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Abstract

In this paper, we re-examine the magnitude of the impact of government spending on private consumption by a new Keynesian approach, focusing on the role of military spending. For this reason, we separate civilian and military spending in the U.S. economy and analyse their respective effects. Our VAR estimates show, as expected, that civilian expenditure induces a positive and significant response on private consumption whereas military spending has a negative impact.

We then develop a simple DSGE new Keynesian model to simulate the empirical evidence under a larger persistence of shocks and a different financing mechanism in military spending, the latter reproducing the propensity of policy-makers to use budget deficits to finance wars. Lastly, simulated impulse response functions of alternative specification models prove the robustness of our analysis.

Keywords: Military and Civilian Spending, SVAR, DSGE Model.

JEL classification: I10, I12, I18

1 Introduction

There is a long tradition in the U.S. in explaining large budgets of military spending by their economic function, necessary to maintain the growth and profitability of the economy. It is argued that, as a component of government spending, the military sector plays an anticyclical role when the economic system cannot generate enough effective demand, consumption and investment to maintain full employment. However, this traditional Keynesian point of view is contradicted by data indicating that downward trends in the share of military spending are not marked by any corresponding upward trends in unemployment or decreases in potential output [1].

Conversely, a neoclassical approach suggests a strategic explanation to account for the economic effects of large cyclical rises in defence spending. Based on major unexpected political events, it assumes that the periods of increased defence spending correspond to the dates of war or the threat of war. Ramey and Shapiro (1998), later extended by Ramey's recent work (2011), proposed a so-called "narrative" approach, which selected the start of the three wars in which the U.S. actively intervened, Korean, Vietnam and the Soviet invasion of Afghanistan and the 2001 terroristic attack, to identify large exogenous increases in the U.S. defence spending empirically. Edelberg et al. (1999), Burnside et al. (2004) and Barro (2011) produced closely related follow-ups of the work by Ramey and Shapiro (1998).

The significant criticism of this approach is that other substantial fiscal shocks may have occurred at around the same time, thus interferring with identification of the military build-up shocks and inferences on the effects of fiscal policy[2].

Following the seminal paper of Blanchard and Perotti (2002), the economic literature has proposed an alternative approach to test the effects of fiscal policy on economy. The models are based on a vector autoregressive model (VAR) with differences in the identification issues of fiscal shocks. A non-exhaustive set of the very large body of empirical literature includes structural restrictions of impulse response functions (Uhlig, 2005; Mountford and Uhlig, 2005; Canova and Pappa, 2007; Enders et al., 2008), relations among variables and error terms in the structural form (Marcellino, 2006; Beetsma et al., 2006; Beetsma, 2008; Benetrix and Lane, 2009; Corsetti et al., 2012) or the inclusion of external and institutional information which tends to exploit the quarterly nature of data

[1] See Smith (2009) for a critical review.

[2] As an example of this debate, Perotti (2005) argues that "Ramey and Shapiro date the start of the Korean war shock in 1950:3, based on the large observed increase in military spending; but in four quarters between 1948:2 and 1950:3, government spending increased by between two and three standard deviations. It is not obvious how to disentangle the effects of the Korean dummy variable from the delayed effects of these large fiscal shocks".

and fiscal policy decision lags (Blanchard and Perotti, 2002; Perotti, 2005; Muller, 2008; Monacelli and Perotti, 2008).

This paper starts by reviewing the empirical economic consequences of changes in U.S. fiscal policy following a baseline structural VAR (SVAR) model extended for the fiscal components of military sector and civilian government purchases. We mostly focus on the short-run consequences of military spending, because the main question of interest is to what extent unexpected military spending produces effects on private consumption. We use as a basis the findings of Galì's et al. (2007), that a positive government spending shock leads to a significant increase in private consumption when military spending is excluded by the data, to infer the hypothesis that military spending has a negligible or negative impact on consumption. However, the literature found conflicting empirical results. For example, Hall's (1986) analysis using annual data back to 1920, and also identifying government spending shocks through shifts in military spending, finds a slightly negative effect of government purchases on consumption.

Similarly to Blanchard and Perotti (2002), who estimate fiscal effects of output multipliers, we report a comparison of the VAR effects of military and civilian spending shocks of consumption for the US: while we find a negative effect of military expenditure on consumption, this does not exclude reconciling this result within the new Keynesian approach for fiscal effect in aggregate. In accordance with this line of inquiry, we also find that civilian government purchases have a large effect on consumption.

The main contribution of our paper is to model consumption response to changes of military and civilian components by a new Keynesian framework with monopolistic competition and nominal rigidities (Bilbiie et al., 2008). This framework encompasses many ingredients of recent dynamic optimizing sticky price models, although it is modified by allowing for the presence of consumers subject to credit constraints, that is households that do not participate in asset markets[3]. In fact, the basic intertemporal models upon representative agents predicts the negative wealth effect associated with an increase in government spending, which lowers consumption and, in turn, lowers the real wage. Despite this negative wealth effect, the response of consumption to a spending shock can be positive under the presence of non-Ricardian consumers (Galì et al., 2007). There is another important specific characteristic of the time-series of government spending components to be considered. In fact, the existence of heterogeneous consumers - Ricardian people - tends to mitigate the immediate economic effects of positive government shocks, and this crowding out channel is emphasized in military spending, where the strong per-

[3]See, Campbell and Mankiw (1989), for the original description of the economic behaviour of non-Ricardian consumers.

sistence of this component, generally recorded in data, is able to reduce the consumption transmission channel of the labour supply by the wealth effect.

In addition, the heterogeneity of consumers also implies different spreads through which fiscal policy transmits the effects to the economy and it is made explicit by the financing mechanism of debt and of current government spending. This issue is particularly important in our analysis, when we examine the effects of military spending with respect a civilian spending because, for example, differences in the taxation propensity (or other forms of financing) lead to heterogeneous responses in private consumption. Different from Favero and Giavazzi (2007), who explicitly include the long run government budget constraint, the new Keynesian model presented below comprises, along with a taxation rule, a deficit financing rule.

Our simulated results of the baseline new Keynesian model show that private consumption responds positively to civilian spending whereas military expenditure affect negatively private consumption. Both the model results seem to be at work in explaining the empirical results. Then, we compare the dynamic responses of private consumption to positive government component shocks with models which have more neoclassical contents. Modelling only households that smooth consumption by participating in asset markets, we also calibrate negative IRFs of civilian spending on consumption, a result in accordance with the new Keynesian predictions. The rest of this paper is organized as follows. Section 2 discusses the basic literature and some stylized facts of how the U.S. finances government spending, in particular within the identified war dates. Section 3 presents our empirical specifications (showing the data and discussing the identification procedure) and contains estimation results (with particular regard to the reaction of private consumption to different kinds of government expenditure shocks). Section 4 presents the theoretical framework of the DSGE model. Section 5 contains the model calibration and examines the simulated impulse response of consumption to the different government spending shocks, focusing on the role of military spending shocks and its consistency with the empirical evidence. Section 6 concludes.

2 Consumption Crowding-out/in and Public Financing: Baseline Literature and Some Stylized Facts

Barro (1974, 1979, 1981) conducted several studies highlighting the economic effects of government spending and the alternative methods and impacts of financing this expenditure. In particular, Barro (1981) stressed the fact that government expenditures can provide direct welfare to economic agents, and that variations in the level of government expenditure may have an impact on the consumption decisions of households. As a result, many studies have estimated the extent to which economic agents treat government expenditure as substitute or complement to private consumption expenditure (e.g., Kormendi, 1983; Aschauer, 1985; Graham and Himarious, 1991; Karras, 1994; Ni, 1995; Amano and Wirjanto, 1998).

However, evidence from the 1980's and 1990's is not conclusive. Using different data sets for the U.S., Aschauer (1985) and Kormendi (1983) found a small substitution effect between private and public consumption, whereas Campbell and Mankiw (1990) did not find any significant effect in a post-war data set for the U.S. Karras (1994) also found complementarity between public and private consumption in a number of countries. This uncertainty of results was confirmed by Ni (1995), who showed that the relationship between private and government consumption was sensitive to the choice of the utility function and the interest rate measurement, as well as the time-span of the sample used in estimates.

