

## RICARDIAN EQUIVALENCE IN THE PRESENCE OF CAPITAL MARKET IMPERFECTIONS

Toshiki YOTSUZUKA\*

*University of Chicago, Chicago IL 60637, USA*

It is a common claim that Ricardian equivalence fails if capital markets are imperfect. The validity of this claim is examined for the case of informationally imperfect capital markets. We present three alternative models of adverse selection and analyze the effects of debt finance in these models. It is shown that a debt-financed tax cut can lead to Pareto improvement in some cases. In the theoretically most preferable model, however, Ricardian equivalence survives in spite of genuine imperfections in the capital market. The results point to the importance of specifying the exact nature of imperfection.

### 1. Introduction

The effects of government deficits are among the most important, yet controversial, topics in macroeconomics. Major issues involved are the efficacy of a debt-financed tax cut as a stabilization policy in the short run, and its adverse effects on capital accumulation in the long run. The Ricardian equivalence theorem, revived by Barro (1974), states that whether government spending is financed by taxes or bonds is inconsequential if the following assumptions are satisfied: (1) successive generations of rational consumers are linked through operative intergenerational transfers, so that consumption decisions can be modeled as being made by a representative consumer with infinite horizons; (2) taxes are non-distortionary (lump-sum); and (3) capital markets are perfect. Under these conditions, any intertemporal reallocation of taxes would be both useless and harmless.<sup>1</sup>

Virtually all well-articulated arguments against the Ricardian doctrine are based on theoretical and empirical criticisms of these three assumptions.<sup>2</sup> A

\*I would like to thank Stanley Fischer and Oliver Hart for many helpful discussions and encouragement. I am also grateful to Robert Barro, Olivier Blanchard, Fumio Hayashi, Robert King, Nobuhiro Kiyotaki, an anonymous referee, and participants in seminars at MIT, Northwestern University, the Universities of Chicago, Michigan, Rochester and Wisconsin, and Yale University for valuable comments. Any remaining errors are mine.

<sup>1</sup>Barro (1986) and Bernheim (1987) provide extensive surveys of the large body of literature on this topic.

<sup>2</sup>It is also often suggested that consumers may not be far-sighted rational optimizers, but the implications of such myopia have hardly been examined systematically.

particularly large amount of work has recently been devoted to examining the first assumption, and the effort has met with remarkable success in clarifying the nature and implications of gift and bequest motives.<sup>3</sup> The simulation results reported by Poterba and Summers (1987), however, suggest that the issue of finite vs. infinite horizons is unlikely to matter as far as short-run effects of budget deficits are concerned. Even if consumers have no motive for intergenerational transfers, the average lifespan seems long enough, relative to the typical time horizon of deficit policies, to make infinite horizon models a good approximation.

Another potential source of debt non-neutrality is the non-lump-sum nature of the actual tax system. One of the relatively few established results on this issue stems from the insurance aspect of postponed taxes levied on uncertain future income. If taxes are an increasing function of income rather than lump-sum, then substitution of future taxes for current taxes will reduce the variance of future after-tax income and increase current consumption. Barsky, Mankiw and Zeldes (1986) have shown that such an effect can be quantitatively significant for realistic parameter values. An important qualification to this argument, however, is that postponement of taxes may decrease, rather than increase, current consumption if it entails intrinsic uncertainty about future tax liabilities uncorrelated with future income [Chan (1983)]. Chan also argues that the income insurance scheme is self-financing and can be established separately from the choice of the debt-tax mix.

What appears to be a more compelling 'Keynesian' argument against Ricardian equivalence comes from the observation that a significant number of consumers seem to face liquidity constraints, where 'liquidity constraints' refer to credit rationing or differential interest rates on lending and borrowing. Since the neutrality proposition derives from full intertemporal optimization by consumers, such imperfection in capital markets is widely believed to cause non-neutrality. In particular, this argument has been a major motivation behind the large body of recent empirical work designed to detect liquidity constraints from consumption data.<sup>4</sup>

One obvious source of liquidity constraints would be transaction costs. However, in order to ensure expansionary effects of tax cuts, one has to assume that the government is more efficient than the private sector in providing *de facto* loans. This assumption is not very likely to be warranted and, in any case, sounds rather meager as a theoretical basis for significant policy effectiveness.<sup>5</sup> Another source of imperfection, generally considered as a

<sup>3</sup>See, for example, Weil (1984), Abel (1985), Bernheim, Shleifer and Summers (1985) and Bernheim and Bagwell (1986).

<sup>4</sup>See Hayashi (1985) for a survey of this literature.

<sup>5</sup>This argument assumes proportional transaction cost. If there is a significant fixed-cost element, a tax cut can be contractionary.

prime suspect, is informational asymmetry between lenders and borrowers. Unobservable risk characteristics of borrowers give rise to the problem of adverse selection and, in many cases, to the phenomenon of credit rationing. Recent literature on such informational imperfections in capital markets [most notably, Jaffee and Russell (1976) and Stiglitz and Weiss (1981)] has often been cited to refute Ricardian equivalence on theoretical grounds.<sup>6</sup>

It is, therefore, only natural to ask the following question: *Do the models of informationally imperfect capital markets provide a theoretical basis for debt non-neutrality?* Unfortunately, the macroeconomic literature on the effects of liquidity constraints provides little insight into this question since most of it has imposed arbitrary forms of borrowing constraints without careful treatment of the source of such constraints. Among the few exceptions are the papers by King (1984) and Hayashi (1985), which offered first answers to the above question in the context of adverse selection. King's model, with an endogenously generated wedge between lending and borrowing rates but no credit rationing, gave a non-neutrality result. Hayashi, on the other hand, considered a model of credit rationing similar to the one by Jaffee and Russell, and obtained Ricardian equivalence. The relationship between these apparently conflicting results, however, remains unclear even when it is recognized that Hayashi's result does not generalize naturally.

This paper is an attempt toward a more integrated analysis of Ricardian equivalence in the presence of adverse selection in the consumer loan market. The analysis abstracts from all other issues associated with Ricardian equivalence in order to focus on the problem of asymmetric information. We examine three alternative models of adverse selection with a common basic structure. In all these models, it is assumed that borrowers have private information regarding their probability of default.

Implications of asymmetric information differ depending on whether some kind of signal can be used to infer hidden information. In our context, loan contracts purchased by a consumer can serve as a potential signal of his risk characteristics. We first consider a case in which the entire set of contracts purchased by a consumer, possibly from several lenders, is not observable to others. The implicit assumption is that lenders do not communicate with each other regarding their customers' indebtedness. This model with *no communication*, which roughly corresponds to King's model, shares its basic insights with Akerlof (1970). We discuss competitive equilibria in such a model and obtain non-neutrality. We then turn to a Jaffee–Russell type model in which contract purchases can be perfectly monitored. All lenders are assumed to share all available information about their customers. This assumption of *full communication* leads to a signaling equilibrium à la Rothschild and Stiglitz (1976) and Wilson (1977). Our model contains Hayashi's as a special case, and his

<sup>6</sup>A recent example of such citation is found in Buiter (1985, p. 42).

neutrality result has to be replaced by a rather complicated verdict on Ricardian equivalence. Both of these models, with and without communication, have some interesting welfare implications.

These two models, however, are unsatisfactory in the sense that lenders' incentives to communicate with each other are not explicitly considered. We argue that, as in Jaynes' (1978) model of insurance markets, it is always profitable for some (but not all) lenders to guarantee that they will never divulge the names of their customers to other lenders. In the third model, this point is incorporated to derive an equilibrium with *endogenous communication*, in which one group of lenders chooses to disclose information on their customers while the other group does not. Ricardian equivalence survives in this model.

