Imperfect information and the excess sensitivity of private consumption to government expenditures.

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Abstract.

In this paper we consider a new explanation for the often encountered observation that private consumption is excessively sensitive to anticipated government expenditures. We show that this excess sensitivity arises if consumers are aware of the government's intertemporal budget constraint, but lack exact information on the aggregate economy. Given the strong assumption that consumers incorporate the government budget constraint, we test our model in three high debt countries where it is more likely that consumers have developed an awareness for government issues. In some of these countries and especially during periods of high debt accumulation, we observe some excess sensitivity with respect to (lagged) income *and* government expenditures which can be interpreted as evidence supporting our model.

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Keywords: private consumption, government expenditures, excess sensitivity, government budget constraint, imperfect information.

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1.Introduction.

The permanent income hypothesis implies that changes in aggregate private consumption are unpredictable (see Hall 1978). In reality, however, private consumption changes are generally found to be 'excessively sensitive' to predictable changes in *income* and are sometimes found to be 'excessively sensitive' to predictable changes in *government expenditures*.

Excess sensitivity of private consumption with respect to *income* has been interpreted most often by assuming the presence of liquidity constrained consumers (see Campbell and Mankiw 1990, 1991). In each period these consumers consume their entire disposable income. Since they cannot save nor borrow, this implies that they can only change their consumption when changes in income effectively materialize. Thus the possibility emerges that consumption changes do occur in response to previously anticipated changes in income.

Other authors have come up with alternative explanations for the failure of Hall's random walk hypothesis of private consumption at the aggregate level. Gali (1990) considers finite lifetimes, whereas Goodfriend (1992), Pischke (1995) and Demery and Duck (2000) assume consumers who have imperfect information on aggregate variables.

Excess sensitivity of private consumption to *government expenditures* has, to the best of our knowledge, only been interpreted in terms of an Edgeworth relationship between private consumption and government expenditures. Aschauer (1985) has modified Hall's Euler equation to allow for (Edgeworth) substitutability or complementarity effects between private consumption and government expenditures. Existing studies have found different results for different countries (Karras 1994, Evans and Karras 1996, Ni 1995). To some extent this is not surprising. One may indeed be sceptical about the validity of an Edgeworth relationship at the aggregate level since some components of government expenditures are likely to be complements to private consumption, while others are likely to be substitutes. Evans and

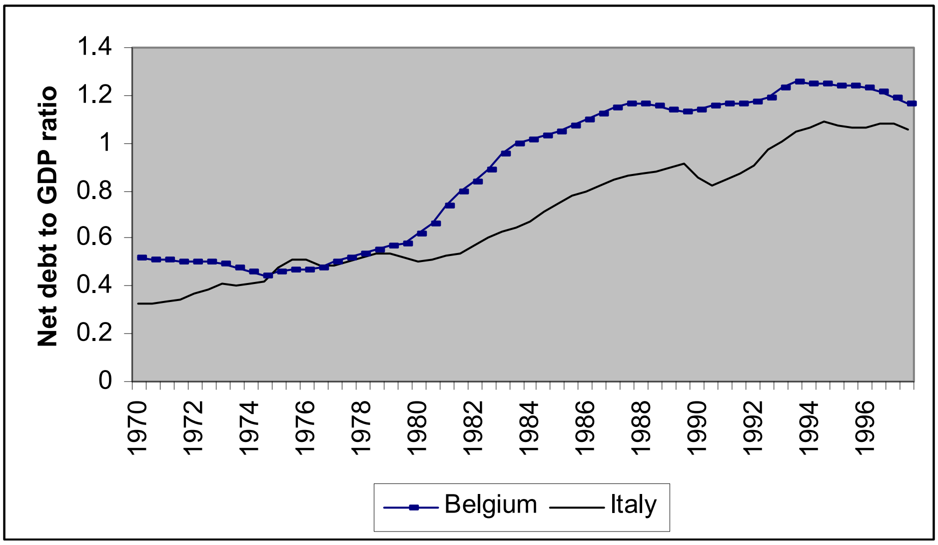
Karras (1998), for instance, show for a sample of 66 countries that private consumption and non-military government spending are generally substitutes or independent, whereas private consumption and military spending are better described as complements.

Given these problems it is rather surprising that no alternative explanations for this observed excess sensitivity of private consumption to government expenditures have been developed. In this paper we interpret this excess sensitivity differently. We focus on the idea of imperfect information as developed by Pischke (1995) and Demery and Duck (2000). Imperfect information can explain why, in contradiction to the permanent income hypothesis, private consumption is observed to be both ‘excessively smooth’ and ‘excessively sensitive’ to income (the so-called ‘Deaton paradox’). Moreover, as an innovation of this paper, assuming imperfectly informed consumers who incorporate the government budget constraint provides an alternative interpretation for the observed excess sensitivity of private consumption to government expenditures at the aggregate level.

The failure of the random walk hypothesis of private consumption at the aggregate level can occur if individual income and/or the individual’s perception of government expenditures has an aggregate and an individual-specific component. Consumers cannot differentiate between both components because they do not know the aggregate component. If there is an innovation in aggregate income or in government expenditures, this innovation will be partly misinterpreted as an innovation in the individual-specific component. Given that the aggregate component is more persistent than the individual-specific component, permanent income will not be adjusted appropriately and consumption will be too smooth. In the next period(s), consumers will notice that the change in income or government expenditures persists and will adjust consumption again so that it will appear excessively sensitive to changes in income and/or government expenditures.

