to the amount of the tax cut) times $1 + r$. Thus bequests increase at time $t = 51$ by more than they did at time $t = 50$.

A young individual increases first period savings ($a_1$) by the amount of the tax cut. At time $t = 51$, this individual pays his own increased taxes out of his own increased savings. He then receives a larger bequest from his parent and has a child who faces a substantial tax increase. The child, borrows from future earnings to pay his taxes. Thus first period savings decrease at time $t = 51$. The parent (young when debt issued) saves the large bequest he receives in order to give an increased bequest to his child. This final increased bequest compensates the child (unborn when debt issued) in his middle-age with an amount equal to what he had to borrow to pay his taxes when young. This explains the bequest increase at time $t = 52$. While not explicitly shown here, the increase in aggregate savings at time $t$,

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16 Output and consumption in each period of life is unaffected by the use of deficit financing.
Figure 1: Baseline: $a_1$

Figure 2: With Debt: $a_1$

Figure 3: Baseline: $a_2$

Figure 4: With Debt: $a_2$

Figure 5: Baseline: Bequests, $B^t$

Figure 6: With Debt: Bequests, $B^t$
t = 50 exactly equals the amount of debt issued by the government. Thus the aggregate capital stock is unchanged. No further effects of the deficit financing occur.

The other specifications exhibit identical behaviors for all variables.

To verify the robustness of this debt neutrality result simulation runs were made with a number of different parameter configurations. For example, repayment of the debt was delayed several periods, instead of occurring immediately. Different size deficits were considered, as were changes in some of the other parameter values. The results always indicate Ricardian equivalence holds.

Discussion

It is unclear whether or not this result should be surprising. It is tempting to conclude the result is a natural outcome of the view that each family is actually “one big happy family” in which the parent effectively determines how the family’s resources will be distributed. This analogy fails when we realize that the resulting allocations are not optimal, as evidenced by the fact that individuals achieve higher utility when allowed to behave strategically than when not. As Seater (1993) observes, it is reasonable to expect Ricardian equivalence fails whenever a child successfully manipulates his parent’s bequest amount. However, since this is not the result here we must re-evaluate our intuition.

Consider that the overlapping generations model contains a sequence of two-period parent-child interactions. It is relatively straightforward to show that shifting tax burdens from parent to child has no effect on consumption or savings in this static, two-period environment. The question is, what happens when we introduce perturbations to the dynamic environment? Specifically, how do these perturbations propagate – do they expand or damp out? Given the subgame perfect nature of the equilibrium in each period small perturbations should damp out, rather than expand, over time. A small perturbation is defined as one
that does not lead to corner solutions in a period. By construction we are studying only interior solutions so all perturbations are small by definition. Thus any change in the timing of taxes should damp out and Ricardian equivalence will hold.

More directly, Bernheim and Bagwell (1988) asserts that, when private transfers are operative, public transfers will be neutral when the game played between generations is strategically equivalent before and after the public transfer. Using their change-of-variable approach reveals that the substitution of debt for taxes produces a linear shift of the strategy space, but leaves the structure of the game unchanged (assuming transfers remain operative). They also show their result to be independent of whether taxes are distortionary or lump sum, a conclusion different from that reached in the next section.\textsuperscript{17}

5 Ricardian Equivalence Under Distortionary Taxes

Given that Ricardian equivalence fails in the presence of distortionary taxes it is useful to be able to gauge how close an approximation Ricardian equivalence is for a particular economy. When Ricardian equivalence holds private savings will increase by the amount of debt issued. When Ricardian equivalence fails private savings increase by some amount less than the amount of debt issued. The difference between the private savings increase and the amount of debt issued is the amount of private savings crowded out by the debt. The ratio of the amount of private savings crowded out to the amount of debt issued can be an effective measure of the extent to which Ricardian equivalence holds in a particular economy.\textsuperscript{18}

Let \( R \) be the degree to which Ricardian equivalence holds. I define \( R \) as

\[
R = \frac{\Delta D - \Delta S}{\Delta D} \tag{10}
\]

\textsuperscript{17}An analogous result is presented by Bergstrom, Blume, and Varian (1986) and Warr (1983). They demonstrate that a wealth redistribution amongst voluntary contributors to a public good has no effect of the provision of the public good. In my model the child's utility is a pure public good – both parent and child enjoy the child's utility non-rivalrously and without possibility of exclusion. The change in the timing of lump sum taxes is a simple redistribution across generations.