The plan of the paper is as follows. The next section lays out a basic framework for analysis and characterizes loan demand functions. Sections 3 through 5 then examine the implications of three alternative models, which are built on this common framework but have different communication structures. Section 6 contains concluding remarks.

## 2. Basic framework

We construct a simple model of a two-period small open economy inhabited by two types of consumers. A fraction  $\theta$  of consumers belongs to type A and the rest to type B. Their total number is normalized to unity. All consumers live for the duration of the economy so that there are no issues associated with finite horizons or intergenerational transfers.<sup>7</sup> Output is exogenous: the first period is a 'recession', while the second period is correctly anticipated to be a 'boom'. There is no aggregate uncertainty, but each individual's income in the second period is stochastic and depends on whether he is 'employed' or 'unemployed'. The first-period (after-tax) income is  $Y_1$  for both types of consumers and is sufficiently 'low' so that all consumers are borrowers in the first period. The second-period income for a type  $i$  ( $i = A, B$ ) consumer is assumed to be  $Y_H$  with probability  $p_i$  and  $Y_L$  ( $< Y_H$ ) with probability  $(1 - p_i)$ . The subsistence level of consumption is set at zero for convenience. For most of the paper, we further assume that  $Y_L$  is equal to zero (the subsistence level), which considerably simplifies the exposition without loss of generality.

Since negative consumption is not feasible, a consumer will default and repay nothing if he receives zero in the second period. We assume  $p_A$  is greater than  $p_B$ , so that type B consumers are more likely to default than type A consumers. The type of any particular consumer is known only to himself. The

<sup>7</sup>The model can also be interpreted as describing a stationary equilibrium in an overlapping-generations model, in which the young are liquidity constrained.

lender cannot distinguish between high-risk and low-risk types until their market behaviour (possibly) reveals their type.

It is assumed that income insurance markets do not exist. Two kinds of justification can be offered for this assumption. First, introducing income insurance has the effect of largely shifting the problem of adverse selection from capital markets to insurance markets, at least in the particular setting adopted in this paper. If the equilibrium in a model with insurance markets is such that both types of consumers hold positive amounts of insurance, then no consumer defaults on loans and, therefore, we would have no capital market imperfection to analyze.<sup>8</sup> Second, the neutrality results in the paper go through even when income insurance has no role because there is no subjective uncertainty (i.e.,  $p_A = 1$ ,  $p_B = 0$ ). This suggests that the insurance aspect implicit in loan contracts is not the major force driving the results.

The riskless real interest rate (gross) is fixed at the world interest rate  $R^*$ . (Namely, the net interest rate is  $R^* - 1$ .) The economy has two kinds of institutions: banks and a government. The banks, which make loans to consumers, eliminate all non-systematic risk by diversification. The banking industry is competitive and allows free entry, so that the return on the aggregate loan asset ('deposit'), which is riskless, is  $R^*$  by arbitrage. Since all consumers in this economy want to be borrowers, the role of the lender is played by the rest of the world. The government issues bonds abroad against its future domestic tax revenue. Their rate of return is also equal to  $R^*$  due to the absence of aggregate risk.

The government, for a given fixed path of expenditures, can alter lump-sum taxes and transfers by changing the amount of debt it issues. Let  $G$  be a cut in lump-sum taxes (or an increase in lump-sum transfers), financed by debt, in the first period. Both types of consumers get the same amount because the government, like banks, cannot distinguish between the two types.  $G$  being zero means balanced budget. In the second period, the government taxes the consumers in order to repay the debt. The intertemporal budget constraint of the government requires that the amount of taxes collected from each non-bankrupt individual in the second period must be equal to  $R_0G$ , where

$$R_0 = R^* / [\theta p_A + (1 - \theta) p_B]. \quad (1)$$

In other words, the government would be making compulsory loans with the interest rate  $R_0$ .

Let  $X_i$  be borrowings by the type  $i$  consumer ( $i = A, B$ ) in the private loan market and  $R$  be the interest rate charged by the lender. For the moment, we

<sup>8</sup>Since bankruptcy guarantees a certain minimum level of consumption, the only reason for the consumer to hold insurance is to provide himself with a level of consumption higher than this minimum when he is 'unemployed'. Therefore, holding of insurance precludes bankruptcy.

treat  $R$  as a constant, although the loan repayment schedule will be non-linear in one of the models considered later. Given time-separable utility over consumption in two periods, the type  $i$  consumer's problem is to choose  $X_i$  so as to maximize

$$V_i(X_i; R, G) = U(Y_1 + G + X_i) + \beta [p_i U(Y_H - R_0 G - R X_i) + (1 - p_i) U(0)], \quad (2)$$

where  $U$  is increasing and strictly concave and  $\beta$  is a discount factor. The first-order condition is

$$U'(Y_1 + G + X_i) = \beta p_i R U'(Y_H - R_0 G - R X_i),$$

for an interior optimum. The optimum will be at the corner ( $X_i = 0$ ) if

$$R^* \leq m_i(G) \leq R \quad \text{where} \quad m_i(G) = \frac{U'(Y_1 + G)}{\beta p_i U'(Y_H - R_0 G)}. \quad (3)$$

Let  $M_i$  denote the set of points  $(R, G)$  which satisfy (3).<sup>9</sup> The loan demand function of type  $i$  consumers,  $X_i^*(R, G)$ , has the following characteristics:

$$X_i^*(R, G) = 0 \quad \text{for} \quad (R, G) \in M_i, \quad (4a)$$

$$\partial X_i^* / \partial R < 0 \quad \text{and} \quad \partial X_i^* / \partial G < 0 \quad \text{for} \quad (R, G) \notin M_i. \quad (4b)$$

Loan demand is a decreasing function of the loan interest rate and of the cut in taxes. A corner solution (no borrowing) obtains if the interest rate is 'too high' or if the size of the tax cut is 'too large'. We also note that the extent to which tax cuts reduce loan demand depends on the relative sizes of  $R$  and  $R_0$ . If  $R = R_0$ , then we have  $\partial X_i^* / \partial G = -1$ , which means that a tax cut simply replaces private loans and does not affect consumption. The set  $M_A$  contains  $M_B$  so that there is a range of interest rates for any given  $G$  where  $X_A$  is zero but  $X_B$  is strictly positive. This makes possible a situation in which only high-risk borrowers ('lemons') are in the market. We can also show the following:

$$X_B^*(R, G) > X_A^*(R, G) \quad \text{for all} \quad (R, G) \notin M_B. \quad (5)$$

Except when  $X_A = X_B = 0$ , *high-risk individuals always wish to borrow more than low-risk individuals*. This difference in preference over loan contracts will serve as a potential signal of the risk type of an individual.

<sup>9</sup>We do not consider the case  $m_i(G) < R^*$ , which occurs when  $G$  is very large. It would imply that the type  $i$  consumer is a lender rather than a borrower.

### 3. A model with no communication

#### 3.1. Adverse selection

We start from the analytically simplest case, namely, a Walrasian equilibrium in the consumer loan market, where loan contracts purchased by any particular individual cannot be monitored by others. In the context of a competitive loan market with many lenders, this assumption is equivalent to precluding communication among lenders. Since contract purchases are the only potential signal of an individual's risk characteristics, the model in this section allows no possibility that the lender may distinguish among different types of consumers. Consumers with different risk characteristics will be charged the same interest rate which must compensate for the average economy-wide default risk.<sup>10</sup> Credit rationing is not feasible since the borrower can go to as many banks as he wishes without being found out.