It is a fact that the diversity of results may be a consequence of a number of restrictive assumptions which were used in the various studies. One evident concern is the use of aggregated government expenditures which assumes that a homogeneous channel of transmission of fiscal policy cannot be distinguished among specific relationships on private decisions of consumption. More recently, studies based on this point have tested the existence of substitution or complementarity of the components of government spending on private consumption (Fleissig and Rossana, 2003; Fiorito and Kollintzas, 2004; Aristei and Pieroni, 2008) and, as a related subject, the optimal size of the public sector.

In addition, part of this literature addressed interest in the impact of alternative financing methods for a given path of government expenditure. We build on this argument to show that different sources of financing of the components of the public sector lead to a different impact on private consumption when consumers are constrained in their asset purchases.

Here, we focus on military spending to describe military outlay and the different mechanisms used to finance it in the U.S. Table 1 shows the financing sources of government outlay (e.g., military and civilian) under the direct control of the fiscal policy[4]. We also stress that our interest focuses on shocks near war time (including times in threat of war) to account for more unanticipated expenditure and financing behaviour. As a link with

[4]The difference between revenue and expenditure should also be matched by changes in money supply.

the literature, we refer to the U.S. war episodes described by Ramey (2011) except for the Korean war, which is outside our sample. This choice does not meaningfully affect the results since the variation in military spending was important during the 1960's and the 1970's (Bilbiie et al., 2008; Pieroni, 2009).

Table 1: Government spending and financing mechanisms in the U.S. for military conflicts and episodes

	Time	**Military outlay (% of GDP)**	**Civilian outlay (% of GDP)**	**Budget Deficit (% of GDP)**	**Tax-revenue (% of GDP)**
Vietnam conflict	Q1-1963	13.61	17.53	-0.85	28.83
	Q1-1965	11.21	17.67	-0.03	28.12
	Q1-1967	13.18	18.09	-2.71	28.51
	Q1-1969	12.15	17.81	0.43	31.57
	Q1-1971	9.73	17.99	-2.47	29.54
	Q1-1973	7.56	17.15	-0.19	31.28
	Q1-1975	7.21	18.76	-4.26	30.64
Carter-Reagan	Q1-1980	6.40	16.71	-2.12	31.36
Military Build-up	Q1-1982	7.16	16.38	-3.89	32.33
	Q1-1984	7.46	15.15	-4.56	31.46
	Q1-1986	7.72	15.82	-5.02	32.00
	Q1-1988	7.89	15.41	-4.04	32.76
Desert Storm	Q1-1989	7.35	15.39	-2.86	33.19
Operation	Q1-1991	7.45	16.27	-4.06	33.03
	Q1-1993	6.27	16.00	-5.83	32.46
11 September 2001	Q1-1999	4.21	14.92	0.63	34.84
and 2nd Iraq War	Q1-2000	4.01	14.81	1.79	35.73
	Q1-2001	4.09	14.83	0.93	35.49
	Q1-2002	4.27	15.34	-3.50	32.17
	Q1-2003	4.44	15.32	-4.68	31.76
	Q1-2004	4.73	14.69	-4.90	31.28

Notes: Percentages of civilian and military expenditures over GDP obtained from Bureau of Economic Analysis (various years). Budget deficit and tax revenues as percentages of GDP from OECD Economic Outlook, No. 88.

It is not difficult to see that budget deficits were used to finance most of the military operations. At the peak of the war episodes, the percentage of budget deficit in GDP was around 4-6%. However, the tax revenue did not change at the onset of war episodes, except during the Carter-Reagan military build-up, when taxation was cut. This "conservative policy" also produced a reduction in taxation during the Afghanistan and second Iraq campaign, leaving almost the whole burden of military outlay on borrowing from the public. Nor do the data support the hypothesis that reductions in other government spending represents military outlay financing course, although we note that there is a significant reduction in civilian outlay in the Carter-Reagan military build-up[5]. We motivate our paper's contribution stating that the effects of military spending on private consumption also depend on the financing mechanisms of government outlay, recognizing that unplanned episodes like wars are generally financed by budget deficits.

Thus, from the Keynesian perspective, wars typically determine a short-term economic boom boosting aggregate demand and consumption, since greater military outlay is not offset by the contraction caused by higher taxes. It is within this policy debate that Feldstein (2008) suggested that any DoD budget cuts may be misguided. He also argued that in the recent downturn cycle, the U.S. government should have recognized the need to increase government spending to offset the decline in consumer demand in the economy, and argued that a rise in military spending would be the best way to provide this stimulus.

The latter predictions are not in line with empirical results in defence economics. Boulding (1973), Edelstein (1990) and Pieroni (2009) have shown that private consumption fluctuates negatively in response to military expenditure changes - even if not always statistically significant - a result similar to those obtained for private investments (Smith, 1980). These results may be in line with the neoclassical hypothesis of the diversion of government resources. The data shown above seem to emphasize the complexity of the effects in the transmission channel toward private consumption, at least, because the financing of the defence sector - and its shocks - may be related to those of civilian spending. Thus, by analyzing government spending effects between these components, one aim is to capture explicitly the different persistence of the spending shocks.

We extend these arguments by a new Keynesian DSGE framework to find an explanation for the possible sources of the crowding-out effect in military consumption observed in some empirical evidence. We incorporate into our model a share of households who do not have access to the bond market and who consume their current disposable income

[5]This result is not in contrast with the findings of Beetsma et al. (2007) who identified "within" substitutions between military and civilian spending since the positive trend of civilian spending is associated with a stable pattern of military spending, excluding war episodes.

at each date. We show the co-existence of sticky prices and a different rule of financing mechanisms for military and civilian spending. The next section illustrates the estimated impulse response analysis of the components of fiscal policy for the U.S.

3 Empirical Evidence

In this section we provide evidence of the above-mentioned discussion by estimating the impulse response functions (IRFs). We compare the results of the fiscal policy shocks of the expenditure of military and civilian components in private consumption to explain how contrasting theoretical models may rationalize the heterogeneity of the effects upon them.

3.1 Specification and Identification

The strategy adopted here to identify the VAR model is based on the assumptions discussed in Bilbiie et al. (2008) that are consistent with the solution of the log-linearized theoretical model presented in next Section[6]. In addition, the use of quarterly data supports the exogenous changes of civilian and military spending, respectively. This is in line with the new Keynesian perspective which sustains that a discretionary fiscal policy plausibly does not respond within a quarter to a change in the economy[7].

As a baseline specification of our model we adopt a SVAR, the reduced form of which is defined by the following dynamic equation:

$$Y_t = c + A\left(L\right) Y_{t-1} + U_t \tag{1}$$

where Y_t indicates the vector of variables specified below, $A(L)$ is an auto-regressive lag polynomial, c a constant term, and U_t the vector of reduced-form innovations. We focus our analysis on the US and use a dataset from 1960:Q1 to 2010:Q4. The reasons for choosing the U.S. were based on the data availability making this economy the main case study of the effects of fiscal policy.

A way of approaching the difference between the fiscal policy components is to note that the prevalence of these government spending shocks is distributed differently across periods of time after World War II. As argued in Bilbiie et al. (2008), in the first part

[6]A recent review of the identification strategy in the VAR literature is discussed in Beetsma and Giulidori (2011).

[7]Following Auerbach (2000, p. 16), "there are many reasons why fiscal decisions announced in advance may not be taken at face value by the public. The yearly budget is often largely a political document, which is discounted as such by the private sector; any decision to change taxes or spending in the future may be modified before the planned implementation time arrives; and... changes in expenditure policy typically have involved not simply changes in program rules, but rather changes in future spending targets, with the ultimate details left to be worked out later and the feasibility of eventually meeting the targets uncertain."

of the sample (e.g., until the end of 70's) defence spending was prevalent, while last part of the sample (e.g., until the first years of XXI century) was dominated by shocks to **civilian** spending. We measure the contemporaneous correlation between the two shocks to defence and civilian spending in GDP and we find that this measure of 0.32 is large enough to undermine the results when we choose the order of the government spending variables in a hypothetical VAR built on the components of government spending [8].

