Fiscal policy, pricing frictions and monetary accommodation.

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Abstract

We investigate the theoretical conditions for effectiveness of government consumption expenditure expansions using US, Euro area and UK data. Fiscal expansions taking place when monetary policy is accommodative lead to large output multipliers in normal times. The 2009-2010 packages need not produce significant output multipliers, may have moderate debt effects, and only generate temporary inflation. Expenditure expansions accompanied by deficit/debt consolidations schemes may lead to short run output gains but their success depends on how monetary policy and expectations behave. Trade openness and the cyclicality of the labor wedge explain cross-country differences in the magnitude of the multipliers.

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Key words: Government consumption expenditure shocks; pricing frictions; monetary policy accommodation; debt and inflation dynamics.

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1. Introduction

The industrialized world suffered over the last few years a number of large negative shocks, initially driven by sharp declines in house and stock prices and by a tightening of credit and financial conditions. The collapse in output and the increase in unemployment produced a loss of confidence that considerably intensified the recessionary pressures. Policy institutions responded with measures that dealt with the solvency of financial institutions. Central banks, on the other hand, reduced interest rates to unprecedented low levels to support aggregate demand and used non-conventional quantitative or credit easing measures to reduce risk premia and to provide liquidity to the financial sector. Despite all efforts, credit remained tight and aggregate demand weakened rapidly. There were important spillovers from industrialized economies to less developed ones increasing the concern that the world economy might be moving into a deep and prolonged recession.

Given that nominal interest rates approached or hit the zero lower bound and that the room for maneuvering credit was limited by the inability of the banking system to properly function, the scope for further monetary stimulus was limited and attention turned to fiscal policy. At the beginning of 2009, governments around the world announced major two years stimulus packages to sustain employment and growth. The packages were extraordinary in size (reaching up to 2 percent of national GDP) and in breath. The U.S. Congress, for example, approved 787 billion dollars of additional spending, transfers and tax reductions with the 2009 *American Recovery and Reinvestment Act*; the European Union initiated the *European Economic Recovery Plan,* while national governments announced their own plans, see e.g. the '' Pacchetto Fiscale'' in Italy, the ''Plan E'' in Spain, the ''Plan de Relance'' in France, the ''Konjunkurpaket I &II'' in Germany and the ''Pre-Budget Report'' in the UK. The legislation raised old questions concerning the effectiveness of temporary expenditure expansions in lessening the depth and duration of the recession, but also new ones, regarding the preferred mix of fiscal actions.

The expansionary impulses were considerably reduced during 2010 in Europe when the sovereign debt crisis, following the adjustments needed to bring fiscal solvency to Greece and Ireland, questioned the sustainability of the debt that would accumulate with the planned expenditure packages. In the U.S., instead, additional expenditures for infrastructures and credits for the automobile and the housing industries were legislated but concerns about the magnitude of the debt emerged. Beside the long-run sustainability of deteriorating fiscal positions, questions concerning the inflation consequences and the long run crowding-out effects of the debt accumulation were asked with increasing frequency.

The economic impact of the announced programs has been difficult to assess and the recent reversal of spending plans, combined with debt consolidation attempts, makes the task even more complicated. A number of authors have tried to measure the effects of the announced measures but the answer has been contradictory (see e.g. Romer and Bernstein (2009); Cogan, et al. (2010), or Cwik and Wieland (2009)). Proponents of fiscal stimulus typically emphasize traditional Keynesian multiplier effects: when consumption is solely a function of after-tax income, a deficit-financed increase in government spending boosts total spending more than one for one. The increase in output brings about higher revenues which

can contain the increase in government debt or even eliminate it, if the fiscal stimulus is properly phased-out as output reaches its potential. Since in globally integrated economies, domestic spending may partly be diverted to imports, proponents of fiscal expansions have typically called for coordinated actions, both across the Atlantic, and within Europe. Critics of fiscal stimulus argue that government spending displaces private spending and reduces domestic competitiveness. Deficit financed government spending increases, in fact, drive real interest rates up, inducing private savings to increase and private expenditure to fall. In addition, if the terms of trade are positively correlated with the real interest rates, the foreign spending component may also be reduced. Finally, since the real interest rate increases, debt may quickly raise to an unsustainable level. Thus, corrective measures will be required and this combination of initial expenditure increases and expenditure cuts or tax increases at later dates may generate perverse output effects. Such a bleak point of view is not shared by all critics of fiscal stimuli. By reducing debt, governments may generate expectations of permanently lower future costs (lower principal and lower interest payments) and stimulate current private spending via a permanent income mechanism. Thus, debt consolidations could be expansionary rather than contractionary. Unfortunately, the empirical evidence on this issue is also contradictory (see e.g. Coenen et al. (2008), Forni et. al (2010) or Afonso (2010)). In general, the uncertainty surrounding the consequences of fiscal measures reflects the lack of consensus on how close to a pure Keynesian framework developed economies are.

Proponents of the fiscal stimulus have also argued that the current conditions are special, in the sense that both empirical evidence obtained from historical data and the predictions of theoretical models are not well suited to explain the effects that government spending increases and debt consolidation schemes may have today. In other words, the current situation - in which many central banks are more likely than normal to keep interest rates low for a protracted time period - makes existing empirical evidence less relevant, because information about the effects of fiscal stimulus are obtained when central banks more aggressively act to keep inflation and inflation expectations down. Similarly, calibration exercises conducted with dynamic stochastic general equilibrium models may not provide reliable information about the effects of planned government spending increases, even if the models were correctly specified and policy actions appropriately designed, because the parameters historically estimated are unlikely to describe well current conditions. For example, as suggested by Barro and Redlick (2009), the responsiveness of the labor supply to the fiscal expansion may be state dependent and stronger when the unemployment rate is large. Similarly, expectations of debt sustainability may vary with the state of the economy.

Hall (2009), Woodford (2011) have recently used simple analytical frameworks within the mainstream New Keynesian paradigm to understand the effects of government spending in general, and to evaluate in which sense current conditions are special relative to historical experience. Coenen et al. (2010) have performed similar exercises in seven large scale models used in the main central banks of the developed world and in international institutions. The general conclusions these authors reach are simple: in normal conditions, expenditure increases induce modest aggregate demand effects. The short run effects could be magnified if spending increases come with provisions of future spending cuts (but not future tax increases), if monetary policy is accommodative, if pricing frictions are important, or if the price markup is strongly countercyclical. Finally, as Christiano et al.

(2009) and Erceg and Linde (2010) show, the timing of expenditure increases is crucial to determine the debt costs of the measures and the magnitude of the output multiplier effects.

This paper empirically investigates whether the necessary conditions set up in theory for government expenditure expansions to be effective hold in the data. We take the predictions of a large class of New Keynesian models currently used in academic and policy institutions at face value and ask whether theoretical conditions for fiscal effectiveness are relevant on average, and in special circumstances capturing some features of the current situation. We wish to evaluate whether one is justified in making the claim that current expansions can produce consequences which are different from those obtained in other historical episodes and ask whether (i) output multipliers could be larger, (ii) debt may become uncontrollable and (iii) inflation responses may give monetary authorities room for maneuvering nominal interest rates. The focus is on the short-run effectiveness of the expansions but we occasionally discuss long run consequences of current measures.

We study the questions of interest with a standard structural VAR model. However, we use state-of-the-art techniques to produce expenditure shocks with the required characteristics and explicitly quantify the uncertainty due to parameter estimates and shock identification. We recover spending shocks using sign restrictions on the response of expenditure, deficits, and output growth and distinguish normal situations from the current one by imposing additional restrictions on the dynamics of tax receipts, inflation and/or the magnitude of the shocks. We also evaluate the effects of consolidation schemes by imposing further restrictions on the dynamics of deficits or debt. To verify the predictions of the theory, we focus attention on the dynamic responses of the real interest rate, which is determined by the interaction of fiscal and monetary policy decisions; and on those of the real wage and of the labor wedge which depend, among other things, on the frictions present in labor and goods markets. Output multipliers, debt and inflation dynamics are used to compare the effectiveness of different policies and the dynamics of government bond yields and of the consumption to output ratio to understand their broader macroeconomic effects.

One unique feature of our investigation is a comparison of the effects of expansionary spending shocks in the US, the Euro area (EA) and the UK. While one can guess that the same measures may not be appropriate to expand output (and decrease unemployment) for all countries and all states of the world (as noted in Spilimbergo et al. (2009)), most empirical analyses failed to draw general conclusions about the suitability of current packages because they have focused on the experience of individual countries. Given the heterogeneities in size, product market regulation and labor market rigidities present in the three economies, our analysis can shed light not only on whether and when fiscal policy could be used to boost aggregate demand, but also inform policymakers on the role of market frictions and institutions in determining the magnitude of the multipliers.

Our work departs from the existing ones along a number of other dimensions. First, rather than examining the sign of consumption and investment responses, as it is common in the literature, we study the dynamics of the real wage, the real interest rate and the labor wedge since, in theory, they give us the most effective information about the questions of interest. Second, while most of the policy debate focuses on the magnitude of the output effects one should expect from current packages, we are instead interested in assessing whether the

economic conditions under which the current packages have been designed could make fiscal expansions have a larger role than they had in history. Third, our focus on fiscal and monetary interaction allows us to study whether lack of coordination has prevented fiscal policy to be more effective than otherwise would be. Finally, since nominal rigidities are, in theory, crucial elements to deliver sizable multipliers, our investigation provides an indirect test of the appropriateness of the mainstream New-Keynesian paradigm.

Since in the three countries we analyze legislated programs primarily involve increases in government consumption expenditure rather than increases in government investment, transfers or cut in taxes – increases in government consumption account for over 60 percent of the total amount of the packages - we focus attention on the effects of government consumption expenditure shocks only. This restrictive focus prevents us to study which fiscal instrument could be more effective in lessening the current recession, but has the advantage of maintaining a tight link with the current situation.

The rest of the paper is organized as follows. Section 2 highlights the theoretical considerations that guide our empirical analysis and reviews the existing literature. Section 3 describes the data and the methodology. Section 4 presents our findings. Section 5 summarizes the results and highlights some policy conclusions.

2. Some theoretical considerations

There is a considerable debate in the literature concerning the domestic effects of unexpected expenditure increases or tax reductions and their international spillovers. Much of the debate has initially focused either on the sign of the impact responses of consumption and the investment or on the magnitude of output multipliers. Since this literature is not concerned with normative statements, the presumption is that the larger are the responses of either output or some of its private expenditure components, the more benign is the policy. Empirically, the sign of consumption and investment responses is controversial: positive and negative responses of one or both variables can be found depending on the model specification and the exact measurement of the variables (compare, for example, Blanchard and Perotti (2002), Burnside et al. (2004) and the evidence in Caldara and Kamps (2008)). There is also considerable heterogeneity in the magnitude of estimated output multipliers: values varying from 0.5 to 3 or even larger have been obtained by researchers (see e.g., Mountford and Uhlig (2009), Barro and Redlick (2009) or Romer and Bernstein (2009)).

2.1. Consumption and investment responses in theory

Existing closed economy general equilibrium theories have sharp predictions regarding the sign of consumption responses and the magnitude of output multipliers in response to government consumption spending shocks, while there is more uncertainty about the sign of the investment responses. With standard time additive preferences and a competitive labor market, when government expenditure is unproductive and yields no utility to private agents, temporary, deficit financed government expenditure increases crowd out private consumption and generate output multipliers which are below one. This is true in both

neoclassical and New Keynesian models, and in the latter case, when either price or wage frictions or both are present, as long as monetary policy is conducted with a standard Taylor rule (a model of this type and its predictions are presented in appendix A).

