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Current Income and Private Consumption – Saving Decisions: Testing the Finite Horizon Model

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Abstract

This paper considers the effects of fiscal policy on private consumption in a framework that encompasses both the conventional (Keynesian) view of fiscal policy and the Ricardian debt neutrality hypothesis. The model is built on Blanchard's stochastic model of intertemporal optimization with finitely lived consumers. As an extension to the basic framework public consumption is explicitly incorporated in the model. The model nests also the excess sensitivity hypothesis whereby the role of current income on consumption can be investigated. Empirical analyses are based on annual data from ten EU countries covering the years 1961–1994 and use the nonlinear instrumental variable GMM estimator both in country-specific and panel estimations. The tests reject clearly the Ricardian debt neutrality for majority of the countries in the sample. Moreover, deviations from Ricardian neutrality seem to arise from excess sensitivity of consumption to current income rather than from a finite planning horizon on the part of consumers. The results also suggest that in the consumers' utility functions, government consumption and private consumption tend to be unrelated or complements rather than substitutes.

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

Tiivistelmä

Tutkimuksessa arvioidaan finanssipolitiikan – verotuksen, budjettialijäämän ja julkisen kulutuksen – vaikutusta talouteen yksityisen kulutuksen ja säästämisen näkökulmasta. Tutkimuksen keskeisenä pyrkimyksenä on selvittää, tukevatko empiiriset havainnot perinteistä keynesiläistä lähestymistapaa vai Ricardon velkaneutraliteettihypoteesia, jonka mukaan finanssipolitiikka on tehotonta: velalla rahoitettu verojen alentaminen eli budjettialijäämän kasvu ei lisää yksityistä kulutusta eikä siten ole taloutta elvyttävää. Tutkimus perustuu 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. Empiirinen aineisto käsittää kymmenen EU-maata ja kattaa vuodet 1961–1994. Analyysimenetelmänä on käytetty epälineaarista instrumenttimuuttujamenetelmää (GMM). Tulokset hylkäävät Ricardon velkaneutraliteettihypoteesin lähes kaikissa maissa. Hylkääminen ei näyttäisi niinkään johtuvan kuluttajien äärellisen suunnitteluhorisontin kuin kulutuksen ja nykyhetken tulojen välisen voimakkaan riippuvuuden takia. Tulosten mukaan julkinen kulutus ja yksityinen kulutus ovat kuluttajien hyötyfunktioissa paremminkin riippumattomia tai toisiaan täydentäviä kuin toisiaan korvaavia.

Asiasanat: yksityinen kulutus, yksityinen säästäminen, tulot, 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 since the late 1970s. Recently the issue has gained even a stronger emphasis especially in Europe as the member countries of the European Union strive to consolidate public finances in order to meet the fiscal convergence criteria required for the participation to the third stage of the European Economic and Monetary Union. Despite the growing interest of policy makers and economists in the sustainability and efficiency of fiscal policy, neither economic theory nor empirical evidence give any clear cut answers to these issues. In fact, there exists sharp controversies on the effects of fiscal policy in general and of budget deficits in particular.

Most of the debate centers around the the question whether government financing decisions influence private consumption and saving or not. At the present state of inquiry, the answer to this question depends ultimately on the degree to which consumers treat government debt as net wealth. According to the conventional (Keynesian) view, that formed a consensus opinion until the 1970s, private sector perceives government bonds totally as net wealth. Consequently, government deficits have a stong stimulative effect on private consumption and aggregate demand particularly in the short run. The resulting decrease in private and national saving lead, however, to higher real interest rates that 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. An important thing to note is that the stimulating effects of the fiscal deficits in this conventional approach are entirely based on an implicit assumption that consumers are too myopic to account for the future fiscal policy implications of current debt accumulation.

The Ricardian equivalence hypothesis stands in sharp contrast to the conventional view by arguing that government deficit financing merely generates the private saving necessary to absorb the additional government debt, leaving national saving and interest rates, investment and output unaltered. Ricardian equivalence holds since an increase in private sector savings will exactly offset the rising government deficit.[1] This result is formally based on Barro's (1974) seminal paper. By introducing rational behaviour and fiscal expectations into a forward-looking permanent income-life cycle consumption model 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. Instead, rational consumers would realize that the public debt created now by government borrowing must be repaid in the future by an increase in taxes. Private consumption remains unchanged 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. Lowering of taxes today will merely induce consumers to

[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).

increase saving in order to avoid sharp decline in their future disposable income and consumption due to higher taxes. If this is a correct representation of the consumer behaviour, the Ricardian equivalence proposition leads to quite drastic policy implications: since a switch from tax financing to debt financing has no stimulating effect on the economy even in the short run, attempts to stabilize economy are doomed to be futile.

As in the case of budget deficits there exist different views concerning the effects of government consumption on economic activity.[2] Under the conventional approach changes in government consumption have no direct effect on private consumption since consumers' current disposable income remains unaltered. However, on aggregate demand they will have one-to-one effect. Ricardian equivalence, on the other hand, suggests that government consumption has a negative but less than one-to-one impact on private consumption. Feldstein (1982) goes even further than the Ricardian equivalence proposition suggesting a complete ex ante crowding out of private consumption implying that current changes in government consumption must induce an equal, but opposite shift in private consumption, ie by increasing government consumption one cannot increase aggregate demand. This extreme view leaves then no room for short run fiscal policy stabilization.

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

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[2]The seminal contribution of the effects of government consumption on private consumption and aggregate economic activity is Bailey (1971). The impact of government consumption on private consumption depends upon whether government consumption increases or decreases the marginal utility of private consumption, ie whether government consumption is an Edgeworth complement or substitute for private consumption. Studies based on Bailey's approach, see Kormendi (1983), Barro (1981), Aschauer (1985), Leiderman and Razin (1988), Haug (1990), Karras (1994), Ni (1995), Evans and Karras (1996).

[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).

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 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.

Although Ricardian equivalence is based on several restrictive and highly unrealistic assumptions it provides a better starting point for analyzing overall effects of fiscal policy on private consumption than the conventional view by taking into account the expectations of future fiscal policy. In an environmont where the concern about the sound fiscal policies is deepening and the need for fiscal adjustment is widely recognized, it is 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. However, the extent to which consumers foresee future taxes or any other fiscal measures associated with current issues of government debt is essentially an empirical question and cannot be resolved by theoretical argumentation. This applies equally to the degree of substitutability between private and government consumption.

1.1 Empirical support to various hypotheses

After Barro's (1974) Ricardian equivalence or debt neutrality proposition there has emerged a considerable amount of empirical reseach on the effects of fiscal policy on private consumption and aggregate demand. Basically, the studies testing Ricardian equivalence has been carried out in two ways: to test whether increases in government debt are perceived as increases in household wealth and in private consumption or alternatively whether larger budget deficits are associated with higher interest rates.[5] Here the focus is on the first group of studies testing the response of private consumption to government budget variables.

The overwhelming part of these studies considers the data for only one country, usually the US.[6] The empirical evidence received is, however, highly

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

[5]Evans (1985), Plosser (1987), Barro (1989a), Correia, Nunes and Stemitsiotis (1995). Barro (1989a) suggests that "overall, the empirical results on interest rates support the Ricardian view. Given these findings it is remarkable that most macro economists remain confident that budget deficits raise interest rates."

[6]The exceptions using data from several countries include Nicoletti (1988), Haque (1988), Evans (1993) and Evans and Karras (1996).

controversial.[7] There are several reasons for mixed results: they are sensitive to the sample period, measurement of variables and variables included, and the estimation methods used.[8] Some of the major problems related to most empirical specifications of Ricardian equivalence can be characterized as follows. First, theoretical equations that are expressed in terms of expected future values, are often approximated in the empirical equations by a distributed lag on realized past values (see Haug (1990)).[9] Second, most of the studies do not estimate regression equations that derive from well-specified theoretical models nesting both Ricardian equivalence and an alternative theory in which budget deficits and current taxes are not equivalent (see Evans (1988, 1993)). Consequently, the results obtained are hard to interpret. Moreover, most of the literature uses nonrational expectations aggregate consumption function that is fundamentally inconsistent with the Ricardian equivalence hypothesis (see Flavin (1987)). Ricardian equivalence requires intertemporal utility maximization and rational expectations that together yield an Euler equation specification.[10] Third, it is not usually established whether the underlying permanent income model is supported by the data (the notable exception being Haug 1990, 1996). Fourth, conflicting results may result from the various measures of private consumption used in the estimations (see Graham (1992)).

On the basis of his recent literature survey Seater (1993) concludes that Ricardian equivalence holds as a close approximation despite its nearly certain invalidity as a literal description of the role of public debt in the economy. Although there appears to exist much empirical evidence suggesting the rejection of Ricardian equivalence, a large part of it fails to attend to econometric problems related to specification, simultaneity, and data stationarity, as well as to measurement of quantities involved. He holds that much of the published evidence on Ricardian equivalence, both supportive and contradictory, is therefore sufficiently flawed to be uninformative. He also points out that Ricardian equivalence appears true only under historical fiscal regimes. If societies change their behaviour with respect to public debt, significant effects of the debt might emerge. When considering whether the Ricardian equivalence is a good approximation to reality on the basis of a more recent evidence the conclusion,

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[7]Evidence consistent with Ricardian debt neutrality or tax disconting hypothesis and rational expectations includes Seater (1982), Kormendi (1983), Aschauer (1985), Seater and Mariano (1985), Kormendi and Meguire (1986, 1990), Haque (1988), Leiderman and Razin (1988), Evans (1988), Evans and Hasan (1994), Brunila (1996). Contradictory or mixed results are found in Feldstein (1982), Blinder and Deaton (1985), Modigliani and Sterling (1986, 1990), Bernheim (1987), Feldstein and Elmendorf (1990), Haug (1990), Graham and Himarios (1991, 1996), Evans (1993), Himarios (1995), Evans and Karras (1996), Ghatak and Ghatak (1996).

[8]For the detailed discussion on the questions concerning the estimation methods or those related to the measurement of variables, see Bernheim (1987), Leiderman and Blejer (1988), Graham (1992), Seater (1993), Himarios (1995) and Graham and Himarios (1996).

[9]Studies of Aschauer (1985), Evans (1988), Haug (1990) and Ghatak and Ghatak (1996) are exceptions.

[10]Only Aschauer (1985), Evans (1988), Haque (1988) and Leiderman and Razin (1988) follow such a procedure in the literature prior the 1990s. The more recent studies are almost invariably based on intertemporal utility maximization, eg Haug (1990, 1996), Graham and Himarios (1991, 1996), Evans (1993), Evans and Hasan (1994), Evans and Karras (1996).

however, seems to be opposite to that of Seater. Recent studies avoid also many of the weaknesses cited by Seater.

As regards to the degree of substitutability between private and government consumption the consensus opinion until the 1990s seems to have been that there is a degree of substitutability between public and private consumption. The more recent studies have, however, found that private consumption and government consumption tend to be rather complements than substitutes.[11] The results have proved to be particularly sensitive to empirical specification used and the measurement of variables (see Ni (1995)). Furthermore, since private consumption as well as government consumption are both extremely heterogeneous, the observed substitutability or complementarity might be related to the composition of these variables (see Evans and Karras (1996)). As some components of government consumption are perceived as close substitutes for private consumption, some might be perceived as complements, and some as unrelated, it is evident that the composition of government consumption matters.

Since the Ricardian equivalence hypothesis is essentially a generalization of the permanent income hypohesis one should test whether the underlying permanent income hypothesis is supported by the data before any far reaching conclusions on the validity of Ricardian equivalence can be made. Since the seminal work of Hall (1978), there has been an extensive empirical literature that has provided tests of the permanent income hypothesis. Almost all of this work has concluded that the permanent income hypothesis is not supported by the aggregate time series data on the ground that consumption has been found to be more sensitive to fluctuations in current income than predicted by the permanent income models. Much of this work has been devoted to estimating the fraction of income or consumption accruing from consumers who do not follow the permanent income hypothesis.[12] The existence of these non-optimizing rule of thumb consumrs has in turn been explained by liquidity constraints, although no direct evidence supporting this explanation is given.