We thus estimate separately the impulse responses of defence and civilian expenditures from a five-variable VAR. Following the strategy mentioned in equation (1), we specify before the model analyzing the effects of the civilian component:

$$Y_t = [C_t, W_t, DINC_t, BD_t, NM_t] \tag{2}$$

composed of private consumption C_t, real wages W_t, disposable income $DINC_t$, the government budget deficit BD_t and the civilian spending NM_t[9]. The empirical specification includes, respectively: the log of real private final consumption expenditure per capita (C); real wages (W), corresponding to the log of real compensation of employees; disposable income ($DINC$), corresponding to real personal disposable income (obtained from the FRED-II database); civilian spending (NM) obtained from the Bureau of Economic Analysis, National Economic Accounts as the difference between government consumption expenditure and national defence data[10]; and a measure of budget deficit (BD) corresponding to gross government fixed capital formation (IG) minus net government saving ($SAVG$). Consistently with the model developed herein, both civilian spending and the budget deficit enter the VAR as a ratio of lagged GDP. All the other real variables are deflated by the GDP deflator. The variables expressed in per capita terms are divided by working-age population.

As an identification strategy for fiscal policy shocks, we adopt a Cholesky factorization, in order to recover the vector of structural shocks ϵ_t (and its variance Ω) from the reduced-form error U_t in (1). It is worthwhile noticing that the structural identification of Blanchard and Perotti (2002) of government spending shocks is identical to a Choleski decomposition, in which government spending is ordered before the other variables[11]. Here, we assume the following set of conditions. We consider civilian spending as the most

[8] Note that this contemporaneous correlation is slightly different from the one of 0.18 estimated by Blanchard and Perotti (2002). The motivation resides in the different years used in the dataset.

[9] The source for almost all the variables used is the OECD Economic Outlook No. 88.

[10] Since we are interested in short to medium-run effects of shocks to government purchases on private consumption, we omit investments from the data. As a robustness check, we include service of capital, but results obtained in the VAR-estimates were close to those presented below.

[11] As in Blanchard and Perotti (2002), the condition for identification is that the component of government spending does not respond to government or private macro-economic variables, contemporaneously.

exogenous variable and analyze the effects of its increase (temporary or permanent). The interaction between civilian expenditure and taxation rate influences the budget deficit: if the civilian spending increase is financed by tax rises the budget deficit may be negative. Conversely, if a civilian expenditure rise is not followed by a corresponding increase in taxation rate, the budget deficit is positive. We implicitly assume that there are heterogeneous behaviours of consumers that include in the choice set decisions in the asset. Because household demands for goods depend on the expected value of taxes (i.e., disposable income), each household subtracts its share of this present value (real wage) from the expected present value of income, in order to determine a net wealth position. Lastly, we consider private consumption as the most endogenous variable, which is therefore affected by all contemporaneous values of all the variables in the VAR.

Since we are primarily concerned with comparison of the private consumption effects of civilian and military shocks, we repeat the same experiment substituting civilian expenditure (NMt) with military spending (Mt) in the VAR model. In this case, the vector of variables Y_t in equation (1) may be expressed as:

$$Y_t = [C_t, W_t, DINC_t, BD_t, M_t]\,. \tag{3}$$

Similarly to the civilian spending case, military spending enters the VAR as a ratio of lagged GDP. Again, we adopt a Cholesky factorization in which private consumption, real wages, disposable income and budget deficits are allowed to depend on the fiscal variable (in this case, military expenditure) and are ordered, respectively.

3.2 Results

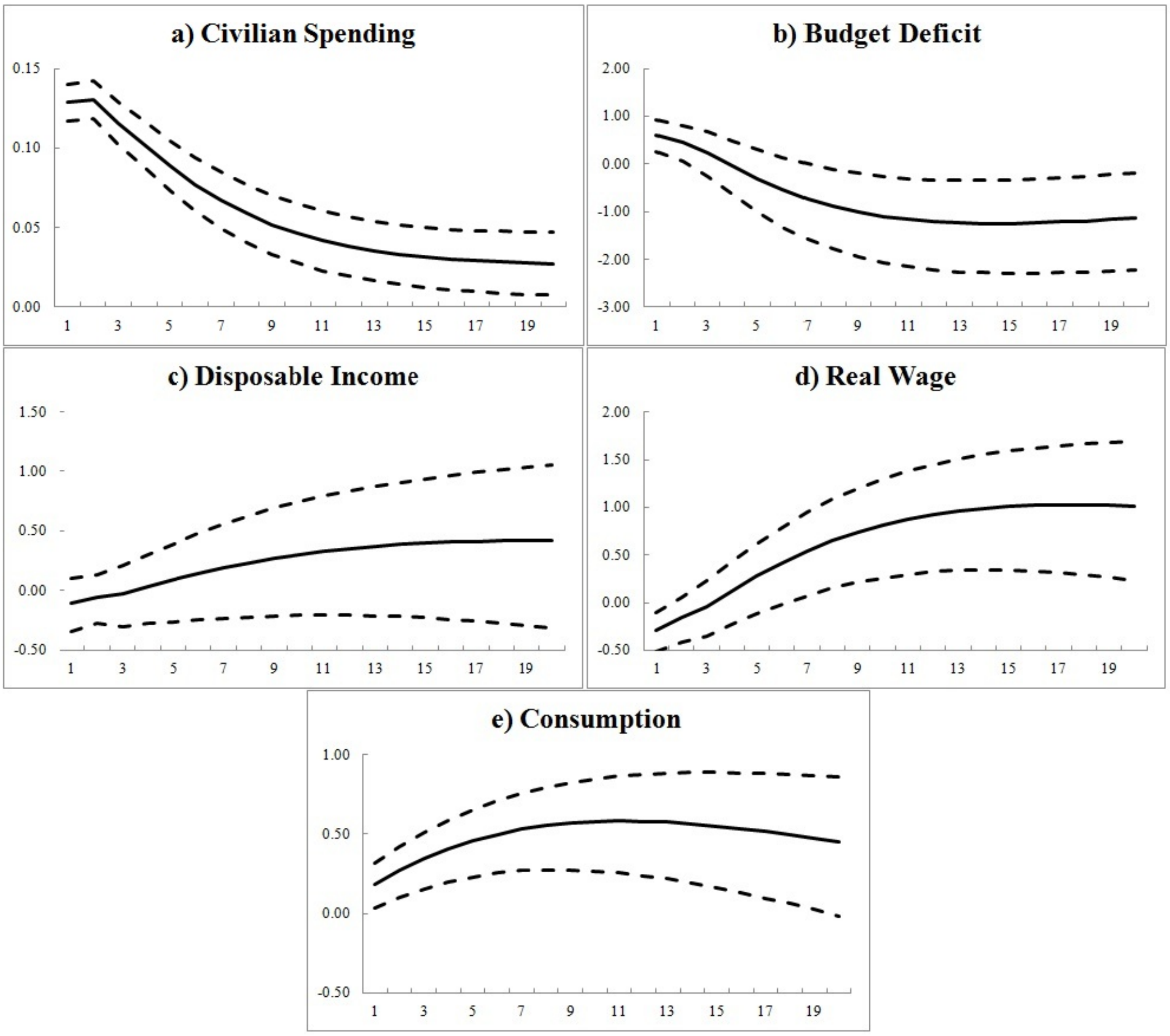
We estimate two VAR models according to specification equations (2) and (3) in order to obtain the empirical $IRFs$. According to the Schwarz information criterion, the number of lags is set to two. In both the specifications for the VAR estimates, we include two dummies corresponding to the dates 1963:Q3 and 1984:Q4. The first allows us to capture the expectation effect related to the threat of the armed conflict onset. The second should account for the change of the monetary regime that had important implications for fiscal policy during early 80's (see, for example the work by Davig and Leeper, 2011).

Diagnostic tests indicate the absence of serial correlation in the residuals by a Lagrange Multiplier test. We also fail to reject the hypothesis of normality of residuals with Jarque-Bera statistics and check the stability condition of the VAR, finding that all eigenvalues lie comfortably inside the unit circle. We also test for the presence of cointegrating relationships among the variables, finding mixed evidence according to rank and maximum eigenvalue tests. As a result, we decide not to impose any cointegrating restriction, and thus estimate both the VARs with the variables in levels (Sims et al., 1990; Giordano et al., 2007).

Figure 1 shows the effects of civilian spending on endogenous variables of equation (2). In accordance with this line of inquiry, in order to derive the 16th and 84th percentiles of the impulse response distribution in the graphs, we perform Monte Carlo simulations and assume normality in the parameter distribution. Accordingly, we construct t-tests based on 10,000 different responses generated by simulations, and check whether the point estimates of the mean impulse responses are statistically different from zero. The responses of the five variables are expressed by multiplying the estimated parameters of the VAR by the sample average share of civilian spending in GDP.