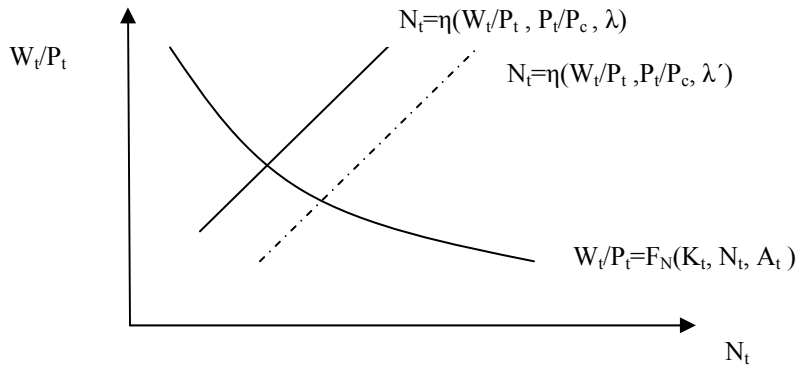
The reason for this outcome is simple. Increases in government consumption expenditure reduce the portion of output available for private uses. Thus, unless agents considerably increase productive inputs, either consumption or investment or both must fall. The negative wealth effect increases labor supply but the effect on capital input is ambiguous. In general, when the production function displays decreasing returns to scale, output will increase by less than the increase in government consumption. Since in these models a permanent income motive is in place, the increase in public deficit will increase the real rate, making private consumption expenditure fall and private saving increase to match the fall in public savings. The output effects of expenditure increases can be magnified if public consumption expenditure yields utility (see e.g. Bouakez and Rebei (2007)) or if it creates production externalities (see e.g. Baxter and King (1993)). The effects could also be larger if preferences are represented with different functional forms (see e.g. Monacelli and Perotti (2008)), if increasing returns to scale are allowed in production (see Deveraux et al. (1996)), or if a share of agents consume a constant fraction of income (see e.g. Galí et al. (2007)). However, even in these cases, it is difficult to simultaneously produce output multipliers exceeding one and consumption responses which are significantly positive.

Given the large measurement error present in consumption and output data and the heterogeneous evidence on the conditional dynamics of these variables, several authors have tried to assess the effects of government consumption expenditure disturbances using easier to measure or empirically less controversial variables. For example, Rotemberg and Woodford (1992), Galí et al. (2007) look at the dynamics of hours; while Caldara and Kamps (2008), and Burnside, et al. (2004) examine a number of macroeconomic variables and important sectorial aggregates. These studies add valuable empirical information but robust stylized facts are typically hard to find, making conclusions whimsical.

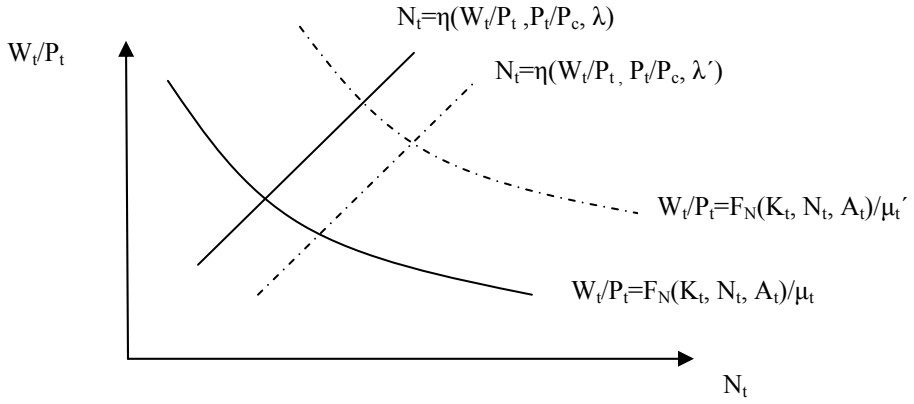
2.2. The dynamics of the real wage

Hall (2009) and Woodford (2011) have examined the conditions under which government consumption expenditure shocks can have large output effects and induce positive consumption dynamics in simple models featuring a variety of market arrangements and government policies. Their analysis points out that a necessary condition for both outcomes to be true is that the equilibrium real wage substantially increases in response to the shock. Without it, the increase in employment will be muted, thus making the output expansion limited. As emphasized in Pappa (2009), the dynamics of the real wage in response to government spending shocks can be used to test Neoclassical versus New-Keynesian models of transmission. In neoclassical models an increase in government spending raises labor supply because of a negative wealth effect. With perfect competition and diminishing returns to labor, the shift in labor supply rises hours and drives productivity and real product wages down (see first box in figure 1). In contrast, in New Keynesian models with imperfect competition, booms produce price wars. Thus, a rise in government spending lowers the markup of price over marginal cost monopolistic competitive firms charge,

a) Competitive model



b) Pricing frictions



c) Increasing returns to scale

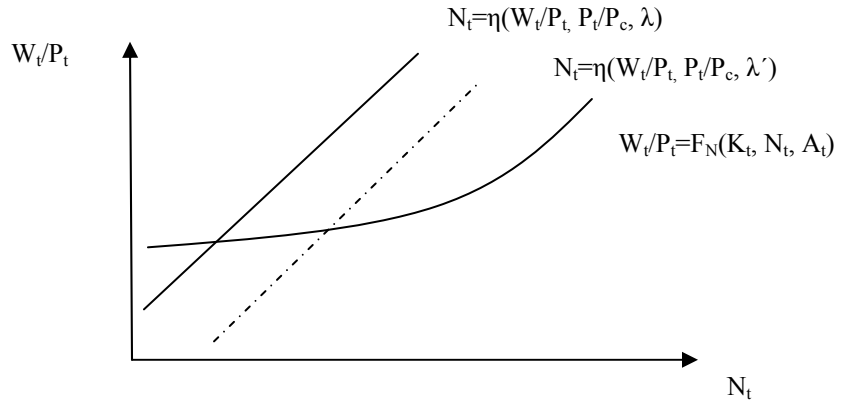


Figure 1: Labor market adjustments in response to government consumption spending shocks. W_t/P_t is the real product wage, P_c is the consumption deflator, λ is the marginal utility of wealth and η is the Frisch labor supply function. F_n is the marginal product of labor, K_t is capital, N_t is labor, A_t is a technological shifter, μ_t the labor efficiency wedge.

rising both real wages and hours, despite a productivity decline. As the second box in figure 1 indicates, the labor supply and the labor demand both move, making it possible for real wages to increase, if the slopes of the curves and the magnitude of the movements are conventional, and for employment to expand more than in the first box. If increasing returns to scale in production are added to monopolistic competition in the product market, an increase in government spending raises real product wage, hours, and productivity (see e.g. Deveraux et al (1996)). As the third box of figure 1 shows, the labor demand curve is upward sloping in these models and shifts in the labor supply curve can increase real wages and employment substantially, without any need for the labor demand curve to move.

Empirically, little is known about the dynamics of real wages in response to government spending shocks. Pappa (2009) and Perotti (2007) report that aggregate real wages increase in response to consumption spending disturbances, both in US states and in a number of OECD countries; Nekarda and Ramey (2011) find that real wages fall at industry level when there is an increase in government demand for the goods produced by that industry. Differences in the conclusions appear to be related to the measurement of real wages, that is, whether nominal wages are deflated by CPI (the consumption real wage) or by the GDP deflator (the production real wage). Regardless of measurement issues, absolute changes in real wages appear to be moderate in magnitude, therefore casting doubts about the possibility of generating large multipliers effects through the '' labor supply'' channel.

2.3. The dynamics of the efficiency wedge

The second condition Hall and Woodford single out for expansionary government consumption expenditure shocks to have large positive effects on output and consumption is that the labor-efficiency wedge, that is the inverse of the difference between real wages and the marginal product of labor, negatively responds to government spending shocks.

This condition is closely related to the previous real wage condition but not equivalent since the efficiency wedge may display the correct cyclical behavior even if the real wage does not. In standard neoclassical models, even when monopolistic competition is assumed, the efficiency wedge is constant. One way to make it time varying is to assume some form of nominal stickiness. As mentioned, increases in government expenditure increase hours, make the marginal product of labor fall, and increase marginal costs. If prices cannot be instantaneously adjusted, the labor-efficiency wedge must fall to ensure that the labour market equilibrium is reached. If the sensitivity of the labor wedge to output changes is large, sizeable multipliers can be created because the aggregate demand increase is translated less in price increases and more in output expansions.

Price stickiness is sufficient but by no means necessary to induce countercyclical movements in the labor-efficiency wedge. For example, as discussed in Rotemberg and Woodford (1992), if an increase in government expenditure reduces the ability of producers to maintain collusion, multipliers can be uniformly larger than in the case in which producers do not have market power, even without price stickiness. Thus, it would be incorrect to use movements in the labor-efficiency wedge in response to demand shocks to test the sticky price assumption. Similarly, evidence of pro-cyclicality in the labor-

efficiency wedge does not signal failure of the sticky price theory, since countercyclical movements are only necessary to make the output multipliers large.

How does the efficiency wedge behave over the business cycle and, in particular, in response to government spending shocks? Recently, Nekarda and Ramey (2011) find that increases in government demand that raise output and hours in a sector of the industry, lower productivity and real product wages, leaving the efficiency wedge roughly unchanged. Interestingly, evidence reported by Gali et al (2007) and Ramey (2009) indicates that, in the aggregate, labor productivity moderately increases, making increases in real wages a necessary condition, and large increases in real wages a sufficient condition for output multipliers to be large.

2.4. The role of monetary policy

The third condition Hall and Woodford indicate for output changes to be large after an unexpected government consumption expansion is that monetary policy is accommodative. Unexpected increases in government spending will normally increase inflation. If the monetary authority strongly reacts to inflation, as it would be the case in inflation targeting regimes or when aggressive Taylor rules are in place, the real rate would increase, increasing private savings. When instead an unexpected government expenditure expansion is accompanied by a (temporarily) weak response of the nominal rate to inflation, the real rate may fall, stimulating both consumption and investment expenditure. In the unlikely case in which the real rate is unchanged after the spending shock – this requires a one-to-one adjustment of the nominal rate to changes in inflation - the output multiplier is one, since private spending will be unaffected by the government expenditure shock.

Clearly, a mechanism of this type exists only in New Keynesian models. In standard neoclassical models without participation constraints, and abstracting from the case where fiscal policy provides a nominal anchor, private decisions, rather than monetary policy, determine the real rate of interest. Here the real rate always increases in response to government consumption spending shocks since its equilibrium value it is obtained from an Euler equation with predetermined consumption growth. In sticky price models the ability of monetary policy to affect real variables via changes in the real rate of interest makes monetary and fiscal interactions important as far as the magnitude of output multiplier is concerned. Whether monetary policy helps or leans against fiscal policy is an interesting empirical question we will investigate. Notice also that temporary deviations from a Taylor principle do not necessarily affect the determinacy of the equilibrium, if fiscal policy is responsibly acting to curb the resulting debt increase. In addition, as long as deviations from the Taylor principle are temporary, inflation expectations need not be affected.

In models with sticky prices, the ability of fiscal policy to affect the real economy is magnified when the nominal interest rate is stuck at the zero bound. Conversely, well designed fiscal measures may help monetary policy out of a liquidity trap. At the zero bound, monetary policy is unlikely to respond to inflation – the preferences of monetary authorities are likely to shift in this situation. Thus, as long as expansionary expenditure shocks generate some inflation, the real rate will fall making fiscal policy more effective.

