The Precautionary Effect of Government Expenditures on Private Consumption*

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Abstract

We provide new evidence on the reaction of private consumption to government consumption changes focusing on a new channel: the precautionary saving motive. We first build a unique panel dataset which links household's private consumption to the government consumption of the region where the household lives, for Italy. We then use regional and time variability of government consumption and measure its effect on individual consumption, for different categories of government expenditures. We estimate a negative impact of public health care on household consumption dispersion. Within our model where individuals are subject to health shocks, this result is interpreted in the light of a precautionary saving motive, with public health care expenditures acting as a form of consumption insurance for households. We then compute the implied consumption multipliers by calibrating an RBC model based on our estimates. The size of the multipliers varies with the persistence of the health shocks. For example, in a benchmark exercise with highly persistent shocks, the consumption multiplier amounts to 0.73 on impact and to -1.49 in the long run. In the case with iid health shocks, the impact and long run consumption multipliers are both negative: they are -0.29 and -1.01 respectively.

JEL classification: E21, E32, E62

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1 Introduction

Over past years, the relationship between private consumption and government spending has been at the heart of the economics and government policy debates. The aim of this paper is to provide new evidence on the sign and magnitude of the reaction of private consumption to public consumption changes. We focus on a new channel at the base of this relationship: the precautionary saving effect. This paper constitutes one of the first attempts to estimate the effects of government consumption on private consumption, using household-level data.

The present paper bridges two streams of literature. First of all, there is the well established fiscal policy literature which suggested the sign of the empirical response of private consumption to government spending shocks as a crucial discriminant between the plausibility of the Neoclassical versus the Keynesian models. In the standard RBC model (Baxter and King 1993) - where public spending enters separable in the utility function - government spending *crowds out* private spending because the tax increase induced by the increase in government spending reduces net present value of disposable income which decreases consumption.[1] In models with nominal rigidities consumption may increase as a consequence of an increase in government spending.[2]

Our paper is also related to the recently growing literature that has invoked the precautionary saving motive for explaining the business cycle dynamics of consumption and saving. Among others, Carroll (1992) explain the tendency of saving to increase during recessions through the precautionary saving channel.[3] Parker (2000) argues that the steady decline in the US personal saving rate, from the early 1980s to the end of the 1990s, was a consequence of a general belief in better economic times in the future coupled with a prominent role of financial liberalization that made easier for households to borrow and to consume more. Guerrieri and Lorenzoni (2011) quantify the effect of a tightening of the household borrowing limits to aggregate quantities and prices. Other studies focus on heterogeneous effects across agents.[4] There is also a large micro-econometrics literature aiming at measuring the importance of

[1] Among others, Bailey (1971) and Barro (1981) allow government consumption to directly affect the welfare of agents. Clearly, in this case, the response of private consumption to public spending would also be determined by the degree of substitutability/complementarity between the two items of interest.

[2] Linnemann and Schabert (2003) show how the strength of the demand effect depends on the response of the real interest rate governed by the monetary policy regime and argue that - in normal times - price stickiness alone is quantitatively not sufficient to explain a rise in consumption as predicted by Keynesian theory at least as long as the Ricardian equivalence holds. In this case, the negative effect on permanent income tends to dominate the demand effect due to sticky prices. Gali, Lopez-Salido and Valles (2007) introduce a share of myopic consumers, and show that the New Keynesian model is able to generate a positive reaction of private consumption to public spending.

[3] For a recent work on a similar topic, see Challe and Ragot (2011).

[4] Among them, Giavazzi and McMahon (2011) study how consumption responds to shifts in military spending using

precautionary effects in different contexts.[5] To the best of our knowledge, this is the first work that detects and quantifies the 'precautionary effect' of public consumption.

We exploit information from two datasets: The Survey of Households Income and Wealth (SHIW) from Bank of Italy, and The Regional Economic Accounts (REA henceforth) from ISTAT (National Institute for Statistics). The first dataset provides panel information on households, such as private consumption, income, demographic characteristics and so on. REA delivers data on government consumption consolidated at a regional level. For each region, REA also disaggregates government consumption along a functional scheme based on COFOG classification (defense, justice, health, education, economics services and so on).

We consider a life cycle model where individuals are subject to preference shocks, and government consumption may affect the process of the preference shocks. The empirical model is characterized by three key processes: the Euler equation, the stochastic process for private consumption's dispersion, and the process for government consumption. Then we build a panel data set linking Italian household's private consumption to various categories of government consumption of the region where the household lives, and we estimate the parameters of interest.

We find three key empirical results. First, as in a number of other works, the growth of household's consumption expenditure increases as consumption's dispersion increases. Second, using regional and time variability of government consumption, we estimate a negative impact of public health care on household consumption dispersion. Third, government consumption, in particular health care, shows a high degree of persistence over time. Within our model, the results are interpreted in the light of a precautionary saving motive, with public health care expenditures acting as a form of consumption insurance for households. As the public provision of health services increases, individuals save less to self-insure themselves against future adverse health shocks. This creates increases today's private consumption.

Our measures of the consumption multipliers are obtained by simulating the path of private consumption in response to an increase of government consumption within a general equilibrium framework. In order to perform such computations, we resort to an otherwise standard RBC that is calibrated using our estimates from micro data. In accordance to the empirical model, households hit by health shocks

household-level data. They find that higher income households increase their consumption whilst lower income households decrease it in response to the spending shock. Other recent works interested on heterogeneous effects of government taxes and transfers are Oh and Reis (2011), Kaplan and Violante (2011), and Misra and Surico (2011).

[5] For the US, we mention Gruber and Yellowiz (1999) and DeNardi et al. (2010) who quantify precautionary effects related to expenditures on health related goods and services. As for Italy, a non-exhaustive list includes: Jappelli and Pistaferri (2000), Jappelli et al. (2007), Bertola et al. (2005), and Atella at al. (2006).

are allowed to self insure by changing their private savings. We account both for the negative wealth effects produced by the need of financing the increased government consumption and for the affects on prices. As well, we disentangle the increase in private consumption due to the precautionary effect alone, at equilibrium prices. Our quantitative analysis finds consumption multipliers - on impact - between 0.73 and -0.29 depending on the persistence of the health shocks process. Long run multipliers are always negative, while the consumption multipliers created by the precautionary effects alone are always positive. We relate our measurements to the results obtained by using aggregate data to estimate VARs and DSGE models. The existing empirical evidence obtain contrasting results.[6] In light of our findings, part of these contrasting results might be due to a different functional composition in the variability of government consumption across the different studies.

In our analysis, the use of individual data is important as we would otherwise be unable to identify the mechanism underlying the relation of interest. The use of micro data has several other advantages in comparison with aggregate data. First, since at least Attanasio and Weber (1993) it is well know that aggregation problems might cause biased estimates of individual parameters based on Euler equation defined on aggregate data. Second, few important endogeneities that are well known issues at the aggregate level, are more credibly excluded when using individual data. For example, it is realistic to suppose that government consumption may affect the consumption of a single household, but the contrary is unlikely to occur. Third, the regional dimension of public consumption considerably improves the identification scheme over existing ones. Indeed, the distribution of the general government expenditure is not homogenous across the Italian territory, so that using cross-sectional variability of consumption expenditure permits us to identify the channel of interest while remaining agnostic about the determinants of the business cycle. One important limitation of individual data is the presence of measurement error. We hence perform also a set of estimates by aggregating individual consumption data at regional level.

The paper is structured as follows. In the next section, we outline the empirical model. The data sets are described in Section 3. In Section 4, we describe our empirical strategy and present the estimation

[6] Ramey (2011), building on Ramey and Shapiro (1998), use a 'narrative' approach and find that private consumption reacts mostly negative to military expenditure shocks for US. This contrasts to the positive relationship estimated by Blanchard and Perotti (2002) within a SVAR methodology, for the same country. Other studies estimate the response of private consumption to government spending shocks within general equilibrium models. Smets and Wouters (2003) estimate a negative response of consumption, while Forni, Monteforte and Sessa (2009) estimate a positive one, both using Euro data. A number of studies analyze the relation in preferences between public and private consumption following a partial equilibrium-approach based on Euler equations. Among others, Aschauer (1985) finds a significant degree of substitutability between the two variables of interest, while Amano and Wirjanto (1998) find only a weak complementarity. Both studies refer to the US economy. Using DSGE models, Bouakez and Rebei (2007) and Ercolani and Valle & Azevedo (2012) find similar contrasting results (complementarity in the first study versus substitutability for the second one).

results. In Section 5 we summarise the measurement exercises, performed using a calibrated general equilibrium model. Section 6 concludes.

2 Empirical Model

Consider an economic environment where individuals are subject to preference shocks that will be seen as health shocks. These shocks may affect private consumption, for example a negative health shock may increase the demand for health care goods or/and may decrease the demand for holidays or travels. We assume that preference shocks, V, follow a unit root process in logs and allow government consumption, G, to affect both their mean and their variance. More precisely, we assume $\ln V_{t+1}^i = \ln V_t^i + \eta_t^i$, where for sake of concreteness we assume the distribution of η_{t+1} conditional on period t history of government expenditures as $\eta_{t+1}|G^t \sim \mathcal{N}\left(\mu(G^t), \sigma(G^t)\right)$. As it is, government consumption can affect the dynamics of private consumption through the mean and the variance of preference shocks.

Our empirical model builds on a simple life cycle model with inelastic labor supply. Households have isoelastic preferences for consumption, with intertemporal elasticity of substitution $\frac{1}{\gamma}$, and trade a risk free asset with deterministic return $1 + r$. The per-period utility for agent i is:

$$U(C_t^i, V_t^i) = \frac{\left(C_t^i\right)^{1-\gamma}}{1-\gamma} V_t^i, \tag{1}$$

where C represents agent's non-durable consumption expenditures. The resulting Euler equation is:

$$\mathbf{E}_t^i \left[\frac{V_{t+1}^i}{V_t^i} \left(\frac{C_{t+1}^i}{C_t^i} \right)^{-\gamma} \right] = \frac{1}{(1 + r_t)\beta}, \tag{2}$$

where β is the subjective discount factor and $\mathbf{E}_t^i$ is the agent's i expectation conditional on information at time t. The corresponding approximated (to the second-order) Euler equation, derived in Appendix A, reads as follows:

$$\mathbf{E}_t^i \left[\Delta c_{t+1}^i\right] \simeq \frac{1 - ((1 + r_t)\beta)^{-1}}{\gamma} - \mathbf{E}_t^i[\Delta c_{t+1}^i \eta_{t+1}^i] + \frac{1+\gamma}{2} \mathbf{E}_t^i \left[\Delta c_{t+1}^i\right]^2 + \frac{1-\gamma}{\gamma} \mathbf{E}_t^i[\eta_{t+1}^i], \tag{3}$$

where lower case letters indicate logs of the original variables. A crucial variable is represented by the consumption dispersion. In particular, the conditional mean of the consumption dispersion has been used by the literature (e.g. Bertola et al. 2005) as an indicator for the consumption risk perceived by agents. We then postulate a process for $\mathbf{E}_t^i \left(\Delta c_{t+1}^i\right)^2$ which includes - among standard regressors - also government consumption:

$$\mathbf{E}_t^i \left(\Delta c_{t+1}^i\right)^2 = \Psi(\Delta g_t, \Delta c_t^i, \Delta y_t^i, c_t^i, y_t^i, g_t), \tag{4}$$

where L denotes the lag operator, and $\Psi(\cdot)$ indicates a polynomial (at least of the second order) in the arguments and their interactions. Individual log income is represented by y, whilst g represents the log of government consumption.