\textsuperscript{18}Altig and Davis (1989) uses a similar measure.
where

$$\Delta S = (a_1^t - \bar{a}_1 + a_2^{t-1} - \bar{a}_2)N$$

(11)

with $\bar{a}_j (j = 1, 2)$ the steady state, pre-debt savings amounts and $\Delta D$ the increase in debt.

$R$ measures the portion of the debt that is crowded out of private savings. I assess the crowding out of private savings by debt when the debt is left outstanding indefinitely. This requires a small tax increase to pay the interest that accumulates each period. This experiment simulates the conditions countries with significant current public debts are likely to experience.

When $R = 0$ the increase in private savings is equal to the increase in public debt and no crowding out occurs.

Most often we have $0 < R < 1$, indicating consumers save only a portion of the tax cut in anticipation of the higher future taxes. The value of $R$ indicates the fraction of the debt crowded out of private savings and thus how far from satisfying Ricardian equivalence the economy is. For example, if $R = 0.2$ in a particular environment we can assert there is a 20% deviation from Ricardian equivalence in that environment. The closer $R$ is to 0 the better Ricardian equivalence is as an approximation for that environment.

It is even possible to have $R > 1$. This occurs when the additional taxes required to pay interest on the debt and the decrease in the capital stock lead to declines in output (and bequests) that depress private savings below their initial level. It is unclear what specific interpretation particular values of $R$ have in these cases. At a minimum the fact that $R > 1$ indicates Ricardian equivalence fails dramatically.

For each specification I evaluate different combinations of lump sum, inheritance, and capital gains taxes. Let $\theta_B$ denote the tax rate on end-of-life bequests. Let $\theta_C$ denote the tax rate on capital gains. Introducing these taxes alters the budget constraints for a consumer born in period $t$ as follows.
For the young consumer:

\[ c_1^t + a_1^t \leq w_t - \tau_t. \] (12)

For the middle-aged consumer:\footnote{The “max” operators on the right hand side of the following expressions reflect the fact that consumers may borrow as well as save, but capital gains taxes are collected only on returns to savings.}

\[ c_2^t + a_2^t \leq w_{t+1} + a_1^t(1 + r_{t+1}) - \max(a_1^t, 0)r_{t+1}\theta_G + B(1 - \theta_B) - \tau_{t+1}. \] (13)

For the elderly consumer:

\[ c_3^t + B^t \leq w_{t+2} + a_2^t(1 + r_{t+2}) - \max(a_2^t, 0)r_{t+2}\theta_G - \tau_{t+2}. \] (14)

The government’s period \( t \) budget constraint is now

\[ x_t + D_{t-1}(1 + r_t) \leq 3N\tau_t + D_t + N\theta_BB^{t-2} + N\theta_G(\max(a_1^{t-1}, 0) + \max(a_2^{t-2}, 0))r_t. \] (15)

**Simulation Results**

Leaving government debt outstanding indefinitely is reasonable given that governments today show little tendency towards repaying the bulk of their outstanding debts. I model this by leaving debt outstanding for a length of time sufficient to allow the economy to reach a new steady state (approximately 25 periods.)\footnote{I calculate these values for the case of immediate debt repayment and for the case when debt is left outstanding indefinitely. Not surprisingly, the ratios are significantly smaller when debt repayment is immediate.}

To ensure the results are not merely an artifact of a specific parameterization I performed a series of Monte Carlo runs. By varying the main parameters of the model I constructed a grid of over 10,000 parameter combinations. For each combination I determine the savings amounts for both the initial, pre-debt, steady state and the final, with-debt, steady
state. I then calculate a value for $R$ for each policy for each model specification. Table III reports the average $R$ values for each case.