Jappelli and Pagano (1989) using this method for an international time series data found that the fraction of consumption falling on non-optimizing rule of thumb consumers vary widely across countries, roughly from 40 per cent to 60 per cent. Similar results on international data was also found in Bayomi and Koujianou (1989). For the aggregate US data the fraction of income going to rule of thumb consumers appears to be in the range of 30 per cent to 50 per cent (Campbell and Mankiw (1989, 1990), Cushing (1992)). Campbell and Mankiw (1991) found that the estimates range from 20 per cent in Canada, through 35 per

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[11]Evidence supporting the view that government consumption substitutes for private consumption is presented in Kormendi (1983), Aschauer (1985), Graham and Himarios (1991), Brunila (1996). The opposite result implying that government consumption complements private consumption was found in Leiderman and Razin (1988), Haug (1990), Karras (1994), Evans and Karras (1996), Brunila (1997). In contrast to these, Modigliani and Sterling (1986, 1990), Feldstein and Elmendorf (1990) and Graham and Himarios (1991) found virtually no effect of government consumption on private consumption.

[12]A general approach to estimating has been the excess sensitivity model proposed by Hall (1978), Hayashi (1982) and Campbell and Mankiw (1989, 1990). The approach involves a random walk model for forward looking permanent income onsumption that is modified by simply adding the current income term in the equation to capture non-forward looking behaviour.

cent in Sweden and the US, to nearly 100 per cent in France. In a recent study by Evans and Karras (1996) the range in selected EU countries was found to be from 25 per cent to nearly 80 per cent.

Most of these studies neither allowed for, nor tested, the variation in the share of non-optimizing consumers. Bayomi and Koujianou (1989) as well as Campbell and Mankiw (1991) are the notable exceptions (see also Fissel and Jappelli (1990), and Patterson and Pesaran (1992)). Both Bayomi and Koujianou (1989) and Campbell and Mankiw (1991) investigate whether the fraction of non-optimizing consumers has changed post 1980, since it is often argued that financial liberalization during the 1980s has relaxed liquidity constraints in most countries which should show up in a fall in that fraction. Bayomi and Koujianou (1989) found a significant decline in the fraction of non-optimizing consumers while the results of Campbell and Mankiw (1991) do not support the idea that liquidity constraints have declined in importance over time.

The problem in both studies is that the estimated change in the fraction of rule of thumb consumers does not necessarily reflect changes in liquidity constraints, and even if it did, changes in liquidity constraints do not arise only on the part of financial markets but also on the part of consumers themselves (creditworthiness). It is possible that other factors, such as an increase in European unemployment in the late 1970s and 1980s have worked to offset the effects of financial deregulation on the fraction of rule of thumb consumers. It is also possible that the methods based on the use of dummy variables are simply not powerful enough to detect movements in that fraction over time.

Rather than purely trying to detect parameter changes, some studies have tried to link variations in the proportion of rule of thumb consumers to various structural factors. In aggregate time-series studies[13] Muellbauer (1982) uses the ratio of current disposable income to previous consumption, while Flavin (1985) uses the umenployment rate as a proxy for the proportion of the population subject to liquidity constraints. Muellbauer (1983) did not find a strong evidence in favour of liquidity constraints, while Flavin (1985) concludes that the estimated excess sensitivity of consumption to current income using unemployment rate as a proxy for the severity of liquidity constraints is large and statistically significant. More recently, using the UK regional data, Bayoumi (1990) looked for a special link with deregulation in financial markets. He estimated an excess sensitivity model in which the coefficient on current income was allowed to move in line with the ratio of consumer credit to GDP. Bayoumi found a significant negative relationship and concluded that financial deregulation was associated with a decrease in the proportion of rule of thumb consumers from 60 per cent in the 1970s to some 30 per cent by 1987.

All in all, empirical evidence on the excess sensitivity of consumption to current income suggests that tests on Ricardian equivalence should be supplemented by tests on the validity of the underlying permanent income model itself before any conclusions on the effects of fiscal deficits on private consumption and aggregate demand can be made.

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[13]In studies using household data, Zeldes (1989) and Runkle (1991) employ low asset holdings to separate their samples, while Jappelli (1990) utilizes survey questions.

1.2 Purpose of the paper

The purpose of this paper is to investigate the effects of fiscal policy on private consumption-saving decisions in a generalized permanent income framework with finite planning horizons and government consumption as a direct conveyer of utility to consumers. Finite horizons allows one to test which of the two main hypotheses - Ricardian or Keynesian - concerning the effect of fiscal deficits on private consumption is supported by the empirical evidence. By incorporating government consumption in the consumers' utility function one is able to test whether government consumption and private consumption are substitutes, complements, or unrelated. The model draws on the works of Hall (1978), Blanchard (1985) and Aschauer (1985).

The model is further extended by nesting the excess sensitivity hypothesis to the intertemporal optimizing framework to investigate whether the underlying finite horizon permanent income model is supported by the data. The extended model is based on the approach suggested by Hayashi (1982), and Campbell and Mankiw (1989). As a first step it is assumed that a constant share of disposable labour income accrues to non-optimizing rule of thumb consumers. In the second step the share of rule of thumb consumers is allowed to change over time.

The rest of the paper is organized as follows. Section 2 derives a finite horizon permanent income consumption function for the purpose of empirical estimation. The questions concerning the empirical implementation and method of estimation are discussed in section 3. Section 4 presents the data and estimation results. Section 5 derives an extended model with rule of thumb consumers and presents the estimation results obtained. Concluding remarks are drawn in section 6.

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 allows individuals to derive utility not only from private consumption but also from public consumption.[14] In order to be able to nest the Ricardian equivalence proposition and the conventional, non-Ricardian hypothesis Aschauer's representative agent model with an infinite horizon is modified by introducing a finite planning horizon in line with Blanchard's (1985) seminal paper. This modification introduces a wedge between the real rate of return on assets and the rate at which consumers discount their uncertain future disposable labour income, thereby causing Ricardian equivalence

[14]Eg Barro (1981) argued that a general model of consumption should include the direct effect of government consumption on private utility.

to fail. Ricardian equivalence holds only in the case when the discount rates on assets and labour income coincide.

The introduction of finitely lived consumers in the overlapping generations framework means that there is no simple and realistic way to derive an aggregate consumption function. Exact or even approximate aggregation is impossible, if the economy is realistically assumed to consist of an infinite number of generations with varying amounts and compositions of accumulated wealth, various time horizons and different propensities to consume out of wealth.[15]

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, the disconnectedness of current consumers from future generations, or as the myopia with which consumers foresee future taxes.[16] Modelling households as if they had finite horizons can also be viewed as a substitute for modelling capital market imperfections which may lead consumers to behave as if they had short horizons (see Evans (1988, 1993)). 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).[17]

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

[16]Blanchard (1985) 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).

[17]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[18]

Consumers are assumed to adjust their consumption according to their lifetime resources rather than to their current income.[19] In each period, each consumer is assumed to face a known probability of survival γ, 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 $1/(1-\gamma)$.[20]

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. Following Blanchard (1985) it is assumed that there exists riskless insurance (annuity) markets, where insurance (annuity) companies make (receive) every period an annuity payment to (from) each consumer holding positive (negative) financial wealth, and inherit all the consumers' wealth contingent on their death.[21] A zero-profit condition in these markets, together with the simple population structure and lifetime uncertainty, implies an effective, risk-adjusted interest factor of $(1+r)/\gamma$ for consumers, with (1+r) being the pure interest factor and $1/\gamma$ the annuity factor. The model excludes thus all bequest motives.

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

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

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 $u'' < 0$.

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

[19]As Flavin (1981) points out consumers' lifetime resources can be represented in stock form or flow form, the stock form being net worth, or the total expected lifetime wealth, and the flow form being permanent income, or the annuity value of net worth. Permanent income can then be thought of as the constant resource flow which, conditional of expectations in period t, can be sustained for the remainder of the consumer's time horizon.

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

[21] 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.

Following Bailey (1971) the total effective consumption c_t^T in period t is a linear combination[22] of private consumption c_t^P and a portion θ of government consumption g_t

$$c_{t,k}^T = c_{t,k}^P + \theta g_t, \quad \theta \gtrless 0 \tag{2}$$

A negative value for θ[23] 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).[24]

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

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

where

[22]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.

[23]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.

[24]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.

$h_{t,k}$ is period t real disposable labour income (human wealth) of a consumer of age k, defined as $y_{t,k} + \tau_{t,k} - t_{t,k}$[25]

$y_{t,k}$ is period t real before-tax labour income of a consumer of age k

$\tau_{t,k}$ 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 of a consumer of age k at the end of period t

$a_{t-1,k}$ real assets accumulated (or debt incurred) in period t−1 of a consumer of age k

r is a constant real rate of interest

Gross labour income y_t, government transfer payments τ_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 specification implies, however, that taxes as well as government transfers are age-specific while government consumption is not. The term $(1+r)/\gamma$ is the risk-adjusted gross rate of return on nonlabour assets (nonhuman wealth). 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 needed to prevent the consumer from running a Ponzi-game (see Blanchard and Fischer (1989)) where an infinite consumption and ever increasing debt burden is financed by new loans in each period. 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

[25] 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.

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

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

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

Since it is assumed that future disposable labour incomes are not known, human capital of a consumer of age k at time t is the discounted sum of expected future disposable labour incomes $E_t H_{t,k}$.[26] In the same vein, $E_t G_t$ denotes the discounted sum of expected future government consumption and $E_t W_{t,k}$ the present value of expected total wealth of a consumer of age k at time t.[27]

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 $\theta E_t G_t$ 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 consumption 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 intertemporal optimization problem with respect to total effective consumption c^T_t gives the Euler equations

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

[26]By focusing on disposable labour income instead of gross income, the impact of transfer payments is abstracted from the analysis. This is a valid approach if consumers perceive taxes and transfer payment symmetrically in which case transfer payments are merely negative taxes (see Barro (1974), Modigliani and Sterling (1986, 1990)). On arguments against this view, see Feldstein (1982), Kormendi (1982).

[27]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.

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. Although the quadratic formulation has some serious shortcomings (see Zeldes (1989)) it is widely used because it delivers a linear Euler equation which can easily be combined with the linear budget constraint to derive a closed-form solution to the consumption problem: a consumption function. Following Hall (1978) the one-period utility function is assumed to be of the form[28]

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

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

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

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 $r=\delta$ and $\theta=0$, 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

[28]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)). 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.

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

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 $E_t W_{t,k}$ of a consumer of age k still alive at time t+j and β_1 the constant marginal propensity to consume out of that wealth. The term $\beta_1 E_t W_{t,k}$ is essentially a generalization of Flavin's (1981) definition of permanent income to a finite horizon and utility function that encompasses also government consumption.

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[29] 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

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

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

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

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

[29] The model can easily be modified to allow for population growth by letting the birth rate exceed the death rate (see eg Weil (1987), Buiter (1988)). This would, however, complicate the exposition without adding substantially to the theoretical analysis (see Evans (1993)). By assuming a constant exogenous rate of population growth s, 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.

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

Equation (15) contrasted with equation (8) shows that the 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 rate applied to nonlabour assets. As the two types of wealth are discounted differently when the planning horizon of consumers is finite, ie when $0<\gamma<1$, government deficit financing is nonneutral.

By assuming that $r = \delta$, $\gamma = 1$ and $\theta = 0$, consumption function (15) reduces to Flavin's (1981) infinite horizon permanent income consumption function

$$c_t^P=ra_{t-1}+\frac{r}{1+r}E_t\sum_{j=0}^{\infty}(1+r)^{-j}h_{t+j}$$

where the right hand side of the equation is defined as permanent income. In this special case the Ricardian debt neutrality holds.

As shown by Campbell (1987) Flavin's permanent income consumption function can be expressed in an alternative form by defining total disposable income as $h_t^T \equiv ra_{t-1} + h_t$ and saving $s_t \equiv h_t^T - c_t^P$. Flavin's permanent income consumption function implies then that $s_t=-\sum_{j=0}^{\infty}(1+r)^{-j}\Delta h_{t+j}$, ie saving takes place when current disposable labour income is above permanent income and is expected to decline in the future.[30] More specifically, this formulation indicates that under infinite planning horizon saving equals the expected discounted value of future declines in disposable labour income.

Solving[31] equation (15) for c_t^P in terms of c_{t-1}^P, given the wealth constraint $a_t = h_t + (1+r)a_{t-1} - c_t^P$, gives (see Appendix 1)

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

---

[30]This implies also that if disposable labour income is first-order integrated, saving is stationary and total income and private consumption are cointegrated.

[31]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 with respect to consumers' planning horizon (hypothesis of infinite horizons is rejected) but not with respect to parameter structure.

where

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

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 as new information about future disposable income and government consumption becomes available. Hence, the unpredictable change in private consumption from t-1 to t is related to the changes in the expected lifetime wealth (ie permanent income) warranted by new information.[32]

Equation (16) gives the expression for aggregate per capita private consumption in terms of expected per capita human wealth, expected aggregate per capita wealth accruing from government consumption, lagged private consumption, current and lagged government consumption, and revisions in expectations. 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 a 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. The 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 bonds is discounted at the rate $1/(1+r)$. 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 bonds. 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 (γ=0), consumers treat government bonds fully as a net wealth.

