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## The Timing of Government Spending in a Dynamic Model of Imperfect Competition

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CENTER DISCUSSION PAPER NO. 641

THE TIMING OF GOVERNMENT SPENDING IN A  
DYNAMIC MODEL OF IMPERFECT COMPETITION

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### Abstract

The debate on macroeconomic implications of fiscal policy has focused on the question of whether the timing of taxes matters but has neglected the study of the relevance of the timing of public spending. This paper tries to fill that hole by presenting a model of dynamic fiscal policy where firms behave non competitively and households have finite horizons. I show that the existence of monopoly rents makes the timing of future government spending relevant. In particular I show that, contrary to the prediction of most other models of fiscal policy, an anticipated increase in public spending financed by subsequent tax increases may have expansionary effects as the positive wealth effect associated with monopoly rents outweighs the negative wealth effect of anticipated higher taxes. I also show that if the public spending expansion is financed by subsequent public spending contraction, the experiment has unambiguous expansionary effects.

The model presented can be thought as a microfounded story of Blanchard's Good-News-Bad-News model of public policy.

## (0) INTRODUCTION

The recent debate on macroeconomic implications of fiscal policy has been centered around the question of whether the timing of taxes has real effects. The Ricardian view revived by Barro (1974) argues that if individuals are intergenerationally linked through bequests, the timing of lump sum taxes is irrelevant as long as the present value of those taxes remains unchanged. Keynesian economists, on the other hand, argue that it is the actual path rather than the present value of taxes what has real economic consequences. They believe that a debt financed temporary tax cut will increase aggregate demand and current interest rates which will reduce investment and the long run capital stock. They argue that the assumptions underlying the Ricardian Equivalence Theorem are unrealistic. Blanchard (1985) shows that if agents have finite horizons a debt financed tax cut will be expansionary. Tobin (1980) argues that if the lump sum taxes are substituted by distortionary income taxes, a temporary tax cut will increase interest rates. Judd (1985) and Barro (1990) show that this is not always the case since the substitution effects going in the direction of decreasing consumption may dominate. Barsky et al. (1986) and Kimball and Mankiw (1989) argue that, if income is uncertain, future income taxes are a form of insurance. Hence a debt financed tax cut will reduce overall uncertainty and increase current consumption. Barro (1990) shows that the existence of some liquidity constrained agents yields both Non-Ricardian and Non-Keynesian results.

The relevance of the timing of government spending, on the other hand, is a largely unquestioned issue. In all the models mentioned above the

timing of future government spending does not have any effect on current real variables as long as the path of future taxes remains unchanged<sup>1</sup>.

Consider a small open economy with infinitely lived households. If the government announces that it will increase future spending (say at  $t_1$ ) and finances it with subsequent spending cuts (say at  $t_2 > t_1$ ), nothing real will happen today as long as the present value of taxes remains constant. When the increase in spending occurs the country will run a current account deficit, which will be financed with future surpluses. If the economy is closed (and output supply is inelastic with respect to interest rates) there will be an increase in real interest rates in  $t_1$  but no real changes will occur today. Under finite horizons the answers will be the same if (not only the present value but) the whole future path of taxes remains constant.

One may think, however, that there are rents associated with government spending, especially if the sectors in which the government operates behave non-competitively. Hall (1988) estimates the ratio of the difference between price and marginal cost to price (what I will later define as profit rate) and finds that for most industries this profit rate is substantially different from zero<sup>2</sup>. Under these circumstances the timing of public

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<sup>1</sup> I am assuming, as most of the models mentioned do, that public spending does not enter private utility or private production. See Baily (1971) for models where public expenditures are partial substitutes for private consumption or are inputs of private production. I am also abstracting from the effects of current government spending on current aggregate demand which we know that, if temporary, has expansionary effects.

<sup>2</sup> It is .545 for construction, .514 for durables, .677 for nondurables, .687 for transportation, .736 for trade, .697 for Finance, Insurance and

spending may have real consequences as it implies an intertemporal redistribution of monopoly rents. Thus, modeling the economy as a set of monopolistic firms may yield surprising results. There are a number of recent papers which model fiscal policy in the context of imperfect competition (see for instance Hart (1982), Mankiw (1987), Blanchard and Kiyotaki (1987), Silvestre (1988) or Startz (1989)). Due to their static nature, these models are inadequate for answering the dynamic questions addressed here.

In this paper I propose a dynamic model of fiscal policy where firms behave monopolistically. I find that the existence of monopoly rents or profits associated with public purchases means that the timing of public spending may no longer be irrelevant. Changes in the timing of spending will imply changes in the timing at which these rents accrue. If individuals care about the timing of their income (as they do if, for instance, they have finite horizons or if credit markets are not perfect), then the timing of public spending will have current real effects. I also find that the existence of monopoly rents does not affect the Ricardian conclusions on the timing of taxes. Finally I show that an anticipated bond financed increase in public spending financed with future tax increases may have expansionary effects today as the positive wealth effect associated with the monopoly rents may outweigh the negative wealth effect of future higher taxes. This non-conventional result contrasts with the unambiguously

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Real Estate and .464 for services. At a more disaggregate level he finds that the profit rate is as high as .972 for communications industries, very close to the maximum possible value, 1..

contractionary effects found in perfectly competitive models<sup>3</sup>.

The rest of the paper is organized as follows. In section 1 I describe consumer behavior. I take the population structure from Blanchard (1985). I assume that, at every point in time, consumers have to choose how much to spend and save and how to allocate their total expenditures among a range of existing goods. In section 2 describes public behavior. The government chooses a stream of expenditures and taxes and the allocation of these expenditures across goods. Firms are described in section 3. They use a technology involving fixed costs and constant marginal costs. Since they face constant elasticity demand functions, their optimal price implies a constant mark-up. Firms generate monopoly rents which are equally distributed across households. Section 4 describes the equilibrium of the model. Section 5 proposes an index of fiscal stance which incorporates the existence of monopoly rents. In Section 6 I perform three fiscal policy experiments and find that the introduction of imperfect competition yields some non-conventional results. Section 7 concludes the paper.