We consider a model with utility maximizing permanent income consumers who 1) are imperfectly informed because they do not observe aggregate variables and 2) are aware that the government must respect a budget constraint. As far as the first assumption is concerned, Pischke (1995) argues that consumers in the US may indeed be imperfectly informed about aggregate variables and may have little incentive to obtain this information since calculations suggest that the benefits of obtaining aggregate information are rather small compared to the costs. As for the second assumption, Lopez et. al. (2000) mention that assuming that consumers internalize the government budget constraint 'imposes formidable requirements on agents' ability to gather and process information'. Especially in our case, where agents are not perfectly informed, this assumption requires a justification. We believe that the level and increase of the government debt in the economy may play a crucial role. It is likely that consumers in high-debt countries will benefit relatively more from information on government financing issues than consumers in countries without a problematic debt history. They are therefore more likely to develop an awareness for the government budget constraint even if they have no incentive to obtain or to use *exact* aggregate information on taxes and government expenditures in their calculations. Some authors have noted that consumers in high-debt countries tend to be more aware of the government budget constraint (see for instance Nicoletti 1988, 1992; Dalamagas 1993, Pozzi 2003). The knowledge of the future tax implications of debt may have a higher value for consumers in high-debt countries because they may feel that the 'day of reckoning' is imminent. Assuming that the idea of imperfectly informed consumers incorporating the government budget constraint is relevant to explain excess sensitivity of private consumption with respect to government expenditures, we would especially expect it to hold in countries characterized by a problematic debt situation[1]. Therefore we estimate our model for a number of OECD countries (Belgium, Italy and Greece) where the debt to GDP ratio has increased rapidly since the mid-seventies. This can be seen in figure 1 for Italy and Belgium where the *net* debt to GDP ratio has reached very high levels, even exceeding 1 during the nineties. In figure 2 we present the evolution of the *gross* debt to GDP ratio for Greece (for which no data on the net debt are available). We can see that the Greek debt situation has become problematic especially since the early eighties (exceeding 50% during the mid-eighties).

Figure 1. Net debt to GDP ratio in Belgium and Italy (1970:01 – 1997:02).

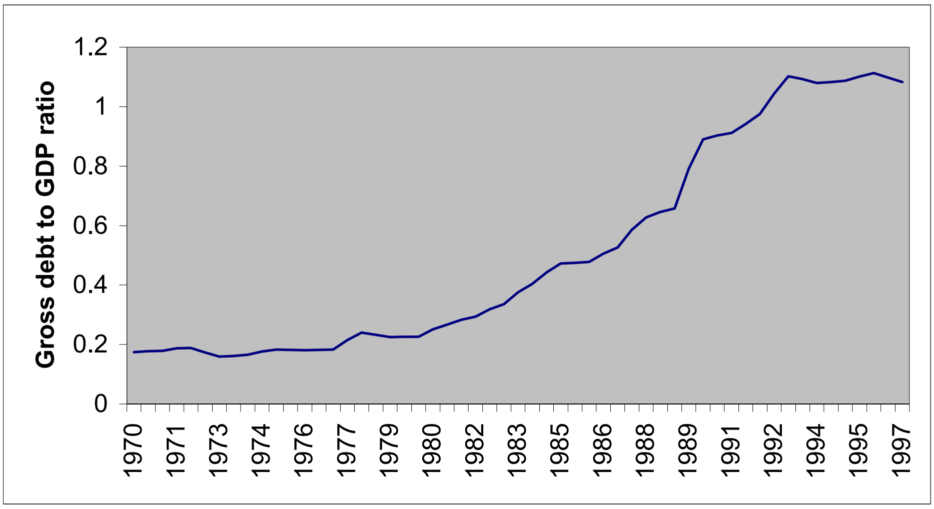


Source: OECD (Economic Outlook CD ROM 2001 Vol. 2).

The remainder of this paper is as follows. In section 2 we present our model which generates the possibility that private consumption changes are excessively sensitive to (lagged) pre-tax income and government expenditure changes. In section 3 we discuss an empirically testable consumption function as well as the data that we use and a number of methodological issues. In section 3 we also present our empirical results. Section 4 concludes.

[1] Though there need not be a reason why it could not hold in low-debt countries as well.

Figure 2. Gross debt to GDP ratio in Greece (1970:01 – 1997:02).



Source: OECD (Economic Outlook CD ROM 2001 Vol.2).

2. The Model.

We consider an economy with the following characteristics:

1) The economy is populated by a very large number (n) of infinitely lived utility maximizing permanent income consumers. Each has a quadratic utility function[2]. We assume that the subjective rate of time preference for all consumers is equal to the constant real interest rate in the economy.

2) The macro structure of the economy is given by the following three equations which describe the processes for aggregate per capita pre-tax income and government expenditures and the intertemporal government budget constraint,

[2] Assuming a utility function of the constant relative risk aversion type will introduce precaution. Though no closed-form solution exists in this case without further assumptions, precaution is then usually captured by allowing the consumer's discount rate for future disposable income to be larger than the discount rate of the government (i.e the real interest rate) with the difference reflecting a risk premium (see Muellbauer and Lattimore 1995). This is equivalent to the assumption of finite horizons (see Blanchard 1985). In these cases the incorporation of the government intertemporal budget constraint will be incomplete. In this paper we choose to focus on consumers who do incorporate the government budget fully but who have incomplete information sets.

(1) $y_t = y_t^p + \varepsilon_t^y$

(2) $g_t = g_t^p + \varepsilon_t^g$

(3) $\sum_{j=0}^{\infty}(1+r)^{-j} g_{t+j} + b_{t-1} = \sum_{j=0}^{\infty}(1+r)^{-j} t_{t+j}$

In these equations y_t is per capita pre-tax income, g_t is per capita government expenditures, t_t is per capita net taxes, r is the exogenous[3] real interest rate and b_{t-1} is per capita government debt. The latter is measured at the end of period t-1. Eq. (3) is the intertemporal budget constraint of the government. We assume that the government does not engage in Ponzi games so that $\lim_{j\to\infty}(1+r)^{-j} b_{t+j-1} = 0$ holds. The intertemporal budget is balanced. In (1) and (2) we assume that pre-tax income and government expenditures can be written as the sum of a temporary component (white noise terms ε_t^y and ε_t^g respectively) and a permanent component. The latter components are random walks given by,

(4) $y_t^p = y + y_{t-1}^p + v_t^y$

(5) $g_t^p = g + g_{t-1}^p + v_t^g$

where v_t^y and v_t^g are white noise terms (see for instance Deaton 1992). Note that our results are not dependent upon our assumption of the processes for pre-tax income and government expenditures (see below).

[3] We assume that the real interest rate is determined on the international capital market and is thus not influenced by (peoples' expectations about) the level of government borrowing.

3) At the micro level, pre-tax income and net taxes of each consumer i, y_{it} and t_{it} can be written as the sum of aggregate per capita pre-tax income and net taxes respectively and an individual-specific component. Furthermore, imperfectly informed consumers are assumed to observe per capita government expenditures with noise (see below). This is captured by the following equations,

(6) $y_{it} = y_t + \varepsilon_{it}^{y}$

(7) $t_{it} = t_t + \varepsilon_{it}^{t}$

(8) $g_{it} = g_t + \varepsilon_{it}^{g}$

where ε_{it}^{y} , ε_{it}^{t} and ε_{it}^{g} are individual-specific white noise terms. These terms are independently distributed across all consumers. Their variance is constant across consumers.