Finally, we assume that realizations to government consumption are observed by individuals within the period before taking saving decisions and the process for log government consumption follows an AR(1) process of the form:

$$g_t = (1-\rho)g_{ss} + \rho g_{t-1} + \varepsilon_t^g, \tag{5}$$

with $0 < \rho < 1$, where g_{ss} is the steady state of government consumption in logs, and ε_t^g a white noise error term.

This simple model has the potential to generate what we call 'the precautionary effect of government consumption'. If we assume that government consumption acts as a form of public insurance against consumption expenditure risk generated by health shocks, then rises in government consumption dampen consumption dispersion. This effect is captured by equation (4). Once individuals perceive that the expected consumption risk has lowered, they dissave by increasing current private consumption relative to the future one. This effect on consumption growth is visible in equation (3). Typically, the magnitude of the precautionary effect increases with the persistence of the government consumption process (i.e., ρ in equation 5).[7]

Consumption growth rates vs consumption levels: a back-of-the-envelope calculation. The Euler equation (3) represents a flexible empirical moment where the precautionary effect appears into changes of consumption *growth*. In order to formalize the effect of government consumption on the *level* of private consumption, we can compare Euler equations in multiperiods. For notational simplicity,

[7] Of course, government consumption can have an effect on $\mathbf{E}_t^i \left(\Delta c_{t+1}^i\right)$ through its influence on the conditional mean of the preference shocks, $\mathbf{E}_t^i(\eta_{t+1}^i)$, as well. This could be for example due to a crowding out effect of government consumption. More precisely, our empirical results are consistent to a story along these lines. An agent expecting a poor public health service (e.g., long waiting lists) saves in part to be able to use privately provided health services in case of adverse health shocks. If the quality of the public sector's services improves, when hit by a negative health shock, the agent will be less forced to rely on the expensive services provided by the private sector. This on the one hand reduces total expenses on health related goods (i.e., affecting the mean of η), on the other hand it reduces the desire to save for precautionary motives we just explained (captured by the effect of G on the variance of η).

consider a simplified Euler equation where we omit both $E_t^i(\eta_{t+1}^i)$ and the covariance term $E_t^i(\Delta c_{t+1}^i \eta_{t+1}^i)$. Now, consider two possible states of the world (indexed with H and L) which differ by just the level of government spending at t, $g_t^H > g_t^L$. Since the individual budget constraints are identical in the two states of the world, we can expect that the two consumption levels will equalize at some point in time in expectations. Let $t+m$ be the date after t where:

$$\mathbf{E}_t^H c_{t+m} = \mathbf{E}_t^L c_{t+m}. \tag{6}$$

If we forward m period ahead equation (3), we get an Euler equation for each state of the world, that is:

$$\mathbf{E}_t^H c_{t+m} = c_t^H + \sum_{k=0}^{m-1} \Phi_{t+k} + \frac{1+\gamma}{2}\mathbf{E}_t^H \left[\sum_{k=0}^{m-1} (\Delta c_{t+k}^H)^2\right], \tag{7}$$

and:

$$\mathbf{E}_t^L c_{t+m} = c_t^L + \sum_{k=0}^{m-1} \Phi_{t+k} + \frac{1+\gamma}{2}\mathbf{E}_t^L \left[\sum_{k=0}^{m-1} (\Delta c_{t+k}^L)^2\right], \tag{8}$$

where $\Phi_{t+k} = \frac{1-((1+r_{t+k})\beta)^{-1}}{\gamma}$.

Now, following (6),we equalize the RHS of (7) and (8), and get:

$$c_t^H - c_t^L = \frac{1+\gamma}{2}\left\{\mathbf{E}_t^L \left[\sum_{k=0}^{m-1} (\Delta c_{t+k}^L)^2\right] - \mathbf{E}_t^H \left[\sum_{k=0}^{m-1} (\Delta c_{t+k}^H)^2\right]\right\}, \tag{9}$$

which is the 'precautionary effect of government consumption' on private consumption. It is clearly positive given that the expected sum of consumption dispersions is - by definition - lower in the state of the world where government consumption is higher. Clearly, one expects that the precautionary motive is larger the higher is the degree of persistence of government consumption. This would be associated to a larger value for m.

The aim of the quantitative section is to perform, numerically, essentially the same calculation with much higher precision and allowing for endogenous prices.

3 Data

Household-level data, such as measures for private consumption and income, are taken by the SHIW of Bank of Italy. We take into account four waves of data (1995-'98-'00-'02). For more information regarding the way of treating data, see Appendix B.

Regional data, government consumption in particular, are taken by REA issued by ISTAT. REA follows the general principles of the European System of National Account (Eurostat 1996) so that government consumption is composed by purchases of goods and services, wages and transfers in kind to households. Transfers in kind refer to benefits or reimbursement of expenditures made by households on specified goods and services. They can be directly provided to households by the government itself or the government can pay for goods and services that the sellers provide to households. Transfers in kind can have either a medical or a social protection nature. Examples of government transfers related to health care are expenditures for medicines, or for the use of family doctors, or again for the use of services provided by private hospitals. Examples of transfers in the context of social protection are reimbursements for periods in retirement institutes and asylums. As well, transfers related to provision of low-cost housing, day nurseries, assistance to sick or injured people, and professional training are connected with the social protection area (see Eurostat 1996, par. 3.79).[8]

This dataset also provides a functional classification of the government consumption according to the COFOG scheme published by the United Nations Statistics Division. It divides public consumption in ten categories, such as: general services, defense, public order and safety, economic affairs, environmental protection, housing and community amenities, education, health, recreation and culture and religion, and social protection. In Table 1, we present government consumption as a share of GDP for each region. Following the national accounts' principles, we also disaggregate government consumption in two main categories: the collective goods and services, and the individual goods and services. The first category includes goods that are provided simultaneously to all members of the community. They are public goods, such as, defense, public order, bureaucracy, etc. The second category is represented by goods that are provided to households for which is possible to observe and record its acquisition by an individual household. These goods are referred to as publicly provided private goods or merit goods (e.g., education and health). The share of the government consumption for Italy is around 20% of GDP and it ranges

[8]Importantly, transfers in cash are not included in our government consumption variable (examples of cash transfers are: retirement subsidies and pensions, unemployment benefits, and family allowances).

between the 13.5% of Lombardia and the 30% of Sicily. Individual goods (merit goods) are the lion's share of the government consumption; they are roughly twice as much as collective goods (public goods). As it can be seen, the distribution of government consumption is not uniform across regions.

Table1: government consumption (% of GDP), year 2002

Regions	**government consumption**	**collective goods** (public goods)	**individual goods** (merit goods)
Piemonte	15.9	6.1	9.8
Valle d'Aosta	26.1	14.6	11.5
Lombardia	13.5	5.1	8.4
Trentino-Alto Adige	20.9	8.4	12.5
Veneto	15.4	5.8	9.6
Friuli-Venezia Giulia	18.2	7.2	11.04
Liguria	17.8	6.8	11.0
Emilia Romagna	14.7	5.5	9.2
Toscana	17.4	6.5	10.9
Umbria	21.3	8.1	13.2
Marche	19.0	7.0	12.0
Lazio	18.5	6.1	12.4
Abbruzzo	22.6	8.1	14.5
Molise	25.6	9.6	16.0
Campania	27.7	9.9	17.8
Puglia	25.0	8.7	16.3
Basilicata	28.3	10.7	17.6
Calabria	31.5	11.6	19.9
Sicilia	30.0	12.0	18.0
Sardegna	27.2	10.6	16.6
Italy	**19.0**	**6.0**	**13.0**

Source: author's compilation using REA

The figures of government consumption provided by REA are consolidated at regional level. In particular, for each region, government consumption corresponds to the sum of the expenditures in towns and provinces within the region, together with those of the region itself, and those of central government imputed to the region. To impute the consumption of central government to each region, the REA follows the principle of the "beneficiary of the services". For example, teachers' wages, although paid by the central government, they are assigned according to the distribution of teachers across the different regions. Expenditures related to defense and public order are allocated according to the residential population in each region, irrespective of the place of the disbursement. The bulk of health services are provided at local level, either by the towns within a region or by the region itself, so no imputation is needed, except for the tiny share of expenditures borne directly by the Ministry of Health, which are allocated across regions according with the numbers of hospitalizations (for more details on these methods, see Malizia 1996).

To determine the timing of recording, REA follows the Eurostat (1996)'s principles represented by the accrual basis methods. That is, expenses are recorded as their economic counterpart occurs, regardless of the timing of the respective cash disbursements.

Table 2 represents the share of each category of spending on total government consumption for Italy over the 7 years of our dataset.[9] It has to be noted that health and education represent the largest items among merit goods.

Table 2: percentage of each category on total government consumption (Italy)

	categories	1995	1996	1997	1998	1999	2000	2001	2002	**mean**
public	**General public services**	12.0	12.8	12.3	12.3	12.2	12.2	12.3	12.3	**12.4**
	Defence	6.3	6.0	5.6	5.6	5.9	5.7	5.7	5.7	**5.8**
	Public order and safety	11.1	11.5	11.2	11.2	10.9	10.5	10.0	9.8	**10.8**
	Economic affairs	7.7	7.5	7.4	7.3	7.1	6.7	6.7	6.7	**7.1**
	Environmental protection	0.7	0.6	0.8	1.0	1.3	1.4	1.4	1.4	**1.1**
	Housing and community amenities	1.3	1.2	1.3	1.3	1.4	1.3	1.3	1.3	**1.3**
merit	**Health**	28.8	28.8	29.6	29.7	29.9	31.4	32.2	32.6	**30.4**
	Recreation, culture and religion	2.3	2.3	2.4	2.4	2.3	2.2	2.1	2.2	**2.3**
	Education	25.3	25.6	25.6	25.6	25.2	24.7	24.0	23.8	**25.0**
	Social protection	3.8	3.8	3.7	3.7	3.7	3.9	4.2	4.2	**3.9**

Authors' calculation based on REA

We merge the SHIW and the REA data and create a unique panel dataset which links household's private consumption to the government consumption of the region where the household lives.

At the end of the paper, we present two useful figures. Figure 1 represents the residuals of the regression of the logarithm of government consumption on time dummies, pooled by regions. Figure 2 represent the residuals of the regression of the first difference of the logarithm of government consumption on time dummies, pooled by regions. These figures show that government consumption has an important degree of variability within and across regions, even after controlling for common macro shocks.