A negative value for θ 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).

More specifically, with γ equal to unity, θ equal to zero and δ equal to r, equation (16) reduces to the Hall's (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.[33] The infinite horizon (γ=1) and the

---

[32]Stochastic, or transitory, component of consumption u_t, defined as zero-mean shocks to the utility function and measurement errors in consumption, is usually added to the error term. Flavin (1981), however, justifies neglecting transitory consumption on an aggregate level provided that individual realizations of transitory consumption are independently distributed across the population.

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

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 (θ=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 (16) is how to handle unobservable future path of disposable labour income h_{t+j} and government consumption g_{t+j}. One solution is to follow Hayashi's procedure (1982) and to use stochastic difference equations implied by the rational expectations assumption to eliminate the unobservables from the estimation equation. The advantage of this method is that one needs not to specify the stochastic processes for disposable labour income and government consumption.[34] Accordingly, the following difference equations are postulated

$$\begin{aligned} E_tH_t - \frac{1+r}{\gamma}E_{t-1}H_{t-1} &= -\frac{1+r}{\gamma}h_{t-1} + e_{Ht} \\ E_tG_t - \frac{1+r}{\gamma}E_{t-1}G_{t-1} &= -\frac{1+r}{\gamma}g_{t-1} + e_{Gt} \end{aligned} \tag{17}$$

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

$$\begin{aligned} e_{Ht} &= \sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j (E_t - E_{t-1})h_{t+j} \\ e_{Gt} &= \sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j (E_t - E_{t-1})g_{t+j} \end{aligned}$$

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

[34] 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 consumption. 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.

correlated with variables dated period t and contemporaneously correlated with each other.

Using equations (17) to form $c_t^P - [(1+r)/\gamma]c_{t-1}^P$ the unobservable variables can be removed from equation (16). Rearranging gives the expression for c_t^P in terms of observable variables:

$$c_t^P = \beta_0' + \left[(1+r)(1-\beta_1) + \frac{1+r}{\gamma}\right]c_{t-1}^P - (1-\beta_1)\frac{(1+r)^2}{\gamma}c_{t-2}^P$$

$$-\beta_1(1-\gamma)\frac{1+r}{\gamma}h_{t-1} - \theta g_t + \theta(1-\beta_1+\gamma)\frac{1+r}{\gamma}g_{t-1} \tag{18}$$

$$-\theta(1-\beta_1)\frac{(1+r)^2}{\gamma}g_{t-2} + \nu_t$$

where

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

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

$$\nu_t = \beta_1\varepsilon_t - \frac{1+r}{\gamma}\beta_1\varepsilon_{t-1} + \beta_1(1-\gamma)e_{Ht} + \theta\beta_1(1-\gamma)e_{Gt}$$

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 (18) 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[35] introduces a first-order moving average term into the lagged consumption expenditure.[36] 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

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

[36]Working (1960) shows that averaging a random walk induces serial correlation between the contemporaneous value and the first difference, but not earlier lags, making first lags invalid instruments. See also Campbell and Mankiw (1990) for time aggregation and Mankiw (1982) for durability.

variables in equation (18). 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_{Ht} and e_{Gt} are orthogonal to the information set at time t−1, I_{t-1}, they might not be orthogonal to h_t and g_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_{Ht} and e_{Gt}.

These arguments for twice-lagging the instruments imply that the error term in equation (18) 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.

GMM both produces robust estimates of the parameters and a test for the model adequacy and the validity of orthogonality conditions implied by the rational expectations hypothesis. Hansen's (1982) overidentifying restrictions test (J-test) is constructed as the sample size times the minimized value of the GMM objective function and has an asymptotic chi-square distribution under the null hypothesis of no misspecification, where the degrees of freedom of the limiting distribution is given by the number of overidentifying restrictions, ie the number of orthogonality (moment) conditions minus the number of parameters to be estimated.

In order for the GMM estimator to be asymptotically justifiable, all variables should be stationary. Nonstationarity would be a problem when estimating in levels,[37] 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, h_{t-1} to obtain stationarity or to estimate equation (18) in the first difference form. The problem in transforming the equation into difference form is that lagged values of Δc_t as instruments do not explain a large fraction of the variance of Δc_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 West (1988) and Sims, Stock and Watson (1990)

[37]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.

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 (18), and the set of variables used in the empirical estimation should be cointegrated. It is shown in the Appendix 3 that the conditions required for estimating in levels are fulfilled for equation (18).

Since the equation (18) 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 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.

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 may extend 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 to compute the imputed services from durable goods, no reliable method exists so far.[38]

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.[39] 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

[38]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).

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

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,[40] 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.[41]

The appropriate definition of labour income is not without problems either. Eg Flavin (1981) and Bernanke (1985) suggest that it may be preferable to use total personal income since innovations in this measure reflect unanticipated capital gains better than other more narrowly defined income measures like wage income. The theoretical model, however, suggests using some measure of non-property income, that includes employers' contributions to social security and pension funds and excludes items like rent, dividends, and interest receipts.

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: albeit consumers may perceive some components of government consumption as close substitutes for private consumption, some items might be perceived as complements, and some as unrelated. This suggests that the measure of government consumption should not treat all expenditures as a one homogenous group. 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

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[40]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)).

[41]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).

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

The annual time series data are from the OECD National Accounts and the sample consists ten EU countries listed in Table 1. The criterion for including a country was the availability of at least thirty observations for the actual estimation period given that some observations are lost due to the use of lagged instruments. Detailed description of the data is given in the Appendix 4.

Table 1. **Countries is the sample and estimation period**

Country	Estimation period
Austria	1963-1994
Belgium	1964-1994
Finland	1963-1995
France	1964-1993
Germany	1963-1993
Greece	1964-1994
Italy	1964-1994
Netherlands	1965-1994
Sweden	1964-1994
UK	1963-1994

Private consumption c_t^P is measured by per capita total private consumption expenditures at constant prices, disposable labour income h_t is measured by per capita total personal income less per capita household income taxes and other direct taxes for Finland, France, Germany, Italy, Sweden and the UK and by per capita non-property income plus government transfer payments less household income taxes and other direct taxes for Austria, Belgium, Greece and the Netherlands. The income measure for a country is chosen on the ground of prior examination of the time series properties of the data and data availability. Government consumption g_t is measured by general government final consumption expenditures per capita at constant prices.

The instrument set consists of the second and third lag of total private consumption, disposable labour income and government consumption. All instruments are measured in per capita terms.[42] In addition a dummy variable D91–93 is included in the regressions concerning Finland on the ground that during these years the Finnish economy was hit by an unexceptionally deep recession and severe banking crisis.[43] The inclusion of this dummy is supported by prior examination of the data and it leads also to a more satisfactory performance of the estimated model. The use of a dummy in this way is of course open to the objection of data mining.

The real interest rate was fixed to 3 % p.a. in the estimations.[44] All data not already valued at constant prices are deflated by the price deflator implied by the ratio of nominal total private consumption expenditures to those valued at constant 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.[45]

Table 2 presents the country-specific estimates of β_1, γ and θ with their autocorrelation and heteroscedasticity consistent standard errors over the sample periods given in Table 1. Estimations were performed assuming $r = \delta$, which is a common assumption in empirical studies based on permanent income hypothesis.

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[42]It is important to note that there are several possible instrumental variables that can be used in the GMM estimation. Ideally, one should derive an efficiency bound for the asymptotic covariance matrices of the GMM estimators and optimal instruments that achieve a lower bound. Instead of this a number of experiments were undertaken with several instrument sets. The results were, however, less satisfactory than those based on the chosen instrument sets. In general, the results do not appear to be significantly affected by the choice of instruments. However, some results proved to be to some extent sensitive to the number of lags included in the sense that the higher the number of lags, the more efficient the estimates.

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

[44]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 several countries in the sample in the 1970s.

[45]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).

Due to this assumption the constant term $\beta_0^{'}$ in equation (18) drops out and the parameter measuring the propensity to consume out of total expected wealth, β_1 equals $(1+r-\gamma)/(1+r)$. This assumption is also justified by the data, since the restriction $\beta_0^{'} = 0$ could not be rejected by the Wald test at conventional levels of significance for any of the countries in the sample.

Table 2. **GMM estimation of equation (18) for selected EU countries**[46]

	β	γ	θ	P-value	Wald-test
Austria					
Unrestricted	.450	.946	-2.391	0.714	
	(.242)	(.042)	(1.379)		
Restrictions					
$\gamma = 1$	-.028		-6.049	0.914	1.659
	(.164)		(4.859)		(0.198)
$\theta = 0$	.410	.962		0.294	3.006
	(.199)	(.028)			(0.083)
$\gamma = 1, \theta = 0$	.241			0.270	3.008
	(.226)				(0.222)
Belgium					
Unrestricted	.063	.900	-3.629	0.758	
	(.536)	(.336)	(5.729)		
Restrictions					
$\gamma = 1$	.263		.406	0.733	0.087
	(.214)		(2.014)		(0.767)
$\theta = 0$	.275	.985		0.751	0.401
	(.183)	(.034)			(0.526)
$\gamma = 1, \theta = 0$	.292			0.818	2.039
	(.188)				(0.361)
Finland					
Unrestricted	.674	.875	3.948	0.966	
	(.070)	(.076)	(2.197)		
Restrictions					
$\gamma = 1$	.613		2.958	0.725	2.698
	(.063)		(1.662)		(0.100)
$\theta = 0$	1.030	.975		0.249	3.231
	(.172)	(.051)			(0.072)
$\gamma = 1, \theta = 0$	.970			0.354	4.349
	(.146)				(0.114)

[46] Due to somewhat inconclusive results of the unit root tests the equation was estimated also using transformed variables suggested by Campbell and Deaton (1989). The conclusions remained roughly the same, the major differences being in the efficiency of estimates. The transformed variables tend to produce more efficient estimates than those obtained in the level form.

Table 2 (continued)

	β	γ	θ	P-value	Wald-test
France					
Unrestricted	.560	.989	.088	0.170	
	(.229)	(.018)	(1.893)		
Restrictions					
$\gamma = 1$	−.124		2.003	0.348	0.329
	(.196)		(2.129)		(0.566)
$\theta = 0$	.566	.990		0.293	0.002
	(.220)	(.011)			(0.963)
$\gamma = 1, \theta = 0$	.473			0.374	0.708
	(.153)				(0.702)
Germany					
Unrestricted	.507	1.052	−2.782	0.336	
	(.323)	(.039)	(1.632)		
Restrictions					
$\gamma = 1$	.476		−1.985	0.177	1.766
	(.212)		(.820)		(0.184)
$\theta = 0$	.667	1.007		0.476	2.907
	(.178)	(.014)			(0.088)
$\gamma = 1, \theta = 0$	.654			0.540	3.337
	(.167)				(0.188)
Greece					
Unrestricted	.876	1.003	−4.109	0.197	
	(.327)	(.076)	(.731)		
Restrictions					
$\gamma = 1$	.880		−4.267	0.313	0.203
	(.313)		(.682)		(0.652)
$\theta = 0$	.182	.982		0.218	31.611
	(.150)	(.030)			(0.000)
$\gamma = 1, \theta = 0$	.132			0.299	40.002
	(.160)				(0.000)
Italy					
Unrestricted	.673	1.015	2.740	0.258	
	(.156)	(.012)	(2.349)		
Restrictions					
$\gamma = 1$	.615		3.306	0.260	1.445
	(.138)		(2.258)		(0.229)
$\theta = 0$	.686	1.028		0.258	1.360
	(.149)	(.010)			(0.243)
$\gamma = 1, \theta = 0$	.448			0.108	4.760
	(.150)				(0.092)

Table 2 (continued)

	β	γ	θ	P-value	Wald-test
Netherlands					
Unrestricted	.755	.939	-1.982	0.556	
	(.175)	(.021)	(.507)		
Restrictions					
$\gamma = 1$	.546		-1.805	0.473	8.396
	(.104)		(.571)		(0.004)
$\theta = 0$	.609	.953		0.331	15.293
	(.133)	(.029)			(0.000)
$\gamma = 1, \theta = 0$	.474			0.402	22.557
	(.089)				(0.000)
Sweden					
Unrestricted	.677	.937	-.425	0.971	
	(.353)	(.016)	(.648)		
Restrictions					
$\gamma = 1$	.043		-.358	0.733	16.300
	(.186)		(1.171)		(0.000)
$\theta = 0$	.520	.932		0.984	0.430
	(.287)	(.020)			(0.512)
$\gamma = 1, \theta = 0$	.022			0.845	19.701
	(.183)				(0.000)
UK					
Unrestricted	.724	.778	7.494	0.913	
	(.730)	(.108)	(10.274)		
Restrictions					
$\gamma = 1$	.064		8.342	0.931	4.173
	(.141)		(5.120)		(0.041)
$\theta = 0$	.452	1.055		0.457	0.532
	(.272)	(.102)			(0.466)
$\gamma = 1, \theta = 0$	.649			0.460	13.036
	(.140)				(0.001)

Notes: Heteroscedasticity and autocorrelation-consistent standard errors are in parentheses. P-value is the significance level of the validity of overidentifying restrictions (J-test). 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 second and third lag of private consumption, government consumption and disposable labour income. Detailed description of country-specific differences in the lag structure of instuments is given in Appendix 4.