4) If consumers were perfectly informed they would observe their own past consumption and their own current and past income and taxes. They would observe government expenditures without noise, thus $\varepsilon_{it}^{g} = 0$. They would also observe past aggregate per capita consumption and current and past aggregate per capita income, taxes and government expenditures (both permanent and transitory components). At the end of period t, when deciding on consumption, perfectly informed consumers would have information set $I_{it}^{PE} = \{c_{it-1}, c_{it-2}, .., x_{it}, x_{it-1}, ..., c_{t-1}, c_{t-2}, ..., x_t, x_{t-1}, ...\}$ where c_{it-1} is i's consumption in period t-1 and c_{t-1} is total per capita consumption in period t-1. x_t is a three-dimensional vector (y_t, t_t, g_t) and x_{it} is the vector (y_{it}, t_{it}, g_{it}) [4].

[4] Note that b_t, b_{t-1},… is also a part of the information set of a perfectly informed consumer given the knowledge of g_t,g_{t-1},…and t_t,t_{t-1},…The same argument can be made for financial wealth (see appendix A).

In this paper we assume that all consumers are imperfectly informed about the aggregate economy. At the end of period t, when deciding on consumption, imperfectly informed consumers have information set $I_{it}^{IM} = I_{it}^{PE} \setminus \{c_{t-1}, c_{t-2} ..., x_t, x_{t-1}, ...\}$. We make the additional assumption that these imperfectly informed consumers are aware of the intertemporal budget constraint of the government. We justify both assumptions by noting that consumers may value knowledge of the government budget constraint (e.g. because the level of government debt makes it worthwhile to 'pierce the government veil') without thinking it is necessary to know or to use the *exact* value of the aggregate variables in their calculations. Thus, we do not assume that consumers cannot obtain the aggregate information, we just assume that they do not value it enough to collect it or to use it (see Pischke, 1995 and Deaton, 1992)[5]. We capture this idea by assuming that consumers' expectations of their future tax liabilities are determined by their expectations of future (noisy) government expenditures. More precisely, we assume that $(E_{it}^{IM} - E_{it-1}^{IM})\left(\sum_{j=0}^{\infty}(1+r)^{-j} t_{it+j}\right) = (E_{it}^{IM} - E_{it-1}^{IM})\left(\sum_{j=0}^{\infty}(1+r)^{-j} g_{it+j}\right)$ where E_{it}^{IM} is the expectations operator conditional on the information set I_{it}^{IM} and E_{it-1}^{IM} is the expectations operator conditional on the information set I_{it-1}^{IM}.

Our assumptions have the following implications,

1) Since n is large and since there is independence across consumers, we have that the macro structure and the micro structure are compatible.

2) The change in consumption of each of the the n consumers can be written as (see appendix A),

$$(9)\quad \Delta c_{it} = r(1+r)^{-1}\sum_{j=0}^{\infty}(1+r)^{-j}(E_{it}^{k} - E_{it-1}^{k})(y_{it+j} - t_{it+j})$$

where i=1,…,n and E_{it}^{k} is the expectations operator conditional on the information set I_{it}^{k} (where k=PE or IM). Consumers make their decision at the end of t using the information set I_{it}^{k} available at the end of t.

3) To incorporate the assumption that consumers do not observe aggregate variables, we use Eq. (1), (2), (4), (5), (6) and (8) to derive the following equations (see appendix B),

$$(10)\quad \Delta y_{it} = y + \eta_{it} - \theta\eta_{it-1}$$

$$(11)\quad \Delta g_{it} = g + \mu_{it} - \phi\mu_{it-1}$$

where the parameters θ (>0) and ϕ (>0) are functions of the (relative) variances of aggregate (permanent and transitory) shocks and idiosyncratic shocks (see appendix B). η_{it} and μ_{it} reflect the innovations in consumer i's own pre-tax income and perception of government expenditures. These innovations are white noise and have a variance that is constant across consumers. In appendix B we show that the higher is the variance of the permanent shocks in pre-tax income and government expenditures, the lower will be the values of θ and ϕ. In this case, as we can see from (10) and (11), innovations in period t that lead to changes in y_{it} and g_{it} will almost not be undone in the next period.

Consumers thus experience shocks without knowing the exact nature of these innovations (aggregate persistent, aggregate temporary or idiosyncratic). Obviously, this is problematic when they calculate their permanent income. Since temporary aggregate and individual-

[5] As noted by Deaton (1992-page 40), individuals have public access to aggregate variables. There is however no guarantee that they will use such information.

specific shocks are white noise (Eqs. (1), (2), (6), (7) and (8)), they call for a small adjustment of permanent income. Aggregate variables may however also be affected by permanent shocks (see Eqs. (4) and (5)) which demand a larger adjustment of permanent income.

Perfectly informed consumers.

If consumers had perfect information about the aggregate economy and thus had information set I_{it}^{PE} , aggregate per capita consumption would be given by (see appendix C),

$$(12)\quad \Delta c_t = r(1+r)^{-1}(\varepsilon_t^y - \varepsilon_t^g) + v_t^y - v_t^g$$

This is the standard result that not only at the individual level (see Eq. 9) but also in the aggregate, perfectly informed permanent income consumers only respond to unanticipated shocks ('surprises'). Since they incorporate the government budget constraint, tax shocks do not enter Eq. (12).

Imperfectly informed consumers.

In appendix D we show that if all consumers are imperfectly informed but do take into account the government budget constraint, the change in per capita consumption is given by,

$$(13)\quad \Delta c_t = b^y a^y - b^g a^g + b^y \Delta y_t - b^g \Delta g_t + b^y \sum_{j=1}^{\infty} \theta^j \Delta y_{t-j} - b^g \sum_{j=1}^{\infty} \phi^j \Delta g_{t-j}$$

where $a^y = -(1-\theta)^{-1} y$, $a^g = -(1-\phi)^{-1} g$, $b^y = (1+r-\theta)(1+r)^{-1}$ and $b^g = (1+r-\phi)(1+r)^{-1}$.

