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Fiscal Policy and Private Consumption – Saving Decisions: Evidence from Finland

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Abstract

The paper presents a theoretical model of private consumption that emcompasses both the conventional (Keynesian) view of fiscal policy and the Ricardian debt neutrality hypothesis. The effects of fiscal policy on private consumption are analyzed in an extended framework built on Blanchard's stochastic model of intertemporal optimization with finitely lived consumers, in which private consumption depends on expected lifetime wealth. The model also nests various hypotheses concerning the relationship between public spending and private consumption. Empirical analysis is based on the Finnish annual data from 1960–1995 and uses the nonlinear instrumental variable GMM estimator. The tests cannot reject the hypothesis that consumers are Ricardian. Moreover, the results suggest that in the consumers' utility functions, government consumption is a substitute for private consumption.

Keywords: private consumption, private saving, fiscal policy, planning horizon

Tiivistelmä

Tutkimuksessa tarkastellaan julkisen talouden rahoitusvaihtoehtojen – verotuksen ja velkarahoituksen – vaikutuksia yksityiseen kulutukseen ja säästämiseen. Teoreettiset tarkastelut perustuvat ajan yli optimoivan kuluttajan mallille, jossa kuluttajien suunnitteluhorisontti on äärellinen ja jossa kulutus riippuu odotetusta elinikäisestä varallisuudesta. Julkinen kulutus vaikuttaa mallissa yksityisen kulutuksen aikauraan sikäli kuin sillä on vaikutusta kotitalouksien kokemaan hyvinvointiin. Se, onko julkinen kulutus yksityistä kulutusta korvaavaa vai täydentävää kulutusta määräytyy viime kädessä havaintoaineiston perusteella. Suomen aineistolla tehty empiirinen analyysi kattaa vuodet 1960–1995. Analyysimenetelmänä on käytetty epälineaarista instrumenttimuuttujamenetelmää (GMM). Tulokset tukevat ns. Ricardon velkaneutraliteettihypoteesia, jonka mukaan velalla rahoitettu verojen alentaminen ei lisää yksityistä kulutusta, koska kuluttajat ottavat huomioon valtion velanhoitomenojen kasvusta aiheutuvat tulevat veronkorotustarpeet ja lisäävät säästämistään. Tulosten mukaan kuluttajat kokevat julkiset menot yksityistä kulutusta korvaavina.

Asiasanat: yksityinen kulutus, yksityinen säästäminen, finanssipolitiikka, suunnitteluhorisontti

Contents

1 Introduction

Large and persistent budget deficits and increasing government indebtedness have been among the most important topics in economic policy discussions worldwide almost two decades. During the 1990s the issue has gained even stronger emphasis as the fiscal position of several countries in the European Union has proved to be the most difficult obstacle in the way towards full economic and monetary union. Despite the growing interest of policy makers and economists in the sustainability of government debt and the efficiency of fiscal policy, neither economic theory nor empirical evidence give any clear cut answers what the effects of fiscal policy in general and of budget deficits and government debt in particular on the aggregate demand are. In fact there exists sharp controversies on this issue.

Most of the debate centers around the question whether government financing decisions influence private consumption and saving or not. In general, the answer to this question depends on the degree to which consumers treat government debt as net wealth. The two opposite views on the subject are the conventional (Keynesian) view and the Ricardian equivalence or debt neutrality hypothesis.[1] The conventional view, that formed a consensus opinion until the 1970s, states that government deficits stimulate private consumption and aggregate demand in the short run, because private sector perceives government bonds as net wealth. Assuming that government expenditure is constant, the larger the government debt is, the wealthier households feel and the more they consume.[2] However, higher real interest rates that result from depressed private and national saving may crowd out private investment and thereby reduce the long run growth potential of the economy. The long run negative effects offset thus at least partially the positive short run effects. What the total effect of deficit financing is, remains unambiguous.

By ignoring the intertemporal budget constraint of the government, the conventional approach is based on an implicit assumption that consumers are too myopic to account for the future fiscal policy implications of current debt accumulation, or that they are liquidity constrained. Alternatively, consumers can be thought to have asymmetric perceptions with regard to the future consequences of the current changes in government debt and taxation (Kormendi (1983)). Since consumers perceive government debt as a part of their wealth, private consumption increases with increases in the debt and decreases with increases in current taxation.

In an environment where the concern about the sustainability of fiscal policies is deepening and the need for fiscal adjustment is widely recognized, it is more

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[1] Recently, there has emerged also a third line of reasoning called non- or anti-Keynesian view stating that with high government debt/GDP ratios and large budget deficits, contractionary fiscal policies may have expansionary effect on private consumption, see Bertola and Drazen (1993), Sutherland (1995), and for empirical evidence Giavazzi and Pagano (1990, 1995).

[2] This can not, however, hold indefinitely in a closed economy, since private sector has to increase their saving alongside the new government debt, and hence consumption must fall unless the private sector does not finance their purchases of government bonds by borrowing. In this case, the net wealth effect is, however, zero assuming that the interest rates are the same for the government and the private sector.

plausible to assume that private consumers are influenced not only by current fiscal policy but also by anticipations about the future path of government budget variables. The most influential attempt to introduce rational behaviour and fiscal expectations into a forward-looking permanent income-life cycle consumption model was made by Barro (1974) in his famous paper on Ricardian equivalence. He showed that intertemporally maximizing rational consumers will not view government debt as a part of their net wealth if they accurately anticipate the future tax liability of that debt. Rational consumers would realize that the public debt created now by government borrowing must be repaid in the future by an increase in taxes. Provided that the present value of government expenditures is not affected by the choice of budget deficits and surpluses, ie by the timing of taxes, private consumption remains unchanged. Instead consumers will increase saving in order to avoid sharp decline in their future disposable income and consumption due to higher taxes. Ricardian equivalence holds when the increase in the private sector savings will exactly offset the rising government deficit.

The key prediction of the Ricardian equivalence is thus that for a given path of government expenditures, the precise mix by which they are financed is irrelevant from the point of view of economic activity. Deficit financing merely generates the private saving necessary to absorb the additional government debt, leaving national saving and interest rates, investment and output unaltered.

Barro demonstrated that Ricardian equivalence holds if consumers and the government have the same effective time or planning horizon,[3] taxes are nondistortionary, capital markets are perfect with no borrowing constraints and there is full certainty about the path of incomes, future taxes and government expenditure. Thus, Ricardian equivalence requires several restrictive assumptions about the economic environment and the behaviour of consumers. By relaxing these assumptions (or some of them) not only does Ricardian equivalence breake down but non-conventional and, especially, non-Keynesian results also start to emerge.[4] Moreover, deviations from debt neutrality occur if the changes in

[3] The models on Ricardian equivalence generally assume that the consumers as well as the government have an infinite planning horizon. This is not, however, a necessary condition for Ricardian equivalence to hold. The sufficient condition is that consumers have the same planning horizon as the government, ie the period that takes to levy the taxes associated with the debt service. If consumers' planning horizon is shorter than that of the government (eg finite horizon) so that part of the debt is shifted to the future generations or if consumers do not fully perceive the future tax implications of the current debt issue (eg consumers are to some extent myopic), the anticipation of future debt service obligations only partially offsets the value of the debt and there will be a net wealth effect leading to an increase in private consumption and interest rates (different discount rates, see Feldstein 1982). Barro (1974), however, asserted that the planning horizon in this context is irrelevant; individuals will act as if they lived forever because they are linked to future generations through a chain of altruistic bequests. Intergenerational altruism leads to debt neutrality. When the assumption of operative bequests is dropped, it is clear that a tax cut represents an increase in lifetime wealth, which therefore could be expected to cause a small increase in consumption in the current and future years. A tax cut that is known to be permanent would of course imply a much larger increase in lifetime wealth and would therefore include a much larger immediate increase in consumption (see Feldstein 1982; Haque 1988). For a detailed discussion about the assumptions required for the Ricardian equivalence to hold, see Bernheim (1987), Leiderman and Blejer (1988), Seater (1993).

[4] For detailed discussions of the literature, see Barro (1989a), Bernheim (1987), Leiderman and Blejer (1988) and Seater (1993).

taxation are accompanied by shifts in government spending and/or transfer payments, monetization of government debt, or in both. All in all, the conventional Keynesian predictions can be obtained also in the intertemporal maximization framework with rational expectations.

The Ricardian and conventional views of government debt have very different policy implications. According to the conventional view the deficit financing can have a considerable impact on private consumption and aggregate demand. If the Ricardian equivalence proposition holds, a switch from tax financing to debt financing has no stimulating effect on the economy even in the short run and hence, the attempts to stabilize economy are doomed to be futile. Private consumption responds only to the level and flow of government expenditure and not to the debt/tax mix by which it is financed. If this is a valid prediction, the scope for macroeconomic stabilization by fiscal policy can be summarized by the path of government expenditures and by the substitutability between private and government consumption.

The extent to which consumers foresee future taxes or any other fiscal measures associated with current issues of government debt is, however, an empirical question and cannot be resolved by theoretical argumentation alone. The relevant question for empirical studies is then which of the views, Ricardian or conventional provides a better framework for analyzing overall effects of fiscal policy on private consumption.

1.1 Purpose of the paper

The purpose of this paper is to derive an intertemporal model of consumption behaviour that is general enough to be able to encompass the main two hypotheses suggested by the literature; the Ricardian equivalence proposition stating that for a given path of government expenditure the substitution of debt for taxes to finance the budget deficit does not affect private consumption and the alternative view in which budget deficits and current taxes are not equivalent. The model draws on the works of Hall (1978), Aschauer (1985) and Blanchard (1985).