An interesting empirical question is whether fiscal actions can generate inflation in general, and in the conditions which have brought the nominal interest rate to zero. Hall (2011) suggests that they did not. One can conjecture that the fiscal stimulus must be large to be able to produce such an effect and that, if the recession which has driven the nominal interest rate to zero is deep and protracted, inflationary effects must be limited. On the other hand, if fiscal policy succeeds in generating inflation, it can give the monetary authorities room to maneuver the nominal interest rate. Such a view seems behind many measures recently taken by the Federal Reserve: the large increase in its balance sheet, in its holding of government debt, and in the liquidity poured into the system are all consistent with an attempt to make the real rate fall, and current and future inflation increase.

Christiano et al. (2009) and Erceg and Linde (2010) have emphasized that the magnitude of the output multipliers induced by government expenditure shocks depend on how much time the economy spends at the zero interest rate bound and on the timing of fiscal actions. In particular, they find that output multipliers are larger when the expenditure expansion is designed and implemented at the time when a shock pushes the nominal interest rate at the zero bound. Delays can cause the fiscal expansion to be much less effective in bringing the economy back to track. In the simulation they run, delays of even one quarter can cut the output multiplier by half and make the debt cost of the expansions much larger.

All these considerations suggest that, in the current conditions, that is, when nominal interest rate is close to zero, when unemployment is high, when inflation is low, and when growth prospects were dim, fiscal expansions could have larger effects than otherwise and '' large'' fiscal actions are probably required to bring the economy back to a growth track.

Simple closed economy models are great tools to build intuition about the mechanics of the transmission of fiscal shocks; but they may be unsuited to shed light on existing events. Practical experience indicates that models with a richer set of sectorial or cross-country interdependencies may make conclusions much fuzzier. Luckily this does not appear to be the case for expenditure expansions. Coenen et al. (2010) examined the predictions of seven medium or large scale dynamic stochastic general equilibrium models used in policy circles and found that the same mechanisms and the same trade-offs Hall and Woodford highlighted are present. Thus, the insights obtained from small scale, closed economy models can be used to analyze potentially open and complex real world economies.

2.5. Ceteris paribus assumptions

Implicit in the discussion of the previous three subsections are a number of a ceteris paribus assumptions, which is useful to spell out in details. The first is that inflation expectations do not change when the unexpected expansions in the government consumption expenditure occur. Both the aggregate supply (Phillips) curve and the aggregate demand curve of the economy, in fact, depend on inflation expectations. If inflation expectations increase when government consumption expenditure expands (for example, because monetary policy is accommodative), the output multiplier may be small, even in the ideal conditions we have described, and the inflation increase larger than otherwise, because outward movements in the aggregate demand are neutralized by inward movements in the aggregate supply.

Thus, the previous arguments assume that the fiscal expansion will not create perceptions of higher future inflation. Conversely, the output effects of fiscal expansions will be maximized when inflation expectations are non-increasing in the fiscal impulse.

The second assumption implicitly made is that, in response to government expenditure changes, the sensitivity of private spending to the real interest rate and output changes is unaffected. For example, all exercises assume that in response to the fiscal disturbances, consumption does not become less sensitive to the real rate and more sensitive to current income, making agents more ''Keynesian'' and less ''Neoclassical''. If the IS (Euler) curve is time varying, as it will be the case if consumers may become credit constrained or more prudent in certain states of nature, the aggregate demand curve may shift and rotate backward, making it difficult to predict both the magnitude and the direction of the output effects of the fiscal expansions.

Finally, future output growth expectations are also assumed to remain constant. In a dynamic setting, the aggregate demand curve is a function of future expected output. If current fiscal expansions change future output prospects, for example, because agents expect higher future distorting taxes, current demand expansions may be completely or partially undone by the expected fall in future output growth. If this occurs, output multipliers could be small, zero, or even negative, even when the theoretical conditions for fiscal effectiveness are satisfied.

2.6. A summary

For government spending disturbances to have substantial output effects the following three conditions should hold: (a) real wages should increase substantially; (b) the labor-efficiency wedge should fall considerably; (c) monetary policy should be accommodative. It is unclear which condition plays the most important role. The first two requirements are likely to boost the supply side effects of the shock, making the aggregate supply flatter, while the latter determines the magnitude of the aggregate demand shift. Non-negative movements in private expenditure are necessary for output to increase following government expenditure shocks in this latter case. However, unless the real wage increases sufficiently to motivate agents to supply the labor needed to make output expansions possible, unless the demand increase is translated in quantity rather than price expansions, and unless monetary policy is accommodative, the increase in government consumption expenditure will simply crowd out private demand or increase inflation.

To the best of our knowledge, the existing literature has not yet examined whether these three conditions hold in the data, whether they are necessary for making output multipliers large, whether they are more likely to hold when the special conditions characterizing today's world economy are in place and, in general, whether the predictions of models with pricing frictions have sufficient support in the data. Auerbach and Gorodnichenko (2010) have studied the effects of fiscal policy in recessions and expansions and found that they are different. Kirchner et al. (2010) also study whether the state of the economy affects the nature of the transmission of fiscal shocks. They notice that the size of the long run output multipliers has declined over time and attribute this fact to a weaker response of the real

wage and a stronger response of the nominal interest rate to government spending shocks. However, neither work addresses the questions of interest in this paper nor provides evidence on the interaction between labor markets, pricing frictions and monetary policy in determining the dynamics induced by government consumption spending disturbances.

Most theoretical analyses assume that increases in government consumption expenditure are financed with lump sum taxes or, if debt is generated, that it will eventually be reduced back to the steady state via lump sum taxation. Furthermore, it is typically assumed that such policy does not affect either government credibility or expectations of future fiscal sustainability. Uhlig (2010) highlights an old but often forgotten issue: the financing of government expenditure matters for the conclusions one reaches. Under the more realistic assumption that only distorting taxes are available, the output multipliers generated by a public expenditure expansion can be negative – the expected distortions due to the tax increase dominates the employment and output gains induced by the shocks. Furthermore, how fast the government seeks to return the debt to its original level affects the magnitude and the sign of the multipliers. An alternative policy, which can potentially produce large positive output effects, is one that cuts distorting taxes now and increases them in the future. Such a policy produces Laffer curve type of dynamics, making deficit and debt accumulation much smaller. In general, who finances the deficit (domestic or foreign residents), how debt consolidations are performed and which instrument is used, are all likely to be crucial to understand the effects of fiscal changes.

Finally, it is worth emphasizing that fiscal expansions are unlikely to exercise an instantaneous effect on the economy. Apart from gestation and legislative delays, there is some evidence that fiscal and monetary policies affect the variability of real variables at different frequencies. For example, Rossi and Zubairy (2009) show that government expenditure shocks explain a large portion of output variability in the medium run, but their ability to affect output variability at business cycle frequencies is small – and the opposite is true for monetary policy. Thus, the fiscal lever may take much longer than the monetary lever to exercise its effects and the lack of noticeable output growth effects in many OECD countries, despite the large fiscal impulse in 2009, appears to be consistent with this fact.

3. The data and the empirical framework

We use quarterly data for the US, the Euro Area (EA) and the UK in the exercise. Data for the US comes from the FRED data base at the Federal Reserve Bank of Saint Louis, the Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS); for the EA it comes from the Area-wide model data base (version 9), and for the UK from the OECD data base and IFS statistics of the IMF. For each country, the variables entering the VARs are: the log ratio of government consumption expenditure to output, the log ratio of total tax receipts to output, the log of one plus the annualized quarter-on-quarter growth rate of real per-capita output, the log of one plus the annualized quarter-on-quarter growth rate of real wages, the log of one plus the ex-post annualized real interest rate, the log of the profit rate; the log of one plus the annualized inflation rate, the log of one plus the yield on long term government bonds, and the personal consumption expenditure to output ratio. The choice of

scaling for each variable ensures that the VAR is roughly free from low frequency movements. Appendix B describes the construction of each variable from the available raw series. For the EA we have also considered the fiscal data bases of Paredes et al. (2009) and Forni et al. (2009). The series for government consumption expenditure and for total tax receipts differ in the three data bases in the 1970s, because of different interpolation procedures used to transform annual into quarterly data and because the sources of information vary. From the early 1990s, the series largely overlap and their correlation is above 0.9. Thus, for the more recent period, it is immaterial which dataset is used.

One may wonder what fiscal disturbances in the EA mean when a central fiscal authority does not exist. However, at least over the last 20 years, discretionary fiscal policy have strongly commoved in the EA (see e.g. Giuliadori and Beetsma, 2008). Furthermore, since aggregate EA fiscal data is a weighted average of the corresponding components of country specific variables, the results we present can be interpreted as driven by shocks occurring in the countries which have the largest weight in the EA.

Ramey and Shapiro (1998) have argued that to properly measure the effects of government shocks, real wages need to be computed deflating nominal wages by a product market deflator rather than a consumption deflator. While the difference is irrelevant in a one-sector model, in a two-sector model the two series may have different dynamics. We have constructed both consumption and product real wages using CPI and the GDP deflator and compared their dynamics in responses to government consumption expenditure shocks. While the consumption real wage typically is more volatile and less correlated with output, government spending shocks induce dynamics for the two series which are quite similar. Thus, we present only product real wages responses.

To measure the labor-efficiency wedge we considered two different series. One is the profit share, i.e. the difference between one and the labor share in output. This measure is a very rough proxy of the wedge and may be contaminated by serious measurement error. The second, which is more related to the theory, uses the difference between the real wage and labor productivity. While the two measures have different levels, they display similar cyclical fluctuations. Thus, we present only results obtained with the first measure.

We employ the ex-post real rate and the inflation rate in the VAR rather than the nominal interest rate and the inflation rate for computational convenience. The results we present, however, are unchanged if the dynamics of the ex-ante real rate (constructed using VAR based inflation expectations) are consider. The yields on long term government bonds are not of direct interest in the investigation but are used to assess deviations from the ceteris paribus assumptions.

The sample period used to estimate the VAR depends on the country. For the US we start in 1984Q1 and end in 2009:4, for the EA we start at 1993Q1 and end in 2008Q4 and for the UK we start in 1993Q1 and end in 2009Q4. The starting date is chosen trying to maintain as much time homogeneity as possible in each country. For cross country comparability, we have also examined the sample 1993Q1-2009Q4 for the US: the results we report are unaffected by this change. In addition, since for the US data is available since the early 1950s, while for in the EA and the UK since the early 1970s, we have examined whether

the conclusions are altered when the longer samples are considered. Overall, the qualitative features of the results are insensitive to the sample period, but the standard errors in the longer samples are larger reflecting the presence of considerable time heterogeneity.

We use four lags for each variable and a constant in the VAR and employ a Bayesian prior to conserve degrees of freedom. The prior is quite standard (see e.g. Canova, 2007, chapter 9), it is described in appendix C and allows analytical computation of the posterior distribution of the VAR coefficients. Using Monte Carlo techniques, we draw 2000 coefficient vectors from these distributions, and for each draw we try to identify a deficit financed expansionary government consumption expenditure shock imposing, at a minimum, three instantaneous sign restrictions: (i) government consumption expenditure increases; (ii) deficit increases; (iii) the growth rate of output increases. Sign restrictions are preferable to more traditional type restrictions for the identification of fiscal shocks because they can be made consistent with the theory that is used to interpret the results – for example, the model in the appendix robustly generates these restrictions when the structural parameters are allowed to vary within a reasonable range and when nuisance features, such as the specification of price stickiness, are modeled in different ways (see e.g. Pappa (2009)). Perhaps more importantly for our purpose, sign restrictions allow us to design expenditure shocks with complex and realistic patterns - more standard approaches based on a triangular decomposition of the covariance matrix or the Blanchard and Perotti (2002) approach, lack this flexibility. We choose to impose only contemporaneous restrictions because existing theories have fragile dynamic predictions for the response of government consumption expenditure, government deficit and output growth. To make sure that sign restrictions hold sufficiently often, for each draw of the coefficient vector, we draw up to 5000 orthonormal matrices rotating the contemporaneous covariance matrix of the shocks – appendix C explains how to do this. Thus, up to 10,000,000 Monte Carlo extractions are performed for each country and in each scenario and, contrary to similar exercises in the literature, the responses we present reflect both coefficient and identification uncertainty.