We first examine how the loan interest rate  $R$  is determined in a Walrasian equilibrium of the loan market.<sup>11</sup> Recall that a fraction  $\theta$  of consumers belong to type A. Thus, the total quantity of loans to the whole population of consumers amounts to  $\theta X_A + (1 - \theta) X_B$ , while the expected repayment is  $R[\theta p_A X_A + (1 - \theta) p_B X_B]$ . The expected gross rate of return is

$$\Gamma(R, G) = \frac{R[\theta p_A X_A^*(R, G) + (1 - \theta) p_B X_B^*(R, G)]}{\theta X_A^*(R, G) + (1 - \theta) X_B^*(R, G)}.$$

Since there is no aggregate risk,  $R$  is determined by an arbitrage condition which ensures that a well-diversified lender has a zero profit:

$$R^* = \Gamma(R, G). \tag{6}$$

We can show the existence of equilibria by observing that eq. (6) has at least one solution. Define

$$R_i = R^* / p_i, \quad i = A, B. \tag{7}$$

Then, it follows from (5) that

$$\Gamma(R_B, G) \geq R^* \quad \text{and} \quad \Gamma(R_A, G) \leq R^*.$$

Since  $\Gamma$  is continuous, there exists at least one borrowing rate  $R^c$  between  $R_0$

<sup>10</sup>There would be more than one interest rate in equilibrium if lenders compete by offering price-quantity contracts. This point will be discussed at the end of the section.

<sup>11</sup>This section's analysis is based on a modified version of King's (1984) model. The model, though closely related to the existing literature [see, e.g., Pauly (1974) and Abel (1986)], turns out to be rather problematic as we shall point out at the end of the section.

and  $R_B$  which makes  $\Gamma(R^c, G)$  equal to  $R^*$ . Furthermore, there is no equilibrium interest rate outside of this interval  $[R_0, R_B]$ . An intuitive explanation would be as follows.  $R_B$  is a rate at which banks break even when the only customers are high-risk (type B) consumers. In a competitive market, the equilibrium rate cannot exceed  $R_B$ . On the other hand, banks can break even at  $R_0$  only if  $X_A = X_B$ . Since loan demand by a low-risk individual is less than that by a high-risk individual, banks must make negative profits if  $R^c$  is set below  $R_0$ . Multiple equilibria cannot be ruled out.<sup>12</sup> However, equilibria can be Pareto-ranked, the one with the lowest interest rate dominating others, so that if banks can set interest rates (instead of an auctioneer), then there will be a unique equilibrium with the minimum solution  $R^c$  to (5).

It is convenient for later exercises to define *adverse selection equilibrium*, in which  $X_A$  is equal to zero and  $X_B$  is positive, i.e., only high-risk borrowers appear in the loan market. It was shown in (4) that loan demand by the type A consumer,  $X_A^*(R, G)$ , will be zero for  $R \geq m_A(G)$ . If (6) has no solution for  $R$  smaller than  $m_A(G)$ , then type A consumers will not borrow at all in equilibrium. Since all loans will be defaulted on with probability  $(1 - p_B)$  in this case, the equilibrium interest rate should be equal to  $R_B$ . Formally, a unique adverse selection equilibrium, characterized by

$$R^c = R_B, \quad X_A = 0, \quad X_B = X_B^*(R_B, G), \quad (8)$$

obtains if the following conditions hold:

$$[A.1] \quad \Gamma(R, G) < R^* \quad \text{for all } R < m_A(G),$$

$$[A.2] \quad X_B^*(R_B, G) > 0 \quad \text{or, equivalently, } m_B(G) > R_B.$$

### 3.2. The effects of debt finance

We now examine the effects of debt-financed tax cuts, which can be viewed as compulsory loans with an implicit interest rate  $R_0$ . We have shown that this implicit interest rate on 'government loans' is less than the equilibrium rate  $R^c$ . Thus, the government will be providing cheaper, though limited, loans than banks. The reason this is possible is that the government can control how much it 'lends' to each individual and, thus, does not suffer from unobservability of borrowings. Private banks, being price takers, have to lend more to high-risk individuals in the aggregate than to low-risk individuals at a market interest rate. If each bank fixes the size of its loan so that all of its applicants borrow the same amount, then each of them will end up with high-risk customers whose number is more than proportional to  $\theta$ .

<sup>12</sup>In the case of log utility, for example, there can be between one and three equilibria.



The simplest case to consider, though somewhat special, would be when the pre-tax-cut ( $G = 0$ ) equilibrium is an adverse selection equilibrium, i.e., the conditions [A.1] and [A.2] hold for  $G = 0$ . To make the exercise interesting, we assume that type A consumers are willing to borrow a positive amount at  $R_0$  when  $G = 0$ :

$$[A.3] \quad X_A^*(R_0, 0) > 0 \quad \text{or, equivalently,} \quad m_A(0) > R_0.$$

Under these assumptions, a tax cut has straightforward effects on consumption and can be shown to be Pareto-improving.

An increase in  $G$ , as long as it does not exceed  $X_A^*(R_0, 0)$ , simply increases the type A's first-period consumption  $Y_1 + G + X_A$  by exactly the same amount. Borrowings by the type A remain at zero since  $X_A$  is non-increasing with respect to  $G$ : if  $X_A^*(R, 0) = 0$ , then  $X_A^*(R, G) = 0$  for all  $G > 0$ . The marginal propensity to consume out of a tax cut is one. The type B consumer's response would be to decrease the amount of borrowings to partially offset the increase in government loans since

$$-1 < \partial X_B^*(R, G) / \partial G < 0 \quad \text{for} \quad R > R_0.$$

Therefore, the type B's first-period consumption does not increase on a one-for-one basis in response to a tax cut. Let  $C_{ij}(G)$  be consumption by non-bankrupt type  $i$  consumers in period  $j$ . (Second-period consumption by bankrupt consumers is always zero.) Then,

$$\begin{aligned} C_{A1}(G) &= Y_1 + G, & dC_{A1}/dG &= 1, \\ C_{B1}(G) &= Y_1 + G + X_B^*(R_B, G), & 0 < dC_{B1}/dG < 1, \\ C_{A2}(G) &= Y_H - R_0G, \\ C_{B2}(G) &= Y_H - R_0G - R_B X_B^*(R_B, G). \end{aligned}$$

Fig. 1 summarizes the discussion above. The horizontal axis gives first-period consumption in excess of  $Y_1$ , which is the sum of the reduction  $G$  in taxes and private borrowings  $X$ , while the vertical axis gives the sum of tax payments  $R_0G$  and loan repayments  $Z$  in the second period. Suppose first-period taxes are cut by  $G_1 > 0$ . When  $G = 0$ , the budget constraint is represented by  $OE$  (whose slope is  $R_B$ ), while it becomes  $OA'F$  as  $G$  is increased to  $G_1$  (the slope of  $OA'$  is  $R_0$ ). The indifference curves, defined as