Since the seminal contribution of Hall (1978), numerous studies have applied an intertemporal optimizing framework to examine consumption behaviour. Most of this research has focused on testing the permanent income hypothesis and not on the relationship between private consumption and government budget variables. The few exceptions that incorporate the government budget constraint explicitly in the consumer's optimization problem and account for the substitutability of government and private consumption include Aschauer (1985), Modigliani and Sterling (1986), Haug (1990), and Graham and Himarios (1991). Since these models are derived in the infinite horizon framework, the nesting of Ricardian equivalence and an alternative hypothesis of non-Ricardian behaviour rests on somewhat ad hoc formulations.

The standard intertemporal framework can, however, be modified to allow for finite horizons and hence, non-Ricardian effects of fiscal policy in line with Blanchard's (1985) seminal paper. A finite planning horizon of consumers in Blanchard's model introduces a wedge between the real rate of return on assets and the rate at which consumers discount their uncertain future labour income, thus causing Ricardian equivalence to fail. Ricardian equivalence emerges then only as a special case when the discount rates on assets and labour income coincide. Blanchard did not consider the effects of public consumption – the focus is solely in the effects of a reallocation of taxes when consumers have finite time horizons.

Since the focus here is not to derive a testable model for the Ricardian equivalence per se, but a more general framework for analysing the effects of fiscal policy on private consumption, the model also nests various hypotheses concerning the relationship between public spending and private consumption following Aschauer (1985). Both the substitutability and complementarity of the public and private consumption are allowed for. One can also test Feldstein's (1982) full fiscal neutrality hypothesis whereby an increase in government consumption induces an ex ante crowding out of an equal amount of private consumption as well as Kormendi's (1983) proposition of asymmetric effects of taxes and government transfer payments. The model can be further extended to incorporate liquidity constraints arising from imperfect capital markets. If part of the consumers are not able to smooth out the fluctuations in current income by borrowing against the future income stream, changes in taxation and government debt will affect consumers' net wealth and consumption.

The rest of the paper is organized as follows. An intertemporal model of consumption behaviour is derived in section 2. The questions concerning the empirical implementation and method of estimation are discussed in section 3. Section 4 presents the data and estimation results. Concluding remarks are drawn in section 5.

2 An intertemporal model of consumption behaviour

The effect of fiscal policy on private consumption is analyzed in the framework of a stochastic intertemporal optimization problem where rational consumers maximize the expected value of utility, subject to the lifetime budget constraint. Individual consumers are assumed to face exogenous stochastic processes of disposable labour income and government consumption. The approach is similar to that of Aschauer (1985) in the sense that it consolidates the budget constraint of utility maximizing consumers with that of the government and allows individuals to derive utility not only from private consumption but also from public consumption.

As a modification to Aschauer's representative agent model with infinite horizon a finite planning horizon is introduced in order to be able to nest the Ricardian equivalence proposition and the conventional, non-Ricardian hypothesis. The introduction of finitely lived consumers in the overlapping generations framework means that there is no simple and at the same time very realistic way to derive an aggregate consumption function. Since the economy consists of consumers of different ages, the amounts and compositions of accumulated wealth, time horizons and propensities to consume out of wealth vary across different consumers.[5]

Generally, the aggregation problem can be handled in two ways which both rely on a set of restrictive assumptions that are needed to keep the models mathematically tractable. One way is to assume that there are only a few generations alive in any period, so that it is simple enough to compute the consumption for each generation and then add them together. The other way, suggested by Blanchard (1985) and followed in this paper, is to assume that all consumers face the same probability of death at each point in time. Despite different ages and different levels of wealth, consumers have the same horizon (the same expected remaining lifetime) and the same propensity to consume out of wealth. Due to this assumption, the economy behaves as if it had only one representative consumer, which makes aggregation possible despite the infinite number of generations.

Blanchard's approach is flexible in the sense that the probability of death that measures the finiteness of life can be interpreted in several ways: as a horizon index between zero and infinity (Blanchard (1985)), the disconnectedness of current consumers from future generations (Barro (1974)), or as the myopia with which consumers foresee future taxes. Modelling households as if they have finite horizons is also a substitute for modelling capital market imperfections which may lead consumers to behave as if they had short horizons (see Evans (1988, 1993)).[6] Generally, by letting the probability of death go to zero, one gets an infinite horizon as a limiting case. In empirical work this interpretational flexibility constitutes clearly a problem. Another problem related to Blanchard's approach is that it does not capture the change in consumer behaviour over life, ie the life-cycle aspect of life. In this respect the formulation is closer to that of permanent income by Friedman (1957) than to life-cycle by Modigliani (1966), and suits better to issues where the finite horizon aspect is important (aggregate consumption studies) than to issues where differences in propensity to consume across consumers is important (cross section studies).[7]

The results of the model are based on several restrictive assumptions of which the most important are the assumptions of constant real interest rate and quadratic utility.

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[5] Modigliani (1966) has pointed out that the relationship among wealth level, wealth composition and propensity to consume makes exact or approximate aggregation impossible.

[6] Blanchard interpreted the death probability as a measure of the consumers' planning horizon. A finite horizon in this context means that the expected lifetime is finite and not that consumers are myopic. Under Barro's (1974) interpretation, the death probability measures the disconnectedness of current households from future generations. If current households treat future households as continuations of themselves and have altruistic bequest motives they behave as if they had infinite horizons (death probability is zero). In this context positive death probability implies that current households feel at least to some extent to be disconnected from future generations (no bequest motive).

[7] If permanent income is taken to be the annuity value of lifetime resources, the two theories are very close. Friedman did not, however, commit himself to this interpretation (see eg Deaton 1992).

2.1 Individual consumer[8]

Consumers are assumed to adjust their consumption according to their lifetime wealth (permanent income) rather than to their current income. In each period, each consumer is assumed to face a known probability of survival γ,[9] which is assumed to be independent of age. Probability of surviving from period t through period t+j is thus γ^j and the expected life of each consumer, or the horizon index in Blanchard's terminology, is $1/(1-\gamma)$.

Consumers are assumed to have unrestricted access to capital markets at which they may accumulate or decumulate assets at the same constant real rate of return r as the government sector, but due to the lifetime uncertainty the effective, risk-adjusted interest factor for consumers is $(1+r)/\gamma$. Following Blanchard (1985) it is assumed that there is no bequest motives, and that negative bequests are prohibited. All the consumers' wealth (positive or negative) will be returned to the riskless life insurance companies contingent on their death.[10]

Each consumer born in period t−k and still alive in period t is assumed to choose a consumption strategy that maximizes expected life-time utility as of period t

$$\operatorname{Max} E_t \sum_{j=0}^{\infty} (\gamma\beta)^j U(c^T_{t+j,k+j}), \quad 0<\gamma \leq 1 \tag{1}$$

where $c^T_{t,k}$ denotes the total effective real consumption of a consumer of age k at time t, β is the subjective discount factor $(1+\delta)^{-1}$ with δ the constant positive rate of subjective time preference, E_t is the mathematical expectation operator conditional on information known to the consumer in period t and $u(c^T_t)$ is a time-invariant, one period utility function satisfying $u' > 0$ and $u'' < 0$.

Following Bailey (1971) the total private effective consumption c^T_t in period t is a linear combination[11] of private consumption c^P_t and a portion θ of government spending g_t

$$c^T_{t,k} = c^P_{t,k} + \theta g_t, \quad \theta \gtrless 0 \tag{2}$$

[8] Throughout the paper, uppercase letters will represent stocks or present discounted values, and lowercase letters will represent the corresponding flows.

[9] $\gamma = 1-p$, where p is the death rate in Blanchard's (1985) model.

[10] An equivalent assumption to the riskless insurance companies is that there exist actuarial bonds. Lenders lend to intermediaries and the claims are cancelled by the death of lenders. Similarly, borrowers borrow from intermediaries and the claims are cancelled by the death of the borrowers. Intermediation is thus riskless.

[11] The most commonly used specification in previous studies has been a linear function like equation (2) (Feldstein (1982), Kormendi (1983), Aschauer (1985), Seater and Mariano (1985), Graham and Himarios (1991) and Graham (1993)). An alternative specification considered by Bean (1986), Campbell and Mankiw (1990) and Ni (1995) is the Cobb-Douglas specification.

A negative value for θ[12] implies that an increase in government consumption raises the marginal utility of private consumption (ie the two are complements), whereas a positive θ would suggest that an increase in government consumption diminishes the marginal utility of private consumption (ie the two are substitutes).[13]

The individual consumer of age k is assumed to maximize the objective (1) subject to the sequence of one period flow budget constraints

$$\begin{aligned} c_{t,k}^{T} &= y_{t,k} + tr_{t,k} - t_{t,k} - a_{t,k} + \frac{1+r}{\gamma} a_{t-1,k-1} + \theta g_t \\ &= h_{t,k} - a_{t,k} + \frac{1+r}{\gamma} a_{t-1,k-1} + \theta g_t \end{aligned} \tag{3}$$

where

$h_{t,k}$ is period t real disposable labour income (human wealth) of a consumer of age k, defined as $y_{t,k} + tr_{t,k} - t_{t,k}$[14]
$y_{t,k}$ is period t real before-tax labour income of a consumer of age k
$tr_{t,k}$ is period t real government transfers (lump-sum) received by a consumer of age k
$t_{t,k}$ is period t real gross tax payments (lump-sum) of a consumer of age k
$a_{t,k}$ real nonlabour assets (or debt, if negative) including government bonds (nonhuman wealth) of a consumer of age k at the end of period t
$a_{t-1,k-1}$ real assets accumulated (or debt incurred) in period t−1 of a consumer of age k−1
r is a constant real rate of interest

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[12] A negative θ would force the marginal utility of government consumption to take negative values as well. Christiano and Eichenbaum (1988) and Barro (1989b) have shown that a function of g_t can be added to the utility function so that the government consumption's marginal utility becomes positive. Equation (1) would be modified to $E_t\left\{\sum_{j=0}^{\infty}(\gamma\beta)^j[U(c_{t+j,k+j}^{T})+\Phi(g_t)]\right\}$ with $\partial\Phi/\partial g_t > 0$. Since consumers have no control over g_t the maximization problem can be solved ignoring the government consumption's contribution to utility through the function Φ.

