Anne Brunila

Fiscal Policy and Private Consumption – Saving Decisions: European Evidence

SUOMEN PANKKI
Bank of Finland

BANK OF FINLAND STUDIES E:8 • 1997

ISBN 951-686-558-5
ISSN 1238-1691

Oy Trio-Offset Ab
Helsinki 1997

(Published also as A-131,
Helsinki School of Economics and
Business Administration,
ISBN 951-791-225-0, ISSN 1237-556X)

Abstract

This study 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 also nests the excess sensitivity hypothesis enabling an investigation of the role of current income in consumption. The empirical analysis is based on annual data from ten EU countries covering the years 1961-1994 and uses the nonlinear instrumental variable GMM estimator both in country-specific and panel estimations. The tests clearly reject Ricardian debt neutrality for the majority of countries in the sample. The 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 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 Ricardon velkaneutraliteettihypoteesia, jonka mukaan velalla rahoitetulla budjettialijäämän kasvulla ei ole vaikutusta kotitalouksien kulutuspäätöksiin. Estimoitava kulutusfunktio johdetaan kotitalouden elinkaaren hyödyn maksimointiongelmasta, jossa kotitalouden elinkaaren tai suunnitteluhorisontin mahdollinen äärellisyys on keskeisessä asemassa testattavien hypoteesien kannalta. 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 äärellisestä suunnitteluhorisontista kuin kulutuksen ja nykyhetken tulojen välisestä voimakkaasta riippuvuudesta. 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

Acknowledgments

I would like to express my deep gratitude for the encouragement and help I received from numerous people during my stay at the Research Department of the Bank of Finland in 1996-1997. My greatest thanks are due to my thesis supervisor, Jouko Vilmunen, who was always available for consultation and most generous with his time. His helpfulness and guidance went beyond any reasonable limits. Without his unfailing support, the study could not have been completed nearly as quickly as was the case. I am also deeply grateful to Juha Tarkka and professor Pertti Haaparanta for their keen interest in my work and their encouragement and valuable comments.

My warm thanks go to professor Erkki Koskela, whose insight and constructive comments substantially improved the contents of the study. In particular, his advice was invaluable in focusing the research in the early phases and in shaping the structure of the study in the final phases.

I also owe much to the official examiners of my thesis, Pasi Holm and Reija Lilja, whose valuable remarks and ideas for further research improved the quality of analysis. I hope I have been able to accomplish what they advised me to do.

I am grateful to my friends and colleagues at the Research Department who showed me what it means to be part of a research community and to discuss research problems with enthusiasm and an open mind. The inspiring and easy-going athmospere in the department made my work a rewarding experience even in the hard times, and this has left me with many unforgettable memories. My warmest thanks here go to Antti Ripatti, who was always willing to help me by discussing research problems and providing me with invaluable assistance whenever I needed it. The support I received from Matti Virén is also gratefully acknowledged. I am indebted to Heli Tikkunen too for her indispensable help with the data processing and to Päivi Lindqvist, who edited the draft with great skill and speed. The friendship and continuous support I received from the whole staff of the department earns a special note of thanks.

I would also like to express my gratitude to Glenn Harma for revising and enriching the language of the study and to Marja Hirvensalo-Niini for handling the printing.

Anne Brunila
Helsinki, September 1997

Contents

1 Introduction

It is only recently that the sustainability of fiscal policies and the effects of fiscal deficits on the economy have emerged as key policy issues in industrial countries. This is hardly a surprise since historically large and persistent fiscal deficits have been confined largely to developing countries. However, over the last two decades the situation has changed dramatically as budget deficits and high levels of public sector indebtedness have become a common problem for several industrial countries as well.[1] This development has directed the attention of economists, policymakers and the society at large to the potential risks and harmful effects that growing fiscal imbalances may entail.

In the 1990s these issues have become even more urgent particularly in the context of the European Union. The obvious reason for this is that in order to fulfil the fiscal convergence criteria[2] set out in the Maastricht Treaty and to qualify for Stage Three of Economic and Monetary Union by 1999, a large number of EU countries have been obliged to reduce budget deficits and public debt levels. Another, and more recent, reason for increased interest in the effects of fiscal policy on the economy has been concern about sufficient measures to ensure the stability of the planned European monetary union. Among the most important requirements has been the avoidance of excessive fiscal deficits. Since this requirement imposes additional constraints on member countries' ability to stabilize economic fluctuations by national fiscal policies, there has also been some concern that excessively restrictive limits on stimulative fiscal actions are harmful rather than beneficial.

Despite the growing interest of policymakers as well as economists in the impacts of fiscal policy on the economy and its efficacy as a tool for economic stabilization, neither economic theory nor empirical evidence give clear cut answers. In fact, there are sharp controversies on the effects of fiscal policy in general and of budget deficits in particular.

---

[1] To a large extent this deterioration in fiscal positions can be explained by expansions in the welfare state - in public health care, unemployment compensation, social security and pension systems - that have taken place since the 1970s (see Alesina and Perotti 1995). More recently, the problem has been aggravated by high real interest rates combined with low economic growth.

[2] According to the Maastricht Treaty, member states are to avoid excessive deficits defined by a reference value of 3 per cent of GDP and a public debt reference value of 60 per cent of GDP.

Most of the debate centres around the question of whether or not government financing decisions influence private consumption and saving. 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, which formed a consensus opinion until the 1970s, the private sector perceives government bonds as net wealth. Consequently, government deficits have a strong stimulative effect on private consumption and aggregate demand, particularly in the short run. The resulting decrease in private and national saving however leads to higher real interest rates, which crowd out private investment and thereby reduce the long-run growth potential of the economy. The long-run negative effects thus offset at least partially the positive short-run effects. It is important to note that the stimulating effects of fiscal deficits in this conventional approach are based on an implicit assumption that consumers are too myopic to account for the future fiscal policy implications of current debt accumulation.[3]

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 unaltered. In other words, Ricardian equivalence holds that an increase in the government deficit will be exactly offset by an increase in private sector savings. Furthermore, as national saving does not change, the real interest rate need not rise in a closed economy to maintain the balance between national saving and investment and hence there is no effect on investment either. In an open economy, there would be no effect on the current account balance because private saving rises by enough to avoid the need to borrow from abroad. Therefore, budget deficits would not cause current account deficits.

These conclusions are 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. Hence, a lowering of taxes

---

[3] Some room for the type of stabilization implied by a simple Keynesian framework can also be generated in a forward-looking optimizing framework with finite horizons and no bequest motives. A finite horizon implies that government debt is regarded to some degree as net wealth by currently living generations.

today will merely induce consumers to increase saving in order to avoid a sharp decline in their future disposable income and consumption due to higher taxes. Private consumption thus 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. If this is a correct representation of consumer behaviour, the Ricardian equivalence proposition leads to quite drastic policy implications: since a deficit-financed tax cut has no effect on aggregate consumer demand, even in the short run, attempts to stabilize the economy are doomed to be futile.

Barro demonstrated that Ricardian equivalence holds if consumers and the government have the same effective time or planning horizon;[4] 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. If these assumptions are relaxed, not only does Ricardian equivalence break down but non-conventional, especially non-Keynesian, results may emerge. Moreover, deviations from debt neutrality will occur if changes in taxation are accompanied by shifts in government consumption and/or transfer payments, or monetization of government debt, or both.

Recently, there has emerged a third line of reasoning called the non-Keynesian view, which stresses the importance of the current fiscal policy in shaping consumers' expectations about the future policy mix.

---

[4] Models with Ricardian equivalence generally assume that 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 it 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 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 (on 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 if 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 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 eg Feldstein 1982). For a detailed discussion of the assumptions required for Ricardian equivalence, see Bernheim (1987), Leiderman and Blejer (1988), and Seater (1993).

Specifically, if the level of government debt affects consumers' expectations on the future path of government budget variables, expansionary fiscal policy today in association with a high government debt to GDP ratio and large budget deficit may have a contractionary effect on private consumption and aggregate demand. For example, Sutherland (1995) shows that if a high level of government debt signals an imminent need for fiscal stabilization, forward-looking rational consumers anticipate the eventual consequences of accumulating government debt and decrease their consumption in response to government deficit fincancing. Hence, at high levels of government debt, a policy action that would be expansionary in a conventional Keynesian model and have no effects at all in the Ricardian framework may be contractionary if it induces sufficiently strong changes in expectations about the future fiscal policy mix. However, at low levels of government debt, deficit financing may exhibit conventional Keynesian effects (ie fiscal deficits stimulating private consumption) if current consumers expect that the future increase in taxes implied by the current deficit financing is very remote and therefore likely to be borne by future generations.

As in the case of budget deficits, there exist different views concerning the effects of government consumption on economic activity.[5] Under the conventional approach, changes in government consumption have no direct effect on private consumption since consumers' current disposable income remains unaltered. However, they will have one-to-one effect on aggregate demand. Ricardian equivalence, on the other hand, suggests that government consumption should have a negative, but less than one-to-one, impact on private consumption, since government consumption summarizes the true resource burden of the government sector on the private sector (see Barro 1981, Feldstein and Elmendorf 1983). Feldstein (1982) goes beyond the Ricardian equivalence proposition to suggest a complete ex ante crowding out of private consumption, implying that a current change in government consumption must induce an equal but opposite-direction shift in private consumption, ie one cannot increase aggregate demand by increasing government consumption. This extreme view leaves no room for short-run fiscal policy stabilization.

Although both Ricardian equivalence and the non-Keynesian view are based on several controversial assumptions, they provide a better benchmark for analysing overall effects of fiscal policy on private

---

[5] The seminal contribution of the effects of government consumption on private consumption and aggregate economic activity is Bailey (1971).

consumption than does the conventional view because they take into account expectations regarding future fiscal policy. In an environment in which 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 issuance 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 for different hypotheses

Since 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. Studies testing Ricardian equivalence have taken two alternative approaches: testing whether increases in government debt are perceived as increases in household wealth and private consumption or testing whether larger budget deficits are associated with higher interest rates.[6] In this study, the focus is on the first approach, ie we test the

[6] 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.' In assessing how seriously one should take the Ricardian equivalence proposition, Blanchard (1997, Chapter 29), however, draws a different conclusion. According to him, most economists would argue that one should take it seriously but 'not seriously enough to think that deficits and debt are irrelevant.'

response of private consumption to government budget variables, using aggregate time-series data.[7]

To an overwhelming extent, these studies consider data for only one country, usually the US.[8] The empirical evidence received is however highly mixed (even in the case of the US).[9] There are several reasons for the contradictory results. First, most studies do not estimate regression equations deriving from well-specified theoretical models both nesting the Ricardian equivalence hypothesis and alternatives 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 functions that are 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] Second, it is not usually established whether the underlying permanent income model is supported by the data (a notable exception being Haug 1990, 1996). Third,

---

[7] There is very little evidence on Ricardian equivalence based on micro data, since it does not seem possible to use micro data to examine the effects of government debt and deficits on individual household behaviour. Specifically, the question whether the individual household anticipates the future tax burden implied by current deficit financing or accumulated government debt is something that existing micro data apparently cannot illuminate very easily (see Seater 1993). Tests of the Ricardian equivalence hypothesis using micro data would require specification of the complete set of familial transfer mechanisms and changes in dynastic resources that are implied by models with operative intergenerational altruism. These transfer mechanisms may however be quite complicated and data problems insurmountable (see Altig 1988 and references therein).

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

[9] Evidence consistent with the Ricardian debt neutrality or tax discounting 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), and Evans and Hasan (1994). 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).

[10] Only Aschauer (1985), Evans (1988), Haque (1988) and Leiderman and Razin (1988) follow such a procedure in the literature prior to 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).

conflicting findings may result from differences in sample periods, measurement of variables, variables included, or estimation methods.[11]

On the basis of his recent literature survey, Seater (1993), however, 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. According to him, a large part of empirical evidence suggesting the rejection of Ricardian equivalence fails to attend to econometric problems related to specification, simultaneity, and stationarity, as well as to measurement of quantities involved. Therefore, much of the published evidence on Ricardian equivalence prior to the 1990s can be considered sufficiently flawed so as 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 debt effects may emerge.

In considering the more recent evidence on Ricardian equivalence, which also avoids many of the weaknesses refered to by Seater, the conclusion seems to be the opposite of that of Seater: Ricardian equivalence is rejected in most cases. Furthermore, since the Ricardian equivalence hypothesis is essentially a generalization of the permanent income-life cycle hypothesis, one should also test whether the underlying permanent income hypothesis is supported by the data before any far-reaching conclusions on the validity of Ricardian equivalence are drawn. Although there has emerged an extensive empirical literature providing tests of the permanent income hypothesis since Hall's (1978) seminal contribution, studies on Ricardian equivalence have in general ignored them. This is clearly a defect, since almost all of the testing of the validity of the permanent income hypothesis has concluded that it is not supported by aggregate time series data, since consumption has been found to be more sensitive to fluctuations in current income than predicted by the permanent income models (see Deaton 1992).

Much of this work has been confined to estimating the fraction of income or consumption accruing to consumers who do not follow the

---

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

permanent income hypothesis.[12] The existence of such non-optimizing rule-of-thumb consumers has in turn been accounted for by liquidity constraints, although no direct evidence supporting this explanation is given. Jappelli and Pagano (1989), using this method with international time series data, found that the fraction of consumption going to non-optimizing rule-of-thumb consumers varies widely across countries, roughly from 40 per cent to 60 per cent. Similar results with international data were also found by Bayomi and Koujianou (1989). For 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 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 vary from 25 per cent to nearly 80 per cent.[13]

Most of these studies neither allowed for, nor tested, variation in the portion of non-optimizing consumers. Bayomi and Koujianou (1989) as well as Campbell and Mankiw (1991) are notable exceptions (see also Fissel and Jappelli 1990, and Patterson and Pesaran 1992). Both Bayomi and Koujianou (1989) and Campbell and Mankiw (1991) use a step dummy (and time trend) to study whether the fraction of non-optimizing consumers has changed since 1980, as is often argued that financial liberalization during the 1980s has relaxed liquidity constraints in most countries, which should show up as 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.

In general, the problem is that since there is no well-specified theory behind the empirical models, interpretation of the results is difficult. Specifically, 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 in

---

[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 consumption, modified by simply adding the current income term in the equation to capture non-forward looking behaviour.

[13] Since Hall and Mishkin (1982) and Hayashi (1985), there has emerged a growing body of evidence on the excess sensitivity of consumption to current income, using micro data on individual households. A critical survey on the results based on micro data (as well as on aggregate time-series studies) is provided by Attanasio (1994).

respect to financial markets but also in respect to 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 methods based on the use of dummy variables indicating the time of such deregulation are simply not powerful enough to detect movements in the fraction of liquidity-constrained consumers over time.

Rather than merely 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 an aggregate time-series study[14] 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 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 UK regional data, Bayoumi (1990) looked for a specific link to deregulation of financial markets. He estimated an excess sensitivity model in which the coefficient for 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 about 30 per cent by 1987.

All in all, empirical evidence on the excess sensitivity of consumption to current income, based on aggregate time-series data, 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 are drawn.

As regards 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

---

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

complements rather than substitutes.[15] The results have proved to be particularly sensitive to the empirical specification and measurement of variables (see Ni 1995). Furthermore, since both private consumption and government consumption are extremely heterogeneous, the observed substitutability or complementarity might be related to the composition of these variables (see Evans and Karras 1996). Because some components of government consumption might be perceived as close substitutes for private consumption, some as complements, and some as unrelated, it is evident that the composition of government consumption is important.

Finally, the evidence on the non-Keynesian view of fiscal deficits is still quite scarce and generally tentative. The obvious reason for this is that the few theoretical models that capture non-Keynesian effects do not readily provide a basis for empirical estimation. Therefore, the analysis of non-Keynesian effects of fiscal policy falls beyond the scope of this study. It is however worth noting the empirical work done by Giavazzi and Pagano (1990, 1995). On the basis of their earlier study, they conclude that recent experience from major fiscal stabilization programmes in Ireland and Denmark provides some evidence supporting the non-Keynesian view of fiscal deficits. In these countries, a sharp fiscal consolidation in the 1980s was associated with an increase in private domestic demand. In their later work, they analyze cross-country data for 19 OECD countries as well as the Swedish fiscal expansion in the early 1990s. In empirical estimations, the possibility that the effects of fiscal variables on private consumption may vary is captured by the interaction of fiscal variables with dummy variables that indicate periods of sharp and/or persistent discretionary changes in the budget. The results of this cross-country study suggest that both contractionary and expansionary fiscal policy may have non-Keynesian effects if they are sufficiently large and persistent.

---

[15] Evidence supporting the view that government consumption is a substitute for private consumption is presented in Kormendi (1983), Aschauer (1985), Graham and Himarios (1991). The opposite result, that government consumption complements private consumption, was found in Leiderman and Razin (1988), Haug (1990), Karras (1994), Evans and Karras (1996). 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.

1.2 Purpose of the study

The main purpose of this study is to investigate whether the response of aggregate consumption to fiscal policy in selected EU countries can be characterized as Keynesian or Ricardian. Albeit there exists a voluminous literature on the Ricardian equivalence hypothesis, there are at least three important reasons why a re-examination of the effects of fiscal policy on private consumption, focusing on European countries, is relevant. Firstly, since the existing evidence concentrates mainly on the US and is to a large extent controversial, it is less useful in assessing the impact of fiscal variables on the economy in other countries. Furthermore, there exist only a few studies on the effects of fiscal policy using comparable data, estimation methods and sample periods and covering a large set of European countries.[16]

Secondly, the question whether one should worry about fiscal deficits and debt has become increasingly important as the fiscal positions in many European and other industrial countries have continuously deteriorated since the 1960s. The development of various government budget variables during the last three and a half decades in a selected set of EU countries[17] is illustrated in Table 1. As shown in the table on the expenditure side, the ratio of average general government consumption to GDP has remained quite stable over the decades, at about 20 per cent, whereas the comparable ratio for general government transfer payments to the household sector has nearly doubled, amounting to about 21 per cent during the first half of the 1990s. On the income side, the ratio of direct income taxes to GDP has steadily increased from 31 per cent in the 1960s to 42 per cent in the 1990s. Despite tightened taxation, the ratio of general government debt to GDP has doubled, from 36 per cent to nearly 74 per cent. If it continues, the situation is clearly a cause for concern.

Thirdly, it is evident that the creation of a single currency and single monetary policy on the outset of the Stage Three of Economic and Monetary Union stresses the role of participant countries' national fiscal policies in the stabilization of country-specific fluctuations in economic activity and idiosyncratic shocks. In this respect, it is crucial to know whether the effects of fiscal policy conform more closely to conventional Keynesian or Ricardian predictions.

---

[16] The few exceptions include Nicoletti (1988), Alesina and Perotti (1995), Giavazzi and Pagano (1995) and Evans and Karras (1996).

[17] Austria, Belgium, Finland, France, Germany, Greece, Italy, the Netherlands, Sweden and the UK.

Table 1. **General government consumption, transfers, taxes and debt, relative to GDP, in selected EU countries***

	1960s	1970s	1980s	1991-1994
Government consumption	19.7	18.6	19.3	18.6
Government transfers	12.8	15.5	19.5	19.5
Direct taxes	30.9	36.7	41.1	42.3
Government debt	36.0	35.7	57.3	73.7

* The figures are averages over the following countries: Austria, Belgium, Finland, France, Germany, Greece, Italy, the Netherlands, Sweden, the UK.

Recent empirical work on Ricardian equivalence has focused almost exclusively on the Euler equations implied by optimizing models of intertemporal choice. Instead of estimating Euler equations as is done in the majority of the works cited above, the aim here is to derive a consumption function from an optimizing model as a basis for estimation. The main reason for the difference in emphasis is that the determination of the absolute level of consumption is essential, as it constitutes a large share of gross domestic product and is thus an important channel for the transmission of fiscal policy measures. The Euler equation determines only the today's consumption relative to tomorrow's consumption.

Ricardian equivalence is used as a starting point or benchmark by which one can characterize the nature and magnitude of departures of the economy from the idealized model. The first departure examined is a finite planning horizon for consumers. This is done by generalizing the standard permanent income model to incorporate a finite planning horizon for consumers, as in Blanchard's (1985) seminal paper. This generalization allows one to test which of the two main hypotheses concerning the effect of fiscal deficits on private consumption - Ricardian or Keynesian - is supported by the empirical evidence. In the model the impact of government financing decisions on private consumption is transmitted through disposable labour incomes, ie taxation and government transfer payments. If the consumer's planning horizon is shorter (finite) than that of the government (infinite), the timing of (net)taxes will affect consumers' expected wealth and lead to the breakdown of Ricardian equivalence. The shorter the planning horizon of consumers, the greater the deviation from Ricardian equivalence and the more Keynesian the effects of government deficit financing.

In this basic setup the effect of government consumption on private consumption is captured by allowing government consumption to be a

direct conveyer of utility to consumers, as suggested by Aschauer (1985). This allows one to test whether government consumption and private consumption are perceived as substitutes (complements), implying that increases in government consumption crowd out (in) private consumption.

To account for further possible departures from the Ricardian benchmark, the consumption function implied by the generalized permanent income model is nested within a more general framework in which a fraction of income accrues to rule-of-thumb consumers, who consume their current income rather than their permanent income. The modelling of this excess sensitivity hypothesis is based on the approach suggested by Hayashi (1982), and Campbell and Mankiw (1989). As a first step it is assumed that a constant fraction of disposable labour income accrues to non-optimizing rule-of-thumb consumers, while in the second step this fraction is allowed to change over time. The larger the fraction of non-optimizing consumers in the economy, the larger the effects of taxation and government transfer policy on private consumption, even if some consumers optimize over an infinite horizon.

The generalized permanent income model is finally modified by integrating the government budget constraint into the consumer's intertemporal optimization problem. In a sense, this is a more complete description of consumers' expectations about future fiscal policy than is the basic model, since in this framework consumers take explicitly into account the long-run solvency of the government. Furthermore, fiscal policy variables, ie taxation, government debt and government consumption, affect private consumption more directly via the government budget constraint.

The major advantages of the approach adopted here are the following. First, it explicitly builds on intertemporal optimization and enforces a close link between theoretical models and empirical specifications. Second, the framework enables testing for two important sources of deviation from Ricardian equivalence, ie finiteness of the planning horizon and excess sensitivity of consumption to current income. Third, the model encompasses also government consumption and hence enables testing of the degree of substitutability between private and government consumption. The empirical analyses are based on annual data from ten EU countries covering the period 1961-1994.

The rest of the study is organized as follows. In Chapter 2 a generalized permanent income consumption function is derived for the purpose of empirical estimation and issues concerning empirical implementation and method of estimation are discussed. Chapter 3 presents the data and estimation results of the generalized permanent

income model. In Chapter 4 the basic model is extended by nesting it into a more general framework in which a fraction of income accrues to rule-of-thumb consumers. Chapter 4 reports on estimation results of this extended model. In Chapter 5 the model is further extended by incorporating the government budget constraint in the consumer's intertemporal optimization problem and estimation results of the consolidated model are presented. Concluding remarks and further considerations are presented in Chapter 6.

2 A generalized permanent income model

The effect of fiscal policy on private consumption is analyzed within the framework of a stochastic intertemporal optimization problem where rational consumers maximize the expected value of utility, subject to a 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.[1] In order to be able to nest the Ricardian equivalence proposition and the conventional non-Ricardian hypothesis, we modify Aschauer's representative agent model with infinite horizon 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 to fail. Ricardian equivalence holds only if the discount rates on assets and labour income are identical.

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.[2]

Generally, the aggregation problem can be handled in two ways, both of which rely on a set of restrictive assumptions that are needed to keep the model 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

---

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

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

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 a single 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, which measures the finiteness of life can be interpreted in several ways: as a horizon index between zero and infinity, as the disconnectedness of current consumers from future generations, or as the myopia with which consumers foresee future taxes.[3] Modelling households as if they had finite horizons can also be viewed as a substitute for modelling capital market imperfections that 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, the horizon goes to infinity as a limiting case. In empirical work this interpretational flexibility clearly presents 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 here is closer to that of the permanent income hypothesis of Friedman (1957) than to the life-cycle hypothesis of Modigliani (1966), and is better suited to the study of issues for which the finite horizon aspect is important (aggregate consumption studies) than to issues for which cross-consumer differences in propensity to consume are crucial (studies using individual data).[4]

---

[3] Blanchard (1985) interpreted 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, 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 disconnected from future generations (no bequest motive).

[4] 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[5]

Consumers are assumed to adjust their consumption according to their lifetime resources rather than current income.[6] In each period, each consumer is assumed to face a known one-period probability of survival, γ, which is assumed to be independent of age. Hence the probability of surviving from period t through period t+j is γ^j and the expected life of each consumer, ie the horizon index in Blanchard's terminology, is $1/(1-\gamma)$.[7]

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 as the government, r. The assumption of a constant real rate of interest is justified on the ground that under certain assumptions it allows one to derive a closed-form solution for private consumption.[8] Following Blanchard (1985) it is assumed that there exist riskless insurance (annuity) markets, in which insurance (annuity) companies in each period make (receive) an annuity payment to (from) each consumer with positive (negative) financial wealth and inherit all the consumer's financial wealth at his death.[9] A zero-profit condition in these markets, together with a simple population structure and lifetime uncertainty, implies an effective, risk-adjusted interest factor of $(1+r)/\gamma$ for

---

[5] Throughout this paper, uppercase letters represent stocks or present discounted values and lowercase letters represent corresponding flows.

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

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

[8] A stochastic real interest rate would of course have been a more realistic assumption, but as noted above, it is impossible to derive a consumption function from an optimizing model in the presence of stochastic real interest rates. In considering the effect of a varying real interest rate on consumption the focus here has therefore been on Euler equations, which allow for a varying and uncertain real interest rate. Furthermore, from the point of view of empirical work, the assumption of a constant (and given) real interest rate can be justified here on the ground that comparable data on real interest rates from all countries in the sample covering the whole estimation period are not readily available.

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

consumers, with (1+r) being the pure interest factor and $1/\gamma$ the annuity factor. The model thus excludes the bequest motive.