[9]Note that the final dataset will contain only 4 years both for individual and regional variables. This is motivated by the the data frequency of the SHIW, which is indeed bi-annual.

3.1 The Italian Health System

As we will see below, government consumption in health pays a key role in our story.

As documented by Jappelli et al. (2007), Italy has a classical social insurance scheme. Risks are pooled in a national fund (the National Health System, or NHS) and health contributions are income-related through a system of regressive payroll tax rates. Since 1978 membership in the NHS has been compulsory for all Italian residents. Importantly, although the government collects health contributions, responsibility for health care is delegated to regional governments, as the 1992 reform introduced principles of decentralization and managerial criteria in the administration of public hospitals.

The Italian health system is universal, and in principle covers all health risks for any amount. In practice, individuals contribute small fees for drugs and medical services, with the exclusion of children under 12 years of age, persons older than 65 and households with income below a given threshold who are fully covered.

Health care is provided by the public sector through public and private hospitals and diagnostic centers. According to ISTAT, in 1998 there were 1489 hospitals in Italy, and more than half (846) were public. Moreover, the vast majority of private hospitals (535) were accredited; they provide services to the national health system and are then reimbursed. Thus truly private hospitals accounted for only 7.2 percent of the total. Moreover, as described in Section 3, public health care manifests itself through the supply of transfers in kind to households. As a result of the wide coverage offered by the public system, private health insurance is not common. For instance, according to SHIW, only 5.9 percent of the respondents older than 50 years and 1.8 percent of those older than 70 were covered by private health insurance in 2000. And even among those who were covered, fewer than 8 percent reported being fully covered for medical expenditures in the previous year. So the overwhelming majority of Italians rely on health care provided directly or indirectly by the national health system.

4 Estimation

This section has three main targets. First, we aim at quantifying the effect of household's consumption dispersion on consumption expenditure growth by estimating the Euler equation (3). Second, we use the empirical counterpart of equation (4) to estimate the impact of various categories of government consumption on household's consumption dispersion. Finally, we estimate the process for government consumption (5), with particular focus to the level of persistence of the health care expenditures.

Since observations in our dataset are yearly quantities recorded at bi-annual frequency, the notation we use in this section allows for the difference operator to embed a time span different from the standard one. In particular, for the annual variable x_t, we denote $\Delta x_{t+1} := x_{t+1} - x_{t-1}$.

Before performing our IV estimations based on the Euler equation (3), we run the simpler OLS regression below where we omitted the consumption dispersion term $\mathbf{E}_{t-1}^{i}\left(\Delta c_{t+1}^{i}\right)^2$:

$$\begin{aligned} \Delta c_{t+1}^{i,r} \simeq\ & Z_t^{i,r} + \phi_0^r + d_t + \theta_0 + \theta_1(\Delta c_{t-1}^{i,r}\Delta g_{t-1}^r) + \theta_2 health_{t-1}^r + \theta_3 health_{t-3}^r + \\ & \theta_4 publ_{t-1}^r + \theta_5 publ_{t-3}^r + \theta_7 edu_{t-1}^r + \theta_7 edu_{t-3}^r + \theta_8 cult_{t-1}^r + \theta_9 cult_{t-3}^r + \epsilon_{t+1}^{i,r}. \end{aligned} \tag{10}$$

In the previous expression, $c_t^{i,r}$ represents the level of the log of non-durable consumption for household i who lives in region r, while $Z_t^{i,r}$ represents a vector of household demographics such as age and the level of education of the household's head. As a proxy for $\mathbf{E}_{t-1}\left[\Delta c_{t+1}^{i,r}\Delta\eta_{t+1}^{i}\right]$ we use the variable $\Delta c_{t-1}^{i,r}\Delta g_{t-1}^r$. We capture the dependence of the conditional distribution (on period t information set) of the preference shocks η_{t+1} to government expenditures by including as regressors four government consumption's items, which are public goods (publ), education (edu), recreation and culture and religion (cult), and health and social protection (health).[10] We also include time dummies d_t that are supposed to capture common shocks and time effects (such as movements to the interest rate). Finally, the term ϕ_0^r represents regional dummies. These aim at controlling for regional specific characteristics of government consumption, such that the quality in providing public services or the "political" power of attracting more resources from the central government. The variable $\epsilon_{t+1}^{i,r}$ is the error term.[11] Estimation results for this specification are in column 1 of Table 3. We see that the coefficients for the government consumption items, but health care, are not significantly different from zero. We also perform an F-test with the null hypothesis that the sum of the health care's coefficients is equal to zero (*F test for health*), and the hypothesis is not rejected.[12] The last result leads us to adopt a more parsimonious specification which will be characterized by the items of government consumption in differences.

[10]We merge the category of health with one of social protection because in the latter there are health related expenditures as, for example, sickness and disability transfers (in kind).

[11]Regressing individual variables on regional ones could lead to residuals that are not independent within regions. We follow the common practice in the literature by clustering standard errors by region, i.e. allowing correlation of the observations within each region.

[12]We performed a regression with government consumption items in differences. As expected, just the coefficient associated to health care was highly significantly different form zero, being -0.71.

In column 2 of Table 3 we display the estimation results of the empirical model based on the appropriate Euler equation which includes consumption variability, that is:

$$\begin{aligned} \Delta c_{t+1}^{i,r} &\simeq Z_t^{i,r} + \phi_0^r + d_t + \psi_0 + \psi_1 \mathbf{E}_{t-1}^i (\Delta c_{t+1}^{i,r})^2 + \psi_2 (\Delta c_{t-1}^{i,r} \Delta g_{t-1}^r) + \psi_3 \Delta health_{t-1}^r + \\ &\quad \psi_4^r \Delta pub_{t-1} + \psi_5 \Delta edu_{t-1}^r + \psi_6 \Delta cult_{t-1}^r + \varepsilon_{t+1,}^{i,r} \end{aligned} \tag{11}$$

where the error term ε_{t+1}^i satisfies $\mathbf{E}_{t-1}^i[\varepsilon_{t+1}^{i,r}] = 0$. Following Bertola et al. (2005), we note that the conditional consumption dispersion $\mathbf{E}_{t-1}^i(\Delta c_{t+1}^{i,r})^2$ is not directly observable as we just observe the realization $(\Delta c_{t+1}^{i,r})^2$. We define the expectational error $\varkappa_{t+1}^{i,r} = (\Delta c_{t+1}^{i,r})^2 - \mathbf{E}_{t-1}^i(\Delta c_{t+1}^{i,r})^2$, so that (11) can be written as:

$$\begin{aligned} \Delta c_{t+1}^{i,r} &\simeq Z_t^{i,r} + \phi_0^r + d_t + \hat{\psi}_0 + \hat{\psi}_1 (\Delta c_{t+1}^{i,r})^2 + \hat{\psi}_2 (\Delta c_{t-1}^{i,r} \Delta g_{t-1}^r) + \hat{\psi}_3 \Delta health_{t-1}^r + \\ &\quad \hat{\psi}_4 \Delta pub_{t-1} + \hat{\psi}_5 \Delta edu_{t-1}^r + \hat{\psi}_6 \Delta cult_{t-1}^r + \zeta_{t+1}^{i,r}, \end{aligned} \tag{12}$$

where $\zeta_{t+1}^{i,r} = \varepsilon_{t+1}^{i,r} - \phi_1 \varkappa_{t+1}^{i,r}$. Given the nature of the error term, we exploit lagged information to instrument for the consumption risk. More precisely, we estimate (12) through 2SLS technique. In the first stage, we regress $\left(\Delta c_{t+1}^i\right)^2$ on a set of variables commonly used in the literature such as $\Delta c_{t-1}^{i,r}$, $c_{t-1}^{i,r}$, $\Delta y_{t-1}^{i,r}$ and $y_{t-1}^{i,r}$. Next, we include the items of government expenditures to check if they have some power in explaining $\left(\Delta c_{t+1}^i\right)^2$, and some regional controls as well.[13] Column 2 shows that when we include $(\Delta c_{t+1}^{i,r})^2$, the coefficient associated to the health care variable (as all other government expenditure variables) is not significantly different form zero anymore.[14] However, the p-value for the overidentification test (see *overid*) does not certifies that the selected instruments allow the moments conditions not to be rejected.[15] To obtain a specification where the moment conditions are not rejected, we estimate an Euler equation without regional dummies or government consumption's items.[16] Column 3 presents the results for this specification; the p-value for the overidentification test is above 0.1 and no first-order autocorrelation is detected in the residuals (see *Ar(1) resid*). The coefficient associated to consumption

[13] The regional controls are: GDP, public wages, and a government expenditure variable (which embeds investments and money transfers) whose inclusion is motivated below.

[14] This remains the case even when we treat government consumption's items in levels, as in Column 1.

[15] Since we allow residuals' correlation within groups (regions in our case), the overidentification test uses the Hansen's J statistic.

[16] Note that the joint effect of government consumption's items on $\Delta c_{t+1}^{i,r}$ is not significantly different from zero (see *F test for G's* in the Table)

dispersion is estimated to be $\hat{\psi}_1 \approx 2.5$, with an associated p-value which is lower than 1%.[17] This value is in line with the most recent findings for Italy. Jappelli and Pistaferri (2000) estimate a coefficient associated to consumption risk of approximately 5, while Bertola et al. (2005) find a lower value, i.e. approximately 1.6. Both mentioned works use the same dataset as ours but different time spans and different identification methodologies (essentially, hey use different sets of instruments).[18] With isoelastic preferences these results imply a value for the coefficient of relative risk aversion varying between 1 and 6. Furthermore, the only demographic which is significantly different from zero is the level of the education of the household head, which enters with a positive sign as expected.

Columns 4 and 5 of Table 3 present some robustness results for the second stage. Note first of all - in column 4 - that private consumption is not sensitive to predictable changes in individual income. Passing this test is somewhat important as it can be seen as validation of our estimation strategy based on the Euler equation.[19] Moreover - in column 5 - we augment the Euler equation with $\Delta c_{t-1}^{i,r}$ to controls for various form of persistencies such as non-unit root health shocks. Including $\Delta c_{t-1}^{i,r}$ does not change significantly the previous results, and the associated coefficient is barely significantly different from zero.

The results of the first stage associated to the benchmark Euler Equation (column 3 of Table 3) are presented in column 1 of Table 4. Health care is the only variable significantly - and negatively - correlated with the consumption risk. As well, the coefficient of the square of the mentioned regressor, i.e. $[\Delta health(-1)]^2$ is significantly different from zero in the regression. This may suggest two things. First, that the effects of health care expenditures on $(\Delta c_{t+1}^{i,r})^2$ are non-linear. Second, that government consumption volatility mitigates the insurance effects (or, equivalently, tends to increase private consumption risk). In the quantitative section, we adopt the first interpretation as the only one consistent with our modeling assumptions.

In order to obtain a more accurate estimate for the consumption dispersion process, equation (4), we augment the first stage regression with those variables which we consider being important to fully explain

[17] Note that this value is close to the one obtained in column 2.