The probability value associated with the orhogonality constraints (P-value) is shown in the fourth column in Table 2. The general conclusion to be drawn is that the model performs satisfactorily for all countries: tests of the overidentifying restrictions do not reject the model while the estimates of γ and θ as well as their stanrdard errors are not overly sensitive to various specifications. Specifically, the estimates of γ turn out to be statistically significant and of the expected sign and magnitude for all countries whereas the parameter value for θ remains unidentified for most of the countries in the sample. The main anomaly pertains to the results for β_1, where the coefficient is almost invariably too high given the overall parameter structure.

The unrestricted estimate of γ proves to be close to unity and statistically significant at 1 per cent level for Austria, France, Germany, Greece and Italy. Moreover, the hypothesis of an infinite planning horizon ($\gamma=1$) cannot be rejected for these countries at conventional levels of significance. For Belgium, Finland, the Netherlands, Sweden and the UK the estimate of γ proves to be somewhat lower, varying in the range of .78 to .94. The restriction $\gamma=1$ is rejected at 5 per cent significance level for the Netherlands, Sweden and the UK, while for Finland it can be rejected only at 10 per cent significance level. Finally, for Belgium the restriction cannot be rejected by the Wald test. The results seem thus to give some support for the Ricardian neutrality hypothesis and infinite planning horizon as a valid approximation of the consumer behaviour in six out of ten EU countries in the sample. This suggests that consumers in these six countries are sufficiently Ricardian in their behaviour to increase their saving one-to-one with increases in the government deficit financing whereas in the remaining four countries a part of the government debt accumulation is treated as net wealth and hence, private saving increases less than one-to-one with increases in the budget deficit.

Under the restriction $\theta=0$ the values of γ appear to be broadly consistent with the unrestricted ones. In the case of Belgium, Finland and the UK the imposition of this restriction results in an increased value of γ.

The unrestricted estimate of β_1 turns out to be excessively high in all but one country. An infinite planning horizon implied by the estimated values of γ or even a planning horizon of approximately sixteen years as in the case of Sweden and the Netherlands renders the values of β_1 economically unplausible.[47] This anomalious result might be due to measurement errors in consumption and disposable labour income and more importantly, due to liquidity constraints[48] that decrease consumers' ability for intertemporal consumption smoothing and make consumption excessively sensitive to current income to conform the predictions of intertemporal optimization (see Flavin (1981)).[49] Under the restriction $\gamma=1$ the estimates of β_1 tend to decrease slightly in some countries or get the wrong sign and become statistically insignificant. The values of β_1 seem also to be sensitive to the restriction imposed on θ.

The parameter estimates of θ are not statistically different from zero for most of the countries suggesting that government consumption and private consumption

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[47]The estimated value of γ .94 for Sweden implies a planning horizon of roughly sixteen years whereas the value of β around .68 implies a planning horizon of only one and a half years!

[48]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.

[49]The anomalious result may be partly due to the mathematical solution in which nonlabour wealth is eliminated from the estimation equation (see Appendix 1). Some support to this can be found in Himarios's (1995) comparative sudy where the estimated value of the parameter β_1 is in line with the values reported here when using a consumption function based on an equivalent mathetical solution. When estimations were based on solutions including nonlabour wealth as a right hand variable, the values of β_1 dropped significantly and were, in general, consistent with those obtained for the parameter γ. See note (31) in page 22.

tend to be unrelated. In fact, the unrestricted estimate of θ turn out to be statistically significant only for Greece and the Netherlands at conventional levels of significance. At 10 per cent significance level it is statistically significant also for Austria, Finland and Germany. For Austria, Germany, Greece and the Netherlands θ is negative implying that government consumption is a complement to private consumption whereas for Finland θ turns out to be positive indicating substitutability instead of complementarity. The restriction $\theta=0$ is rejected by the Wald test at 5 per cent significance level for Greece and the Netherlands and at 10 per cent level for Austria, Finland and Germany.

Finally, the joint restriction, $\gamma=1$ and $\theta=0$, cannot be rejected at 5 per cent significance level for Austria, Belgium, Finland, France, Germany and Italy whereas it is strongly rejected for Greece, the Netherlands, Sweden and the UK. The consumption model for the first group of countries is thus in line with Flavin's (1981) infinite horizon permanent income model, the major empirical inconsistency being excessively high values for β_1 in these countries.

4.3 Panel estimation results

Since empirical results for individual countries may suffer from various econometric shortcoming due to relatively short sample periods, the data is used as a panel for the ten EU countries in the sample. Specifically, country-specific panel data provide several benefits for econometric estimation since the data contain information with regard to intercountry differences in private consumption behaviour as well as its time variation in each country. The general structure of the estimated fixed effect or within model can be written as

$$c_{it}^{P}=\alpha_0+\alpha_i+\mu'X_{it}+\varepsilon_{it}, \qquad t=1,...,T_i \text{ and } i=1,...,N.$$

where c_{it}^{P} denotes aggregate per capita private consumption in country i at time t, α_0 and α_i are parameters, $\mathbf{X}_{it}$ is a vector of variables including the interest rate and predetermined variables for country i at time t, and ϵ_{it} is the error term.

The estimates are obtained by allowing a fixed effect for each country, ie allowing a different intercept for each country regression. The parameter α_{1i} = α_0 + α_i is the intercept of the ith country, where α_0 is the mean intercept and α_i represents the unobservable country-specific effect calculated as the difference from the mean for the ith country. The hypothesis that the intercepts are aqual across the countries is then tested by the Wald-test.

To obtain asymptotically efficient estimates of panel data without imposing either conditional homoscedasticity or independence over time on the disturbances of the model, the GMM estimator proposed by Hansen and Singleton (1982)[50] is used. Since the estimation period differs across countries the panel is unbalanced. The use of unbalanced panel data gives 314 observations.

The panel estimations were run using three different measures for disposable labour income to check the robustness of results with respect to income variable.

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[50]See also Arellano and Bond (1991).

The first line in Table 3 gives the unrestricted panel estimates of β_1, γ and θ with their autocorrelation and heteroscedasticity consistent standard errors using the same disposable income measure as in the country-specific estimations (see Chapter 4.1). The results reported in the second line are from estimations where disposable income is measured by total personal income less household income taxes and other direct taxes for all countries except Greece and the Netherlands where data on total personal income was not available.[51] The third line gives the results using non-property income plus government transfer payments less household income taxes and other direct taxes as a measure of income for all countries in the sample. A fixed real interest rate of 3 per cent is used in all estimations.

As shown in the table the panel estimation results are broadly in line with the conclusions made on the basis of separate country-specific estimations. The results prove also to be robust with respect to various measures of income. The unrestricted estimate of γ turns out to be close to unity and statistically significant at 1 per cent level. As expected, the restriction γ=1 cannot be rejected by the Wald-test.

Table 3. **GMM estimation of equation (18) using a panel of 10 EU-countries**

	Unrestricted estimates				Wald-test			
	β	γ	θ	P-value	γ=1	θ=0	γ=1 θ=0	Equal intercepts
r=0.03								
Country-specific	.449 (.105)	.996 (.007)	−1.234 (.450)	0.988	0.266 (0.606)	7.529 (0.006)	8.799 (0.012)	3.596 (0.936)
Total income	.465 (.110)	.998 (.005)	−1.171 (.361)	0.862	0.180 (0.671)	10.543 (0.001)	21.333 (0.000)	11.221 (0.261)
Non-property income	.314 (.113)	1.010 (.012)	−1.044 (.641)	0.638	0.632 (0.427)	2.654 (0.103)	4.077 (0.130)	6.272 (0.712)
r=0.05								
Country-specific	.223 (.115)	1.007 (.017)	−2.297 (.481)	0.779	0.158 (0.691)	22.840 (0.000)	23.030 (0.000)	8.315 (0.503)
Total income	.209 (.115)	1.008 (.014)	−2.365 (.518)	0.438	0.302 (0.582)	20.865 (0.000)	20.873 (0.000)	11.942 (0.216)
Non-property income	.194 (.127)	1.028 (.027)	−2.110 (.345)	0.827	1.090 (0.296)	37.455 (0.000)	61.164 (0.000)	7.294 (0.505)

Notes: Heteroscedasticity and autocorrelation-consistent standard errors are in parentheses. P-value is the significance level of the validity of overidentifying restrictions (J-test). The Wald-test is for the validity of the imposed restrictions with its significance level in parentheses. The instruments for the unrestricted and restricted specifications include the second and third lag of private consumption, government consumption, disposable labour income and nine country-dummies.

[51] For these two countries non-property income plus government transfer payments was used instead of total personal income.

The unrestricted estimate of θ is negative and statistically significant indicating that private consumption and government consumption are rather complements than substitutes. This result is well in line with the ones found in two recent studies by Karras (1994) and Evans and Karras (1996). The restriction $\theta=0$ and the joint hypothesis, $\gamma=1$ and $\theta=0$, are rejected by the Wald-test at 1 per cent significance level when using the first two income variables. When income is measured by non-property income, ie excluding rent, dividens and interest income, the restrictions cannot be rejected at conventional levels of significance.

The unobservable country-specific effects (not reported in the table) proved to be statistically unsignificant for each country. As expected, the hypothesis that the intercepts are equal across the countries cannot be rejected by the Wald-test.

To check the robustness of the results with respect to the interest rate the panel estimation is also run using a given real interest rate of 5 per cent. The fourth, fifth and sixth lines in Table 3 give the estimates of β_1, γ and θ under the assumption of a 5 per cent real interest rate. The estimate of γ proves to be robust whereas the values of β_1 and θ are found to be somewhat sensitive to the interest rate applied. The interest rate sensitivity of β_1 is obvious from the theoretical model, where β_1 is equal to $(1+r-\gamma)/(1+r)$ when the subjective rate of time preference, δ, is assumed to be equal to the real rate of interest r. According to the results β_1 decreases with the increases in the interest rate. With γ virtually unchanged this is, however, unplausible and in fact, exactly the opposite to what one would expect. For lack of better explanations this contradictory result is likely to arise due to the problems associated with the estimation of β_1 in general.

As regards the parameter θ, its absolute value and statistical significance increase with the increases in the real interest rate making the complementarity of government consumption and private consumption stronger in both cases. The interest rate sensitivity of the parameter θ was reported also in the recent study by Ni (1995). He noted that due to the fact that government consumption is relatively small compared to private consumption the GMM estimates of θ might become sensitive to the measurement of interest rates. Finally, the rejection $\theta=0$ and the joint rejection, $\gamma=1$ and $\theta=0$, are strongly rejected by the Wald-test irrespective of the income measure used.

So far, it has been assumed that the GMM estimates are structurally stable over the sample period. This assumption is required the for asymptotic properties of the GMM estimates to hold and the Hansen's J-test to remain valid asymptotically. Structural instability over the sample period will invalidate conventional significance test and can yield misleading parameter estimates. A potential candidate causing structural instability would be the financial market liberalization that took place in the majority of countries included in the sample during the 1980s. The major implication of this with respect to private consumption is that by improving the borrowing possibilities of consumers it should also improve the possibility for intertemporal consumption smoothing inherent in the underlying theoretical model compared to the situation in the 1960s and early 1970s.

Table 4. **GMM estimation of equation (18) using a panel of 10 EU-countries for the subperiod starting from the mid 1970s**

	Unrestricted estimates				Wald-test			
	β	γ	θ	P-value	$\gamma=1$	$\theta=0$	$\gamma=1$ $\theta=0$	Equal intercepts
r = 0.03								
Country-specific	.383 (.119)	1.002 (.009)	-1.644 (.490)	0.999	0.079 (0.779)	11.246 (0.001)	11.497 (0.003)	11.438 (0.247)
Total income	.410 (.115)	1.007 (.007)	-1.799 (.461)	0.784	0.938 (0.333)	15.252 (0.000)	15.275 (0.000)	23.251 (0.006)
Non-property income	.284 (.127)	1.017 (.016)	-1.356 (.433)	0.892	1.198 (0.274)	9.799 (0.002)	15.196 (0.000)	12.074 (0.209)

Notes: See Table 3.