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:

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

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

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

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

This formulation implies that a unit of government consumption yields the same utility as θ units of contemporaneous private consumption (see eg Barro 1981). A positive value for θ indicates that government consumption is a substitute for private consumption (ie an increase in government consumption diminishes the marginal utility of private consumption) whereas a negative θ[10] would suggest that government consumption and private consumption are complements (ie an increase in

---

[10] 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 $E_t\left\{\sum_{j=0}^{\infty} (\gamma\beta)^j [U(c^T_{t+j,k+j}) + \Phi(g_t)]\right\}$ 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.

government consumption raises the marginal utility of private consumption).[11]

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

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

where

$h_{t,k}$ is period t real disposable labour income (human wealth) of a consumer aged k, defined as $y_{t,k} + \tau_{t,k} - t_{t,k}$[12]

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

$\tau_{t,k}$ is period t real government transfers (lump-sum) received by a consumer aged k

$t_{t,k}$ is period t real gross tax payments (lump-sum) of a consumer aged k

$a_{t,k}$ real nonlabour assets (debt, if negative) including government bonds of a consumer aged k at the end of period t

---

[11] It should be noted that we do not refer to substitutability in the sense of Hicks-Allen but rather in the sense of Auspitz-Lieben-Edgeworth-Pareto (ALEP) (see Samuelson 1974). Let the utility function be $U(c^P_t, g_t)$. Substitutability between c^P_t 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^P_t), then c^P_t and g_t are ALEP substitutes. If $U_{cg} > 0$, they are ALEP complements, and if $U_{cg} = 0$, they are ALEP independents - in this case c^P_t and g_t are separable. Under the additivity assumption of private consumption and government consumption (equation 2) and $U(c^P_t + \theta g_t)$ concave, $U_{cg} < (>,=) 0$ if and only if $\theta > (<,=) 0$. Negative θ corresponds to complementarity and positive θ to substitutability. In a general form, $U(c^P_t, g_t)$, the marginal rate of substitution between private and government consumption depends on the consumption levels per se, while imposing eg homogeneity on U implies that θ depends only on the ratio of private consumption to government consumption. The assumption of a constant θ considerably simplifies the computation, albeit it implies restrictions on the structure of the consumer's preferences. Two alternative and more general specifications, Cobb-Douglas and CES, are almost exclusively considered in the context of Euler equations (see eg Campbell and Mankiw 1990, and Ni 1995).

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

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

g_t is period t real government consumption of a consumer

r is the 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 stochastic variables following given stochastic processes outside the control of the consumer. The specification however implies that taxes as well as government transfers are age-specific while government consumption is not. Furthermore, government consumption, g_t, enters the consumer's one-period budget constraint (3), multiplied by θ. The term $(1+r)/\gamma$ is the risk-adjusted gross rate of return on nonlabour assets (nonhuman wealth). During period t the consumer saves (borrows, if negative) $a_t - a_{t-1}$ to buy assets and new government bonds and expects to receive a stream of interest payments on the accumulated assets.

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 infinite consumption and an ever-increasing debt burden are 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 aged k at time t in terms of total effective consumption:

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

where

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

is the expected present value of the future effective consumption of a consumer aged k at time t,

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

is the discounted sum of the expected disposable labour incomes (human capital) of a consumer aged k at time t,[13] and

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

is the expected present value of government consumption. $E_t W_{t,k}$ denotes the present value of expected total wealth of a consumer aged k at time t.[14]

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

---

[13] 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). For arguments against this view, see Feldstein (1982), Kormendi (1982).

[14] These formulations require that consumer behaviour exhibit certainty equivalence: the individual consumer chooses the path of consumption as if his 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 the utility function is quadratic and uncertainty exogenous (see eg Turnovsky 1977). With a linear marginal utility function the marginal utility of consumption is equal to the marginal utility of expected consumption. In this case the consumer behaves as if expected consumption were known with certainty. Hence, only expected values count, not variances. More details are given below.

can be shielded from period to period fluctuations in income through borrowing and lending.

The term $\theta E_t G_t$ in the definition of wealth implies that with $E_t G_t$ unchanged, an increase in government consumption today implies some direct crowding out (in) of contemporaneous private consumption, if $\theta > 0$ (< 0).

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

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

The set of Euler equations (5) characterize the relation between two adjacent periods along the optimal path of consumption: at an optimum point reallocating 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 and exogenous uncertainty.[15] Although the quadratic

[15] 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 a 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). Furthermore, to account for uncertainty (income risk), one should be able to specify its nature, ie whether it is idiosyncratic or common to all consumers. If uncertainty is idiosyncratic, the timing of taxes will affect the consumer's current consumption-saving decisions, causing Ricardian equivalence to fail (see Barsky, Mankiw and Zeldes 1986, and Kimball and Mankiw 1989). By contrast, if uncertainty is aggregate with no idiosyncratic component, Ricardian equivalence holds (see Abel 1988).

formulation has some serious shortcomings[16] it is widely used because it delivers a linear Euler equation which can be easily 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

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

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 the dynamic equilibrium condition of the consumer is independent of the survival probability). This is due to the fact that the aged k consumer's future utility is discounted at the rate $(\gamma\beta)$ whereas future values are discounted at the rate $\gamma/(1+r)$. 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 consumption in period t+1 relative to that in 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

---

[16] An important shortcoming of this assumption is that it implies increasing absolute risk aversion (that is, a willingness to pay more to avoid a given bet as wealth increases) and hence rules out the precautionary savings motive due to uncertainty. If utility is quadratic, marginal utility is linear in consumption ($U'''=0$), indicating that an increase in the variance of consumption has no effect on expected marginal utility and thus no effect on optimal behaviour. More plausible utility functions implying that an increase in uncertainty raises the expected marginal utility are such that $U'''>0$. To maintain equality in (5), the expected future consumption must then increase compared to current consumption. Uncertainty thus gives rise to the precautionary savings motive, which leads consumers to defer consumption. It is however difficult and in some cases even impossible to solve for optimal consumption in the presence of the precautionary savings motive (see Blanchard and Fisher 1989). A case that can be solved is that of constant absolute risk aversion (CARA) (see Caballero 1990, and Kimball and Mankiw 1989). Under CARA, consumption can however be negative along the optimal path. In this respect, a more plausible utility function would be the constant relative risk aversion (CRRA) function (see eg Zeldes 1989 and Kimball 1992). It should however be noted that under such preferences and income uncertainty, one cannot derive a closed-form solution for the consumer's optimizing problem.

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, ie the innovation in permanent income. According to this formulation the optimal forecast for current consumption is the previous period's consumption.

Substituting the Euler equation (6) into the consumer's lifetime budget constraint (4) allows solution for the total effective consumption of a consumer aged k at time t:

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

where

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

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

In terms of private consumption, c^P_t, equation (7) can be written as

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

The term in brackets in equations (7) and (8) represents total expected wealth, $E_t W_{t,k}$, of a consumer aged 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 the finite horizon and a utility function that encompasses also government consumption.

2.2 Aggregate consumption

Since the economy consists of overlapping generations, derivation of the aggregate consumption function requires the determination of the size of each generation and summation across generations. The population is normalized so 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 consumers aged k in each period. The size of the population is therefore constant[17] and is 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 the population yields expected per capita aggregate private consumption, c_t^P, as

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

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:

$$E_t W_t = (1-\gamma) \sum_{k=0}^{\infty} \gamma^k W_{t,k} = E_t H_t + (1+r) a_{t-1} + \theta E_t G_t, \tag{11}$$

where

---

[17] The model can be easily 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 $(1-\gamma)$ 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 the population is growing. If instead households act as if their memberships are growing less rapidly than the population, then Blanchard's alternative to Ricardian equivalence holds.

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

is the expected value of aggregate per capita disposable labour income,

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

is aggregate per capita real non-labour assets, and

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

is the expected value of aggregate per capita government consumption multiplied by θ.

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

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

Equation (15), in contrast to 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 thus results 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 ($0<\gamma<1$), consumers do not completely internalize the burden of future government debt associated with a current tax cut. Hence, the net wealth of consumers currently alive rises due to a current cut in taxes, and they react by increasing consumption. This implies that private saving does not rise by enough to fully offset the increase in the budget deficit (or equivalently the decline in government saving), which causes government deficit financing to be 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 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 as $s_t \equiv h_t^T - c_t^P$. Flavin's permanent income consumption function then implies that $s_t = -\sum_{j=1}^{\infty} (1+r)^{-j} \Delta h_{t+j}$, ie saving takes place when current disposable labour income is greater than permanent income and is expected to decline in the future.[18] More specifically, this formulation indicates that, under an infinite planning horizon, saving equals the expected discounted value of future declines in disposable labour income.

In view of empirical implementation, equation (15) for c_t^P is solved in terms of c_{t-1}^P, given the wealth constraint, $a_t = h_t + (1+r)a_{t-1} - c_t^P$ (see Appendix 1)[19]:

$$\begin{aligned} c_t^P = & -r\beta_0 + (1+r)(1-\beta_1)c_{t-1}^P + \beta_1(1-\gamma)E_t H_t \\ & + \beta_1\theta(1-\gamma)E_t G_t - \theta g_t + (1+r)(1-\beta_1)\theta g_{t-1} + \beta_1\gamma(e_{Ht} + \theta e_{Gt}) + u_t, \end{aligned} \tag{16}$$

where error terms

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

and

---

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

[19] This is done for the reason that internationally compatible and reliable data on nonlabour assets is not readily available. The solution might not be without problems (see Himarios 1995), although in principle alternative mathematically equivalent solutions of consumption functions derived using the Euler equation approach should give the same empirical results. More details are given below.

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

reflect revisions of expectations about the sequence of h_{t+j} and g_{t+j} made by consumers as new information about future labour income, net taxes $(t_t-\tau_t)$ and government consumption becomes available. Hence, the unexpected change in private consumption from t-1 to t is related to changes in expected lifetime wealth (ie permanent income) resulting from unexpected changes (or innovations) in labour income, net taxes and government consumption.

These unexpected changes in disposable labour income and government consumption can be temporary or permanent. From the consumer's intertemporal budget constraint (4) it follows that a temporary shock to his disposable income or to government consumption has a relatively small effect on the expected present value of disposable labour income and government consumption and, accordingly, a small effect on his current and future consumption decisions. Unexpected permanent changes, on the contrary, have larger effects on the expected present values and therefore a larger impact on the consumer's current and future consumption decisions.[20] Moreover, it should be noted that the effect of unexpected changes in government consumption enters the consumer's intertemporal budget constraint directly through the expected present value of government consumption and indirectly through changes in the expected present value of (net) taxes.

The additional error term, u_t, is added to represent the stochastic, ie transitory, component of consumption, defined as zero-mean shocks to the utility function and measurement errors in consumption.[21]

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 the Ricardian

---

[20] If the innovations e_{Ht} and e_{Gt} in disposable labour income and government consumption are permanent, they constitute permanent changes in disposable labour income and government consumption. The effect of such innovations is to change the present value of expected disposable labour income and government consumption. The response to such innovations is a permanent change in private consumption.

[21] Flavin (1981) however justifies neglect of transitory consumption on the aggregate level provided that individual realizations of transitory consumption are independently distributed across the population.

and non-Ricardian hypotheses as special cases. If Ricardian equivalence holds, private consumption should change only when there are unexpected changes in labour income, net taxes or government consumption. Furthermore, the response of private consumption to these unexpected changes will be larger if they are perceived to be permanent rather than transitory.

The key parameters in assessing the effects of fiscal policy on private consumption are γ and θ. With γ equal to unity, forward-looking rational consumers have an 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 and not on the timing of tax collections.

The parameter γ being less than unity implies that, due to a shorter planning horizon, 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. Thus finite-horizon consumers give a smaller weight to the future expected tax increase than to the current tax cut. In the case of extreme myopia ($\gamma=0$), consumers treat government bonds fully as net wealth.

A positive value for θ implies that an increase in government consumption diminishes the marginal utility of private consumption (ie the two are substitutes), whereas a negative θ would suggest that an increase in government consumption raises the marginal utility of private consumption (ie the two are complements). Hence, with the expected present value of government consumption, E_tG_t, unchanged, substitutability (complementarity) implies that private consumption declines (increases) with increases in government consumption, in accordance with the parameter θ. The greater the utility substitution (complementarity) at the margin between private consumption and government consumption, as measured by θ, the larger the negative (positive) response of private consumption to an increase in government consumption. However, as long as $0<\theta<1$, aggregate demand will rise by a fraction $(1-\theta)$ of an increase in government consumption. If government consumption is a perfect substitute for private consumption

(θ=1), then Feldstein's (1982) condition for complete ex ante crowding out of private consumption and fiscal policy neutrality is satisfied.

More specifically, with $\gamma = 1$, $\theta = 0$ and δ= r, equation (16) reduces to the Hall's (1978) specification in which current consumption and last-period consumption differ only by the extent of the forecast error in current disposable income.[22] The infinite horizon (γ=1) and the assumption of no population growth imply that there is no way for individuals to avoid taxes by dying and/or levying taxes on future generations. Moreover, an infinite planning horizon implies that the propensity to consume out of total expected wealth, β_1, should be close to r/(1+r). When $\gamma < 1$ and $\theta \neq 0$, expected human wealth, government consumption and government debt affect current consumption above and beyond the impact of lagged consumption.

Although the results derived above are essentially applicable to a closed economy, they can be extended to an open economy provided that the given real interest rate, r, faced by the economy is equal to the real interest rate, r*, in international capital markets and that consumers in the economy can freely borrow and lend at this interest rate.[23] If the international interest rate faced by private consumers is about the same as that faced by the government, then the same set of assumptions that give rise to Ricardian equivalence in a closed economy will also give rise to it in the open economy. Specifically, an expected tax cut that is accompanied by an equal increase in the government's foreign debt will have no effect on private consumption and wealth if γ=1. In this case the increase in the government's external debt is fully internalized by the private sector, which takes into account the taxes to be imposed in the future to finance the flow of payments to foreign lenders. Thus, internal and external government debt are treated in the same way by the private sector.

2.3 Derivation of the reduced-form consumption function

The main problem in estimating an intertemporal consumption function with rational expectations like equation (16) is how to handle the unobservable future paths of disposable labour income, h_{t+j}, and

---

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

[23] On Ricardian equivalence in an open economy, see Frenkel and Razin (1986 and 1987).

government consumption, g_{t+j}. In general, this would require specification of stochastic processes governing the evolution of h_{t+j} and g_{t+j}. This is usually done by assuming that the expected values of the variables under consideration are given by past values of themselves and possibly by past values of other auxiliary variables.[24] There are however two major problems in using these kinds of forecast equations. First, it is doubtful that past values alone are sufficient to estimate future values of stochastic variables. The second problem is to determine the appropriate number of lags to use for annual data. The problem is particularly serious with short time series data.

In order to save degrees of freedom here, Hayashi's (1982) procedure, is applied, in which the stochastic difference equations implied by the rational expectations assumption are used to eliminate the unobservables from the estimation equation.[25] The advantage of this method is that it obviates the need to specify stochastic processes for disposable labour income and government consumption, which would be highly problematic. Accordingly, we postulate difference equations expressing changes in expected values of disposable labour income and government consumption from period t-1 to period t as being determined by the present value of period t-1 disposable labour income and government consumption and unexpected changes in these variables:

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

where e_{Ht} and e_{Gt} are the expectational revisions of consumers from period t-1 to period t. Formally,

---

[24] For example, Aschauer (1985) uses 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 it allows distinction between debt as a potential source of wealth, which is the concern of Ricardian equivalence, and the role of debt as a signal of future levels of government consumption.

[25] This method is used eg by Leiderman and Razin (1988) and Graham and Himarios (1991).

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

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

These surprise terms are, by construction, orthogonal to the information set available in t-1, I_{t-1}, and thus serially uncorrelated. They may however be correlated with variables dated 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[26]:

---

[26] As can be seen from the reduced form representation of c_t^P in equation (18), the level of private consumption is essentially generated by a second order autoregressive and distributed lag process on government consumption (and disposable income) with autoregressive and moving average errors. This particular representation, which has been generally used in the literature, involves potentially subtle problems associated with the roots of the autoregressive lag polynomial, which have thus far gone undiscussed in the literature. First, the autoregressive polynomial can be factored into $(1-\lambda_1 L)(1-\lambda_2 L)$, where $\lambda_1 + \lambda_2 = (1+r)(1-\beta_1) + (1+r)/\gamma$ and $\lambda_1\lambda_2 = (1-\beta_1)(1+r)^2/\gamma$. Hence, the roots are $\lambda_1^{-1} = \gamma/(1+r) < 1$ and $\lambda_2^{-1} = (1+r)/[\gamma(1+\delta)] \geq 1$, so that only one of the roots, λ_2^{-1}, can lie outside the unit circle (a sufficient condition being $r \geq \delta$). The other root, λ_1^{-1}, must (with a non-negative real interest rate) lie on or inside the unit circle. Thus, in this case the consumption process does not appear to be stable (and 'invertible'). The distributed and moving average polynomials may have common roots, in which case the underlying consumption process can be reduced to a simpler form by cancelling the common polynomial factors. Interestingly, one can see from equation (18) that in the case where γ equals one (representative-consumer case) the autoregressive and distributed lag polynomials have identical roots (full cancellation), while there is a common factor in the autoregressive and moving average polynomials corresponding to the 'unstable' root, λ_1^{-1}. If so the error process (to the level of private consumption) can be represented by a stable autoregressive process (of order one). Note further that assuming $r = \delta$ implies a higher stable λ_2^{-1}, bringing it nearer to a unit root for a 'nearly Ricardian economy'.

$$c_t^P=\beta_0'+\left[(1+r)(1-\beta_1)+\frac{1+r}{\gamma}\right]c_{t-1}^P-(1-\beta_1)\frac{(1+r)^2}{\gamma}c_{t-2}^P$$
$$-\beta_1(1-\gamma)\frac{1+r}{\gamma}h_{t-1}-\theta g_t+\theta(1-\beta_1+\gamma)\frac{1+r}{\gamma}g_{t-1} \qquad (18)$$
$$-\theta(1-\beta_1)\frac{(1+r)^2}{\gamma}g_{t-2}+v_t,$$

where

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

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

and

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

Since the error terms, u_t, e_{Ht} and e_{Gt}, may be correlated, the error structure has an unrestricted variance-covariance matrix. This means that one cannot recover the response of private consumption to innovations in labour income, net taxes or government consumption.

2.4 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. Estimation of equation (18) involves a number of problems that may result in inconsistent parameter estimates. Firstly, the time aggregation imposed on the consumption function by the use of annual data and the

inclusion of consumer durables in the measure of private consumption[27] introduce a first-order moving average term in lagged consumption expenditure.[28] To avoid misspecification arising from time-averaging and durability, the instruments must be lagged at least two periods. There may also be white-noise errors in the levels of consumption and income variables due to 'transitory consumption' or measurement errors. White-noise errors in levels become first-order moving average errors in the specification and may be correlated with once-lagged instruments though not with twice-lagged instruments.

The second problem pointed out by Hayashi (1982) is that even if 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 also requires use of an instrumental variables estimator with at least twice-lagged variables as instruments, which are by definition orthogonal to 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 not taken into account 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) Generalized Method of Moments (GMM) estimator is used. The reported standard errors are thus heteroscedasticity- and autocorrelation-consistent standard errors (White 1980).

The basic ideas behind GMM, its statistical properties and some tests are outlined in the following. Consider a case where a p-dimensional vector η of unknown parameters is to be estimated (here $\eta = (\beta_0,\beta_1,\gamma,\theta)'$). Let $g(x_t,\eta)$ be a k-dimensional vector of possibly non-linear functions, where x_t is the vector of the regressors and the dependent variable and let $v_t = g(x_t,\eta_0)$ be 'disturbance' vector, where η_0 denotes the true value of η. Suppose that there exist conditional moment restrictions, $E[v_t|I_t] = 0$, where $E[\cdot|I_t]$ denotes mathematical expectation conditioned on information set I_t. Let z_t be a $q \times k$ matrix of random variables contained

---

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

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

in the information set I_t.[29] The conditional moment restrictions then imply the following q orthogonality conditions (population moment conditions):

$$E[z_t g(x_t, \eta_0)] = 0. \qquad \text{(i)}$$

Suppose that the law of large numbers applies to the sample moment of $z_t g(x_t, \eta)$; then

$$\lim_{t\to\infty} \frac{1}{T} \sum_{t=1}^{\infty} z_t g(x_t, \eta) = E[z_t g(x_t, \eta)] \qquad \text{(ii)}$$

with probability one. Population moment conditions (i) combined with (ii) then imply that

$$\lim_{t\to\infty} \frac{1}{T} \sum_{t=1}^{T} z_t g(x_t, \eta_0) = 0.$$

The basic idea of GMM estimation is to mimic the moment restrictions $E[z_t g(x_t, \eta)] = 0$ by minimizing a quadratic form of the sample moments

$$J_T(\eta) = \left\{ \frac{1}{T} \sum_{t=1}^{T} z_t g(x_t, \eta) \right\}' W_T \left\{ \frac{1}{T} \sum_{t=1}^{T} z_t g(x_t, \eta) \right\} \qquad \text{(iii)}$$

with respect to η. Here W_T is a positive semidefinite symmetric matrix that satisfies

$$\lim_{t\to\infty} W_T = W_0 \qquad \text{(iv)}$$

---

[29] There are infinitely many possible instrumental variables because any variable in I_t can be used as an instrument. Instrumental variables should however be chosen so as to correlate as much as possible with regressors but not with the error term. On the choice of instruments, see also note 5 in Chapter 3.

with probability one, for a positive definite symmetric matrix W_0. The matrices W_T and W_0 are both referred to as the distance or weighting matrix. The GMM estimator of η is η_T, the value that minimizes $J_T(\eta)$ with respect to η. Under fairly general regularity conditions (see Hansen 1982), the GMM estimator η_T is a consistent and asymptotically normally distributed estimator for arbitrary distance matrices.

Suppose that a central limit theorem applies to the 'disturbance' vector, $\nu_t = g(x_t,\eta_0)$, so that $(1/\sqrt{T})\sum_{t=1}^{T} \nu_t$ has an asymptotic normal distribution with mean zero and covariance matrix Ω for large samples. If ν_t is serially correlated,

$$\Omega=\lim_{j\to\infty}\Sigma_{-j}^{j}E(\nu_t \nu_{t-j}'). \qquad (v)$$

Let $\Gamma = E(\partial g(x_t,\eta)/\partial\eta')$ be the expectation of the $q \times p$ matrix of the derivatives of $g(x_t,\eta)$ with respect to η and assume that Γ has a full column rank. Under suitable regularity conditions (see Hansen 1982), $\sqrt{T}(\eta_T - \eta_0)$ is approximately normally distributed with mean zero and covariance matrix

$$V_\Gamma=\{\Gamma'W_0\Gamma\}^{-1}\{\Gamma'W_0\Omega\Gamma W_0\Gamma\}\{\Gamma'W_0\Gamma\}^{-1} \qquad (vi)$$

for large samples. Hansen (1982) shows that the covariance matrix (vi) is minimized when $W_0 = \Omega^{-1}$. With this optimal distance matrix, $\sqrt{T}(\eta_T - \eta_0)$ is approximately normally distributed with mean zero and the asymptotically efficient GMM estimator η_T^* has the covariance matrix

$$V_\Gamma^*=\{\Gamma'\Omega^{-1}\Gamma\}^{-1}. \qquad (vii)$$

To construct η_T^*, one needs a weighting matrix W that is both consistent for Ω^{-1} and positive definite. The solution is to adopt a multi-stage estimation procedure. The first stage GMM estimator is obtained by setting $W_T = I$, and then Ω_T is estimated from the first stage GMM estimate η_T. The second stage GMM estimator is formed by setting $W_T = \Omega_T^{-1}$. This procedure is iterated using the second stage GMM estimate to form the distance matrix for the third stage GMM estimator. This

iterative procedure can be continued until convergence, at which point the resulting estimator will have the same asymptotic properties as the two-stage estimator.

Finally, the overidentifying restrictions test in the context of nonlinear dynamic models is considered. When the number of moment conditions (q) exceeds the number of parameters to be estimated (p), the model is overidentified. In this case $1/T \sum_{t=1}^{T} z_t g(x_t, \eta_T) \neq 0$ in general. However, if the population moment condition $E[z_t g(x_t, \eta_0)] = 0$ holds, then $1/T \sum_{t=1}^{T} z_t g(x_t, \eta_T) \approx 0$. Therefore the sample moment provides a convenient test of the model specification. Hansen (1982) shows that the test statistic

$$\tau_J = TJ_T(\eta_T^*),$$

where $J_T(\eta_T^*)$ is the minimized value of the GMM objective function, converges in distribution to χ^2_{q-p} under the null hypothesis, $E[z_t g(x_t, \eta_0)] = 0$. This test is called Hansen's J-test.

Theoretical hypotheses are tested as follows. Consider n nonlinear restrictions H_0: $R(\eta_0) = r$, where R is an $s \times 1$ vector of functions. The null hypothesis H_0 is tested against the alternative that $R(\eta_0) \neq r$. Let $\Lambda = \partial R/\partial \eta'$ and let Λ_T be a consistent estimator of Λ, with rank s. If the restrictions are linear, then $R(\eta_0) = \Lambda\eta_0$ and Λ is known. Let η_T^u be an unrestricted GMM estimator and assume that $W_0 = \Omega^{-1}$ is used for both estimators. The Wald test statistic is

$$T(R(\eta_T^u) - r)'[\Lambda_T(\Gamma_T \Omega_T^{-1} \Gamma_T)^{-1} \Lambda_T']^{-1} (R(\eta_T^u) - r),$$

where Ω_T, Γ_T and Λ_T are estimated from η_T^u. Under a set of regularity conditions, the Wald test statistic has asymptotic χ^2 distribution with s degrees of freedom. The null hypothesis is rejected when the test statistic is larger than the critical value obtained from the appropriate χ^2 distribution.

In order for the GMM estimator to be asymptotically valid, all variables should be stationary. Nonstationarity is a problem in estimating

with levels,[30] 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 divide all variables by the lagged level of income, h_{t-1}, to obtain stationarity or to estimate equation (18) in 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 approximately 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) show that inference and estimation may proceed in the standard way and no adjustment for 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 between levels of variables in equation (18), and the set of variables used in the empirical estimation should be cointegrated. It is shown in Appendix 3 that the conditions required for estimating in levels can be considered to be fulfilled.