Most striking about the results is a significant difference between the $R$ values obtained for the non-manipulative specification and those obtained for the two manipulative specifications. In contrast, the $R$ values obtained for the two manipulative specifications are quite similar. Many of the values are fairly large, indicating government debt crowds out a substantial amount of private savings when debt is left outstanding indefinitely.

Crowding out is greater in the non-manipulative specification primarily because of a greater decline in bequests. Recall that the form of manipulation considered here induces larger bequests. Even with distortionary taxes the pressure for large bequests is substantial in the manipulative specifications. The example of Table II showed that a considerable portion of second period savings is used for bequests. In the non-manipulative specification parents can more easily reduce bequests when confronted with inheritance or capital gains taxes. Since smaller bequests require smaller second period savings amounts, total private saving declines more, for a given policy, in the non-manipulative specification than it does in the manipulative specifications. The bottom line here is that the form of the intergenerational relationship (manipulative vs. non-manipulative) plays a notable role in determining how much private savings is crowded out by government debt.

There are also qualitative similarities between the $R$ values of the different model specifications. Not surprisingly Ricardian equivalence is the best approximation when tax revenues are in some part raised with lump sum taxes. Ricardian equivalence is least valuable as an approximation when tax revenues are raised using only inheritance taxes. It is understandable that consumers would save the smallest portion of a tax cut when a major motivation for savings (i.e., giving bequests) is taxed most heavily.
Table III: Average Portion of Debt Crowded Out of Private Savings

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump Sum Tax (Baseline)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Inheritance Tax only</td>
<td>134.2%</td>
<td>97.6%</td>
<td>97.1%</td>
</tr>
<tr>
<td>Capital Gains Tax only</td>
<td>100.0%</td>
<td>80.1%</td>
<td>78.8%</td>
</tr>
<tr>
<td>50% LS + 50% IN</td>
<td>60.4%</td>
<td>43.2%</td>
<td>43.0%</td>
</tr>
<tr>
<td>50% LS + 50% CG</td>
<td>43.5%</td>
<td>35.1%</td>
<td>34.0%</td>
</tr>
<tr>
<td>50% IN + 50% CG</td>
<td>114.0%</td>
<td>88.6%</td>
<td>88.0%</td>
</tr>
<tr>
<td>1/3 LS + 1/3 IN + 1/3 CG</td>
<td>71.6%</td>
<td>54.3%</td>
<td>53.7%</td>
</tr>
</tbody>
</table>

aLS refers to the lump sum tax; IN to the inheritance tax and CG to the capital gains tax.


6 Conclusion

This paper has two primary goals. First, I extend the analysis of Ricardian equivalence and the intergenerational “Samaritan’s dilemma” to a dynamic, general equilibrium environment by constructing a model with overlapping generations of three-period lived consumers. Analyzing computer simulations of this model, I show the temporary substitution of government debt for current lump sum taxes has no effect on consumption, aggregate savings, or output in this framework. This result is independent of the sequence of choices undertaken within a period and of the specific parameter values selected.

The second goal of this paper is to use the simulations to compare the crowding out effect of government debt in model specifications with and without intergenerational strategic behavior when taxes are distortionary. The amount of crowding out is much greater in the specification without strategic behavior than it is in the specifications with strategic behavior. The exact form of strategic behavior (simultaneous vs. sequential choices) has little impact on the results. In the specifications with strategic behavior the fact that parents give a larger bequest (than they do in the specification without strategic behavior) requires a parent to save more in these specifications, accounting for the smaller amount of crowding out observed in models with strategic behavior.

The debt neutrality result might suggest further studies of the effects of deficit financing need not include strategic behavior. However, we observe that allowing strategic behavior does change the resulting allocations. We also note non-strategic specifications can suffer time consistency problems and comparisons between strategic and non-strategic specifications indicate notable differences in crowding out effects. Thus it seems important to continue considering intergenerational strategic behavior in future analyses.
Bibliography