[18] In both works the main instrument is the conditional subjective variance of the income growth which is built exploiting information on individual expected earnings and it is present in the SHIW dataset up to 1995.

[19] It is well known that this test tend to be rejected when aggregate data is used instead (e.g., Attanasio and Weber 1993).

Table 3: Euler Equation

	(1)	(2)	(3)	(4)	(5)
	OLS	IV	IV	IV	IV
	Δc	Δc	Δc	Δc	Δc
[Δc]^2		**2.66****	**2.43****	**2.63****	**2.59****
		[0.000]	**[0.000]**	**[0.000]**	**[0.000]**
Δc(-1)Δg(-1)	-4.70**	-1.13+	-1.25*	-1.07+	2.15
	[0.000]	[0.069]	[0.017]	[0.092]	[0.272]
publ(-1)	0.3				
	[0.789]				
publ(-2)	0.7				
	[0.269]				
edu(-1)	-0.08				
	[0.893]				
edu(-2)	-0.60+				
	[0.099]				
cult(-1)	0.28				
	[0.369]				
cult(-2)	0.17				
	[0.348]				
health(-1)	-0.91*				
	[0.034]				
health(-2)	1.12**				
	[0.006]				
Δpubl(-1)		0.63			
		[0.342]			
Δedu(-1)		0.17			
		[0.742]			
Δcult(-1)		0.04			
		[0.785]			
Δhealth(-1)		-0.14			
		[0.724]			
y(-1)				-0.02	-0.01
				[0.566]	[0.756]
y(-2)				0.01	0.00
				[0.666]	[0.987]
Δc(-1)					-0.24+
					[0.078]
constant	-2.22	-0.35**	-0.30**	-0.31**	-0.28**
	[0.524]	[0.005]	[0.001]	[0.033]	[0.049]
Observations	2600	2600	2600	2600	2600
overid. (p-value)		0.00	0.19	0.01	0.01
Ar(1) resid. (p-value)	0.02	0.34	0.27	0.32	0.41
F test for health (p-value)	0.67				
F test for G's (p-value)		0.84			
F test for y (p-value)				0.84	

Data are in logs. *p values* in brackets (+ significant at 10%; * significant at 5%; ** significant at 1%). Associated standard errors are clustered by region. Time dummies are added. Regional dummies are added to columns 1, 2, 4 and 5 .

$E_t^i(\Delta c_{t+1}^{i,r})^2$. Thus, we take to the data the following specification:[20]

$$\begin{aligned}(\Delta c_{t+1}^{i,r})^2 &= Z_t^{i,r} + \phi_0^r + d_t + \psi_0 + \psi_1 c_{t-1}^{i,r} + \psi_2 \Delta c_{t-1}^{i,r} + \psi_3 (\Delta c_{t-1}^{i,r})^2 + \psi_4 y_{t-1}^{i,r} + \\ &\quad \psi_5 \Delta y_{t-1}^{i,r} + \psi_6 (\Delta y_{t-1}^{i,r})^2 + \psi_7 \Delta health_{t-1}^r + \psi_8 \left(\Delta health_{t-1}^r\right)^2 + \psi_9 \Delta publ_{t-1}^r + \\ &\quad \psi_{10} \Delta edu_{t-1}^r + \psi_{11} \Delta cult_{t-1}^r + \psi_{12} \left(\Delta g\_noh_{t-1}^r\right)^2 + COV_{t-1}^{i,r} + Z_{t-1}^r + \varkappa_{t+1}^{i,r},\end{aligned} \tag{13}$$

where the term $(\Delta c_{t-1}^{i,r})^2$ allows for some degree of persistence in the consumption dispersion. The vector $COV_{t-1}^{i,r}$ includes all interaction terms between individual variables (such as $c_t^{i,r}$ and $y_t^{i,r}$) and regional government consumption items, so controlling for potential interactions effects on consumption risk. As well, we include regional dummies ψ_0^r and a vector of control regional variables Z^r, which include GDP, public wages and a government expenditure variable (which embeds investments and money transfers).[21] The first item controls for the regional economic business cycle. The second one controls for the potential income effect created by wages. Indeed, public wages have a double nature in our analysis; on the one hand, they concur to the production of those services that government offers to households, on the other hand they represent money that directly enter the public sector's employees.[22] Finally, the third variable controls for any other effect of government spending on the consumption dispersion, which is not generated by government consumption itself. The variable $\varkappa_{t+1}^{i,r}$ is the expectational error we defined above. In order to reduce the number of regressors, we aggregate the items of government consumption other than health care under the variable labelled as $\left(\Delta g\_noh_{t-1}^r\right)^2$. Column 2 of Table 4 displays the estimation results related to equation (13), and suggests that the qualitative results of the first stage regression (i.e. column 1) are robust to the inclusion of a larger set of regressors.[23]

Columns 3, 4, and 5 present a set of robustness. In column 3 we estimate equation (13) on a sample of people working outside the public sector, i.e. the ones who don't receive incomes from the government.

[20]We tried several specifictions; for example, we included government spending items to the third power but their coefficients were never significantly different from zero.

[21]Unfortunately, the variable for public wages is not provided at regional level. We decide to use a proxy for it, i.e. the public sector's value added at regional level. Moreover, REA does not provide items related to public investement and money transfers, which are taken from another source (see Appendix B for details)

[22]Note that the potential income effect created by public wages can be also also controlled by the measures of individual disposable income in the consumption dispersion process.

[23]Note that if we keep the social protection category separated by the one of health care, the quantitative results remains almost the same. Indeed, the coefficients for the linear part of health and social protection are -1.46 and -0.13 (with associated p-values below the 3%), respectively. Furthermore, to study the issues associated to the government wage component, we run the same regression omitting regional public wages, and the point estimates are very close to the ones of Column 2. We also added $(\Delta c_{t-1}^{i,r})^4$ to Column's 2 regressors and the results virtually do not change. The results are available upon request.

Table 4: Consumption Dispersion Process

	(1)	(2)	(3)	(4)	(5)
	First Stage	Full Process	Full Process: Non PA Employees	Regional Averages	Cross Section *(a)*
	OLS	OLS	OLS	OLS	OLS
	[Δc]^2	[Δc]^2	[Δc]^2	[Δc]^2	[Δc]^2
[Δc(-1)]^2		0.11**	0.13**	-0.08	
		[0.000]	[0.000]	[0.681]	
Δpubl(-1)	0.19	-1.19+	-1.08	0.68	0.20
	[0.780]	[0.086]	[0.192]	[0.195]	[0.962]
Δedu(-1)	0.14	-0.68	-0.6	0.28	0.18
	[0.650]	[0.128]	[0.234]	[0.358]	[0.564]
Δcult(-1)	-0.03	-0.03	-0.04+	-0.03	-0.16*
	[0.363]	[0.148]	[0.097]	[0.543]	[0.021]
Δhealth(-1)	**-1.11****	**-1.41****	**-1.52****	**-1.28****	**-1.86****
	[0.000]	**[0.000]**	**[0.001]**	**[0.004]**	**[0.006]**
c(-1)	-0.17**	-0.15**	-0.16**	0.01	-0.16**
	[0.000]	[0.000]	[0.000]	[0.895]	[0.000]
Δc(-1)	-0.04	-0.01	-0.01	-0.01	0.02
	[0.378]	[0.913]	[0.798]	[0.841]	[0.878]
y(-1)	0.07**	0.06**	0.05**	-0.08	0.07**
	[0.000]	[0.000]	[0.000]	[0.318]	[0.001]
Δy(-1)	-0.03*	-0.06+	-0.06	-0.01	-0.04*
	[0.011]	[0.091]	[0.138]	[0.888]	[0.029]
[Δy(-1)]^2	0.02*	0.02*	0.02*	0.05	0.04*
	[0.013]	[0.018]	[0.034]	[0.458]	[0.032]
[Δhealth(-1)]^2	**5.28****	**7.73****	**8.64****	**6.52****	**9.49****
	[0.005]	**[0.001]**	**[0.001]**	**[0.008]**	**[0.003]**
[ΔNOhealth(-1)]^2	-9.28	10.42	7.99	-13.95+	-10.52
	[0.306]	[0.210]	[0.458]	[0.089]	[0.233]
Constant	0.56**	0.58**	0.60**	1.41	0.50**
	[0.000]	[0.000]	[0.000]	[0.217]	[0.000]
Observations	2600	2600	2040	38	3951
Ar(1) resid. (p-value)	0.49	0.61	0.57	0.40	

Data are in logs. *p values* in brackets (+ significant at 10%; * significant at 5%; ** significant at 1%). Associated standard errors are clustered by region in columns 1, 2,3 and 5, and are robust in column 4. Time dummies are added in columns 1, 2,3 and 4. Regional controls are added in columns 1,2,3, and 5. Regional dummies are added in columns 2 and 3.

(a) Being column's 4 regression a static one, the variables' temporal indeces don't apply here.

The quantitative results are almost identical to the ones of column 2.[24]

Column 4 presents the results obtained by estimating the process using regional averages of individual data. Specifically, we let the sample analog of $\mathbf{E}_t^i(\Delta c_{t+1}^{i,r})^2$ for region r, at given time t, be:

$$\overline{\left(\Delta c_{t+1}^{r}\right)^2} = \frac{\sum_{i=1}^{I^r}\left(\Delta c_{t+1}^{i,r}\right)^2}{I^r}, \tag{14}$$

where I^r is the number of households in region r. Working with regional averages has the key advantage of mitigating the measurement error problem. At the same time, the identification strategy may even improve as both individual and regional variables share the same cross-sectional variability.[25] As it is visible from column 4, the results with regional averages tend to confirm the ones obtained in column 2. Column 5 presents the results obtained by estimating the process of consumption using only cross sectional variability. More precisely, we let the sample analog of $\mathbf{E}_t^i(\Delta c_{t+1}^{i,r})^2$ for individual i, in region r, be:

$$\overline{\left(\Delta c^{i,r}\right)^2} = \frac{\sum_{j=0}^{J-1}\left(\Delta c_{t+j}^{i,r}\right)^2}{J}, \tag{15}$$

where $J = 3$ is the number of waves of our dataset, considering differences. Clearly, regional level variables needs to be transformed accordingly. Again, the results using cross-sectional variations tend to confirm the ones obtained in column 2.

Finally, Table 5 presents the results for the process of government consumption as in equation (5). For obvious reasons, we focus on health care consumption expenditures. In all the three columns, the process for health care shows a pretty high degree of persistence over time since the coefficient associated to the lagged dependent variable is around 0.9. In columns 2 and 3 we augment the estimation of process (5) by including $\overline{c_{t+1}^r}$, i.e. the regional averages of non-durable private consumption. Column 2 presents an OLS regression, whilst column 3 a 2SLS regression where $\overline{c_{t+1}^r}$ is instrumented with lagged levels and differences of both $\overline{c^r}$ and gdp^r. In both cases, $\overline{c_{t+1}^r}$ has not a direct effect on g_{t+1}^r. We include $\overline{c_{t+1}^r}$ to control for potential feedback effects of private consumption on government consumption.