Since 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 Ricardian equivalence. However, by using a nonlinear estimator one can however get direct estimates of the parameters in question, which will give a more meaningful measure of the probability of rejection.

---

[30] 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. 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 a shift in the asymptotic distribution when a deterministic trend is included.

3 Estimation results from the generalized permanent income model

3.1 Description of the data

In studing intertemporal consumption behaviour, it is important to distinguish between consumption and consumer expenditure. Ideally, private consumption should be measured by expenditures on nondurable goods and a service flow that durable goods render to the consumer during the time period considered. However, the problem is that despite efforts to compute imputed services from durable goods, we still do not have a reliable method.[1]

Due to the arbitrariness and difficulties involved in the imputation of a service flow from a stock of consumer durables, both the permanent-income hypothesis and Ricardian equivalence have generally been tested by using consumption expenditures on services and nondurable goods as the measure of private consumption.[2] However, since this measure excludes 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 method of accounting for this imbalance is to rescale the data by netting durables out of the income measure.

Rescaling the data does not however solve the basic problem with this procedure, which requires that the components making up real expenditure on nondurable goods and services have constant relative prices so that they can be treated as a Hicks composite commodity and that the momentary utility function be separable as 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

---

[1] A number of studies have used consumption data based on the computation method developed by Christensen and Jorgenson (1973) for 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).

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

testing quadratic models of aggregate consumption using data on nondurables and services only can be called into question.

In this study total private consumption expenditures are used as a measure for private consumption although this is not strictly in line with the underlying model of utility maximization.[3] Despite the problems associated with the chosen measure, it is considered to be a better measure of private consumption than those that exclude durable goods altogether or use computed values of the service flow.[4] Lack of data on nondurable consumption expenditures over the sample period would in any case have prevented the use of this as a measure of private consumption. Moreover, when the main concern is with 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 the Ricardian equivalence hypothesis, since purchases of durables are often considered to be more sensitive to income or wealth changes than are nondurables.

The appropriate definition of labour income is not without problems either. For instance, 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 nonproperty income that includes employers' contributions to social security and pension funds and excludes items like rent, dividends, and interest receipts. Since there is no clear cut answer as to which income measure is most appropriate, both measures are used. The income measure for a country is chosen on the basis of data availability and/or statistical properties. The robustness of the results is investigated in the context of panel estimations in Section 3.3.

---

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

[4] 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 consumption measure. In Graham and Himarios (1991), however, the choice of the consumption measure proved to be critical to rejection or nonrejection of some of the hypotheses tested. On the importance of the choice of consumption measure for Kormendi's (1983) results, see Graham (1992).

Government consumption, as measured in national accounts, consists mainly of public sector wages and salaries. Since there exists no 'true' value of government spending on goods and services, measured government consumption is likely to suffer from severe errors, which may lead to biased estimates and hamper the interpretation of the results.

Among the key problems in measuring government consumption is the distinction between government spending on goods and services that provides utility to private consumers in the current period and that which yields utility in future periods via government investment (see Kormendi 1983 on that and other aspects). Here the problems involved in measuring durability are even more severe than in the case of private consumption. Another problem stems 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 implies that government consumption should be measured in terms of subcomponents rather than total consumption expenditure. Kormendi (1983) has suggested a rough way to correct total government consumption expenditures by excluding national defence expenditures. This is however not possible in the present study due to a lack of disaggregated data. Therefore, we follow the convention of using total government consumption expenditure without differentiating between its components or accounting for durability.

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

The annual time series data are from the OECD National Accounts and the sample includes the ten EU countries listed in Table 2. 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. A detailed description of the data is given in Appendix 4.

Table 2. **Countries in the sample and estimation periods**

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 for Finland, France, Germany, Italy, Sweden and the UK and by per capita nonproperty income plus government transfer payments less household income taxes for Austria, Belgium, Greece and the Netherlands. Government consumption, g_t, is measured by general government per capita final consumption expenditure at constant prices.

The benchmark instrument set consists of second and third lags of total private consumption, disposable labour income and government consumption.[5] All instruments are measured in per capita terms. In addition, a dummy variable, D91-93, is included in the regressions for Finland on the ground that during these years the Finnish economy was suffering from an unexceptionally deep recession and severe banking crisis.[6] The inclusion of this dummy is supported by prior examination of the data and it leads also to more satisfactory performance of the

[5] It is important to note that there are several possible instrumental variables that could 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 so as to 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 somewhat sensitive to the number of lags included in the sense that the higher the number of lags, the more efficient the estimates.

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

estimated model.[7] The use of a dummy here is of course open to the data mining objection.

The real interest rate is fixed at 3 per cent p.a. in the estimations.[8] It is taken to respresent the average international long-term real interest rate over the estimation period (see eg Lee and Prasard 1994, Mussa and Masson 1995). The robustness of the results with respect to the interest rate used is investigated in Section 3.3 in the context of panel estimations. All data not already valued at constant prices are deflated by the price deflator implied by the ratio of nominal to constant-price total private consumption expenditure.

3.2 Estimation results

Deviations from Ricardian neutrality have generally been attributed to differences in planning horizons of the government and private sectors. The theory suggests that the effects of government financing decisions on private consumption depend crucially on the estimated value of the parameter γ, eg on the length of the average horizon for private consumption and saving decisions, $1/(1-\gamma)$. An estimated value of γ less than unity results in a shorter planning horizon for the private sector and hence in nonneutrality for fiscal policy. The unrestricted version of the consumption equation is estimated first and then the theoretical restrictions on γ and θ are tested using the Wald test.

Table 3 presents country-specific estimates of β_1, γ and θ with their autocorrelation- and heteroscedasticity-consistent standard errors over the sample periods given in Table 2. Estimations are performed assuming $r = \delta$, which is a common assumption in empirical studies based on the

---

[7] As for the results regarding the dummy variable D91-93 for Finland (not reported in Table 3), it is statistically significant in all specifications and ranges between -4.04 and -5.94. The reason for this is an open question. The negative coefficient could however be interpreted to result from limited access to financing due to the banking crisis and soaring unemployment in Finland during the early 1990s and hence reduced consumption possibilities out of permanent income. In general, the result conforms with the structural break that occured during the recession years in the Finnish economy.

[8] The existing data on real interest rates for a subset of the countries in the sample however shows that real interest rates have varied quite substantially 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.

permanent income hypothesis.[9] Due to this assumption the constant term β_0' in equation (18) drops out and the parameter measuring 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 significance levels for any of the countries in the sample.[10]

Table 3. **GMM estimation of equation (18) for selected EU countries[11]**

	β_1	γ	θ	J test	Wald test
Austria					
Unrestricted	.450	.946*	-2.391	1.362	
	(.242)	(.042)	(1.379)	(0.714)	
Restrictions					
$\gamma = 1$	-.028		-6.049	0.975	1.659
	(.164)		(4.859)	(0.914)	(0.198)
$\theta = 0$	.410*	.962*		4.930	3.006
	(.199)	(.028)		(0.294)	(0.083)
$\gamma = 1, \theta = 0$	.241			6.396	3.008
	(.226)			(0.270)	(0.222)
Belgium					
Unrestricted	.063	.900*	-3.629	1.178	
	(.536)	(.336)	(5.729)	(0.758)	
Restrictions					
$\gamma = 1$	.263		.406	2.017	0.087
	(.214)		(2.014)	(0.733)	(0.767)
$\theta = 0$	.275	.985*		1.916	0.401
	(.183)	(.034)		(0.751)	(0.526)
$\gamma = 1, \theta = 0$	.292			2.221	2.039
	(.188)			(0.818)	(0.361)

[9] As pointed out in Section 2.3 (note 26), this assumption can complicate the interpretation of the results given in Table 3, since it may introduce a unit root to the consumption process (in a 'nearly Ricardian economy'). However, results from slightly different parameterizations of the consumption function which do not suffer from this problem were remarkably similar to those in the table. These additional calculations and estimation results are available from the author upon request.

[10] Omission of the constant term did not markedly alter the parameter estimates. The standard errors however tend to be smaller when the constant term is omitted.

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

Table 3 (continued)

	β_1	γ	θ	J test	Wald test
Finland					
Unrestricted	.674*	.875*	3.948	0.266	
	(.070)	(.076)	(2.197)	(0.966)	
Restrictions					
$\gamma = 1$	.613*		2.958	2.060	2.698
	(.063)		(1.662)	(0.725)	(0.100)
$\theta = 0$	1.030*	.975*		5.400	3.231
	(.172)	(.051)		(0.249)	(0.072)
$\gamma = 1, \theta = 0$	.970*			5.540	4.349
	(.146)			(0.354)	(0.114)
France					
Unrestricted	.560*	.989*	.088	5.023	
	(.229)	(.018)	(1.893)	(0.170)	
Restrictions					
$\gamma = 1$	-.124		2.003	4.456	0.329
	(.196)		(2.129)	(0.348)	(0.566)
$\theta = 0$	.566*	.990*		4.940	0.002
	(.220)	(.011)		(0.293)	(0.963)
$\gamma = 1, \theta = 0$	.473*			5.355	0.708
	(.153)			(0.374)	(0.702)
Germany					
Unrestricted	.507	1.052*	-2.782	3.387	
	(.323)	(.039)	(1.632)	(0.336)	
Restrictions					
$\gamma = 1$	.476*		-1.985*	6.312	1.766
	(.212)		(.820)	(0.177)	(0.184)
$\theta = 0$	.667*	1.007*		3.509	2.907
	(.178)	(.014)		(0.476)	(0.088)
$\gamma = 1, \theta = 0$	.654*			4.067	3.337
	(.167)			(0.540)	(0.188)
Greece					
Unrestricted	.876*	1.003*	-4.109*	6.028	
	(.327)	(.076)	(.731)	(0.197)	
Restrictions					
$\gamma = 1$	.880*		-4.267*	5.927	0.203
	(.313)		(.682)	(0.313)	(0.652)
$\theta = 0$	.182	.982*		7.032	31.611
	(.150)	(.030)		(0.218)	(0.000)
$\gamma = 1, \theta = 0$	.132			7.243	40.002
	(.160)			(0.299)	(0.000)

Table 3 (continued)

	β_1	γ	θ	J test	Wald test
Italy					
Unrestricted	.673*	1.015*	2.740	6.529	
	(.156)	(.012)	(2.349)	(0.258)	
Restrictions					
$\gamma = 1$	.615*		3.306	7.716	1.445
	(.138)		(2.258)	(0.260)	(0.229)
$\theta = 0$	.686*	1.028*		7.735	1.360
	(.149)	(.010)		(0.258)	(0.243)
$\gamma = 1, \theta = 0$	.448*			11.789	4.760
	(.150)			(0.108)	(0.092)
Netherlands					
Unrestricted	.755*	.939*	-1.982*	3.957	
	(.175)	(.021)	(.507)	(0.556)	
Restrictions					
$\gamma = 1$	.546*		-1.805*	5.572	8.396
	(.104)		(.571)	(0.473)	(0.004)
$\theta = 0$	.609*	.953*		6.895	15.293
	(.133)	(.029)		(0.331)	(0.000)
$\gamma = 1, \theta = 0$	.474*			7.262	22.557
	(.089)			(0.402)	(0.000)
Sweden					
Unrestricted	.677*	.937*	-.425	0.522	
	(.353)	(.016)	(.648)	(0.971)	
Restrictions					
$\gamma = 1$	.043		-.358	2.786	16.300
	(.186)		(1.171)	(0.733)	(0.000)
$\theta = 0$	.520	.932*		0.675	0.430
	(.287)	(.020)		(0.984)	(0.512)
$\gamma = 1, \theta = 0$	.022			2.707	19.701
	(.183)			(0.845)	(0.000)
UK					
Unrestricted	.724	.778*	7.494	0.977	
	(.730)	(.108)	(10.274)	(0.913)	
Restrictions					
$\gamma = 1$	.064		8.342	1.337	4.173
	(.141)		(5.120)	(0.931)	(0.041)
$\theta = 0$	.452	1.055*		4.672	0.532
	(.272)	(.102)		(0.457)	(0.466)
$\gamma = 1, \theta = 0$	.649*			5.680	13.036
	(.140)			(0.460)	(0.001)

Notès: Heteroscedasticity- and autocorrelation-consistent standard errors are in parentheses. The J test is a test of the validity of the overidentifying restrictions (significance level in parentheses). The Wald test is for the validity of the imposed restriction (significance level in parentheses). An asterisk (*) denotes statistical significance at least at the 5 per cent level. Instruments for unrestricted and restricted specifications include the second and third lags of private consumption, government consumption and disposable labour income. A detailed description of country-specific differences in lag structures of instuments is given in Appendix 4.

The probability value associated with the overidentifying restrictions (J test) is shown in parentheses in the fourth column in Table 3. The general conclusion that can be drawn here is that the model performs satisfactorily for all the countries: tests of overidentifying restrictions do not reject the model while country-specific estimates of γ and θ as well as their standard errors are not overly sensitive to differing 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 imprecise 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 the 1 per cent level for Austria, France, Germany, Greece and Italy. Moreover, the hypothesis of an infinite planning horizon (γ=1) cannot be rejected for these countries at conventional significance levels. 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 γ=1 is rejected at the 5 per cent level for the Netherlands, Sweden and the UK, while for Finland it can be rejected only at the 10 per cent level. Finally, for Belgium the restriction cannot be rejected by the Wald test. The results thus seem to give some support for the Ricardian neutrality hypothesis and infinite planning horizon as a valid approximation of consumer behaviour in six out of the ten EU countries in the sample. This suggests that consumers in these six countries are sufficiently Ricardian in behaviour to increase their saving one-to-one with increases in 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 θ=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 for γ.

The parameter estimates of θ are not statistically different from zero for most of the countries, suggesting that government consumption and private consumption tend to be unrelated. In fact, the unrestricted estimate of θ turns out to be statistically significant only for Greece and the Netherlands at conventional levels of significance. At the 10 per cent 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 the 5 per cent level for Greece and the Netherlands and at the 10 per cent level for Austria, Finland and Germany.

Finally, the joint restriction, $\gamma=1$ and $\theta=0$, cannot be rejected at the 5 per cent 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. In fact, the unrestricted estimate of β_1 turns out to be excessively high in all but one country. An infinite planning horizon, as 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, render the estimated values of β_1 economically implausible.[11]

This anomalious result for β_1 might be due to measurement errors in consumption and disposable labour income and, more importantly, to liquidity constraints[12] that decrease consumers' possibilities for intertemporal consumption smoothing and make consumption too sensitive to current income to conform to the predictions of intertemporal optimization (see Flavin 1981). Under the restriction $\gamma=1$, 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.

Another and quite distinct reason behind the excessively high estimates for β_1 may be the mathematical solution used to eliminate nonlabour wealth from the estimation equation (see Appendix 1). Some support for this can be found in Himarios's (1995) study, which is based on three alternative solutions used in the literature: one in which human wealth is eliminated (Evans 1988), one in which nonhuman wealth is eliminated (Haque 1988) and one which incorporates both forms of wealth (Hayashi 1982). The estimated value of the parameter β_1 turns out to be in line with the values reported here when the consumption function excludes nonhuman wealth in the same manner as in the present study.

---

[11] The estimated value of γ (.94) for Sweden implies a planning horizon of roughly sixteen years whereas the value of β_1 (about .68) implies a planning horizon of only one and a half years!

[12] 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.

When estimations were based on solutions including nonlabour wealth as a right-hand variable, the values of β_1 dropped significantly and were generally consistent with those obtained for the parameter γ. Despite the fact that all three expressions are mathematically equivalent, they resulted in different empirical results for the parameter β_1, even after controlling for the existence of liquidity constraints in the estimated models.

3.3 Panel estimation results

Since the empirical results for individual countries may suffer from various econometric shortcoming due to relatively short sample periods, the data are 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 on 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 groups model can be written as

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

where c_{it}^{P} denotes aggregate per capita private consumption in country i at time t, α_0 and α_i are parameters, 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 $\alpha_{1i} = \alpha_0 + \alpha_i$ is the intercept for the i^{th} 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 i^{th} country. The hypothesis that the intercepts are equal across the countries is then tested by the Wald test.[13]

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) is used. Since the estimation period differs

[13] In general, one could assume that also the slope coefficients vary across the countries and use F-statistics to test the hypothesis that the coefficients are equal. Due to the fact that the estimation equation (18) is nonlinear in its parameters this could not be done here.

across countries the panel is unbalanced. The use of unbalanced panel data results in 314 observations.

The panel estimations are run using three different measures for disposable labour income to check the robustness of results with respect to income variable. The first line in Table 4 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 Section 3.1). The results reported on 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, for which data on total personal income were not available.[14] The third line gives the results using non-property income plus government transfer payments less household income taxes as a measure of disposable income for all countries in the sample. This last measure of disposable labour income conforms more closely than the other two with the theoretical model derived in Chapter 2. A fixed real interest rate of 3 per cent is used in the estimations.

As shown in the table the panel estimation results are broadly in line with the conclusions drawn on the basis of separate country-specific estimations. The results also prove 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 the 1 per cent level. Moreover, the restriction $\gamma=1$ cannot be rejected by the Wald test.

[14] For these two countries nonproperty income plus government transfer payments was used instead of total personal income.

Table 4. **GMM estimation of equation (18) using a panel of 10 EU countries**

	Unrestricted estimates				Wald test			
	β_1	γ	θ	J test	$\gamma=1$	$\theta=0$	$\gamma=1$ $\theta=0$	Equal intercepts
r=0.03								
Country-specific	.449* (.105)	.996* (.007)	-1.234* (.450)	28.559 (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)	35.757 (0.862)	0.180 (0.671)	10.543 (0.001)	21.333 (0.000)	11.221 (0.261)
Nonproperty income	.314* (.113)	1.010* (.012)	-1.044 (.641)	24.817 (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)	29.278 (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)	33.593 (0.438)	0.302 (0.582)	20.865 (0.000)	20.873 (0.000)	11.942 (0.216)
Nonproperty income	.194 (.127)	1.028* (.027)	-2.110* (.345)	25.353 (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. The J test tests the validity of overidentifying restrictions (significance level in parentheses). The Wald test tests the validity of the imposed restrictions (significance level in parentheses). An asterisk (*) denotes statistical significance at least at the 5 per cent level. The instrument set includes the second and third lags of private consumption, government consumption, disposable labour income and nine country-dummies.

The unrestricted estimate of θ is negative and statistically significant, indicating that private consumption and government consumption are complements rather than substitutes. This result is well in line with those of 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 the 1 per cent significance level when the first two income variables are used. When income is measured by nonproperty income, ie excluding rent, dividends 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 insignificant for every 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 was also run using a given real interest rate of 5 per

cent.[15] The fourth, fifth and sixth lines in Table 4 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 increases in the interest rate. With γ virtually unchanged, this is however implausible and in fact exactly the opposite to what one would expect. For lack of a better explanation, one might say that this contradictory result is likely to arise because of problems associated with the estimation of β_1 in general.

As regards the parameter θ, its absolute value and statistical significance increase with increases in the real interest rate, making the complementarity of government consumption and private consumption stronger. The interest rate sensitivity of the parameter θ was reported also in a recent study by Ni (1995) using US data. He estimated Euler consumption equations using two different measures of real interest rates, the real pre-tax T-bill rate and the return on the New York Stock Exchange Composite Index. As noted in his study, government consumption is relatively small compared to private consumption, and therefore GMM estimates of θ might become sensitive to the measurement of interest rates. Finally, the hypothesis $\theta=0$ and the joint hypothesis $\gamma=1$ 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 for the asymptotic properties of the GMM estimates to hold and for Hansen's J test to remain valid asymptotically. Structural instability over the sample period will invalidate a conventional significance test and can yield misleading parameter estimates. A potential candidate as the cause of 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 for private consumption is that improving consumers' borrowing possibilities should also improve the possibilities for the intertemporal consumption smoothing inherent in the underlying theoretical model, as compared to the situation in the 1960s and early 1970s.

---

[15] The equation was also estimated using a given real interest rate of 1 per cent. As shown in Appendix 5, Table A4, the results conform roughly with those reported in Table 4.

Another, and more crucial, factor contributing to parameter instability might be changes in the fiscal policy regime itself. According to Lucas' (1976) well-known critique, rational consumers will change their expectations and behaviour when government changes its policy. Therefore, there is no a priori reason to expect a stable relationship between private consumption and other relevant economic variables in econometric estimations, if policy regimes have changed during the estimation period. In other words, when policy regimes change, the relationship between expectations, past information and behaviour may also change.[16]

Table 5. **GMM estimation of equation (18) using a panel of 10 EU countries for the subperiod starting in the mid-1970s**

	Unrestricted estimates				Wald test			
	β_i	γ	θ	J test	$\gamma=1$	$\theta=0$	$\gamma=1$ $\theta=0$	Equal intercepts
r = 0.03								
Country-specific	.383* (.119)	1.002* (.009)	-1.644* (.490)	25.991 (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)	32.777 (0.784)	0.938 (0.333)	15.252 (0.000)	15.275 (0.000)	23.251 (0.006)
Nonproperty income	.284* (.127)	1.017* (.016)	-1.356* (.433)	23.392 (0.892)	1.198 (0.274)	9.799 (0.002)	15.196 (0.000)	12.074 (0.209)

Notes: See Table 4.

In order to investigate the stability of the parameters, the consumption equation is estimated for the period starting in the mid-1970s.[17] The resulting subsample consists of 194 observations and the results are presented in Table 5. When comparing the results obtained from the subsample to those of the total sample with 3 per cent interest rate (Table

[16] An important implication of rational expectations analysis is thus that the effect of a particular policy depends ultimately on what economic agents expect this policy to be. When this is the case, there is much less certainty about the effects of any particular policy change.

[17] A more formal test of parameter instability in the GMM framework would have been Andrews's (1993) test. However, due to the relatively short sample periods, this test could not be performed with respect to country-specific estimations.

4), 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 one 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 in Finland in the 1990s, the effect of which was controlled by a dummy variable in the country-specific estimations (see Section 3.1).

3.4 Summary

The empirical results based on the generalized permanent income consumption function derived in Chapter 2 seem to give strong support to infinite planning horizons and thus to Ricardian debt neutrality for Austria, France, Germany, Greece and Italy. The same result is also found in the panel estimations. If taken literally, this would mean that consumers, at least in these five countries, take into account the future implications of current financing decisions of the government in a way that effectively mitigates any intentions of the government to stabilize economic fluctuations by timing the taxes. The validity of this outcome is however not without doubts, since the propensity to consume out of total expected wealth is found to be excessively high, given an infinite planning horizon for consumers.

The findings from the country-specific estimations indicate that during the estimation period government consumption and private consumption tended to be complements or unrelated rather than substitutes. Complementarity is also found in the panel estimations. Hence, the results do not in general support the often-stated hypothesis that government consumption crowds out private consumption. Complementarity seems to hold specifically for Austria, Germany, Greece and the Netherlands. Contrary to this general tendency, government consumption and private consumption are found to be substitutes in Finland.

All in all, the empirical evidence presented so far on the Ricardian equivalence hypothesis should be regarded as inconclusive. On the one hand, the results from country-specific as well as panel estimations seem to provide 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 that was found in the estimations is not compatible with an infinite horizon, but in fact suggests a rather short horizon. Since this inconsistent parameter structure may well be an indication of excess sensitivity of consumption to current income, the next chapter seeks to examine the issue by extending the generalized permanent income model to incorporate the excess sensitivity hypothesis.

4 Excess sensitivity and the permanent income hypothesis

The existence of liquidity constraints[1] would provide a tempting explanation for the implausibly high estimates of the propensity to consume out of wealth found in the previous chapter because of 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 rather than zero. Only when consumers have free access to capital markets does maximization of lifetime utility subject to an overall lifetime budget constraint lead to the independence of current consumption from transitory fluctuations in current income.[2] Liquidity constraints, by preventing the consumer from realizing his desired (optimal) consumption plan, can thus cause private consumption to be too sensitive to current income to conform to the predictions of the

[1] A variety of forms of liquidity constraints have been examined in the literature, all of which involve price and/or quantity constraints on borrowing. Borrowing constraints can arise when individuals have private information about their future labour income or riskiness of a 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 than the rate at which they could lend (differential rates). A third form of imperfect capital markets arises if loan rates increase with the amount of borrowed funds (see Scott 1996).

[2] It should be noted that the interpretation of an eventual correlation between consumption and income as an indication of the existence of liquidity constraints depends crucially on the assumption that consumption and leisure are separable in the utility function (see Attanasio 1994 and the references therein). For further discussion concerning evidence on the prevalence of liquidity constraints, see Section 4.4.

intertemporal optimizing framework, even where consumers are rational and forward-looking.[3]

Because the problems related to proper modelling of liquidity constraints in an intertemporal maximization framework with rational expectations have raised nearly insurmountable obstacles, at least from the point of view of empirical tractability, and because of problems related to proper measurement of the extent of liquidity constraints (see Section 4.4), no attempt is made in the present study to model liquidity constraints endogenously. Instead, the primary objective of this chapter is to test whether there are significant deviations from the underlying permanent income model derived in Section 2.1, of which the excessively high estimates of the parameter β_1 could be an indication. If private consumption is found to be excessively sensitive to current income, the obvious consequence is that the forward-looking permanent income model is likely to suffer from misspecification problems; in particular, the omission of current income can bias upwards the estimate of the propensity to consume out of wealth.

Despite its limitations, the chosen approach has important implications when assessing the validity of Ricardian debt neutrality as suggested in Chapter 3. If private consumption is found to be excessively sensitive to current income, the obvious consequence is that government budget deficits will have real effects, even if some 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 suitably designed fiscal policy.

---

[3] Since Flavin (1981, 1985) 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 is warranted by the forward-looking rational expectations-permanent income hypothesis. 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.

4.1 An extended permanent income model (constant-λ model)

If the excess sensitivity of consumption is at the root of the inconsistent parameter structure reported in Section 3.2, one would expect that the inclusion of current income in the consumption function would reduce the estimates of the parameter β_1, which is the propensity to consume out of total expected wealth. This is tested by nesting the excess sensitivity hypothesis in the finite-horizon permanent income consumption function (15) by assuming two types of consumers, along the lines proposed by Hall (1978), Hayashi (1982) and Campbell and Mankiw (1989, 1990).[4] In this approach, 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.[5] 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 going to rule-of-thumb consumers and $1-\lambda$ the fraction going to 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.[6] 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 with structural changes in the capital

---

[4] 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 using aggregate time-series data (see Cushing 1992, Heijdra and van Dalen 1996, Himarios 1995, Leiderman and Razin 1988, Evans and Karras 1996).