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<sup>3</sup> Blanchard (1981) has a pseudo-dynamic version of the IS/LM model where he finds that increases in  $G$  may have expansionary or contractionary effects. In the "Good News Case" where the parameters of the model are such that an increase in output triggers a boom in the stock market, an increase in public spending is expansionary. In the "Bad News Case" an increase in public spending is contractionary. In this sense, one could view the present paper as a micro-foundation for the Blanchard "Good news-Bad news" model.

(1) HOUSEHOLDS.

The structure of the population is taken from Blanchard (1985). Thus I will assume that the economy is populated by individuals facing a constant probability of death,  $\rho$ <sup>4</sup>. Total population is assumed not to grow so a new cohort (normalized to be of size  $\rho$ ) joins the economy at every instant. At time  $t$ , therefore, the size of the cohort born at time zero is  $\rho e^{-\rho t}$  so the total size of the population is 1. Individuals face an uncertainty problem since they do not know when they are going to die. They maximize an expected utility function subject to a dynamic budget constraint. Given that the probability of being alive at time  $v$  is  $e^{-\rho(v-t)}$ , the individual objective function is:

$$(1.1) \quad \text{MAX}_t E \int_t^{\infty} u(s,v) e^{-\delta(v-t)} dv = \text{MAX}_t \int_t^{\infty} u(s,v) e^{-(\delta+\rho)(v-t)} dv$$

where  $u(s,v)$  is the instantaneous utility function at time  $v$  for individuals born at time  $s$ . As in Spence (1976) and Dixit and Stiglitz (1977) I will assume that there is a variety of consumption goods. Although this is not a

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<sup>4</sup> This implies that the random variable "time until death" is an exponential distribution with parameter  $\rho$ , where  $\rho$  can take any positive value. The expected value of this exponential distribution is  $\rho^{-1}$  which can be interpreted as the time horizon (expected lifetime). In the limiting case where  $\rho=0$ , the economy is populated by individuals with infinite horizon.



critical assumption, I will assume that the marginal utility of a good  $i$  is independent of all other goods. The instantaneous utility function is

$$(1.2) \quad u(s, v) = \sum_{i=1}^N c_i(s, v)^{1-\sigma} / (1-\sigma)$$

where, in order to get well behaved demand functions  $0 < \sigma < 1$  will be assumed. Further, in order to ensure positive consumption I will assume that the parameters  $\sigma$  and  $\delta$  are such that  $r - (1/\sigma)(r - \delta) > 0$  applies.

Each individual is assumed to be born with zero non-human wealth. The mere fact of being alive, however, allows him to collect a share of the profits of the company. I will not assume that there exists a stock market and that the profits are distributed in the form of dividends among the shareholders. Recent studies show that most of the monopoly rents accrue to workers rather than capital owners. For instance Katz and Summers (1989) examine panel data for the United States and show that there is a strong positive correlation between total industry rents and labor rents. They also show that labor rents seem closely related to firm's capital-labor ratio. They interpret these findings as evidence of the leverage that labor has in extracting monopoly rents. Hoshi, Kashyap and Scharfstein (1988) find similar results for Japan. Hence, I will assume that the monopoly profits will be equally distributed across currently alive individuals in the form of higher wages.

A key assumption is the existence of perfect annuity markets: individuals may contract to receive  $\rho w$  every instant and to pay  $w$  contingent to their death. In the absence of a bequest motive, consumers will find it optimal to have such contracts (see Blanchard (1985) and Blanchard and

Fischer (1989)). The effective rate of return for each private individual will be  $\rho+r(t)$  where  $r(t)$  is the rate of return on financial assets. Notice that consumers in debt will be required to pay a premium  $-\rho w$  to account for the risk of defaulting which they will do with probability  $\rho$ .

Let  $\pi(s,v)$ ,  $\tau(s,v)$  and  $w(s,v)$  be respectively, profits, taxes and financial wealth at time  $t$  of an individual born at time  $s$ . Taxes are assumed to be lump sum (but since I do not allow for leisure choice an equivalent assumption would be a consumption tax).

I will assume that the interest rate is fixed. I will think of the model as describing a small open economy that takes the interest as given. Under this interpretation an increase in current aggregate demand will generate a current account deficit since aggregate supply is fixed. One could also think that I am only modeling the demand side of the economy. Given the interest inelastic aggregate supply, movements in aggregate demand will generate similar movements in real interest rates so as to clear the real bond market. Finally, the model could be extended to include intertemporal leisure choice as in Barro (1989). The aggregate supply would in this case be interest rate elastic. Changes in aggregate demand would generate partial increases in work effort and output and partial increases in interest rates<sup>5</sup>. But for now let me just think about an internationally given real interest rate.

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<sup>5</sup> Of course in this case the individual choice of work effort would not be independent of the wealth effects of the model.

Thus, individuals face the following dynamic budget constraint (DBC):

$$(1.3) \quad \dot{w}(s,v) \equiv \partial w(s,v)/\partial v = \\ = (r+\rho)w(s,v) + E(s,v) + \pi(s,v) - \tau(s,v) - \sum_{i=1}^N p_i c_i(s,v)$$

where all variables are expressed in terms of labor. The term  $\rho w(s,v)$  is the return from the annuities market and  $E(s,v)$  is labor income. All households work the same amount of time, they have the same productivity and their labor income is constant over time. That is,  $E(s,v)=E(v)=E$  for all  $s$  and  $v$ .