We note that civilian spending (graph a)) increases significantly and does not display a large persistence. To give an idea in order to compare below with shocks in military spending, the pattern of persistence decreases with a half-life of about two years. The response of the budget deficit variable (graph b)) indicates a contrasting pattern: although it starts positively, it decreases and remains significantly negative, meaning that unexpected civilian expenditure appears to be financed by an increase in the taxation rate.

Concerning disposable income (graph c)), we observe a positive pattern for all of the period considered. This result is in line with the prediction of the new Keynesian models with limited asset market participation, where the low persistence of civilian spending shock reduces the present discounted value of taxes and the wealth effect on asset holders.



Notes: Estimated impulse responses to a civilian spending shock in SVAR. Sample Period 1960:1-2010:4. Horizontal axis: quarters after shock. Confidence intervals: (+/-)1 standard deviations of empirical distributions, based on 10,000 Monte Carlo replications.

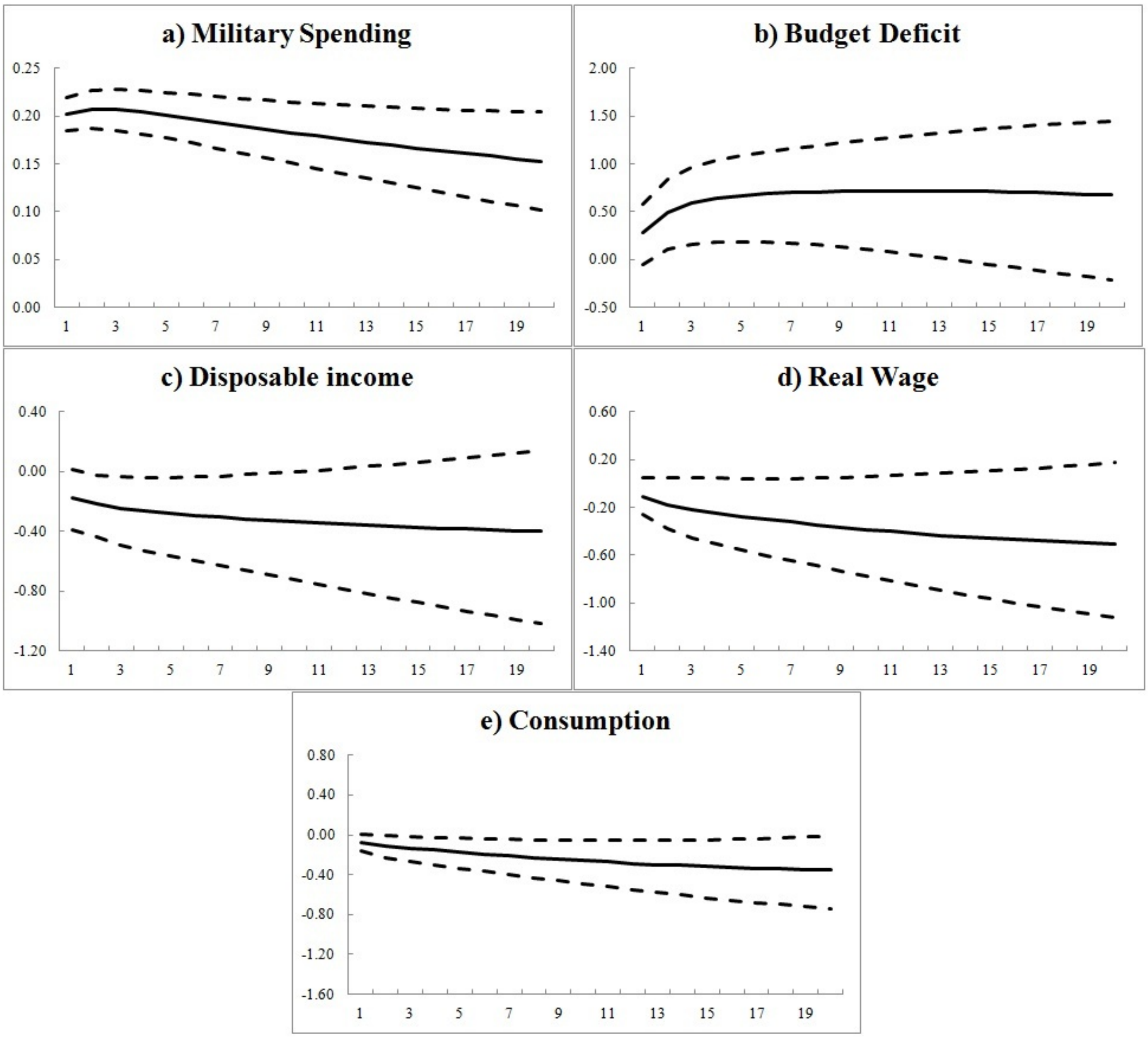
Figure 1: Response of VAR model to a civilian spending shock

As predicted by the new Keynesian models, real wage (graphs d)) shows a positive and persistent response to a unitary shock of civilian spending. Most interestingly, the effect of a civilian expenditure shock on consumption is shown to be significant for a large time-span, persistently above zero (graph e)). As we can observe, the response of consumption follows, almost one-for-one, that of disposable income.

Figure 2 displays the IRFs of VAR in equation (3) to a positive shock in military spending. Defence expenditure response (graph a)) rises significantly showing a higher persistence with respect to civilian shocks. From the patterns of IFRs, we estimate that to achieve half-life takes more than eight years. Graph b) pertains to the estimated response of the budget deficit variable, reproducing the evidence in the U.S., shown in the Section 2, that the defence sector is largely financed by budget deficits.

The response of disposable income is negative (graph c)) due to the high persistence of military spending shock that increases the present discounted value of taxes and the wealth effect on Ricardian households.

The point estimates shown in the IRFs indicate that real wages decrease in response to the military spending shock (graph d)). Interestingly, as found in the defence spending literature which follows the neoclassical point of view, the pattern of consumption also decreases its impact (graph e)), and the point estimates reveal that the shock may produce a significant effect. Also in this case, the consumption follows, almost one-for-one the pattern of disposable income response.



Notes: Estimated impulse responses to a military spending shock in SVAR. Sample Period 1960:1-2010:4. Horizontal axis: quarters after shock. Confidence intervals: (+/-)1 standard deviations of empirical distributions, based on 10,000 Monte Carlo replications.

Figure 2: Response of VAR model to a military spending shock

The robustness of the results presented for the components of government expenditure is tested by the estimated fiscal policy multipliers on consumption. Table 2 lists the results. Particularly interesting for our study is the fact that positive multipliers on consumption of civilian expenditure, for the $4th$, the $8th$ and the $12th$ quarter, are +0.25, +1.73, and +3.88, respectively. On the contrary - as expected from the point estimates - consumption multipliers are negative for military expenditure for the same quarters, between -0.47, -1.27 and -2.32, respectively. Confidence intervals of these government expenditures at 95% also indicate a statistical significance of separate consumption multipliers, emphasizing the important differences in the transmission IRFs responses of military and civilian expenditures shocks on private consumption.

Table 2: Estimated fiscal policy effects (civilian and military spending)

Estimated Fiscal Policy Multipliers			
Quarters	4	8	12
Civilian spending	0.25 [0.16/0.34]	1.73 [1.49/1.97]	3.88 [3.43/4.34]
Military spending	-0.47 [-0.39/-0.55]	-1.27 [-1.07/-1.46]	-2.32 [-1.98/-2.67]

Notes: Results from cumulated IRFs. 95% confidence intervals (CI) are listed in brackets.

4 A Theoretical Model

The previous section showed dynamic consequences of fiscal policy shocks for civilian and military components on the U.S. consumption. Our aim here is to assess whether our model can account for these estimated patterns. We first present the log-linearized equations under a simple dynamic general equilibrium model with new Keynesian predictions. Then, we focus on the key fiscal transmission channels related to: (i) the financing mechanism of the specific expenditure, and (ii) the persistence of military and civilian shocks.