In order to investigate the stability of parameters the consumption equation is estimated for the period starting from the mid 1970s. The resulting subsample consists of 194 observations and the results are presented in Table 4. When comparing the results obtained from the subsample to those of the total sample with 3 per cent interest rate (Table 3), the obvious conclusion is that the parameter estimates seem not to be overly sensitive to the estimation period. In fact, the results are remarkably similar suggesting that structural instability does not pose any serious problems for the validity of results. It should, however, be noted that the hypothesis of equal intercepts is rejected by the Wald-test in two out of three cases depending on the income variable used. This result is entirely due to the Finnish data since the unobservable country-effect (not reported in the table) proved to be statistically significant only for Finland. The apparent explanation for this is the severe recession hit by the economy in the 1990s, the effect of which was controlled by a dummy-variable in the country-specific estimations (see Chapter 4.1).

5 The excess sensitivity hypothesis

The empirical evidence on the Ricardian equivalence hypothesis presented in Chapter 4.2 proved to be inconclusive due to the inconsistencies found in the parameter structure. On the one hand, the results from the country-specific as well as panel estimations seem to give a strong support for an infinite planning horizon on the part of consumers, and thus for Ricardian debt neutrality. On the other hand, the excessively high propensity to consume out of total expected wealth found in the estimations is not compatible with an infinite horizon, but in fact, itself suggests a rather short one.

The existence of liquidity constraints[52] would provide a tempting explanation for the unplausibly high estimates for the propensity to consume out of wealth due to the well known fact that if capital market imperfections prevent consumers from borrowing to smooth consumption over transitory fluctuations in income consumption becomes constrained by current income. In this case actual consumption and transitory income will be positively correlated and the marginal propensity to consume out of transitory income will be positive instead of being zero. Only when consumers have free access to capital markets the maximization of lifetime utility subject to an overall lifetime budget constraint leads to the independence of current consumption from transitory fluctuations in current income. Liquidity constraints by preventing the consumer from realizing her desired (optimal) consumption plan can, therefore, cause private consumption to be too sensitive to current income to conform the predictions of the intertemporal optimizing framework even if consumers were rational and forward-looking.

Thus, if the assumption of perfect capital markets is violated, empirical consumption functions derived from the forward-looking permanent income models are likely to suffer from misspecification problems and specificly, the omission of liquidity constraints can bias the estimate of the propensity to consume out of wealth upwards. This implies that before making any far-reaching conclusions about the validity of Ricardian equivalence and its economic policy implications the finite horizon permanent income model derived in Chapter 2.1 has to be extended to incorporate also the effects of current income on consumption. One can then test, whether the underlying permanent income model is supported by the data.

5.1 Modeling liquidity constraints or the excess sensitivity of demand?

Since Flavin (1981, 1985)[53] there has emerged a large body of empirical studies based on aggregate time series data that give strong support to the hypothesis that consumption is more sensitive to current income than warranted by the forward looking rational expectations-permanent income hypothesis. Although there are

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[52]A variety of forms of liquidity constraints have been examined in the literature, each of which involves some price and/or quantity restrictions on the borrowing. Borrowing constraints can arise when individuals have private information about their future labour income or riskiness of the project to be financed. The resulting adverse selection and/or moral hazard problems can lead to credit rationing, a market failure that would not arise under perfect information (see Stiglitz and Weiss (1981)). According to Hayashi (1985) the most widely accepted definition of liquidity constraints is that consumers are said to be liquidity constrained if they face quantity constraints on the amount of borrowing (credit rationing) or if the loan rates available to them are higher that the rate at which they could lend (differential rates).

[53]Flavin (1985) asks if the excess sensitivity of consumption to current income is due to liquidity constraints or myopia in the sense that the marginal propensity to consume out of transitory income is non-zero. Flavin concludes that the findings indicate that a simple consumption function with non-zero marginal propensity to consume out of transitory income is an incomplete model and suggests that liquidity constraints rather than myopic behaviour explain the observed excess sensitivity of consumption to current income.

several reasons that make the interpretation of the results rather problematic, the general conclusion has been that the found excess sensitivity can be regarded as evidence on the existence of liquidity constraints (see Jappelli and Pagano (1989), Campbell and Mankiw (1989)). This interpretation can be called in question first of all due to the fact that empirical estimations refered to are not based on well-specified theoretical models incorporating liquidity constraints. Instead the standard approach in the context of aggregate data has been the one suggested by Hall (1978), Hayashi (1982), and Campbell and Mankiw (1989, 1990)[54] where the excess sensitivity of consumption to predictable changes in income is accounted for by a constant fraction of the population behaving as Keynesian non-optimizing rule of thumb consumers.[55] This simple Keynesian consumption function is then nested to the forward-looking permanent income model (Euler-equation) by assuming that aggregate per capita consumption is equal to a weighted average of the two types of consumers, with weights λ and $1-\lambda$. The parameter λ is then interpreted as the fraction of income accruing from liquidity constrained consumers and $1-\lambda$ as the fraction accruing from forward-looking permanent income consumers. To be specific, the interpretation should rather be that λ denotes the degree of excess sensitivity of consumption to current income compared to the case where every consumer behaves according to the forward-looking permanent income hypothesis.

If the consumption equation characterizing the behaviour of the rule of thumb consumers is attributed to liquidity constraints, one must assume that there are both borrowing and lending constraints that are binding in every period,[56] which is not a very palusible assumption. If only borrowing constraint is assumed, individuals must be choosing never to save. This means that individuals must want to consume more than what they earn and must have run down their net asset positions. However, under rational behaviour, there is no general presumption that liquidity constrained consumers consume all their current disposable labour income and that an increase in this income would be entirely reflected in an increase in consumption. As individuals generally receive both good and bad draws of income, they will choose to save in good times to avoid declines in the consumption during bad times. Instead of being liquidity constrained the simple Keynesian behaviour followed by the rule of thumb consumers may be justified by myopia in which case consumers do not take into account the future consequences of current fiscal policy.

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[54]This has been adopted as a standard approach to incorporate liquidity constraints in the models testing Ricardian equivalence in the context of the permanent income hypothesis, see Cushing (1992), Heijdra and van Dalen (1996), Himarios (1995), Leiderman and Razin (1988), Evans and Karras (1996).

[55]Rule of thumb consumers are assumed to have no assets nor access to the capital markets and the best they can do is to consume all their disposable income. This rule of thumb or simple Keynesian policy is not generally optimal in the presence of borrowing constraints. The random walk case is one of several income processes that produce the result. When income is a random walk, it turns out that those who wish to borrow but cannot do so typically can do no better than consume their incomes (see Deaton (1991)).

[56]This does not mean that if liquidity constraints are not binding consumption behaviour is unaffected.

Attempts to model liquidity constraints in a more satisfactory manner include Mariger (1987), Zeldes (1989) and Deaton (1991). In general, this is done by adding to the consumer's optimization problem an additional constraint (an exogenous quantity constraint on assets faced by consumers) which reflects limited borrowing opportunities for some consumers. The resulting Euler equation for consumption has then an additional term which reflects the shadow price of borrowing, that is time dependent. This means that if liquidity constraints affect consumers' behaviour along the lines suggested by Zeldes (1989) and others, the fraction of liquidity constrained consumers is endogenous and cannot be taken as a constant over time. The problem in this approach is that there is no tractable closed-form solution for the purpose of estimation. Furthermore, attempts to formalize liquidity constraints have not led to directly testable implications for the reason that the key variable, which is the shadow price of borrowing, is not observable. Due to these problems, the rule of thumb model with a constant share of liquidity constrained consumers is used as a first approximation despite its obvious shortcomings and interpretational difficulties.[57]

Second, distinguishing the effects of liquidity constraints from other sources of misspecification with aggregate data is fairly impossible. Recent research has shown that the excess sensitivity, if found in the data, may also arise from improper aggregation over consumers and/or over time, or from imposing auxiliary restrictions on preferences, like quadratic preferences and the separability between consumption and leisure in the utility function, or from ingoring habit formation (see Hayashi (1985), Hall (1987), Campbell and Mankiw (1989), Gali (1990), Attanasio and Weber (1993), Goodfriend (1992), Pischke (1995)). Moreover, the excess sensitivity can be due to the failure of other assumptions required by models based on rational expectations-permanent income hypothesis, such as consumers' ability to make rational forecasts of future income, taxes, transfer payments, government consumption and other relevant variables.

The third problem is related to the second in the sense that to be able to solve the second problem, ie to be able to distinguish the effect of liquidity constraints from other explanations would obviously require panel data on individual households. The problem, however, is that this kind of data is not readily available, and even if it were available, liquidity constrained consumers are not directly observable. In the absence of a direct measure of liquidity constrained consumers analyses has to be based on various proxy variables and sample splitting methods that in itself are not without problems either (see Jappelli (1990)).

Since the problems related to the proper modeling of liquidity constraints in an intertemporal maximization framework with rational expectations has proved to raise nearly insurmountable obstacles at least from the point of view of empirical tractability and due to problems related to proper measurement of the extent of liquidity constraints, there is no attempt in the present study to model liquidity constraints endogenously. Instead the primary objective of this chapter is to investigate whether the inconsistencies in the parameter structure discussed in

[57]To my knowledge, only Jappelli and Pagano (1989), and Evans and Karras (1996) try to investigate the validity to interprete the parameter λ as the fraction of income accruing from liquidity constraint consumers in the context of aggregate time series data. The evidence presented in these studies support the hypothesis of liquidity constraints.

Chapter 4.2 and above could be explained by the excess sensitivity of consumption to current income. This is done by using the familiar λ-model, which means that the results cannot be interpreted as a direct evidence on the prevalence of liquidity constraints. This does not invalidate the main purpose of the study, since the objective here is not to explain liquidity constraints per se, but to detect whether there are any significant deviations from the underlying permanent income model derived in Chapter 2.1, of which the excessively high estimates of the parameter β_1 could be an indication.

Despite the limitations associated with the chosen approach, it has important implications when assessing the validity of Ricardian debt neutrality suggested by the results in Chapter 4.2. If private consumption is found to be excessively sensitive to current income, the obvious consequence is that the underlying permanent income model is misspecified, and that government budget deficits will have real effects even if all consumers optimize over an infinite horizon (eg $\gamma=1$). Hence, under excess sensitivity private consumption is not invariant to changes in government taxes and transfer policies and the Ricardian equivalence proposition fails giving a larger scope for anticyclical fiscal policy.

5.2 An extended permanent income model (λ-model)

If the excess sensitivity of consumption is at the root of empirical anomalies found in Chapter 4.2, one would expect that the inclusion of current income in the consumption function reduces the estimates of the parameter β_1 that measures the propensity to consume out of total expected wealth. This is tested by nesting the excess sensitivity hypothesis to the finite horizon permanent income consumption function (15) by assuming two types of consumers along the line proposed by Hall (1978), Hayashi (1982) and Campbell and Mankiw (1989, 1990). Thus, aggregate per capita consumption is assumed to be a weighted average with weights λ and $1-\lambda$, where λ denotes the fraction of disposable income accrued by rule of thumb consumers and $1-\lambda$ denotes the fraction accrued by finite horizon permanent income consumers. For this aggregation to be meaningful, the fraction of total disposable income going to rule of thumb consumers should be relatively stable over time. If this is not the case, the rule of thumb model may be misspecified.[58] Specifically, if excess sensitivity is assumed to be due to liquidity constraints a more plausible assumption would be a variable λ in the sense that the willingness to borrow may be stable over time but the degree of the constraints can vary reflecting structural changes in the capital markets. Structural changes have important implications also for the empirical estimation of the constant λ-model, since if there has occured a structural break over the sample period, the parameter estimates and their asymptotic standard errors may be misleading.

[58] In the context of the λ-model some evidence suggests that the fraction of income accruing from rule of thumb consumers is unlikely to remain stable over time (Bayoumi and Koujianou (1989), Wirjanto (1991, 1994, 1997) while others maintain that λ has been relatively stable over time (Fissel and Jappelli (1990), Campbell and Mankiw (1991)). All in all as noted by Hayashi (1985) estimates of the fraction of income that accrues to 'liquidity constrained consumers' using panel data are more stable, precise, and uniform than are time-series estimates.