$$U(Y_1 + G + X) + \beta p_i U(Y_H - R_0G - Z) = \text{constant},$$

are upward sloping, with the slope

$$\frac{U'(Y_1 + G + X)}{\beta p_i U'(Y_H - R_0G - Z)},$$

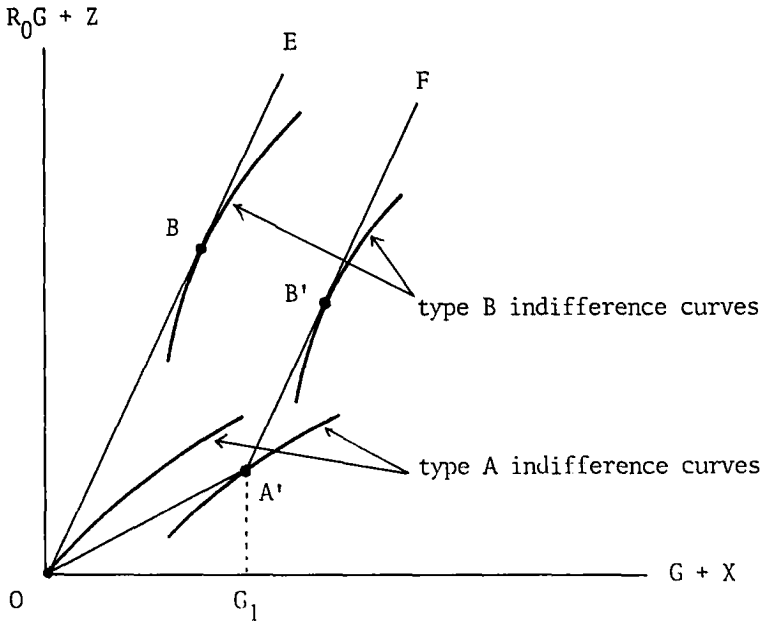


Fig. 1

and are concave (differentiate the above expression again). Note that the type B indifference curve is steeper than the type A indifference curve at every point. The tax cut increases first-period consumption of type A from  $Y_1$  to  $Y_1 + G_1$ , which corresponds to a move from  $O$  to  $A'$ . Type B consumers are at  $B$  if  $G = 0$ . When  $G$  is increased to  $G_1$ , they gain access to  $A'$ , but they further borrow at the interest rate  $R_B$  to reach  $B'$ . It can be seen that consumption by both types is increased.

Fig. 1 also shows that both types are made better off by this policy. Algebraically, it can be seen as follows. Let

$$V_i^*(R, G) = \max_{X_i} [V_i(X_i; R, G)],$$

where  $V_i$  is defined in (2). Then,

$$\partial V_i^*(R_B, G) / \partial G \geq \beta(1 - p_i)(R_B - R_0)U'(Y_H - R_0G - R_BX_i) > 0, \tag{9}$$

with an equality for type B. The policy of increasing  $G$  improves welfare of both type A and type B consumers and, therefore, we conclude that an adverse selection pre-tax-cut equilibrium offers room for a Pareto-improving debt

issue. For the case in which both types borrow in the initial equilibrium (hence  $R^c \neq R_B$ ), this result does not necessarily hold since an increase in  $G$  will have an adverse effect of raising the equilibrium interest rate. In general, we have the following result.

*Proposition 1. Suppose  $R^c$  is the unique equilibrium interest rate. Then, a small increase in  $G$  is Pareto-improving if*

$$R^c - R_0 > \frac{\Gamma_2(R^c, G)}{\Gamma_1(R^c, G)} X_i^*(R^c, G)$$

holds for  $i = A, B$ , where  $R^c$  is the equilibrium interest rate before the increase in  $G$  and  $\Gamma_j$  ( $j = 1, 2$ ) is the partial derivative of  $\Gamma$  with respect to the  $j$ th argument.<sup>13</sup>

To see the intuition behind this proposition, note that  $\Gamma_2/\Gamma_1$  is equal to  $dR^c/dG$  [differentiate the both sides of (6)]. Then, the left-hand side is the benefit of a marginal increase in ‘cheap’ government loans, while the right-hand side is the increase in loan repayment through a change in the interest rate.

### 3. Problems with the model

There are at least two serious problems with the preceding analysis. First, the ‘Walrasian’ or price-competition equilibrium breaks down if we assume that banks can offer price-quantity contracts (contracts that specify both interest rates and loan sizes), which seems to be a more natural assumption. In this alternative setting, one bank (call it M) which offers a loan contract of a limited size  $X_A^*(R_0, G)$  per person at the interest rate  $R_0$  will attract all consumers and will break even. Since type A consumers demand no more loans at an interest rate equal to or higher than  $R_0$ , the remaining banks will supply ‘supplementary’ loans to type B consumers at the rate  $R_B$ . No other bank will supply the same contract as bank M because it would make losses by attracting only the high-risk consumers who borrow from more than one bank without being detected.

<sup>13</sup>A sketch of the proof is as follows. The utility level in equilibrium is

$$V_i^* = U[Y_1 + G + X_i^*(R^c, G)] + \beta \{ p_i U[Y_H - R_0 G - R^c X_i^*(R^c, G)] + (1 - p_i) U(0) \}.$$

Using the envelope theorem, we obtain

$$\begin{aligned} dV_i^*/dG &= U'(Y_1 + G + X_i^*) - \beta p_i [R_0 + (dR^c/dG) X_i^*] U'(Y_H - R_0 G - R^c X_i^*) \\ &= \beta p_i [R^c - R_0 - (dR^c/dG) X_i^*] U'(Y_H - R_0 G - R^c X_i^*) \\ &= \beta p_i [R^c - R_0 - (\Gamma_2/\Gamma_1) X_i^*] U'(Y_H - R_0 G - R^c X_i^*), \end{aligned}$$

whose sign is the same as that of the expression in the square bracket.

In this monopolistic equilibrium, bank M plays the role of the government or, in other words, there is no role for the government. Debt neutrality obtains. However, this equilibrium is not strictly a Nash equilibrium since, given that other banks supply loans at  $R_B$ , bank M has an incentive to charge an interest rate slightly higher than  $R_0$  and make positive profits. This action, however, will induce another bank to take over the position of bank M by offering a lower interest rate. The market structure is unstable. These observations suggest that models with no communication suffer from the lack of an appropriate equilibrium concept.

Another caveat in the model is directly related to the unobservability of borrowings. Namely, how can we prevent all the borrowers from borrowing as much as possible (possibly infinite) in the first period and going bankrupt with probability one in the second period? This problem can be avoided if a certain restriction is imposed on the form of the utility function, or if there is a prohibitively high penalty on defaulting when employed, but these solutions are clearly unsatisfactory.<sup>14</sup>

#### 4. A model with full communication

##### 4.1. Signaling equilibrium

As we have seen in section 2, consumers of different risk types have different preference orderings over the set of possible loan contracts. This fact raises the possibility that contracts purchased by a consumer serve as a potential signal of his risk characteristics. Banks may be able to design a set of contracts which would induce customers to reveal their characteristics. Or high-risk borrowers may, as in Jaffee and Russell (1976), choose to mimic the behavior of low-risk borrowers so as not to reveal themselves. This mechanism, known as signaling, is made viable by the assumption that all lenders communicate with each other regarding their customers' purchases, enabling themselves to observe the borrowing behavior of each consumer. The implications of signaling equilibria that arise in such a model are explored here in the context of Ricardian equivalence.

Banks compete with each other by offers of price-quantity contracts of the form  $(R, X)$  that specify both an interest rate  $R$  and an amount  $X$  any consumer can borrow at that rate.<sup>15</sup> Contracts of this form clearly dominate

<sup>14</sup>The restriction on preference must ensure that there is no incentive to default when 'employed': formally,

$$\lim_{C \rightarrow \infty} U(C) + \beta U(0) < V_i[X_i^*(R, G); R, G], \quad i = A, B.$$

<sup>15</sup>The linearity of loan contracts here is a result of using a particular probability distribution, and equilibrium contracts would specify non-linear schedules for a more general distribution. Such a generalization is conceptually straightforward but cumbersome to carry out.

price-only contracts when borrowings are observable. A Nash equilibrium in this model is defined as a set of contracts such that, when consumers choose contracts to maximize expected utility, (1) no contract in the equilibrium set makes negative profits and (2) there is no contract outside the equilibrium set that, if offered, makes a positive profit. We assume that each bank offers only one contract, so that there is no cross-subsidization across contracts. This assumption can be relaxed by slightly modifying the Nash equilibrium concept [see Wilson (1977)], but is retained for simplicity. We also assume free entry so that any collusive behavior is ruled out.