The individual household program can be solved in two steps. First choose consumption of each individual variety,  $c_i(s,v)$ , subject to a given total expenditure  $x(s,v)$ . That is

$$(1.4) \quad \text{Max}_{c_i} \sum_{i=1}^N c_i(s,v)^{1-\sigma} / (1-\sigma) \quad \text{subject to} \quad \sum_{i=1}^N p_i c_i(s,v) = x(s,v)$$

the first order conditions of this program imply

$$(1.5) \quad c_i(s,v) = x(s,v) p_i^{-(1/\sigma)} / \left( \sum_{i=1}^N p_i^{(\sigma-1)/\sigma} \right)$$

Equation (1.5) is the time  $v$  demand of good  $i$  from individuals born at time  $s$ . Second choose the optimal amount of expenditure in each period. This can be readily done by plugging (1.5) in  $u(s,v)$  and choosing  $x(s,v)$  so as to maximize (1.2) subject to (1.3). The first order conditions are well known

$$(1.6) \quad \dot{x}(s,v)/x(s,v) = (r - \delta)/\sigma$$

where  $\dot{x}(s,v) = \partial x(s,v)/\partial v$ . Individual consumption expenditure growth is linearly related to the difference between the real interest rate and the subjective rate of time preference. Consumers also need to satisfy a limiting transversality condition. The optimal individual consumption expenditure at each time  $t$  can be found by solving the differential equation in (1.6) between times  $v$  and  $t$  and using the dynamic budget constraint (1.3)

$$(1.7) \quad x(s,t) = (r + \rho - (r - \delta)/\sigma) \left\{ w(s,t) + \int_t^{\infty} e^{-(r+\rho)(v-t)} [E + \pi(s,v) - \tau(s,v)] dv \right\}$$

That is, individual consumption expenditure will be a fraction of financial plus human wealth, where human wealth equals the present value of all future labor incomes net of taxes plus profits or monopoly rents. The constant marginal propensity to consume out of wealth is equal to  $(r + \rho - (r - \delta)/\sigma)$  which is positive. The total private demand for good  $i$  at time  $v$  can be found by integrating (1.5) across all individuals,  $s$

$$(1.8) \quad C_i(v) = X(v) p_i^{-(1/\sigma)} / \left( \sum_{i=1}^N p_i^{(\sigma-1)/\sigma} \right)$$

where  $C_i(v)$  is total consumption and  $X(v) = \int_{-\infty}^v x(s,v) \rho e^{\rho(s-v)} ds$  is the total private expenditure in terms of labor.

## (2) GOVERNMENT.

The government collects lump sum taxes and spends the proceeds in all goods. To make it parallel to the private consumer case, I will assume that the public demand for each good has the same elasticity as the private demand. That is

$$(2.1) \quad G_i(t) = \Gamma(t) p_i^{-(1/\sigma)} / \left( \sum_{i=1}^N p_i^{(\sigma-1)/\sigma} \right)$$

where  $G_i(t)$  is the real demand of good  $i$  and  $\Gamma(t)$  is total public expenditure in terms of labor. This simplifying assumption is not crucial but it will allow me to easily aggregate private and public demand for each individual firm. I will further assume that the public purchase of these private goods provides no private utility and does not affect the private production function. The government can borrow and lend at the internationally given interest rate. The dynamic budget constraint for the government is, therefore:

$$(2.2) \quad \dot{D}(t) = rD(t) + \Gamma(t) - \psi(t)$$

where  $D(t)$  is government debt and  $\psi(t)$  is the total tax collection, both in units of labor. The government is also subject to an intertemporal solvency constraint which does not allow it to borrow infinitely. That is

$$(2.3) \quad \lim_{v \rightarrow \infty} D(v) e^{-rv} = 0$$

### (3) FIRMS.

As mentioned above there is a fixed number of firms,  $N$ , each of whom enjoys a monopolistic position in the production of a single variety. Consumers own the firms and earn the profits. I will further assume that the number of firms is large so every one of them is small relative to the whole economy. Thus, firms take aggregate expenditure as given. The demand function for each firm is the sum of private and public demands from (1.6) and (2.1) respectively.

$$(3.1) \quad Q_i(t) = C_i(t) + G_i(t) = Y(t)p_i^{-(1/\sigma)} / \left( \sum_{i=1}^N p_i^{(\sigma-1)/\sigma} \right)$$

where  $Q_i(t)$  is real demand of good  $i$ ,  $Y(t)$  is the total aggregate expenditure (equal to total private  $X(t)$  and public expenditures  $\Gamma(t)$ ), and  $p_i(t)$  is the relative price of output in terms of labor. The term in the denominator is an aggregate price level. If  $N$  is large enough, they will ignore this term and their perceived elasticity will be approximately<sup>6</sup>  $1/\sigma$ . The operating profits are the difference between sales income and total

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<sup>6</sup> The true elasticity is equal to  $1/\sigma + [(\sigma-1)/\sigma] p_i^{(\sigma-1)/\sigma} / \sum_{i=1}^N p_i^{(\sigma-1)/\sigma}$ . If all varieties are equally priced (as it will happen in equilibrium), the second term of the elasticity becomes  $(\sigma-1)/N\sigma$ , and it goes to zero as the number of firms goes to infinity. The  $1/\sigma$  approximation is exact when the set of potential varieties is a continuum and the set of varieties is of nonzero measure. See Helpman and Krugman (1986) for further discussion of this issue.

cost. The cost structure is assumed to be a fixed sunk cost  $\beta$  and a constant marginal cost  $\gamma$ . Thus, the operating profits for firm  $i$  are

$$(3.2) \Pi_i(Q_i) = p_i Q_i - \gamma Q_i$$

I am assuming that each individual owns a small fraction of firms<sup>7</sup>. Given the instantaneous utility function in (2.1) individuals would like to spread any given expenditure among as many products as possible<sup>8</sup>. Hence, it will be optimal for household purchase all available goods. Therefore every household will be receiving rents from only one (or few) firms and purchasing goods from all of them. This is important because, as owners of firms, individuals would like to increase prices so as to maximize profits. But as consumers, they want prices to be as low as possible. Since consumers own the firms, one could be tempted to say that the optimal solution is the competitive (pareto optimal) pricing with no monopoly rents. The existence of an asymmetry between the number of markets in which they buy and sell ensures that firms will want to maximize profits. If they do, the first order condition at each moment involves constant mark up pricing

$$(3.3) p_i = \gamma/(1-\sigma)$$

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<sup>7</sup> In fact, if we interpret profits as monopoly rents accruing to workers, we can assume that each household works in only one firm.