Direct estimation of λ has the advantage of providing a useful measure of the economic importance of deviations from the generalized permanent income model (equation 18), and hence, from the Ricardian debt neutrality. If the estimate of λ is close to zero and γ close to unity, then one can claim that the forward-looking optimizing behaviour and Ricardian equivalence are approximately true even if the estimate of λ is statistically significant, since most income goes to infinite horizon permanent income consumers (see Campbell and Mankiw (1989)). Conversely, if the estimate of λ is large and statistically significant, then one must conclude that the evidence points away from the permanent income hypothesis and Ricardian equivalence even if the planning horizon of consumers is infintie, ie γ is close to unity.[59]

Since the rule of thumb consumers are assumed to follow a simple Keynesian consumption function without borrowing and nonlabour assets, their budget constraint implies that the best they can do is to consume all their disposable income h_t^K, defined as $h_t^K = y_t^K + \tau_t^K - t_t^K$ and $h_t^K \equiv \lambda h_t$, where y_t^K, τ_t^K and t_t^K denote per capita gross labour income, government transfer payments and income taxes of the rule of thumb consumers and h_t denotes aggregate per capita disposable income. Consumption of the rule of thumb consumers c_t^K is thus

$$c_t^K = y_t^K + \tau_t^K - t_t^K = \lambda h_t \tag{19}$$

This formulation implies that it is the amount of current taxes the rule of thumb consumers have to pay and current transfers they obtain that matter for their consumption decisions, and not the expectations of future fiscal policy or even the current government consumption. Since there are no forward looking elements in the consumption function, changing the timing of taxes and transfers would change consumption of the rule of thumb consumers.

Finite horizon permanent income consumers are assumed to maximize their intertemporal utility and behave according to the consumption equation (15').

$$\begin{aligned} c_t^P &= \beta_0 + \beta_1 (E_t H_t^P + \theta E_t G_t^P + (1+r) a_{t-1}^P) - \theta g_t^P \\ &= \beta_0 + \beta_1 [(1-\lambda) E_t H_t + \theta (1-\lambda) E_t G_t + (1+r) a_{t-1}] - \theta (1-\lambda) g_t \end{aligned} \tag{15'}$$

where

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

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

[59]Empirical findings of this model with values of λ considerably different from zero may be consistent with Hall's findings in certain special situations (see Campbell and Mankiw (1991, p. 729), Cushing (1992, p. 136)).

Equation (15') states that consumption of the finite horizon permanent income consumers with access to capital markets is proportional to their expected aggregate wealth. Since these consumers make up $(1-\lambda)$ of the aggregate disposable income, h_t, they hold $(1-\lambda)$ of the expected aggregate human wealth, E_tH_t, but hold all of the financial wealth, a_{t-1}, in the economy. If λ is zero, the model reduces back to equation (15).

Artificially nesting the consumption of the two types of consumers gives aggregate per capita consumption c_t as a linear function of the consumption of the forward looking permanent income consumers, c_t^P and the rule of thumb consumers, c_t^K. Formally, total aggregate per capita private consumption c_t is given by[60]

$$c_t=\beta_0+\lambda h_t+\beta_1[(1-\lambda)E_tH_t+\theta(1-\lambda)E_tG_t+(1+r)a_{t-1}]-\theta(1-\lambda)g_t \tag{20}$$

The implicit assumption in equation (20) is that both types of consumers face the same income process, the one faced by the representative consumer.[61] Equation (20) can be used to test the degree to which private consumption corresponds to the forward looking optimizing model and the significance of the excess sensitivity of consumption to current income.

Following the same procedure as in Chapter 2.2, nonlabour assets a_{t-1} are eliminated from the consumption function (20). As shown in the Appendix 2, equation (20) can be written as

$$\begin{aligned} c_t=&-r\beta_0+(1+r)(1-\beta_1)c_{t-1}+\lambda h_t-\lambda(1+r)(1-\beta_1)h_{t-1} \\ &-\theta(1-\lambda)g_t+\theta(1+r)(1-\beta_1)(1-\lambda)g_{t-1} \\ &+\beta_1(1-\gamma)(1-\lambda)E_tH_t+\beta_1(1-\gamma)(1-\lambda)\theta E_tG_t \\ &+\beta_1(1-\lambda)\varepsilon_t \end{aligned} \tag{21}$$

where $\epsilon_t = (\gamma\epsilon_{Ht} + \theta\gamma\epsilon_{Gt})$. Error terms $(E_t - E_{t-1})H_t$ and $(E_t - E_{t-1})G_t$ reflect the revisions in expectations about the sequence of h_{t+j} and g_{t+j} that forward-looking permanent income consumers make when proceeding from period t-1 to period t.

Finally, the empirical reduced form consumption function that nests the forward looking optimizing behaviour with the excess sensitivity hypothesis is derived using the method introduced in Chapter 3.1. Equation (22) gives the extended aggregate per capita consumption function in terms of observable variables:

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[60]See Appendix 2 for details.

[61]This is a strong assumption which means that the prevalence of liquidity constraints cannot be explicitly tested by this kind of formulation. Explicit testing would require disaggregated data on liquidity constrained and unconstrained consumers as discussed in Chapter 5.2.

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

where

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

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

The error term v_t has the following first-order moving average structure

$$v_t = \beta_1(1-\lambda)\varepsilon_t - \left(\frac{(1+r)}{\gamma}\right)\beta_1(1-\lambda)\varepsilon_{t-1} + \beta_1(1-\gamma)(1-\lambda)e_{Ht} + \theta\beta_1(1-\gamma)(1-\lambda)e_{Gt}.$$

Critical assumptions from the point of view of the debt neutrality are whether the planning horizon of the forward looking consumers is infinite, ie $\gamma=1$, and whether the fraction of the rule of thumb consumers, λ, is zero. With a positive λ a switch from tax to debt financing is nonneutral even if consumers are rational and have finite horizons ($\gamma=1$). With λ equal to zero equation (15) instead of (20) can be interpreted to be as a valid specification of the consumption function. In this case fiscal policy nonneutrality can arise only if the consumers have a finite planning horizon, ie $0<\gamma<1$.

5.3 Estimation results from the λ-model

Estimation results based on a constant λ-model are reported in Table 5. The table gives the country-specific estimates of β_1, γ, θ and λ with their autocorrelation and heteroscedasticity consistent standard errors. The far right hand columns give the probability values associated with the Hansen's J-test for the validity of overidentifying restrictions and the significance level of the Wald-test indicating the validity of various theory-generated restrictions imposed. All estimations are based on an assumption of a constant real interest of 3 % p.a. and that the subjective rate of time preference, δ, equals the real interest rate r.

Table 5. **GMM estimation of equation (22) for selected EU countries**

	β	γ	θ	λ	P-value	Wald-test
Austria						
Unrestricted	.734	.985	−2.552	.472	0.616	
	(.348)	(.046)	(1.604)	(.346)		
Restrictions						
$\lambda = 0$	.450	.946	−2.391		0.714	1.857
	(.242)	(.042)	(1.379)			(0.173)
$\gamma = 1$	.783		−2.446	.587	0.778	0.107
	(.250)		(1.606)	(.192)		(0.743)
$\theta = 0$	.816	1.028		.821	0.590	2.530
	(.276)	(.022)		(.196)		(0.112)
$\gamma = 1, \theta = 0, \lambda = 0$	.241				0.270	3.008
	(.226)					(0.222)
Belgium						
Unrestricted	.369	1.061	6.983	.704	0.703	
	(.558)	(.095)	(21.433)	(.535)		
Restrictions						
$\lambda = 0$	.063	.900	−3.629		0.758	1.734
	(.536)	(.336)	(5.729)			(0.188)
$\gamma = 1$	.258		−.560	.473	0.826	0.408
	(.591)		(6.160)	(.420)		(0.523)
$\theta = 0$	.353	1.025		.536	0.879	0.106
	(.549)	(.040)		(.395)		(0.744)
$\gamma = 1, \theta = 0, \lambda = 0$	.292				0.818	2.039
	(.188)					(0.361)
Finland						
Unrestricted	.670	.851	3.450	−.175	0.992	
	(.072)	(.093)	(2.353)	(.414)		
Restrictions						
$\lambda = 0$	.674	.875	3.948		0.966	0.178
	(.070)	(.076)	(2.197)			(0.673)
$\gamma = 1$	.607		3.393	.115	0.573	2.539
	(.083)		(1.992)	(.268)		(0.111)
$\theta = 0$	.789	1.015		.342	0.343	2.150
	(.488)	(.082)		(.382)		(0.142)
$\gamma = 1, \theta = 0, \lambda = 0$	.970				0.354	4.538
	(.146)					(0.103)

Table 5 (continued)

	β	γ	θ	λ	P-value	Wald-test
France						
Unrestricted	.116	.943	.057	.428	0.173	
	(.130)	(.056)	(3.095)	(.104)		
Restrictions						
$\lambda = 0$	.560	.989	.088		0.170	16.738
	(.229)	(.018)	(1.893)			(0.000)
$\gamma = 1$	.085		1.759	.472	0.237	1.015
	(.264)		(3.559)	(.141)		(0.314)
$\theta = 0$	.116	.943		.428	0.320	0.0003
	(.128)	(.056)		(.096)		(0.985)
$\gamma = 1, \theta = 0, \lambda = 0$	.473				0.374	34.663
	(.153)					(0.000)
Germany						
Unrestricted	.261	.974	1.075	.702	0.520	
	(.363)	(.036)	(2.543)	(.113)		
Restrictions						
$\lambda = 0$	.507	1.052	−2.782		0.336	38.228
	(.323)	(.039)	(1.632)			(0.000)
$\gamma = 1$	.012		1.664	.765	0.728	0.512
	(.390)		(2.762)	(.117)		(0.474)
$\theta = 0$	.379	.981		.642	0.625	0.178
	(.230)	(.013)		(.074)		(0.672)
$\gamma = 1, \theta = 0, \lambda = 0$	.654				0.540	112.602
	(.167)					(0.000)
Greece						
Unrestricted	.363	1.012	.376	.601	0.487	
	(.227)	(.011)	(2.801)	(.148)		
Restrictions						
$\lambda = 0$	.876	1.003	−4.109		0.197	16.541
	(.327)	(.076)	(.731)			(0.000)
$\gamma = 1$	.304		1.462	.629	0.474	1.150
	(.177)		(3.928)	(.156)		(0.283)
$\theta = 0$	.370	1.012		.585	0.644	0.018
	(.212)	(.011)		(.108)		(0.893)
$\gamma = 1, \theta = 0, \lambda = 0$	.132				0.299	32.042
	(.160)					(0.000)
Italy						
Unrestricted	.312	1.004	.682	.504	0.064	
	(.216)	(.017)	(3.096)	(.162)		
Restrictions						
$\lambda = 0$	.673	1.015	2.740		0.258	9.624
	(.156)	(.012)	(2.349)			(0.002)
$\gamma = 1$	.320		.738	.494	0.110	0.049
	(.217)		(2.970)	(.158)		(0.825)
$\theta = 0$	.310	1.006		.502	0.115	0.048
	(.188)	(.016)		(.131)		(0.826)
$\gamma = 1, \theta = 0, \lambda = 0$	.249				0.245	15.965
	(.157)					(0.001)

Table 5 (continued)

	β	γ	θ	λ	P-value	Wald-test
Netherlands						
Unrestricted	.750	.931	-1.897	-.042	0.484	
	(.195)	(.029)	(.550)	(.104)		
Restrictions						
$\lambda = 0$	.755	.939	-1.982		0.556	0.162
	(.175)	(.021)	(.507)			(0.687)
$\gamma = 1$	.587		-1.947	.037	0.314	5.575
	(.113)		(.631)	(.077)		(0.018)
$\theta = 0$	.444	.937		-.227	0.495	11.895
	(.132)	(.049)		(.103)		(0.000)
$\gamma = 1, \theta = 0, \lambda = 0$	.474				0.402	23.797
	(.089)					(0.000)
Sweden						
Unrestricted	.768	.931	-.544	-.118	0.930	
	(.343)	(.023)	(.584)	(.338)		
Restrictions						
$\lambda = 0$	.677	.937	-.425		0.971	0.123
	(.353)	(.016)	(.648)			(0.726)
$\gamma = 1$	-.029		1.423	.309	0.938	8.604
	(.210)		(2.648)	(.242)		(0.003)
$\theta = 0$	.477	.936		.080	0.966	0.866
	(.339)	(.026)		(.273)		(0.352)
$\gamma = 1, \theta = 0, \lambda = 0$	.022				0.845	22.164
	(.183)					(0.000)
UK						
Unrestricted	.284	1.024	-1.421	.675	0.081	
	(.289)	(.063)	(2.687)	(.160)		
Restrictions						
$\lambda = 0$	.724	.778	7.494		0.913	17.827
	(.730)	(.108)	(10.274)			(0.000)
$\gamma = 1$	.315		-1.299	.662	0.146	0.142
	(.268)		(2.482)	(.149)		(0.706)
$\theta = 0$	.211	.992		.720	0.143	0.280
	(.234)	(.065)		(.181)		(0.597)
$\gamma = 1, \theta = 0, \lambda = 0$	.649				0.460	21.506
	(.140)					(0.000)

Notes: See Table 2.