An equilibrium can only take one of the two forms: a *pooling equilibrium* and a *separating equilibrium*. If a set of contracts (separating contracts) can be designed to make high-risk borrowers reveal themselves, then a separating equilibrium obtains; otherwise, we have a pooling equilibrium with a pooling contract. We first need to characterize the two alternative forms of contracts to define these equilibria. *Separating contracts* are a set of two contracts,  $[R_A, X_S(G)]$  to be purchased by the low-risk borrowers and  $[R_B, X_B^*(R_B, G)]$  to be purchased by the high-risk borrowers, where  $R_i$  is defined as  $R^*/p_i$  and  $X_S(G)$  is the solution to

$$\max_X V_A(X; R_A, G) \quad \text{subject to} \quad V_B(X; R_A, G) \leq V_B^*(R_B, G).$$

It should be recalled that

$$V_B^*(R_B, G) = V_B[X_B^*(R_B, G); R_B, G],$$

which is the utility level of a type B consumer associated with his optimal borrowings at the interest rate  $R_B$ . Thus,  $X_S(G)$  gives optimal borrowings by type A under the constraint that type B consumers are better off by revealing themselves than by mimicking type A.

A *pooling contract*, on the other hand, makes both types borrow the same amount at the same interest rate. It takes the form  $[R_0, X_P(G)]$ , where  $X_P(G)$  maximizes  $V_A(X; R_0, G)$  without constraints or, equivalently,

$$X_P(G) = X_A^*(R_0, G). \tag{10}$$

$R_0$ , defined in (1), is the interest rate which makes the pooling contract break even. Since the government 'loans', which bear the implicit interest rate  $R_0$ , are a perfect substitute for the pooling contract, the following simple relationships hold:

$$X_P(G) = X_P(0) - G, \tag{11a}$$

$$V_i[X_P(G); R_0, G] = V_i[X_P(0); R_0, 0] \quad i = A, B. \tag{11b}$$

The latter expression will be abbreviated as  $V_i[X_P(0)]$  hereafter.

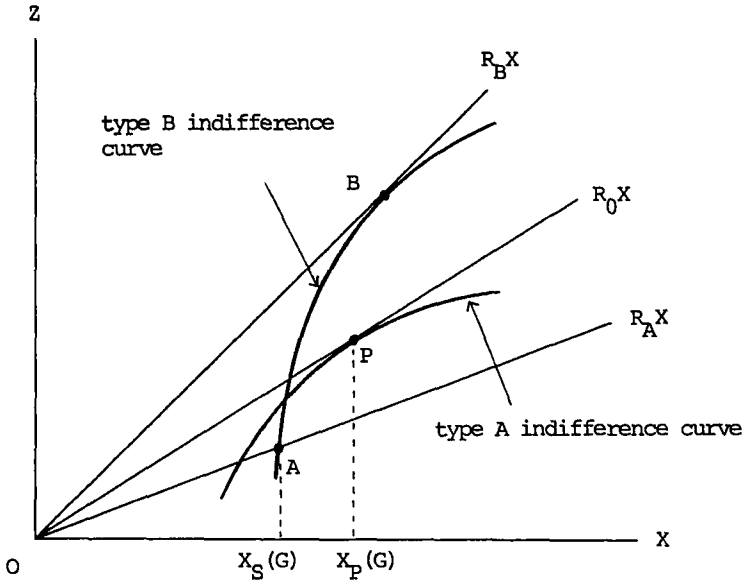


Fig. 2

A separating equilibrium obtains if and only if type A consumers prefer a separating contract over a pooling one:

$$[SE] \quad V_A [X_S(G); R_A, G] \geq V_A [X_P(0)].$$

Loan demand by each type in this equilibrium is given by

$$X_A = X_S(G) \quad \text{and} \quad X_B = X_B^*(R_B, G). \tag{12}$$

Fig. 2 depicts a typical separating equilibrium. The indifference curves are upward-sloping and concave as in fig. 1. The two separating contracts are represented by the points *A* and *B*, and are purchased by type A and type B individuals, respectively. The point *P* represents a pooling contract. The condition for a separating equilibrium, [SE], requires that the type A indifference curve through the point *P* should cut the  $Z = R_A X$  line to the left of the point *A*. This equilibrium can be shown to be a Nash equilibrium.

Fig. 3 gives an example of a pooling equilibrium, which could obtain if [SE] is violated (type A consumers prefer the pooling contract). The point *P* represents the pooling contract with interest rate  $R_0$ , where the type A consumer's utility is at an unconstrained maximum given  $R_0$ , while type B consumers are 'credit rationed'. Type A consumers are better off at *P* than at

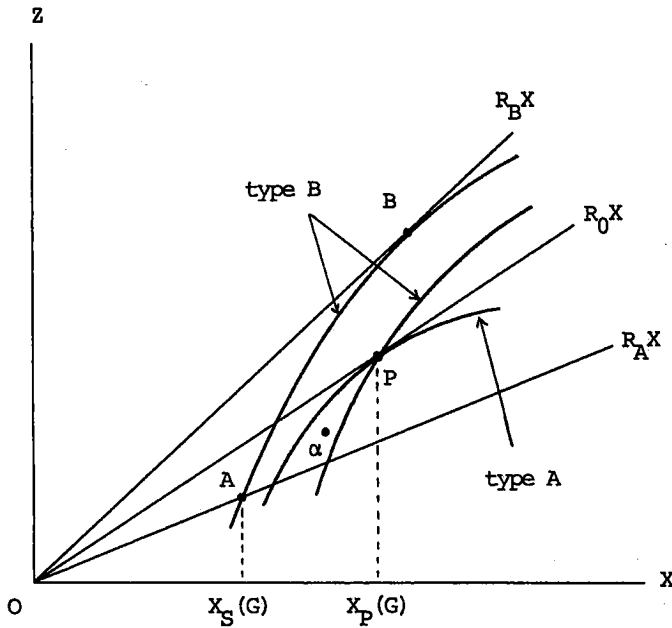


Fig. 3

A which represents the most preferable separating contract available to them. Thus, we have

$$X_A = X_B = X_P(G). \tag{13}$$

This pooling equilibrium basically corresponds to the well-known model of credit rationing by Jaffee and Russell [or its refined version by Smith (1983)]. However, as Rothschild and Stiglitz (1976) pointed out (and as Smith notes), there is no Nash pooling equilibrium in a model of this type. Namely, there is incentive for banks to deviate from the equilibrium and offer contracts such as  $\alpha$  which would attract only low-risk types. Since existing contracts yield non-negative profits only when both types purchase them, such deviation will make existing contracts unprofitable and destroy the equilibrium. In view of this non-existence problem, some alternative quasi-dynamic equilibrium concepts have been proposed. Wilson's E2 equilibrium is one of them, and the above pooling equilibrium in fact exists as an E2 equilibrium. It assumes that a bank offers a new contract only if it makes non-negative profits after all the contracts that become unprofitable because of the new offer are withdrawn. Wilson showed that an E2 equilibrium always exists and can be either a separating one or a pooling one. The E2 separating equilibrium is identical to the Nash separating equilibrium, and thus, need not be considered separately.