[13] This does not refer to the substitutability in the sense of Hicks–Allen. Instead, the Edgeworth criterion is used according to which private and public consumption are "net rivals" if the marginal utility of one decreases as the quantity of the other increases, and "net complements" if the opposite holds. Let the utility function be $U(c_t^P, g_t)$. The substitutability between c_t^P and g_t is reflected by the gross second derivative U_{cg}. If $U_{cg} < 0$ (ie an increase in g_t reduces the marginal utility of c_t^P), then c_t^P and g_t are Edgeworth substitutes. If $U_{cg} > 0$, they are Edgeworth complements, and if $U_{cg} = 0$, they are Edgeworth independent – in this case c_t^P and g_t are separable. Under the additivity assumption of private consumption and government spending (equation (2)) and $U(c_t^P + \theta g_t)$ concave, $U_{cg} < (>,=)\ 0$ if and only if $\theta > (<,=)\ 0$. A negative θ corresponds to complementarity and a positive θ to substitutability. According to Ni (1995) the empirical estimates of the parameter θ are sensitive to the specification of total effective consumption: when specified as a linear function like equation (2), government spending tends to be a substitute for private consumption, whereas Cobb-Douglas as well as CES forms tend to imply complementarity.

[14] Since the human wealth includes social security contributions and excludes payroll taxes, social security wealth is treated as part of human wealth in the consumption function.

Gross labour income y_t, government transfer payments tr_t, taxes t_t and government consumption g_t are assumed to be random variables and to follow given stochastic processes outside the control of the consumer. The term $(1+r)/\gamma$ is the risk-adjusted gross rate of return on nonlabour assets. During period t the consumer saves a_t-a_{t-1} (borrows if negative) to buy assets and new government bonds and expects to receive a stream of interest payments on the accumulated assets. Government consumption g_t enters the consumer's one period budget constraint (3) multiplied by θ.

In the case of no binding borrowing constraints the conventional solvency condition is used to rule out Ponzi-games (see Blanchard and Fischer (1989)) where consumers can borrow indefinitely to finance an infinite consumption and ever increasing debt burden in each period by new loans; if the consumer is still alive at time t+j, then

$$E_t \lim_{j\to\infty}\left(\frac{\gamma}{1+r}\right)^j a_{t+j,k+j}=0$$

The no-Ponzi-game condition thus requires that the expected rate of growth of assets must be less than the risk-adjusted interest rate $(1+r)/\gamma$. Subject to this solvency condition the forward substitution in equation (3) gives the expected value of the lifetime budget constraint of a consumer of age k at time t in terms of total effective consumption

$$\begin{aligned} E_t C^T_{t,k} &= E_t H_{t,k} + \theta E_t G_t + \frac{1+r}{\gamma} a_{t-1,k-1} \\ &= E_t W_{t,k} \end{aligned} \tag{4}$$

where

$$E_t C^T_{t,k} = E_t \sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j c^T_{t+j,k+j}$$

$$E_t H_{t,k} = E_t \sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j h_{t+j,k+j} = E_t \sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j (y_{t+j,k+j} + tr_{t+j,k+j} - t_{t+j,k+j})$$

$$E_t G_t = E_t \sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j g_{t+j}$$

Since it is assumed that future disposable labour incomes are not known, human capital of a household of age k at time t is the discounted sum of expected future disposable labour incomes $E_t H_{t,k}$. In the same vein, $E_t G_t$ denotes the discounted sum of expected future government consumption and $E_tW_{t,k}$ the present value of expected total wealth of a consumer of age k at time t.[15]

Equation (4) states that the expected present value of total effective consumption at time t equals the expected present value of disposable labour income, initial nonlabour assets a_{t-1} and interest earned between period t−1 and t. The important thing here is that the consumer is constrained only by the lifetime budget constraint, so that consumption can be shielded from period to period fluctuations in income through borrowing and lending.

The term θE_tG_t appears in the definition of wealth because according to Aschauer (1985) a higher level of government consumption imposes a negative (positive) wealth effect on the consumer if $\theta < 1$ (> 1). If θ equals one, an increase in government spending has one-to-one wealth effect and if θ equals zero, a permanent increase in government consumption has no wealth effect. In case that θ is negative, an increase in government consumption will produce a wealth loss.

The first-order necessary conditions for the consumer's maximization problem with respect to total private consumption c_t^T gives the Euler equations

$$E_t u'(c^T_{t+j,k+j}) = [\beta(1+r)]^{-j} u'(c^T_{t,k}) \tag{5}$$

The sequence of Euler equations (5) characterize the relation between two adjacent periods along the optimal path of consumption: in optimum reallocation of c_t^T between two periods cannot increase utility.

A closed-form solution for c_t^T can be obtained in the special case of quadratic utility. Following Hall (1978) the one-period utility function is assumed to be of the form[16]

$$u(c_t^T) = -\frac{1}{2}(\bar{c} - c_t^T)^2$$

[15] This formulation requires that consumer behaviour exhibits certainty equivalence: the individual consumer chooses the path of consumption as if her future incomes and government consumption were certain to equal their means. Hence, uncertainty about future disposable income or government consumption has no impact on private consumption. The certainty equivalence arises when utility function is quadratic. With linear marginal utility function the marginal utility of consumption is equal to the marginal utility of expected consumption. In this case it is as if expected consumption were known with certainty. Hence, only the expected values count, and not the variances.

[16] Unless the utility function takes a specific form like a quadratic form, the Euler equation does not aggregate across consumers. Hall (1978) has demonstrated that if one-period utility function is assumed to be a local approximation of the consumer's true utility function, different functional forms can be locally approximated by a quadratic form (see also Hayashi (1982), pp. 898−899). Its simplicity does not, however, come without serious shortcomings (see Zeldes (1989)). A more plausible utility function is the constant relative risk aversion (CARA) function. Under such preferences and stochastic future labour income, the solution for consumer's maximization problem derived above is only an approximation. When future labour income uncertainty is high, an approximate consumption function would predict lower consumption than predicted by the certainty equivalent solution.

where $\bar{c}$ is the bliss level of consumption. In this case, the Euler equation can be written as

$$E_t c_{t+1}^T = \frac{r-\delta}{1+r}\bar{c} + \frac{1+\delta}{1+r} c_t^T \tag{6}$$

Note that equation (6) is independent of the survival probability γ (ie dynamic equilibrium condition of the consumer is independent of the survival probability). This comes from the fact that the consumer's (of age k) future utility is discounted at the rate ($\gamma\beta$) whereas future values are discounted at the rate of $\gamma/(1+r)$. This implies that the intertemporal marginal rate of substitution, IMRS, is $(\gamma/(1+r))/(\gamma\beta) = (\beta(1+r))^{-1}$, which is the intertemporal relative price of period t+1 consumption relative to that of period t.

By assuming that $r = \delta$, $\theta=0$ and $\gamma=1$, one obtains Hall's (1978) well known random walk in consumption implied by the permanent income hypothesis, eg the Euler equation is $E_t c_{t+1}=c_t$. Alternatively, this can be written as $c_t = c_{t-1} + \epsilon_t$, where ϵ_t is a rational forecast error, the innovation in permanent income. According to this formulation the optimal forecast for current consumption is the previous period's consumption.

Using the Euler equation (6) to substitute out $c_{t+j,k+j}^T$ from the consumer's lifetime budget constraint (4), allows to solve for the total effective consumption of a consumer of age k at time t

$$\begin{aligned} c_{t,k}^T &= \beta_0 + \beta_1\left(E_t H_{t,k} + \theta E_t G_t + \frac{1+r}{\gamma} a_{t-1,k-1}\right) \\ &= \beta_0 + \beta_1 E_t W_{t,k} \end{aligned} \tag{7}$$

where

$$\beta_0 = \frac{\gamma(\delta-r)}{(1+r)(1+r-\gamma)}\bar{c}$$

$$\beta_1 = \frac{(1+r)^2-\gamma(1+\delta)}{(1+r)^2}$$

In terms of private consumption c_t^P, equation (7) can be written as

$$\begin{aligned} c_{t,k}^P &= \beta_0 + \beta_1\left(E_t H_{t,k} + \theta E_t G_t + \frac{1+r}{\gamma} a_{t-1,k-1}\right) - \theta g_t \\ &= \beta_0 + \beta_1 E_t W_{t,k} - \theta g_t \end{aligned} \tag{8}$$

The term in the brackets in equations (7) and (8) represents total expected wealth $E_t W_{t,k}$ and β_1 the constant marginal propensity to consume out of wealth.

Specifications (7) and (8) imply that taxes as well as government transfers are age-specific while government consumption is not.