[5] Rule-of-thumb consumers are assumed to have no assets nor access to 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 to consume their incomes (see Deaton 1991).

[6] In the context of the λ-model, some evidence suggests that the fraction of income going to 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 goes to 'liquidity constrained consumers' using panel data are more stable, precise, and uniform than are time-series estimates.

markets. Structural changes have important implications also for the empirical estimation of the constant-λ model, since if there has occured a structural break during the sample period, the parameter estimates and their asymptotic standard errors may be misleading.

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 Ricardian debt neutrality. If the estimate of λ is close to zero and γ close to unity, then one can claim that 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, ie the fraction $1-\lambda$ is large (see Campbell and Mankiw 1989). Conversely, if the estimate of λ is large and statistically significant, then one must conclude that the evidence is against the permanent income hypothesis and Ricardian equivalence even if the planning horizon of the fraction of consumers $1-\lambda$ is infinite, ie γ is close to unity.

Since 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 rule-of-thumb consumers and h_t denotes aggregate per capita disposable income. Consumption of rule-of-thumb consumers, c_t^K, is thus

$$c_t^K = y_t^K + \tau_t^K - t_t^K = \lambda h_t \qquad (19)$$

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

Finite-horizon permanent-income consumers are assumed to maximize their intertemporal utility and behave according to the consumption equation

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

where

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

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

Equation (15') states that the consumption of finite-horizon permanent-income consumers with access to capital markets is proportional to their expected aggregate wealth. Since these consumers receive the fraction $(1-\lambda)$ of aggregate disposable income, h_t, they hold $(1-\lambda)$ of expected aggregate human wealth, $E_t H_t$, but hold all of the financial wealth, a_{t-1}, in the economy. If λ is zero, the model reduces 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[7]

$$c_t = \beta_0 + \lambda h_t + \beta_1[(1-\lambda)E_t H_t + \theta(1-\lambda)E_t G_t + (1+r)a_{t-1}] - \theta(1-\lambda)g_t. \quad (20)$$

Equation (20) can be used to test the degree to which private consumption corresponds to the forward-looking optimizing model and the significance of excess sensitivity of consumption to current income.

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

[7] See Appendix 2 for details.

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

where $\epsilon_t = (\gamma e_{Ht} + \theta\gamma e_{Gt})$ and u_t represents transitory consumption. The error terms $e_{Ht} = (E_t - E_{t-1})H_t$ and $e_{Gt} = (E_t - E_{t-1})G_t$ reflect revisions in expectations about the sequence of h_{t+j} and g_{t+j} that forward-looking permanent-income consumers make in going from period t−1 to period t.

Finally, the empirical reduced-form consumption function that nests forward-looking optimizing behaviour with the excess sensitivity hypothesis is derived using the method introduced in Section 2.3. Equation (22) gives the extended aggregate per capita consumption function in terms of observable variables:

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

where

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

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

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

$$v_t=\beta_1(1-\lambda)(e_{Ht}+\theta e_{Gt})-\beta_1(1-\lambda)(1+r)(e_{Ht-1}+e_{Gt-1})$$
$$+(1-\lambda)u_t-(1-\lambda)\frac{1+r}{\gamma}u_{t-1}.$$

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

4.2 Estimation results with the constant-λ model[8]

Estimation results based on a constant-λ model are reported in Table 6. The table gives 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 probabilities associated with Hansen's J test for the validity of overidentifying restrictions and the significance level of the Wald test, indicating the validity of restrictions imposed on the parameters. Estimations are based on the assumption of a constant real interest rate of 3 per cent p.a. and that the subjective rate of time preference, δ, equals the real interest rate, r.[9]

[8] As in the case of the generalized permanent income model, the constant-λ model could not be estimated as a panel due to lack of convergence.

[9] See note 9 in Section 3.2.

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

	β_1	γ	θ	λ	J test	Wald test
Austria						
Unrestricted	.734*	.985*	-2.552	.472	0.970	
	(.348)	(.046)	(1.604)	(.346)	(0.616)	
Restrictions						
$\lambda = 0$	.450	.946*	-2.391		1.362	1.857
	(.242)	(.042)	(1.379)		(0.714)	(0.173)
$\gamma = 1$	.783*		-2.446	.587*	1.096	0.107
	(.250)		(1.606)	(.192)	(0.778)	(0.743)
$\theta = 0$	.816*	1.028*		.821*	1.916	2.530
	(.276)	(.022)		(.196)	(0.590)	(0.112)
$\gamma = 1, \theta = 0, \lambda = 0$	.241				6.396	3.008
	(.226)				(0.270)	(0.222)
Belgium						
Unrestricted	.369	1.061*	6.983	.704	0.145	
	(.558)	(.095)	(21.433)	(.535)	(0.703)	
Restrictions						
$\lambda = 0$	.063	.900*	-3.629		1.178	1.734
	(.536)	(.336)	(5.729)		(0.758)	(0.188)
$\gamma = 1$	.258		-.560	.473	0.897	0.408
	(.591)		(6.160)	(.420)	(0.826)	(0.523)
$\theta = 0$	.353	1.025*		.536	0.675	0.106
	(.549)	(.040)		(.395)	(0.879)	(0.744)
$\gamma = 1, \theta = 0, \lambda = 0$	.292				2.221	2.039
	(.188)				(0.818)	(0.361)
Finland						
Unrestricted	.670*	.851*	3.450	-.175	0.016	
	(.072)	(.093)	(2.353)	(.414)	(0.992)	
Restrictions						
$\lambda = 0$	.674*	.875*	3.948		0.266	0.178
	(.070)	(.076)	(2.197)		(0.966)	(0.673)
$\gamma = 1$	.607*		3.393	.115	1.999	2.539
	(.083)		(1.992)	(.268)	(0.573)	(0.111)
$\theta = 0$	.789	1.015*		.342	3.331	2.150
	(.488)	(.082)		(.382)	(0.343)	(0.142)
$\gamma = 1, \theta = 0, \lambda = 0$	.970*				5.540	4.538
	(.146)				(0.354)	(0.103)

Table 6 (continued)

	β_1	γ	θ	λ	J test	Wald test
France						
Unrestricted	.116	.943*	.057	.428*	3.509	
	(.130)	(.056)	(3.095)	(.104)	(0.173)	
Restrictions						
$\lambda = 0$	.560*	.989*	.088		5.023	16.738
	(.229)	(.018)	(1.893)		(0.170)	(0.000)
$\gamma = 1$	.085		1.759	.472*	4.241	1.015
	(.264)		(3.559)	(.141)	(0.237)	(0.314)
$\theta = 0$	.116	.943*		.428*	3.503	0.0003
	(.128)	(.056)		(.096)	(0.320)	(0.985)
$\gamma = 1, \theta = 0, \lambda = 0$	.473*				5.355	34.663
	(.153)				(0.374)	(0.000)
Germany						
Unrestricted	.261	.974*	1.075	.702*	1.308	
	(.363)	(.036)	(2.543)	(.113)	(0.520)	
Restrictions						
$\lambda = 0$	.507	1.052*	-2.782		3.387	38.228
	(.323)	(.039)	(1.632)		(0.336)	(0.000)
$\gamma = 1$	.012		1.664	.765*	1.305	0.512
	(.390)		(2.762)	(.117)	(0.728)	(0.474)
$\theta = 0$	.379	.981*		.642*	1.755	0.178
	(.230)	(.013)		(.074)	(0.625)	(0.672)
$\gamma = 1, \theta = 0, \lambda = 0$	.654*				4.067	112.602
	(.167)				(0.540)	(0.000)
Greece						
Unrestricted	.363	1.012*	.376	.601*	3.441	
	(.227)	(.011)	(2.801)	(.148)	(0.487)	
Restrictions						
$\lambda = 0$	.876*	1.003*	-4.109*		6.028	16.541
	(.327)	(.076)	(.731)		(0.197)	(0.000)
$\gamma = 1$	.304*		1.462	.629*	4.544	1.150
	(.177)		(3.928)	(.156)	(0.474)	(0.283)
$\theta = 0$	.370	1.012*		.585*	3.362	0.018
	(.212)	(.011)		(.108)	(0.644)	(0.893)
$\gamma = 1, \theta = 0, \lambda = 0$	.132				7.245	32.042
	(.160)				(0.404)	(0.000)

Table 6 (continued)

	β_1	γ	θ	λ	J test	Wald test
Italy						
Unrestricted	.312	1.004*	.682	.504*	10.426	
	(.216)	(.017)	(3.096)	(.162)	(0.064)	
Restrictions						
$\lambda = 0$	.673*	1.015*	2.740		6.529	9.624
	(.156)	(.012)	(2.349)		(0.258)	(0.002)
$\gamma = 1$	.320		.738	.494*	10.368	0.049
	(.217)		(2.970)	(.158)	(0.110)	(0.825)
$\theta = 0$	.310	1.006*		.502*	10.224	0.048
	(.188)	(.016)		(.131)	(0.115)	(0.826)
$\gamma = 1, \theta = 0, \lambda = 0$	.249				10.289	15.965
	(.157)				(0.245)	(0.001)
Netherlands						
Unrestricted	.750*	.931*	-1.897*	-.042	3.459	
	(.195)	(.029)	(.550)	(.104)	(0.484)	
Restrictions						
$\lambda = 0$	.755*	.939*	-1.982*		3.957	0.162
	(.175)	(.021)	(.507)		(0.556)	(0.687)
$\gamma = 1$	.587*		-1.947*	.037	5.920	5.575
	(.113)		(.631)	(.077)	(0.314)	(0.018)
$\theta = 0$	.444*	.937*		-.227	4.391	11.895
	(.132)	(.049)		(.103)	(0.495)	(0.000)
$\gamma = 1, \theta = 0, \lambda = 0$	.474*				7.262	23.797
	(.089)				(0.402)	(0.000)
Sweden						
Unrestricted	.768*	.931*	-.544	-.118	0.449	
	(.343)	(.023)	(.584)	(.338)	(0.930)	
Restrictions						
$\lambda = 0$	.677	.937*	-.425		0.522	0.123
	(.353)	(.016)	(.648)		(0.971)	(0.726)
$\gamma = 1$	-.029		1.423	.309	0.806	8.604
	(.210)		(2.648)	(.242)	(0.938)	(0.003)
$\theta = 0$	.477	.936*		.080	0.576	0.866
	(.339)	(.026)		(.273)	(0.966)	(0.352)
$\gamma = 1, \theta = 0, \lambda = 0$	.022				2.707	22.164
	(.183)				(0.845)	(0.000)

Table 6 (continued)

	β_1	γ	θ	λ	J test	Wald test
UK						
Unrestricted	.284	1.024*	-1.421	.675*	8.290	
	(.289)	(.063)	(2.687)	(.160)	(0.081)	
Restrictions						
$\lambda = 0$	.724	.778*	7.494		0.977	17.827
	(.730)	(.108)	(10.274)		(0.913)	(0.000)
$\gamma = 1$	.315		-1.299	.662*	8.189	0.142
	(.268)		(2.482)	(.149)	(0.146)	(0.706)
$\theta = 0$	.211	.992*		.720*	8.255	0.280
	(.234)	(.065)		(.181)	(0.143)	(0.597)
$\gamma = 1, \theta = 0, \lambda = 0$	.549*				7.739	21.506
	(.117)				(0.356)	(0.000)

Notes: See Table 3.

As shown in Table 6 the tests for overidentifying restrictions do not reject the extended permanent income model, although the probability associated with the test is quite low in the case of Italy and the UK. At the 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 of λ in Table 6 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 lowest in France and 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. However, for Austria the estimate of λ becomes 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 $\gamma=1$ and $\theta=0$. However, the restriction $\lambda=0$ cannot be rejected for either of the countries, even at the 10 per cent significance level, and hence the direct effect of current income on consumption cannot be assessed.

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

The results concerning the parameter λ can be roughly summerized as follows: current income affects consumption least (or not at all) 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 largely consistent with previous findings[9] even though the data, econometric methods and sample periods are different. Specifically, the effect of current income on consumption has been found to be insignificant in the Netherlands and Sweden and relatively strong 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 provide at least partial support. In general, the unrestricted estimates of β_1 follow roughly two distinct patterns when excess sensitivity of consumption is accounted for. First, for those countries where the estimate of λ proves to be positive and statistically significant (France, Germany, Greece, Italy, the UK), the value of β_1 turned 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 $\lambda=0$ in Table 6). 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 insignificant (Austria, Belgium, Finland, the Netherlands, Sweden), the value of β_1 tends to be roughly of the same order of magnitude as that obtained with the specification that ignors the excess sensitivity hypothesis (Table 3 and the line $\lambda=0$ in Table 6).

---

[9] See Jappelli and Pagano (1989), Campbell and Mankiw (1991), Evans and Karras (1996).

All in all, the results with respect to the parameter β_1 are 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 Section 3.2. For the first group of countries, the results suggest that estimates of β_1 are likely to be substantially upward biased when current income is ignored in the consumption function. Obviously, the finite-horizon permanent-income model specified here is not a sufficient approximation of actual consumption behaviour in these countries. For the second group of countries, it is harder to draw any specific conclusions. It seems that 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, an 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 $\gamma=1$ can be rejected at conventional significance levels for the Netherlands and Sweden and roughly at the 10 per cent level for Finland. The estimate of γ is to some extent sensitive to the restriction $\lambda=0$ in the case of Belgium and the UK. For both countries, the imposition of $\lambda=0$ results in a decreased value of γ, implying a shorter (finite) planning horizon. These results are in line with arguments put forward eg by 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 consumer's planning horizon.

The results concerning the unrestricted estimates of θ are qualitatively much the same as those obtained from the generalized permanent income model (see Table 3). For most countries, θ is not statistically different from zero and in fact the statistical significance of θ drops in most cases, the only exception being the Netherlands, where the results agree with those based on the generalized permanent income model. Not surprisingly, the restriction $\theta=0$ cannot be rejected for any country in the sample except the Netherlands.

The statistical significance and value of θ also proved to be sensitive to the inclusion of current income in the estimation equation in Evans and Karras (1996). They found, as here, that when current income is omitted from the estimation equation, the estimated values of θ tended to be statistically significant and negative, while the inclusion of current income in the model tended to destroy the statistical significance of the parameter θ. Hence, if government consumption and current disposable income are correlated, omitting one of the two variables from the model may bias the estimated coefficient of the other. It is however worth

noting that the statistical significance of λ is not greatly affected when equation (22) is estimated under the restriction $\theta=0$. The same result was also found in the Evans-Karras study.

To further investigate the sensitivity of other parameters to the value of β_1, we tested the restriction forcing the value of β_1 to be consistent with the general parameter structure, ie $\beta_1 = (1+r-\gamma)/(1+r)$. This restriction cannot be rejected by the Wald test for Austria, Belgium, France, Germany, Italy, Sweden and the UK, implying that at least for these countries the values and statistical significance of estimated parameters seem not be invalidated when the value of β_1 is restricted to conform with the estimated value of γ.[10]

Finally, the joint hypothesis of an infinite horizon, absence of excess sensitivity, and independence of private consumption and government consumption (ie $\gamma=1$, $\lambda=0$ and $\theta=0$) cannot be rejected for Austria, Belgium and Finland at the 5 per cent significance level. However, at the 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 sum up, the inclusion of the excess sensitivity hypothesis in the forward-looking consumption model alters considerably the conclusions drawn so far on the effects of fiscal policy on private consumption and on Ricardian equivalence as a valid approximation of 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 Ricardian debt neutrality seem to arise from excess sensitivity of consumption to current income rather than from a shorter planning horizon for consumers. This result is in line with the findings of Hubbard and Judd (1986), who show that the impact of liquidity constraints on the extent to which government debt shifts the tax burden to future generations is quantitatively more important than the impact of finite horizons.

4.3 Has λ changed over time?

The assumption that λ is constant over time is not very plausible, particularly if the excess sensitivity of consumption to current income is due to liquidity constraints. In this case one would rather expect that the degree of excess sensitivity is closely linked to the extent of financial

[10] For those countries where the restriction is rejected, the results from restricted equations could not be evaluated due to a lack of convergence.

market regulations[11] and to the creditworthiness of the borrowers. With heavily regulated credit markets and low net worth of borrowers,[12] consumption ought to track current income closely while financial deregulation and improvement in the creditworthiness of borrowers ought to result in consumption being determined by expected lifetime wealth, ie by permanent income. Since most of the countries in the sample have undergone substantial deregulation of their financial markets during the 1980s (see Bingham 1985), the constant-λ model (equation 22) is modified to allow the excess sensitivity parameter, λ, to vary with different proxies for financial deregulation and creditworthiness of consumers.

Variations in creditworthiness of consumers can be proxied by the unemployment rate, since negative transitory income realizations associated with unemployment will reduce the consumer's permanent income (expected lifetime wealth), although not by as much as the reduction in current income (see Flavin 1985, King 1985). Another way to rationalize the use of the unemployment rate as a proxy for the proportion of population subject to liquidity constraints is that credit rationing is likely to be more prevalent in periods when current spending power is low relative to expected spending power of consumers, ie when h_t and a_{t-1} are low relative to E_tH_{t+j}. It should however be noted that the effect of unemployment on consumers' permanent income and hence on the prevalence of liquidity constraints may have changed during the sample period due to the adoption of comprehensive unemployment insurance systems and other supplementary welfare benefit systems in European countries during the 1970s and 1980s.[13]

Furthermore, the unemployment rate does not capture the effects arising from structural changes in financial markets and the subsequent relaxation of borrowing constraints. Therefore, the estimations were also run using the ratio of the stock of private sector credit to GDP as a proxy

---

[11] The idea that consumption behaviour has changed because of financial deregulation has been proposed in a number of papers (see eg Bayoumi and Koujianou 1989, Muellbauer and Murphy 1990, Miles 1992, Koskela, Loikkanen and Virén 1992 and Bayoumi 1993). A common theme in most of these papers is that financial liberalization may have had a direct effect on consumption choices of previously-credit-constrained consumers, as well as an indirect effect operating via wealth effects created in the housing market.

[12] What is important here is not so much that current resources are low absolutely but that they are low relative to lifetime resources.

[13] On the role of unemployment insurance in removing liquidity constraints on recipients while unemployed, see Hamermesh (1982), Hubbard and Judd (1985), and Hansen and İmrohoroğlu (1992).

for financial deregulation.[14] Although this proxy variable measures the level of credit extended to the whole private sector, it is plausible to assume that changes in it also reflect changes in household sector credit and can thus be used as an indirect measure of the degree to which consumers are willing and able to use financial markets to smooth their consumption behaviour. Hence, the higher ratio of private sector credit to GDP is interpreted to indicate better access to various forms of financing and thus reduced liquidity constraints. The ratio of private sector credit to GDP has been relatively stable in the 1960s and early 1970s in most countries in the sample and started to rise steadily in the mid-1980s in line with financial deregulation.

The basic model is modified by adding first the unemployment rate as a proxy for changes in consumers' net worth and second, the ratio of private sector credit to GDP as a proxy for financial deregulation. Since there is no generally applicable way to model the variability of excess sensitivity over time, various specifications using both proxy variables were tried. Excess sensitivity was first allowed to change directly with changes in the unemployment rate and, alternatively, with changes in the ratio of private sector credit to GDP, yielding an expression $\lambda+\lambda_1(v)$, with v denoting the proxy variable used for the degree of excess sensitivity. The estimation results were generally unsatisfactory. A specification $(\lambda+\lambda_1(v-\bar{v}))$, where v is the proxy variable and $\bar{v}$ its sample mean, proved to be more satisfactory, and the estimation results reported here are therefore based on this specification.[15]

The specification $(\lambda+\lambda_1(v-\bar{v}))$ implies that the parameter λ is now to be interpreted as the share of disposable income going to liquidity-constrained consumers when the prevalence of liquidity constraints equals the 'average or expected degree of credit constraints' during the sample period and λ_1 represents deviations from it. If changes in the unemployment rate are an important factor in changes in excess sensitivity, one would expect that a lower unemployment rate would reduce the degree of excess sensitivity. It the liberalization of financial markets is important for consumption, one would expect to see a less tight relation between consumption and current disposable income when the ratio of private sector debt to GDP exceeds its sample mean.

---

[14] It would have been better to use the stock of household credit instead, but due to lack of data this was not possible (see Bayoumi 1990, 1993).

[15] Several other proxy variables were also tried, eg a step dummy indicating the years of major steps in capital market deregulation, the ratio of total labour force to total population and the ratio of employed to total population. The results were generally less satisfactory than those reported here.

Table 7 reports the results for the augmented model of λ, where λ is allowed to change with deviations of the unemployment rate from its sample mean. In general, the results do not support the hypothesis that excess sensitivity of consumption to current income varies over time with the unemployment rate. In most countries λ_1 obtains positive but statistically insignificant values. The only exception is Italy, where λ_1 is significantly positive. For three countries, Finland, the Netherlands and the UK, the estimate of λ_1 obtains the wrong sign, but the values are small and not statistically different from zero. The hypothesis that λ is constant over time (ie $\lambda_1=0$) is rejected by the Wald test only for Italy at the 5 per cent significance level.

Table 7. **GMM estimation of equation (22) for selected EU countries with $\lambda + \lambda_1(u-\bar{u})$**

	Unrestricted estimates						Wald test		
	β_1	γ	θ	λ	λ_1	J test	$\gamma=1$	$\lambda=0$	$\lambda_1=0$
Austria	.089	.938*	-10.202	.388	.215	0.236	0.086	0.126	0.667
	(.587)	(.212)	(17.901)	(1.091)	(.263)	(0.972)	(0.769)	(0.722)	(0.414)
Belgium	.803*	1.035*	5.593	.796*	.003	2.468	0.218	5.820	0.002
	(.230)	(.074)	(11.417)	(.330)	(.069)	(0.650)	(0.640)	(0.016)	(0.967)
Finland	.796*	1.103*	.540	.360	-.039	0.119	0.085	1.935	3.532
	(.225)	(.046)	(1.313)	(.258)	(.021)	(0.942)	(0.770)	(0.164)	(0.060)
France	.051	.962*	2.306	-.266	.212	1.706	0.038	0.202	2.449
	(.195)	(.195)	(2.923)	(.592)	(.136)	(0.636)	(0.846)	(0.653)	(0.118)
Germany	.388	.976*	4.382	.655*	.050	3.018	0.255	8.393	2.071
	(.357)	(.047)	(8.176)	(.226)	(.035)	(0.389)	(0.613)	(0.004)	(0.150)
Greece	.008	1.089*	-1.339	.737*	.110	2.752	0.097	10.792	2.668
	(.090)	(.287)	(7.236)	(.224)	(.067)	(0.738)	(0.755)	(0.001)	(0.102)
Italy	.648*	1.029*	6.430*	.363*	.171*	5.028	3.364	4.234	4.799
	(.329)	(.016)	(3.095)	(.177)	(.078)	(0.170)	(0.067)	(0.040)	(0.028)
Netherlands	.872*	.938*	-1.833*	.029	-.027	4.503	3.632	0.041	0.856
	(.271)	(.033)	(.461)	(.146)	(.029)	(0.609)	(0.057)	(0.839)	(0.355)
Sweden	.378	.939*	-1.433	.153	.223	4.110	5.494	0.465	1.673
	(.254)	(.026)	(1.108)	(.224)	(.173)	(0.534)	(0.019)	(0.495)	(0.196)
UK	.615	.908*	3.304	.717*	-.147	1.882	2.871	10.139	1.240
	(.726)	(.054)	(2.140)	(.225)	(.132)	(0.757)	(0.090)	(0.001)	(0.265)

Notes: Heteroscedasticity- and autocorrelation-consistent standard errors are in parentheses. The J test is a test for the validity of overidentifying restrictions (significance level in parentheses). The Wald test is for the validity of the imposed restriction (significance level in parentheses). The asterisk (*) denotes statistical significance at least at the 5 per cent level. The instrument set consists of second and third lags of private consumption, government consumption, disposable labour income and unemployment rate. A detailed description of country-specific differences in lag structures of instruments is given in Appendix 4.

The estimates of λ remain qualitatively roughly the same as those obtained from the constant-λ model (see Table 6). The values of λ and the set of countries where λ is found to be positive and statistically significant are practically the same as reported in Table 6. Notable exceptions are Belgium, where also the unrestricted estimate of λ turns out to be statistically significant, and France, where the unrestricted estimate of λ becomes negative and statistically insignificant when λ is allowed to change over time. The restriction $\lambda=0$ is rejected for Belgium, Germany, Greece, Italy and the UK.

The unrestricted estimates of γ do not differ markedly from those of the constant-λ model. The major exceptions are Finland and the UK. For Finland the value of γ increases from .85 to close to unity while for the UK the value drops from unity to .91. The restriction $\gamma=1$ cannot however be rejected for either country. As in the constant-λ case, the restriction $\gamma=1$ is rejected by the Wald test at conventional levels of significance only for the Netherlands and Sweden.

The unrestricted values of β_1 turn out to be puzzling in this specification, remaining essentially unaffected when the excess sensitivity parameter is allowed to change with the unemployment rate. This being the case, the unreasonably high β_1's obtained from the generalized permanent income model (Section 3.2, Table 3) cannot in general be attributed to the excess sensitivity of consumption to current income.

The substitutability parameter, θ, is again statistically insignificant except for the Netherlands, where it is negative and statistically significant.