<sup>8</sup> The marginal utility of the number of goods holding constant the total expenditure is positive and equal to  $\sigma N^{-(1-\sigma)} X^{(1-\sigma)}$  where  $N$  is the number of varieties and  $X$  is total consumption expenditure.

Notice that the price is independent of  $i$  and  $t$ . Let me define  $p_{it}=p$  for all  $i$  and  $t$ . Using (3.1) we see that the real quantity of good  $i$  sold at moment  $t$  is

$$(3.4) \quad Q_i(t) = Y(t) / (Np)$$

which is also independent of  $i$ . The Aggregate Quantity of goods produced,  $Q$ , Aggregate Consumption,  $C$ , and Total Real Government Purchases,  $G$  are, respectively

$$(3.5) \quad Q(t) = Y(t)/p$$

$$C(t) = X(t)/p$$

$$G(t) = \Gamma(t)/p$$

where  $Q = \sum_{i=1}^N Q_i$ ,  $C = \sum_{i=1}^N C_i$  and  $G = \sum_{i=1}^N G_i$ . Individual profits can now be calculated using the optimal price (3.3). Aggregate profits are the sum of individual profits across all existing firms

$$(3.6) \quad \Pi(t) = \sum_{i=1}^N \pi_i = pNQ_i(t) - \gamma NQ_i(t) = (p - \gamma)Q(t) = \mu Y(t)$$

where  $\mu = (p - \gamma)/p$  is the profit margin. Thus, profits are a constant fraction of aggregate expenditure,  $Y(t)$ . At this points, most models assume that there is free entry so the zero profit condition determines the number of firms and varieties,  $N$  (see for instance Helpman and Krugman (1986), Grossman and Helpman (1989) and Barro and Sala-i-Martin (1990)). This



assumption allows them to ignore profits as part of households' income. In the present paper, however, this assumption is not made for two reasons. First, unlike the authors above, I am interested in relatively high frequency economic events related to short run fiscal policy. It seems more reasonable to assume that, in the short run, the number of firms (and products) is given and that changes in economic conditions are reflected in changes in short run monopoly rents. Second, I am interested in studying the role that these monopoly rents play in government fiscal policy. Setting them equal to zero would make the whole problem uninteresting.

#### (4) AGGREGATE BEHAVIOR AND GENERAL SOLUTION.

Let aggregate consumption, private wealth, profits and taxes be respectively,  $C(t)$ ,  $W(t)$ ,  $\Pi(t)$  and  $\psi(t)$ . These aggregate variables are all related to their individual counterparts by the following expression:

$$(4.1) \quad Z(t) = \int_{-\infty}^t z(s,t) \rho e^{\rho(s-t)} ds \quad \text{for } z()=w(), c(), \pi() \text{ and } \tau().$$

So every aggregate variable is the sum across households of its individual counterpart. Since I am assuming that this is an open economy, the economy as a whole can borrow or lend the difference between aggregate demand and the exogenously given aggregate supply at the world real interest rate. The current account is, therefore, the difference between national income (interest payments plus wages plus profits,  $rF+E+\Pi = rF+E+(p-\gamma)Q$ )

minus national expenditure ( $Y=pQ$ ).

$$(4.2) \quad \dot{F} = CA = rF + E - \gamma Q$$

where  $F$  is an international asset denominated in labor units (it pays  $rF$  units of labor every instant). Households hold two type of assets, foreign and public debt. Thus private wealth evolves according to the following differential equation<sup>9</sup>:

$$(4.3) \quad \dot{W}(t) = rW(t) + E - \psi(t) + \mu\Gamma(t) - (1-\mu)X(t)$$

where equations (2.2) and (3,7) have been used. Notice that aggregate private wealth does NOT accumulate at the individual rate ( $\rho+r$ ) but at the rate  $r$ . The reason is that the amount  $\rho W(t)$  is an annuity market transfer from the individuals who die to the individuals who remain alive so aggregate wealth is not affected by it. The optimal aggregate consumption expenditure is

$$(4.4) \quad X(t) = \\ = (r+\rho-(r-\delta)/\sigma) \left[ W(t) + \int_t^{\infty} e^{-(r+\rho)(v-t)} [E + \Pi(v) - \psi(v)] dv \right]$$

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<sup>9</sup>  $\dot{W} = \dot{F} + \dot{D} = (rF+E-\gamma D) + (rD+\Gamma-\psi) = rW+E - [\gamma/p]pQ + \Gamma - \psi =$   
 $= rW+E - (1-\mu)X + \mu\Gamma - \psi$ . An alternative way of writing this expression is  
to take into account that  $\mu(X+\Gamma)=\Pi$  and see that  $\dot{W} = rW+E+\Pi-\psi-X$  which states  
that increases in private wealth (savings) equal private income (including  
profits and net of taxes) minus private expenditure.