Finally, we want to stress that, since we are using the log of government consumption expenditure over output and the log of output per-capita in the VAR, the multipliers we construct are not directly comparable to those available in the empirical literature – the log of government consumption expenditure and the log of output are typically employed[1]. In general, the multipliers we present are compatible with those derived in theory when population is exogenously growing and output growth is, on average, positive.

4. The evidence

To facilitate the presentation of the results, we split the discussion in a number of parts.

[1] To have an idea of how to compare, suppose that population does not change and that the partial change operator can be interchanged with the log operator - which is not necessarily the case. Then, the effect of a change in expenditure to output ratio on output (scaled by the steady state values of the two variables) is equivalent to how much the square of output will change when expenditure changes (scaled by the steady state G/Y^2 ratio). Thus, the multipliers found in the literature are, to a first approximation, square root of the numbers we present.

First, we describe the average responses of the three variables of interest and of per-capita output multipliers to government consumption expenditure shocks over the samples – averages are computed allowing for both coefficient and identification uncertainty. Second, to evaluate the importance of the three theoretical conditions, we compare output multipliers when additional constraints are imposed. Third, we examine whether the responses of the three variables of interest and the per-capita output multipliers are different in scenarios that mimic the current economic situation and discuss the debt and inflation consequences of fiscal expansions. Fourth, we consider expenditure expansions which are accompanied by future deficit and debt consolidation provisions.

4.1. What happens on average in the sample?

Figure 2 shows the average responses of real wages, of the real rate of interest, of the labor-efficiency wedge and of the per-capita output multiplier for horizons up to 20 quarters. We report the point-wise median response (red circled line) and the point-wise one standard error posterior interval (blue dashed lines) at each horizon; row 1 refers to the US, row 2 to the EA, and row 3 to the UK.

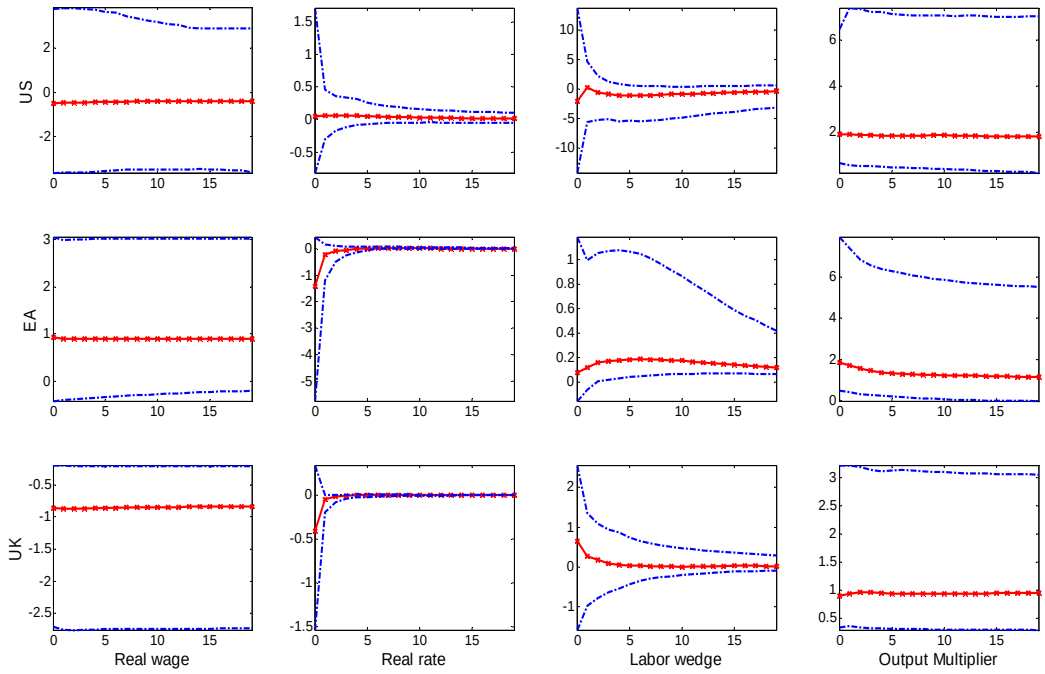


Figure 2: Responses to a deficit financed government consumption expenditure shock and per-capita output multipliers. The horizontal axis reports the horizon in quarters.

Overall, the data is not very informative about the dynamics of the real wage, the real rate of interest and the labor-efficiency wedge in response to deficit financed expansionary government consumption disturbances. In terms of point estimates, the real wage falls in the US and the UK, and increases in the EA; the real rate increases in the US and falls in the EA and the UK; and the labor wedge falls in the US and increases in the EA and the

UK. However, in all countries, responses are insignificant at all horizons. We can think of three potential reasons for this outcome. First, the shocks we have identified mix structural shocks of different types. We find it hard to conceive meaningful theoretical disturbances whose impact implications for government consumption expenditure, the deficit and output growth are identical to the ones we consider. Second, measurement errors dominate. While this is a possibility for the labor wedge measure, it is difficult to believe that the problem is relevant for the real rate. Moreover, since both the consumption real wage and the product real wage display similar responses, measurement error is unlikely to be the main reason for the lack of information in the data. The third possibility is that, in the samples we consider, there are episodes where deficit financed expansionary consumption expenditure shocks induce positive responses of each of the three variables and episodes where the responses are negative. In other words, the identification restrictions we employ are insufficient to get a precise view of the dynamics of these variables. Labor markets, monetary policy and the markups may react both ways, depending on circumstances that the analysis so far has not controlled for.

The dynamics of the real wage in the US are at odds with the characterization of the empirical evidence presented in Ramey (2009). She, in fact, claims that in the US the real wage increases when expenditure shocks are identified though VARs and falls when they are identified with large unexpected military expansions. In contrast, figure 1 shows that the median impact response of the real wage is negative in our VAR. More importantly, the figure indicates that, unless other restrictions are imposed, the responses of the real wage cannot be signed with high probability at any horizons in the VAR systems we consider.

Perhaps unsurprisingly, given that we are unable to sign the response of the three variables that theory singles out as crucial for understanding the magnitude of the output effects of government expenditure shocks, we cannot say much about the magnitude of the per-capita output multipliers either. In the US the instantaneous median estimate is slightly below 2.0 and constant across horizons; in the EA it is also slightly below 2.0 and decreasing with the horizon; in the UK is below 1.0 and increasing with the horizon. However, since the multipliers are imprecisely estimated, we cannot exclude with high probability that they are less than one at any horizon in all three countries.

4.2. Adding identification restrictions

Since the patterns present in figure 2 are quite robust to standard specification changes analyzed in the literature (for example, they are robust to changes in the sample period, the lag length and the transformation of the variables entering the VAR, etc.), one could stop the analysis and simply conclude that the data is unable to provide clear conclusions regarding the relevance of the theory. Rather than giving up the investigation, we study whether inference could be sharpened by adding identification restrictions. Thus, in addition to the constraints on the instantaneous responses of government consumption expenditure, the deficit and output growth, we also restrict either the contemporaneous response of the real wage, of the real rate, of the labor wedge or all three responses jointly. To make sure that the ceteris paribus conditions roughly hold, we also require the responses of bond yields to be instantaneously unchanged. Adding identification restrictions implies

that the response intervals of figure 2 are sliced and certain scenarios eliminated. We want to determine whether the data could have been consistent with certain impact constraints on the real wage, the real rate, and the labor wedge and whether these restrictions help us to better measure output multipliers.

	Average	Adding restrictions			
		r<0	w>0	Wedge<0	All
US	1.93	2.20	0.33	3.26	4.84
	(0.65, 6.47)	(2.03, 2.22)	(0.28, 0.35)	(3.13, 3.28)	(4.70, 4.98)
EA	1.86	2.62	0.15	0.54	3.64
	(0.56, 7.92)	(2.55, 2.69)	(0.11, 0.16)	(0.51, 0.58)	(3.56, 3.73)
UK	0.89	1.90	0.22	0.08	2.20
	(0.33, 3.21)	(1.86, 1.94)	(0.18, 0.25)	(0.05, 0.09)	(2.15, 2.24)

Table 1: Contemporaneous per-capita output multipliers. Median estimates with standard errors in parenthesis.

Table 1, which reports the instantaneous output per-capita multiplier obtained in each of the four exercises we conduct (posterior one standard error intervals are in parenthesis), displays a few interesting facts. First, imposing any of the three restrictions sharpens inference quite a lot and the magnitude of the multipliers is much better measured. Second, adding that the real rate falls in response to government consumption expenditure disturbances makes output multipliers in all countries larger relative to the median we obtain on average. Thus, an accommodative monetary policy is very important for expenditure expansions to be effective. The gain is particularly large for the UK which, it is worth recalling, was in an inflation targeting regime during the sample period. Third, restricting real wages to be positive is insufficient to make instantaneous per-capita output multipliers large. In fact, the per-capita multipliers we obtain in this case are the smallest of all and are in the tails of the distribution of multipliers produced on average. To put this result differently, increases in the real wage are necessary but by no mean sufficient to produce large output expansions. Fourth, imposing that the labor efficiency wedge falls generates different results in different countries: per-capita output multipliers are larger in the US; but in the EA and the UK they are significantly below one. There are two potential explanations for this heterogeneity. It could be that, in the relevant region, nominal frictions are much more important for the US than the other two countries, making the slope of the Phillips curve much flatter in the US than in Europe. Alternatively, the marginal product of labor reacts to changes in fiscal variables in US but not in Europe, thus making it possible to produce a larger output at a given cost. Finally, imposing that all three conditions are satisfied increases the magnitude of per-capita output multipliers in all countries. In the US the gain is the largest; in the UK imposing all the restrictions only marginally increases per-capita multipliers relative to the case where only restrictions on the real rate are used.

Differences in the nature of the three economies may account for the differences in the magnitude of the per-capita multipliers across the rows of table 1. For example, the UK, which is much more open to trade than the EA or the US, has uniformly smaller per-capita

multipliers than the other two countries. However, other important idiosyncrasies seem to matter less. Consider labor market institutions, for instance. It is well known that in the EA the real wage adjusts much more slowly than, say, in the US in response to shocks because of the nature of labor market (in particular, because of the strength of unions and the high replacement costs). Thus, one would expect that imposing a fast response of the real wage to expenditure shock (as it is done in the third column of the table) would make output multipliers larger in the EA relative to the other two countries. Clearly, this is not the case. Similarly, the size of the government does not appear to be relevant to explain magnitude differences. As indicated, e.g. in Gali (1994), the larger is the size of the government, the stronger are the stabilization properties of expenditure shocks and therefore, the largest are output multipliers. On average, output multipliers in the EA – where government size is the largest – and in the US – where it is the smallest – are similar. Thus, having a large public sector is irrelevant when the theoretical conditions we highlight are satisfied.

To summarize, a standard sticky-price New Keynesian model appears to provide useful guidance to understand the mechanisms leading to effective fiscal expansions and when the conditions on the real rate, the real wage and the labor efficiency wedge are satisfied, expenditure increases can lead to large output expansions. Of the three conditions the theory has singled, accommodative monetary policy appears to be the most relevant one and real wages which are sensitive to demand conditions the least crucial one. Cross country differences in the magnitude of per-capita output multipliers appear to be driven by two main factors: cyclicality of the labor wedge and trade openness. Other things being equal, the more open a country and the less reactive the markup to cyclical conditions are, the smaller is the per-capita output multiplier that an expenditure expansion generates.