[24]Since we don't include individuals perceiving labor income from the public sector, we also run the regression without controlling for public wages and - as expected - the quantitative results are virtually the same.

[25]Of course, aggregation problems are absent since we transform individual variables before aggregating them at regional level. Note also that, because of the few number of observations, we had to eliminate some control variables from the original regression, which are: ψ_0^r, Z_{t-1}^r, and $COV_{t-1}^{i,r}$, but $\Delta c_{t-1}^{i,r}\Delta health_{t-1}^r$. Including or not the latter does not change the results.

Table 5: Government Consumption (Health) process

	(1)	(2)	(3)
	OLS	OLS	IV
	health	health	health
health(-1)	**0.89****	**0.88****	**0.95****
	[0.000]	**[0.000]**	**[0.000]**
c (regional mean)		-0.01	-0.01
		[0.576]	[0.746]
const	0.47+	0.59+	0.3
	[0.070]	[0.084]	[0.489]
Obs	60	59	39
overid. (p-value)			0.21
Ar(1) resid. (p-value)	0.71	0.30	0.33

Data are in logs. p values in brackets (+ significant at 10%; * significant at 5%; ** significant at 1%).
Standard errors are robust. Time dummies are added.

4.1 Interpretation of the Empirical Results

The previous section presents few key empirical results. First, the (second order approximation of the) Euler equation is valid within our dataset and - conditional on consumption dispersion - we do not detect any direct effect of government consumption on private consumption growth. Second, household's consumption growth rates are positively affected by the expected consumption volatility. Third, using regional and time variability of government consumption, we estimate a negative impact of public health care on household consumption variance. Finally, government consumption, in particular health care, shows a high degree of persistence over time.

Within our empirical model, these results are interpreted in the light of a precautionary saving motive, with public health care expenditures acting as a form of consumption insurance for households. A persistent rise in health and social protection expenditures dampens the (expected) volatility of private consumption, stimulating private consumption itself. This happens since individuals know that - whenever they are hit by negative health shocks - a larger part of treatments and services (or treatments and services of higher quality) will be provided by the government.

4.2 The Macroeconomic Effect of Precautionary Saving

As briefly explained above, our results tend to predict an increase in the *level* of private consumption as a consequence of the insurance effect of government consumption in health services. In order to measure such a consumption increase, we need to simulate the path of private consumption in response to an increase of government consumption. To perform such computations, we resort to an otherwise standard RBC with heterogeneous agents, using as input our estimates from micro data. In this model, the household sector is the one described in Section 2, where agents are hit by health shocks and are allowed to self insure by modifying their private savings.

Adopting a general equilibrium framework, allows us to account for other general equilibrium effects, such as the negative wealth effects produced by the need of financing the increased government consumption and the effects on prices. As well, from counterfactual exercises, we are able to disentangle the increase in private consumption due to the precautionary effect alone, at equilibrium prices.

Below, we describe the mentioned RBC model, the steady state calibration and the simulation results. Finally, we discuss the comparison of our measurements with ones in other studies.

4.3 General Equilibrium Model

We consider an incomplete insurance market framework similar to Aiyagari (1994), with a (measure one) continuum of ex-ante identical and infinitely lived agents. In every period, each agent supplies inelastically 1 unit of labor, and faces idiosyncratic shocks on labor productivity. Household i, with labor productivity shock s_t^i, receives labor income $W_t s_t^i$, where W_t is the real wage set by the firm sector. We assume that s follows a finite state Markov process with support $\mathcal{S}$ and transition probability matrix $\Pi(s, s') = \Pr(s_{t+1}^i = s' | s_t^i = s)$. Agents are also subject to an (idiosyncratic) preference shock, V. We assume for these shocks a finite state Markov process, as well, with support V and transition probability matrix $\Omega(V, V') = \Pr(V_{t+1}^i = V' | V_t^i = V)$. As explained in Section 2, we interpret V as health shocks, whose variance is allowed to depend on changes in health government consumption; Section 5.4 provides a formal link for this relationship.[26]

Agent i's maximization problem can be represented as follows (adopting the same notation as in Section 2):

[26] Clearly, we don't allow government consumption to affect the mean of the preference shocks because of the results of our regressions.

$$\max_{\{C_t^i, A_t^i\}_{t=0}^{\infty}} \mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_t^i\right)^{1-\gamma}}{1-\gamma} V_t^i \right] \tag{16}$$

s.t.

$$C_t^i + \frac{A_t^i}{(1+r_t)} = A_{t-1}^i + (1-\tau_t) W_t s_t^i, \tag{17}$$

where $r_t = r_t^K - \delta$ with r_t^K being the marginal productivity of capital and δ is the capital depreciation rate. The variable τ is the tax rate paid by household on labor income.

Markets are competitive and firms have a standard Cobb-Douglas production function with constant returns to scale. The aggregate production function is:

$$Y_t = K_t^{\alpha} (N)^{1-\alpha}, \tag{18}$$

where K_t is the aggregate capital stock and $N = \mathbf{E}^{\Pi}[s]$ the aggregate level of labor input in efficiency units.[27] Firms maximize profits by choosing labor and capital inputs taking factor prices as given, that is:

$$W_t = (1-\alpha) \left(\frac{K_t}{N} \right)^{\alpha} \tag{19}$$

$$r_t^K = \alpha \left(\frac{N}{K_t} \right)^{1-\alpha}. \tag{20}$$

For simplicity, we assume that the government balances its budget every period:

$$G_t = \tau_t W_t N, \tag{21}$$

where G contains also expenditures in health.

We now write the recursive formulation of the maximization problem stated above. We simplify notation by indicating next-period variables by by 'primes' and by eliminating individual's indices. For example, we denote $A_{t-1}^i = A$ and $A_t^i = A'$. We define $A_{\min}$ and $A_{\max}$ as the lower and upper bound values for assets, respectively, and $\mathcal{A} \equiv [A_{\min}, A_{\max}]$. Let define the individual state vector of a particular agent be as $x = (A, s, V)$. Then, we define $X = \mathcal{A} \times \mathcal{S} \times \mathcal{V}$ and let the associated $\mathcal{X}$ be the Borel σ-algebra.

[27] Clearly, the (unconditional) expectation defining N is taken with respect to the stationary distribution associated to the transition matrix Π (assumed to be unique).

For any set $B \in \mathcal{X}$, $\lambda(B)$ is the mass of agents whose individual state vector vectors lie in B. Clearly, the agent's decision problem depends not only on current idiosyncratic states and asset holdings but also on present and future aggregate variables such as wages and interest rates, which are affected by the current and future measures over $\mathcal{X}$. To compute such measures, agents need to know the entire current period measure λ and the associated law of motion - indicated by H - so that $\lambda' = H(\lambda)$. We can now define the problem of an agent having an individual state vector x, as follows:

$$v(A, s, V, \lambda) = \max_{C, A'} \; u(C, V) + \beta \mathbf{E} \left[v(A', s', V', \lambda') | s, V \right] \tag{22}$$

s.t.

$$C = A - \frac{A'}{(1 + r(\lambda))} + (1 - \tau(\lambda))W(\lambda)s \tag{23}$$

$$\lambda' = H(\lambda), \tag{24}$$

where $\tau(\lambda)$, $W(\lambda)$, and $r(\lambda)$ are the tax rate and price functions, respectively.

4.4 Equilibrium

The policy functions associated to problem (22) are $A' = h(x, \lambda)$ and $C = h_c(x, \lambda)$. The kernel function $Q(x, B; \lambda, h)$ defines the probability that an agent in state $x = (A, s, V)$ will have a state vector lying in B in the next period, given the current distribution λ and decision rule h for assets. Recalling that s and V are independent from each others, we can denote by B_s and B_V the sets of values s' and V' included in the last two entries of the set B. We can hence define each set B by the Cartesian product of three sets (or projections) as follows $B = B_A \times B_s \times B_V$, where B_A represents the set of (next period) asset levels in B. We have:

$$Q(x, B; \lambda, h) := \begin{cases} \Sigma_{V' \in B_V} \Sigma_{s' \in B_s} \Pi(s, s') \Omega(V, V') \text{ if } h(x, \lambda) \in B_A \\ 0 \qquad \text{otherwise.} \end{cases} .$$

The aggregate law of motion implied by Q assigns a measure to each Borel set B, and for each given

h is defined as:

$$\lambda'(B) = T_h(\lambda, Q)(B) = \int_X Q(x, B; \lambda, h)\ \lambda\,(dx)\,. \tag{25}$$

Definition 1. Given a government consumption level G, and an initial distribution λ_0, a *recursive competitive equilibrium* outcome consists of a tax function, $\tau(\lambda)$, a value function $v(A, s, V, \lambda)$, associated policy functions $h(x, \lambda)$ and $h_c(x, \lambda)$, a vector of price functions $(W(\lambda), r^K(\lambda), r(\lambda))$, and an aggregate law $H(\lambda)$, such that:

- Given prices, initial distribution λ_0 and aggregate law H, the policy functions solve the optimization problem defining $v(A, s, V, \lambda)$ for all equilibrium values of λ and A, and all $(s, V) \in \mathcal{S} \times \mathcal{V}$.
- Factor price functions are determined according to (19), (20) and $r(\lambda) = r^K(\lambda) - \delta$.
- Government budget balances: $G = \tau(\lambda)\, W(\lambda)\, N$ for all distributions in the equilibrium path.
- Markets clear, that is:

$$K' = \int_X h(x, \lambda) d\lambda; \tag{26}$$

$$N = \int_X s d\lambda. \tag{27}$$

- The conjectured law of motion on aggregate distributions is consistent with individual behavior, i.e., $H(\lambda) = T_h(\lambda, Q)$ along the equilibrium path.

Definition 2. A *stationary equilibrium* outcome is an equilibrium outcome where the probability measure λ is stationary, i.e. $\lambda(B) = T_h(\lambda, Q)(B)$ for all $B \in \mathcal{X}$.

4.5 Steady State Calibration

The model is calibrated at a yearly frequency on the Italian economy. To calibrate these parameters, we exploit information from our dataset and resort to previous studies available in the literature. The share of capital α is set to 0.35, which implies the labour share equal to 0.65 (see Censolo and Onofri, 1993 and Maffezzoli, 2006). The steady state ratio $\frac{Y}{K}$ is set to 0.52 (see D'Adda and Scorcu, 2001). The mean of the yearly real interest rate - during the year of our analysis - is 5.48% (see World Bank's website). Using the last number together with the target for $\frac{Y}{K}$ and the value for α within equation (20) implies a depreciation rate $\delta = 0.1272$. The coefficient of relative risk aversion, γ, is set to 4 in accordance to our results of Table 3. The discount factor β is calibrated to match the steady state ratio $\frac{Y}{K}$.