Aggregate consumption is a constant fraction of the human and financial wealth of those currently alive. Since profits are a constant fraction of aggregate demand ( $\Pi(t) = \mu Y(t)$ ) and aggregate demand is the sum of private consumption plus government expenditures ( $Y(t) = X(t) + \Gamma(t)$ ), equation (4.4) can be rewritten as

$$(4.5) \quad X(t) = (r + \rho - (r - \delta)/\sigma) \left[ W(t) + M(t) + \mu K(t) \right]$$

where  $W(t) = D(t) + F(t)$  is total financial wealth,

$M(t) = \int_t^\infty e^{-(r+\rho)(v-t)} [E + -\psi(v) + \mu\Gamma(v)] dv$  is the present value of all labor

incomes minus taxes and plus the contributions of all future government

expenditures to profits and  $\mu K(t) = \mu \int_t^\infty e^{-(r+\rho)(v-t)} X(v) dv$  is the present

value of all future contributions of consumption to profits. Equations

(4.3) and (4.5) form the key system of equations which, as shown in the

appendix, can be rewritten in real terms as

$$(4.6) \quad \begin{aligned} \dot{C}(t) &= (1/\sigma)(r - \delta)C(t) - (r + \rho - (r - \delta)/\sigma)\rho(1 - \mu)W(t)/\gamma \\ \dot{W}(t)/\gamma &= -C(t) + rW(t)/\gamma + \{E/\gamma - T(t)/(1 - \mu) + \mu/(1 - \mu)G(t)\} \end{aligned}$$

where  $C$ ,  $T$ ,  $G$ ,  $E/\gamma$  and  $W/\gamma$  are real consumption, real tax payments, real government expenditures, real labor income and real assets respectively.

The perfect-foresight-no-bubble algebraic solution for the initial value of

consumption (derived in the appendix) is

$$(4.7) \quad C(0) = \vartheta \left[ W(0) + \int_0^{\infty} e^{-\lambda_1 s} [E/\gamma - T(t)/(1-\mu) + (\mu/(1-\mu))G(t)] ds \right]$$

where  $\vartheta$  and  $\lambda_1$  are, respectively:

$$(4.8) \quad \vartheta = (1/2) \left[ \delta + \Delta - (1/\sigma)(r-\delta) \right]$$

$$(4.9) \quad \lambda_1 = (1/2) \left[ (1/\sigma)(r-\delta) + r + \Delta \right] > r > 0$$

$$\text{and } \Delta = \sqrt{(r - (1/\sigma)(r-\delta))^2 + 4(r+\rho - (r-\delta)/\sigma)\rho(1-\mu)}$$

Notice that the economy's marginal propensity to consume out of total wealth,  $\vartheta$ , is positive as long as  $r - (1/\sigma)(r-\delta) > 0$ . The term  $r - (1/\sigma)(r-\delta)$  is the marginal propensity in an infinite horizon perfect competition model of consumption (this can be seen by setting  $\rho=0$ ). See Blanchard and Fischer (1989) for an interpretation of this propensity in terms of income, substitution and wealth effects.

Note also that the economy's discount rate,  $\lambda_1$  is always larger or equal to  $r$ . It is exactly equal to  $r$  only under infinite horizons ( $\rho=0$ ). Further,  $\lambda_1$  is a decreasing function of the profit margin,  $\mu$ . Under competitive pricing,  $\lambda_1$  equals  $(r+\rho)$ . Finally, under infinite horizon, the existence of a positive profit margin does not change any of the propensities to consume or effective discount rates. The reason is that if individuals have infinite horizons they do not really care when they receive the profits (as long as their present value is held constant).

# (5) AN INDEX OF FISCAL STANCE.

Intertemporal models of fiscal policy suggest that looking at current deficits only may not be the correct way to measure the impact of fiscal policy on aggregate demand: the stream of all future deficits may also play an important role. Blanchard (1985) proposes an index of fiscal stance to summarize these effects. It includes the direct (expansionary) effect of government expenditures and the indirect (contractionary) effect of current anticipated future tax increases on current wealth and consumption. The introduction of imperfect competition suggests a modification of this index. Collecting the policy terms that affect aggregate demand in equation (4.7) we can define the new index as:

$$(5.1) \text{ IFS}(t) = \\ = G(t) + \theta \left[ d(t) - \int_t^{\infty} e^{-\lambda_1(v-t)} T(v)/(1-\mu) dv \right] + \theta \mu \left[ \int_t^{\infty} e^{-\lambda_1(v-t)} G(v)/(1-\mu) dv \right]$$

The first two terms are parallel to Blanchard's. The multiplier is different to reflect the iterative effects of consumption on profits. The third term is new. It reflects the effects of future public spending on profits: future government spending will have a future expansionary effect. This, in turn, will have a positive effect on contemporaneous profits. Since consumption today is a fraction of the present value of all future incomes (including future profits), consumption and aggregate demand today

will expand<sup>10</sup>. This expansionary effect will tend to offset the old contractionary effect of future taxes stressed by Blanchard (1985).

#### (6) SOME FISCAL POLICY EXPERIMENTS.

We are now ready to use the model to analyze the macroeconomic implications of several fiscal policy experiments such as changes in the timing of taxes and government expenditures. I will first show that imperfect competition does not change the qualitative results of changing the timing of taxes. Then I will show that, differently from traditional dynamic models of public finance, the present model suggests that changing the timing of government purchases has real effects and that anticipated increases in public spending may be expansionary.