2.2 Aggregate consumption

Since the economy consists of overlapping generations, the derivation of the aggregate consumption function requires the determination of the size of each generation and to sum across all generations. The population is normalized such that the initial size of each generation is one. As a fraction γ of consumers in each generation survives each period, there are γ^k members of the consumers of age k in each period. The size of the population is therefore constant[17] and given by

$$\sum_{k=0}^{\infty}\gamma^k=\frac{1}{1-\gamma} \tag{9}$$

Aggregating consumption over all generations and dividing by the size of population yields expected per capita aggregate private consumption c_t^P

$$c_t^P=(1-\gamma)\sum_{k=0}^{\infty}\gamma^k c_{t,k}^P \tag{10}$$

Similarly, expected per capita aggregate wealth in period t can be obtained by dividing the discounted sum of expected total wealth of all consumers from all generations by the total population

$$E_tW_t=(1-\gamma)\sum_{k=0}^{\infty}\gamma^k W_{t,k}=E_tH_t+(1+r)a_{t-1}+\theta E_tG_t \tag{11}$$

where

$$E_tH_t=(1-\gamma)\sum_{k=0}^{\infty}\gamma^k\sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j E_th_{t+j,k+j}=\sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j E_th_{t+j}, \tag{12}$$

[17] Allowing for nonzero population growth as in Weil (1987) would complicate the exposition without adding substantially to the theoretical analysis (see Evans (1993)). Population growth can be incorporated in the analysis by assuming a constant exogenous rate of population growth s. In this case the interest rate r is replaced by $(r-s)/(1+s)$, the net interest rate, and if $(1-\gamma)$ is replaced by $(1-\gamma+s)/(1+s)$, the rate at which disconnected households flow into the economy; ie, the "birth rate". Ricardian equivalence holds if all new households are connected to old households; ie, if $1-\gamma = s$. In that case, households act as if their memberships are growing at the same rate as population is growing. If instead households act as if their memberships are growing less rapidly than population, then Blanchard's alternative to Ricardian equivalence holds.

$$a_{t-1}=(1-\gamma)\sum_{k=1}^{\infty}\gamma^{k-1}a_{t-1,k-1} \tag{13}$$

and

$$\theta E_tG_t=\theta(1-\gamma)\sum_{k=0}^{\infty}\gamma^k\sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j E_tg_{t+j}=\theta\sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j E_tg_{t+j} \tag{14}$$

Aggregate per capita private consumption may now be written as a function of expected aggregate per capita wealth

$$c_t^P=\beta_0+\beta_1\left(E_tH_t+\theta E_tG_t+(1+r)a_{t-1}\right)-\theta g_t \tag{15}$$

Equation (15) contrasted with equation (8) shows that marginal propensity to consume out of total wealth remains invariant across aggregation. Furthermore, instead of the risk-adjusted interest rate on nonlabour assets in equation (8), the rate applicable in equation (15) is the risk-free interest rate. The finiteness of individual lives results thus in a higher effective discount rate on human wealth than the discount rate for nonlabour assets. Since human wealth is specific to the individual, it disappears from the system when the individual dies whereas the insurance mechanism guarantees that assets or nonlabour wealth is retained within the system. Therefore, the two types of wealth are discounted differently implying the nonneutrality of government debt and deficits.

With a view towards empirical implementation, the nonlabour assets are eliminated from the consumption function.[18] It is shown in the Appendix 1 that equation (15) can be rearranged as

$$\begin{aligned} c_t^P=&-r\beta_0+(1+r)(1-\beta_1)c_{t-1}+\beta_1(1-\gamma)E_tH_t \\ &+\beta_1\theta(1-\gamma)E_tG_t-\theta g_t+(1+r)(1-\beta_1)\theta g_{t-1}+\beta_1\epsilon_t \end{aligned} \tag{16}$$

where

$$\epsilon_t=\gamma\epsilon_{Ht}+\gamma\theta\epsilon_{Gt}.$$

[18] In principle, alternative mathematically equivalent solutions of consumption functions based on the Euler equation approach should give the same empirical results. Himarios' (1995) empirical study shows, however, that this may not be the case. He uses as examples three alternative solutions, one in which human wealth is eliminated (based on Evans (1988)), one in which nonhuman wealth is eliminated (based on Haque (1988)) and one which incorporates both forms of wealth (based on Hayashi (1982)). Despite the fact that all three expressions are mathematically equivalent they result in different empirical results. Himarios concludes that the reason for this is most likely the misspecification from not controlling the existence of liquidity constraints in the estimated models. When this source of misspecification is corrected the different mathematical solutions yield the same empirical results.

Error terms $\epsilon_{Ht} = (E_t - E_{t-1})H_t$ and $\epsilon_{Gt} = (E_t - E_{t-1})G_t$ reflect the revisions of expectations about the sequence of h_{t+j} and g_{t+j} that consumers make between period t−1 and t. Hence, the change in private consumption from t−1 to t, that is unpredictable at time t−1, is related to the new information about disposable labour income and government consumption. New information at t will cause the consumer to revise previously held expectations about current and future disposable labour income and government consumption, so that the discounted present value of these expectations will itself change. This is the change in permanent income that is warranted by news, and it is this that sets the change in consumption.

Equation (16) gives the expression for aggregate per capita private consumption in terms of lagged private consumption, current and lagged government consumption, lagged government debt, expected per capita human wealth, expected aggregate per capita wealth accruing from government consumption and revisions in expectations consumers make about human capital and government consumption when proceeding from period t−1 to period t.

2.3 The government sector

By definition forward looking rational consumers take into account the future consequences of current fiscal policy when making their consumption and saving decisions. In addition they take into account the benefits to be derived from the future government consumption. Accordingly, the private and public sectors can be consolidated by the substitution of the government budget constraint into the aggregate per capita private consumption function (16). When γ equals unity consumers fully regocnize the future tax obligations implicit in current debt finance of a given path of future government consumption. In this case consumers have infinite horizons and the Ricardian equivalence proposition holds. With γ smaller than one, consumers behave myopically or have shorter planning horizon than the government, which leads to the break down of the Ricardian equivalence.

In period t the government one-period budget constraint in real per capita terms is

$$t_t = g_t + tr_t - b_t + (1+r)b_{t-1} \tag{17}$$

where b_t denotes one-period real government debt.

Forward substitution for government debt in (17) gives the intertemporal constraint for the public sector

$$E_t T_t = E_t G_t + E_t TR_t + (1+r)b_{t-1} - \lim_{j\to\infty}\left(\frac{1}{1+r}\right)^j b_{t+j} \tag{18}$$

where

$$E_tT_t = E_t\sum_{j=0}^{\infty}(1+r)^{-j}t_{t+j}$$

$$E_tG_t = E_t\sum_{j=0}^{\infty}(1+r)^{-j}g_{t+j}$$

$$E_tTR_t = E_t\sum_{j=0}^{\infty}(1+r)^{-j}tr_{t+j}$$

Imposing the solvency constraint $E_t\lim_{j\to\infty}(1+r)^{-j}\, b_{t+j} = 0$ for the government sector that prohibits the Ponzi game where government can run primary deficits indefinitely and accumulate an ever increasing public debt by new loans gives[19]

$$E_tT_t = E_tG_t + E_tTR_t + (1+r)b_{t-1} \tag{19}$$

The government budget constraint (19) equates the present value of expected tax receipts to the initial government debt and the present value of expected government consumption plus transfer payments. This intertemporal constraint states that, for a given path of government consumption, a deficit-financed cut in current taxes leads to higher future taxes that have the same expected value as the current tax cut.

Substituting equation (19) into (16) gives

$$\begin{aligned} c_t^P = {} & -r\beta_0 + (1+r)(1-\beta_1)c_{t-1} + \beta_1(1-\gamma)E_tY_t \\ & + \beta_1(1-\gamma)(\theta-1)E_tG_t - \theta g_t + (1-\beta_1)(1+r)\theta g_{t-1} - \beta_1(1-\gamma)(1+r)b_{t-1} + \beta_1\epsilon_t + u_t \end{aligned} \tag{20}$$

where $E_tY_t\left(=E_t\sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j y_{t+j}\right)$ represents the discounted value of expected future labour incomes and u_t represents transitory consumption.[20] Equation (20) expresses aggregate private consumption per capita as a function of a constant term, expected lifetime labour income, expected government consumption as well

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[19] The government sector solvency constraint to be satisfied, government debt must grow at a rate below r (a necessary condition for the Ricardian equivalence to hold, see Hamilton and Flavin (1986)). If the debt grows at the rate r, interest payments for b_t are financed by issuing new debt. If the debt grows at any rate above r, the limit would be infinite leading to unsustainable situation. In theory, government debt can grow at the rate of the real interest rate in a growing economy, but for the debt-to-GDP ratio to remain finite in each period, the real growth rate of the economy must be less than the real interest rate.

[20] Transitory consumption is defined as zero-mean shocks to the utility function and measurement errors in consumption. Flavin (1981, p. 992) justifies neglecting transitory consumption on an aggregate level. If individual realizations of transitory consumption are independently distributed across the population, aggregate transitory consumption is negligible.

as current and lagged government consumption, lagged private consumption purchases and government debt. It nests both Ricardian and non-Ricardian hypotheses as special cases. The key parameters are γ and θ. With γ equal to unity, forward looking rational consumers have infinite horizon and consider today's deficit financing as tomorrow's tax liabilities. Hence, deficits have no effect on current consumption. Consumers base their consumption decisions on lifetime (permanent) income, which depends on the present value of government consumption but not on the timing of tax collections.

The parameter γ less than unity implies that due to shorter planning horizon, myopia or liquidity constraints consumers will regard their holdings of government bonds as net wealth. When this is the case, a current tax cut financed by issuing new government debt will increase expected human wealth and private consumption. This positive effect derived from an intertemporal reallocation of taxes is due to the different discount rates: if $0 < \gamma < 1$, consumers discount taxes at a rate $\gamma/(1+r)$ whereas the future interest income on government debt is discounted at a rate $(1+r)^{-1}$. In other words one unit of taxes in period t+j has the present value $(\gamma/(1+r))^j$ which is smaller than $(1+r)^{-j}$, the present value of one unit of interest income on debt. The future tax increase is thus given a smaller weight by finite-horizon consumers than the weight attached by them to the current tax cut. In the case of extreme myopia ($\gamma=0$), consumers treat government debt fully as a net wealth.

More specifically, with γ equal to unity, θ equal to zero and δ equal to r, equation (20) reduces to the Hall (1978) specification in which the current consumption and last period's consumption differ only by the extent of the forecast error in current disposable income.[21] The infinite horizon ($\gamma=1$) and the assumption of no population growth imply that there is no way for individuals to evade taxes by dying and/or levying taxes on other generations.