Table 8. **GMM estimation of equation (22) for selected EU countries with $\lambda + \lambda_1(d-\bar{d})$**

	Unrestricted estimates						Wald test		
	β_1	γ	θ	λ	λ_1	J test	γ=1	λ=0	λ_1=0
Austria	.963*	1.007*	-1.536	.454	-.007	3.528	0.021	2.543	0.117
	(.214)	(.051)	(1.359)	(.285)	(.022)	(0.474)	(0.885)	(0.111)	(0.732)
Belgium	.838*	1.019*	2.000	.698*	.007	3.292	0.441	7.339	0.351
	(.313)	(.029)	(5.026)	(.258)	(.013)	(0.510)	(0.507)	(0.007)	(0.553)
Finland	.617*	1.040*	1.946	.253	-.028	0.820	0.472	1.245	4.509
	(.080)	(.059)	(1.884)	(.227)	(.013)	(0.845)	(0.492)	(0.264)	(0.034)
France	.455	.980*	-2.629	.865*	-.011	4.099	0.852	4.773	0.610
	(.248)	(.022)	(4.348)	(.396)	(.014)	(0.251)	(0.356)	(0.029)	(0.435)
Germany	.591	1.005*	-.379	.671*	-.004	3.494	0.030	7.623	0.242
	(.552)	(.032)	(3.133)	(.243)	(.008)	(0.479)	(0.863)	(0.006)	(0.623)
Greece	.248*	1.016*	24.915	.891*	.149	4.970	0.548	12.166	0.101
	(.115)	(.021)	(64.152)	(.255)	(.469)	(0.419)	(0.459)	(0.000)	(0.750)
Italy	.452*	1.021*	-2.799	.104	.217*	4.500	1.073	0.091	9.411
	(.124)	(.020)	(2.518)	(.346)	(.071)	(0.609)	(0.300)	(0.763)	(0.002)
Netherlands	-.299	1.071*	-5.282	.404	-.026	0.763	0.110	0.653	0.897
	(.673)	(.215)	(5.507)	(.499)	(.028)	(0.943)	(0.740)	(0.419)	(0.344)
Sweden	.898*	.977*	-.419	.758*	.111*	3.286	2.556	20.853	5.579
	(.171)	(.014)	(.822)	(.166)	(.047)	(0.656)	(0.110)	(0.000)	(0.018)
UK	.035	.931*	8.697	.878*	-.007	1.467	0.064	97.156	2.296
	(.459)	(.272)	(6.404)	(.089)	(.005)	(0.832)	(0.800)	(0.000)	(0.130)

Notes: See Table 7. The instrument set consists of the second and third lags of private consumption, government consumption, disposable labour income and the ratio of private sector debt to GDP. For further details, see Appendix 4.

When λ is allowed to vary along the private sector credit/GDP ratio, the results are not very satisfactory in the sense that there is no clear tendency for λ_1 to be positive or negative across countries, and in most countries it is statistically insignificant (Table 8). In fact, λ_1 is of the expected sign and statistically significant only for Finland, indicating that liberalization of financial markets has contributed to the reduction of borrowing constraints and improved ability of consumers to smooth consumption over transitory fluctuations in current income. The drawback is however that the estimate of λ, which measures the share of income going to liquidity-constrained consumers when the level of constraints conforms to the 'average' situation, is not statistically significant for Finland. For Italy and Sweden the estimate of λ_1 is found to be statistically significant, but of the wrong sign, and in the case of Italy, the value of λ is insignificant. All in all, the hypothesis of a constant λ (ie λ_1=0) is rejected for three

countries, Finland, Italy and Sweden, but in the case of Italy and Sweden the measured effect of liberalization is clearly unreasonable.

The use of the private sector credit/GDP ratio as a proxy for deregulation of financial markets tends to increase the excess sensitivity parameter, λ, compared to the constant-λ model and the model in which the unemployment ratio is used as a proxy for borrowing constraints. Qualitatively, the results remain unchanged for all other countries except for Belgium, Italy and Sweden. As shown in Table 8 the estimate of λ turns out to be quite low and statistically insignificant for Italy, while for Sweden the estimate is high and statistically significant. These results are clearly contradictory to those reported in Tables 6 and 7. However, for Belgium the results conform to those obtained with the unemployment rate as a proxy for borrowing constraints (Table 7). The restriction $\lambda=0$ is rejected at the 5 per cent significance level for Belgium France, Germany, Greece, Sweden and the UK.

The estimate of γ seems to be sensitive to the proxy variable used in the case of the Netherlands and Sweden. Contrary to earlier results, the hypothesis of an infinite planning horizon cannot be rejected for these two countries when the parameter λ is allowed to move with the private sector debt/GDP ratio. When using this particular specification for excess sensitivity, the restiction $\gamma=1$ cannot be rejected for any of the countries in the sample.

With respect to the parameter β_1, the same conclusions as presented above also apply here. Hence, the upward bias found in the value of β_1 cannot be associated with the likely misspecification arising from the assumption of a constant λ nor with the proxy variable used. As for the parameter θ, the results remain equally inconclusive as before. The estimate is not statistically significant for any of the countries.

To check the robustness of other parameter estimates with respect to the value of β_1, the restriction $\beta_1 = (1+r-\gamma)/(1+r)$ was again tested. The restriction cannot be rejected by the Wald test for Austria, Belgium, France, Germany, Italy and Sweden. This suggests that, despite the inconsistent parameter structure associated with the unconstrained specifications of the variable-λ model, the results for γ, θ and λ are not invalidated when β_1 is restricted to be consistent with the estimated value of γ, at least for the above-mentioned countries.[17]

[17] For those countries where the restricition is rejected, the results from restricted equations could not be evaluated due to a lack of convergence.

Table 9. **Summary of the unrestricted estimates of γ, λ and λ_1**

a) Unrestricted estimates of γ

	without λ	constant λ	$\lambda + \lambda_1(u-\bar{u})$	$\lambda + \lambda_1(d-\bar{d})$
Austria	.946**	.985**	.938*	1.007**
Belgium	.900*	1.061**	1.035**	1.019**
Finland	.875**	.851**	1.103**	1.040**
France	.989**	.943**	.962*	.980**
Germany	1.052**	.974**	.976**	1.005**
Greece	1.003**	1.012**	1.089*	1.016**
Italy	1.015**	1.004**	1.029**	1.021**
Netherlands	.939**	.931**	.938**	1.071*
Sweden	.937**	.931**	.939**	.977**
UK	.778*	1.024**	.908**	.931*

b) Unrestricted estimates of λ

	constant	$\lambda + \lambda_1(u-\bar{u})$		$\lambda + \lambda_1(d-\bar{d})$	
	λ	λ	λ_1	λ	λ_1
Austria	.472	.388	.215	.454	-.007
Belgium	.704	.796*	.003	.698*	.007
Finland	-.175	.360	-.039	.253	-.028*
France	.428*	-.266	.212	.865*	-.011
Germany	.702*	.655*	.050	.671*	-.004
Greece	.601*	.737*	.110	.891*	.149
Italy	.504*	.363*	.171*	.104	.217*
Netherlands	-.042	.029	-.027	.404	-.026
Sweden	-.118	.153	.223	.758*	.111*
UK	.675*	.717*	-.147	.878*	-.007

Notes: u denotes the unemployment rate and $\bar{u}$ its sample mean, d denotes the private sector debt to GDP ratio and $\bar{d}$ its sample mean. Asterisks (**) indicate statistical significance at the 0.01 level and (*) at the 0.05 level.

To facilitate comparison of results obtained from the generalized permanent income, equation (18), and the extended model (22) with various specifications of the excess sensitivity parameter λ, the unrestricted parameter estimates of γ, λ and λ_1 are summarized in Table 9. As shown in the table, the parameter γ seems to be quite robust to different specifications. Only in some cases does its value tend to increase when excess sensitivity is accounted for in the estimation equation. As regards the estimate of λ, its value tends to increase when excess sensitivity of consumption to current income is allowed to change along with the two proxy variables, the notable exception being Italy,

where the opposite holds. Finally, the values of λ_1 remain mostly statistically insignificant irrespective of the proxy variable used, suggesting that there has not been any noteworthy changes in the impact of current income on private consumption during the sample period. It is however also possible that the specification and proxies used are simply not good enough to detect movements in excess sensitivity over time.

4.4 Interpretation of λ

As mentioned earlier, the excess sensitivity of consumption to current income in aggregate time series studies using the λ-model has in general been interpreted as evidence on the existence of liquidity constraints (see eg Jappelli and Pagano 1989, Campbell and Mankiw 1989). According to the standard interpretation the parameter λ thus represents the fraction of income going to liquidity-constrained consumers and $1-\lambda$ represents the fraction going to forward-looking permanent-income consumers with access to capital markets. There are however several reasons for questioning this interpretation. First, the empirical estimations refered to are not based on well-specified theoretical models incorporating liquidity constraints. To be specific, the interpretation should rather be the one used in the present study, where λ is taken to denote 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,[18] which is highly implausible. If only the 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 of 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 cuts in consumption in bad times. Instead of being liquidity-constrained, the simple Keynesian behaviour followed by rule-of-thumb consumers

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

may be justified by myopia, in which case consumers do not take into account the future consequences of current fiscal policy.

Attempts to model liquidity constraints in a more satisfactory manner include Mariger (1987), Zeldes (1989b) 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) that reflects limited borrowing opportunities for some consumers. The resulting Euler equation for consumption then has an additional term that reflects the shadow price of borrowing and is time dependent. This means that if liquidity constraints affect consumers' behaviour along the lines suggested by Zeldes (1989b) and others, the fraction of liquidity-constrained consumers is endogenous and cannot be taken as a constant over time. The problem with 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 because the key variable (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 can be justified as a first approximation despite its obvious shortcomings and interpretational problems.[18]

Second, distinguishing the effects of liquidity constraints from other sources of misspecification with aggregate data is virtually impossible. Recent research has shown that the presence of excess sensitivity in the data may also stem from improper aggregation over consumers and/or over time or from imposing auxiliary restrictions on preferences, such as quadratic preferences and 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). In particular, it has proved difficult to separate behaviour induced by binding liquidity constraints from that based on the precautionary motive, since both models have a distinct Keynesian imprint: models with binding liquidity constraints because consumption responds directly to disposable income due to myopia and precautionary saving models because the uncertain future is to some extent more heavily discounted in current consumption

[18] To my knowledge, only Jappelli and Pagano (1989), Antzoulatos (1994), and Evans and Karras (1996) try to investigate the validity of interpreting the parameter λ as the fraction of income going to liquidity-constrained consumers in the context of aggregate time series data. The evidence presented in these studies support the hypothesis that the presence in the data of excess sensitivity of consumption to current income is due to liquidity constraints.

saving decisions.[19] Fiscal policies that do not change expected lifetime resources can therefore have large effects on consumption, as consumers behave as if they have overdiscounted the future. Furthermore, as Zeldes (1989) shows, utility functions with positive third derivatives can exhibit excess sensitivity even though consumption is optimal and there are borrowing constraints.

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 is however 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, analysis must be based on various proxy variables and sample splitting methods, which also raise problems (see Jappelli 1990).

4.5 Summary

Due to the inconsistency of results found in Chapter 3, the validity of the underlying generalized permanent-income consumption function and hence of the findings supporting the Ricardian equivalence hypothesis is checked by nesting the excess sensitivity hypothesis in the generalized permanent income model. The inclusion of the direct effect of current income on consumption alters the results markedly. The findings based on the specification with a constant excess sensitivity parameter, λ, suggest that aggregate consumption responds not only to changes in expected lifetime wealth, as predicted by the generalized permanent income model, but also to changes in current income in France, Germany, Greece, Italy, the UK and possibly in Belgium. The degree of excess sensitivity was estimated to vary between .43 and .70 in these countries, thus indicating a substantial departure from the permanent income hypothesis. As private consumption is not invariant to changes in government taxes and transfer policies under excess sensitivity, the Ricardian equivalence proposition fails in the above-mentioned countries. Besides this, Ricardian equivalence is shown to fail due to shorter (finite) planning horizons in Finland, the Netherlands and Sweden.

---

[19] Zeldes (1989), Kimball (1990) and Carroll (1992), among others, have shown that optimal consumption behaviour for consumers facing income uncertainty can be remarkably different from the certainty equivalence case.

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 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.

To check the robustness of the results with respect to the hypothesis that excess sensitivity is constant over time, the equation was augmented by allowing the excess sensitivity parameter to change along with two proxy variables measuring the extent of liquidity constraints. When the unemployment rate was used as a proxy for the creditworthiness of the consumers, the results remained basically the same as those obtained from the constant-λ model. However, when the ratio of private sector debt to GDP was used as a proxy for deregulation of financial markets, the assumption of an infinite horizon could not be rejected for any of the countries in the sample. In this case excess sensitivity was found in Belgium, France, Germany, Greece, the UK and possibly in Italy. Finally, and more importantly, virtually no indication of variability of excess sensitivity over time was found with either specification.

The inclusion of the excess sensitivity hypothesis in the estimation equation tends to render the estimate of θ, which measures the degree of substitutability between private and government consumption, statistically insignificant. Statistically significant complementarity is found only for the Netherlands when excess sensitivity is accounted for.

5 A permanent income hypothesis with a consolidated government sector

According to the generalized permanent income model derived in Chapter 2, rational forward-looking consumers take into account the future implications of current financing decisions of the government in making their consumption-saving decisions. An important issue not explicitly taken into account in this setup is the long-run sustainability of government budget policy. Sustainability of fiscal policy implies that an expansionary phase today, whether in the form of expenditure increases or tax reductions, must be offset by expenditure cuts or tax increases in the future.[1] Requiring that the government budget policy be sustainable thus rules out Ponzi-games in which government debt is continuously rolled over. In the absence of this condition, the government could cut current taxes while leaving current consumption expenditures as well as all future taxes and expenditures unchanged. In this case, an increase in government debt will feed upon itself as the government is obliged to borrow money in order to finance interest payments on previously incurred debt. If continued, this leads to ever-increasing government debt. Hence, the government's long-term solvency is clearly an important aspect that should be accounted for in the analysis.

It is then obvious that rational forward-looking consumers will hold government bonds only if they are sure that the government will raise sufficient tax revenues to cover both expenditures and debt repayment in the future. The important implication of this is that consumers with rational expectations also take into account government solvency in their optimization problem. Accordingly, the private and public sectors can be consolidated by integrating the government budget constraint into the familiar linear-quadratic intertemporal optimization problem introduced in Chapter 2.[2]

---

[1] In other words, fiscal policy is sustainable if the expected present value of the implied future stock of government debt converges to zero (see eg Trehan and Walsh 1991).

[2] Previous work on Ricardian equivalence incorporating the government budget constraint explicitly in the consumer's optimization problem includes Aschauer (1985), Modigliani and Sterling (1986), Haug (1990), and Graham and Himarios (1991).

5.1 Intertemporal government budget constraint

In order to incorporate the government intertemporal budget constraint into the consumer's intertemporal optimization problem, this section starts by laying out the one-period government budget constraint in real per capita terms in period t:

$$t_t = g_t + \tau_t - b_t + (1+r)b_{t-1}, \tag{23}$$

where

t_t is period t real per capita government tax receipts (lump-sum)
g_t is period t real per capita government consumption
τ_t is period t real per capita government transfer payments (lump-sum)
b_t is real per capita government debt at the end of period t
b_{t-1} is real per capita government debt incurred in period t-1
r is the constant real interest rate

Forward substitution for government debt in (23) gives the intertemporal constraint for the government:

$$E_t T_t = E_t G_t + E_t T_t + (1+r)b_{t-1} - \lim_{j\to\infty}\left(\frac{1}{1+r}\right)^j b_{t+j}, \tag{24}$$

where

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

is the expected present value of government tax receipts at time t,

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

is the expected present value of the government consumption at time t, and

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

is the expected present value of government transfer payments at time t. Note that the discount factor is 1/(1+r) instead of γ/(1+r) due to an infinite planning horizon for the government sector.

Imposing the no-Ponzi-game solvency constraint for the government sector, $E_t \lim_{j\to\infty}(1+r)^{-j} b_{t+j} = 0$, gives[3]

$$E_t T_t = E_t G_t + E_t T_t + (1+r) b_{t-1}. \qquad (25)$$

The government budget constraint (25) equates the present value of expected tax receipts to the initial government debt plus the present values of expected government consumption and transfer payments. From this intertemporal constraint, it follows that for a given path of government consumption a deficit-financed cut in current taxes leads to higher future taxes having the same expected value as the tax cut.[4]

Ricardian equivalence can be shown to emerge in this setup by substituting the expression for taxes in equation (25) into the private consumption function (16) to yield the following consolidated model for private consumption:

---

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

[4] Tests investigating whether data-generating processes are consistent with the intertemporal budget constraint have been developed and implemented only recently. The results are mixed. For instance, Trehan and Walsh (1988) and Haug (1991) were unable to reject the hypothesis of intertemporal budget balance using US data, while Wilcox (1989) and Hakkio and Rush (1991) conclude that postwar US data are inconsistent with this hypothesis. Trehan and Walsh (1991) have shown that if expected real interest rates are constant, the existence of a stationary linear combination of the stock of government debt and the primary (non-interest) deficit is necessary and sufficient for the intertemporal budget constraint to hold.

$$c_t^P = -r\beta_0 + (1+r)(1-\beta_1)c_{t-1} + \beta_1(1-\gamma)E_tY_t$$
$$+\beta_1(1-\gamma)(\theta-1)E_tG_t - \theta g_t + (1+r)(1-\beta_1)\theta g_{t-1} \quad (26)$$
$$-\beta_1(1+r)(1-\gamma)b_{t-1} + \beta_1\epsilon_t + u_t,$$

where $E_tY_t\left(=E_t\sum_{j=0}^{\infty}\left(\frac{\gamma}{1+r}\right)^j y_{t+j}\right)$ represents the discounted value of expected future labour incomes and the error term, $\epsilon_t = (\gamma e_{Yt} + \gamma\theta e_{Gt})$, denotes revisions of expectations arising from unexpected changes in labour income and government consumption in going from period t−1 to period t. The term u_t represents transitory consumption.

According to equation (26) private consumption is determined by the expected present value of real resources available to consumers minus the initial value of the government debt commitment. For a given value of this predermined government debt, neither taxes (or transfers) nor the government's subsequent borrowing have any effect on consumer's wealth if γ equals unity. With γ equal to unity, private consumption is affected only by the government consumption variables g_t and g_{t-1} and not by the type of financing.

An important difference between this consolidated model and the generalized permanent income model presented in Chapter 2 arises from the innovation process, ie from the unexpected changes that are allowed to affect private consumption. Equation (26) is more restricitive in this respect than the generalized permanent income model and in a sense more Ricardian, since private consumption will change only in response to unexpected changes in labour income and government consumption. Thus, contrary to the generalized permanent income model, private consumption does not respond to unexpected changes in net taxes. Hence, in the consolidated model it is only unexpected changes in government consumption of the fiscal policy variables that will affect current and future private consumption under Ricardian equivalence.[5] However, from the government's intertemporal budget constraint it follows that an unexpected change in government consumption leads to a change in future taxes by an amount equal to the innovation to the expected present value of government consumption. Since the resulting change in private

[5] In a strict sense Ricardian equivalence requires that the path as well as the present value of expected government consumption not be affected by the choice of budger deficits and surpluses, ie by the timing of taxes. In a stochastic setting, private consumption is however affected by unexpected changes in government consumption.

consumption is distributed over the consumers' entire planning horizon, such a policy measure would be of little use for stabilization purposes.

Equation (26) holds under the assumption that consumers internalize the government budget constraint to the extent determined by their planning horizon, γ. If consumers have a shorter planning horizon than the government (ie $0<\gamma<1$), they discount taxes, government transfer payments and government consumption at the rate $\gamma/(1+r)$ instead of $(1+r)^{-1}$, which is the discount factor for the government. In other words, one unit of taxes, transfers or government consumption in period t+j has a smaller present value for the consumer than for the government, since $(\gamma/(1+r))^j < (1+r)^{-j}$.[6] A future increase in taxes, transfer payments or government consumption is thus given a smaller weight by finite-horizon consumers than by the government, which leads to the break down of Ricardian equivalence and nonneutrality of fiscal policy.

The reduced form consumption function is derived for estimation purposes using the method proposed by Hayashi (1982) and introduced in Section 2.3. The consolidated model yields the following expression for c_t^P in terms of observable variables:

$$\begin{aligned} c_t^P = \beta_0' &+ \left[(1+r)(1-\beta_1) + \frac{1+r}{\gamma}\right] c_{t-1}^P - (1-\beta_1)\frac{(1+r)^2}{\gamma} c_{t-2}^P \\ &- \beta_1(1-\gamma)\frac{1+r}{\gamma} y_{t-1} - \theta g_t + \theta\left(1-\beta_1\left(\frac{\gamma-1}{\theta}+1\right)+\gamma\right)\frac{1+r}{\gamma} g_{t-1} \\ &- \theta(1-\beta_1)\frac{(1+r)^2}{\gamma} g_{t-2} - \beta_1(1-\gamma)(1+r) b_{t-1} \\ &+ \beta_1(1-\gamma)\frac{(1+r)^2}{\gamma} b_{t-2} + v_t, \end{aligned} \tag{27}$$

where

[6] Consolidation of the government budget constraint into the consumer's optimization problem thus leaves the present value of expected net taxes unchanged in the consumer's intertemporal budget constraint.

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

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

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

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

The surprise terms

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

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

which reflect revisions in expectations about the sequence of y_{t+j} and g_{t+j}, are by construction orthogonal to the information set available in t−1, I_{t-1}, and are thus serially uncorrelated. They may however be correlated with t-dated variables and contemporaneously with each other.

As in the case of the generalized permanent income model (see Section 2.2) the key parameters in assessing the effects of fiscal policy on private consumption are γ and θ. With γ equal to unity, forward-looking rational consumers have infinite horizons and consider today's deficit financing as tomorrow's tax liabilities. The infinite horizon and zero-population-growth assumptions imply that there is no way for individuals to avoid taxes by dying and/or levying taxes to future generations. Hence, deficits have no effect on current consumption. A value of less than unity for the parameter γ implies that due to a shorter planning horizon 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. In the case of extreme myopia (γ=0), consumers treat government bonds fully as net wealth.

A positive value for θ implies that an increase in government consumption diminishes the marginal utility of private consumption (ie the two are substitutes), whereas a negative θ would suggest that an increase in government consumption raises the marginal utility of private consumption (ie the two are complements). Hence, with a given path of government consumption, substitutability (complementarity) implies that private consumption declines (increases) with increases in government consumption in accord with the parameter θ. If government consumption substitutes perfectly for private consumption (θ=1), the situation fulfils Feldstein's (1982) condition for complete ex ante crowding out of private consumption and fiscal policy neutrality.

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.

5.2 Estimation results for the consolidated model

The estimations are performed using the same data as in Chapters 3 and 4 except for the income variable. Since the incorporation of the government budget constraint into the consumer's optimizing problem eliminates taxes and transfer payments from the consumption equation, the resulting income variable is before-tax labour income instead of disposable income. Since nonproperty income conforms more closely to the theoretical model than does total personal income, before-tax labour income, y_t, is measured by nonproperty income (see Appendix 4 for further details). Government debt, b_t, is measured by the book value of general government gross debt. Time series properties of the variables and tests for cointegration for equation (27) are presented in Appendix 3.

The benchmark instrument set includes a constant, the second and third lags of total private consumption, c_t^P, before-tax labour income, y_t, government consumption, g_t, government debt, b_t and household income taxes, t_t. All variables are measured in real per capita terms. The dummy

variable D91-93 is again included in the regressions for Finland (see Section 3.1).[7]

The same constant 3 per cent real interest rate is used as before. The sensitivity of the results with respect to this assumption is investigated in Section 5.3 in the context of panel estimations.

Table 10 presents the estimates of β_1, γ and θ with their autocorrelation- and heteroscedasticity-consistent standard errors over the sample periods given in Table 2 in Section 3.1. Since the hypothesis that the constant term $\beta_0'=0$ could not be rejected for all countries in the sample, it is included both as an instrument and a regressor but is not reported in the tables.[8]

The overall results suggest that the unrestricted form of the model performs satisfactorily for all countries. Tests of the overindentifying restrictions do not reject the model for any of the countries. Furthermore, the country-specific unrestricted estimates are broadly consistent with the restricted ones, albeit some restrictions result in economically unreasonable, but statistically insignificant, parameter estimates for France, Italy and Sweden. The estimate of γ turns out to be statistically significant and of the expected sign and magnitude for all countries, whereas the estimates of β_1 and θ are not as precise.

As discussed in Chapter 2 and above, Ricardian equivalence holds when consumers and the government have the same planning horizon, eg $\gamma=1$. The unrestricted estimate of γ proves to be close to unity for all countries. Moreover, the restriction $\gamma=1$ can be rejected by the Wald test only for one country in the sample (Germany). The consolidated model seems thus to give support for infinite horizons and Ricardian debt neutrality for a larger set of countries than does the generalized permanent income model (see Section 3.2, Table 3). Estimation results based on that model suggested that Ricardian debt neutrality is not supported by the data for the Netherlands, Sweden and the UK due to a shorter planning horizon for the consumers.

---

[7] As for the results regarding the dummy variable D91-93 for Finland (not reported in the table), it is statistically significant in all specifications and of magnitude -4.14 to -6.50. The result thus conforms with the structural breaks that occured during the the first half of the 1990s in the Finnish economy.

[8] The exclusion of the constant term for those countries where it can be justified by the data did not affect the magnitudes of parameter estimates. The standard errors however tend to be smaller when the constant term is excluded from the estimation equation.