4.1 The Basic new Keynesian Framework

This subsection describes the model, which follows the framework of Galì et al. (2007). The model consists of an economy populated by a continuum of infinitely lived households in which these are divided into Ricardian and non-Ricardian behaviours. In particular, consider λ the share of non-Ricardian households present in the economy, that is, households which do not have access to capital markets and consume their current labour income. Conversely, complementary share $1-\lambda$ defines Ricardian households.

As regards labour market structure, it is assumed that there is an economy-wide union setting wages in a centralized manner. Hence, hours worked are not chosen optimally by households, but are determined by firms, given the wage set and the union.

The economy produces a single final good and a continuum of intermediate goods. The final goods sector is perfectly competitive and is consumed by households. There is monopolistic competition in the markets for intermediate goods, each of which is produced by a single firm. The model assumes that intermediate an goods producer faces restrictions in the price setting process, as in Calvo (1983). In particular, θ defines the probability of a firm keeping its prices unchanged, and $1-\theta$ that of an intermediate firm can re-optimize its prices.

The model encompasses a monetary authority which sets its policy instrument, the nominal interest rate, according to a generalised Taylor rule (1993).

The detailed linearized model is set out in Table 3, except the equations related to the government sector. We are going to analyse them in detail in the next subsection since our main contribution relates to consumption responses to shocks of fiscal policy components.

Table 3: Linearized model equations

Equations	Log-linearized equation
Tobin's q equation	$q_t = \beta E_t \{q_{t+1}\} + [1-\beta(1-\delta)] E_t \left\{r^k_{t+1}\right\} - (r_t - E_t\{\pi_{t+1}\})$
Investment equation	$i_t - k_t = \eta q_t$
Capital accumulation	$k_{t+1} = \delta i_t + (1-\delta) k_t$
Euler equation for Ricardians	$c^r_t = E_t\{c^r_{t+1}\} - (r_t - E_t\{\pi_{t+1}\})$
Euler equation for non-Ricardians	$c^{nr}_t = \left(\frac{WN^{nr}}{C^{nr}}\right)(w_t + n^{nr}_t) - \left(\frac{Y}{C^r}\right) t^{nr}_t$
Aggregate consumption equation	$c_t = \lambda c^{nr}_t + (1-\lambda) c^r_t$
Aggregate hours worked equation	$n_t = \lambda n^{nr}_t + (1-\lambda) n^r_t$
Wage equation	$w_t = c_t + \varphi n_t$
Intertemporal eq. condition for agg. cons.	$c_t = E_t\{c_{t+1}\} - \sigma(r_t - E_t\{\pi_{t+1}\}) -$
	$\Theta_n E_t\{\Delta n_{t+1}\} + \Theta_{tax} E_t\{\Delta t^{nr}_{t+1}\}$
New Keynesian Phillips curve	$\pi_t = \beta\{\pi_{t+1}\} - \lambda_p \hat{\mu}^p_t$
Price mark-up equation	$\mu^p_t = (y_t - n_t) - w_t = (y_t - k_t) - r^k_t$
Production function of final good firms	$y_t = (1-\alpha) n_t + \alpha k_t$
Monetary policy function	$r_t = r + \phi_\pi \pi_t$
Definitions	
	$t^{nr}_t = \frac{T^{nr}_t - T^{nr}}{Y}$
	$r_t \equiv R_t - 1$
Parameters	
	$\sigma = \gamma_c \Phi \mu^p (1-\lambda)$
	$\Theta_n = \lambda\Phi(1-\alpha)(1+\varphi)$
	$\Theta_{tax} = \lambda\Phi\mu^p$
	$\Phi = (\gamma_c \mu^p - \lambda(1-\alpha))^{-1}$
	$\gamma_c \equiv \frac{C}{Y}$
	$\lambda_p = (1-\beta\theta)(1-\theta)\frac{1}{\theta}$

Notes: Lower-case letters denote log-deviations with respect to the corresponding steady state values. q_t is the current value of capital stock, r^k_{t+1}, the expected rental rate, r_t, the nominal interest rate, π_{t+1}, the expected inflation, i_t, the investment, k_t, the capital service, c^r_t, the consumption of Ricardian households, c^{nr}_t, the consumption of non-Ricardian households, n^r_t, the hours worked of Ricardian households, n^{nr}_t, the hours worked of non-Ricardian households, w_t, the real wage rate, t^{nr}_t, the lump sum taxes of non-Ricardian consumers, c_t, the aggregate consumption, n_t, the aggregate hours worked, μ^p_t, the price mark-up, y_t, the final output.

4.2 The Government Sector: Military and Civilian Expenditures

Government budget constraints assume that to finance public spending, the government should issue bonds and raise lump-sum taxes. As one of the main aims of this paper, we separate government purchases into the components of expenditure of civilian (NM_t) and military (M_t) and, consequently, display a composite budget constraint as:

$$P_t T_t + R_t^{-1} B_{t+1} = B_t + P_t (NM_t + M_t) \tag{4}$$

$$where \quad : \quad T_t \equiv \lambda T_t^{nr} + (1-\lambda)\, T_t^{r}$$

where T_t denotes the real taxes (lump sum) paid by (Ricardian and non-Ricardian) consumers to the government, and the variable B_{t+1} the quantity of one-period bonds purchased by households at time t. P_t denotes the price level. The last expression encompasses the sum of civilian and military components according to the additive principle.

Equation (5) shows that linearization of the government budget constraint remains around the steady state, with zero debt and a balanced primary budget:

$$b_{t+1} = \frac{1}{\beta}(b_t + nm_t + m_t - t_t) \tag{5}$$

$$\begin{aligned} where \quad &: \quad nm_t \equiv \frac{NM_t - NM}{Y} \\ where \quad &: \quad m_t \equiv \frac{M_t - M}{Y} \\ and \quad &: \quad t_t \equiv \frac{T_t - T}{Y} \\ and \quad &: \quad b_t \equiv \frac{(B_t/P_{t-1}) - (B/P)}{Y} \end{aligned}$$

where nm_t, m_t and t_t are expressed as deviations from their respective steady states and normalized by steady state output, whereas budget deficit is given by the real deficit at time t, divided by the last period's prices minus the steady state nominal deficit and normalized by steady state of output.

Fiscal policy rules have been studied extensively, for instance, by Bohn (1998) and Galí and Perotti (2003). Here, we assume an extension that allows us to consider the two different fiscal policy components:

$$t_t = \phi_b b_t + \phi_{nm} nm_t + \phi_m m_t \tag{6}$$

where ϕ_{nm} and ϕ_m are parameters indicating the response of taxes to civilian and military expenditures, respectively. ϕ_b is the parameter capturing the response of taxes to budget deficit in the case of increases in civilian and military expenditures.

If we insert the fiscal policy rule (6) into the linearized budget constraint (5), we obtain:

$$b_{t+1} = \frac{1}{\beta}\left(1 - \phi_b\right) b_t + \frac{1}{\beta}\left(1 - \phi_{nm}\right) nm_t + \frac{1}{\beta}\left(1 - \phi_m\right) m_t \tag{7}$$

A necessary and sufficient condition for non-explosive deficit dynamics is given by:

$$\frac{1}{\beta}\left(1 - \phi_b\right) b_t < 1 \quad \Rightarrow \quad \phi_b > 1 - \beta \tag{8}$$

This assumption is crucial in order to choose the value of ϕ_b in the model calibration.

Civilian and military expenditures (in deviations from their respective steady states, and normalized by output steady state) evolve exogenously, according to two distinct first-order autoregressive processes. Indeed, we assume that the resources destined for civilian and military sectors are (AR(1)) processes in line with the dynamic responses of our VAR based estimates:

$$nm_t = \rho_{nm} nm_{t-1} + \epsilon_t^{nm} \tag{9}$$

$$where \quad : \quad 0 < \rho_{nm} < 1 \ \epsilon_t^{nm} \sim N\left(0, \sigma_\epsilon^2\right)$$

and:

$$m_t = \rho_m m_{t-1} + \epsilon_t^m \tag{10}$$

$$where \quad : \quad 0 < \rho_m < 1 \ \epsilon_t^m \sim N\left(0, \sigma_\epsilon^2\right)$$

where ρ_{nm} and ρ_m are persistence parameters, and ϵ_t^{nm}, ϵ_t^m are the i.i.d. shocks of civilian and military expenditures.