When $\gamma < 1$ and $\theta \neq 0$, expected human wealth, government consumption and government debt affect current consumption over and beyond the impact of lagged consumption. If government consumption substitutes perfectly private consumption ($\theta=1$), one has Feldstein's (1982) condition for complete ex ante crowding out and fiscal policy neutrality.

3 Empirical implementation

3.1 Derivation of the reduced form consumption function

The main problem in estimating intertemporal consumption function with rational expectations like equation (20) is how to handle unobservable future path of labour income Y and government consumption G. One solution is to follow Hayashi's procedure (1982) and to exploit the stochastic difference equation on expected labour income and government consumption to eliminate the unobservables from the estimation equation. The advantage of this method is that

[21] According to Flavin (1981) consumption would be an exact random walk only if the transitory component of income were identically equal to zero.

one needs not to specify the stochastic processes for labour income and government consumption.[22] Accordingly, the following difference equations are stipulated

$$E_tY_t-\frac{1+r}{\gamma}E_{t-1}Y_{t-1}=-\frac{1+r}{\gamma}y_{t-1}+e_{Yt}$$
$$E_tG_t-\frac{1+r}{\gamma}E_{t-1}G_{t-1}=-\frac{1+r}{\gamma}g_{t-1}+e_{Gt} \tag{21}$$

where e_{Yt} and e_{Gt} are the expectational revisions made by consumers as they proceed from period t-1 to period t. Formally,

$$e_{Yt}=\sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^{j}(E_t-E_{t-1})y_{t+j}$$
$$e_{Gt}=\sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^{j}(E_t-E_{t-1})g_{t+j}$$

These surprise terms are, by construction, orthogonal to the information set available in t-1, I_{t-1}, and thus serially uncorrelated. They may, however, be correlated with variables dated period t and contemporaneously correlated with each other.

Using equations (21) to form c_t^P - $[(1+r)/\gamma]c_{t-1}^P$ the unobservable variables can be removed from equation (20). Rearranging gives the expression for c_t^P in terms of observable variables:

$$\begin{aligned}c_t^P=\beta_0'+&\left[(1+r)(1-\beta_1)+\frac{1+r}{\gamma}\right]c_{t-1}^P-(1-\beta_1)\frac{(1+r)^2}{\gamma}c_{t-2}^P\\&-\beta_1(1-\gamma)\frac{1+r}{\gamma}y_{t-1}-\theta g_t+\theta\left(1-\beta_1\left(\frac{\gamma-1}{\theta}+1\right)+\gamma\right)\frac{1+r}{\gamma}g_{t-1}\\&-\theta(1-\beta_1)\frac{(1+r)^2}{\gamma}g_{t-2}-\beta_1(1-\gamma)(1+r)b_{t-1}+\beta_1(1-\gamma)\frac{(1+r)^2}{\gamma}b_{t-2}+v_t\end{aligned} \tag{22}$$

where

$$\beta_0'=\frac{r(\delta-r)}{(1+r)}\bar{c} \text{ and } \beta_1=1-\frac{\gamma(1+\delta)}{(1+r)^2}$$

[22] Another approach to model the future path of government consumption followed by Aschauer (1985) is to use an explicit forecast equation in which present and past values of government debt and deficit are used to signal changes in government spending. This kind of formulation has the advantage that if allows to distinguish between debt as a potential source of wealth, which is the concern of the Ricardian equivalence, and debt's role as a signal of future levels of government consumption.

$$v_t=\beta_1\epsilon_t-\frac{1+r}{\gamma}\beta_1\epsilon_{t-1}+u_t-\frac{1+r}{\gamma}u_{t-1}$$
$$+\frac{\beta_1(1-\gamma)}{\gamma}e_{Yt}+\frac{\beta_1(1-\gamma)(\theta-1)}{\gamma}e_{Gt}$$

3.2 Econometric issues

Before the model can be estimated, it is necessary to address several issues of specification that arise from the nature of aggregate time series data used in estimations. The estimation of equation (22) involves a number of problems, which risk to result in inconsistent parameter estimates. Firstly, the time aggregation imposed on consumption function by the use of annual data in the estimations and the inclusion of consumer durables in the measure of private consumption[23] introduces a first-order moving average term into the lagged consumption expenditure (see Working (1960) and Campbell and Mankiw (1990) for time aggregation and Mankiw (1982) for durability). To avoid misspecification arising from time-averaging and durability requires the use of instruments that are lagged more than one period so that there is at least two period time gap between the instruments and the variables in equation (22). There may also be white-noise errors in the levels of the consumption and income variables due to 'transitory consumption' or to the measurement errors. White-noise errors in levels become first-order moving average errors in the specification and could be correlated with once-lagged instruments, but not with twice-lagged instruments.

Second problem pointed out by Hayashi (1982) is that although ϵ_t, e_{Yt} and e_{Gt} are orthogonal to the information set at time t-1, I_{t-1}, they might not be orthogonal to y_t, g_t and b_t, since these variables do not belong to I_{t-1}. To correct for this problem requires also the use of instrumental variables estimator, where at least twice-lagged variables are chosen as instruments, which by definition are orthogonal to ϵ_t, e_{Yt} and e_{Gt}.

These arguments for twice-lagging the instruments imply that the error term in equation (22) has a first-order moving average structure (MA(1)). If this is ignored and standard nonlinear least squares and instrumental variables procedures are used, the coefficient estimates remain consistent but the standard errors are inconsistent. To derive consistent standard errors in the presence of serial correlation and conditional heteroscedasticity in the error term Hansen's (1982) GMM estimator is used. The reported standard errors are thus heteroscedasticity and autocorrelation consistent standard errors (White (1980)) calculated by the Parzen kernel estimator.

Since the equation (22) is nonlinear only in its parameters, it could be estimated as an unrestricted linear model. One could then test whether the estimated composite coefficients have the probability limits implied by the Ricardian equivalence. However, given that the model is overidentified, the

[23] See Ch. 4 and Appendix 3 for further details on the measurement of the data.

underlying parameters cannot be recovered. By using a nonlinear estimator one can get direct estimates of the parameters in question that will give a more meaningful measure of any rejection that might occur. The model adequacy is tested by Hansen's (1982) overidentifying restrictions test (J-test).[24]

In order for the GMM estimator to be asymptotically justifiable, all variables should be stationary. Nonstationarity would be a problem when estimating in levels,[25] because it can give rise to a spurious relationship among the levels of the variables (see Phillips (1986)). Also the parameter estimates from a regression of one such variable on others are inconsistent and may not even be convergent. To account for the nonstationarity a possible solution would be to follow Campbell and Deaton (1989) and to divide all variables by the lagged level of income, y_{t-1} to obtain stationarity or to estimate equation (22) in the first difference form. The problem in transforming the equation into difference form is that lagged values of $\triangle c_t$ as instruments do not explain a large fraction of the variance of $\triangle c_t$, if the univariate time series process for c_t is close to a random walk.

These transformations are, however, not needed, if the variables are cointegrated. Recent results by Sims, Stock and Watson (1990) and West (1988) show that inference and estimation may proceed in the standard way and no special steps to handle the nonstationarity is necessary, if the nonstationary regressors are cointegrated and the unconditional mean of their first differences is non-zero. The underlying theory clearly suggests that there should be a stable long run relationship among the levels of variables in equation (22), and the set of variables used in the empirical estimation should be cointegrated. It is shown in the Appendix 2 that the conditions required for estimating in levels are fulfilled for equation (22).

4 Description of the data and estimation results

In the study of intertemporal consumption behaviour, it is important to distinguish between consumption and consumer expenditure. At any point in time the consumption of previously purchased durable goods yield utility without inducing any consumer spending. Likewise, the utility derived from current consumer expenditure on durable goods is not restricted to the time of purchase, but extends to several periods. Ideally, consumption of durable goods should therefore be measured in terms of service flow these goods render to the consumer during several periods and not in terms of current expenditures. Despite the efforts made

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[24] The test statistic converges in distribution to χ^2_{r-q} with degrees of freedom equal to the number of moment (orthogonality) conditions minus the number of parameters to be estimated.

[25] Flavin (1981, 1985), Hayashi (1982), and others generally specify the permanent income model with variables in levels and then remove a deterministic time trend from the data to achieve stationarity of the variables. Mankiw and Shapiro (1985), however, show that such detrending can lead to spurious excess sensitivity of consumption to income innovations. On the other hand, Stock and West (1988) show that the spurious sensitivity is not due to spurious cycles but rather to the shift in the asymptotic distribution when a deterministic trend is included.

to compute the imputed services from durable goods, no reliable method exists so far.[26]

Due to the arbitrariness and difficulties involved in the imputation of a service flow from the stock of consumer durables, the permanent-income hypothesis and Ricardian equivalence has generally been tested by using consumption expenditures on services and nondurable goods as a relevant measure for private consumption.[27] However, since the measure excluding consumption expenditures on durables and semidurables excludes also services rendered by previously acquired durable goods, it is no longer strictly valid to estimate the consumption function along with the budget constraint. The usual procedure to account for this imbalance is to rescale the data by netting durables out of the income measure.

Rescaling of the data does not, however, solve the basic problem involved in this procedure. It requires that the components making up real expenditure on nondurable goods and services have constant relative prices so that they can be treated as a Hicks composite commodity and that the momentary utility function is separable between this composite commodity and the service flow from durable goods. There is, however, substantial evidence against this assumption (see eg Eichenbaum and Hansen (1990), Deaton (1992)). When this is the case the practice of testing quadratic models of aggregate consumption using data on nondurables and services only can be called into question.