As can be seen from (13), the lack of information on aggregate variables causes consumption to be excessively sensitive to (lags in) income (see Pischke 1995 and Demery and Duck 2000). Consumption is also excessively sensitive to (lags in) government expenditures. Consumption does not respond only to 'surprises' in income and government expenditures as is the case when consumers have complete information (see Eq. (12)). For instance, if in period t there is a permanent shock in government expenditures, this will lead to a change in g_{it} , g_{it+1},…. Consumers take this into account when determining consumption since they incorporate the government budget constraint. They will be uncertain about how much government expenditures have augmented since these expenditures are observed with noise. Consumers will therefore interpret the shock only partly as a permanent shock in aggregate g_t and will thus underestimate the persistence of the shock. They will change their estimate of permanent income insufficiently. Consumption in t will adjust, but the adjustment will be too small. The reaction depends on the relative variance of idiosyncratic and temporary aggregate versus permanent aggregate shocks. This can be seen from equation (13) where the change in consumption in period t due to a change in government expenditures in t depends on b^g. From appendix B we can derive that if the variance of v_t^g is small compared to the variances of ε_t^g and ε_{it}^g, the consumer will expect that shocks are mainly temporary or idiosyncratic and ϕ(>0) will be relatively large. At the aggregate level we then have $b^g = (1+r-\phi)(1+r)^{-1}$ and the reaction (of all consumers) to aggregate (permanent or temporary) shocks within the same period will be relatively small. In the next period(s), as the effect of a permanent shock is observed to persist, consumers will again be surprised and permanent income and consumption will be adjusted again. Consumption will then be excessively sensitive to lagged changes in government expenditures. The intuition for income is similar to that for government expenditures.

Note that our results on excess sensitivity of income and government expenditures are dependent on the imperfect information assumption at the individual level and on the aggregation bias that results from it. Consumption changes are unpredictable at the individual level, not at the aggregate level. We refer to appendix D for more on this. Working with a representative permanent income consumer would never generate excess sensitivity because the optimization problem of a representative consumer always implies unpredictable consumption changes at the aggregate level.

Note also that our results are not dependent on the presence of temporary aggregate shocks. We assume specifications like (1) and (2) with permanent and transitory shocks to leave room for predictability of income and government expenditure changes, given the random walk assumption of the permanent components. Assuming more general univariate processes for income and government expenditure changes would give similar results leading to private consumption changes that are excessively sensitive to (lagged) pre-tax income and government expenditure changes [6].

3. Methodology and results.

3.1 A testable consumption function, estimation issues and data issues.

Specifications in which the change in private consumption is a function of current and lagged changes in pre-tax income and government expenditures can be obtained from different

[6] Demery and Duck (2000) obtain a similar result using an ARMA(p,q) for the change in aggregate income. In fact as long as Δy_{it} and Δg_{it} are covariance-stationary we can (by using the Wold theorem – see Hamilton 1994) write equations of the form $\Delta y_{it} = \mu + \psi(L)u_{it}$ where u_{it} is white noise and where $\psi(L)$ is an infinite-order lag polynomial with ψ_0=1 (and similar for Δg_{it}). Assuming the underlying parameters of the aggregate processes are such that the lag polynomials are invertible, we can obtain an expression similar to (13).

assumed income and government expenditure processes. Thus, it may be too restrictive to test the model by imposing the assumed processes for income and government expenditures on the data [7]. In appendix E we therefore report the results of estimating Eq.(13) directly (i.e. the estimates for θ and ϕ) while in this section we estimate a more general consumption function,

$$(14)\quad \Delta c_t = \gamma + \delta_0^y \Delta y_t + \delta_0^g \Delta g_t + \sum_{j=1}^{q} \delta_j^y \Delta y_{t-j} + \sum_{j=1}^{q} \delta_j^g \Delta g_{t-j} + \varepsilon_t^c$$

where γ is a constant and the expected signs of the parameters are $\delta_0^y > 0$, $\delta_0^g < 0$, $\delta_j^y > 0$ (for j=1,…,q) $\delta_j^g < 0$ (for j=1,…,q). Note that strictly speaking an infinite number of lagged Δy_t and Δg_t terms should be included in (14), which is obviously not possible. Therefore, we follow the approach of Demery and Duck (2000) and we add a finite number q of lags. Given that enough lags of Δy_t and Δg_t are included we should find no increase in likelihood if lagged Δc_t terms are added to this equation. Lags of Δc_t added to our empirical specification (14) are indeed never significant and do not affect our results. All our results reported (for all countries) are for q=1 since using Wald tests we can easily reduce the number of lags to that number. We never find significant parameter estimates on Δy_{t-j} and Δg_{t-j} for j=2,3,….[8]. Given their endogeneity we must instrument Δy_t and Δg_t. The error term ε_t^c can be interpreted as a preference shock or as resulting from transitory components in the level of consumption. In the latter case it will follow an MA(1) process and instruments must be

[7] Pischke finds that individual income changes are well described by an MA(2) Process. As noted by Deaton (1992), an MA(1) process for individual income changes, as in Eq. (10), may be a relatively good approximation to reality. This says nothing of Eq. (11) for government expenditures however.

[8] Note that specification q=2 does generally not strongly affect the significance of our results (the standard errors and parameter estimates of the current value and first lag of Δy and Δg remain relatively stable). The significance of our results starts deteriorating however when more (insignificant) lags are added.

lagged at least twice to obtain consistent estimation. Stated differently, the variables Δy_{t-1} and Δg_{t-1} must also be instrumented. This is also necessary if we consider the possibility of time aggregation (Working 1960). We use lags of $\Delta c_t, \Delta y_t$ and Δg_t as instruments in our regressions.

To estimate (14) we use semi-annual data for 3 high-debt OECD countries (Belgium, Italy and Greece) from 1973:1 –1997:2. We take 1973 as a first observation because it marks the first oil shock. This crisis and the fiscal and debt problems that it provoked, may have increased consumers' awareness of government issues. Using semi-annual data gives the possibility to estimate (14) over relatively small subperiods and to capture the dynamics implied by the lag structure in (14). We would prefer quarterly data but these are not available for all countries for all necessary variables. More details on the construction of the used variables are given in table 1.