4.3 Market Clearing

The final goods market is in equilibrium if production equals demand by total household consumption, aggregate private investment and total government spending. The log-linearized market equilibrium condition may be expressed as follows:

$$y_t = \gamma_c c_t + \gamma_i i_t + nm_t + m_t \tag{11}$$

$$where \quad : \quad \gamma_c = \frac{C}{Y}$$

$$\gamma_i = \frac{I}{Y}$$

where γ_c and γ_i denote the steady state ratios of consumption-output and investment-output, respectively. Note that, even disentangling government spending in its components of expenditure, the steady state of consumption does not depend on the fraction of non-Ricardian consumers (as reported in Appendix).

5 Model Simulations

We now explore the quantitative implications of the model, first examining the parameters used in the calibration model (Subsection 5.1). We then analyze the structural model presented above by matching its implied impulse responses with those obtained from the SVAR. We carry out simulation experiments of the effects of government expenditure components within the framework of our structural model.

5.1 Calibration of the Parameters

We propose a model calibration with quarterly data starting from "standard" parameters extracted from new Keynesian literature. While here we discuss briefly the model parameters, Table 4 summarizes their values and sources. Thus, the discount factor, β, is set at 0.99, which implies an annual steady state real interest rate of 0.04. while depreciation rate, δ, is set at 0.025 per quarter, which implies an annual depreciation on capital of 0.10. In addition, α, at 0.30, which roughly implies a steady state share of U.S. labour income in total output of 0.70. In addition, we fix the parameter capturing the mark-up, μ^p, at 0.2. The fraction of non-Ricardian households, λ, is set at 0.5, a value which is in line with the one assumed by Galí et al. (2007), within the range of estimated values in the literature (see Mankiw, 2000).

The probability of firms keeping their prices unchanged, θ, is fixed at 0.75 (see Bilbiie et al., 2008). The value for the elasticity of wages with respect to hours worked, φ, is set at 0.2, in line with the calibrations of Rotemberg and Woodford (1997, 1999). Following King and Watson (1996), the elasticity of investment with respect to q, η, is fixed at 1. Lastly, we follow Clarida et al. (2000) in setting the parameter, capturing the response of the monetary authority to inflation, ϕ_π, at 1.5. This value clearly satisfies the Taylor principle.

Now we focus on the parameters describing the fiscal sector which are estimated from our sample. In equation (6), we set the parameters capturing the responses of civilian

(ϕ_{nm}) and military (ϕ_m) expenditures to taxes, respectively. These values are obtained as the difference of the estimated effects of the VAR in civilian/military expenditures and the budget deficit. In line with the findings in the literature, the estimates for our sample are of ϕ_{nm}=0.16 and ϕ_m=0.18.

We also estimate the persistence parameters of civilian and military expenditures, ρ_{nm} and ρ_m, according to the procedure proposed by Marques (2004), in which the absence of mean reversion of a given series is measured by using the following statistic:

$$\rho = 1 - \frac{n}{t} \tag{12}$$

where n stands for the number of times the series crosses the mean during a time interval with t observations. Montecarlo simulations have shown the correctness and consistence of this estimator to obtain measure of persistence.

Our VAR-based estimates indicate the lower persistence of civilian spending shock, whereas the higher persistence appears in the estimated patterns of military expenditure. By using the persistent estimator in equation (12), after detrending the time-series of the fiscal components, we estimate $n = 60$ for civilian and $n = 8$ for military spending, such as we have $\rho_{nm} = 0.7$ and $\rho_m = 0.97$, respectively[12].

Finally, given ρ_{nm}, ρ_m, ϕ_{nm} and ϕ_m, we calibrate the parameter ϕ_b such that the dynamics of civilian spending (9), military expenditure (10) and debt (7) are consistent with the horizon at which the deficit is back to steady state, matching our empirical VAR responses of the fiscal deficit. Thus, we fix ϕ_b equal to 0.1.

[12]The persistences can also be obtained by the AR(1) coefficients that match the half-life of the estimated government expenditure responses. We estimated them for civilian and military expenditures and the results were similar to the ones based on the hypothesis of the absence of mean reversion.

Table 4: Calibrated Parameters of the Model

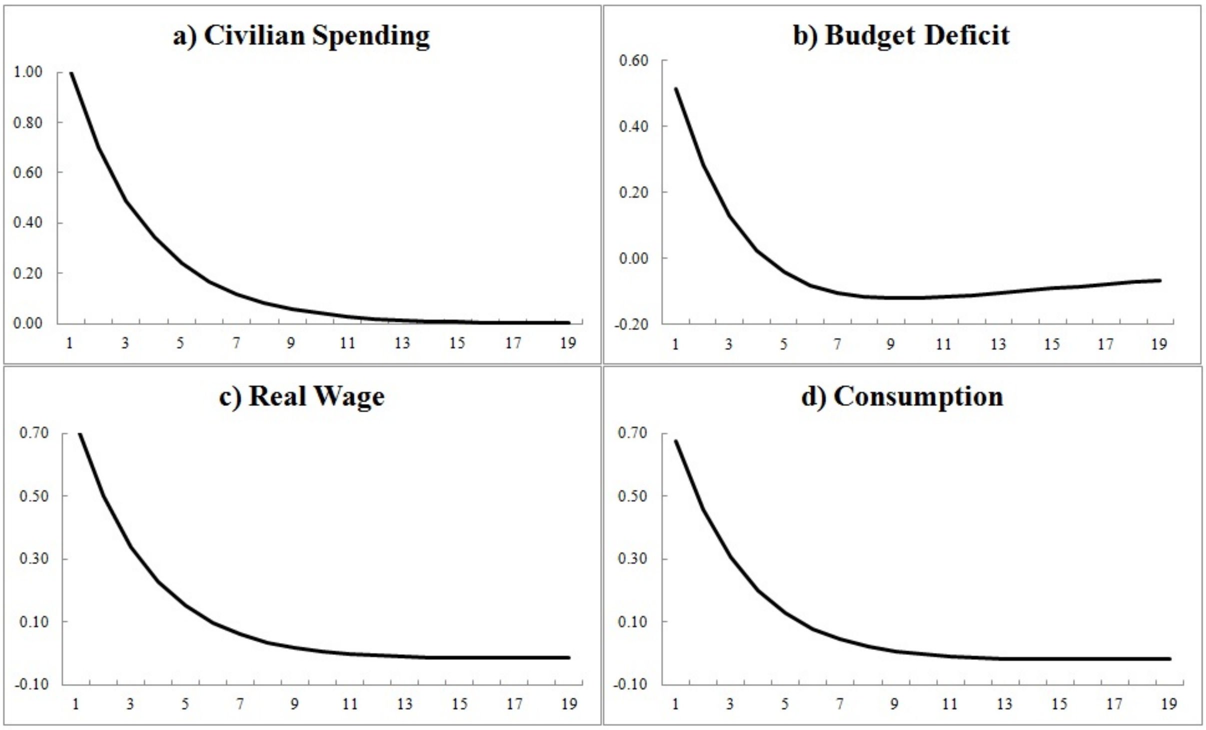
Parameter	Symbol	Value	Target/Source
Discount Factor	β	0.99	Steady state real interest rate: 0.04
Elasticity of Investment wrt q	η	1	King and Watson (1996)
Depreciation Rate	δ	0.025	Annual depreciation on capital: 0.10
Fraction of non-Ricardians	λ	0.5	Galì et al. (2007)
Capital Share	α	1/3	Labour share: 70%
Elasticity of Wages wrt Hours Worked	φ	0.2	Rotemberg and Woodford (1997, 1999)
Mark-up Parameter	μ^p	0.2	Galì et al. (2007)
Probability of Price Fixed	θ	0.75	Average price duration: 4 quarters
Policy Rate Response to Inflation	ϕ_π	1.5	Clarida et al. (2000)
Response of Taxes to Civilian Spending	ϕ_{nm}	0.16	Estimates from our data sample
Response of Taxes to Military Spending	ϕ_m	0.18	Estimates from our data sample
Response of Taxes to Budget Deficit	ϕ_b	0.1	Calibrated according our estimates
Persistence of Civilian Spending	ρ_{nm}	0.7	Estimates from our sample
Persistence of Military Spending	ρ_m	0.97	Estimates from our sample

Notes: Calibration of the parameters according quarterly data.