Table 10. **GMM estimation of equation (27) for selected EU countries**[9]

	β_1	γ	θ	J test	Wald test
Austria					
Unrestricted	.331	1.048*	-1.671	2.368	
	(.418)	(.308)	(.991)	(.937)	
Restrictions					
$\gamma = 1$	.349		-1.883	2.315	.025
	(.300)		(1.055)	(0.970)	(0.875)
$\theta = 0$	.273	1.000*		5.459	2.841
	(.237)	(.105)		(0.708)	(0.092)
$\gamma = 1, \theta = 0$	.273			5.457	2.909
	(.211)			(0.793)	(0.233)
Belgium					
Unrestricted	.523*	.964*	-.952	4.860	
	(.184)	(.037)	(.772)	(0.677)	
Restrictions					
$\gamma = 1$	.359		-.452	4.721	0.967
	(.208)		(.896)	(0.787)	(0.325)
$\theta = 0$	.351*	.943*		4.117	1.518
	(.174)	(.060)		(0.846)	(0.218)
$\gamma = 1, \theta = 0$	.265			4.363	1.715
	(.179)			(0.886)	(0.424)
Finland					
Unrestricted	.639*	1.033*	2.723*	7.106	
	(.059)	(.062)	(1.069)	(0.626)	
Restrictions					
$\gamma = 1$	.669*		2.510*	8.301	.282
	(.026)		(.707)	(0.600)	(0.595)
$\theta = 0$	1.767*	.984*		5.117	6.489
	(.291)	(.023)		(0.883)	(0.011)
$\theta = 1$	.936*	1.035*		7.915	2.598
	(.119)	(.033)		(0.637)	(0.107)
$\gamma = 1, \theta = 1$	.749*			10.261	3.342
	(.050)			(0.507)	(0.188)
$\gamma = 1, \theta = 0$	1.611*			6.170	9.726
	(.215)			(0.862)	(0.008)

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

Table 10 (continued)

	β_1	γ	θ	J test	Wald test
France					
Unrestricted	.255	1.030*	-4.937*	7.641	
	(.363)	(.249)	(1.549)	(0.571)	
Restrictions					
$\gamma = 1$	-.339		-5.138*	7.261	0.014
	(.191)		(1.406)	(0.701)	(0.904)
$\gamma = 1, \theta = 0$	-.198			9.071	12.473
	(.135)			(0.615)	(0.002)
Germany					
Unrestricted	.470*	.841*	-2.002*	5.711	
	(.178)	(.043)	(.861)	(0.456)	
Restrictions					
$\gamma = 1$	.793*		-.354	5.174	13.238
	(.217)		(.811)	(0.639)	(0.000)
$\theta = 0$	.677*	.827*		4.707	5.401
	(.148)	(.058)		(0.696)	(0.020)
$\gamma = 1, \theta = 0$	.755*			5.118	21.226
	(.179)			(0.745)	(0.000)
Greece					
Unrestricted	.779*	1.070*	-3.306*	5.486	
	(.212)	(.035)	(.381)	(0.359)	
Restrictions					
$\gamma = 1$	.478*		-3.780*	6.184	4.008
	(.228)		(.679)	(0.403)	(0.050)
$\theta = 0$	.036	1.027		7.002	75.419
	(3.411)	(3.554)		(0.321)	(0.000)
$\gamma = 1, \theta = 0$	.056			6.991	78.152
	(.116)			(0.430)	(0.000)
Italy					
Unrestricted	.560*	.988*	1.451	7.255	
	(.146)	(.046)	(1.830)	(0.403)	
Restrictions					
$\gamma = 1$	.574*		1.468	7.411	0.065
	(.143)		(1.468)	(0.493)	(0.799)
$\theta = 0$	-.002	2.511*		7.791	0.628
	(.005)	(.880)		(0.454)	(0.428)
$\gamma = 1, \theta = 0$	.606*			7.558	1.284
	(.143)			(0.579)	(0.526)

Table 10 (continued)

	β_1	γ	θ	J test	Wald test
Netherlands					
Unrestricted	.428	1.015*	-2.695*	6.725	
	(.263)	(.105)	(.679)	(0.567)	
Restrictions					
$\gamma = 1$	.457*		-2.783*	6.713	.021
	(.147)		(.593)	(0.667)	(.885)
$\theta = 0$	.404*	1.000*		10.106	15.747
	(.156)	(.069)		(0.342)	(0.000)
$\gamma = 1, \theta = 0$	.405*			10.110	20.568
	(.095)			(0.431)	(0.000)
Sweden					
Unrestricted	.161	.899*	4.938*	1.544	
	(.122)	(.155)	(1.533)	(0.992)	
Restrictions					
$\gamma = 1$	.105		4.128*	1.802	0.018
	(.092)		(1.488)	(0.986)	(0.893)
$\theta = 0$	.012	.876*		4.037	4.080
	(.227)	(.121)		(0.854)	(0.043)
$\gamma = 1, \theta = 1$	-.046			2.647	4.114
	(.154)			(0.977)	(0.128)
$\gamma = 1, \theta = 0$	-.145			4.010	7.209
	(.169)			(0.911)	(0.027)
UK					
Unrestricted	.264	1.107*	-.593	6.892	
	(.368)	(.415)	(.704)	(0.331)	
Restrictions					
$\gamma = 1$	.387*		-.682	7.451	.066
	(.113)		(.568)	(0.384)	(0.797)
$\theta = 0$	.193	1.179*		6.452	.709
	(.406)	(.594)		(0.488)	(0.400)
$\gamma = 1, \theta = 0$	.340*			7.575	1.359
	(.099)			(0.476)	(0.507)

Notes: Heteroscedasticity- and autocorrelation-consistent standard errors are in parentheses. The J test is a test for the validity of overidentifying restrictions (significance level in parentheses). The Wald test is for the validity of the imposed restriction (significance level in parentheses). The asterisk (*) denotes the statistical significance at least at the 5 per cent level. The instruments for the unrestricted and restricted specifications include the constant, the second and third lags of private consumption, government consumption, before-tax labour income, government debt and household income taxes. A detailed description of country-specific differences in lag structures of instuments is given in Appendix 4.

As in the context of the generalized permanent income model (Section 3.2), the parameter estimates of θ again tend to vary more across countries than those of γ and β_1. In comparing country-specific unrestricted estimates of θ based on the generalized permanent income model (equation 18) to those from the consolidated model (equation 27), it is obvious that θ is more precisely estimated with the consolidated model. The estimated values of θ are however relatively high.

As shown in Table 10, the unrestricted estimates of θ turn out to be negative and statistically significant for France, Germany, Greece and the Netherlands. As expected, the restriction $\theta=0$ is rejected at the 5 per cent significance level for these countries.[10] For Finland and Sweden, the estimates of θ are positive and statistically significant.[11] Hence, instead of being complements, as for the countries above, government consumption and private consumption are found to be substitutes in Finland and Sweden, implying that increases in government consumption there crowd out private consumption. According to the results, the effect of government consumption in Finland and Sweden is thus opposite to that in France, Germany, Greece and the Netherlands, where government consumption is shown to crowd in private consumption.

The restriction $\theta=0$ is rejected at the 5 per cent significance level for Finland and Sweden, while the restriction $\theta=1$ (conforming to Feldstein's hypothesis of complete ex ante crowding out of private consumption) cannot be rejected by the Wald test at conventional levels of significance for either country.[12] This result implies that in Finland and Sweden aggregate demand cannot be affected by the changes in government consumption.

For Austria, Belgium, Italy and the UK, the estimated value of θ proves to be statistically insignificant and the restriction $\theta=0$ cannot be rejected by the Wald test for these countries, indicating that government consumption and private consumption are unrelated in these countries. For Italy the restriction however results in an implausibly high and

---

[10] For France the restricted equation could not be estimated due to nonconvergence of the data.

[11] Results for Finland and Sweden are well in line with earlier studies using US data (Kormendi 1983, Aschauer 1985). However, Karras (1994) and Evans and Karras (1996), using Euler equation approach found that private consumption and government consumption are complements in Finland, while for Sweden Karras (1994) reports them to be unrelated and Evans and Karras (1996) to be substitutes.

[12] The relevant Wald test statistics for Sweden are not reported in Table 10 due to a lack of convergence.

statistically insignificant estimate of γ as well as negative but statistically insignificant β_1.

Finally, the joint restriction, $\gamma=1$ and $\theta=0$, cannot be rejected at the 5 per cent significance level for Austria, Belgium, Italy and the UK whereas it is strongly rejected for Finland, France, Germany, Greece, the Netherlands and Sweden. For completeness, the joint restriction, $\gamma=1$ and $\theta=1$, is also tested for Finland and Sweden. According to the Wald test, the restriction cannot be rejected for either country, indicating complete fiscal policy neutrality. In other words, this result suggests that it is useless to try to stabilize economic fluctuations by timing taxes or by changing government consumption in these two countries.

The estimated values of β_1 again prove to be excessively high, given an infinite planning horizon or even a planning horizon of approximately six years in the case of Germany.[13] Furthermore, the constant 3 per cent real rate of return and the estimated values of β_1 render the imputed value of the subjective time preference, δ, negative. This anomalious result is related to the empirical puzzle where high growth of aggregate consumption is observed in the presence of a low or negative real interest rate (Deaton 1986), although for any certainty equivalence model of consumption with time separable utility, the growth rate of consumption should be negative if the interest rate is less than the rate of time preference. A negative time preference is therefore required in order to explain positive expected growth rates of individual consumption with low or negative real risk-free interest rates (Zeldes 1989).[14] Under the restriction $\gamma=1$ the estimates and standard errors of β_1 tend to decrease slightly.

The cross-country evidence on Ricardian debt neutrality and the degree of substitutability between private and government consumption based on the consolidated model is summarized in Table 11 together with some of the data describing public finances over the sample period. For each country the table reports the unrestricted estimates of γ and θ and the sample mean of the government debt/GDP ratio, the debt/household income taxes ratio and the government consumption/GDP ratio. The table seems to indicate that there is no clear association between the degree of Ricardian debt neutrality (or tax discounting) and the level of the debt

---

[13] The estimated value of .84 for γ for Germany implies a planning horizon of roughly six years whereas the value of about .5 for β implies a planning horizon of only two years.

[14] There is a close analogy to Weil's (1989) risk-free interest rate puzzle. A related problem pointed out by Lewbel (1987) is that the exact constraints on β_0 and β_1 imposed by quadratic utility imply implausible estimates of the bliss level of consumption, $\bar{c}$.

ratio nor between the degree of substitutability and the ratio of government consumption to GDP across countries.

Table 11. **Unrestricted estimates of γ and θ and government financing in selected EU countries over the sample period**

	γ	θ	b/GDP	b/t	g/GDP
Austria	1.048*	-1.671	0.40	1.89	0.16
Belgium	.964*	-.952	0.93	3.80	0.15
Finland	1.033*	2.723*	0.21	0.92	0.17
France	1.030*	-4.937*	0.35	1.64	0.17
Germany	.841*	-2.002*	0.31	1.23	0.18
Greece	1.070*	-3.306*	0.43	3.22	0.16
Italy	.988*	1.451	0.64	3.37	0.15
Netherlands	1.015*	-2.695*	0.61	2.29	0.15
Sweden	.961*	4.275*	0.46	1.56	0.24
UK	1.107*	-.593	0.74	4.78	0.20

Notes: b/GDP denotes the ratio of general government gross debt to GDP, b/t the ratio of general government gross debt to household income taxes and g/GDP the ratio of general government consumption to GDP. Asterisk (*) indicates statistical significance at least at the 0.05 level.

According to the estimation results, Ricardian nonneutrality in government financing holds only for Germany, where the debt ratio is among the lowest in the group of ten EU countries. This finding agrees with Nicoletti's (1988) results for comparisons of private consumption behaviour across eight OECD countries for the period 1960-1987. His study indicates that, with the exception of France and the UK, the degree of Ricardian nonneutrality tends to be associated across countries with the level and variance of the debt ratio. Ricardian nonneutrality was found only in countries where the level and variance of the public debt ratio was low, whereas sizeable tax-discounting effects were detected in countries like Italy and Belgium, having high levels of government debt. The results obtained in the present study however indicate that the association, if any, between level of government debt and degree of tax discounting is not as straightforward as is suggested by Nicoletti.

As regards θ, the findings conform to a large extent with results reported in two recent studies (Karras 1994, Evans and Karras 1996) on the degree of substitutability between private consumption and government consumption. The general conclusions in these studies indicate that government consumption and private consumption tend to be complements rather than substitutes. The major exceptions to the general pattern in Table 11 turn out to be Finland and Sweden, where

private consumption and government consumption are found to be strong substitutes. This finding cannot however be attributed to a higher-than-average ratio of government consumption to GDP, as one might have expected, since it holds only for Sweden.

According to Evans and Karras (1996) cross-country differences in the degree of substitutability tend to be negatively related to the fraction of government spending going to national defence. Differences in the composition of government consumption are thus a potential source of cross-country differences in the degree of substitutability. Evans and Karras also conclude that government size has no apparent effect on substitability between private and government consumption, whereas raising the quality of government services was found to make them more substitutable for private consumption.

5.3 Panel estimation results for the consolidated model

The data are also used as a panel, since the results might suffer from econometric shortcomings due to relatively short sample periods. The use of unbalanced panel data gives 314 observations. The hypothesis that the intercepts are equal across countries is again tested by the Wald test as in Section 3.3.

The first line in Table 12 gives unrestricted panel estimates of β_1, γ and θ, given a fixed real interest rate of 3 per cent, with autocorrelation- and heteroscedasticity-consistent standard errors. As shown in the table the panel estimation results confirm the qualitative conclusions made on the basis of separate country-specific estimations reported in Table 10. The results also conform broadly with panel estimations based on the generalized permanent income model (Section 3.3, Table 4). The unrestricted estimate of γ turns out to be close to unity and is statistically significant at the 1 per cent level. As expected, the restriction $\gamma=1$ cannot be rejected by the Wald test.

Table 12. **GMM estimation of equation (27) using a panel of 10 EU countries**

	Unrestricted estimates			Wald test				
	β_1	γ	θ	J test	$\gamma=1$	$\theta=0$	$\gamma=1$ $\theta=0$	Equal intercepts
r=0.03	.289*	1.043*	-1.010	38.636	1.297	3.136	4.373	19.174
	(.108)	(.038)	(.570)	(0.954)	(0.255)	(0.077)	(0.112)	(0.024)
r=0.05	.172	1.067*	-1.389*	35.292	0.563	5.073	5.575	13.730
	(.144)	(.089)	(.617)	(0.995)	(0.453)	(0.024)	(0.061)	(0.132)
Subperiod	.263*	1.058*	-1.649*	41.721	1.910	10.639	12.940	32.453
(obs=244)	(.113)	(.042)	(.506)	(0.997)	(0.167)	(0.001)	(0.001)	(0.000)

Notes: Heteroscedasticity- and autocorrelation-consistent standard errors are in parentheses. The J test is the test for validity of overidentifying restrictions (significance level in parentheses). The Wald test is for the validity of imposed restrictions (significance level in parentheses). An asterisk (*) denotes statistical significance at least at the 5 per cent level. The instrument set includes a constant, the second and third lags of private consumption, government consumption, before-tax labour income, government debt, the second lag of household income taxes and nine country-dummies.

The unrestricted estimate of θ is negative and economically more plausible than in the case of individual country-specific estimations. The estimate is however somewhat imprecise and the restriction $\theta=0$ cannot be rejected at conventional levels of significance. Nevertheless, at the 10 per cent level the restriction is rejected. Finally, the joint hypothesis, $\gamma=1$ and $\theta=0$, cannot be rejected by the Wald test.

The unobservable country-specific effects (not reported in the table) proved to be statistically significant only for Finland and Sweden. Despite the fact that the overwhelming majority of these country-specific effects were statistically insignificant, the hypothesis that the intercepts are equal across countries is rejected by the Wald test. This result suggests that a fixed-effects model should be used rather than a pooled one.

To check the robustness of the panel estimation results, the model was also estimated using a real interest rate of 5 per cent[15] and alternatively using a subperiod starting in 1970 instead of the total sample period starting in 1963. The second line in Table 12 gives the estimates of γ and θ under the assumption of a 5 per cent real interest rate and the third line those for the subperiod. The estimate of γ proves to be robust with respect to both changes whereas the estimate of θ proves to be somewhat sensitive to the interest rate applied as well as to the estimation

[15] The equation was also estimated using a real interst rate of 1 per cent. As shown in Appendix 5, Table A5 the results conform roughly with those reported in Table 12.

period. Specifically, the absolute value and statistical significance of θ increases in both cases, making the complementarity of government consumption and private consumption stronger in both cases. The conclusions thus conform closely to those based on the generalized permanent income model reported in Section 3.3. The hypothesis $\theta=0$ and the joint hypothesis, $\gamma=1$ and $\theta=0$, are soundly rejected by the Wald test. The hypothesis that the intercepts are equal across countries cannot however be rejected under the assumption of a higher real interest rate.

5.4 Results for the consolidated model with a constant λ

To investigate whether the consolidated model and underlying optimizing behaviour, ie the internalization of the government budget constraint by the forward-looking rational consumers, is supported by the data, the consumption equation (26) is nested within a more general model to account for excess sensitivity of consumption to current income. This is done by nesting the rule-of-thumb consumers with the forward-looking permanent income consumers using the approach introduced in Section 4.1. Since the findings so far (see Section 4.3) provide virtually no support for the hypothesis that the degree of excess sensitivity varies over time, only a specification with a constant fraction of rule-of-thumb consumers is considered here.

Formally, the consolidated model allowing for the excess sensitivity of consumption is derived by inserting the government budget constraint into equation (21)[16] in Section 4.1. This gives the following aggregate per capita consumption, c_t:

$$\begin{aligned} c_t = & -r\beta_0 + (1+r)(1-\beta_1)c_{t-1} + \beta_1(1-\gamma)(1-\lambda)E_tY_t \\ & + \beta_1(1-\gamma)(\theta-1)(1-\lambda)E_tG_t \\ & + \lambda h_t - \lambda(1+r)(1-\beta_1)h_{t-1} \\ & - \theta(1-\lambda)g_t + (1+r)(1-\beta_1)\theta(1-\lambda)g_{t-1} \\ & - \beta_1(1+r)(1-\gamma)(1-\lambda)b_{t-1} + \beta_1(1-\lambda)\varepsilon_t + u_t, \end{aligned} \tag{26'}$$

[16] Note that $E_tH_t \equiv E_tY_t + E_tT_t - E_tT_t$.

where h_t is disposable labour income. If consumption does not show any excess sensitivity to current income, ie the fraction of income accruing to rule-of-thumb consumers is zero ($\lambda = 0$), equation (26') reduces to equation (26).

The corresponding reduced form consumption function is derived using Hayashi's (1982) method to form $c_t - [(1+r)/\gamma]c_{t-1}$ so as to remove the unobservables from equation (26'):

$$
\begin{aligned}
c_t = \beta_0' &+ \left[(1+r)(1-\beta_1) + \frac{1+r}{\gamma}\right] c_{t-1} - \frac{(1+r)^2}{\gamma}(1-\beta_1)c_{t-2} + \lambda h_t \\
&- \lambda\left[(1+r)(1-\beta_1) + \frac{1+r}{\gamma}\right] h_{t-1} + \lambda\frac{(1+r)^2}{\gamma}(1-\beta_1)h_{t-2} \\
&- \beta_1(1-\gamma)(1-\lambda)\frac{1+r}{\gamma} y_{t-1} - \theta(1-\lambda)g_t \\
&+ \theta\frac{1+r}{\gamma}\left[1+\gamma-\frac{\beta_1(\theta+\gamma-1)}{\theta}\right] g_{t-1} \\
&- \theta\frac{(1+r)^2}{\gamma}(1-\beta_1)(1-\lambda)g_{t-2} \\
&- \beta_1(1+r)(1-\gamma)(1-\lambda)\left(b_{t-1} - \frac{1+r}{\gamma} b_{t-2}\right) + v_t,
\end{aligned}
\tag{28}
$$

where

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

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

and the error term is

$$v_t=\beta_1(1-\lambda)(e_{Yt}+\theta e_{Gt})-\beta_1(1-\lambda)(1+r)(e_{Yt-1}+\theta e_{Gt-1})$$

$$+(1-\lambda)u_t-(1-\lambda)\frac{1+r}{\gamma}u_{t-1}.$$

The estimation results based on equation (28) are given in Table 13. The obvious conclusion when comparing these results to the generalized permanent income model with a constant λ, reported in Section 4.2 (Table 6), is that the unrestricted parameter estimates of γ are roughly of the same order of magnitude and statistical significance under both specifications of the underlying optimizing model. As regards the estimated value of γ, only minor deviations can be detected. For Finland, the Netherlands and Sweden the value of γ increases somewhat, whereas for the UK it decreases, when the consolidated model is used instead of the generalized permanent income model as the underlying optimizing model. However, the qualitative results change only for the Netherlands and Sweden, so that the hypothesis of an infinite planning horizon ($\gamma=1$) cannot be rejected when the consolidated model is used to characterize the behaviour of forward-looking consumers. All in all, the hypothesis of an infinite horizon cannot be rejected for any of the countries in the sample under the specification based on the consolidated model at conventional levels of significance.

Table 13. **GMM estimation of equation (28) for selected EU countries**

	Unrestricted estimates					Wald test		
	β_1	γ	θ	λ	J test	γ=1	λ=0	γ=1 λ=0
Austria	.890*	1.032*	-1.505	.510*	2.598	0.049	6.777	7.076
	(.181)	(.143)	(1.405)	(.196)	(0.627)	(0.825)	(0.009)	(0.029)
Belgium	.941*	1.021*	.103	.679*	4.881	0.223	28.887	29.428
	(.126)	(.045)	(.071)	(.126)	(0.559)	(0.637)	(0.000)	(0.000)
Finland	.690*	.966*	3.212	-.016	0.522	0.184	1.373	1.481
	(.084)	(.079)	(1.817)	(.014)	(0.971)	(0.668)	(0.241)	(0.477)
France	.568	1.027*	-.084	.416*	4.409	0.200	35.055	45.573
	(.379)	(.061)	(.077)	(.070)	(0.492)	(0.655)	(0.000)	(0.000)
Germany	.528*	1.106*	.004	.764*	2.098	0.249	34.236	89.079
	(.225)	(.213)	(.020)	(.130)	(0.910)	(0.618)	(0.000)	(0.000)
Greece	.549*	1.123*	.032	.537*	5.335	3.342	83.443	99.936
	(.157)	(.067)	(.040)	(.059)	(0.502)	(0.067)	(0.000)	(0.000)
Italy	.194	1.073	.043	.554*	10.109	0.012	14.974	15.530
	(.667)	(.666)	(.040)	(.143)	(0.120)	(0.912)	(0.000)	(0.000)
Netherlands	.536*	1.065*	-1.709*	.069	4.311	0.622	2.757	2.887
	(.140)	(.082)	(.566)	(.042)	(0.505)	(0.430)	(0.097)	(0.236)
Sweden	.102	.961*	4.155	-.001	0.452	0.011	0.017	0.027
	(.361)	(.375)	(2.239)	(.011)	(0.994)	(0.917)	(0.896)	(0.986)
UK	-.579	.740*	.010	.542*	5.226	2.007	16.227	16.677
	(.601)	(.183)	(.052)	(.135)	(0.515)	(0.156)	(0.000)	(0.000)

Notes: Heteroscedasticity- and autocorrelation-consistent standard errors are in parentheses. The J test is the test for validity of overidentifying restrictions (significance level in parentheses). The Wald test is for validity of the imposed restriction (significance level in parentheses). An asterisk (*) denotes statistical significance at least at the 5 per cent level. The instrument set includes a constant, the second and third lags of private consumption, before-tax labour income, disposable labour income, government consumption, and government debt.

The unrestricted estimates of the excess sensitivity parameter, λ, also prove to be quite robust with respect to the underlying optimizing model. Compared to the earlier results the estimated value of λ remains roughly the same but becomes statistically significant also for Austria and Belgium. The hypothesis of no excess sensitivity (λ=0) is thus rejected only for Finland, the Netherlands and Sweden under the specification based on the consolidated model. Finally, the joint restriction, γ=1 and λ=0, is rejected for all other countries except for Finland, the Netherlands and Sweden at the 5 per cent significance level, suggesting that in these three countries consumer behaviour exhibits Ricardian rather than

Keynesian properties. As before, the results are dubious since the estimated values of β_1 are all too high to conform the estimates of the parameter γ.

As was the case when the generalized permanent income model was used as the underlying model for the forward-looking behaviour, the absolute value of the parameter θ turns out to be consistently less than its standard error. Again, the only notable exception to this general pattern proves to be the Netherlands. The imprecise estimates of the parameter θ in models where current disposable income is included as a right-hand-side variable might, at least partially, be due to the problems related to the proper measurement of government consumption (see Section 3.1). Since it is measured mainly by wages and salaries of public sector employees, it is likely to be highly correlated with current disposable income, thus causing the estimate of θ to become statistically insignificant when current income is included in the model.

5.5 Summary

The generalized permanent income consumption function was extended to incorporate the intertemporal government budget constraint in the consumer's optimizing problem. Compared to the generalized permanent income model, where the effect of taxes and government transfer payments on private consumption is transmitted through expected disposable labour income and that of government consumption through the consumer's utility function, the consolidated model allows government debt and government consumption to have direct effects on private consumption. This modification alters the results from the generalized permanent model presented in Chapter 3 essentially in two ways. First, the tests cannot reject the infinite horizons and Ricardian equivalence for any country except Germany. Second, in addition to Germany, Greece, and the Netherlands, government consumption and private consumption proved to be complements in France also, but not in Austria, as was found previously. Moreover, government consumption and private consumption were found to be substitutes in two countries, Finland and Sweden. The results of the panel estimation proved to be in conformity with those based on the generalized permanent income model.

When this consolidated consumption model was nested within a more general model incorporating the excess sensitivity hypothesis, it turned out that the hypothesis of an infinite horizon could not be rejected for any of the countries in the sample. Despite this, Ricardian equivalence

does not hold for the majority of the countries, as aggregate consumption is shown to respond strongly to changes in current income in all the countries except Finland, the Netherlands and Sweden. The results thus suggest that the effects of fiscal deficits on private consumption are Keynesian rather than Ricardian in Austria, Belgium, France, Germany, Greece, Italy and the UK, whereas for Finland, the Netherlands and Sweden the findings suggest the opposite. The results in favour of Ricardian equivalence should however be interpreted with caution, since the estimated value of the propensity to consume out of total expected wealth proved to be too high to conform to an infinite planning horizon.

As was the case in the specification in which the generalized permanent income model was used to characterize the behaviour of forward-looking consumers, the inclusion of current income in the consumption equation leads to insignificant estimates of the substitutability parameter, the only exception again being the Netherlands, which shows statistically significant complementarity between government and private consumption.

6 Concluding remarks

The main objective of this study was to test whether empirical evidence based on aggregate time-series data from selected EU countries supports the Ricardian equivalence hypothesis or the conventional Keynesian view on 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. A summary of the main findings is presented in Table 14.

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. The assumption of a finite planning horizon for consumers allows one to test whether the effects of a government deficit on private consumption conform more closely with Ricardian or Keynesian properties.