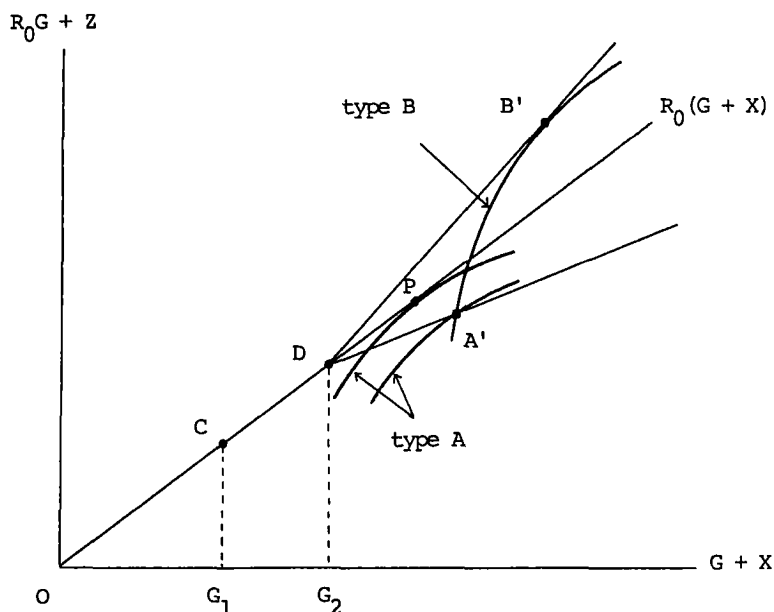


Fig. 4

#### 4.2. The effects of debt finance

We are now ready to examine the consequences of debt finance. We first consider the case in which a Jaffee–Russell (E2) pooling equilibrium obtains for  $G = 0$ . The point  $P$  in fig. 4 represents this original equilibrium. Suppose, as in section 3, the government provides a debt-financed tax cut of size  $G$  to all consumers in the first period and repays the debt  $R_0G$  through a tax increase in the second period. In fig. 4, this policy of ‘mandatory non-discriminatory government lending’ is represented by  $C$  (if  $G = G_1$ ) or  $D$  (if  $G = G_2$ ). The private loan market operates given these new endowment patterns.

Due to continuity, the condition [SE] will continue to be violated for a small increase in  $G$ , say from zero to  $G_1$ , so that the equilibrium will be unchanged at  $P$ . First-period consumption by each type of consumer stays constant since the size of the pooled loan in the private market ‘shrinks’ in response to an increase in the pooled loan supplied by the government. Thus, Ricardian equivalence holds locally. However, if  $G$  is further increased to  $G_2$ , [SE] will now be satisfied and we will have a separating equilibrium represented by  $A'$  and  $B'$ . The slope of  $DA'$  is  $R_A$ , while that of  $DB'$  is  $R_B$ . The type B individual’s first-period consumption will be greater at  $B'$  than at  $P$ . The type A individual’s first-period consumption, on the other hand, could decrease



initially although it will eventually exceed the original level as  $G$  is further increased.

Welfare implications are less ambiguous. The figure suggests that the post-tax-cut separating equilibrium is Pareto-superior to the pre-tax-cut pooling equilibrium. In fact, the following proposition holds:<sup>16</sup>

*Proposition 2. Let  $G^\circ$  be such that  $V_B^*(R_B, G^\circ) = V_B[X_P(0)]$ . Then, for any  $G \in [G^\circ, X_P(0)]$ , (i) the condition [SE] is satisfied so that a separating equilibrium obtains and (ii) this equilibrium Pareto-dominates the original pooling equilibrium.*

It suffices to show (ii) since Pareto-domination implies that type A consumers prefer the separating equilibrium (i.e., [SE] holds). We showed in (9) that  $V_B^*(R_B, G)$  is increasing in  $G$ . This implies  $G^\circ < X_P(0)$  since  $V_B^*(R_B, X_P(0)) > V_B[X_P(0)]$ . Hence,  $V_B^*(R_B, G)$  is no smaller than  $V_B[X_P(0)]$  for all  $G \in [G^\circ, X_P(0)]$ . Therefore,  $P$  must be above the type B indifference curve through  $A'$ . This implies that  $P$  must also be above the type A indifference curve through  $A'$  since it is flatter than the type B indifference curve. Thus, both types of consumers are made better off. Government lending plus the new separating loan contracts in the private market Pareto-dominates the original pooling equilibrium.

This government-induced separation does not occur in the special case where  $p_B = 0$ . The original pooling equilibrium represents the only possible allocation regardless of the size of  $G$  since no bank would lend to type B consumers if they are so identified. Thus, the 'local' Ricardian equivalence discussed above becomes a global result.<sup>17</sup>

Now we turn to the case of a separating equilibrium. Fig. 5 shows a debt finance policy (represented by  $C$ ) and two separating equilibria, one before the policy (the pair  $A$  and  $B$ ) and the other after the policy ( $A'$  and  $B'$ ). By the tax cut, the government effectively provides a pooled loan  $OC$ , to be supplemented by private loans  $CA'$  and  $CB'$ . Both types of consumers increase their first-period consumption. Since the government's loan is a substitute for private loans, borrowings in the private market are reduced, and therefore, the magnitude of the increase in consumption is less than that of the tax cut. There is no general welfare result available in this case. However, it is possible to construct an example of Pareto-improvement, and in fact, the relative location of indifference curves in the figure indicates that this particular policy is Pareto-improving.

<sup>16</sup>This proposition is parallel to those in Wilson (1977) and Eckstein, Eichenbaum and Peled (1985).

<sup>17</sup>Hayashi's model, which produced global neutrality, essentially corresponds to this special case with a further assumption that  $p_A = 1$ .



incorporates these considerations and yields some surprising policy implications.

We first discuss the questions above in an intuitive manner by considering the following game in the loan market: In the first stage of the game, banks make loan contract offers which consist of (1) the terms  $(R, X)$ , (2) an exclusivity clause regarding other loan contract purchases, and (3) a list of banks to whom the purchase of the contract by a consumer will be communicated. In the second stage, the consumer chooses a combination of contracts with an understanding that any detected violation of an exclusivity clause results in an automatic cancellation of the contract.

The first question of whether there is any incentive to withhold information can most easily be answered by referring back to fig. 2. This is the case where a Nash separating equilibrium exists with full communication. It is clear from the figure that any type B consumer can be made better off if allowed to purchase a loan contract  $A$  plus a contract on the line  $OB$ . This is not a feasible choice if all banks know about his contract purchases. However, in our present setting, there is an incentive for a new bank to enter the market, offer a loan at the interest rate  $R_B$  (or slightly above it) and agree not to divulge the names of its customers to other banks. This strategy makes the contract  $A$  unprofitable, and therefore destroys the separating equilibrium.

This observation does not imply that there will be a complete absence of communication. As an example, suppose two banks offer the same pooling contract  $[R_0, X_P(G)]$ . Further suppose that high-risk individuals prefer  $[R_0, 2X_P(G)]$  to  $[R_0, X_P(G)]$ , which is a reasonable assumption. If the two banks do not share customer information, high-risk borrowers will attempt to purchase contracts from both banks. The banks will suffer losses since each of them will have a higher share of high-risk customers than what would make it break even. Thus, there is an obvious incentive for these banks to send customer information to each other. In fact, all banks offering pooling contracts have an incentive to share information, and doing otherwise cannot be a rational behavior.