We use a finite approximation method for the process of the productivity shocks. Following the literature the process is approximated by a 7-state Markov chain using Tauchen (1986) method. The process reads:

$$\ln(s') = \rho_s \ln(s) + \epsilon'_s, \tag{28}$$

where ϵ'_s is a normal iid with zero mean and variance $\sigma^2_{\epsilon_s}$. To recover the persistence ρ_s, we estimate an AR(1) process using the log of idiosyncratic labor income.[28] The parameter ρ_s is estimated to be 0.71.[29] The variance $\sigma^2_{\epsilon_s}$ is calibrated to match the variance of yearly income $var(\ln(s)) = 0.34$ obtained in the data. This number is actually the mean of the yearly cross sectional variance of the log of idiosyncratic labor income along the years of our dataset.

We use the same method for approximating the process of the preference (health) shocks. The process is again approximated by a 7-state Markov chain using Tauchen (1986) method. The process is:[30]

$$\ln(V') = \rho_v \ln(V) + \epsilon'_v, \tag{29}$$

where ϵ'_v is a normal iid with zero mean and variance $\sigma^2_{\epsilon_v}$. Unfortunately, we do not have any individual measure over time (such as a panel of individual medical expenses) that would allow us to calibrate the persistence parameter of health shocks ρ_v. We hence perform the measurement exercise for three different values of ρ_v: 0 (iid shocks), 0.5, and 0.9.[31] For each exercise, the parameter β and the variance $\sigma^2_{\epsilon_v}$ are re-calibrated to match the income-to-wealth ratio and consumption dispersion in the data. The value $var(\ln(c)) = 0.2$ represents the mean of the yearly cross sectional variance of the log of non-durable

[28] We follow Kruger and Perri (2005) to build the variable of interest. We use our dataset to create earnings, dividing labor income by hours worked. Then, we regress earnings on a set of age, sex and educational dummies. We interpret the residuals of this regression as idiosincratic labor income.

[29] Our model is at yearly frequency. Since our data consists on yearly flows recorded bi-annually, we actually estimate $s_t = \rho_s^2 s_{t-2} + \rho_s \epsilon_{t-1} + \epsilon_t$. We estimate a value for ρ_s^2 of 0.502; we hence set $\rho_s = 0.71$.

[30] For tractability purposes, we model preference shocks with a stationary autoregressive process.

[31] The value of 0.9 is roughly the persistence parameter of 0.92 for individual medical expenses estimated in De Nardi et al. (2010) for the US.

consumption along the years of our dataset.

Finally, government consumption is constant at the steady state. In particular, labour income tax τ is set to 0.273 in order to balance government's budget for the ratio $\frac{G}{Y} \simeq 0.178$, which is the ratio between government consumption and GPD for Italy during the years of analysis (e.g., see Table 1). In accordance with italian data, the ratio of government health expenditures to GDP is set to $\frac{HEALTH}{Y} \simeq 0.054$ which implies $\frac{HEALTH}{G} \simeq 0.3$.

Table 6 summarizes the values for the calibration exercise. We calculate the stationary distributions conditional on the described parametrization. See Appendix C for computational details.

Table 6: Steady State Calibration

parameter	value	moment	source
α	0.35	N/Y	Maffezzoli (2006)
β	0.62*	Y/K	D'Adda and Scorcu (2001)
δ	0.1272	r_{ss} and Y/K in eq. (20)	authors' calculation
γ	4	-	Table 3, column 3
ρ_s	0.71	-	SHIW
$\sigma^2_{\epsilon_s}$	0.1686	$var(\ln(s))$	SHIW
$\sigma^2_{\epsilon_v}$	0.874*	$var(\ln(c))$	SHIW
τ	0.273	G/Y in eq. (21)	REA
$\frac{HEALTH}{Y}$	0.054	$\frac{HEALTH}{G}$	REA

*Values are based on $\rho_v = 0.9$. The values based on $\rho_v = 0$ and on $\rho_v = 0.5$ are available upon request.

4.6 The Effect of a Government Consumption Shift

In this section, we measure the consumption multipliers generated by changes in government consumption within the above described economy.[32] The core of our calibration exercise relies on the fact that changes over time of government health expenditures affect the variance of preference shocks. Such variance equals $\sigma^2_{\epsilon_{v,t}}/(1-\rho_v^2)$. Taking into account the empirical specification adopted for the consumption dispersion

[32]The definition of the equilibrium outcome during the transition period is the natural extension of our equilibrium concept in Definition 1. For a more detailed description of the transition exercise, refer to the last section in Appendix C.

process, we allow the term $\sigma^2_{\epsilon_v,t}$ to respond to changes in government health spending as follows:

$$\sigma^2_{\epsilon_v,t} = \sigma^2_{ss} + \phi_\sigma \Delta health_t, \tag{30}$$

where σ^2_{ss} is the steady error term variance as calibrated in Section 5.3, i.e. $\sigma^2_{\epsilon_v}$, and ϕ_σ is the parameter which will be calibrated to reproduce the results of our empirical estimates.[33] Also, we recall that our estimates are based on annual data recorded every two years. That said, in all simulation exercises, we assume that we are in steady state at time $t = 0$ and before. Then, an unexpected increase in government health expenditures manifests itself at $t = 2$ such that $\frac{HEALTH_2 - HEALTH_0}{HEALTH_0} \simeq health_2 - health_0 > 0$.[34] Thus - according to the results in column 2 of Table 4 - we calibrate the coefficient ϕ_σ so that an $x\%$ increase in the growth rate of government health expenditures, above mentioned, changes $\mathbf{E}_2(c^i_4 - c^i_2)^2$ by $[7.73 * (x\%)^2 - 1.41 * x\%]$. Since the effect of government health on consumption dispersion is non-linear, we set the size for the health care shock to the 'typical' increase we have observed in the data. Where for the 'typical' change we take the 0.8% in term of (real) GDP, which corresponds to the annual standard deviation of (real) government health consumption observed for Italy during the years of analysis. According to our estimates, health expenditures show a persistence equal to 0.94.[35] We then simulate the transition of the economy along the path of the health expenditures with the aim of eventually measuring consumption multipliers both on impact and in the long-run. Again, please refer to Appendix C for computational details.

Table 7 summarizes the multipliers for three set of exercises, named as A, B and C. For each case, we report consumption multipliers conditional on having iid health shocks and persistent ones. As well, we report both the impact and the long run multipliers.[36] We disentangle the 'total' consumption multiplier, i.e. the effect produced by the model where both the negative wealth effect and the precautionary motive

[33] Public health care can also affect idiosyncratic labor income and its variability. We performed a battery of regressions of both s^i_t and $(s^i_t)^2$ - as defined in footnote 29 - on the different items of public spending and a set of individual controls and regional and time dummies. We did not find any significant effect of public health care on the variables of interest.

[34] Generating the shock at time 2, we implicitly assume that our economy is in steady state up to time 1. Of course, we could have created the same increase in health spending between time 0 and time 2, generating the shock at time 1.

[35] For the simulations, we assume that government consumption and its subcategories are not characterized by uncertainty, i.e. they follow a deterministic path with $\rho = \sqrt{0.9}$.

[36] We use the notion of present value multipliers formulated in Mountford and Uhlig (2009); the present value multiplier of consumption T years after an increase in government consumption is $\sum_{k=0}^{T}(1+r_{ss})^{-k}\hat{C}_k / \sum_{k=0}^{T}(1+r_{ss})^{-k}\hat{G}_k$, where $\hat{C}_k$ and $\hat{G}_k$ represent the actual deviation of consumption and government consumption, respectively, from their steady-states. Note that r_{ss} is the steady-state real interest rate as calibrated above. The impact multiplier is obtained by setting $T = 1$. The long run multiplier is calculated by setting $T = 200$.

are at work - from the pure 'precautionary effect' multiplier, i.e. the consumption multiplier generated by the precautionary effect alone (at the new equilibrium prices).[37]

Exercise A considers the case where only government health spending is shocked by a 0.8% of the GDP. This increase in spending is financed with labor taxes. Exercises B and C are motivated by the fact that the results in exercise A are difficult to compare to other studies because we tend to underestimate the wealth effect. Virtually all existing studies indeed, analyze the effects of an increase of government consumption without discriminating the different items of spending. Exercises B and C keep the size of the increase in government health expenditures at 0.8% of GDP but have different assumptions on the total increase in taxes. Exercise B sets the increase in total government consumption to the standard deviation observed in the data, which amounts to 1.5% of GDP; while Exercise C aims at maintaining the ratio $\frac{HEALTH}{G}$ to the one observed in the data, i.e. 0.3, so that the increase in total government consumption amounts to 2.66% of GDP in this case. A constant $\frac{HEALTH}{G}$ ratio is roughly consistent with cross-countries evidence showing that the increase over time of the share of merit goods within the government consumption aggregate has been contained (see Fiorito and Kollitznas 2004). In our specific case, the ratio $\frac{HEALTH}{G}$ ranges between 0.29 and 0.32 during the years of analysis. Of course, in all cases, labor taxes are again set to satisfy government's budget period by period.

Some common patterns emerge from the three exercises. First, the persistence of the preference shocks strongly affects the multiplier size, even affecting the sign of the 'total impact' multipliers in Exercises B and C. Second, the 'precautionary effect' multiplier is always positive, ranging from a minimum of 0.18 (the long run multiplier of Exercise C with iid preference shocks) to a maximal level of 5.18 (the impact multiplier of Exercise A with persistent preference shocks). Finally, the 'total' multiplier, represented by the sum of the precautionary and the wealth effects, assumes both positive and negative values, ranging between -2.47 (the long run multiplier of Exercise A with persistent preference shocks) and 3.97 (the impact multiplier of Exercise A with persistent preference shocks).

The main lesson we draw from these measurements is that if, on the one hand, a flexible price model can, in principle, generate non-negative reactions of consumption to government spending shifts; on the other hand, the precautionary saving motive generated by public health expenditures is not always enough to generate positive consumption multipliers. The resulting 'total' multiplier might depend on

[37]More precisely, we first run a transition where government health expenditures are fully financed (obtaining the total multipliers). We then save the path for the equilibrium prices. Finally, we run another transition in which government health expenditures increase but taxes remain at the initial steady state level, and prices are those in the previously saved path. This last run produces the so called 'precautionary' multipliers.

Table 7: Consumption Multipliers

		Iid shocks (ρv=0)		Persistent shocks (ρv=0.5)		Persistent shocks (ρv=0.9)	
		Impact	Long run	Impact	Long run	Impact	Long run
Exercise A: health spending shock	Total multiplier	0.50	-1.02	0.66	-1.06	3.97	-2.47
	Precautionary multiplier	1.19	0.36	1.45	0.61	5.18	1.83
Exercise B: G shock (standard deviations)	Total multiplier	-0.03	-1.02	0.06	-1.04	1.81	-1.82
	Precautionary multiplier	0.63	0.24	0.76	0.37	2.76	1.02
Exercise C: G shock (health/G=0.3)	Total multiplier	-0.29	-1.01	-0.24	-1.03	0.73	-1.49
	Precautionary multiplier	0.35	0.18	0.42	0.26	1.55	0.63

the persistence of health shocks and on the co-movement between public health consumption and total government expenditures.