Moreover, when the primary interest is in the effects of fiscal policy variables on private consumption, the exclusion of consumer durables from the consumption measure could seriously bias the results in favour of Ricardian equivalence hypothesis, since purchases of durables are often considered more sensitive to income or wealth changes than are nondurables. Although the total private consumption expenditure is not in line with the underlying model of utility maximization,[28] it is considered to be a better measure for private consumption than those excluding durable goods altogether or those using computed values of the service flow.[29]

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[26] A number of studies have used the consumption data based on the computation method developed by Christensen and Jorgenson (1973) for the US data (eg Hayashi (1982), Kormendi (1983), Graham and Himarios (1991)). For a discussion of a potential problem with Christensen and Jorgenson's imputed service flow, see Cushing (1992).

[27] See eg Aschauer (1985), Evans (1988), Evans and Hasan (1994), Graham and Himarios (1996), Haug (1990), Himarios (1995).

[28] Since an intertemporally separate utility function means that the marginal rate of substitution between any two periods is independent of the level of consumption in any other period, it does not allow for goods whose effects last over time. It is not, however, clear on theoretical grounds that the separability assumption is seriously misleading for an aggregate of commodities (real consumption) with preferences defined over the quarterly or annual frequencies that are usual in empirical work (see Deaton (1992)).

[29] Total private final consumption expenditure is used by Haque (1988) and Evans (1993). Campbell and Mankiw (1990) used both total consumption expenditures and expenditures on nondurables and services. No inferences were affected by the choice of the consumption measure. In Graham and Himarios (1991), however, the choice of the consumption measure proved to be critical to the rejection or nonrejection of some hypotheses tested. On the importance of the choice of consumption measure for Kormendi's (1983) results, see Graham (1992).

When measuring the government consumption the distinction between government spending on goods and services that provides utility to the private consumers in the current period and that yielding utility in future periods via government investment would potentially be important (see Kormendi (1983) on that and further aspects). However, the problems arising from the correct measurement of durability are the same here as in private consumption. Another problem arises from the heterogeneity of government consumption – some components can be considered as close substitutes, some as complements to private consumption, for some items neither substitutability nor complementarity may exist. A rough way to correct the measure of government consumption due to heterogeneity of its components is to exclude national defence expenditures (Kormendi (1983), Evans and Karras (1996)). This is not, however, possible in the present study due to the lack of data. Consequently, the conventional practice to use total government expenditure without differentiating between consumption and nonconsumption measures or durability is followed here. This might bias the coefficient on government consumption downward.

No attempt is made to distinguish temporary changes in fiscal policy variables from permanent changes. In principle this could be an important issue, since under rational expectations only permanent changes in fiscal policy variables can affect consumption due to changes in permanent income. Changes that are known to be transitory cannot influence private consumption. In practice, the classification of changes in fiscal variables as unambiguously temporary or permanent is virtually impossible.

4.1 Data

To estimate the model, annual time series data for Finland from 1960 to 1995 obtained from the OECD National Accounts and the Bank of Finland data bank are used. Given that some observations are lost due to the use of lagged instruments the actual estimation period starts from 1964. Detailed description of the data is given in the Appendix 3.

Private consumption c_t is measured by per capita total private consumption expenditures at 1990 prices, before-tax labour income y_t is measured by per capita wages and salaries including employers' contributions for social security and private pension, operating surplus of private unincorporated enterprises and withdrawals from private quasi-corporate enterprises. Taxes t_t are measured by per capita household income taxes and other direct taxes. Government consumption g_t is measured by general government final consumption expenditures per capita at 1990 prices. Government debt b_t is measured by per capita general government debt in book value.

In addition a dummy variable D91–93 is included in the regressions on the ground that during these years the Finnish economy was hit by an unexceptionally deep recession and severe banking crisis.[30] The inclusion of this dummy is supported by prior examination of the data and it leads also to a more satisfactory

[30] On the effects of banking crisis on private consumption and saving in Finland, see Brunila and Takala (1993).

performance of the estimated model. The use of a dummy in this way is of course open to the objection of data mining.

The instrument set consists of a constant, the second through fourth lag of total private consumption, the second and third lag of before-tax labour income, government debt, household income taxes, the second lag of government consumption, the first and second lag of the terms of trade and the dummy variable. All instruments except the terms of trade and the dummy are measured in per capita terms. The same set of instruments were used in all estimations.[31]

The real interest rate was fixed to 3 % p.a. in the estimations. The average real rate of return measured by the 10 year interest rate on government bonds was 2.7 % over the sample period.[32] All data not already valued at 1990 prices are deflated by the price deflator implied by the ratio of nominal total private consumption expenditures to those valued at 1990 prices.

4.2 Estimation results

Deviations from Ricardian neutrality have generally been explained by different planning horizons of the government and private sector. As suggested by the theoretical framework the effects of government financing decisions on private consumption depend crucially on the estimated parameter value of γ, eg on the length of average horizon for private consumption and saving decisions, $1/(1-\gamma)$. Estimated parameter values for γ less than unity results in a shorter planning horizon for the private sector and hence, in fiscal policy nonneutrality. The unrestricted version of the consumption equation is estimated first and then theory-generated restrictions on γ and θ are tested using the Wald test.[33]

Table 1 presents the estimates of β, γ and θ with their autocorrelation and heteroscedasticity consistent standard errors over the 1964–1995 sample period. A constant term is always included as both an instrument and a regressor but is not reported in the tables. The J-statistic is a χ^2 test for the validity of the overidentification restrictions and its significance level is shown in parentheses underneath.

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[31] Some results are to some extent sensitive to the number of lags included. In general, the higher the number of lags, the more efficient the estimates. When the equations were estimated with non linear least squares, the conclusions remained unaffected.

[32] The variability of the real interest rate has, however, been quite substantial during the sample period. It should also be noted that the real interest rate was very low and even negative in 1971–1982.

[33] The hypotheses to be tested are written as h(b)=0, where b is the vector of parameters of the unconstrained model and h(b) is a set of m nonlinear constraints on those parameters. Given a set of estimates b and the associated covariance estimate V(b), the constraints h(b) and their covariance matrix (all evaluated at the estimated b vector) is computed as: $V(h(b)) = (\partial h/\partial b)'\ V(b)\ (\partial h/\partial b)$. From h(b) and its variance a test statistic is formed $T = h(b)\ \mathbf{V}(h(b))^{-1}\ (h(b))'$. This test statistic is distributed asymptotically as a χ^2 variable with degrees of freedom equal to m under the null hypothesis (when the constraints hold).

Table 1. **GMM estimation of equation (22), 1963–1995 with constant real interest rate of 3 per cent**

	Unrestricted	Restrictions					
		$\gamma=1$	$\theta=1$	$\theta=0$	$\gamma=1$ $\theta=1$	$\gamma=1$ $\theta=0$	$\beta_0'=\frac{r(\delta-r)}{(1+r)}\bar{c}$ $\beta_1'=1-\frac{\gamma(1+\delta)}{(1+r)^2}$
β	.639 (.059)	.669 (.026)	.936 (.119)	1.767 .291	.749 (.050)	1.611 .215	
γ	1.033 .062		1.035 (.033)	.984 .023			1.033 .062
θ	2.723 1.069	2.510 .707					2.723 1.069
δ							-.629 .042
$\bar{c}$							-10.576 13.310
D91-93	-5.314 1.105	-5.048 .654	-4.901 (.566)	-6.496 1.043	-4.136 (.219)	-6.135 .907	-5.314 1.105
J-test	7.106 (.626)	8.301 (.600)	7.915 (.637)	5.117 .883	10.261 (.507)	6.170 .862	7.106 .626
Wald-test (χ^2)		0.282 0.595	2.598 (0.107)	6.489 0.011	3.342 (0.188)	9.726 0.008	32.916 (0.000)

Notes: Heteroscedasticity and autocorrelation-consistent standard errors are in parentheses. The J-test is a test of the validity of overidentifying restrictions with its significance level in parentheses. The Wald-test is for the validity of the imposed restriction with its significance level in parentheses. The instruments for the unrestricted and restricted specifications include the constant, the second through the fourth lag of private consumption, the second and third lag of before-tax labour income, government debt, household income taxes, the second lag of government consumption, the first and second lag of the terms of trade and the dummy variable.

Overall results suggest that all parameter estimates are statistically significant at least at 5 per cent level and have the expected sign. Moreover, the parameter estimates and their statistical significance remain virtually unchanged in various specifications except those of β which prove to be somewhat sensitive to the various restrictions imposed on the value of θ.

As discussed in section 3 and above, Ricardian equivalence holds when consumers and the government have the same planning horizon, eg $\gamma=1$. The unrestricted estimate of γ turns out to be around unity and is statistically significant at 1 per cent significance level. This result gives a strong support for the Ricardian neutrality hypothesis and infinite planning horizon. In other words, the wealth effect of government debt financing is zero. This implies that during the sample period one cannot reject the hypothesis that consumers take fully into account the future tax implications of the government debt accumulation and do not increase their consumption with the government deficit financing.

The estimate of β, that measures the marginal propensity to consume out of total expected wealth, is, however, much too high given the infinite planning horizon.[34] With constant 3 per cent real rate of return and estimated β about .64, the imputed value of subjective time preference δ becomes negative. This anomalious result is related to the empirical puzzle where high growth of aggregate consumption is observed in the presence of a low or negative real interest rate (Deaton (1986)), although under any certainty equivalence model of consumption with time separable utility, the growth rate of consumption must be negative, if the interest rate is less than the rate of time preference. A negative time preference is therefore required in order to explain positive expected growth rates of individual consumption with low or negative real risk-free interest rates (Zeldes (1989)).[35] In addition, the upward bias of β may at least partly reflect the existence of liquidity (or borrowing) constraints.[36]

In line with earlier studies on the US data (Kormendi (1983), Aschauer (1985)) the unconstrained estimate for the substitutability parameter θ turns out to be positive implying that consumers perceive government consumption as a substitute for private consumption. The estimate is statistically significant at 5 per cent level. Recent studies (Karras (1994), Evans and Karras (1996)) using the same kind of formulation for total consumption as here (equation (2)) but otherwise different specifications have, however, found significant negative values for θ in Finland. With γ equal to unity the wealth effect produced by government consumption is, however, zero and independent of the value of θ.