The arguments above suggest that, if there is an equilibrium, it would be supported by two groups of banks, one sharing customer identity information and the other refusing to divulge it. The solution proposed by Jaynes goes basically as follows. Since a separating equilibrium is impossible, the equilibrium should involve some degree of pooling. Start from the pooling equilibrium of the previous section, in which both types purchase the same pooling contract. Type B consumers are 'credit rationed' in this case and are willing to pay a higher interest rate  $R_B$  to borrow some more. That is, there is an incentive for some banks to offer additional loans along the line  $OH$  in fig. 6, with the promise that they will not communicate the names of their customers to those banks offering the pooling contract  $P$ . This enables type B consumers to combine the two contracts  $P$  and  $H$  and attain the point  $L$ . Thus, all



- (b) Given the constellation of contract offers, consumers choose a contract or a combination of contracts.
- (c) Banks then decide what customer information they want to divulge and which other banks they want to send this information to.
- (d) Finally, banks that have received such information from other banks choose whether or not to enforce their exclusivity conditions.

To see how this formulation works, consider an offer  $\alpha$  in fig. 6, which by itself attracts only type A consumers and makes positive profits. We have already seen that a deviation with such an offer destroys the pooling equilibrium in the full communication case. In the current four-stage game, however, the following off-the-equilibrium-path behavior ensures that this deviation does not upset the equilibrium: After the first stage in which some bank offered the contract  $\alpha$ , all consumers purchase this contract along with appropriate amounts of the pooling contract (both types) and the supplementary contract (type B only). In the third stage, the suppliers of the pooling contract send customer information to each other, but none of them sends any information to the defector that offered  $\alpha$ . In the fourth stage, the banks offering the pooling contracts do not enforce exclusivity conditions on buyers of  $\alpha$ .

Along this off-the-equilibrium path, both types of consumers find it utility-increasing to purchase  $\alpha$  and an appropriate fraction of the pooling contract. The defecting bank, lacking contract purchase information, has no way of preventing this behavior and, therefore, makes negative profits. In anticipation of this, it will not make such an offer. It is not difficult to see that all other kinds of deviation fail to upset the equilibrium. Furthermore, the preceding discussions of the first game also apply to this game and preclude any other solution. Therefore, we have established a unique sequential equilibrium.

### 5.2. Ricardian equivalence

Now we are ready to show that a change in  $G$  has no effect on consumption. We know that, in equilibrium

$$X_A = X_P(G) = X_P(0) - G,$$

$$X_B = X_P(G) + X_L = X_P(0) + X_L - G,$$

for  $G \in [0, X_P(0)]$ . The crucial difference with the full communication case is that a change in  $G$  never threatens the existence of the pooling contract. Note that  $X_L$  is invariant with respect to  $G$  since (11a) and (14) imply

$$X_L = \arg \max_x \{ U [ Y_1 + X_P(0) + X ] \\ + \beta p_B U [ Y_H - R_0 X_P(0) - R_B X ] \}.$$

It follows that first-period consumption of each type does not depend on  $G$ :

$$C_{A1}(G) = Y_1G + X_A = Y_1X_P(0),$$

$$C_{B1}(G) = Y_1G + X_B = Y_1X_P(0) + X_L.$$

The same is true for consumption in the following period:

$$C_{A2}(G) = YY_H - R_0G - R_0X_P(G) = YY_H - R_0X_P(0),$$

$$\begin{aligned} C_{B2}(G) &= YY_H - R_0G - R_0X_P(G) - R_BX_L \\ &= YY_H - R_0X_P(0) - R_BX_L. \end{aligned}$$

Hence, we have the following result:

*Proposition 3. Ricardian equivalence holds in the model with endogenous communication. Namely, for any  $G_1, G_2 \in [0, X_P(0)]$ , we have  $C_{ij}(G_1) = C_{ij}(G_2)$ , ( $i = A, B, j = 1, 2$ ).*

An alternative way to look at this proposition is to use the fact that, given the structure of equilibrium contracts, total loan repayments  $Z$  by either type can be written as a function of  $X$  of the following form:

$$\begin{aligned} Z &= R_0X && \text{if } X \leq X_P(G), \\ &= R_0X_P(G) + R_B[X - X_P(G)] && \text{if } X > X_P(G). \end{aligned} \quad (15)$$

This implies that the sum of tax payments and loan repayments in the second period is given by

$$R_0G + Z = \Phi(X + G),$$

where

$$\begin{aligned} \Phi(X + G) &= R_0(X + G) && \text{if } X + G \leq X_P(0), \\ &= R_0X_P(0) + R_B[X + G - X_P(0)] && \text{if } X + G > X_P(0). \end{aligned}$$

Using this relationship, we can rewrite the consumer's optimization problem as

$$\max U(Y_1 + X_i + G) + \beta p_i U[Y_H - \Phi(X_i + G)], \quad i = A, B.$$

It should be evident from this expression that the consumer, faced with a change in  $G$ , can achieve the same optimum as before through an exactly

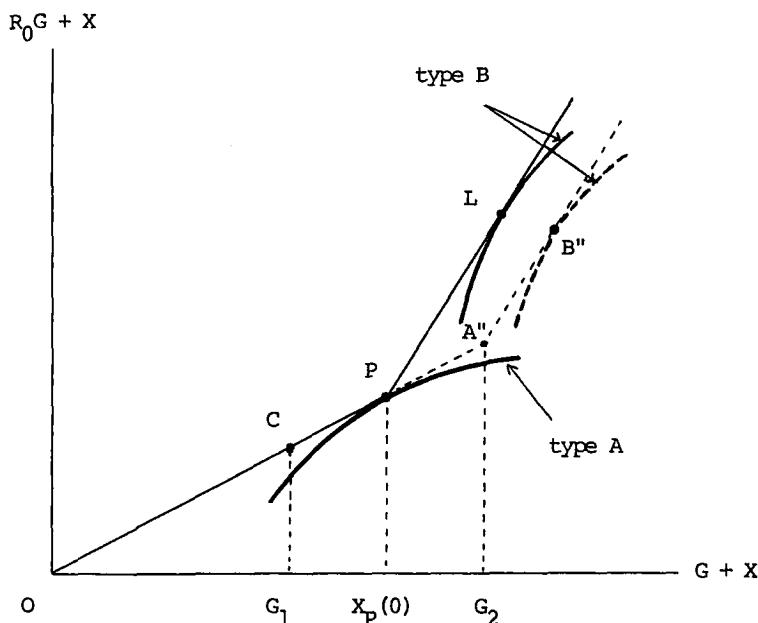


Fig. 7

offsetting change in  $X_i$ . In other words, a change in  $G$  does not alter the intertemporal budget constraint relevant for the consumer.

Fig. 7 shows the argument graphically. If the government cuts taxes by  $G_1$  (represented by a move from  $O$  to  $C$ ), banks offering the pooling contract will reduce the size of their loan from  $OP$  to  $CP$ , and the remaining banks will provide the same supplementary loan contract  $PL$  as before. A tax cut replaces the pooling contract on a dollar-for-dollar basis and leaves the budget constraint and optimal consumption unchanged. The result holds even if  $Y_L$  (income when unemployed) is not zero as we have assumed. In terms of fig. 7, a positive  $Y_L$  means that the graph  $OPL$  should start from a point with coordinates  $(Y_L/R^*, Y_L)$  instead of the origin. Loans up to  $Y_L/R^*$  are risk-free and will carry the riskless interest rate  $R^*$ . Since such loans are immune to the adverse selection problem, it does not matter who provides this portion of loan supply. Therefore, an increase in  $G$  is neutral not only in the current model but also in the model with full communication if  $R^*G$  does not exceed  $Y_L$ . The neutrality result also remains valid for any finite number of risk types. If there are  $N$  types, then, there will be  $N$  kinds of contracts offered in the market, with the  $j$ th contract pooling  $j$  highest-risk types. A bank will share customer identity information only with those banks that offer the same contract as it

does. The contract that pools all  $N$  types will play the role of the pooling contract in this section.