##### Policy Experiment I.- A bond financed temporary tax cut.

We want to see what is the effect on current expenditure of a tax cut in period  $t_1$  financed by a tax increase in  $t_2$  ( $t_2 > t_1$ ) leaving the public expenditure path constant. The government's budget constraint says that the two tax changes must satisfy the relation:

$$(6.1) \quad dT(t_1) + e^{-r(t_2-t_1)}dT(t_2) = dT(t_1) + e^{-rh}dT(t_2) = 0$$

where  $h=t_2-t_1>0$ . The effect of such a policy experiment on current

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<sup>10</sup> The change in the consumption path will also affect wealth and consumption. This has also been taken into account in solving the model.

aggregate demand can be found by substituting this expression into equation (4.7) (I normalize the current period to  $t=0$ ):

$$\begin{aligned} (6.2) \quad dQ(0) &= -[\theta/(1-\mu)] [e^{-\lambda_1 t_1} dT(t_1) + e^{-\lambda_1 t_2} dT(t_2)] = \\ &= -[\theta/(1-\mu)] e^{-\lambda_1 t_1} dT(t_1) [1 - e^{-(\lambda_1 - r)h}] \end{aligned}$$

Since  $\lambda_1$  is always larger or equal to  $r$  (and exactly equal when  $\rho=0$ ), the effect of a tax cut on current consumption will always be nonnegative. If agents are intergenerationally linked so they effectively have infinite horizons, ( $\rho=0$ ) the effect of a bond financed tax cut is null. This is the Ricardian Equivalence Theorem proposed by Barro (1974). On the other hand, if the probability of dying (and shifting the tax burden to future non-connected-to-us individuals) is positive, then the tax cut will be expansionary, and the more expansionary the larger the period of time elapsing between the tax cut and the tax hike. As shown, among others, by Blanchard (1985) the reason is that currently alive households assign a nonzero probability to being alive at the moment of the tax cut and not being around by the time of the tax hike. They will, therefore, feel richer and they will increase their current consumption. The increase in current consumption will be financed (in this particular model) with a current account deficit. In a closed economy where aggregate savings must end up being null, the tax cut will translate into higher interest rates to preclude people from excess borrowing. Consumption of future generations (in particular, generations alive at the time of the tax hike) will be lower. The country will then run trade surpluses that will help to pay the debt inherited from today's individuals. The whole experiment will end up being a transfer of wealth from generations not yet born (and therefore with

a zero marginal propensity to consume) to currently alive generations<sup>11</sup>. Hence, this model predicts similar qualitative effects of a temporary bond financed tax cut as a model of perfect competition. The quantitative responses are different to reflect the iterative effects of profits on consumption and vice versa (what Mankiw (1988) calls keynesian multiplier).

Policy Experiment II.- An anticipated bond financed increase government expenditure financed with subsequent tax increases.

Consider now an increase in public spending at time  $t_1$  financed with an increase in taxes at time  $t_2$  where  $t_2 > t_1$ . The government is constrained to satisfy

$$(6.4) \quad dT(t_2) = dG(t_1)e^{r(t_2-t_1)} = dG(t_1)e^{rh}$$

The effect of this policy experiment on aggregate demand can readily be found by substituting (6.4) in Equation (4.7)

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<sup>11</sup> As shown by Buiter (1986) and Weil (1987), it is the fact that "new people will be born" and not that "current people will be dead" that matters. To see that, consider a world where people have infinite horizons but new agents enter the economy in a stochastic manner. A temporary tax cut would Not be neutral because people would know that at the time of tax hike there would be more people around to pay taxes so the per capita tax rate would be smaller. Therefore, they would expand current consumption and aggregate demand. Thus, it is the possibility of shifting taxes to somebody with zero current Marginal Propensity to Consume and not the finiteness of the horizons which breaks the Ricardian results.



$$\begin{aligned}
(6.5) \quad dQ(0) &= (\vartheta/(1-\mu)) \left[ -e^{-\lambda_1 t_2} dT(t_2) + \mu e^{-\lambda_1 t_1} dG(t_1) \right] = \\
&= (\vartheta/(1-\mu)) \left[ \mu - e^{-(\lambda_1 - r)h} \right] dG(t_1)
\end{aligned}$$

where  $h=t_2-t_1$ . Which may be positive or negative, depending on the relative sizes of  $\mu$  (profit margin),  $\rho$  (probability of death) and  $h$  (the time elapsed between the moment of government spending and the moment of the tax increase). The first term  $[(\vartheta/(1-\mu))\mu]$  represents the expansionary effect of future government expenditure (profit effect), the second term  $[(\vartheta/(1-\mu))e^{-(\lambda_1-r)h}]$  corresponds to the contractionary effect of the future tax increases. Under perfect competition,  $\mu$  is equal to zero so the profit effect disappears. Thus, anticipated government expenditures are invariably contractionary. If  $\rho=0$ , that is, if individuals have infinite horizons,  $dQ(0) = -(r-(1/\sigma)(r-\delta))\delta e^{-\delta t_1} dG(t_1) < 0$ . Hence, future government expansions are again contractionary. The reason is that under infinite horizon the timing of taxes or profits do not matter so the only macroeconomic implication of the experiment is the negative wealth effect of a larger government.

But if people have finite horizons ( $\rho > 0$ ) and there is imperfect competition ( $\mu > 0$ ), then there is always an  $h$  for which future public expenditures are expansionary today. In other words there is always a sufficiently large period of time between the profit increase and the tax increase that will lead households to increase consumption. This policy experiment is equivalent to a transfer from future generations to the present: the government buys output at market prices so it pays the corresponding markup. To finance that, it increases taxes in the future. Hence, future generations are charged for the marginal cost of the output

that the government purchases plus the profit that the firms (owned by currently living individuals) charge for their good. This direct transfer from the future is expansionary if agents are not intergenerationally linked. This feature is exclusive of imperfectly competitive economies because the vehicle that generates these intertemporal transfers of public expenditures (the monopoly rent or profit) does not exist under competitive pricing. The transfer or profit effect represents a positive wealth effect that tends to offset and maybe reverse the traditional negative wealth effect of the anticipated tax increase (which, effectively, is a transfer of resources in the other direction).