The impact multipliers are increasing with the persistence of the health shocks. This is in line with the most standard self-insurance literature. Agents facing incomplete insurance markets are much more able to self-insure against temporary shocks than against permanent shocks.

Although precautionary effect (alone) has a positive effect on consumption both in the short and in the long-run, long-run multipliers are much lower than impact multipliers. Given that the individual budget constraint and the ability to generate income is unchanged, the increase of consumption on impact is obtained by depleting private wealth. In order for assets to go back to the initial steady state values, consumption must remain below its long run level before returning to its level of steady state. Clearly, the described mechanism is even stronger in the case of the 'total' multiplier, due to the additional negative wealth effect.

Comparing our measures with ones in the literature is not an easy task. First, VARs or general equilibrium models are estimated using quarterly data, whilst our multipliers are produced from a yearly calibration exercise. Second, the definition adopted for the government spending differ across studies, but in no case contemplates a disaggregation based on functional classification. Finally, almost all these studies focus either on the US or on the Euro area.

A paper which analyzes the government spending effects for Italy is Giordano, Momigliano, Neri and Perotti (2007). They study the effect of two spending shocks, a shock to government purchases of goods and services and one to public wages, both of 1% GDP size. To make their numbers somehow comparable to ours, we average their private consumption's reactions over the first four quarters. We obtain that private consumption's responses are around 0.15% and less than 0.1% of GDP conditional on the first and the second type of shock, respectively.[38] These numbers lie within our impact multipliers' range for Exercise C, which is [-0.29 0.73]. Blanchard and Perotti (2002) study the effects of a shock to government purchases of goods and services, for the US. Averaging their consumption multipliers between the $1st$ and the $4th$ quarters we obtain 0.335 (under a deterministic detrending of the data) and 0.565 (under a stochastic one).

Ramey (2011) uses somewhat exogenous shocks on military spending, and find that consumption reaction is either zero or negative in the first 4 quarters. Mountford and Uhlig (2009) use a signs restriction identification approach and find that a balance budget government spending shock (consumption plus investment) generates either zero or negative reactions of consumption during the first 4 quarters. Our results do not contradict these studies. For example, according to our empirical estimates, defense spending has no effect on consumption variability. It is well known that simulating such a shock within a RBC model, would unambiguously generates a negative consumption multiplier (both in the short and in the long runs) due to the plain negative wealth effect.

5 Conclusions

The lessons we draw from our analysis can be summarized as follows. First, various public spending categories can affect the economy differently. Second, the precautionary effect generated by the government health expenditures is quantitatively important. We have quantified the effects using a flexible price model with perfect competition. We have seen that such a model can generate non-negative reactions for

[38] We had to infer these numbers by looking at the graphs of the IRFs presented in the paper, so the reported measures could be a bit inaccurate.

consumption to government spending shocks, provided that the heterogeneity among the effects of various public spending categories is seriously taken into account. Allowing for sticky prices and monopolistic competition would add the demand effects to our quantifications, further increasing the positive response of private consumption (or reducing its negative response) as a consequences of an increase in public consumption in the short run. The demand effects however, are typically found to be small, at least in models with forward looking agents and when the nominal interest rate is not close to zero.

The model can potentially generate positive welfare effects, which are perhaps worth investigating quantitatively. Interestingly, the welfare effects are only weakly related to the fiscal multipliers, as they are more associated to changes in second order moments and the degree of aversion to consumption risk of the households.

6 References

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7 Appendix

7.1 A: Generalized Euler Equation with Preference Shocks

Following the notation of Section 2, the utility function - omitting individual i index - is:

$$u\left(C_t, V_t\right) = \frac{C_t^{1-\gamma} V_t}{1-\gamma}.$$

Preference shocks follow a unit root process in logs already defined in the main text as $\ln V_{t+1} = \ln V_t + \eta_{t+1}$, where we have allowed the distribution of the innovation η_{t+1} to depend on past $g_{t-s} := \ln G_{t-s}$ for $s \geq 0$.

The individual budget constraint is the following:

$$C_t + \frac{A_t}{(1+r_t)} = Y_t + A_{t-1},$$

where Y is the stochastic labor income after taxes. The Euler Equation takes the form:

$$C_t^{-\gamma} V_t = \beta(1+r_t)\mathbf{E}_t \left[C_{t+1}^{-\gamma} V_{t+1}\right].$$

The timing is the following. We assume that C_t and A_t are decided after observing both Y_t and V_t, and V_t is exogenous to the agent.

Let's set:

$$u_c^{'}\left(C_t, V_t\right) := f\left(C_t, V_t\right),$$

and approximate $f\left(C_{t+1}\left(\omega\right), V_{t+1}\left(\omega\right)\right)$ around $\left(C_t, V_t\right)$. For each ω in the support of the conditional distribution given (C_t, V_t), we have:

$$\begin{aligned} u_c'\left(C_{t+1}, V_{t+1}\right) = {} & u_c'\left(C_t, V_t\right) + u_{cc}''\left(C_t, V_t\right)\left(C_{t+1} - C_t\right) + u_{cv}''\left(C_t, V_t\right)\left(V_{t+1} - V_t\right) + \\ & \frac{1}{2}\left[C_{t+1} - C_t, V_{t+1} - V_t\right] \begin{bmatrix} u_{ccc}''' & u_{ccv}''' \\ u_{ccv}''' & u_{cvv}''' \end{bmatrix} \begin{bmatrix} C_{t+1} - C_t \\ V_{t+1} - V_t \end{bmatrix} + o(\|[\Delta C, \Delta V]\|^2), \end{aligned} \tag{31}$$

where we neglect the indexing on ω. In our formulation:

$$
\begin{aligned}
u_c'(C_t, V_t) &= C_t^{-\gamma} V_t \\
u_{cc}''(C_t, V_t) &= (-\gamma) \frac{u_c'(C_t, V_t)}{C_t} \\
u_{ccc}'''(C_t, V_t) &= (-\gamma)(-\gamma - 1) \frac{u_c'(C_t, V_t)}{C_t^2},
\end{aligned}
$$

moreover

$$
\begin{aligned}
u_{cv}''(C_t, V_t) &= \frac{u_c'(C_t, V_t)}{V_t} = C_t^{-\gamma} \\
u_{cvv}'''(C_t, V_t) &= 0 \\
u_{ccv}'''(C_t, V_t) &= (-\gamma) \frac{u_c'(C_t, V_t)}{V_t C_t}.
\end{aligned}
$$

Let's divide both sides in (31) by $u_c'(C_t, V_t)$. If we ignore the error term, we get:

$$
\begin{aligned}
\frac{u_c'(C_{t+1}, V_{t+1})}{u_c'(C_t, V_t)} \simeq 1 - \gamma \frac{C_{t+1} - C_t}{C_t} + (1 - \gamma) \frac{V_{t+1} - V_t}{V_t} + \\
\frac{1}{2} [C_{t+1} - C_t, V_{t+1} - V_t] \begin{bmatrix} \frac{\gamma(1+\gamma)}{C_t^2} & -\frac{\gamma}{V_t C_t} \\ -\frac{\gamma}{V_t C_t} & 0 \end{bmatrix} \begin{bmatrix} C_{t+1} - C_t \\ V_{t+1} - V_t \end{bmatrix}.
\end{aligned}
$$

Unraveling the quadratic form, we have:

$$
\begin{aligned}
\frac{u_c'(C_{t+1}, V_{t+1})}{u_c'(C_t, V_t)} \simeq 1 - \gamma \frac{C_{t+1} - C_t}{C_t} + (1 - \gamma) \frac{V_{t+1} - V_t}{V_t} + \\
\frac{1}{2} \left\{ [\gamma (1 + \gamma)] \left(\frac{\Delta C_{t+1}}{C_t} \right)^2 - 2\gamma \frac{\Delta C_{t+1}}{C_t} \frac{\Delta V_{t+1}}{V_t} \right\}.
\end{aligned}
$$

Using the Euler equation and solving for $\frac{C_{t+1} - C_t}{C_t}$, we have:

$$
\mathbf{E}_t \left[\frac{C_{t+1} - C_t}{C_t} \right] \simeq \frac{1 - ((1 + r_t)\beta)^{-1}}{\gamma} + \frac{(1 - \gamma)}{\gamma} \mathbf{E}_t \left[\frac{V_{t+1} - V_t}{V_t} \right] + \frac{1 + \gamma}{2} \mathbf{E}_t \left[\left(\frac{\Delta C_{t+1}}{C_t} \right)^2 \right] - \mathbf{E}_t \left[\frac{\Delta C_{t+1}}{C_t} \frac{\Delta V_{t+1}}{V_t} \right],
$$

which can be easily related to equation (3) in the main text.

7.2 B: Data

Non durable consumption is the sum of the expenditure on food, clothing, education, medical expenses, entertainment, housing repairs and additions, and imputed rents. *Disposable income* is the sum of wages and salaries, self-employment income, and income from real assets, less income taxes and social security contributions. Wages and salaries include overtime bonuses, fringe benefits and payments in kind and exclude withholding taxes. Self-employment income is net of taxes and includes income from unincorporated businesses, net of depreciation of physical assets. *Education of the household head* is made up of six levels who are coded as follows: no education (0 years of education), completed elementary school (5 years), completed junior high school (8 years), completed high school (13 years), completed university (18 years), postgraduate education (more than 20 years).

Household-level data are treated before the estimation. We rule out households having negative values on income and consumption, and data with inconsistent information on age, sex, and education level. We consider in the sample households with the age of the head ranging from 25 to 65. We do not consider observations when the identity of the household's head changes. In order to eliminate possible outliers, we rule out individuals having non-durable consumption less (above) the 1 (99) percentile of the distribution and those having the rate of growth of consumption less (above) the 1 (99) percentile of the distribution. Furthermore, individual variables (such as consumption and disposable income) are adjusted for the equivalent scale factor; specifically we refer to the 'OECD-modified scale' which assigns a value of 1 to the household head, of 0.5 to each additional adult member, and 0.3 to each child (see Haangenars et al. 1994 for details). Regional data are divided by the number of household of the regions (census information issued by ISTAT). All data are deflated by a national deflator (NIC issued by ISTAT). Regional GPD and the proxy for public wages are taken from ISTAT. The government expenditure variable which includes investments and money transfers is taken from the Treasury Department. The real interest rate (taken by World Bank) is defined as the lending interest rate which banks charge on loans to prime customers, adjusted for inflation as measured by GDP deflator.

7.3 C: Computational Procedures

7.3.1 Stationary Distribution

We use value function iteration methods to calculate the stationary distribution. We set up a grid for assets $\mathcal{A}$ with 500 points, having $A_{\min} = 0$ and $A_{\max} = 50$. The grid is finer for lower values of assets since we noted a larger mass of individuals on the left tail of the asset distribution.[39] The stochastic processes (28) and (29) are modelled using Tauchen (1986) procedure. We want to solve the problem for (22) subject to the limits (23) and (24), conditional on having a target for the steady state interest rate, i.e. r_{ss}. Thus, the steps for calculating the steady state are the following:

1. Start with a first guess for the discount factor, the value function, the joint distribution of asset and shocks, $(\beta^0, \upsilon^0, \lambda^0)$

2. Using (27) compute $\hat{N}^j$. Then, using $\hat{N}^j$ and r_{ss} in the firm's FOCs compute K^j and W^j, with $j = 0$ for the first iteration. The second iteration will have $j = 1$ and so on and so forth.