4.3 Are the conditions of 2009-2010 different?

It is often claimed in policy circles that the current conditions are different from those prevailing, on average, in the past. Commentators often cite the fact that the current recession is deeper than any other post WWII recession; that the fiscal packages came after an important financial crisis; that they were enacted at a time when the ability of monetary policy to stabilize cyclical fluctuations was limited; and that unprecedented global factors matter. To the extent that the current fiscal expansion occurs in a truly unique environment, it is impossible to use past data to learn about its macroeconomic consequences. However, if episodes with similar characteristics could have been realized in the past – in the sense that the existing economic conditions had some probability to have materialized in the sample - we can study whether the three necessary conditions for effectiveness of fiscal policy are more likely to hold in these situations and analyze whether the perceived wisdom that the magnitude of the output multiplier is larger than in normal times is correct or not.

Given the lack of measures of financial tightness in the VAR and the linear framework we use, our exercise is limited in scope. Nevertheless, we can mimic the current situation in two important respects. First, we can analyze the dynamics of macroeconomic variables when the size of the consumption expenditure shock (or the size of the induced deficit) is large relative to historical standards and the nominal rate cannot move in response to the shock. Second, we can study whether consumption expenditure shocks taking place in

recessions, where by this we mean expenditure shocks accompanied by a simultaneous fall in tax revenues and in inflation, are different from those we have recover on average. To produce the first set of circumstances, we impose, in addition to restrictions on the contemporaneous response of expenditure, deficit and output growth, the constraints that the government expenditure to output ratio (deficit to output ratio) increases on impact by at least 1 percent (0.5 percent) and that the nominal rate is unchanged[2]. In the second case, we add the restrictions that tax revenues and the inflation rate contemporaneously fall in response to the shock. Given that restrictions on the magnitude of the impact response of the government expenditure to output ratio or the deficit to output ratio produce qualitatively similar dynamics, we only report results obtained restricting the former. We summarize the constraints used in the third and fourth column of table 2. Figure 3 reports the responses of the variables of interest in the "large spending" scenario. Figure 4 presents the corresponding responses for the "recessions" scenario. In each figure, the first row corresponds to the US, the second to the EA and the third to the UK.

	Basic	Conditional	Large Spending	Recession	Reversals	Consolidation
G spending	>0	>0	>>0	>0	>0 and <0 after 2 quarters	>0
Deficit	>0	>0	>0	>0	>0	>0 and <0 after 2 quarters
GDP growth	>0	>0	>0	>0	>0	>0
Real wage growth		>0				
Real rate		>0				
Labor wedge		>0				
Nominal rate			=0			
Tax revenues				<0		
Inflation				<0		
Bond yield		=0				
C/Y		=0				

Table 2: Contemporaneous identifying restrictions for different scenarios.

Large expenditure shocks taking place when the nominal rate is fixed make the real rate fall roughly by the same amount in all countries while the pattern of responses of the other two variables is heterogeneous: the real wage falls in the US and UK, and increases in the EA; the labor efficiency wedge increases in the US and in the EA, and falls in the UK. On the other hand, per-capita output multipliers are roughly similar in size and significantly less than one in the EA and the UK, while the multiplier in the US is about three times as large and significantly above one, at least on impact. Thus, in this scenario, the dynamics of the real wage, the real rate and the labor efficiency wedge do not fully determine the magnitude

[2] We have also considered a different scenario where the nominal interest rate is fixed at zero rather than at the steady state. Since this scenario had negligible probability to have materialized in the past, little can be learned from it for the current experience.

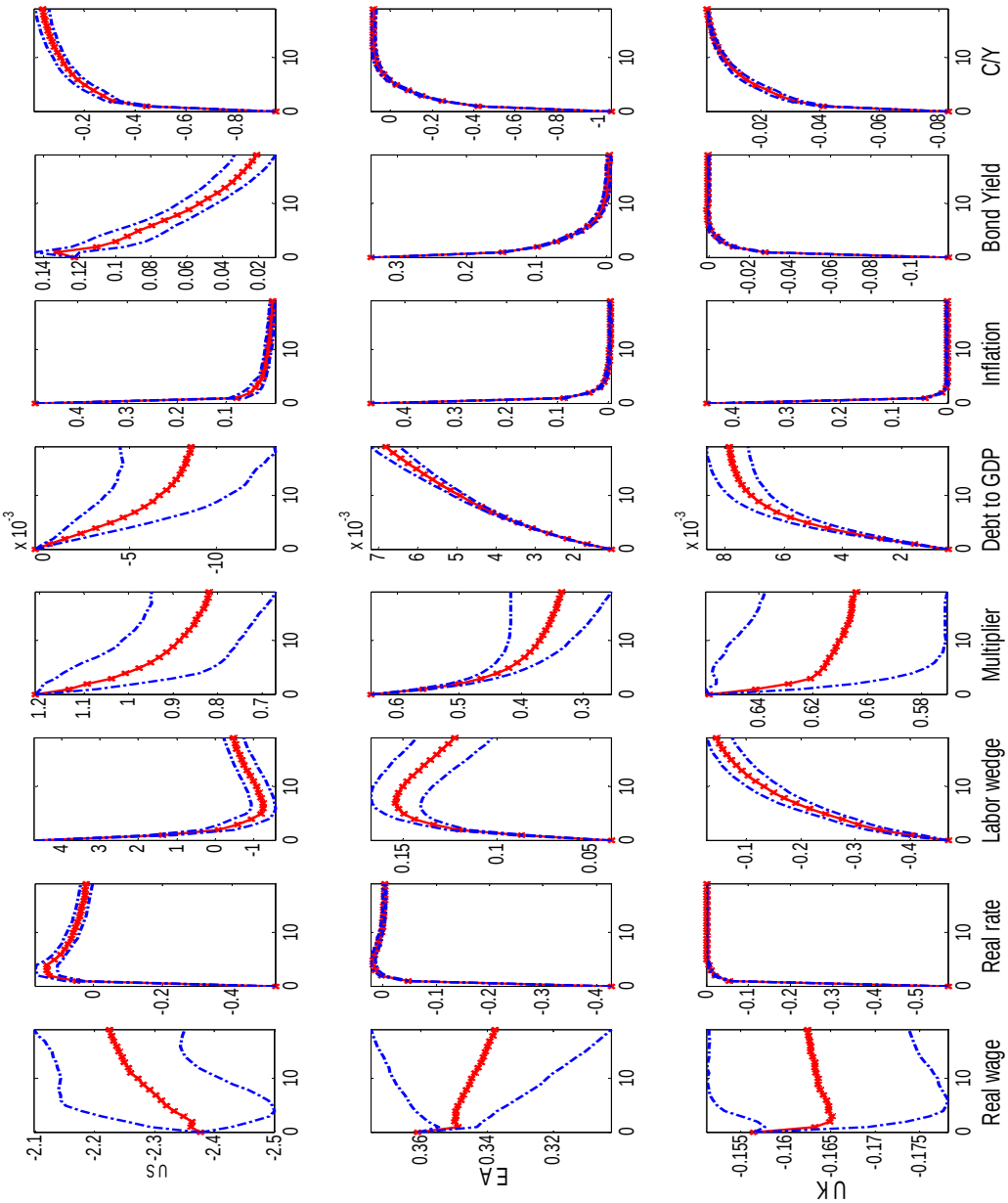


Figure 3: Dynamics in response to deficit financed large expenditure shocks when the nominal rate is fixed.

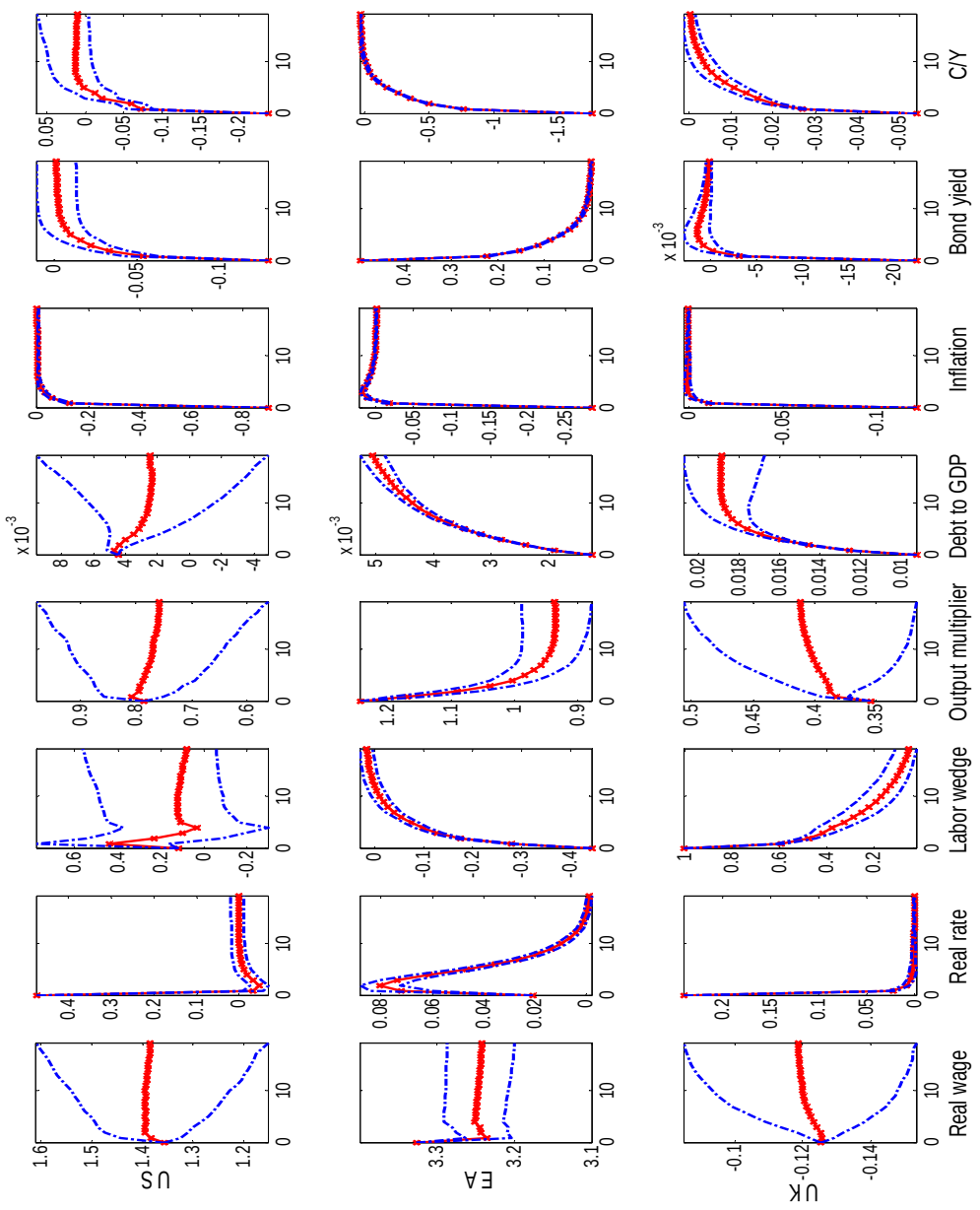


Figure 4: Dynamics in response to deficit financed expenditure shocks taking place in recession.

of the output effects of the expenditure expansion. Since in all countries the real interest rate falls roughly the same amount, it is highly unlikely that differences in the way the IS curve shifts are responsible for the differences we observe.