The ambiguous effect on current consumption translates into ambiguous effects on the current account. This, again, contrasts with the unambiguous trade surplus that results in traditional models involving perfect competition. In a closed economy model, the ambiguous effect on current aggregate demand would translate into similar movements of interest rates. Traditional models predict a fall in real rates due to the unambiguous contraction in aggregate demand.

Policy Experiment III.-. An anticipated temporary increase in public spending financed by subsequent cuts in public spending.

Finally, consider an anticipated increase in public purchases, financed with a subsequent decrease in public spending leaving the path of taxes unchanged. Conventional models of public finance predict that the effects on current aggregate demand of such a policy experiment will be zero. The reason is that government spending is generally assumed to be useless in the sense of being unproductive or non substitutable for private consumption.

Given the path of taxes, public purchases have no effect on private income or wealth. Hence private consumption and aggregate demand are unaffected so future public spending has no current real economic effect<sup>12</sup>. The model I am proposing here has different implications. Despite the fact that public spending is assumed to be non distorting in the sense of Baily (1971), it affects contemporaneous income through monopoly rents. Again, the government budget constraint requires:

$$(6.7) \quad dG(t_1) + e^{-rh} dG(t_2) = 0$$

The change in aggregate demand can be found by substituting this expression in Equation (4.7)

$$(6.8) \quad dQ(0) = (\theta/(1-\mu)) \mu \left[ e^{-\lambda_1 t_1} dG(t_1) + e^{-\lambda_1 t_2} dG(t_2) \right] = \\ = (\theta/(1-\mu)) \mu dG(t_1) (1 - e^{-(\lambda_1 - r)h})$$

Notice that, as mentioned above, under competitive pricing ( $\mu=0$ ), this effect is always zero. The reason is that movements in future government expenditures that leave the path of future taxes unchanged can have an effect today only through changes in the timing of profit. Second, if agents have infinite horizons  $\rho=0$ , the effect is again zero (recall that  $\lambda_1=r$  when  $\rho=0$ ), even if there is imperfect competition. The reason is that when people have infinite horizons, they do not care when the profits are collected. Third, if there is imperfect competition and finite horizons,

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<sup>12</sup> See Footnote 1.

the experiment will always be expansionary. The reason is that individuals will not react to the very distant future decrease in expenditure as much as they will do to the near future increase, since they know that there is a probability (equal to  $1 - e^{-\rho h}$ ) that they will not pay the costs of future government spending contraction due to death. Again, this policy is like a transfer from the future: the government takes the profits of future generations and gives them to currently alive individuals. Since future generations have a zero marginal propensity to consume and current cohorts have a positive one, the experiment will be expansionary. Thus, changing the timing of future spending has real economic effects today.

#### (7) SUMMARY AND CONCLUSIONS.

This paper studies the effect of introducing imperfect competition in a finite horizon model of fiscal policy. The main findings are that the existence of monopoly rents can overturn some of the traditional results on the timing of government purchases and taxes. First I find that the qualitative results of a temporary bond financed tax cut are not changed, although their quantitative nature is different and reflects some multiplier effects similar to those highlighted by Mankiw (1988). I then show that an anticipated increase in public spending financed with future taxes may have an expansionary effect on aggregate demand. This unconventional result stems from the fact that the monopoly rents associated with the extra spending will represent a positive wealth effect which tends to offset the traditional negative wealth effect of anticipated taxes. This policy experiment is analogous to a transfer from the generations paying higher taxes to the generations receiving the monopoly rents. If current

generations have a higher marginal propensity to consume out of wealth than future ones, this experiment may have a positive (non-conventional) effect on aggregate demand, current account deficit and/or real interest rates.

The second non conventional result is that, when there are monopoly rents, changing the timing of future public spending has real effects, even though the present path of taxes is left unchanged. I show that an anticipated temporary increase in public expenditures financed by subsequent cuts in public spending will trigger a transfer of monopoly rents from future generations to current ones. Again, if the current marginal propensity to consume out of wealth is higher for currently living individuals, this experiment will have expansionary effects.

The results in this paper suggest that the existence of imperfect competition and monopoly rents may play an important role in the way we think about dynamic fiscal policy.

APPENDIX 1. Derivation of equations (4.6), (4.7) (4.8) and (4.9)

Let me start from equation (4.5):

$$(4.5) \quad X(t) = m \left[ W(t) + M(t) + \mu K(t) \right]$$

where  $m=r+\rho-(1/\sigma)(r-\delta)$ , and  $W(t)$ ,  $M(t)$  and  $K(t)$  are defined in the text.

We can take the time derivative of  $X(t)$ ,  $W(t)$ ,  $M(t)$  and  $K(t)$  to get the following system (we drop the time subscripts):

$$(A1) \quad \dot{X} = m(\dot{W} + \dot{M} + \mu\dot{K})$$

$$(A2) \quad \dot{W} = D + F = rD + \Gamma - \psi + rF + \Pi + E - X - \Gamma = \\ = rW - (1-\mu)X + E - \psi + \mu\Gamma.$$

$$(A3) \quad \dot{M} = (r+\rho)M - (E - \psi + \mu\Gamma)$$

$$(A4) \quad \mu\dot{K} = \mu(r+\rho)K - \mu X$$

We can now plug (A2), (A3) and (A4) in (A1) to get:

$$(A6) \quad \dot{X} = m[rW + (r+\rho)(M + \mu K) - X]$$

But from (A1), we know that  $M + \mu K = -W + X/(\delta+\rho)$ , which we can plug in (A6) to get the following system of two linear non-homogeneous differential equations.