5.2 Quantitative Implications for the Model with Heterogeneous Fiscal Policy Shocks

We begin by considering the baseline model in which the fraction of non-Ricardian households is large enough ($\lambda = 0.5$) and the probability of firms keeping their prices unchanged (θ) is equal to 0.75. Figure 3 and 4 show the IRFs of the variables to positive civilian or military spending shocks. The sizes of these shocks are normalized to 1% of the steady states of the respective government expenditures.

We start by analyzing the implications of the model for two fiscal variables, i.e. the specific government spending and the budget deficit. Graphs a) in Figures 3 and 4 display that the model is able to mimic different persistence in military and civilian expenditures. In particular, the IRFs show very similar patterns of civilian spending compared to total government expenditure found in the literature (Galí et al., 2007), whereas the model accounts for the higher level of persistence of VAR-estimates with respect to military spending shock. The model does a better job of explaining the response of the budget deficit to fiscal shocks. The decomposition of government purchases mimics their contrasting responses, enough so as to be close to our point estimates. As a first conclusion, if we do not set different behaviours in financing government expenditure, the explicative power of the model may deteriorate markedly, offsetting the heterogeneity of the responses related to the source of financing the government spending. With respect to civilian shock, a persistent and positive response to military spending shocks, emerges. These results are in accordance with the idea that policy-makers in periods of uncertainty, like wars or threat episodes, perceive the conflict challenges and their unpredictability by developing preferences to postpone the taxation to the future generations.



Notes: The shock is normalized to 1% of civilian expenditure in steady state.

Figure 3: Dynamic effects of civilian spending shock

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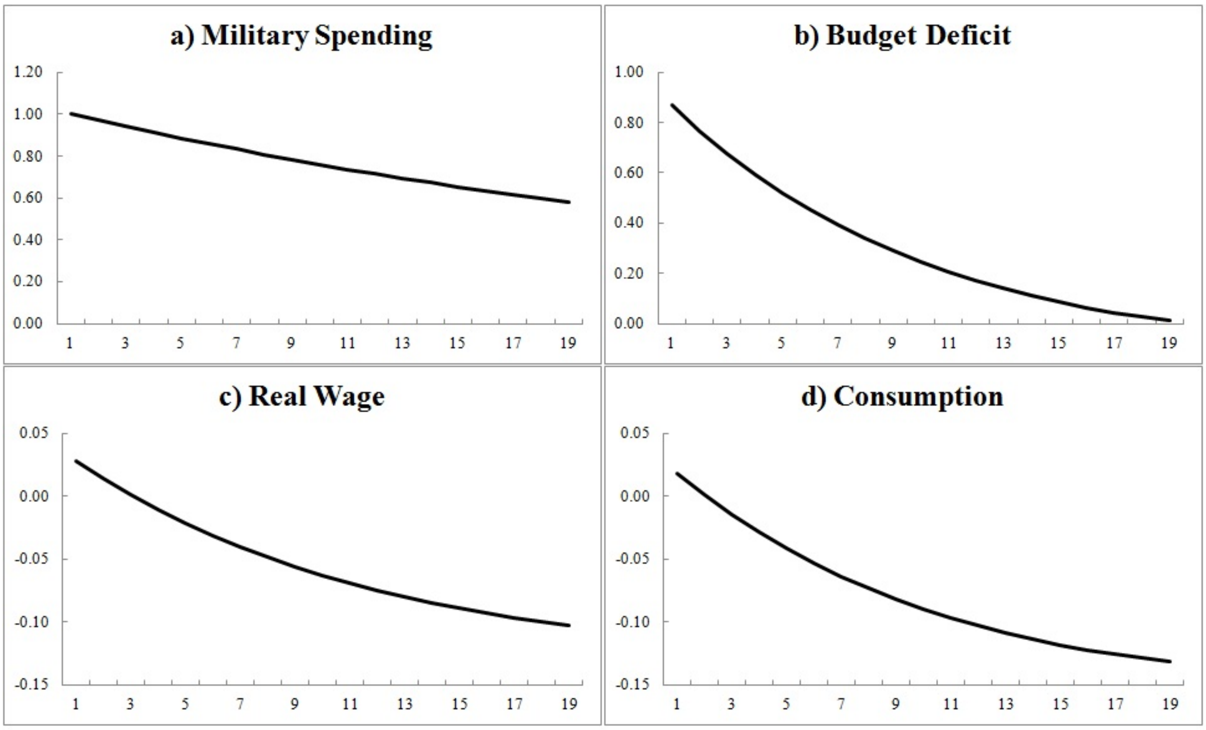

Notes: The shock is normalized to 1% of military expenditure in steady state.

Figure 4: Dynamic effects of military spending shock

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The model closely reproduces the response of consumption, which now rises in a pronounced way in civilian spending, but it is slightly negative to military spending shocks. We state that the key reasons for explaining this result are based on how differences in persistence of fiscal policy shocks act on the expectation of net wealth effect of Ricardian consumers, in addition to the transmission channel of the budget deficit. Although we know that the basic intuition for explaining consumption response is based on the interplay between labour demand and supply, here the complexity of the fiscal transmission channels for specific government spending shocks is enhanced, because they are linked heterogeneously with Ricardian and non-asset holder consumers. Based on the business cycle models of "crowding-out" effects in consumption (Baxter and King, 1993), the higher persistence of fiscal variables can increase the present discounted value of taxes and the wealth effect on Ricardian consumers. Thus, since the response of consumption to the components of government spending shocks depends on the positive or negative reaction of the real wage, an high response of the real wage implies a large movement of private consumption in response to these shocks. According to the results shown in graphs c) and d) of Figure 3, this implies that an increase in civilian spending produces a lower negative wealth effect on Ricardian consumers with respect to the opposite case. As a consequence, a positive change in civilian spending implies a shift in the labour supply, previously dominated by labour demand. A "crowding-in" effect therefore occurs, and private consumption increases. Conversely, as we can note from graphs (c) and (d) of Figure 4, the prediction of the "crowding-out" effect generated by a positive military expenditure shock is based on the negative wealth effect by labour demand which prevails over (non-negative) labour supply.

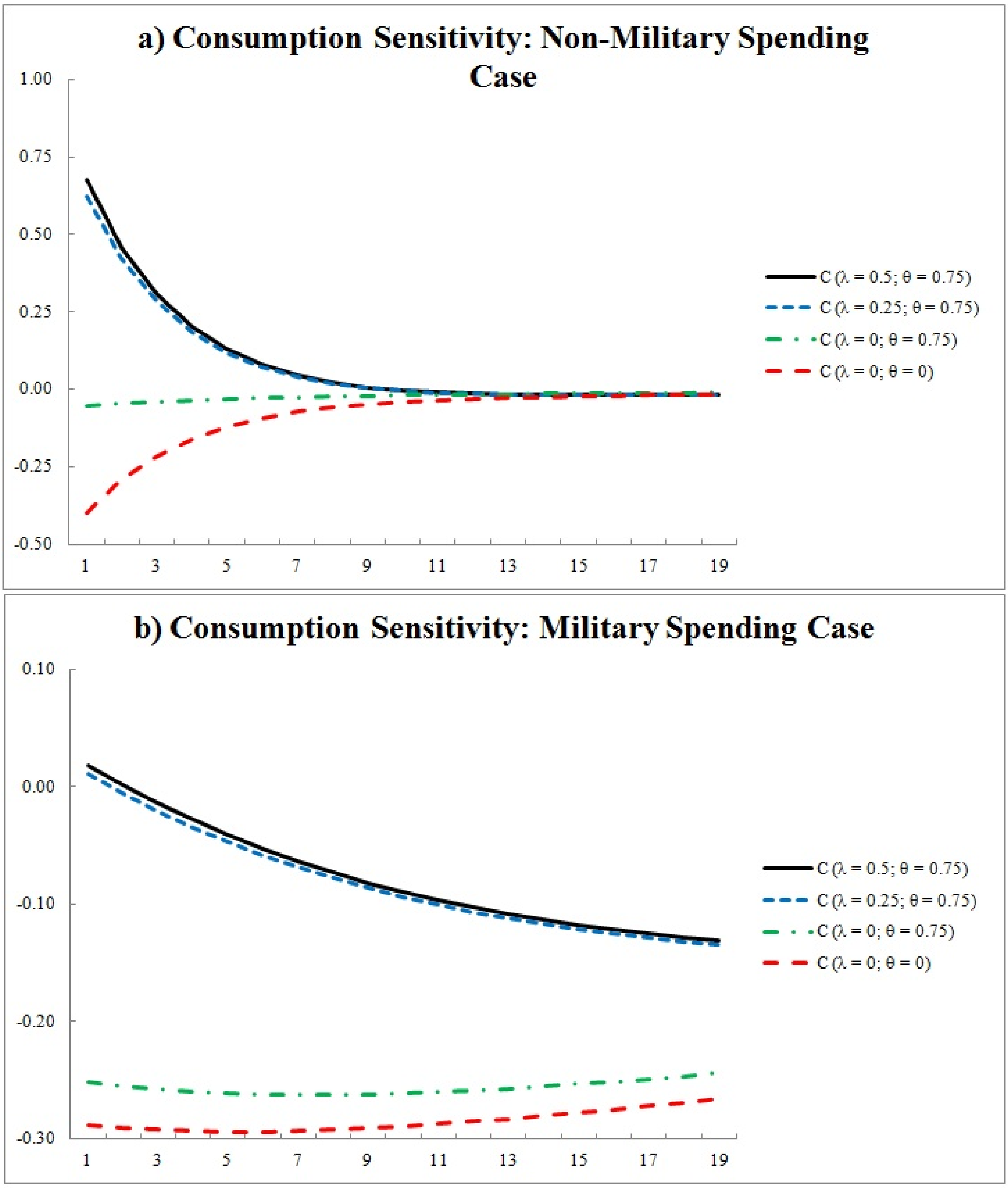
Here allowing for heterogeneous fiscal shocks alleviates the salient quantitative shortcomings of the aggregate government spending model and enables us to match the timing of the consumption response much better. Note that, when we account for the transmission heterogeneous channel of deficit financing of military spending shocks, we can model a different reduction of the income effect on non-Ricardian consumers. The approach to specific components of government expenditure may indeed be justified not only by assuming an exogenous fraction of credit constrained agents, but also for the existence of a precise portion of government spending which stimulates a fraction of consumers, specifically those who directly and indirectly benefit by that expenditure and who consume out of it as a result (Giavazzi and McMahon, 2012).