In recessions, unexpected increases in government spending drive the real rate up in all countries while, once again, the response of the other two variables is heterogeneous: real wage increases in the US and the EA, and decreases in the UK; and the efficiency wedge increases in the US and the UK and decreases in the EA. Interestingly, monetary policy is quite tight in all countries in the recession scenario - in the US and the EA the nominal rate falls but less than inflation; in the UK the nominal rate increases despite the decrease in inflation – and this tightness seems to be responsible for the modest per-capita output multipliers we obtain. Note that the slightly larger magnitude of the per-capita output multiplier in the EA appears to be due to the movements in the real wage, which are considerably larger than in the other countries.

Comparing figures 3 and 4 one can see that even though the two scenarios are designed to capture aspects of the current situation, they produce different implications for the real wage, the real rate and the labor efficiency wedge in each country. It is also worth pointing out that, even though the real rate responds negatively in figure 3 and positively in figure 4, per-capita multipliers are not uniformly larger in the ‘’large expenditure’’ scenario. Thus, it is important to look at other variables to be able to interpret the pattern we obtain.

Three important conclusions can be drawn from the exercises we conduct in this subsection. Per-capita output multipliers generated in situations like those prevailing in 2009-2010 are unlikely to be larger than those obtained on average in the past, primarily because the conditions for effectiveness of fiscal expansions are either not satisfied or less sufficient in these scenarios. Moreover, it is unclear which of the conditions characterizing the current situations matter most. In the US the per-capita output multiplier is larger when the size of the shocks is large and the nominal rate is unchanged, but in the EA it is larger when a recession is ongoing. Interestingly, the role of fiscal policy in the US during recessions is rather small: the per-capita output multiplier we generate in this situation is among the smallest of all we obtain. This conclusion should be compared with those of Auerbach and Gorodnichenko (2010) who, employ a different technique, and find that fiscal policy has quite different effects in recessions and expansions.

Perhaps more interesting, the pattern of responses we present is somewhat difficult to explain within the New Keynesian paradigm we have used as reference. For example, in the EU accommodative monetary policy do not seems enough to produce large output expansions and the conditions which would make the aggregate supply curve flatter are generally violated in the environments we consider. What could drive these results? One possibility is that some of the ceteris paribus conditions do not hold in some of these scenarios or, given some scenario, they may hold in some countries but not others. Another is that the New Keynesian framework we have used as organizing principle to interpret the evidence cannot account for the extreme events we consider in this subsection. We investigate which hypothesis is more likely in the next subsection.

4.4 The effects on debt and inflation

An important part of the public debate, following the extraordinary fiscal packages many countries legislated in 2009, had to do with the size of the debt, the increased perception of default and the inflation effects they would produce. Many commentators believed that the legislation would have generated unsustainable debt dynamics and financial markets agreed and reacted in the spring and the fall of 2010 by increasing the spread between bonds yields of countries with potentially unsustainable debt. On the other hand, many policy-markers believed that the fiscal packages would not have impaired the sustainability of the debt if they managed to generate sufficient output expansions and some inflation. There would have been also an important by-product if the latter happened: higher inflation meant that central banks could have acquired some room for maneuvering again the traditional monetary policy instrument – a possibility which waned when nominal interest rates reached the zero bound. In this subsection, we examine the debt and inflation dynamics induced by expansionary deficit-financed consumption expenditure disturbances taking place in the two scenarios analyzed in the previous subsection. The fifth and sixth columns of figures 3 and 4 display the responses of the debt to output ratio and of inflation to the shocks; again the first row refers to the US, the second to the EA and the third to the UK.

Since government debt is not a variable of the VAR, we construct debt to output dynamic responses using a budget constraint identity, as in Favero and Giavazzi (2007), assuming that at time zero the debt to output ratio is at the steady state, that one-period real bonds are used to finance the deficit and that no corrective measures are taken at any horizons in the future. Thus, the debt to output dynamics we present are those that would have been generated if the government completely disregarded the effects that a temporary shock to consumption expenditure would have on future debt and expectations were constant.

In the US, shocks that increase expenditure by a large amount when the nominal rate is unchanged leave the debt to output ratio unchanged in the short run and decrease it in the medium run. In the median, and after 8 quarters, one should expect about a one percent decrease from the steady state level. Authors' calculations suggest that if the shock lasts six rather than one quarter, the debt to output ratio effect at the 8 quarter horizon would be roughly 5 times larger (in absolute value). Thus, the fact that shocks are large does not necessarily induce uncontrolled debt dynamics. Two reasons explain this result: the fall in the real rate reduces the service costs of the debt; the output increase produces a significant increase in tax revenues. Given that the nominal rate is instantaneously fixed and that the real rate falls, large expenditure shocks increase inflation. However, the increase is short very lived. The response of the debt to output ratio in a recession is significantly positive and somewhat larger in size since the real rate increases and tax revenues fall here. In the median, a deficit financed government consumption expansion adds two percentage points to the debt to output ratio after 8 quarters. Afterward the effect becomes insignificant.

In the EA, the debt to output ratio modestly but significantly increases in both scenarios. Quantitatively, it is expected to increase by about one percentage point after 8 quarters and to reach its new steady state about 2 percent higher after 5 years. As in the US, the inflation rate increases with large spending shocks, but the effect is also short lived. In the UK, large

expenditure shocks occurring when the nominal rate is instantaneously unchanged induce debt and inflation dynamics which are similar to those of the EA: debt to GDP is positive, it reaches a new steady state about 2 percent higher after 4.5 years, and inflation instantaneously increases but the effect is short lived. Since the magnitude of the changes in the real rate, in output per-capita and in tax revenues are similar, the magnitude of the changes in the debt to GDP ratio and inflation in the EA and the UK are also similar. However, contrary to the US, tax revenues to GDP fall in the EA and UK in both scenarios.

To understand why the results do not conform to the predictions of the class of New Keynesian models we consider, it is useful to study why the dynamics of inflation differ in the two scenarios. The last two columns of figures 3 and 4 show the dynamics of the yield on long term government bonds and of the consumption to output ratio. Recall that when deriving theoretical predictions, we have implicitly assumed that the responses of the former are negligible. In practice, this does not appear to be the case.

The yield on long term government bonds increases in the US and the EA and decreases in the UK in the "large expenditure" scenario, while it increases in the EA and falls in the US and UK in the "recession" scenario. Thus, either long term inflation expectations, or long term output expectations, or both change following an unexpected increase in government expenditure. Also, while in the EA and the UK the sign of the responses are the same in the two scenarios, in the US the sign switches. Thus, differences in the dynamics of the real rate, real wage and of the per-capita multiplier in the two scenarios could be due to this sign difference. In general, it appears that the aggregate supply curve shifts when the aggregate demand moves, making the outcome of the fiscal expansion somewhat unpredictable.

The consumption to output ratio falls in both scenarios and in all countries. Thus, it appears that the sensitivity of consumption to current income decreases in response to the shock. If agents are more prudent in their spending patterns, or lose confidence about the future evolution of the economy in these situations, then savings may increase or dis-savings may fall when output increases. There is plenty of evidence that consumers become more prudent in spending their income in recessions or when the economic environment is less favorable. Regardless of the which explanation is correct, an increase in government spending in these scenarios does not only shift the aggregate demand curve, but it also changes its slope and can even twist it backward, if investment is similarly affected.

In sum, expansionary expenditure shocks occurring in scenarios that mimic the current situation induce only modest debt to output ratio dynamics. The magnitude of the responses is country and somewhat state dependent and the sign of the revenue responses shapes both their magnitude and their sign. The inflation effects of large expansionary shocks are quite temporary and similar across countries. Thus, while in theory there is this possibility that fiscal expansions may give monetary policy some lever to move nominal rates, in practice, this appears to remain just a wishful hope. Finally, in the two scenarios we consider, increases in government spending do not only shift the aggregate demand curve but also twist it and alter the aggregate supply locus, making the conditions on the real wage, the real rate and the labor efficiency wedge neither necessary nor sufficient for effective fiscal expansions and the magnitude of per-capita output multipliers difficult to interpret.

4.5 Consolidation schemes

The tensions in the markets for sovereign debt of 2010 have brought back at the center stage of public attention the question of the sustainability of public debt and the need for fiscal consolidation schemes that bring the debt back to manageable levels. As we have seen, fears of uncontrolled debt dynamics do not appear to have a strong empirical foundation. Nevertheless, analyzing consolidation schemes is useful since it may shed important light on the nature of the adjustments taking place in these situations.

Since earlier work by Giavazzi and Pagano (1990), there is a widespread folk wisdom in the profession that consolidation schemes could be expansionary. The idea is that by creating expectations of a permanently sounder policy stance, agents may be induced to expand private spending by more than the fall in government absorption. Recently, Afonso (2010) has shown that effects of this type are present in the EA when consolidation schemes considerably reduce the real rate of interest and thus the financing cost of the debt. Coenen et al. (2008), on the other hand, using the estimated New-area wide model employed at the ECB, show that fiscal consolidations are always contractionary in the short run, even though they may generate positive long run output effects. Forni et al (2010) also confirm that short run costs could be large. This variety of opinions about the macroeconomic consequences of consolidation schemes is present also in the policy arena and, for example, following the G-20 meeting of the summer of 2010, many US officials believed that the measures adopted by the EA would have led the area into a new great depression – cutting expenditure when economic activity had not recovered would have made the situation worse than no action at all.

Our empirical model allows us to consider two consolidation schemes discussed in the literature: current expenditure expansions accompanied by future expenditure cuts (the so-called spending reversals); current expenditure expansions accompanied by future deficit cuts (obtained either by future expenditure cuts or by future revenue increases). Corsetti et al. (2009) claim that, other things being equal, spending reversals can help making the size of the output multiplier larger by signaling agents the temporary nature of the measures and the commitment of the government to return to the fiscal orthodoxy as soon as the negative circumstances requiring the fiscal stimulus are removed. Uhlig (2010) warns instead against deficit consolidation schemes carried out too rapidly. When lump sum taxes are not available, expectations of future tax increases can make current output multipliers negative. Canova and Pappa (2006) document that unexpected expenditure increases which are rapidly matched with increases in distorting tax revenues had historically large and negative effects in US states that are required by constitution or legislation to balance the budget at the end of the year (or of the fiscal cycle).