As shown in Table 5 the test of the overidentifying restrictions do not reject the extended permanent income model, although the probability value (P-value) associated with the test is quite low in the case of Italy and the UK. At 10 per cent significance level the model would be rejected by the J-test for Italy and the UK. In general the results turn out to be quite sensitive to the inclusion of the excess sensitivity hypothesis in the estimation equation. As expected, the values of the parameter β_1 are most affected.

Estimates presented in Table 5 indicate that there are marked differences across countries in the effect of current income on private consumption. The rule of thumb consumers' share of disposable income, λ, obtains plausible values and is significantly different from zero in half of the countries, ie in France, Germany, Greece, Italy and the UK, suggesting the importance of taking into account the effect of current income on consumption. The unrestricted estimate of λ in these five countries is large and varies between .43 and .70 so that the effect of current income on private consumption is the lowest in France and the highest in Germany. Furthermore, the estimated value of λ and its statistical significance remain roughly the same under the hypothesis of an infinite horizon (γ=1) as well as under the restriction θ=0. As expected, the hypothesis that current income and permanent income are equal (λ=0) is strongly rejected by the Wald-test in each of these countries.

For Austria and Belgium λ is positive and large, but statistically insignificant. In Austria the estimate of λ becomes, however, significant and increases in value under the restriction γ=1 as well as under the hypothesis that private consumption and government consumption are unrelated (θ=0). For Belgium, the value of λ and its standard error decrease under the restrictions γ=1 and θ=0. The restriction λ=0 cannot, however, be rejected for either of the countries even at 10 per cent significance level, so the direct effect of current income on consumption cannot be identified.

For Finland, the Netherlands and Sweden the estimate of λ obtains the wrong sign, but the values are small and insignificantly different from zero. The same result was found also in the recent study by Evans and Karras (1996). In the Netherlands the estimate of λ is not affected by the imposition of other parameter restrictions while in Finland and Sweden λ becomes positive and quite large under the restriction γ=1, and under θ=0 for Finland. Although the standard errors also decrease, the estimates of λ remain statistically insignificant. The restriction λ=0 cannot be rejected for any of these three countries.

A rough summary of the results concerning the parameter λ is that current income affect consumption least in the Netherlands, Finland and Sweden, somewhat more in Austria and Belgium and most of all in France, Germany, Greece, Italy and the UK. This pattern of results is to a great extent consistent with previous findings (Jappelli and Pagano (1989), Campbell and Mankiw (1991), Evans and Karras (1996)) even though the data, econometric methods and sample periods are different. Specifically, the effect of current income on consumption has been found insignificant in the Netherlands and Sweden and relatively high in France, Greece, Italy and the UK.

As regards to the hypothesis that the estimate of β_1 might be especially sensitive to the omission of current income from the consumption model, the results give at least a partial support. In general the unrestricted estimates of β_1 follow roughly two distinct patterns when the excess sensitivity of consumption is accounted for. First, for those countries where the estimate of λ proves to be positive and statistically significant (ie France, Germany, Greece, Italy and the UK), the value of β_1 turns out to be low or substantially lower than in the specification where the effect of the current income on consumption was ignored (see Table 3 and the line λ=0 in Table 5). The unrestricted estimate of β_1 is, however, not statistically different from zero in any of these countries. Second, for those countries where the estimate of λ is very low and/or statistically unsignificant (ie Austria, Belgium, Finland, the Netherlands, and Sweden), the value of β_1 tends to be roughly of the same order of magnitude as obtained in the specification ignoring the excess sensitivity hypothesis (Table 3 and the line λ=0 in Table 5).

All in all the results with respect to the parameter β_1 lie roughly in conformity with the hypothesis that excess sensitivity of consumption to current income may explain a large part of the inconsistencies found in the parameter structure in Chapter 4.2. For the first group of countries, the results suggest that the estimate of β_1 is likely to be substantially upward biased when the current income is ignored in the consumption function. Obviously, the finite horizon permanent income model is not a sufficient approzimation of the reality and consumption behaviour in these countries. For the second group of countries it is harder to draw any specific conclusions. It seems that the excess sensitivity is not an issue in these countries, and the anomalious results concerning the estimates of β_1 remain unexplained in the present setting. However, equally plausible conclusion would be that the simple λ-model does not apply to these countries.

The unrestricted estimates of γ turn out to be close to unity in all but three countries, Finland, the Netherlands and Sweden. The restriction γ=1 can be rejected at conventional levels of significance for the Netherlands and Sweden and roughly at 10 per cent level for Finland. The estimate of γ is to some extent sensitive to the restriction λ=0 in the case of Belgium and the UK. For both countries the imposition of λ=0 results in a decreased value of γ implying a shorter (finite) planning horizon. These resulte are in line with the arguments put forward by eg Hayashi (1985) and Evans (1988, 1993) that the expectation of a future binding liquidity constraint with a zero borrowing limit is equivalent to a shortening of the planning horizon of the consumer.

The results concerning the unrestricted estimates of θ are qualitatively much the same as those obtained from the forward-looking permanent income model (see Table 3). Again, for most countries θ is not statistically different from zero. In fact, the statistical significance of θ drops in most cases, the only exception being the Netherlands where the results are in conformity with those obtained earlier (see Table 3). Not surprisingly, the restriction θ=0 cannot be rejected for any other country in the sample except the Netherlands.

The joint hypothesis of an infinite horizon, the absence of excess sensitivity and no substitutability or complementarity between private and government consumption (ie γ=0, λ=0 and θ=0) cannot be rejected for Austria, Belgium and Finland at 5 per cent significance level while at 10 per cent level the restiction is rejected for Finland. The restiction is unambigously rejected for France, Germany, Greece, Italy, the Netherlands, Sweden and the UK.

To further test the robustness of these results the estimations are also run under the restriction of $\beta_1 = (1+r-\gamma)/(1+r)$. This restriction is rejected by the Wald-test only for Finland and the Netherlands. The estimation results cannot, however, be reported for all countries due to lack of convergence. As shown in Table 6 the country-specific P-values associated with the overidentifying restrictions test increase considerably. More importantly, in most cases the results remain qualitatively the same as obtained from the unrestricted estimations reported in Table 5. The notable exception is Belgium, where the estimate of λ becomes statistically significant without any substantial change in its value. Moreover, the restriction $\lambda=0$ is rejected at 1 per cent significance level. This clearly suggests that the excess sensitivity hypothesis is supported also by Belgian data.

Table 6. **GMM estimation of equation (22) for selected EU countries: β_1 restricted**

	Unrestricted estimates				Wald-test
	γ	θ	λ	P-value	$\lambda=0$
Austria	.929 (.168)	-5.884 (6.424)	.096 (.809)	0.756	0.014 (0.905)
Belgium	.909 (.077)	11.981 (9.894)	.664 (.265)	0.969	6.280 (0.012)
France	.934 (.036)	.201 (3.125)	.421 (.100)	0.318	17.640 (0.000)
Germany	.953 (.053)	1.691 (2.141)	.744 (.113)	0.754	43.013 (0.000)
Italy	.990 (.116)	-1.836 (2.812)	.375 (.117)	0.188	10.258 (0.001)
Sweden	.922 (.071)	1.341 (2.313)	.282 (.240)	0.968	1.371 (0.241)
UK	1.075 (.222)	1.142 (1.638)	.490 (.156)	0.231	9.829 (0.002)

Notes: See Table 2.

To sum up, the inclusion of the excess sensitivity hypothesis in the forward-looking consumption model alters considerably the conclusions made so far on the effects of fiscal policy on private consumption and on Ricardian equivalence as a valid approximation to reality. The results obtained from the extended permanent income model suggest that fiscal policy has been nonneutral in the majority of the countries in the sample during the estimation period. Furthermore, deviations from the Ricardian debt neutrality seem to arise from excess sensitivity of consumption to current income rather than from a shorter planning horizon of consumers.

6 Concluding remarks

The main objective of this paper was to test whether empirical evidence based on aggregate time-series data from ten EU countries supports the Ricardian equivalence hypothesis or the conventional Keynesian view of the effects of government deficit financing on aggregate private consumption. The objective was also to test whether there exists substitutability or complementarity between private consumption and government consumption in these countries.

The effects of fiscal policy on private consumption-saving decisions is first investigated in a generalized permanent income framework with finite planning horizons and government consumption as a direct conveyer of utility to consumers. Given the limitations of aggregate time series data, the results from this model seem to give a strong support for an infinite planning horizon for consumers and thus, for Ricardian debt neutrality in six out of ten countries in the sample. The validity of this outcome is, however, not without doubts, since the high propensity to consume out of total expected wealth, that was found in the study, is not compatible with an infinite planning horizon but in fact, suggests a rather short one. The findings also indicate that during the estimation period government consumption and private consumption tended to be unrelated or complements rather than substitutes.

Due to the inconsistency in the results the validity of Ricardian equivalence was checked by nesting the excess sensitivity hypothesis to the permanent income model. The inclusion of the direct effect of current income on consumption altered the results markedly. The findings suggest that aggregate consumption responds not only to the changes in the expected lifetime wealth as predicted by the generalized permanent income model, but also to changes in current income in six out of ten countries in the sample. Since private consumption is not invariant to changes in government taxes and transfer policies under excess sensitivity, the Ricardian equivalence proposition fails in these countries. Besides this, Ricardian equivalence is shown to fail due to shorter (finite) planning horizons in two more countries.

All in all the results suggest that fiscal policy has been nonneutral in the majority of the countries studied during the estimation period. Furthermore, deviations from the Ricardian debt neutrality seem to arise from excess sensitivity of consumption to current income rather than from shorter planning horizons on the part of consumers.

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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

$$c_t^P=\beta_0+\beta_1 E_t W_t-\theta g_t \tag{A7}$$

Lagging (A7) and rearranging yields

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

Substituting (A8) into (A6) yields

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

where

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

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

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

Appendix 2

Aggregate per capita consumption c_t over the two types of consumers given by equation (20) in the text is

$$c_t=\beta_0+\lambda h_t+\beta_1[(1-\lambda)E_tH_t+\theta(1-\lambda)E_tG_t+(1+r)a_{t-1}]-\theta(1-\lambda)g_t \tag{20}$$

Economy-wide aggregate per capita flow budget constraint is given by

$$a_t=h_t+(1+r)a_{t-1}-c_t \tag{B1}$$

Aggregate per capita human wealth h_t in period t over the two types of consumers can be expressed as

$$h_t=\lambda h_t+(1-\lambda)\left(E_tH_t-\frac{\gamma}{1+r}E_tH_{t+1}\right) \tag{B2}$$

Substituting the consumption function (20) and equation (B2) into (B1) gives

$$\begin{aligned}a_t=&-\beta_0+(1-\lambda)(1-\beta_1)E_tH_t-(1-\lambda)\frac{\gamma}{1+r}E_tH_{t+1}-\beta_1\theta(1-\lambda)E_tG_t\\&+(1+r)(1-\beta_1)a_{t-1}+\theta(1-\lambda)g_t\end{aligned} \tag{B3}$$

Lagging (B3) by one period and multiplying both sides by (1+r) yields

$$\begin{aligned}(1+r)a_{t-1}=&-(1+r)\beta_0+(1+r)(1-\beta_1)(1-\lambda)E_{t-1}H_{t-1}-\gamma(1-\lambda)E_{t-1}H_t\\&-(1+r)\beta_1\theta(1-\lambda)E_{t-1}G_{t-1}+(1+r)^2(1-\beta_1)a_{t-2}+(1+r)\theta(1-\lambda)g_{t-1}\end{aligned} \tag{B4}$$

Total expected wealth accruing from the forward-looking permanent income consumers is given by

$$E_tW_t^P=(1-\lambda)E_tH_t+(1+r)a_{t-1}+\theta(1-\lambda)E_tG_t \tag{B5}$$

Using (B5) and equation (B4) the total expected wealth accruing from forward-looking permanent income consumers can be expressed as follows

$$\begin{aligned}E_tW_t^P=&-(1+r)\beta_0+(1-\lambda)E_tH_t-\gamma(1-\lambda)E_{t-1}H_t+(1+r)(1-\beta_1)(1-\lambda)E_{t-1}H_{t-1}\\&+\theta(1-\lambda)E_tG_t-(1+r)\beta_1\theta(1-\lambda)E_{t-1}G_{t-1}+(1+r)^2(1-\beta_1)a_{t-2}\\&+(1+r)\theta(1-\lambda)g_{t-1}\end{aligned} \tag{B6}$$