Table 1. Data and data sources.

c_t	Real aggregate per capita private consumption. Taken from OECD Economic Outlook (CD ROM 2001 Vol.2) and reported in real terms with code CPV (deflated by implicit deflator for aggregate consumption, 1995=100).
y_t	Real per capita pre-tax income. Calculated using variables from OECD Economic Outlook (CD ROM 2001 Vol.2). Multiply the wage rate in the business sector (with code WR) by employment in the business sector (with code ETB) and then add government wages (with code CGAA). Then deflate this sum by the private consumption deflator (with code PCP, 1995=100). Note that this measure cannot be constructed on a semi-annual basis for Belgium before 1980. For Belgium we therefore use wages and salaries (code WAGE in OECD statistics) which is basically the same and which is available from 1973 onwards. We also deflate this series with PCP. Estimations with both measures (after 1980) are practically identical. We name these proxies Y2. Since this type of proxy cannot be constructed for Greece we also proxy pre-tax income by real per capita GDP with code GDP (see for instance Evans and Karras 1996, 1998). We name this proxy Y1.
g_t	Real per capita government consumption plus real per capita government investment. Taken from OECD Economic Outlook (CD ROM 2001 Vol.2). Real government consumption is reported with code CGV (deflated by implicit deflator for government consumption, 1995=100). Real government investment is reported with code IGV (deflated by implicit deflator for government investment, 1995=100).

Note: all variables are seasonally adjusted. Per capita measures are obtained after dividing by total population. Semi-annual data for total population are constructed by dividing the data for the population between 15 and 64 years of age (which are available on a semi-annual basis in OECD Economic Outlook CD ROM 2001 Vol.2 with code POPT) by the ratio of the population of 15-64 to total population, which can be calculated on a yearly basis. The latter is calculated using total population (available on a yearly basis only) from OECD Economic Outlook CD ROM 2001 vol.2 (with code POP).

3.2 Estimation results.

Note first that we do reject the hypothesis of a unit root in all series used for $\Delta c_t, \Delta y_t$ and Δg_t for all countries and over all sample periods considered. Unit root tests are not reported but they are available upon request.

We report our results for Eq. (14) with q=1 using the instrumental variables (IV) approach in tables 2 (Italy), 3 (Greece) and 4 (Belgium). Note that specifications with q=2 do generally lead to the same conclusions, though the additional lags are never significant. For each country we consider subperiods and a number of different variables to proxy pre-tax income (Y1,Y2). We use instrument sets containing the second to the fifth lag of $\Delta c_t, \Delta y_t$ and Δg_t when estimating our equation. Note that changing the number of instruments in all these cases does only marginally affect our results.

Table 2. IV estimates of (14) with q=1 for Italy.

Coefficient	(1) 1973:01-1997:02 with Y1 [b]	(2) 1973:01-1997:02 with Y2 [b]	(3) 1982:01-1997:02 with Y2 [b]
δ_0^y	0.219** (0.082)	0.479* (0.295)	0.493** (0.169)
δ_0^g	-0.829** (0.239)	-0.716** (0.248)	-0.440* (0.261)
δ_1^y	0.207** (0.095)	0.358** (0.183)	0.402* (0.205)
δ_1^g	0.384* (0.220)	0.156 (0.345)	0.133 (0.248)
N obs.	50	50	32
R^2	0.371	0.124	0.455
DW[a]	2.270	1.678	1.561

Notes: Newey-West standard errors between brackets (lag truncation = 3). * indicates significance at the 10% level. ** indicates significance at the 5% level. The instrument set contains lags 2 to 5 of $\Delta c_t, \Delta y_t$ and Δg_t.
[a] DW indicates the Durbin-Watson test statistic. [b] Y1 is real per capita GDP used as a proxy for y_t ,Y2 is real per capita total wages used as a proxy for y_t.

Table 2 presents the results for Italy. In the first equation we estimate (14) over the period 1973:01-1997:02 with real per capita GDP (Y1) as a proxy for y_t. All coefficients have the expected sign, except δ_1^g which is positive. This contradicts the intuition of the model. In the second equation where we use real per capita total wages (Y2) as a proxy for y_t, our coefficient estimates are considerably different. δ_1^g is now insignificant.

Note that if we estimate (14) over smaller sample periods as in the third equation, the results remain the same. We report the results for the period 1982:01-1997:02 because in 1982 the net debt to GDP ratio reached 50% and a long uninterrupted increase followed (see figure 1 in section 1). The results are robust to estimation over other sample periods starting in the early to mid eighties however.

We thus find excess sensitivity with respect to current pre-tax income and government expenditures and with respect to the first lag in income. Lagged changes in government expenditures do not enter the regression in a significant way. A possible explanation for this could be that most of the adjustment in government expenditures occurs immediately, for instance in the first quarter after the shock. This could also explain why δ_0^g is quite large in absolute terms (especially in Eqs (1) and (2)). Consumers may think that changes in government expenditures are usually rather persistent so that adjustment occurs fast and over a small period. Quarterly data might be more useful to capture the adjustment. However, due to data limitations, only semi-annual data are available.

Note that the usual interpretation for the observation that private consumption responds negatively to government expenditure changes would be that private consumption and government expenditures are Edgeworth substitutes. As noted earlier, at the aggregate level, there may be reason to question such a relationship. The finding that lagged pre-tax income enters the regression significantly provides support for the alternative explanation considered in this paper.

Additional support for the idea of this paper is given by the results for Greece in table 3. For Greece we can only use Y1 as a proxy for real per capita pre-tax labour income. In the first equation we estimate (14) over the period 1973:01-1997:02. No variables are significant except current income. The Durbin Watson statistic being smaller than 1, our consumption function seems to be rather misspecified for this period. Note however that during the seventies and most of the early eighties the debt ratio in Greece remained relatively low (see figure 2 in section 1). If we estimate (14) over the period 1985:01-1997:02, a period of high debt levels (almost exceeding 50% in 1985) and a very strong increase in the debt ratio, another picture emerges. We find results strongly in line with these for Italy. Again, we find excess sensitivity with respect to current pre-tax income and government expenditures and the first lag in income. We do not find a significant influence from lagged changes in government expenditures. The Durbin-Watson statistic is much closer to 2 this time.

Table 3. IV estimates of (14) with q=1 for Greece.