The results from this generalized permanent income model seem to conform to an infinite planning horizon for consumers and thus to Ricardian debt neutrality in half of the countries in the sample. For the other half, the findings indicate a shorter (finite) planning horizon and thus nonneutrality of government financing decisions. The evidence in favour of Ricardian equivalence should however be interpreted with caution, since the high propensity to consume out of total expected wealth is incompatible with an infinite (or even relatively long) planning horizon but instead suggests a rather short horizon. The findings also indicate that during the estimation period government consumption and private consumption tended to be complements or unrelated rather than substitutes. Hence, contrary to the common view, increases in government consumption do not tend to crowd out private consumption but, if anything, they tend to crowd in private consumption, thus leaving more room for fiscal policy via changes in government consumption. The results from panel estimations conform closely with the conclusions drawn above.

Due to the above-mentioned anomalies, the validity of the underlying permanent income model and thus Ricardian equivalence was further analysed by nesting the permanent income model and the excess sensitivity hypothesis. In this extended model, the larger the excess sensitivity of consumption to current income, the larger the effects of taxation and government transfer policies on private consumption and hence the greater the deviation from Ricardian debt neutrality. It was first

assumed that the excess sensitivity is constant over time, after which it was allowed to change over time in a way captured by the unemployment rate and alternatively by the ratio of private sector credit to GDP.

Findings from the model with constant excess sensitivity suggest that aggregate consumption responds not only to changes in expected lifetime wealth, as predicted by the generalized permanent income model, but also to changes in current income in six out of ten EU countries in the sample. Hence, in these six countries private consumption varies with changes in government taxes and transfer payments, thus causing the Ricardian equivalence proposition to fail. This result clearly indicates that the generalized permanent income model is not in general a sufficient approximation of consumption behaviour. Moreover, Ricardian equivalence is shown to fail due to shorter (finite) planning horizons in two other countries.

When excess sensitivity was allowed to change over time, the results remained broadly consistent with those based on the assumption of constant excess sensitivity. Moreover, the findings suggest that there have not been any significant changes during the estimation period in the importance of current income for private consumption, at least conditional on unemployment and credit conditions.

All in all, the results from various model specifications where the generalized permanent income model and excess sensitivity hypothesis are nested in a common model suggest that consumers exhibit conventional Keynesian rather than Ricardian properties in the majority of EU countries studied. Inclusion of the excess sensitivity hypothesis in the estimation equation however rendered the estimates for the parameter measuring the degree of substitutability between government and private consumption imprecise, so that no significant effect of government consumption on private consumption could be detected.

The generalized permanent income model was finally modified by integrating the government intertemporal budget constraint in the consumer's optimization problem to yield a consolidated model for private consumption. Because consumers take explicitly into account also the long-run solvency of the government they de facto assume complete transparency of government activities. Since the consolidated model is an essentially different model, the results cannot be directly compared to those from the generalized permanent income model.

Table 14. **Summary of the main findings**

	Finite horizon ($\gamma<1$)	Excess sensitivity ($\lambda>0$)	Substitutability ($\theta\neq0$)
(a) **Generalized permanent income model** (equation 18, Table 2)			
Austria			complements
Belgium	X		
Finland	X		substitutes
France			
Germany			complements
Greece			complements
Italy			
Netherlands	X		complements
Sweden	X		
UK	X		
(b) **Generalized permanent income model with constant** λ (equation 22, Table 5)			
Austria			
Belgium		(X)	
Finland	X		
France		X	
Germany		X	
Greece		X	
Italy		X	
Netherlands	X		complements
Sweden	X		
UK		X	
(c) **Consolidated model** (equation 27, Table 10)			
Austria			
Belgium			
Finland			substitutes
France			complements
Germany	X		complements
Greece			complements
Italy			
Netherlands			complements
Sweden			substitutes
UK			
(d) **Consolidated model with constant** λ (equation 28, Table 13)			
Austria		X	
Belgium		X	
Finland			
France		X	
Germany		X	
Greece		X	
Italy		X	
Netherlands			complements
Sweden			
UK		X	

Notes: x denotes that the hypotheses of an infinite planning horizon and/or no excess sensitivity of consumption to current income is rejected at the 10 per cent significance level by the Wald test. Complementarity or substitutability between government and private consumption is reported if the estimate is significant at the 10 per cent level.

For the consolidated model, the tests could reject the hypothesis of an infinite planning horizon and thus Ricardian debt neutrality for only one country. Furthermore, the substitutability parameter turned significant for six countries, of which four showed private consumption and government consumption to be complements and two substitutes. For the latter two countries, the tests could not reject Feldstein's hypothesis of complete ex ante crowding out of private consumption, implying that by increasing government consumption one cannot increase aggregate demand. Together with an infinite planning horizon, this outcome suggests complete fiscal policy neutrality in two out of ten EU countries studied. Again, the results from the panel estimations conform closely with the above results.

The validity of the conclusions based on the consolidated model however suffers from the same weakness as the generalized permanent income model, due inconsistencies found in the parameter structure. Therefore the consolidated model was also nested within a more general framework encompassing the excess sensitivity hypothesis. As was the case in the context of the generalized permanent income model, the inclusion of the excess sensitivity hypothesis led to rejection of the Ricardian debt neutrality hypothesis in nearly all EU countries in the sample, despite the fact that the tests could not reject the hypothesis of an infinite planning horizon for any country. It turned out that aggregate consumption responds strongly to changes in current disposable income in all but three EU countries studied.

As before, no significant effect of government consumption on private consuption could be detected when excess sensitivity was accounted for, except for one country. This outcome may be due to the multicollinearity between disposable income and government consumption arising from the way in which government consumption is measured.

The main anomaly in the findings, irrespective of specification, proved to be an excessively high estimate of the propensity to consume out of total expected wealth, given an infinite or at least relatively long planning horizon for consumers. Possible explanations for this outcome include, among others, the mathematical solution whereby nonhuman wealth was eliminated from the consumption equation, the specific parameterization of the utility function, and/or the problems arising from the aggregation procedures in general and the use of Blanchard's approach to aggregation of finite-horizon consumers in particular.

The problem is that in order to be able to derive an aggregate consumption function based on the Euler equation approach and finite horizons, one must assume that the optimizing behaviour of a single

representative consumer is a good approximation of aggregate behaviour. Specifically, one must assume that the preference ordering of all consumers over time can be represented by a time invariant utility function of a single representative consumer and that the one-period probability of survival is the same for all individuals irrespective of age. The obvious implication of identical preferences is that all consumers must have the same propensity to consume out of total expected wealth. If preferences are not identical, then the aggregate preference ordering (ie the preference ordering of the representative consumer) either will not exist or will be subject to substantial changes over time. Thus, if there are marked differences in propensities to consume out of wealth and/or survival probabilities across individuals, aggregation may fail and thus lead to inconsistent parameter estimates in empirical time series analyses using aggregate data.

The great advantage of using linear-quadratic assumptions, despite their obvious shortcomings, is the implication of certainty equivalence, ie that decision rules depend only on expected values of determining variables. Hence, in the case of aggregate uncertainty or effects of idiosyncratic uncertainty on private consumption-saving decisions being minor compared to other issues at hand, certainty equivalence is clearly advantageous (see Abel 1988). However, when there is reason to believe that the qualitative effect of idiosyncratic uncertainty on private consumption-saving decisions is important, certainty equivalence is disadvantageous.

To sum up, the findings from the various specifications suggest that, despite the fact that some fraction of consumers behave as if the maximize over an infinite horizon, the Ricardian equivalence hypothesis fails in the majority of the EU countries studied. Furthermore, deviations from 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. This suggests that generalization of the permanent income model by allowing finite horizons along the lines proposed by Blanchard (1985) is not in itself a sufficient means of making the predictions of permanent income models conform to reality. Since a substantial part of private consumption is found to exhibit near-Keynesian responses to changes in disposable income, changes in taxes and government transfer policies are likely to have a marked impact on private consumption and saving.

From the point of view of economic policy this implies that, contrary to the Ricardian equivalence proposition, one should pay attention to budget deficits in assessing the equilibrium of the economy. The analysis

does not however tell us anything about the principles by which fiscal policy should be implemented.

Fiscal regimes and the signalling role of current fiscal policy

An important factor affecting consumer expectations and the responses of private consumption to fiscal policy not dealt with so far is the question of fiscal regimes. In general, the issues related to the nature of actual fiscal regimes and regime changes have not received much attention in the literature on fiscal policy effects on economy and the validity of Ricardian equivalence. In a strict sense Ricardian equivalence holds only in a fiscal regime characterized by complete fiscal accommodation of deficits, in which the government provides full backing for its interest-bearing debt at each point in time by committing to the levying of a stream of future taxes with a present discounted value matching the current value of its debt obligation (Sargent 1982). In the Ricardian regime a current tax cut accompanied by an increase in government debt must be assumed to signal an increase only in future taxes with no change in government consumption.

The stochastic formulation of Ricardian equivalence used in the present study however underscores the importance of distinguishing between expected and unexpected changes in labour income, net taxes and government consumption. Within a stochastic framework, expected changes in these variables do not affect private consumption, whereas innovations to these variables will change private consumption even under Ricardian equivalence. Furthermore, unexpected changes will have a greater effect on private consumption if they are permanent than if they are temporary. One should also note that under the stochastic version of Ricardian equivalence innovations to government consumption that are permanent will also signal a permanent change in net taxes, which will lead to changes in current and future private consumption. The subsequent change in private consumption is however distributed over consumers' entire planning horizon, making the effects of unexpected changes in government consumption of little importance.

The exact opposite to the Ricardian regime would be a fiscal regime in which the government does not finance the debt by taxes but by money creation (on the monetization of public debt, see Sargent 1982). In such a regime, new government debt issues would signal a change in the future monetization but no change in future taxes. Since the inflationary tax implicit in money creation is distortionary, an increase in government debt is likely to affect private consumption.

The backing of government debt or the way in which the government commits to meet obligations on its interest-bearing debts has important implications not only for the likely outcome of current fiscal policy but for the intertemporal relationship between monetary and fiscal policy. The distinction between the two polar fiscal regimes discussed above illustrates the extreme situations faced by fiscal and monetary authorities due to an increase in government debt. In a Ricardian regime, fiscal policy fully accommodates new debt by future tax levies, and monetary policy need not respond at all to the resulting increase in the deficit. The way in which a current deficit is financed is thus irrelevant from the point of view of monetary policy. The reverse holds in the opposite-type regime, in which monetary policy fully accommodates a fiscal deficit by monetizing the debt with current and future money creation. Fiscal policy in such a regime is insensitive to the implicit inflationary tax (see Sargent and Wallace 1981).

In between these two polar cases lies a continuum of fiscal regimes with varying fractions of debt backed by taxes, expenditure changes or monetization (see Aiyagari and Gertler 1985). The generalized permanent income framework, on which the present study is based, as well as its extensions allowing for excess sensitivity of consumption to current income fall into this category of fiscal regimes. In the basic formulation, the degree to which consumers believe that government debt is backed by future taxation is measured by the length of the consumers' planning horizon. The shorter the consumers' planning horizon, the less they expect to bear the future tax burden associated with the current deficit financing and the larger the net wealth effects of the government debt. Hence, the fiscal signals conveyed by consumers in the finite horizon framework are basically the same as in the infinite-horizon case, the important difference being the degree to which consumers expect to avoid taxes by dying and/or levying them on future generations. Excess sensitivity, on the other hand, reflects the degree to which expectations of future implications of current fiscal policy are neglected altogether in making consumption-saving decisions.

The issue concerning actual fiscal regimes is complicated, since in reality fiscal regimes and hence consumers' expectations as to the future policy mix do not necessarily remain the same over time but may change, which makes the relationship between fiscal variables and private consumption more complex than that assumed in the standard intertemporal optimizing framework. Specifically, the relationship between private consumption and fiscal variables is likely to involve breaks and/or non-linearities over time. Depending on what kind of policy is anticipated, the response of private consumption to changes in

the budget deficit could exhibit Keynesian, Ricardian and even non-Keynesian properties.

Accounting for changes in regime and consumers' expectations is a tricky problem in empirical work. More importantly, a variable response of consumption to fiscal signals implies that econometric analyses like those reported in the present study can generate information only on the average effects on private consumption of changes in government consumption, taxes, transfers and debt. Although such estimates do not provide enough information to guide short-run macroeconomic policy, they are in principle sufficient to test the hypotheses concerning the degree of fiscal policy neutrality.

This being the case, what can be said about the fiscal regimes in Europe from the 1960s until the early 1990s on the basis of the findings of the present study? If anything, one can say that fiscal regimes in Europe do not represent either of the two polar cases, the Ricardian or that in which government debt is fully monetized but rather lies somewhere in between. As regards economic policy, the findings indicate that, contrary to Ricardian predictions, fiscal deficits have real effects and thus are potentially useful in aggregate demand management. At the same time, this also means that concern over persistent fiscal deficits and accumulating government debt is not at all irrelevant from the point of view of the equilibrium of the economy.

References

Abel, A.B. (1988) **The Implications of Insurance for the Efficiency of Fiscal Policy.** NBER Working Paper No. 2517, February.

Aiyagari, S.R. - Gertler, M. (1985) **The Backing of Government Bonds and Monetarism.** Journal of Monetary Economics, Vol. 16, July.

Alesina, A. - Perotti, R. (1995) **Fiscal Expansions and Fiscal Adjustment in OECD Countries.** NBER Working Paper No. 5214.

Altig, D. (1988) **Econometric Analysis of Consumption Behavior and Fiscal Policy. A Review Essay.** Journal of Monetary Economics, Vol. 22.

Andrews, D.W.K. (1993) **Tests for Parameter Instability and Structural Change with Unknown Change Point.** Econometrica, Vol. 61.

Antzoulatos, A. (1994) **Borrowing Constraints, Income Expectations and the Euler Equation.** Economics Letters, Vol. 45.

Aschauer, D.A. (1985) **Fiscal Policy and Aggregate Demand.** American Economic Review, Vol. 75, No. 1, March.

Attanasio, O. (1994) **The Intertemporal Allocation of Consumption: Theory and Evidence.** Working Papers in Economics E-94-4, Domestic Studies Program, Hoover Institution, Stanford University.

Attanasio, O. - Weber, G. (1993) **Consumption Growth, the Interest Rate and Aggregation.** Review of Economic Studies, Vol. 60.

Bailey, M.J. (1971) **National Income and the Price Level: A Study in Macroeconomic Theory.** 2nd ed. New York: McGraw-Hill.

Barro, R.J. (1974) **Are Government Bonds Net Wealth?** Journal of Political Economy, Vol. 82, November/December.

Barro, R.J. (1981) **Output Effects of Government Purchases.** Journal of Political Economy, Vol. 89, No. 6.

Barro, R.J. (1984) **Marcroeconomics.** Wiley, New York.

Barro, R.J. (1989a) **The Ricardian Approach to Budget Deficits.** Journal of Economic Perspectives, Vol. 3, No. 2, Spring.

Barro, R.J. (1989b) **The Neoclassical Approach to Fiscal Policy.** In: R.J. Barro ed., Modern Business Cycle Theory, Mass.: Harvard University Press.

Barsky, R.B. - Mankiw, N. - Zeldes, S.P. (1986) **Ricardian Consumers with Keynesian Propensities.** American Economic Review, Vol. 76, September.

Bayoumi, T. (1990) **Financial Innovation and Consumption in the United Kingdom.** IMF Working Paper WP/90/95.

Bayoumi, T. (1993) **Financial Deregulation and Household Saving.** Economic Journal, Vol. 103.

Bayoumi, T. - Koujianou, P. (1989) **The Effects of Financial Deregulation on Consumption.** IMF Working Paper WP/89/88.

Bean, C.R. (1986) **The Estimation of Surprise Models and the Surprise Consumption Function.** Review of Economic Studies, Vol. 53.

Bernanke, B. (1985) **Adjustment Costs, Durables, and Aggregate Consumption.** Journal of Monetary Economics, Vol. 15.

Bernheim, B.D. (1987) **Ricardian Equivalence: An Evaluation of Theory and Evidence.** NBER Working Paper No. 2330, July.

Bertola, G. - Drazen, A. (1993) **Trigger Points and Budget Cuts: Explaining the Effects of Fiscal Austerity.** American Economic Review, Vol. 83 No. 1, March.

Bingham, T.R.G. (1985) **Banking and Monetary Policy.** OECD, Paris.

Blanchard, O.J. (1985) **Debt, Deficits, and Finite Horizons.** Journal of Political Economy, Vol. 93, No. 2.

Blanchard, O.J. (1997) **Macroeconomics.** Prentice Hall, New Jersey.

Blanchard, O.J. - Fischer, S. (1989) **Lectures on Macroeconomics.** Cambridge, Mass.: MIT Press.

Blinder, A.S. - Deaton, A. (1985) **The Time Series Consumption Function Revisited.** The Brookings Papers on Economic Activity, No. 2.

Brunila, A. - Takala, K. (1993) **Private Indebtedness and the Banking Crisis in Finland.** Bank of Finland Discussion Papers, Economics Department, No. 9/93.

Caballero, R.J. (1990) **Consumption Puzzles and Precautionary Saving.** Journal of Monetary Economics, Vol. 25.

Campbell, J.Y. (1987) **Does Saving Anticipate Declining Labour Income? An Alternative Test of the Permanent Income Hypothesis.** Econometrica, Vol. 55.

Campbell, J.Y. - Deaton, A. (1989) **Why Is Consumption So Smooth?** Review of Economic Studies, Vol. 56.

Campbell, J.Y. - Mankiw, N.G. (1989) **Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence.** NBER Macroeconomics Annual, Vol. 4, The MIT Press, Massachusetts.

Campbell, J.Y. - Mankiw, N.G. (1990) **Permanent Income, Current Income, and Consumption.** Journal of Business & Economic Statistics, Vol. 8, No. 3, July.

Campbell, J.Y. - Mankiw, N.G. (1991) **The Response of Consumption to Income. A Cross-Country Investigation.** European Economic Review, Vol. 35.

Carroll, C.D. (1992) **The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence.** Brooking Papers on Economic Activity, No. 2.

Carroll, C.D. - Kimball, M.S. (1996) **On the Concavity of the Consumption Function.** Econometrica, Vol. 64, July.

Christensen, L.R. - Jorgenson, D.W. (1973) **Measuring Economic Performance in the Private Sector.** In: M. Moss ed., The Measurement of Economic and Social Performance, New York: Columbia University Press.

Christiano, L.J. - Eichenbaum, M. (1988) **Is Theory Really Ahead of Measurement? Current Real Business Cycle Theories and Aggregate Labor Market Fluctuations.** Working Paper No. 412, Federal Reserve Bank of Minneapolis.

Clarida, R.H. (1991) **Aggregate Stochastic Implications of the Life-Cycle Hypothesis.** Quarterly Journal of Economics, Vol. 106.

Correia-Nunes, J. - Stemitsiotis, L. (1995) **Budget Deficit and Interest Rates: Is there a Link? International Evidence.** Oxford Bulletin of Economics and Statistics, Vol. 57, No. 4.

Cushing, M.J. (1992) **Liquidity Constraints and Aggregate Consumption Behavior.** Economic Inquiry, Vol. 30., January.

Deaton, A. (1986) **Life-Cycle Models of Consumption: Is the Evidence Consistent with the Theory.** NBER Working Paper No. 1910.

Deaton, A. (1991) **Saving and Liquidity Constraints.** Econometrica, Vol. 59 No. 5, September.

Deaton, A. (1992) **Understanding Consumption.** Oxford University Press.

Dickey, D.A. - Fuller, W.A. (1979) **Distributions of the Estimators for Autoregressive Time Series with a Unit Root.** Journal of the American Statistical Association, Vol. 75, June.

Eichenbaum, M. - Hansen, L.P. (1990) **Estimating Models with Intertemporal Substitution Using Aggregate Time Series Data.** Journal of Business & Economic Statistics, January.

Evans, P. (1985) **Do Budget Deficits Raise Nominal Interest Rates? Evidence from Six Countries.** Journal of Monetary Economics, Vol. 20 No. 2.

Evans, P. (1988) **Are Consumers Ricardian? Evidence for the United States.** Journal of Political Economy, Vol. 96 No. 5.

Evans, P. (1993) **Consumers Are Not Ricardian: Evidence from Nineteen Countries.** Economic Inquiry, Vol. 31, October.

Evans, P. - Hasan, I. (1994) **Are Consumers Ricardian? Evidence for Canada.** The Quarterly Review of Economics and Finance, Vol. 34 No. 1, Spring.

Evans, P. - Karras, G. (1996) **Private and Government Consumption with Liquidity Constraints.** Journal of International Money and Finance, Vol. 15, No. 2, April.

Feldstein, M. (1982) **Government Deficits and Aggregate Demand.** Journal of Monetary Economics, Vol. 9.

Feldstein, M. - Elmendorf, D.W. (1990) **Government Debt, Government Spending, and Private Sector Behavior Revisited: Comment.** American Economic Review, Vol. 73, No. 5.

Fissel, G.S. - Jappelli, T. (1990) **Do Liquidity Constraints Vary over Time? Evidence From Survey and Panel Data.** Journal of Money, Credit, and Banking, Vol. 22 No. 2, May.

Flavin, M.A. (1981) **The Adjustment of Consumption to Changing Expectations about Future Income.** Journal of Political Economy, Vol. 89, No. 5.

Flavin, M.A. (1985) **Excess Sensitivity of Consumption to Current Income: Liquidity Constraints or Myopia?** Canadian Journal of Economics, Vol. 18 No. 1, February.

Flavin, M.A. (1987) **Comment.** NBER Macroeconomics Annual, Vol. 2, The MIT Press, Massachusetts.

Friedman (1957) **A Theory of the Consumption Function.** Princeton University Press.

Gali, J. (1990) **Finite Horizons, Life-Cycle Savings, and Time-Series Evidence on Consumption.** Journal of Monetary Economics, Vol. 26.

Ghatak, A. - Ghatak, S. (1996) **Budgetary Deficits and Ricardian Equivalence: The Case of India, 1950-1986.** Journal of Public Economics, Vol. 60.

Giavazzi - Pagano (1990) **Can Severe Fiscal Contractions be Expansionary? Tales of Two Small European Countries.** CEPR Discussion Paper No. 417, May.

Giavazzi, F. - Pagano, M. (1996) **Non-Keynesian Effects of Fiscal Policy Changes: International Evidence and the Swedish Experience.** Swedish Economic Policy Review, Vol. 3, Spring.

Goodfriend, M. (1992) **Information Aggregation Bias.** American Economic Review, Vol. 82.

Graham, F.C. (1992) **On the Importance of the Measurement of Consumption in Tests of Ricardian Equivalence.** Economics Letters, Vol. 38.

Graham, F.C. (1993) **Fiscal Policy and Aggregate Demand: Comment.** American Economic Review, Vol. 83.

Graham, F.C. - Himarios, D. (1991) **Fiscal Policy and Private Consumption: Instrumental Variables Tests of the "Consolidated Approach".** Journal of Money, Credit, and Banking, Vol. 23 No 1, February.

Graham, F.C. - Himarios, D. (1996) **Consumption, Wealth, and Finite Horizons: Tests of Ricardian Equivalence.** Economic Inquiry, Vol. 34, July.

Hakkio, C. - Rush, M. (1991) **Is the Budget Deficit Too Large?** Economic Inquiry, Vol. 29.

Hall, R.E. (1978) **Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence.** Journal of Political Economy, Vol. 86, No. 6.

Hall, R.E. (1987) **Consumption.** NBER Working Paper No. 2265, May.

Hall, R.E. - Mishkin, F. (1982) **The Sensitivity of Consumption to Transitory Income: Estimate from Panel Data on Households.** Econometrica, Vol. 50.

Hamermesh, D.S. (1982) **Social Insurance and Consumption: An Empirical Inquiry.** American Economic Review, Vol. 72, March.

Hamilton, D. - Flavin, M.A. (1986) **On the Limitations of Government Borrowing: A Framework for Empirical Testing.** American Economic Review, Vol. 76, No. 4.

Hansen, G.D. - İmrohoroğlu, A. (1992) **The Role of Unemployment Insurance in an Economy with Liquidity Constraints and Moral Hazard.** Journal of Political Economy, Vol. 100.

Hansen, L.P. (1982) **Large Sample Properties of Generalized Methods of Moments Estimators.** Econometrica, Vol. 50, July.

Hansen, L.P. - Singleton, K.J. (1982) **Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Models.** Econometrica, Vol. 50.

Haque, N. (1988) **Fiscal Policy and Private Saving Behavior in Developing Economies.** IMF Staff Papers, Vol. 35, No. 2, June.

Haug, A.A. (1990) **Ricardian Equivalence, Rational Expectations, and the Permanent Income Hypothesis.** Journal of Money, Credit, and Banking, Vol. 22 No.3, August.

Haug, A.A. (1991) **Cointegration and Government Borrowing Constraints: Evidence for the U.S.** Journal of Money, Credit, and Banking, Vol. 23.

Haug, A.A. (1996) **Blanchard's Model of Consumption: An Empirical Study.** Journal of Business and Economic Statistics, Vol. 14, No. 2, April.

Hayashi, F. (1982) **The Permanent Income Hypothesis: Estimation and Testing by Instrumental Variables.** Journal of Political Economy, Vol. 90, No. 5, October.

Hayashi, F. (1985) **Tests for Liquidity Constraints: A Survey.** NBER Working Paper No. 1720, October.

Heijdra, B.J. - van Dalen, H.P. (1996) **Is the Dutch Consumer a True Ricardian?** De Economist, Vol. 144, No. 4.

Helpman, E. - Razin, A. (1987) **Exchange Rate Management: Intertemporal Tradeoffs.** American Economic Review, Vol. 77, March.

Himarios, D. (1995) **Euler Equation Tests of Ricardian Equivalence.** Economc Letters, Vol. 48.

Hubbard, R.G. - Judd, K.L. (1985) **Social Security and Individual Welfare: Precautionary Saving, Liquidity Constraints and the Payroll Tax.** NBER Working Paper No. 1736.

Hubbard, R.G. - Judd, K.L. (1986) **Liquidity Constraints, Fiscal Policy, and Consumption.** Brookings Papers on Economic Activity, No. 1.

Jappelli, T. (1990) **Who Is Credit-Constrained in the U.S. Economy?** Quarterly Journal of Economics, Vol. 105, February.