Equation (B6) can be rewritten as

$$E_tW_t^P=-(1+r)\beta_0+(1+r)(1-\beta_1)[(1-\lambda)E_{t-1}H_{t-1}+(1+r)a_{t-2}+\theta(1-\lambda)E_{t-1}G_{t-1}] \\ +(1-\gamma)(1-\lambda)E_tH_t+\theta(1-\gamma)(1-\lambda)E_tG_t+\gamma(1-\lambda)\epsilon_{H_t}+\gamma\theta(1-\lambda)\epsilon_{G_t} \tag{B7}$$

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 (20) implies that

$$c_t=\beta_0+\lambda h_t+\beta_1E_tW_t^P-\theta(1-\lambda)g_t \tag{B8}$$

Lagging (B8) and rearranging yields

$$E_{t-1}W_{t-1}^P=\frac{1}{\beta_1}(c_{t-1}-\beta_0-\lambda h_{t-1}+\theta(1-\lambda)g_{t-1}) \tag{B9}$$

Substituting (B9) into (B6) yields

$$E_tW_t^P=-(1+r)\beta_0+(1+r)(1-\beta_1)\frac{1}{\beta_1}(c_{t-1}-\beta_0-\lambda h_{t-1}+\theta(1-\lambda)g_{t-1}) \\ +(1-\gamma)(1-\lambda)E_tH_t+\theta(1-\gamma)(1-\lambda)E_tG_t+(1-\lambda)\epsilon_t \tag{B10}$$

where

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

Substituting (B10) into (B8) gives the expression for aggregate per capita private consumption (equation (21) in the text),

$$
\begin{aligned}
c_t = & -r\beta_0 + (1+r)(1-\beta_1)c_{t-1} + \lambda h_t - \lambda(1+r)(1-\beta_1)h_{t-1} \\
& -\theta(1-\lambda)g_t + \theta(1+r)(1-\beta_1)(1-\lambda)g_{t-1} \\
& +\beta_1(1-\gamma)(1-\lambda)E_tH_t + \beta_1(1-\gamma)(1-\lambda)\theta E_tG_t \\
& +\beta_1(1-\lambda)\varepsilon_t
\end{aligned} \tag{21}
$$

Appendix 3

Time series properties of the data

Based on the theory of cointegrated processes, recent research on consumption has been conducted in level form.[62] 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 equations (18) and (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 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 all but two of the series tested. The null hypothesis that each first-differenced series has one unit root can be rejected for all series at the 0.05 level only for the UK. However, roughly at the 0.10 level, the null can be rejected for all series also for Austria and Sweden. The results suggest that the series b_t is integrated of order two in Belgium, Finland, Germany, Greece and the Netherlands. The I(2)ness 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 positions in the long term in these countries. The government debt has grown rapidly in several European countries during the 1980s and early 1990s. The growth rate of the debt has, however, started to slow down in all countries due to comprehensive measures taken in order to consolidate public finances and to fulfil the convergence criteria required for the third stage of the European Monetary and Economic Union. The combined effect of these events 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 low power (see Perron 1989). Moreover, these same qualifications apply to some extent to several other series in the sample, but particularly so to private consumption and income series in Finland that experienced considerable breaks in the early 1990s, that may cause the series to appear as trend stationary,[63] as well as to income series in Belgium, France and Italy with considerable breaks in the 1980s and 1990s and to government consumption series in Sweden with breaks during the 1990s. Due to these breaks the series (excluding the Finnish data) appear to be integrated of order two instead of an economically more plausible of order one. Hence, the evidence regarding the magnitude of the root in these series is treated as inconclusive and further analyses are conducted assuming that all series are I(1) variables.

The results for cointegration are given in Table A2 for the I(1) variables and instruments used in the estimations. Tests for cointegration are based on the

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

[63] When the years 1991–1995 are excluded from the sample, the unit root hypothesis cannot be rejected for both series in levels.

Johansen's (1988) maximum likelihood estimation procedure with two lags in the VAR, which produces white noise residuals.

Table A1. **Augmented Dickey-Fuller tests for selected EU countries**

Variable	Levels ADF (1)	First differences ADF(1)
Austria	1962-1994	1963-1994
c_t	-1.893	-3.962
h_t	-1.635	-2.213
h_t^+	-2.887	-4.221
y_t	-1.940	-2.106
g_t	-1.089	-2.074
b_t	-1.994	-2.012
t_t	-3.007	-3.864
Belgium	1963-1994	1964-1994
c_t	-1.784	-2.963
h_t	-1.649	-2.287
h_t^+	-1.927	-2.457
y_t	-1.540	-1.991
g_t	-2.611	-2.266
b_t	-2.337	-1.741
t_t	-1.239	-2.227
Finland	1962-1995	1963-1995
c_t	-3.571	-3.524
h_t	-1.897	-3.472
h_t^+	-3.316	-3.512
y_t	-3.789	-4.384
g_t	-1.797	-2.967
b_t		-2.332
t_t	-3.028	-3.967
tt_t	-2.974(3)	-3.276
France	1963-1993	1964-1993
c_t	-1.780	-2.892
h_t	-2.249	-2.633
h_t^+	-1.618	-3.515
y_t	-0.604	-1.314
g_t	-2.882	-3.941
b_t	-1.358	-2.426
t_t	-1.744	-4.063
Germany	1962-1993	1963-1993
c_t	-2.043(2)	-4.522
h_t	-2.453	-3.848
h_t^+	-2.853	-3.667
y_t	-2.880	-4.234
g_t	-2.203	-2.857
b_t	-0.051(4)	-0.491
t_t	-1.667	-3.396

Table A1 continues

Variable	Levels ADF (1)	First differences ADF(1)
Greece	1962-1994	1963-1994
c_t	-2.128	-3.065
h_t	-1.618	-4.385
y_t	-1.690	-4.095
g_t	-1.573	-2.425
b_t		-1.781
t_t	-1.991	-3.658
Italy	1963-1994	1964-1994
c_t	-3.544	-3.615
h_t	-2.098	-2.108(2)
h_t^+	-2.624	-2.559
y_t	-1.180	-1.694
g_t	-1.757	-2.353
b_t	-0.847	-2.191
t_t	-0.685	-1.434
Netherl.	1963-1994	1964-1994
c_t	-1.987	-2.923
h_t	-1.961	-3.643
y_t	-2.436	-2.737
g_t	-2.164	-2.953
b_t	-2.563	-1.667
t_t	-2.343	-3.135
Sweden	1963-1994	1964-1994
c_t	-2.006	-3.395(2)
h_t	-2.923	-5.093
h_t^+	-2.272	-3.562
y_t	-1.889	-3.644
g_t	-1.963(2)	-1.644
b_t	-2.516	-2.969
t_t	-1.992	-3.305(2)
UK	1962-1994	1963-1994
c_t	-2.447	-3.678
h_t	-2.581	-3.877
h_t^+	-2.611	-3.808
y_t	-2.762	-3.213
g_t	-1.929	-4.849
b_t	-1.833	-3.849
t_t	-2.712	-4.006

Notes: ADF(1) is the ADF statistic of order 1, if not otherwise indicated; the critical values of the ADF statistics are from MacKinnon (1991), the 0.05 critical value for the sample 1962-1993 is -3.556, for the sample 1962-1994 -3.551, for the sample 1962-1995 -3.547, for the sample 1963-1993 -3.561, for the sample 1963-1994 -2.959, for the sample 1963-1995 -2.953, and for the sample 1964-1993 -2.963. Including additional lags did not affect the results. The variables included are: private consumption c_t, disposable non-property income h_t, disposable total personal income h_t^+, non-property income y_t, general government consumption g_t, general government debt b_t, household income taxes t_t. All variables are expressed in per capita real terms.

According to the trace test (Table A2) the hypothesis of cointegration is rejected at the conventional 5 % significance level for all countries in the sample. Given the small sample sizes, the 10 per cent significance level could be regarded as adequate for the nonrejection of cointegration. At 10 per cent level, the hypothesis of cointegration cannot be rejected for all but two countries, Germany and Greece. The trace test is, however, sufficiently close to significance at the 10 per cent level to treat the variables as cointegrated also for these two countries.

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

Table A2. **Johansen's maximum likelihood tests for cointegration**

	Eigenvalue	Null hypothesis [c,h,g]	Trace	0.05 critical value	0.10 critical value
Austria (h_t)	0.385	$r = 0$	25.20	29.7	26.8
	0.228	$r \leq 1$	9.16	15.4	13.3
	0.018	$r \leq 2$	0.59	3.8	2.7
Belgium (h_t)	0.511	$r = 0$	28.27	29.7	26.8
	0.119	$r \leq 1$	5.34	15.4	13.3
	0.039	$r \leq 2$	1.27	3.8	2.7
Finland (h_t^+)	0.364	$r = 0$	26.66	29.7	26.8
	0.253	$r \leq 1$	11.27	15.4	13.3
	0.038	$r \leq 2$	1.33	3.8	2.7
France (h_t^+)	0.504	$r = 0$	28.76	29.7	26.8
	0.199	$r \leq 1$	7.73	15.4	13.3
	0.035	$r \leq 2$	1.07	3.8	2.7
Germany (h_t^+)	0.334	$r = 0$	23.98	29.7	26.8
	0.199	$r \leq 1$	10.98	15.4	13.3
	0.114	$r \leq 2$	3.86	3.8	2.7
Greece (h_t)	0.342	$r = 0$	23.89	29.7	26.8
	0.214	$r \leq 1$	10.06	15.4	13.3
	0.061	$r \leq 2$	2.09	3.8	2.7
Italy (h_t^+)	0.495	$r = 0$	28.72	29.7	26.8
	0.154	$r \leq 1$	6.87	15.4	13.3
	0.046	$r \leq 2$	1.52	3.8	2.7
Netherlands (h_t)	0.455	$r = 0$	28.58	29.7	26.8
	0.194	$r \leq 1$	9.13	15.4	13.3
	0.067	$r \leq 2$	2.24	3.8	2.7
Sweden (h_t^+)	0.414	$r = 0$	32.21	29.7	26.8
	0.242	$r \leq 1$	15.12	15.4	13.3
	0.177	$r \leq 2$	6.23	3.8	2.7
UK (h_t^+)	0.507	$r = 0$	27.90	29.7	26.8
	0.122	$r \leq 1$	4.57	15.4	13.3
	0.008	$r \leq 2$	0.27	3.8	2.7

Notes: All equations are estimated assuming that 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).

Appendix 4

Data

The data are from OECD National Accounts, Vol. II, covering the period 1960–1994 for Austria, Greece and the UK, the period 1961–1994 for Belgium, Italy, the Netherlands and Sweden, the period 1960–1995 for Finland, the period 1960–1993 for Germany and the period 1961–1993 for France. The data for Germany refer to West Germany until 1991 and the united Germany thereafter. All variables are in per capita terms and deflated by the implicit price deflator of which the base year for Greece is 1970, for France 1980, for Belgium and Italy 1985, and for Austria, Finland, the Netherlands, Sweden and the UK 1990. In panel estimations the base year for all countries in the sample is 1990 and the variables are expressed in US dollars.

Private consumption c_t: private final consumption expenditure.

Disposable non-property income h_t: the sum of household sector wages, salaries, employers' social security contributions and other non-property income (ie operating surplus of private unincorporated businesses and withdrawals from quasi-corporate enterprises) plus government transfer payments to households less household income taxes and other direct taxes, employees' social security contributions and fees, fines and penalties.

Disposable total personal income h_t^+: total personal income (incl. government transfer payments), net income taxes.

Government consumption g_t: general government final consumption expenditure.

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

Population: end-of-year total population.

Instruments

Austria, Belgium: the second and third lag of private consumption, disposable non-property income, and government consumption.

Finland: a constant, the second and third lag of private consumption, disposable total personal income, government consumption and the dummy variable D91–93 obtaining the value one in 1991–1993 and zero otherwise.

France, Germany: the second and third lag of private consumption, disposable total personal income, and government consumption.

Greece, the Netherlands: the second through fourth lag of private consumption and disposable non-property income, and the second and third lag of government consumption.

Italy: the second and third lag of private consumption, disposable total personal income, government consumption, and general government debt.

Sweden: the second through fourth lag of private consumption, the second and third lag of disposable total personal income, and government consumption.

The UK: the second through fourth lag of private consumption and disposable total personal income, and the second and third lag of government consumption.

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