3. Solve problem:

$$\upsilon^{j+1}(A, s, V) = \max_{C,A'} u(C) + \beta^j \mathbf{E}\left[\upsilon^j(A', s', V')|s, V\right] \tag{32}$$

s.t.

$$C = A - \frac{A'}{(1 + r_{ss})} + (1 - \tau(G))W^j s. \tag{33}$$

Given that we do not have to calculate υ^{j+1}conditional all the possible distributions λ, we have omitted the dependence of υ^{j+1} from λ. Denote policy function $h^{j+1}(A, s, V)$ associated with the above problem.

4. Using the policy function h^{j+1}, update the joint distribution for asset and shocks, obtaining λ^{j+1}. Compute the aggregate capital, K^{j+1}.

[39] For all the calculated stationary distributions - the percentage of agents holding zero capital was extremely tiny, i.e. around 0.5%. On the other hand, our value for $A_{\max}$ never binds anyone' assets.

5. Compare K^{j+1} with K^j and update accordingly the discount factor, obtaining β^{j+1}. Iterate from step 2 until convergence. Note that an equivalent procedure is to update the discount factor in order to match the target for $\frac{Y}{K}$ whose value is described in Section 5.3.

7.3.2 Computation of the Consumption Dispersion

In this section, we show how we compute $\mathbf{E}_2(c_4^i - c_2^i)^2$ in the calibration exercise. We compute it as the average of individual consumption conditional second moments $E(\log c_4 - \log c_2|x)^2$, where, recall, $x = (A, s, V)$ is the state vector of each agent at the time of the shock. Denote (s', V') and (s'', V'') realizations of exogenous states in two consecutive periods (e.g. periods 3 and 4 if the shock happens in period 2) so that $((s', V'), (s'', V'')|s, V)$ is a history conditional on (s, V). We also denote $x_4 = (A_4, s'', V'')$ and $x_3 = (A_3, s', V')$, where $A_4 = h_3(A_3, s', V', \lambda_3)$ and $A_3 = h_2(x, \lambda_2)$. Then the average of individual consumption conditional second moments can be computed according to the formula:

$$\int_X E_2(\log c_4 - \log c_2|x)^2 d\lambda_2(x) =$$
$$\int_X \left[\sum_{(s'',V''),(s',V')} \{\log h_{c4}(x_4, \lambda_4) - \log h_{c2}(x, \lambda_2)\}^2 \mu_{2,3}\left((s', V'), (s'', V'')|s, V\right) \right] d\lambda_2(x) \tag{34}$$

where $\mu_{2,3}((s', V'), (s'', V'')|s, V)$ represents is the transition probability for the exogenous states (s, V) across periods 2 and 3.

The distribution of agents $\lambda_2(x)$ is the same as the steady state distribution $\lambda(x)$ if we understand it in the cardinal sense, i.e. the probability mass assigned to each level of (s, V) is the same for the two distributions. Thus, the average of individual consumption conditional second moments computed at the steady state is:

$$\int_X E(\log c_4 - \log c_2|x)^2 d\lambda_2(x) =$$
$$\int_X \left[\sum_{(s'',V''),(s',V')} \left\{\log h_c(h(h(x,\lambda), s', V', \lambda), s'', V'', \lambda) - \log h_c(x, \lambda)\right\}^2 \mu((s', V'), (s'', V'')|s, V) \right] d\lambda(x). \tag{35}$$

Policy functions, distributions and probabilities without time subscripts are the time invariant ones in an economy without aggregate shocks, and λ is the steady state distribution.

7.3.3 Transition

In order to compute the transitions, we adopt a modified version of the code used for the steady state computations where we set the simulation horizon T to 200. We then set both the path for government consumption and health expenditures in accordance with both our model and our empirical results. At this point, the exercise is run in two phases.

First, we need to calibrate the effect of a shock to government consumption, specifically to health expenditures, on the consumption dispersion, as explained is Section 5.4. Since our empirical estimations are performed within a partial equilibrium model, this phase of transition does not allow prices to change, so that we keep the interest rate at its steady state level in each period of the transition. The same is true for the labor tax. Thus, having in mind equation (30), we start with an initial guess for ϕ_σ. We find a stable value function for each period in the transition, conditional on both the mentioned interest rate path and the initial guess for ϕ_σ. From the resulting policy functions we calculate the joint distributions of asset and shocks for each period t of the transition and of course we compute (34). We then check if the spending shock has produced the desired change in the consumption dispersion (i.e. the difference between the value obtained from (34) and the one from (35)). If so, we save the coefficient value and name it as ϕ_σ^*, otherwise, we chose another value for ϕ_σ and iterate again on the value functions.[40]

Second, once we obtain a value for ϕ_σ^*, we perform simulations in a general equilibrium framework. Practically, both prices and taxes are now allowed to adjust in accordance with our model. Note, instead, that ϕ_σ^* is kept constant over the transition path. At this point, we need to have a first guess for the entire path of interest rate. Practically, we set the guess for the path of the interest rate for all T periods to its value at the steady state. We are able to calculate the aggregate capital in each period of the transition by using the firm's FOCs. Then, we exploit value function iteration in a backward fashion. By considering (32), we identify the iteration label j with the time period $t+1$, and the results of the current iteration, denoted by $j+1$, with values in t. We start by moment $t = T-1$, then, by using the procedure of the step 3 in Section 8.3.1, we update t to $T-2$ and repeat the cycle until $t = 1$. Eventually, we have T value functions and policy functions, one for each period of the transition. The next part of the problem is to update the joint distributions of assets and shocks given the policy functions just calculated. Starting by the steady state joint distribution of assets and shocks and conditional on the calculated value functions, we update the entire path of the joint distributions following the law of motion

[40] We recall that we calibrate this coefficient separately for each persistence level of the preference shock.

(25). We have a joint distribution of assets and shocks for each period of the transition. Finally, for each of the T periods, we compare the aggregate capital calculated from the joint distributions with the one obtained from the firm's FOCs. We update the interest rate for each period accordingly. We repeat the entire procedure until the gap between the two values for the aggregate capital is sufficiently small in all periods.

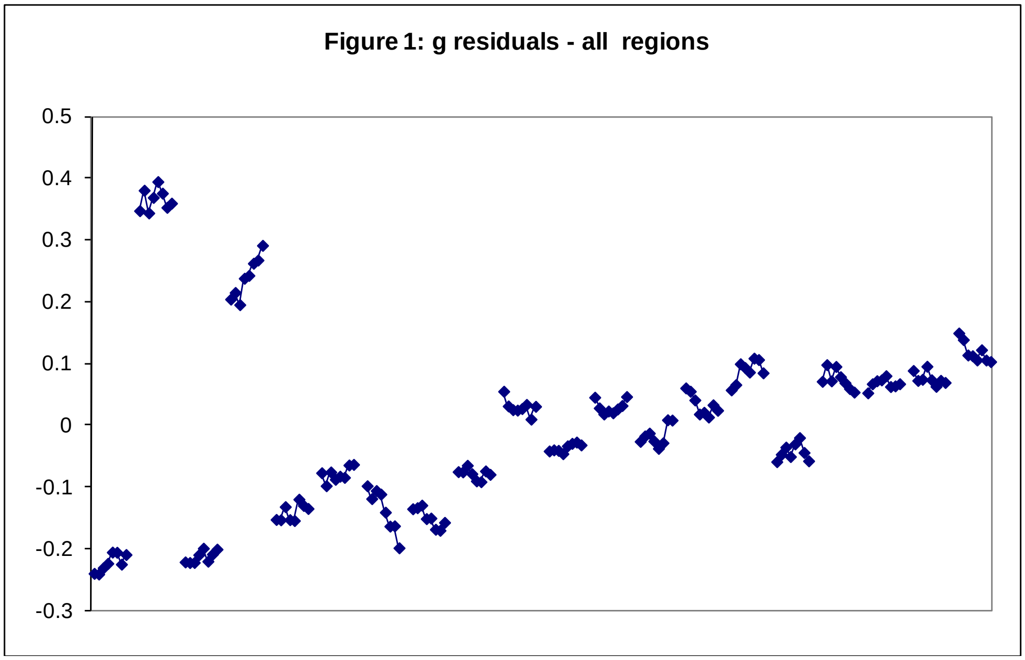
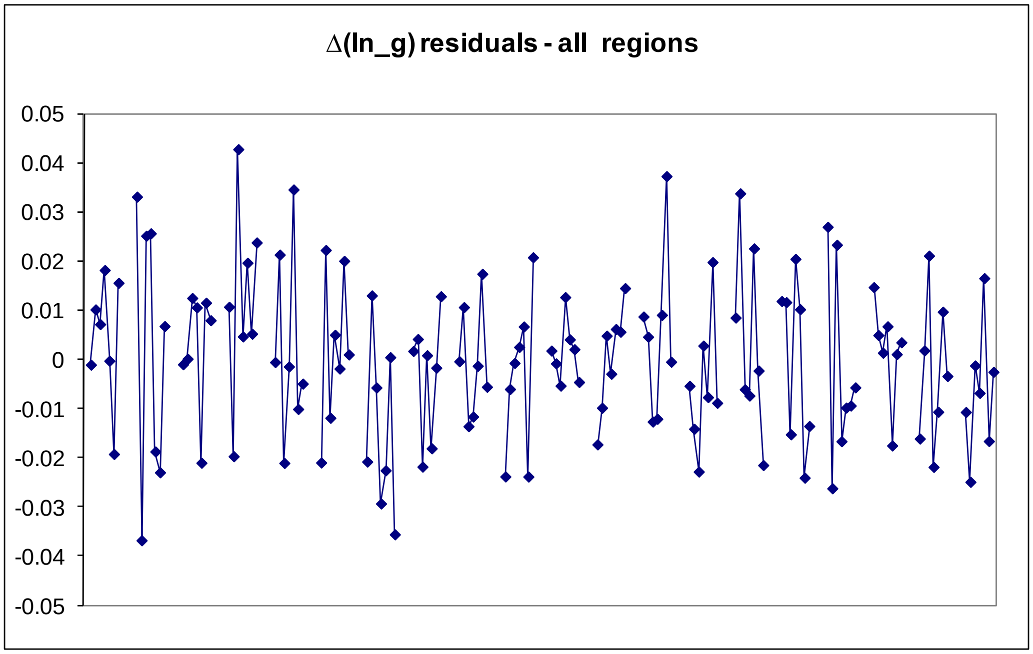


Figure 1: g residuals - all regions
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3


Δ(ln_g) residuals - all regions
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05