$$(A7) \quad \dot{X}(t) = (1/\sigma)(r-\delta)X(t) - \rho(r+\rho-(1/\sigma)(r-\delta))W(t)$$

$$\dot{W}(t) = -(1-\mu)X(t) + rW(t) + E-\psi(t)+\mu\Gamma(t)$$

It will be convenient to operate in real terms. Let me divide both equations by the marginal cost,  $\gamma$ , and let me use the fact the the price marginal cost ratio is equal to  $1/(1-\mu)$  to get the following system

$$(A7)' \quad \dot{C}(t) = (1/\sigma)(r-\delta)C(t) - \rho m(1-\mu)W(t)/\gamma \quad \dot{W}(t)/\gamma = -C(t) + rW(t)/\gamma \\ + E/\gamma - T(t)/(1-\mu) + (\mu/(1-\mu))G(t)$$

which corresponds to equation (4.6) in the text. In order to solve this system of differential equations it will be convenient to write it as

$$(A8) \quad \dot{J} = AJ + H(s)$$

With  $J = \begin{bmatrix} j1(s) \\ j2(s) \end{bmatrix} = \begin{bmatrix} C(s) \\ W(s)/\gamma \end{bmatrix}$ ,  $A = \begin{bmatrix} (1/\sigma)(r-\delta) & -\rho m(1-\mu) \\ -1 & r \end{bmatrix}$  and  $H(s) = \begin{bmatrix} 0 \\ E/\gamma - T(s)/\gamma + (\mu/(1-\mu))G(s) \end{bmatrix}$ .  $J1$  is the jumping variable and  $J2(0) = J2_0$  is predetermined. I require  $\det(A) < 0$  so we have the desired saddle path stability. This, in turn, implies that the system has two real eigenvalue of opposite sign. Without loss of generality, let's assume that  $\lambda_1 > 0$  and  $\lambda_2 < 0$ . Let  $C$  be the matrix of corresponding eigenvectors. We can transform  $A$  to Jordan canonical form  $A = C\Lambda C^{-1}$  where  $\Lambda$  is the diagonal matrix of characteristic roots. Let's premultiply both sides of (A8) by  $C^{-1}$  and define  $Y = C^{-1}J$  to get:

$$(A9) \quad \dot{Y} = \Lambda Y + C^{-1}H(s)$$

The differential equations system has been reduced to a two  $1 \times 1$

differential equations with solutions:

$$(A10) \quad Y_i(t) = e^{\lambda_i t} Y_i(0) + e^{\lambda_i t} \int_0^t e^{-\lambda_i s} B_i H(s) ds \quad \text{for } i = 1, 2.$$

where  $B_i$  is the  $i^{\text{th}}$  row of the matrix  $C^{-1}$ . Now since I took  $\lambda_1 > 0$ , we see that  $\lim_{t \rightarrow \infty} Y_1(t) = \infty$  unless we choose  $Y_1(0)$  to be

$$(A11) \quad Y_1(0) = - \int_0^{\infty} e^{-\lambda_1 s} [b_{11} \quad b_{12}] H(s) ds.$$

In other words, we need to choose  $Y_1(0)$  (initial value of the jumping variable) to be exactly at the stable arm. Now I can transform back to the  $J$  variables. By definition,

$$(A12) \quad Y_1(0) = b_{11} J_1(0) + b_{12} J_2(0) \text{ so}$$

$$(A14) \quad J_1(0) = Y_1(0)/b_{11} - J_2(0) (b_{12}/b_{11}) = \\ = \frac{-1}{b_{11}} \left[ b_{12} J_2(0) + \int_0^{\infty} e^{-\lambda_1 s} (b_{11} \quad b_{12}) H(s) ds \right]$$

In our particular case we can write (A14) as:

$$(A15) \quad C(0) = \vartheta \left[ W(0) + \int_0^{\infty} e^{-\lambda_1 s} [E/\gamma - T(t)/(1-\mu) + (\mu/(1-\mu))G(t)] ds \right]$$

So  $\vartheta = -b_{12}/b_{11}$ . This equation corresponds to equation (4.7) in the text.

The final step is to find the eigenvalues and eigenvectors of matrix  $A$ . We



know that the characteristic equation will be of the form  $\lambda^2 - \text{tr}(A)\lambda + \det(A)$ .

So the two eigenvalues will be:

$$(A16) \quad \lambda = \frac{\text{tr}(A) \pm \sqrt{\text{tr}(A)^2 - 4\det(A)}}{2}$$

Since  $\det(A) < 0$ , the two roots will be real and one of each sign.

They are

$$(A17) \quad \begin{aligned} \lambda_1 &= (1/2) \left[ (1/\sigma)(r-\delta) + r + \Delta \right] > 0 \\ \lambda_2 &= (1/2) \left[ (1/\sigma)(r-\delta) + r - \Delta \right] < 0 \end{aligned}$$

where  $\Delta = \sqrt{[r - (1/\sigma)(r-\delta)]^2 + 4(r+\rho - (r-\delta)/\sigma)\rho(1-\mu)}$ . The positive root  $\lambda_1$  corresponds to equation (4.9) in the text. The associated eigenvectors are

$$\begin{aligned} V1 &= \{ \rho m(1-\mu) \quad , \quad (-r-\Delta + (r-\delta)/\sigma)/2 \} \\ V2 &= \{ (r+\Delta - (r-\delta)/\sigma)/2 \quad , \quad 1 \} \end{aligned}$$

We can plug them as columns of Matrix C which, when inverted, will give us the coefficients  $b_{11}$ ,  $b_{12}$ ,  $b_{21}$  and  $b_{22}$ :

$$(A17) \quad B = C^{-1} = \begin{bmatrix} 1 & [(1/\sigma)(r-\delta) - r - \Delta]/2 \\ [(1/\sigma)(r-\delta) - r - \Delta] & \rho m(1-\mu) \end{bmatrix} * \det(C)^{-1}$$

Thus,  $\vartheta = -b_{12}/b_{11} = (1/2) \left[ r + \Delta - (r-\delta)/\sigma \right]$ , which corresponds to equation (4.8) in the text.



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