The significance of the result becomes clear if we consider the case in which  $p_A$  is unity so that type A consumers never go bankrupt. Since there is no risk of default, type A consumers would have access to loans at the riskless rate  $R^*$  in a competitive market with symmetric information. There will be neither credit rationing nor a wedge between lending and borrowing rates for them. Under asymmetric information, however, these individuals are indistinguishable from risky customers (type B) and are charged an interest rate higher than  $R^*$ . We have a wedge between lending and borrowing rates where there should be none. Furthermore, we also have credit rationing of sorts for type B consumers, since they cannot borrow as much as they wish at the pooling rate  $R_0$ . In spite of these genuine imperfections in the capital market, Ricardian equivalence still goes through. Tax cuts with a correctly anticipated future tax increase simply replace private lending and have no real effects.

The intuition behind debt neutrality may be described as follows. By assumption, the government does not have any informational advantage over the private sector, so that the only weapon it possesses to affect real allocation is its ability to force the pooling contract (or its fraction) on all consumers. In the model with no communication, this weapon proved effective because the private sector could not offer the pooling contract. In the model with full communication, the pooling contract either did not exist in equilibrium (a separating equilibrium) or, if it did, was eventually replaced by separating contracts as the size of a tax cut increased. By contrast, in the present model with endogenous communication, the private loan market supports the pooling contract regardless of the intertemporal reallocation of taxes. The size of the pooling contract offered by banks will adjust so that the total size of the two pooling contracts, governmental and private, remains constant.

So far, we have only considered the case where  $G$  does not exceed  $X_p(0)$ . If  $G$  is greater than  $X_p(0)$ , an increase in  $G$  will increase first-period consumption of both types up to a point. This effect comes from the fact that the interest rate  $R_0$  implicit in the tax cut is higher than the lending rate  $R^*$ , which implies that type A consumers cannot exactly undo 'forced lending' by the government. Fig. 7 shows that, with a tax cut of  $G_2$ , consumers of types A and B will move to  $A''$  and  $B''$ , respectively. This 'non-neutrality' actually has little to do with informationally imperfect capital markets since the same mechanism applies to the symmetric information case as well. The policy is simply a subsidy for high-risk individuals at the expense of low-risk individuals, and therefore, no Pareto-improvement is possible.

## 6. Concluding remarks

The question asked at the beginning was: do the models of informationally imperfect capital markets provide a theoretical basis for debt non-neutrality?



The answer depends crucially on the extent to which information is shared among lenders. Among the three models with different assumptions on communication, the first two yield non-neutrality results (although Ricardian equivalence may hold 'locally' in the second model), along with a further implication that it is possible in many cases to achieve Pareto-improvement by a debt-financed tax cut. However, these models have the theoretical weakness of imposing arbitrary restrictions on the extent of communication. When incentives for communication are explicitly considered, the conclusions are reversed. Ricardian equivalence survives.

Although the model in the paper is highly stylized, it illustrates the point that adverse selection in capital markets, supposedly the prime cause of market imperfections, does not imply a failure of Ricardian equivalence. The all-too-common remark that the validity of Ricardian equivalence hinges upon perfect capital markets seems to be unfounded. The paper also makes a more general point that, even if market 'imperfections' exist, the government may not be able to take advantage of them since private market outcomes are likely to change in response to the government's actions.

It would be premature, however, to conclude that capital market imperfections do not matter. For example, certain institutional arrangements or constraints may render one of the first two models more relevant than the theoretically preferable model with endogenous communication. Furthermore, even our preferred model might yield different results if moral hazard is introduced as an alternative form of informational asymmetry. What kind of imperfection, if any, leads to a profitable way out of Ricardian equivalence still largely remains an open question.

## References

- Abel, Andrew B., 1985, Gifts and bequests: Comments and extension, Mimeo. (Harvard University, Cambridge, MA).
- Abel, Andrew B., 1986, Capital accumulation and uncertain lifetimes with adverse selection, *Econometrica* 54, 1079–1097.
- Akerlof, George A., 1970, The market for 'lemons': Qualitative uncertainty and the market mechanism, *Quarterly Journal of Economics* 84, 488–500.
- Barro, Robert J., 1974, Are government bonds net wealth? *Journal of Political Economy* 82, 1095–1117.
- Barro, Robert J., 1986, The neoclassical approach to fiscal policy, in: Robert J. Barro ed., *Handbook of modern business cycle theory* (Wiley, New York) forthcoming.
- Barsky, Robert B., N. Gregory Mankiw and Stephen P. Zeldes, 1986, Ricardian consumers with Keynesian propensities, *American Economic Review* 76, 676–691.
- Bernheim, B. Douglas, 1987, Ricardian equivalence: An evaluation of theory and evidence, in: Stanley Fischer, ed., *NBER macroeconomics annual 1987* (MIT Press, Cambridge, MA) forthcoming.
- Bernheim, B. Douglas and Kyle Bagwell, 1986, Is everything neutral? NBER working paper no. 2086.
- Bernheim, B. Douglas, Andrei Shleifer and Lawrence Summers, 1985, The strategic bequest motive, *Journal of Political Economy* 93, 1045–1076.
- Buiter, Willem H., 1985, A guide to public sector debt and deficits, *Economic Policy* 1, 14–79.
- Chan, Louis K.C., 1983, Uncertainty and the neutrality of government financing policy, *Journal of Monetary Economics* 11, 351–372.

- Eckstein, Zvi, Martin Eichenbaum and Dan Peled, 1985, Uncertain lifetimes and the welfare enhancing properties of annuity markets and social security, *Journal of Public Economics* 26, 303–326.
- Hayashi, Fumio, 1986, Tests for liquidity constraints: A critical survey, NBER working paper no. 1720.
- Hellwig, Martin F., 1986, A note on the specification of inter-firm communication in insurance markets with adverse selection, Mimeo. (University of Bonn, Bonn).
- Jaffee, Dwight M. and Thomas Russell, 1976, Imperfect information, uncertainty, and credit rationing, *Quarterly Journal of Economics* 4, 651–666.
- Jaynes, Gerald D., 1978, Equilibria in monopolistically competitive insurance markets, *Journal of Economic Theory* 19, 394–422.
- King, Mervyn, 1984, Tax policy and the business cycle, Mimeo. (MIT, Cambridge, MA).
- Kreps, David M. and Robert Wilson, 1982, Sequential equilibria, *Econometrica* 50, 863–894.
- Pauly, Mark V., 1974, Overinsurance and public provision of insurance, *Quarterly Journal of Economics* 88, 44–62.
- Poterba, James M. and Lawrence H. Summers, 1987, Finite lifetimes and the effects of budget deficits on national savings, *Journal of Monetary Economics*, this issue.
- Rothschild, Michael, and Joseph Stiglitz, 1976, Equilibrium in competitive insurance markets: An essay on the economics of imperfect information, *Quarterly Journal of Economics* 90, 629–649.
- Smith, Bruce, 1983, Limited information, credit rationing, and optimal government lending policy, *American Economic Review*, 73, 305–318.
- Stiglitz, Joseph and Andrew Weiss, 1981, Credit rationing in markets with imperfect information, *American Economic Review* 71, 393–411.
- Weil, Philippe, 1984, 'Love thy children': Reflections on the Barro debt neutrality theorem, Mimeo. (Harvard University, Cambridge, MA).
- Wilson, Charles, 1977, A model of insurance markets with incomplete information, *Journal of Economic Theory* 16, 167–207.