Coefficient	(1) 1973:01-1997:02 with Y1[b]	(2) 1985:01-1997:02 with Y1[b]
δ_0^y	0.235** (0.075)	0.358** (0.086)
δ_0^g	-0.191 (0.353)	-0.822** (0.343)
δ_1^y	0.011 (0.047)	0.331** (0.103)
δ_1^g	0.255 (0.206)	0.001 (0.191)
N obs.	50	26
R^2	0.583	0.670
DW[a]	0.966	1.605

Notes: Newey-West standard errors between brackets (lag truncation = 3). * indicates significance at the 10% level. ** indicates significance at the 5% level. The instrument set contains lags 2 to 5 of Δc_t, Δy_t and Δg_t.
[a] DW indicates the Durbin-Watson test statistic. [b] Y1 is real per capita GDP used as a proxy for y_t.

Far less convincing are the results for Belgium, however (table 4). From figure 1 in section 1 we note that of all countries considered Belgium has the highest debt level. Our results are not reflecting this. In the first equation (full sample with Y1) only current income enters significantly. The Durbin-Watson test is very low suggesting model misspecification. In the second equation we use real per capita total wages (Y2) as a proxy for y_t. Again only current income is significant, though current government expenditures have the expected sign. Using subsamples does not improve the results.

Table 4. IV estimates of (14) with q=1 for Belgium.

Coefficient	(1) 1973:01-1997:02 with Y1 [b]	(2) 1973:01-1997:02 with Y2 [b]	(3) 1985:01-1997:02 with Y2 [b]
δ_0^y	0.313** (0.074)	0.434** (0.136)	0.589** (0.280)
δ_0^g	0.052 (0.116)	-0.156 (0.108)	0.336 (0.559)
δ_1^y	0.015 (0.047)	0.008 (0.114)	-0.204 (0.148)
δ_1^g	0.053 (0.082)	0.002 (0.081)	-0.503 (0.295)
N obs.	50	50	26
R^2	0.662	0.464	0.275
DW[a]	1.096	1.075	1.003

Notes: Newey-West standard errors between brackets (lag truncation = 3). * indicates significance at the 10% level. ** indicates significance at the 5% level. The instrument set contains lags 2 to 5 of Δc_t, Δy_t and Δg_t.
[a] DW indicates the Durbin-Watson test statistic. [b] Y1 is real per capita GDP used as a proxy for y_t, Y2 is real per capita total wages used as a proxy for y_t.

Summarizing, though our results are not conclusive, there are indications that our model can explain certain observations of excess sensitivity of consumption to income and government expenditures in some countries during some periods.

4. Conclusions.

In this paper we consider an alternative to the Edgeworth interpretation of excess sensitivity of aggregate consumption to anticipated changes in government expenditures building on the idea of imperfect information as developed by Pischke (1995). Given the theoretical problems of the Edgeworth concept at the aggregate level and the disparity in empirical results, we find it surprising that, to the best of our knowledge, no alternative interpretations have been given to this form of excess sensitivity in the literature.

We basically consider a model of Ricardian Equivalence under imperfect information where rational utility maximizing permanent income consumers are assumed to be imperfecly informed about the aggregate economy. They do however (imperfectly) incorporate the intertemporal budget constraint of the government. At the aggregate level this generates excess sensitivity of private consumption changes to predictable pre-tax income and government expenditure changes.

In the empirical section we estimate a consumption function implied by the model for three high debt countries (Italy, Greece and Belgium). We concentrate on high debt countries since, as suggested by existing research, it may be expected that consumers in these countries value information on government budget issues more than consumers in other countries.

Our findings suggest that in Italy and Greece (especially during periods of high debt accumulation) private consumption changes are indeed excessively sensitive to (lagged) changes in pre-tax income and government expenditures. Our results are not fully conclusive however since for Belgium there are no indications that the model provides a satisfying approximation to reality. Thus we do not wish to oversell our alternative explanation but we consider it a good starting point to consider more alternatives to the standard Edgeworth interpretation of excess sensitivity of private consumption to government expenditures.

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Appendix A: Derivation of (9).

Given the quadratic utility assumption and the assumption that the subjective rate of time preference equals the constant real interest rate, the first order condition at time t can be written as (∀j),

$$\text{(A1)} \quad E^k_{it} c_{it+j} = c_{it}$$

with k=IM (or PE if consumers are perfectly informed) and i=1,…,n. This is the standard random walk result (see Hall 1978). The period t budget constraint of these consumers can be written as,

$$\text{(A2)} \quad c_{it} + w_{it}(1+r)^{-1} = y_{it} - t_{it} + w_{it-1}$$

where w_{it} is consumer i's financial wealth (including government bonds) measured at the end of period t. Solving (A2) forwards, imposing a solvency condition and taking expectations E^k_{it} leads to,

$$\text{(A3)} \quad \sum_{j=0}^{\infty}(1+r)^{-j} E^k_{it} c_{it+j} = w_{it-1} + \sum_{j=0}^{\infty}(1+r)^{-j} E^k_{it}(y_{it+j} - t_{it+j})$$

Substituting (A1) into (A3) we obtain,

$$\text{(A4)} \quad c_{it} = r(1+r)^{-1}\left(\sum_{j=0}^{\infty}(1+r)^{-j} E^k_{it}(y_{it+j} - t_{it+j}) + w_{it-1}\right)$$

Substituting the budget constraint (A2) written for t-1 into (A4), we obtain

$$\text{(A5)}\quad c_{it} = r(1+r)^{-1}\sum_{j=0}^{\infty}(1+r)^{-j}E_{it}^{k}(y_{it+j} - t_{it+j}) + r(y_{it-1} + w_{it-2} - t_{it-1} - c_{it-1})$$

Lagging (A4) one period, multiplying both sides by 1+r and extracting the term for j=0 from the summation, we obtain,

$$\text{(A6)}\quad (1+r)c_{it-1} = rw_{it-2} + r(y_{it-1} - t_{it-1}) + r\sum_{j=1}^{\infty}(1+r)^{-j}E_{it-1}^{k}(y_{it+j-1} - t_{it+j-1})$$

Rearranging terms, (A6) can also be written as,

$$\text{(A7)}\quad c_{it-1} = -rc_{it-1} + rw_{it-2} + r(y_{it-1} - t_{it-1}) + r(1+r)^{-1}\sum_{j=0}^{\infty}(1+r)^{-j}E_{it-1}^{k}(y_{it+j} - t_{it+j})$$

Subtracting (A7) from (A5) we obtain (9) in the main text.

Appendix B: Derivation of (10) and (11).