Until now, we have shown the amplifying effects of the introduction of non-Ricardian consumers and sticky prices: the consumption response is expected systematically higher than that generated by the neoclassical model - when prices are fully flexible, and/or when all consumers are Ricardian, irrespective of the sector of expenditure. As an exercise, Figure 5 compares the dynamic responses of private consumption to positive civilian (graph a)) and military (graph b)) spending shocks under our baseline calibration and with different parameterizations of λ and θ. In both the civilian and military cases, while the first three IRFs mimic different fractions of non-Ricardian households, λ, at 0.50 (our benchmark), 0.25 and 0, with the probability of firms which keep their prices unchanged, θ, equal to 0.75, the fourths IRF correspond to the neoclassic model calibration, which excludes non-Ricardian consumers and considers fully flexible prices (e.g., $\lambda = 0; \theta = 0$).

Graph a) of Figure 5 indicates that although the short-run effect is emphasized when the model is simulated with the higher share of non-Ricardian consumers, even for a share of non-Ricardian consumers λ equals to 0.25, the model generates a positive impact on consumption after a positive fiscal policy shock. Only the closeness of neoclassical consumers' parameterization reduces the impact of a civilian positive shock on private consumption to be non-significant. This result is emphasized in simulated neoclassical model, where the positive civilian shock appears to affect negatively consumption, an estimate in sharp contrast with the empirical evidence shown in Section 3.

Similarly, moving from our new Keynesian benchmark toward models with neoclassic characteristics, we find that the negative response of consumption to a positive military spending shock is strengthened and significant (graph b)). The magnitude of negative impact is in accordance with the findings in the defence economics literature using partial equilibrium specification[13] and, from our perspective, is explained by the exclusion of non-Ricardian consumers from the population of the investigated economy.

[13]See, for example, Pieroni (2009).



Notes: solid black line: new Keynesian case; dotted red line: neoclassical case; dotted blue and green lines: intermediate cases.

Figure 5: Sensitivity analysis: baseline vs. neoclassical model

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6 Conclusions

This paper analysed the heterogeneous effects of fiscal policy shocks on consumption. The particular feature of our analysis is that we explicitly allowed for the impact of both military and civilian spending. We used time-series U.S. data to reproduce IRFs of these government spending components, emphasizing the differences with the current literature addressed to evaluate the effects of aggregate government spending shocks. Most interestingly, when we examined IRF estimates of components of fiscal policy, we found that civilian spending mimics patterns in the variables close to aggregate ones, while a negative impact was found between military spending shock and consumption response. This contrasting result is mainly presumed to depend on the interplay of labour supply and household demand and on contrasting budget deficit responses. We therefore examined whether a new Keynesian model may account for these findings.

Our main results are as follows. Focusing on changes in military spending, we were able to calibrate the negative consumption response of the VAR-estimates, identifying two specific channels. Firstly, a positive response of the budget deficit, through which military spending is generally financed, to military shocks in presence of non-asset households, generates a less positive consumption response. However, when we calibrated the model with the higher estimated parameters of persistence in military with respect to civilian spending, its quantitative performance was enhanced and does not allow the findings against the data to be rejected. That is, the crowding-out effect in Ricardian households, generated by the persistence response of own shock on net wealth of this government shock, can offset the "Keynesian" result produced by the deficit financing channel. As a corollary, in a new Keynesian model, the lower persistence of civilian expenditure from its own shocks can therefore predict a positive and significant response in consumption.

Although we believe that this analysis is a useful contribution to more effective management of fiscal policy tools on the expenditure side, it does leave several interesting questions open for future research. Firstly, the general validity of our findings is certainly limited by the closed-economy one-country investigation. We believe that comparative analysis would give a more complete answer to our original question. Secondly, issues in estimating the parameter of non-Ricardian households has received increasing interest in the macro-econometric literature. Obviously, a framework which includes Bayesian estimation provides opportunities for future research.

Appendix: Steady State Analysis of the Components of Fiscal Policy

Here we show that the steady state ratio of consumption to total output does not depend on the fraction of non-Ricardian consumers. Note that the market clearing condition for final goods implies:

$$Y_t = C_t + I_t + NM_t + M_t \quad \Rightarrow \quad C_t = Y_t - I_t - NM_t - M_t \tag{A1}$$

and in steady state:

$$C = Y - I - NM - M \tag{A2}$$

Dividing by Y and knowing that $\frac{I}{K} = \delta$, we can write:

$$\gamma_c = 1 - \frac{\delta\alpha}{\alpha\frac{Y}{K}} - \gamma_{nm} - \gamma_m \tag{A3}$$

where $\gamma_c = \frac{C}{Y}$, $\gamma_{nm} = \frac{NM}{Y}$ and $\gamma_m = \frac{M}{Y}$.
When we consider the marginal product of capital:

$$\alpha\frac{Y}{K}\lambda_t(j) = R^k \tag{A4}$$

the first order condition of the intermediate firm's problem in steady state:

$$MC = \frac{1}{\mu_p} = \lambda_t(j) \tag{A5}$$

we obtain:

$$R^k = \frac{\alpha Y}{\mu_p K} \tag{A6}$$

Let:

$$R^k = \frac{1}{\beta} - 1 + \delta \tag{A7}$$

we can equate:

$$R^k = \frac{1}{\beta} - 1 + \delta = \frac{\alpha Y}{\mu_p K} = R_t^k \tag{A8}$$

solving for:

$$\frac{1}{\beta} - 1 + \delta = \frac{\alpha Y}{\mu_p K} \quad \Rightarrow \quad \alpha \frac{Y}{K} = \mu_p \left(\frac{1}{\beta} - 1 + \delta \right) \tag{A9}$$

Lastly, we obtain:

$$\begin{aligned}
\gamma_c &= 1 - \frac{\delta\alpha}{\alpha\frac{Y}{K}} - \gamma_{nm} - \gamma_m \\
&= (1 - \gamma_{nm} - \gamma_m) - \frac{\delta\alpha}{\alpha\frac{Y}{K}} \\
&= (1 - \gamma_{nm} - \gamma_m) - \frac{\delta\alpha}{\mu_p\left(\frac{1}{\beta} - 1 + \delta\right)}
\end{aligned}$$

This result confirms that the steady state ratio between consumption and output is independent from share of non-Ricardian consumers.

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