To further test the theory-generated hypotheses, the model is estimated under various restrictions (Table 1). Under the restriction $\gamma=1$ the estimated value of β and its statistical significance increase slightly while the estimated value of θ and its standard error decrease. Finally, and more importantly, the restriction $\gamma=1$ cannot be rejected by the Wald test.

The restiction $\theta=1$ conforms to Feldstein's complete ex ante crowding out of private consumption -hypothesis, which requires θ to be positive and equal to unity. Under this restriction all coefficient estimates except β maintain thc same or nearly the same values and become statistically more significant. According to the Wald test statistics the restriction $\theta=1$ cannot be rejected at the conventional levels of significance. The alternative restricton $\theta=0$, reflecting the neutrality of government and private consumption, is strongly rejected by the Wald-test. Moreover, under this restriction the estimate of β becomes as high as 1.7. A potential explanation for the substantial upward bias in the estimated value of β is

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[34] Himarios (1995) obtained the estimated value of β that is in line with the values reported here when he used a consumption function that is based on mathematically equivalent solution.

[35] There is a close analogy to Weil's (1989) risk-free interest rate puzzle.

[36] Under potentially binding liquidity constraints, the underlying Euler equation does not hold since some consumers who would like to borrow at the given interest rate but are prevented from doing so consume relatively less in period t and relatively more in period t+1 than in the absence of liquidity constraints.

that the effect of government consumption is captured indirectly through other explanatory variables.

The joint restiction, $\gamma=1$ and $\theta=1$, cannot be rejected by the Wald test. Again, the upward bias in the estimate of β increases to some extent. For the sake of completeness also the restriction $\gamma=1$ and $\theta=0$ is jointly tested. The result is qualitatively the same as under the restriction $\theta=0$ and the same reasoning as above applies also here.

Finally, the joint restriction, $\beta_0 = r(\delta-r)\bar{c}/(1+r)$ and $\beta_1 = 1-\gamma(1+\delta)/(1+r)^2$ is imposed. The restricted parameter estimates of γ and θ and their statistical significance remain unchanged. The joint restriction is, however, strongly rejected by the Wald-test. Specifically, there appears to be a significant deviation in the unrestricted value of β and the one computed from the restricted parameter values of γ and δ. The estimation was also run with δ restricted to positive values and alternatively equal to the real interest rate. The results are, however, not reported here due to non-convergence and singularity.

As for the results regarding the dummy variable D91–93, one can immediately see that it is statistically significant in all specifications and of magnitude −4.14−−6.50. The negative coefficient can be interpreted to result from a limited access to financing due to banking crisis and hence, reduced consumption possibilities out of permanent income. In general, the result is in conformity with the structural break that occured during the recession years.

4.3 The robustness of the results

The robustness of the results is investigated with respect to different values for real rate of interest and different estimation periods. The estimated values of β, γ and θ and their standard errors for different values of r are reported in Table 2. Setting r at 1 per cent increases slightly the upward bias in the estimate of β while the value of γ decreases to .95. With 5 per cent real interest rate the estimated value for β decreases and that of γ increases. Their standard errors also decrease. The estimate of θ and the absolute value of the coefficient of the dummy variable decrease with the increase in the real interest rate.[37]

[37] The estimate of θ was found to be sensitive to the real rate of return in a recent study by Ni (1995).

Table 2. **GMM estimation of equation (22), 1963–1995 with constant real interest rate of 1 per cent and 5 per cent**

	r = 0.01	r = 0.05
β	.681	.506
	(.034)	(.150)
γ	.953	1.181
	(.023)	(.124)
θ	3.008	1.382
	1.141	(.694)
D91–93	-5.130	-4.289
	(1.092)	.843
J-test	6.039	9.141
	(.736)	(.424)

Notes: See notes to Table 1.

Table 3 shows the results for two sample periods 1964–1987 and 1970–1995. As seen from the Table the results are particularly sensitive to the estimation period. For the first subsample the estimate of β increases considerably, which may be taken as an indication of the existence of liquidity constraints.

During the sample period 1964–1987 the estimate of γ decreases to .93 implying the rejection of Ricardian equality. The estimated value of γ during this subperiod may be interpreted to conform to a planning horizon of 14 years, in which case consumers do not expect to bear the whole tax burden associated with current debt financing. Alternatively, it can be interpreted as an indication of myopic behaviour with respect to government financing decisions, whereby consumers treat at least part of the government debt as net wealth and increase their consumption accordingly, or as the existence of liquidity constraints.

As expected, the value of β decreases significantly and γ increases during the subperiod starting from 1970 and ending in 1995. Both results are consistent with the proposition that financial market liberalization that took place during the 1980s has resulted in increasing possibilities for intertemporal consumption smoothing. The estimate of θ decreases when moving from the earlier estimation period to the more recent one (ie the degree of substitutability falls).

Table 3. **GMM estimation of equation (22) for the subsamples 1964–1987 and 1970–1995 with constant real interest rate of 3 per cent**

	1964–1987 sample	1970–1995 sample
β	1.044	.378
	(.121)	(.098)
γ	.933	1.282
	(.040)	(.083)
θ	2.232	1.202
	(1.383)	(.902)
J-test	8.445	7.471
	(.490)	.588

Notes: See notes to Table 1.

The sensitivity of parameter estimates to the estimation period is hardly a surprise for several reasons. As already noted, the first half of the estimation period is characterized by more extensive financial market regulations and hence, possibly more binding liquidity constraints, which of course make the underlying working assumption of perfect capital markets less plausible. The latter half of the estimation period and especially the last ten years are, however, characterized by increasingly deregulated and more sophisticated capital markets with generally better access to various forms of financing. The estimated changes in the parameters over this period are consistent with this interpretation.

Another and a more crucial factor contributing to the parameter instability might be the changes in fiscal policy regime itself. According to Lucas' (1976) well-known critique, consumers, if they are rational will change their expectations and behaviour when government changes its policy. Therefore, there is no reason to expect a stable relationship between consumption and other relevant economic variables in econometric estimations incorporating shifts in policy regimes. In other words, when policy changes, the relationship between expectations, past information and behaviour may change and as a consequence, also the relationships in an econometric model may change. An important implication of rational expectations analysis is then, that the effect of a particular policy depends critically on what economic agents expect this policy to be. When this is the case, there is much less certainty about the effects of any particular policy change.

5 Concluding remarks

In general, the results seem to give support to Ricardian equivalence hypothesis suggesting that it provides a reasonable approximation to reality and in particular during the latter part of it. One should, however, be cautious and not to interpret the results too literally, since the estimated high propensity to consume out of total expected wealth is not entirely compatible with an infinite planning horizon but in fact, itself suggests a rather short one. It may also reflect the effects of liquidity constraints which, therefore, should be taken explicitly into account in empirical analyses.

During the estimation period government consumption seems to be a substitute for private consumption. Moreover, the tests cannot reject Feldstein's hypothesis of complete ex ante crowding out of private consumption in which case government consumption substitutes private consumption one-to-one.

From the point of view of the economy and economic policy the non-rejection of Ricardian equivalence hypothesis would have several implications. First, government deficit financing would not result in an increase in private consumption, but rather a one-to-one increase in private saving. When this is the case the ability of fiscal policy to stabilize cyclical changes would be quite limited. Second, government financing decisions would not affect the economic policy mix. Since government deficit financing would be fully backed by taxation, its influence on monetary policy credibility would be nil. When this is the case the risk of monetization and higher inflation would be nonexistent. All this is, however, contrary to the recent experiences shared by several countries with high government debt.

An important aspect to be taken into account when considering the applicability of the results in current situation in Finland is the fact that a fiscal policy change in any year may cause consumers to revise their expectations about future fiscal policy and thus induce adjustments in their behaviour not accounted for in the empirical estimations. Since the fiscal regime (policy objectives and instruments) in Finland has undergone a major shift during the last few years, the relationship between fiscal variables and private consumption might have undergone a change, too.

Since the outcome of current fiscal policy actions depend on the way they affect consumers' expectations, it is crucial to understand fiscal signals embodied in the current policy and the mechanisms by which consumers revise their expectations concerning the future policy regime. To account for this is a tricky problem since the fiscal signals conveyed by certain policy actions and the resulting change in private consumption are hard to disentangle, since the changes in expectations as well as in behaviour depend on the whole history of previous fiscal regimes, the overall macroeconomic situation, as well as on public debate on these issues. Moreover, if the sustainability of fiscal policy affects the consumers' perception of the future fiscal regime, the relationship between private consumption and fiscal variables is likely to involve breaks and/or non-linearities over time. It might therefore be impossible to predict with accuracy how private consumption will respond to the fiscal change in a particular year on the basis of historical experience.

The variable response of consumption to fiscal signals implies that econometric analysis cannot produce results that are valid and readily applicable to a particular situation but only the average effects on private consumption of changes in government consumption, taxes, transfers and debt. Although such estimates do not provide enough information to guide short-run macroeconomic policy, they are in principle sufficient to test the hypotheses concerning the degree of fiscal policy neutrality.