We focus on the derivation of (10), the derivation of (11) is completely identical. Substituting (1) and then (4) into (6), and rewriting the result in first differences, we obtain,

$$\text{(B1)}\quad \Delta y_{it} = y + v_t^y + \varepsilon_t^y - \varepsilon_{t-1}^y + \varepsilon_{it}^y - \varepsilon_{it-1}^y$$

In (B1) we have a combination of various white noise errors. To capture the fact that consumers do not observe aggregate variables, we can write this combination of errors as an MA(1) process,

$$\text{(B2)} \quad v_t^y + \varepsilon_t^y - \varepsilon_{t-1}^y + \varepsilon_{it}^y - \varepsilon_{it-1}^y = \eta_{it} - \theta\eta_{it-1}$$

with η_{it} being a white noise term with a variance that is constant across consumers. The value of θ that ensures the white noise structure of η_{it}, is obtained if we equate the first-order autocorrelations of both sides of (B2) [9]. This leads to

$$\text{(B3)} \quad \theta^2 + 1 = \left(\frac{\sigma^2_{v^y} + 2\sigma^2_{\varepsilon^y} + 2\sigma^2_{\varepsilon_i^y}}{\sigma^2_{\varepsilon^y} + \sigma^2_{\varepsilon_i^y}} \right)\theta$$

where $\sigma^2_{\varepsilon_i^y}$, $\sigma^2_{\varepsilon^y}$ and $\sigma^2_{v^y}$ are the unconditional variances of ε_{it}^y, ε_t^y and v_t^y respectively.

Eq. (B3) is a quadratic of the form $a\theta^2 + b\theta + c = 0$ with a=c=1 and $b = -\left(\frac{\sigma^2_{v^y} + 2\sigma^2_{\varepsilon^y} + 2\sigma^2_{\varepsilon_i^y}}{\sigma^2_{\varepsilon^y} + \sigma^2_{\varepsilon_i^y}} \right)$. To have at least one real solution θ* the condition must hold that $b^2 \geq 4$. This condition always holds. Note that from (B3) it is obvious that θ>0. The two roots are given by $\theta_1 = (1/2)(-b + \sqrt{b^2 - 4})$ and $\theta_2 = (1/2)(-b - \sqrt{b^2 - 4})$. Using the solution θ* into (B2) and substituting this into (B1) we obtain,

$$\text{(B4)} \quad \Delta y_{it} = y + \eta_{it} - \theta^* \eta_{it-1}$$

[9] Where we use the assumption that there is no correlation between permanent aggregate, temporary aggregate and idiosyncratic shocks (not contemporaneous and not at any lead nor lag).

which equals (10) in the main text. Note that only with the root θ_2 we have $\theta_2<1$. This is the invertibility condition that guarantees that from (B4) we can write,

(B5) $$\eta_{it} = a^y + \sum_{j=0}^{\infty}\theta^j \Delta y_{it-j}$$

where $\theta = \theta^* = \theta_2$ and $a^y = -(1-\theta)^{-1} y$.

In exactly the same way we can derive Eq. (11) in the main text. We can write,

(B6) $$v_t^g + \varepsilon_t^g - \varepsilon_{t-1}^g + \varepsilon_{it}^g - \varepsilon_{it-1}^g = \mu_{it} - \phi\mu_{it-1}$$

with $\phi>0$. Note that only the second root ϕ_2 will satisfy the invertibility condition $\phi_2<1$ so that we can write from (11),

(B6) $$\mu_{it} = a^g + \sum_{j=0}^{\infty}\phi^j \Delta g_{it-j}$$

where $\phi = \phi^* = \phi_2$ and $a^g = -(1-\phi)^{-1} g$.

Appendix C: Derivation of (12).

From the main text we know that perfectly informed consumers observe all aggregate variables (information set I_{it}^{PE}). We start from Eq. (9) into which we substitute Eqs. (6) and

(7) written for period t+j. Substituting out taxes by means of the budget constraint (3), we obtain,

$$\text{(C1)}\quad \Delta c_{it} = r(1+r)^{-1}\sum_{j=0}^{\infty}(1+r)^{-j}(E_{it}^{PE} - E_{it-1}^{PE})\left[y_{t+j} - g_{t+j} + \varepsilon_{it+j}^{y} - \varepsilon_{it+j}^{t}\right]$$

Using Eqs. (1),(2),(4) and (5) into (C1) we obtain,

$$\text{(C2)}\quad \Delta c_{it} = r(1+r)^{-1}(\varepsilon_t^y - \varepsilon_t^g + \varepsilon_{it}^y - \varepsilon_{it}^t) + v_t^y - v_t^g$$

Summing Eq. (C2) over all n consumers makes the idiosyncratic shocks disappear. We obtain Eq. (12) in the main text.

Appendix D: Derivation of (13).

At the end of period t imperfectly informed consumers have information set I_{it}^{IM}. We also know that these consumers form expectations according to $(E_{it}^{IM} - E_{it-1}^{IM})\left(\sum_{j=0}^{\infty}(1+r)^{-j}t_{it+j}\right) = (E_{it}^{IM} - E_{it-1}^{IM})\left(\sum_{j=0}^{\infty}(1+r)^{-j}g_{it+j}\right)$. Substituting this into Eq. (9) with k=IM we obtain,

$$\text{(D1)}\quad \Delta c_{it} = r(1+r)^{-1}\sum_{j=0}^{\infty}(1+r)^{-j}(E_{it}^{IM} - E_{it-1}^{IM})(y_{it+j} - g_{it+j})$$

We first put (D1) into a different form. Note that we can write (D1) as,

(D2)

$$\Delta c_{it} = \sum_{j=0}^{\infty}(1+r)^{-j}(E_{it}^{IM} - E_{it-1}^{IM})(y_{it+j} - g_{it+j}) - (1+r)^{-1}\sum_{j=0}^{\infty}(1+r)^{-j}(E_{it}^{IM} - E_{it-1}^{IM})(y_{it+j} - g_{it+j})$$

The second term of (D2) can also be written as $-\sum_{j=0}^{\infty}(1+r)^{-j}(E_{it}^{IM} - E_{it-1}^{IM})(y_{it+j-1} - g_{it+j-1})$.

Plugging this into (D2) we obtain,

(D3) $\Delta c_{it} = \sum_{j=0}^{\infty}(1+r)^{-j}(E_{it}^{IM} - E_{it-1}^{IM})(\Delta y_{it+j} - \Delta g_{it+j})$

Substituting Eqs. (10) and (11) into (D3) leads to

(D4) $\Delta c_{it} = b^{y}\eta_{it} - b^{g}\mu_{it}$

where $b^{y} = (1+r-\theta)(1+r)^{-1}$ >0 (given that it follows from app. B that 0<θ<1), $b^{g} = (1+r-\phi)(1+r)^{-1}$ >0 (given that it follows from app.B that 0<ϕ<1).