The last two columns of table 2 display the identification restrictions used in these two scenarios and figures 5 and 6 the dynamic responses of the variables of interest: the first row refers to the US, the second to the EA and the third to the UK. We present expenditure schemes which are reversed after two quarters, but the results are qualitatively unchanged if the reversal is expected to take place four periods after the initial government consumption expenditure shock occurs. More importantly for interpretation purposes, the

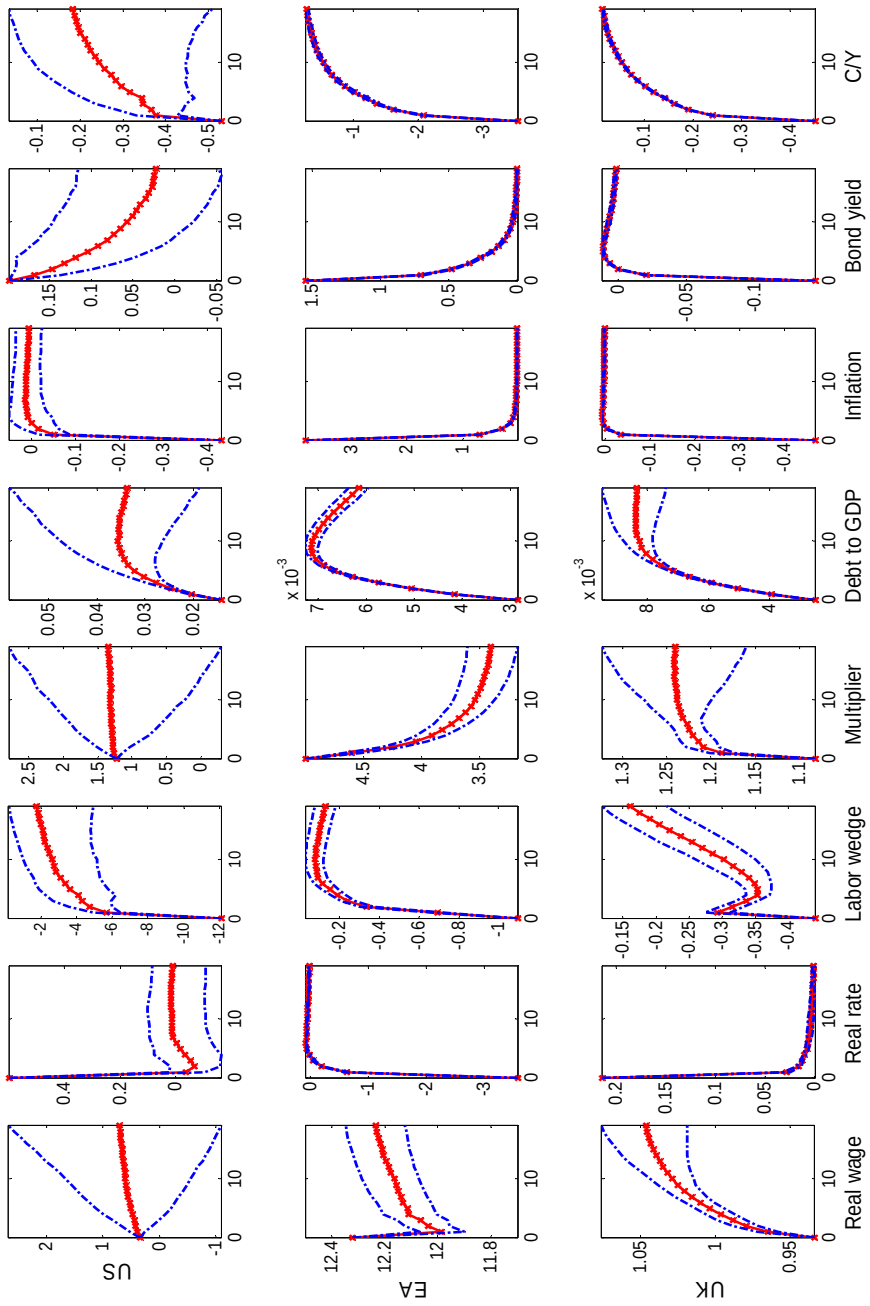


Figure 5: Dynamics in response to deficit financed spending shock which is reversed after two periods.

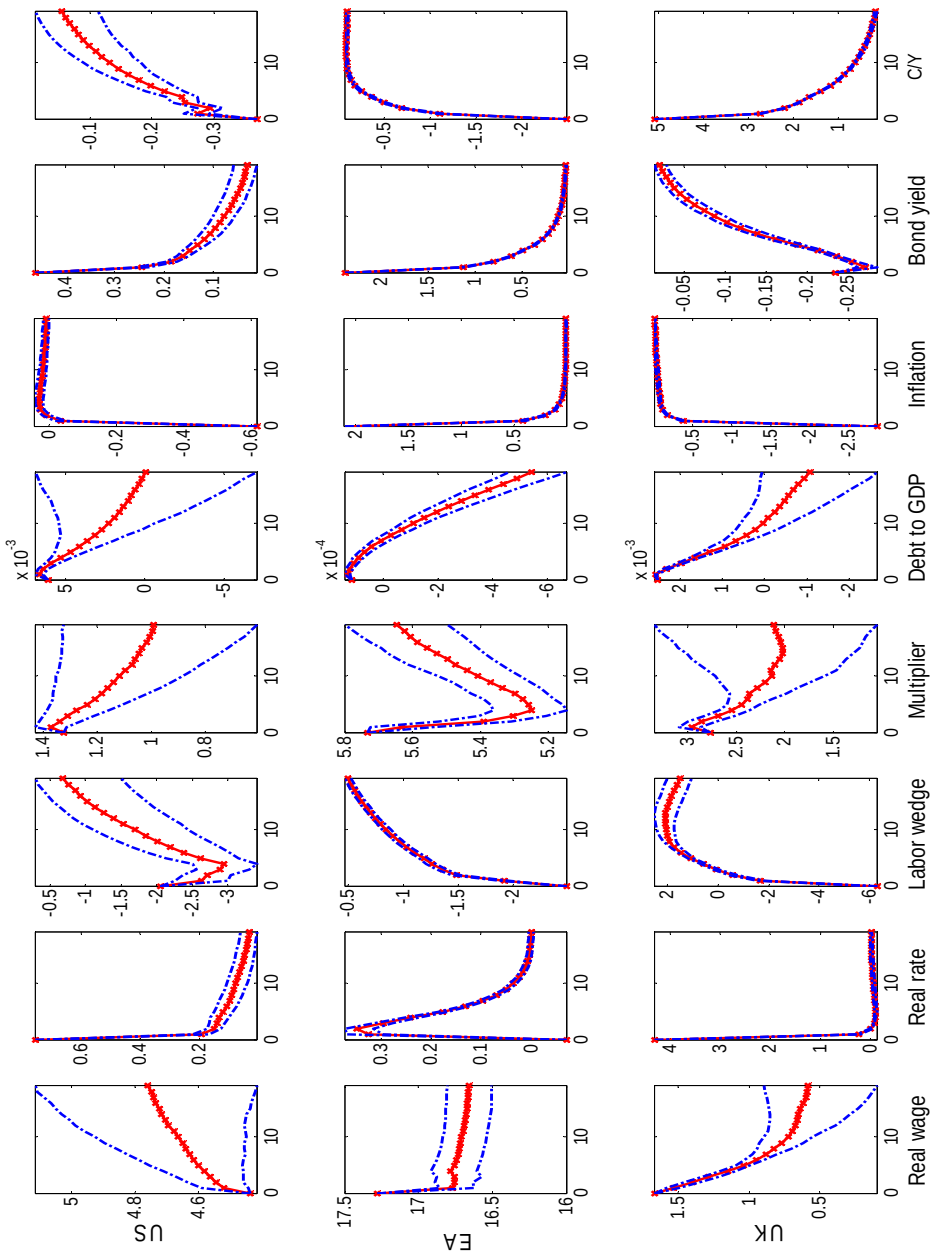


Figure 6: Dynamics in response to a deficit financed government expenditure shock which is consolidated after two periods.

spending reversal and the deficit consolidation programs are assumed to be known to agents when government consumption expenditure unexpectedly increases.

Government expenditure reversal schemes induce positive real wage responses and negative labor efficiency wedge responses in all countries. However, while in the EA the real rate decreases, it increases in the other two countries. Per-capita output multipliers are only slightly above one in the US and the UK, and considerably above one in the EA. Thus, the dynamics of the real rate are crucial to determine the magnitude of the real effects of government spending shocks also in this scenario. Note that the program makes inflation fall in the US and the UK, but strongly increases it in the EA. Interestingly, monetary policy appears to significantly deviate from the Taylor principle in this scenario: in the US the nominal interest rate is roughly unchanged when inflation falls; in the EA the nominal interest rate is roughly unchanged despite the increase in inflation; in the UK a fall in inflation is accompanied by a fall in the nominal rate, but of a smaller magnitude.

To understand why the dynamics of inflation are different in the three countries, it is useful to examine the behavior of the long term government bond yields, which in this scenario are likely to provide us with information about long term inflation expectations. In the UK, inflation falls because the program shifts not only the aggregate demand, but also the aggregate supply curve. As we have mentioned, the aggregate supply curve depends on expected future inflation. Since the reversal scheme reduces long term inflation expectations, it induces a shift to the right in the aggregate supply curve and the combined movement of the aggregate demand and the aggregate supply schedules make current inflation fall. In the EA, the shift in the aggregate demand curve is instead accompanied by an increase in long term inflation expectations. Thus, the aggregate supply shifts inward following the increase in government consumption expenditure and this creates considerable inflation. The US pattern is difficult to justify since inflation falls and at the same time long term inflation expectations increase. One possible explanation is that the scheme is not entirely credible and the reversal is perceived as temporary, making the aggregate supply curve temporarily move outward and then overshoot inward in the medium long run. Alternatively, the shock may alter, e.g. the steady state markup may be altered, making the aggregate supply curve rotate.

The dynamics of the private consumption to output ratio are also useful to interpret the results we obtain. Recall that this variable help us to understand whether the sensitivity of consumption to income changes with the policy and the scenario we consider, and how the IS curve shifts in response to the expenditure increase. The response of the consumption to output ratio is qualitatively similar across countries: it instantaneously falls and returns to its steady state quite slowly. However, the magnitude of the changes is considerably larger in the EA than in the other countries – consumption is crowded out more in the EA. Thus, following government expenditure shocks that are expected to be reversed in the near future, consumers act more neoclassical and less Keynesian, in the sense that the sensitivity of consumption to current income falls. In this scenario, the dynamics of the real interest rate may be more important for consumption expenditures than on average. Since the real rate falls in the EA and increases in the US and the UK, the EA multiplier is almost three times as large as in the other two countries.

The consolidation scenario presents similar features. Unexpected increases in government consumption expenditure which are known to bring deficit reductions in the future increase the real wage and make the labor efficiency wedge fall, while the real rate responds positively in the US and UK and negatively in the EA, although the effect in the EA is quite temporary. The magnitude of the per-capita output multiplier in the two scenarios is roughly similar in the US; it is slightly larger in the consolidation scenario in the EA, primarily because the responses of the real wage and the efficiency wedge are larger; and it is larger in the UK in the consolidation scenario. Given that the dynamics of inflation and of long term inflation expectations are similar in the two programs, differences in the magnitude of UK per-capita multiplier must be due to the fact that in the consolidation scenario the behavior of consumers is different. The last column of figure 6 shows that, indeed, the private consumption to output ratio strongly increases in this scenario (it fell in the reversal scenario, see figure 5). Thus, consumer spending becomes more Keynesian and this may explain why the output boost is larger with this consolidation program.

What have we learned from these two exercises? Neither the pessimistic view about debt consolidation programs contained in Uhlig (2010), nor the optimistic view about spending reversals of Corsetti et al. (2009), are fully supported in the data. There is some evidence that well designed and well understood reversible expansionary expenditure schemes could lead to output expansions that are larger than those obtained with an expansionary expenditure scheme which is not expected to be reversed in the future. However, for this to be the case one of two conditions need to be satisfied. A consolidation program which is accompanied by a fall in the real rate of interest has more chances to be output effective in the short run. Similarly, given a real rate response, a consolidation program which induces a more Keynesian consumption expenditure pattern may deliver larger output multipliers. Thus, regardless of the debt containment scheme, the short run effectiveness of the fiscal expansions crucially depends on what monetary policy does and what agents perceive the future will bring them in terms of output and inflation. In general, rather than the details of the scheme, it is the credibility of the program and the monetary policy stance that determine how successful the expansion will be.

5. Conclusions

What conclusions can one draw from our study? First, the class of sticky price New Keynesian models now used as benchmark for policy analysis provides, in normal times, useful guidance to understand the mechanisms leading to effective fiscal expansions in all countries. The three conditions the theory has singled out as necessary to deliver large output effects have different importance in practice: how monetary policy responds to the fiscal expansions is crucial in determining the magnitude of per-capita output multipliers, while the sensitivity of real wages to demand conditions appears to be minor. Cross country differences in the magnitude of per-capita output multipliers are important and can be related to two main factors: the cyclicality of the markup and trade openness. Other things being equal, the more open is a country and the less reactive is the markup to cyclical conditions, the smaller is the per-capita output multiplier that a given expenditure expansion generates. Other factors, such as the "size" of the government sector or the

extent of labor market regulations seem to be much less important in accounting for the cross country differences in the magnitude of per-capita output multipliers we report.