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Appendix 1

Aggregating the individual flow budget constraint (3) over all generations gives the aggregate per capita flow budget constraint in terms of private consumption

$$a_t = h_t + (1+r)a_{t-1} - c_t^P \tag{A1}$$

From equation (11) human wealth in period t can be expressed as

$$h_t = E_t H_t - \frac{\gamma}{1+r} E_t H_{t+1} \tag{A2}$$

Substituting the consumption function (15) and equation (A2) into (A1) gives

$$a_t = -\beta_0 + (1-\beta_1)E_t H_t - \frac{\gamma}{1+r} E_t H_{t+1} - \beta_1 \theta E_t G_t + (1+r)(1-\beta_1)a_{t-1} + \theta g_t \tag{A3}$$

Lagging (A3) by one period and multiplying both sides by (1+r) yields

$$\begin{aligned}(1+r)a_{t-1} = {} & -(1+r)\beta_0 + (1+r)(1-\beta_1)E_{t-1}H_{t-1} - \gamma E_{t-1}H_t \\ & -(1+r)\beta_1 \theta E_{t-1}G_{t-1} + (1+r)^2(1-\beta_1)a_{t-2} + (1+r)\theta g_{t-1}\end{aligned} \tag{A4}$$

After rearranging and manipulating equation (A4) the total expected wealth can be expressed as follows

$$\begin{aligned}E_t W_t = {} & -(1+r)\beta_0 + E_t H_t - \gamma E_{t-1}H_t + (1+r)(1-\beta_1)E_{t-1}H_{t-1} + \theta E_t G_t \\ & -(1+r)\beta_1 \theta E_{t-1}G_{t-1} + (1+r)^2(1-\beta_1)a_{t-2} + (1+r)\theta g_{t-1}\end{aligned} \tag{A5}$$

Equation (A5) can be rewritten as

$$\begin{aligned}E_t W_t = {} & -(1+r)\beta_0 + (1+r)(1-\beta_1)[E_{t-1}H_{t-1} + (1+r)a_{t-2} + \theta E_{t-1}G_{t-1}] \\ & +(1-\gamma)E_t H_t + \theta(1-\gamma)E_t G_t + \gamma \epsilon_{H_t} + \gamma \theta \epsilon_{G_t}\end{aligned} \tag{A6}$$

where

$$\epsilon_{Ht} = (E_t - E_{t-1})H_t$$

and

$$\epsilon_{Gt}=(E_t-E_{t-1})G_t$$

reflect the revisions of expectations about h_{t+j} and g_{t+j} that consumers make between period t-1 and t.

Equation (15) in the text implies that

$$c_t^P=\beta_0+\beta_1 E_t W_t-\theta g_t \qquad \text{(A7)}$$

Lagging (A7) and rearranging yields

$$E_{t-1}W_{t-1}=\frac{1}{\beta_1}(c_{t-1}^p-\beta_0+\theta g_{t-1}) \qquad \text{(A8)}$$

Substituting (A8) into (A6) yields

$$\begin{aligned} E_t W_t=&-(1+r)\beta_0+(1+r)(1-\beta_1)\frac{1}{\beta_1}(c_{t-1}^p-\beta_0+\theta g_{t-1})+(1-\gamma)E_t H_t \\ &+\theta(1-\gamma)E_t G_t+\epsilon_t \end{aligned} \qquad \text{(A9)}$$

where

$$\epsilon_t=\gamma\epsilon_{Ht}+\gamma\theta\epsilon_{Gt}.$$

Substituting (A9) into (A7) gives the expression for aggregate per capita private consumption.

$$\begin{aligned} c_t^P=&-r\beta_0+(1+r)(1-\beta_1)c_{t-1}^p+\beta_1(1-\gamma)E_t H_t \\ &+\beta_1\theta(1-\gamma)E_t G_t-\theta g_t+(1+r)(1-\beta_1)\theta g_{t-1}+\beta_1\epsilon_t \end{aligned} \qquad \text{(A10)}$$

Appendix 2

The time series properties of the data

Based on the theory of cointegrated processes, recent research on consumption has been conducted in level form.[38] Augmented Dickey-Fuller (1979) tests for unit roots as well as Johansen's maximum likelihood tests for cointegration were performed to check whether estimation of equation (22) in levels is appropriate.

Table A1 presents the results of augmented Dickey-Fuller tests of the null hypothesis that each series has one unit root and of the null that its first difference has one unit root. The unit root test for each series x_t is based on the following augmented Dickey-Fuller equation:

$$\Delta x_t = \alpha + \beta x_{t-1} + \Upsilon \Delta x_{t-1} + \delta t + u_t \tag{A11}$$

where Δx_t is the variable in question, Δ is the first difference operator, t is a time trend, and u_t is a stationary error term. Equation (A1), allows for the possibility that the series has a time trend, while the lagged first-difference term allow for autocorrelation correction. The null-hypothesis of a unit root is rejected if β is significantly negative.

The test statistic used for testing non-stationarity is the MacKinnon surface response statistic.[39] Unlike the Dickey-Fuller and other test statistics, the MacKinnon statistic is conditional upon the number of observations and the presence or absence of a time trend as well as the number of variables used in the regression. The null hypothesis is that the time series is non-stationary. Rejection of the null requires that the regression estimate of the test statistic is greater in absolute value than the critical value of the MacKinnon statistic.

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[38] See eg Evans (1988), Leiderman and Razin (1988), Graham and Himarios (1991, 1996), Himarios (1995).

[39] See MacKinnon (1991). The critical values are calculated as $(\beta+\lambda/T+\delta/T^2)$, where β is the estimate of the asymptotic critical value for a test of size p, and λ and δ are estimates of the slope of the response function conditional upon the sample size T. MacKinnon provides estimates of the critical values for different significance levels and for various variable combinations, as well as for the case where a constant and a time trend are included in the estimation equation.

Table A1. **Augmented Dickey-Fuller tests, sample 1960–1995**

Variable	Levels ADF (1) 1962–1995	First differences ADF(1) 1963–1995
c_t	-3.571	-3.524
y_t	-3.789	-4.384
g_t	-1.797	-2.967
b_t	-1.394	-2.332
t_t	-3.028	-3.967
tt_t	-2.974(3)	-3.276

Notes: ADF(1) is the ADF statistic of order 1; the critical values of the ADF statistics are from MacKinnon (1991); the 0.05 critical value for the sample 1962–1995 is -3.547 and -2.953 for the sample 1963–1995. The 0.01 critical values are -4.251 and -3.642 respectively. Including additional lags did not affect the results.

The test results indicate that the null hypothesis that each series in levels has one unit root cannot be rejected at the 0.05 level for four series, g_t, b_t, and t_t. On the basis of the test series tt_t is stationary while c_t and y_t appear to be trend-stationary in levels. The null hypothesis that each first-differenced series has one unit root can be rejected for all but one series at the 0.05 level. The results suggest b_t to be integrated of order two. This is, however, clearly an implausible result suggesting that the real per capita government debt would be in an explosive path and consequently, leading to unsustainable government debt position in the long term. The government debt in Finland has grown very rapidly in the early 1990s due the severe recession. The growth rate of the debt has started to slow down only recently due to economic recovery and strong actions taken by the government to consolidate public finances. The combined effect of these events and decisions seems to have been that the debt series has undergone structural breaks which may cause the standard unit root test – which do not allow for the possibility of one or more structural breaks under the null and alternative hypotheses – to have a low power (see Perron (1989)). Hence, the evidence regarding the magnitude of the root in the debt series is treated as inconclusive. Moreover, these same qualifications apply also to the private consumption and income series that experienced considerable breaks in 1991 and 1994, that may cause the series to appear as trend stationary. When the years 1991–1995 are excluded from the sample, the unit root hypothesis cannot be rejected for both series in levels. Further analyses are conducted assuming that b_t, c_t and y_t are I(1) variables.

The results for cointegration are given in Table A2 for the I(1) variables and instruments used in the estimation equation (22). The cointegration estimation is based on the Johansen's (1988) maximum likelihood estimation procedure with two lags in the VAR, which produces white noise residuals.

Table A2. **Johansen's maximum likelihood tests for cointegration, 1962–1995**

Eigenvalue	Null hypothesis [c,y,g,b,t]	Trace	0.05 critical value
0.642	$r = 0$	96.04	68.5
0.546	$r \leq 1$	61.14	47.2
0.423	$r \leq 2$	34.29	29.7
0.261	$r \leq 3$	19.57	15.4
0.144	$r \leq 4$	5.29	3.8

Notes: All equations are estimated assuming the data do not contain a deterministic trend. Lag length of two was used to remove autocorrelation in the residuals. Critical values for the trace tests are obtained from Johansen (1988).

According to the trace test (Table A2) the hypothesis of cointegration cannot be rejected at the conventional 5 % significance level. The fact that the cointegration rank is as high as as five, may reflect the possible I(2)ness of the government debt series b_t (see also ADF-test in Table A1)

Because of the upward trend in c_t, y_{dt}, g_t and b_t the condition that the unconditional mean of their first-differences is non-zero is also fulfilled.

Appendix 3

Data

All variables except terms of trade are in per capita terms and deflated by the implicit price deflator. The data are from OECD National Accounts from the period 1960–1995, if not otherwise indicated.

Private consumption c_t: private final consumption expenditure at 1990 prices.

Pre-tax labour income y_t: the sum of household sector wages, salaries and employers' social security contributions, operating surplus of private unincorporated businesses and withdrawals from quasi-corporate enterprises.

Disposable labour income y_{dt}: the sum of pre-tax labour income and transfer payments, net taxes.

Government consumption g_t: general government final consumption expenditure at 1990 prices.

Taxes t_t: the sum of household income taxes and other direct taxes, employees' social security contributions and fees, fines and penalties.

Government debt b_t: data are end-of-year observations of outstanding central government debt at book value (source: Bank of Finland).

Terms-of-trade tt_t: export price index divided by import price index (source: Bank of Finland).

Price deflator: the ratio of final private consumption expenditures at current prices to the value of these expenditures at 1990 prices.

Dummy variable D91–93: the dummy variable D91–93 is 0 in 1964–1990 and 1994–1995 and 1 in 1991–1993.

Population: total population in Finland.