Substituting Eqs. (B5) and (B6) into (D4) and aggregating over the n consumers leads to (13) in the main text.

Note from (D4) that at the individual level the change in consumption is white noise. If in period t a persistent aggregate shock occurs, consumption will be adjusted. In the following period, due to the persistence of the shock, the consumer will again be surprised. The consumption change is thus orthogonal to the information set of the imperfectly informed consumer, but not orthogonal to last period's aggregate shock. Note that it is assumed that consumers never learn about the aggregate persistent shocks. Given that calculations by

Pischke (1995) suggest that for consumers in the US the costs of obtaining aggregate information may be far greater than the benefits, it seems plausible that consumers choose to remain ignorant indefinitely (see Deaton 1992).

At the aggregate level consumption changes are not white noise, however. If we aggregate Eq. (D4) over all n consumers we obtain $\Delta c_t = b^y \eta_t - b^g \mu_t$ where $\eta_t = (1/n)\sum_{i=1}^{n} \eta_{it}$ and $\mu_t = (1/n)\sum_{i=1}^{n} \mu_{it}$. Note now that while η_{it} and μ_{it} are white noise, η_t and μ_t are not. To see this, we can use (B2) and (B6). The presence of the terms in ε_{it}^{y} and ε_{it}^{g} forces the selection of particular values for θ and ϕ to guarantee white noise in each η_{it} and μ_{it}. On aggregation, since the terms in ε_{it}^{y} and ε_{it}^{g} disappear and since θ and ϕ are the same, η_t and μ_t will not be white noise.

Appendix E: Estimation of Eq. (13).

In this appendix we estimate the parameters θ and ϕ directly from Eq. (13). We first rewrite Eq. (13) in a different form. Note that from (B4) we can write $\eta_{it} = (\Delta y_{it} - y)(1-\theta L)^{-1}$ where L is the lag operator. We can do the same for government expenditures, so that we have $\mu_{it} = (\Delta g_{it} - g)(1-\phi L)^{-1}$. Substituting both expressions in (D4), multiplying both sides by $(1-\theta L)(1-\phi L)$ and aggregating[10], we obtain,

(E1)
$$\begin{aligned}\Delta c_t &= (\theta+\phi)\Delta c_{t-1} - \theta\phi\Delta c_{t-2} + (1-\theta)(1+r-\phi)(1+r)^{-1} g - (1-\phi)(1+r-\theta)(1+r)^{-1} y \\ &+ (1+r-\theta)(1+r)^{-1}((1-\phi L)\Delta y_t) - (1+r-\phi)(1+r)^{-1}((1-\theta L)\Delta g_t)\end{aligned}$$

In table E1 we report the results of the estimation of Eq.(E1) over the indicated sample periods for Italy, Greece and Belgium. We use real per capita wages for y_t for Italy and Belgium (Y2) and real per capita GDP for Greece (Y1). We report the results obtained for the estimation of θ and ϕ with imputed values for y, g (which are the averages of Δy_t and Δg_t over the sample period) and r. We set r=0.02 in all estimations, but the results are not sensitive to the use of other values for r in the interval 0.01-0.05.

Table E1. IV estimates of Eq. (E1) with r=0.02.

	Coefficient		N Obs
	θ	ϕ	
(1)	0.747**	0.158	50
Italy (1973:01-1997:02)	(0.102)	(0.239)	
(2)	0.813**	0.166	32
Italy (1982:01-1997:02)	(0.170)	(0.252)	
(3)	0.714**	0.694**	50
Greece (1973:01-1997:02)	(0.073)	(0.136)	
(4)	0.567**	0.447**	26
Greece (1985:01-1997:02)	(0.072)	(0.149)	
(5)	0.732**	0.775**	50
Belgium (1973:01–1997:02)	(0.165)	(0.110)	
(6)	0.637**	0.996**	26
Belgium (1985:01-1997:02)	(0.174)	(0.228)	

Notes: Newey-West standard errors between brackets (lag truncation = 3). * indicates significance at the 10% level. ** indicates significance at the 5% level. The instrument set contains lags 2 to 5 of Δc_t , Δy_t and Δg_t . Y2 is used for Italy and Belgium; Y1 is used for Greece (see table 1 for exact definitions).

From the results in table E1 we note that the estimates for θ are significant and plausible (i.e. between 0 and 1) in all cases considered. The estimates for ϕ are insignificant for Italy but have significant values between 0 and 1 for the other countries. Note that whereas the point estimates for θ are very similar over the different countries, the point estimates for ϕ are very

[10] Note that the conditions θ<1 and ϕ<1 are not necessary here (values larger than 1 would be rather unrealistic however). This also implies that b^y and b^g could be negative.

different (close to 0 for Italy, close to 0.5 for Greece and close to 1 for Belgium). The point estimates for θ are all relatively close to 1. In terms of the model this implies a relatively high variance of the transitory and/or individual-specific components in income (see Eq. 13) so that consumers may think that changes in income are usually not very persistent. Permanent income and consumption will not be adjusted very much in the period of the shock and will adjust relatively slowly in the consequent periods.

The result that ϕ is relatively low in Italy is more or less in accordance with the results found in table 2 where a more general consumption function is estimated (Eq. 14) and where the lagged changes in government expenditures are insignificant. The variance of permanent shocks in government expenditures may be relatively high so that consumers may think that changes in government expenditures are usually rather persistent so that adjustment occurs fast and over a small period (see Eq. 13 in the paper to see this). More or less the same conclusion can be drawn for Greece if we estimate over the period 1985:01-1997:02 (the point estimate for ϕ is still lower than 0.5 and significant in this case). In the other cases (Greece 1973:01-1997:02 and Belgium over both sample periods considered) we find relatively high values for ϕ. These cases coincide with general estimations (Eq.14) of very poor quality (see the discussion in the main text). Rather than taking these estimates for ϕ (and the large differences across countries which are implausible) seriously, we conclude that these results may also be due to the fact that the estimation of (13) and (E1) may be too restrictive (especially the process for government expenditures assumed in the model – see footnote 7).