Jappelli, T. - Pagano, M. (1989) **Consumption and Capital Market Imperfections: An International Comparison.** American Economic Review, Vol. 79, No. 5, December.

Johansen, S. (1988) **Statistical Analysis of Cointegrating Vectors.** Journal of Economic Dynamics and Control, Vol. 12.

Karras, G. (1994) **Government Spending and Private Consumption: Some International Evidence.** Journal of Money, Credit, and Banking, Vol. 26, No. 1, February.

Kimball, M.S. (1990) **Precautionary Saving and the Marginal Propensity to Consume.** NBER Working Paper No. 3403.

Kimball, M.S. - Mankiw, N.G. (1989) **Precautionary Saving and Timing of Taxes.** Journal of Political Economy, Vol. 97, No. 41.

King, M. (1985) **The Economics of Saving: A Survey of Recent Constributions.** In: K.J. Arrow and S. Honkapohja eds., Frontiers of Economics, Basil Blackwell, Great Britain.

Kormendi, R.C. (1983) **Government Debt, Government Spending, and Private Sector Bahavior.** American Economic Review, Vol. 73 No. 5, December.

Kormendi, R.C. - Meguire, P. (1986) **Government Debt, Government Spending, and Private Sector Behavior: Reply.** American Economic Review, Vol. 76, No. 5.

Kormendi, R.C. - Meguire, P. (1990) **Government Debt, Government Spending, and Private Sector Behavior: Reply and Update.** American Economic Review, Vol. 80, No. 3.

Koskela, E. - Loikkanen, H. - Virén, M. (1992) **House Prices, Household Saving and Financial Market Liberalization in Finland.** European Economic Review, Vol. 36.

Lee, W. - Prasad, E. (1994) **Changes in the Relationship Between the Long-Term Interest Rate and its Determinants.** IMF Working Paper, September.

Leiderman, L. - Blejer, M.I. (1988) **Modeling and Testing Ricardian Equivalence.** IMF Staff Papers, Vol. 35, No. 1, March.

Leiderman, L. - Razin, A. (1988) **Testing Ricardian Neutrality with an Intertemporal Stochastic Model.** Journal of Money, Credit, and Banking, Vol. 20, No. 1, February.

Lewbel, A. (1987) **Bliss Levels That Aren't.** Journal of Political Economy, Vol. 95.

Lucas, R.E. (1976) **Econometric Policy Evaluation: A Critique.** In: K. Brunner and A. Meltzer eds., The Phillips Curve and Labour Markets, Carnegie-Rochester Conference Series on Public Policy, Vol. 1, Amsterdam.

MacKinnon, J. (1991) **Critical values for Cointegration Tests.** In: R.F. Engle and W. Granger eds., Long-Run Economic Relationships: Readings in Cointegration, Oxford University Press.

Mankiw, N.G. (1982) **Hall's Consumption Hypothesis and Durable Goods.** Journal of Monetary Economics, Vol. 10, November.

Mankiw, N.G. - Shapiro, M. (1985) **Trends, Random Walks and Tests of the Permanent Income Hypothesis.** Journal of Monetary Economics, Vol. 16, September.

Mariger, R.P. (1987) **A Life-Cycle Consumption Model with Liquidity Constraints.** Econometrica, Vol. 55.

Masson, P.R. (1985) **The Sustainability of Fiscal Deficits.** IMF Staff Papers, Vol. 32.

Miles, D. (1992) **Housing Markets, Consumption and Financial Liberalisation in the Major Economies.** European Economic Review, Vol. 36.

Modigliani, F. (1966) **The Life Cycle Hypothesis of Saving, the Demand for Wealth and the Supply of Capital.** Social Research, Vol. 33, June.

Modigliani, F. - Sterling, A. (1986) **Government Debt, Government Spending and Private Sector Behavior: Comment.** American Economic Review, Vol. 76 No. 5, December.

Modigliani, F. - Sterling, A. (1990) **Government Debt, Government Spending and Private Sector Behavior: A Further Comment.** American Economic Review, Vol. 80, No. 3, June.

Muellbauer, J. (1982) **Surprises in the Consumption Function.** Economic Journal, Supplement.

Muellbauer, J. - Murphy, A. (1990) **Is the UK Balance of Payments Sustainable?** Economic Policy, Vol. 11.

Mussa, M. - Masson, P. (1995) **Long-Term Tendencies in Budget Deficits and Debt.** In: Budget Deficits and Debt: Issues and Options. A Symposium Sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming.

Ni, S. (1995) **An Empirical Analysis on the Substitutability between Private Consumption and Government Purchases.** Journal of Monetary Economics, Vol. 36.

Nicoletti, G. (1988) **Private Consumption, Inflation and the "Debt Neutrality Hypothesis": The Case of Eight OECD Countries.** OECD Working Papers, Department of Economics and Statistics, No. 50, January.

Patterson, K.D. - Pesaran, B. (1992) **The Intertemporal Elasticity of Substitution in Consumption in the United States and the United Kingdom.** Review of Economics and Statistics, Vol. 1974.

Perron, P. (1989) **The Great Crash, the Oil Price Shock and the Unit Root Hypothesis.** Econometrica, Vol. 57.

Phillips, P.C.B. (1986) **Understanding Spurious Regressions in Econometrics.** Journal of Econometrics, Vol. 33.

Pischke, J.S. (1995) **Individual Income, Incomplete Information, and Aggregate Consumption.** Econometrica, Vol. 63, July.

Plosser, C.I. (1987) **Fiscal Policy and the Term Structure.** Journal of Monetary Economics, Vol. 20.

Reimers, H.E. (1992) **Comparisons of Tests for Multivariate Cointegration.** Statistical Papers, Vol. 33.

Runkle, D.E. (1991) **Liquidity Constraints and the Permanent Income Hypothesis: Evidence from Panel Data.** Journal of Monetary Economics, February.

Samuelson, P. (1974) **Complementarity - An Essay on the 40th Anniversary of the Hicks-Allen Revolution in Demand Theory.** Journal of Economic Literature, Vol. 12.

Sargent, T. (1982) **Beyond Demand and Supply Curves in Macroeconomics.** American Economic Review Papers and Proceedings, Vol. 72, May.

Sargent, T.J. - Wallace, N. (1981) **Some Unpleasant Monetarist Arithmetic.** Quarterly Review, Federal Reserve Bank of Minneapolis, Vol. 5.

Scott, A. (1996) **Consumption, 'Credit Crunches' and Financial Deregulation.** CEPR Discussion Paper No. 1389, May.

Seater, J.J. (1982) **Are Future Taxes Discounted?** Journal of Money, Credit and Banking, Vol. 14, No. 3, August.

Seater, J.J. (1993) **Ricardian Equivalence.** Journal of Economic Literature, Vol. 31, March.

Seater, J.J. - Mariano, R.S. (1985) **New Tests of the Life Cycle and Tax Discounting Hypotheses.** Journal of Monetary Economics, Vol. 15.

Sims A. - Stock, J.H. - Watson, M.W. (1990) **Inference in Linear Time Series Models with Some Unit Roots.** Econometrica, Vol. 58, No. 1.

Stiglitz, J. - Weiss, A. (1981) **Credit Rationing in Markets with Imperfect Information.** American Economic Review, Vol. 71, June.

Stock, J.H. - West, K.D. (1988) **Integrated Regressors and Tests of the Permanent Income Hypothesis.** Journal of Monetary Economics, Vol. 21, January.

Sutherland, A. (1995) **Fiscal Crises and Aggregate Demand: Can High Public Debt Reverse the Effects of Fiscal Policy.** CEPR Discussion Paper No. 1246, September.

Trehan, B. - Walsh, C. (1988) **Common Trends, Intertemporal Budget Balance, and Revenue Smoothing.** Journal of Economic Dynamics and Control, Vol. 12, June/September.

Trehan, B. - Walsh, C. (1991) **Testing Intertemporal Budget Constraints: Theory and Applications to U.S. Federal Budget and Current Account Deficits.** Journal of Money, Credit, and Banking, Vol. 23, No. 2.

Turnovsky, S.J. (1977) **Macroeconomic Analysis and Stabilization Policies.** Cambridge University Press, Cambridge.

Weil, P. (1987) **Permanent Budget Deficits and Inflation.** Journal of Monetary Economcis, September.

Weil, P. (1989) **The Equity Premium Puzzle and the Risk-Free Rate Puzzle.** Journal of Monetary Economics, Vol. 24.

West, K.D. (1988) **Asymptotic Normality When Regressors Have a Unit Root.** Econometrica, Vol. 56, No. 6, November.

White, H. (1980) **A Heteroscedasticity-Consistent Covariance Matrix and a Direct Test for Heteroscedasticity.** Econometrica, Vol. 48.

Wilcox, D. (1989) **The Sustainability of Government Deficits: Implications of the Present-Value Borrowing Constraints.** Journal of Money, Credit, and Banking, Vol. 21.

Wirjanto, T.S. (1991) **Testing the Permanent Income Hypothesis: the Evidence from Canadian Data.** Canadian Journal of Economics, Vol. 24.

Wirjanto, T.S. (1994) **Aggregate Consumption Behaviour and Liquidity Constraints: the Canadian Evidence.** Canadian Journal of Economics, Vol. 28.

Wirjanto, T.S. (1997) **Aggreagte Consumption Behaviour with Time-Nonseparable Preferences and Liquidity Constraints.** Applied Financial Economics, Vol. 7, February.

Working, H. (1960) **Note on the Correlation of First Differences of Averages in a Random Chain.** Econometrica, Vol. 28, October.

Yotsuzuka, T. (1987) **Ricardian Equivalence in the Presence of Capital Market Imperfections.** Journal of Monetary Economics, Vol. 20.

Zeldes, S.P. (1989) **Optimal Consumption with Stochastic Income: Deviations from Certainty Equivalence.** Quarterly Journal of Economics, Vol. 15, May.

Zeldes, S.P. (1989b) **Consumption and Liquidity Constraints: An Empirical Investigation.** Journal of Political Economy, Vol. 97.

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

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

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

$$E_tW_t=-(1+r)\beta_0+E_tH_t-\gamma E_{t-1}H_t+(1+r)(1-\beta_1)E_{t-1}H_{t-1}+\theta E_tG_t$$
$$-(1+r)\beta_1\theta E_{t-1}G_{t-1}+(1+r)^2(1-\beta_1)a_{t-2}+(1+r)\theta g_{t-1}. \quad (A5)$$

Equation (A5) can be rewritten as

$$E_tW_t=-(1+r)\beta_0+(1+r)(1-\beta_1)[E_{t-1}H_{t-1}+(1+r)a_{t-2}+\theta E_{t-1}G_{t-1}]$$
$$+(1-\gamma)E_tH_t+\theta(1-\gamma)E_tG_t+\gamma\epsilon_{H_t}+\gamma\theta\epsilon_{G_t}, \quad (A6)$$

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 for h_{t+j} and g_{t+j} that consumers make in going from period t-1 to t.

Equation (15) in the text implies that

$$c_t^P=\beta_0+\beta_1E_tW_t-\theta g_t. \quad (A7)$$

Lagging (A7) and rearranging yields

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

Substituting (A8) into (A6) yields

$$E_tW_t=-(1+r)\beta_0+(1+r)(1-\beta_1)\frac{1}{\beta_1}(c^p_{t-1}-\beta_0+\theta g_{t-1})+(1-\gamma)E_tH_t$$
$$+\theta(1-\gamma)E_tG_t+\epsilon_t, \qquad \text{(A9)}$$

where

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

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

$$c^P_t=-r\beta_0+(1+r)(1-\beta_1)c^p_{t-1}+\beta_1(1-\gamma)E_tH_t$$
$$+\beta_1\theta(1-\gamma)E_tG_t-\theta g_t+(1+r)(1-\beta_1)\theta g_{t-1}+\beta_1\epsilon_t. \qquad \text{(A10)}$$

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

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

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

$$(1+r)a_{t-1}=-(1+r)\beta_0+(1+r)(1-\beta_1)(1-\lambda)E_{t-1}H_{t-1}-\gamma(1-\lambda)E_{t-1}H_t$$
$$-(1+r)\beta_1\theta(1-\lambda)E_{t-1}G_{t-1}+(1+r)^2(1-\beta_1)a_{t-2} \qquad \text{(B4)}$$
$$+(1+r)\theta(1-\lambda)g_{t-1}.$$

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

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

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

$$E_tW_t^P=-(1+r)\beta_0+(1-\lambda)E_tH_t-\gamma(1-\lambda)E_{t-1}H_t$$
$$+(1+r)(1-\beta_1)(1-\lambda)E_{t-1}H_{t-1}+\theta(1-\lambda)E_tG_t$$
$$-(1+r)\beta_1\theta(1-\lambda)E_{t-1}G_{t-1}+(1+r)^2(1-\beta_1)a_{t-2} \qquad \text{(B6)}$$
$$+(1+r)\theta(1-\lambda)g_{t-1}.$$

Equation (B6) can be rewritten as

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

where

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

and

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

reflect revisions of expectations for h_{t+j} and g_{t+j} that consumers make in going from period t−1 to t.

Equation (20) implies that

$$c_t=\beta_0+\lambda h_t+\beta_1 E_t W_t^P-\theta(1-\lambda)g_t. \tag{B8}$$

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

$$\begin{aligned}E_t W_t^P=&-(1+r)\beta_0+(1+r)(1-\beta_1)\frac{1}{\beta_1}(c_{t-1}-\beta_0-\lambda h_{t-1}+\theta(1-\lambda)g_{t-1})\\&+(1-\gamma)(1-\lambda)E_tH_t+\theta(1-\gamma)(1-\lambda)E_tG_t+(1-\lambda)\epsilon_t,\end{aligned} \tag{B10}$$

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):

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

Appendix 3

Time series properties of the data

Recent research on consumption, based on the theory of cointegrated processes, has been conducted in level form.[1] Here, augmented Dickey-Fuller (1979) tests for unit roots and Johansen's maximum likelihood tests for cointegration were performed to check whether the estimation of equations (18) and (22) in levels is appropriate.

Table A1 presents the results of the 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 every series in levels has one unit root cannot be rejected at the 0.05 level except for two of the series tested. The null hypothesis that each first-differenced series has one unit root can be rejected for all the 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, as it suggests that real per capita government debt in these countries would follow an explosive path and thus would lead to government debt positions that are unsustainable in the long run. 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 Stage Three of European Economic and Monetary Union. The combined effect of these events seems to have been that the debt series have undergone structural breaks that may cause the standard unit root test - which does 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 the private consumption and income series for Finland (which experienced considerable breaks in the

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

early 1990s that may cause the series to appear as trend stationary[2]) and to income series for 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 the economically more plausible order one. Hence, the evidence on 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.

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*
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*

[2] When the years 1991-1995 are excluded from the sample, the unit root hypothesis cannot be rejected for either series in levels.

Table A1 continues

Variable	Levels ADF (1)	First differences ADF(1)
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
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)*

Table A1 continues

Variable	Levels ADF (1)	First differences ADF(1)
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 5 % 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; for the sample 1964-1993, -2.966; and for the sample 1964-1994, -2.963. Adding additional lags did not affect the results. The variables included are: private consumption, c_t, disposable nonproperty income, h_t, disposable total personal income, h_t^+, nonproperty 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.

The results for cointegration are given in Table A2 for the I(1) variables and instruments used in the estimations based on equation (18) and those based on equation (27) are given in Table A3. Tests for cointegration are based on Johansen's (1988) maximum likelihood estimation procedure with two lags in the VAR, which produces white noise residuals.

According to the trace test in Table A2, the hypothesis of cointegration for equation (18) is rejected at the conventional 5 per cent 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 nonrejection of cointegration. At the 10 per cent level, the hypothesis of cointegration cannot be rejected except for four countries (Austria, Finland, Germany, 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 countries.

Because of the upward trend in c_t, h_t and g_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 (equation (18))**

	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 ≤ 1	9.16	15.4	13.3
	0.018	r ≤ 2	0.59	3.8	2.7
Belgium (h_t)	0.511	r = 0	28.27	29.7	26.8
	0.119	r ≤ 1	5.34	15.4	13.3
	0.039	r ≤ 2	1.27	3.8	2.7
Finland (h_t^+)	0.364	r = 0	26.66	29.7	26.8
	0.253	r ≤ 1	11.27	15.4	13.3
	0.038	r ≤ 2	1.33	3.8	2.7
France (h_t^+)	0.504	r = 0	28.76	29.7	26.8
	0.199	r ≤ 1	7.73	15.4	13.3
	0.035	r ≤ 2	1.07	3.8	2.7
Germany (h_t^+)	0.334	r = 0	23.98	29.7	26.8
	0.199	r ≤ 1	10.98	15.4	13.3
	0.114	r ≤ 2	3.86	3.8	2.7
Greece (h_t)	0.342	r = 0	23.89	29.7	26.8
	0.214	r ≤ 1	10.06	15.4	13.3
	0.061	r ≤ 2	2.09	3.8	2.7
Italy (h_t^+)	0.495	r = 0	28.72	29.7	26.8
	0.154	r ≤ 1	6.87	15.4	13.3
	0.046	r ≤ 2	1.52	3.8	2.7
Netherlands (h_t)	0.455	r = 0	28.58	29.7	26.8
	0.194	r ≤ 1	9.13	15.4	13.3
	0.067	r ≤ 2	2.24	3.8	2.7
Sweden (h_t^+)	0.414	r = 0	32.21	29.7	26.8
	0.242	r ≤ 1	15.12	15.4	13.3
	0.177	r ≤ 2	6.23	3.8	2.7
UK (h_t^+)	0.507	r = 0	27.90	29.7	26.8
	0.122	r ≤ 1	4.57	15.4	13.3
	0.008	r ≤ 2	0.27	3.8	2.7

Notes: A lag length of two was used to remove autocorrelation in the residuals. Critical values for the trace tests are from Johansen (1988).

The trace test presented in Table A3 indicates that the hypothesis of cointegration for equation (27) cannot be rejected at the conventional 5 per cent significance level for any of the countries. The fact that the cointegration rank is as high as four, or even five for Finland and Sweden, may reflect the possible I(2)ness of some of the series (see also ADF-test in Table A1).

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 A3. **Johansen's maximum likelihood tests for cointegration (equation 27)**

	Eigenvalue	Null hypothesis [c,y,g,b,t]	Trace	0.05 critical value
Austria	0.721	r = 0	89.51	68.5
	0.538	r ≤ 1	47.37	47.2
	0.327	r ≤ 2	21.88	29.7
	0.224	r ≤ 3	8.80	15.4
	0.013	r ≤ 4	0.44	3.8
Belgium	0.694	r = 0	85.62	68.5
	0.518	r ≤ 1	47.77	47.2
	0.362	r ≤ 2	24.41	29.7
	0.256	r ≤ 3	10.01	15.4
	0.017	r ≤ 4	0.54	3.8
Finland	0.642	r = 0	96.04	68.5
	0.546	r ≤ 1	61.14	47.2
	0.423	r ≤ 2	34.29	29.7
	0.261	r ≤ 3	19.57	15.4
	0.144	r ≤ 4	5.29	3.8
France	0.750	r = 0	72.32	68.5
	0.361	r ≤ 1	29.32	47.2
	0.238	r ≤ 2	15.43	29.7
	0.180	r ≤ 3	7.01	15.4
	0.030	r ≤ 4	0.94	3.8
Germany	0.621	r = 0	95.17	68.5
	0.501	r ≤ 1	43.19	47.2
	0.300	r ≤ 2	20.23	29.7
	0.172	r ≤ 3	8.47	15.4
	0.066	r ≤ 4	2.24	3.8
Greece	0.781	r = 0	105.10	68.5
	0.630	r ≤ 1	55.02	47.2
	0.312	r ≤ 2	22.20	29.7
	0.215	r ≤ 3	9.88	15.4
	0.056	r ≤ 4	1.89	3.8
Italy	0.645	r = 0	96.37	68.5
	0.541	r ≤ 1	63.23	47.2
	0.446	r ≤ 2	38.33	29.7
	0.376	r ≤ 3	19.40	15.4
	0.126	r ≤ 4	4.31	3.8
Netherlands	0.624	r = 0	69.54	68.5
	0.440	r ≤ 1	38.27	47.2
	0.287	r ≤ 2	19.72	29.7
	0.180	r ≤ 3	8.88	15.4
	0.076	r ≤ 4	2.54	3.8

Table A3. continues

	Eigenvalue	Null hypothesis [c,y,g,b,t]	Trace	0.05 critical value
Sweden	0.599	$r = 0$	88.18	68.5
	0.544	$r \leq 1$	58.96	47.2
	0.444	$r \leq 2$	33.80	29.7
	0.289	$r \leq 3$	15.04	15.4
	0.120	$r \leq 4$	4.10	3.8
UK	0.610	$r \geq 0$	68.95	68.5
	0.380	$r \leq 1$	37.84	47.2
	0.375	$r \leq 2$	22.04	29.7
	0.175	$r \leq 3$	6.55	15.4
	0.006	$r \leq 4$	0.20	3.8

Notes: A lag length of two was used to remove autocorrelation in the residuals. Critical values for the trace tests are 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 through 1991 and to 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 the panel estimations, the base year for all countries in the sample is 1990 and the variables are converted into US dollars at 1990 exchange rates.

Private consumption, c_t^P: private final consumption expenditure.

Disposable nonproperty income, h_t: the sum of household sector wages, salaries, employers' social security contributions and other nonproperty 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 of income taxes.

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

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

Government consumption, g_t: general government final consumption expenditure.

Government debt, b_t: data are end-of-year observations of outstanding general government debt at book value. The series is extrapolated using the data of general government net lending for the years 1961–1963 for Italy and the years 1960–1969 for Austria and the UK, and using the data on central government debt from IMF International Financial Statistics for the years 1961–1969 for Belgium, the Netherlands and Sweden and the years 1961–1976 for France.

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

D91-93: the dummy variable for Finland, obtaining the value one in 1991-1993 and zero otherwise.

Population: end-of-year total population.

Benchmark instruments sets: equation (18)

Austria, Belgium: second and third lags of private consumption, disposable nonproperty income, and government consumption.

Finland: a constant, the second and third lags of private consumption, disposable total personal income, government consumption and the dummy variable D91-93.

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

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

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

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

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

Benchmark instrument sets: equation (27)

Austria, Belgium, Italy, Sweden: a constant, the second and third lags of private consumption, pre-tax labour income, government consumption, government debt and household income taxes.

Finland: a constant, the second through fourth lags of total private consumption, the second and third lags of before-tax labour income, government consumption, government debt, household income taxes, and the dummy variable D91-93.

France: a constant, the second through fourth lags of private consumption and pre-tax labour income, the second and third lags of

government consumption and government debt and the second lag of household income taxes.

Germany: a constant, the second and third lags of private consumption, pre-tax labour income, government consumption, government debt and the second lag of household income taxes.

Greece: a constant, the second through fourth lags of private consumption, the second lag of pre-tax labour income, government consumption and household income taxes, and the second and third lags of government debt.

The Netherlands: a constant, the second through fourth lags of private consumption, the second and third lags of pre-tax labour income, government consumption, government debt and housheld income taxes.

The UK: a constant, the second and third lags of private consumption, government consumption, government debt and household income taxes, and the second lag of pre-tax labour income.

Appendix 5

Table A4. **GMM estimation of equation (18) using a panel of 10 EU countries**

	Unrestricted estimates				Wald test			
	β_1	γ	θ	J test	$\gamma=1$	$\theta=0$	$\gamma=1$ $\theta=0$	Equal intercepts
r=0.01								
Country-specific	.307* (.085)	.999* (.010)	-1.314 (.699)	42.730 (0.981)	0.003 (0.955)	3.534 (0.060)	3.571 (0.168)	21.551 (0.010)
Total income	.287* (.090)	1.005* (.010)	-1.290 (-1.595)	46.428 (0.942)	0.295 (0.587)	2.545 (0.111)	3.540 (0.170)	23.258 (0.006)
Non-property income	.283* (.075)	.969* (.016)	-.011 (1.038)	29.273 (0.997)	3.682 (0.055)	0.001 (0.991)	4.287 (0.117)	10.503 (0.162)

Notes: See Table 4.

Table A5. **GMM estimation of equation (27) using a panel of 10 EU countries**

	Unrestricted estimates				Wald test			
	β_1	γ	θ	J test	$\gamma=1$	$\theta=0$	$\gamma=1$ $\theta=0$	Equal intercepts
r=0.01	.323* (.104)	1.009* (.024)	-.156 (.770)	28.899 (0.977)	0.131 (0.717)	0.041 (0.839)	0.150 (0.928)	5.695 (0.681)

Notes: See Table 12.

Publications of the Bank of Finland

Series E (ISSN 1238-1691)

(Series E replaces the Bank of Finland's research publications series B, C and D.)

E:1 Jukka Vesala **Testing for Competition in Banking: Behavioral Evidence from Finland.** 1995. 206 p. ISBN 951-686-447-3.

E:2 Juha Tarkka **Approaches to Deposit Pricing: A Study in the Determination of Deposit Interest and Bank Service Charges.** 1995. 166 p. ISBN 951-686-457-0.

E:3 Timo Tyrväinen **Wage Determination, Taxes, and Employment: Evidence from Finland.** 1995. 212 p. ISBN 951-686-459-7.

E:4 Sinimaaria Ranki **Realignment Expectations in the ERM: Causes and Measurement.** 1996. 164 p. ISBN 951-686-507-0.

E:5 Juhana Hukkinen **Kilpailukyky, ulkomaankaupan rakenne ja taloudellinen kasvu** (Competitiveness, structure of foreign trade and economic growth). 1996. 134 p. ISBN 951-686-512-7.

E:6 Eelis Hein **Deposit Insurance: Pricing and Incentives.** 1996. 120 p. ISBN 951-686-517-8.

E:7 Vesa Vihriälä **Banks and the Finnish Credit Cycle 1986–1995.** 1997. 200 p. ISBN 951-686-537-2.

E:8 Anne Brunila **Fiscal Policy and Private Consumption – Saving Decisions: European Evidence.** 1997. 147 p. ISBN 951-686-558-5.
(Published also as A-131, Helsinki School of Economics and Business Administration, ISBN 951-791-225-0, ISSN 1237-556X)