Second, per-capita output multipliers generated in situations like those prevailing in 2009-2010 are unlikely to be larger than those obtained on average in the past. There are two reasons for why our results differ from those presented in the literature. The first one is that, historically, in the scenarios we consider the ceteris paribus assumptions theory employs are unlikely to be satisfied, making the conditions for effectiveness of fiscal expansions either not satisfied or less sufficient. In particular, we find that expectations may be substantially affected and that parameters which are typically regarded as structural may instead be state dependent. Thus, a more complex model needs to be used to fully understand the implications of fiscal expansions in situations of deep economic crises. The second reason is that the scenarios we consider may have a hard time to capture the fact that, right now, the nominal interest rate is stuck at zero, simply because the probability that this happened in the past is essentially negligible. If this is the case, care should be exercised when using the implications of our analysis to predict the effects of current expenditure expansions. However, while per-capita output multipliers are unlikely to be large, there are important differences in the ability of fiscal policy to affect output in different countries and in different conditions. Explaining these heterogeneities requires a detailed analysis of the structural difference the three economies display in these scenarios, an analysis which is beyond the scope of this paper. In general, the cross country differences we detect indicate that while the predictions of the class of models are generally valid, one should be careful in using them when special conditions are in place, not only because the conditions are outside of the norm, but also because different countries may be reacting differently to the same fiscal impulse.

Third, the debt consequences of the expenditure programs we have considered are quite small. Thus, neither the fact that the current packages are large as percentage of output nor the fact that output growth is currently low appear to threaten fiscal sustainability in any of the three countries we examine. Our calculations are conditional on future expectations being roughly constant, but even if shifts in expectations consistent with the dynamics of government bond yields we obtain are considered, debt effects appear to be limited. To justify the pressures in the bond markets which appeared in 2010, expectations need to shift considerably more than in the past in response to the current expenditure expansion. However, to analyze the consequences of fiscal policy actions when considerable swings in the future perceptions of the state of the economy are possible may require an alternative theoretical framework where expectations may not necessarily be rational. Studying the implications of spending shocks using these alternative frameworks is clearly interesting, but beyond the scope of the current paper.

Fourth, the expenditure increases contemplated for 2009 and 2010 are unlikely to lead to significant and persistent increases in inflation. Thus, it is highly improbable that fiscal policy will help to liberate monetary policy from the zero nominal interest rate trap. However, since changes in fiscal policy may have state dependent effects on the private sector, other channels the analysis has not considered may affect the conclusions we reach.

Fifth, expenditure expansions accompanied by well designed future deficit reduction

schemes may lead to short run output expansions that are larger than those obtained with expenditure expansions which are not expected to be corrected in the future. For this to occur, however, monetary policy needs to be accommodative and the policy credible, in the sense that future inflation expectations are under control. When monetary policy is restrictive, consolidation policies which make consumers care more about current and less about future income have the potential to produce large short run output expansions. The details of the consolidation scheme as well as its timing appear to be much less crucial in determining the quality of the outcome. What appears to be important is that the policy is well understood and the commitment to return to the fiscal orthodoxy solid. All in all, the interaction between fiscal and monetary policy and the expectations effects appears to be a crucial ingredient to understand the output effects of expenditure expansions and of consolidation schemes.

We are well aware of the limitations of our analysis and we would like to spell out some of them in details. While the results we obtain lead to a consistent pattern of conclusions, one should mention that our analysis completely disregards open economy considerations. While a closed economy point of view may not be a huge problem for the US and EA, it may be more relevant for the UK and twin deficits dynamics (see Corsetti and Muller (2006)) may result. In addition, the analysis of the paper concentrates entirely on government consumption expenditure disturbances and does not analyze expansions that occur, for example, because of increases in transfers or reductions in the social security contributions of firms and employees. While our focus on the current situation justifies our choice, one should be aware that they may be government programs that are more expansionary in terms of output than government consumption expenditure increases. Similarly, it is important to recognize that policies reducing the size of the government sector (i.e. combination of tax and expenditure cuts) could have important expansionary effects, while leaving the deficit unchanged. The paper has also sidestepped the issue of fiscal predictability. Because fiscal policy decisions are typically taken in a parliament, legislation and implementation lags may make fiscal changes forecastable. That is, agents may react to the announcement of the fiscal change, anticipating the effect of the expenditure expansion and, conversely, the economy may not display any visible change at the time when the actual expenditure takes place. Leeper at al. (2009), Ramey (2009), Mertens and Ravn (2008) and Forni and Gambetti (2010) indicated that such a problem could be important and inference distorted if predictability is not taken into account. An earlier version of this paper compared the dynamics induced by unpredictable and predictable shocks and did indeed find differences in the pattern of responses. However, since the general conclusions are maintained even when shocks are predictable, we prefer to defer the discussion of predictability issues to a related work (Canova and Pappa, 2011). Finally, we would like to remind the reader that our empirical framework allows us to consider only certain types of consumption expenditure disturbances. Other interesting shocks, for example, fiscal disturbances which occur in combination with financial disturbances and which may generate important non-linear effects, need to be analyzed with more complicated nonlinear and time varying coefficient models.

Appendix A: A prototypical New Keynesian model

The model we present in this appendix is a simplified version of the one considered in Pappa (2009) and can be used to illustrate the typical predictions of New Keynesian models regarding the instantaneous effects of deficit financed government expenditure shocks on consumption, hours, the real wage and output.

The economy is populated by a representative consumer whose preferences are represented by a utility function of the form

$$E_0 \sum_{t=0}^{\infty} \left\{ \beta^t \frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\phi}}{1+\phi} \right\}$$

where C_t is private consumption, N_t is hours worked, $\sigma>0$ is the constant relative risk aversion coefficient, $\varphi>0$ is the inverse of the Frisch labour supply elasticity, $0<\beta<1$ is the discount factor and $\chi>0$ is a constant. Here E_o represents the expectation operator, conditional on the information available at time zero.

Consumers earn income by renting capital and labour services to firms and by holding one period government bonds and shares in the firms. The government collects taxes via a distorting income tax which is levied on labour and capital income and via lump sum taxes. Consumers maximize their lifetime utility choosing sequences for private consumption, investment, hours worked, and bond holdings, taking as given prices and tax rates, subject to the sequence of budget constraints

$$P_t(C_t + I_t) + R_t^{-1} B_{t+1} \leq (1-\tau)(P_t w_t N_t + (r_t - \delta) P_t K_t) + B_t + \Xi_t - T_t P_t$$

and the law of motion of capital

$$K_{t+1} = I_t + (1-\delta) K_t - v\left(\frac{K_{t+1}}{K_t}\right) K_t$$

where P_t is the price level, I_t is investment, B_t are one period nominal bonds, R_t is the nominal interest rate, w_t is the real wage, r_t the rental rate of capital, T_t are lump sum transfers and Ξ_t are profits from owing the intermediate goods firms; τ is the income tax rate, δ is the depreciation rate of capital and v controls the costs of adjusting capital which are assumed to be quadratic.

In the production sector, there is a competitive firm assembling intermediate goods into a final good using the following constant-returns-to-scale technology:

$$Y_t = \left[\int_0^1 Y_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

where $\varepsilon > 1$ is the constant elasticity of demand for intermediate goods, Y_t is final output and $Y_t(j)$ is the output of intermediate good j. The final good can be used for private and government consumption and investment, i.e.

$$Y_t = C_t + I_t + G_t$$

There is a continuum of firms producing intermediate goods. Each intermediate firm j produces output according to the constant return to scale technology:

$$Y_t(j) = (A_{zt} N_t(j))^{1-\alpha} K_t(j)^{\alpha}$$

where A_{jt} is a technological disturbance and α the share of capital in production. These firms are perfectly competitive in the input markets and minimize costs by choosing private inputs, taking wages and the rental rate of capital as given. Since firms are identical, they all choose the same amount of private inputs and cost minimization implies:

$$\frac{K_t}{N_t} = \frac{\alpha}{1-\alpha}\left(\frac{w_t}{r_t}\right)$$

Thus, the common real marginal costs are given by:

$$mc_t = \frac{1}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} r_t^{\alpha} w_t^{1-\alpha}$$

In the output market intermediate goods are monopolistic competitors. The strategy firms use to set prices depends on whether prices are flexible or sticky. In the latter case the probability for an intermediate good producer to reset her price is set equal to $(1-\gamma)$. When a producer receives a signal to change her price, she chooses a new price to maximize expected profits. The solution to the profit-maximizing problem produces the optimal pricing rule:

$$P_t^* = \frac{\varepsilon}{\varepsilon - 1} \frac{E_t \sum_{j=0}^{\infty} Q_{t,t+j} \gamma^j \left[mc_{t+j}^i Y_{t+j}^i \right]}{E_t \sum_{j=0}^{\infty} Q_{t,t+j} \gamma^j Y_{t+j}^i}$$

where $Q_{t,t+j}$ is the shareholder's discount factor (the marginal utility for consumers of one unit of nominal profits t+j periods from now) and the aggregate price index evolves according to:

$$P_t = \left[\gamma P_{t-1}^{1-\varepsilon} + (1-\gamma) P_t^{*1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}}$$

When prices are flexible the fraction of firms that can reset their price at each t is equal to one ($\gamma=0$) and prices are set as a constant mark-up over marginal costs

$$P_t^* = \frac{\varepsilon}{\varepsilon - 1} mc_t$$

Government's income consists of tax receipts and the proceeds from new debt issue; expenditures consist of consumption purchases and repayment of debt. The government budget constraint is:

$$R_t^{-1}B_{t+1} = P_tG_t + B_t - T_tP_t - \tau\ (P_tw_tN_t - P_t(r_t - \delta)K_t)$$

There is an independent monetary authority which sets the nominal interest rate as a function of current inflation, according to the rule:

$$R_t = R + \zeta_\pi \pi_t + q_t^R$$

where ζ_π a feedback parameter. To close the model one has several options. The first one is to assume a balance budget in each period (i.e. B_t =0 for all t), absence of distorting taxation (τ=0) . Alternatively, one could balance the budget using distorting tax revenues and let T_t=0 for all t. If debt is allowed, one has the option of letting the debt grow without limits or use a debt targeting rule of the form:

$$T_t = \overline{T}\exp(\zeta_b(B_t - \overline{B}))$$

where $\overline{T}$ is a constant, $\overline{B}$ is some target level of debt and ζ_b a feedback parameter. In case lump sum taxes cannot be used to limit the growth of debt and only distorting taxes are available, the rule becomes

$$\tau_t = \overline{\tau}\exp(\zeta_b(B_t - \overline{B}))$$

where now distorting tax rates are time varying.

Pappa (2009) has shown that expansionary shocks to government consumption expenditure which are financed with bond creation induce robust impact responses for G_t (it increases), the deficit G_t- T_t (it increases), and output growth ΔY_t (it increases) when the parameters (σ, χ, φ, υ, δ, ε, α, γ, ζ_π, ζ_b) of the model are allowed to vary within a reasonable range.

To show the implications of the model for the variables of interest and to show what are the differences between the New Keynesian and the neoclassical version of the model we assume that (β=0.99, σ=1, χ=1, φ=2, υ=2, δ=0.25, ε=7, α=0.3, ζ_π=1.5, ζ_b=0.2, τ=0) and simulate the responses of consumption, investment, real wage, the real rate, hours and output when an impulse in government expenditure shock lasting one period in the log-linearized solution of the model. Figure A1 reports in the top panel the responses when γ=0.75 and in the bottom panel the responses when γ=0.

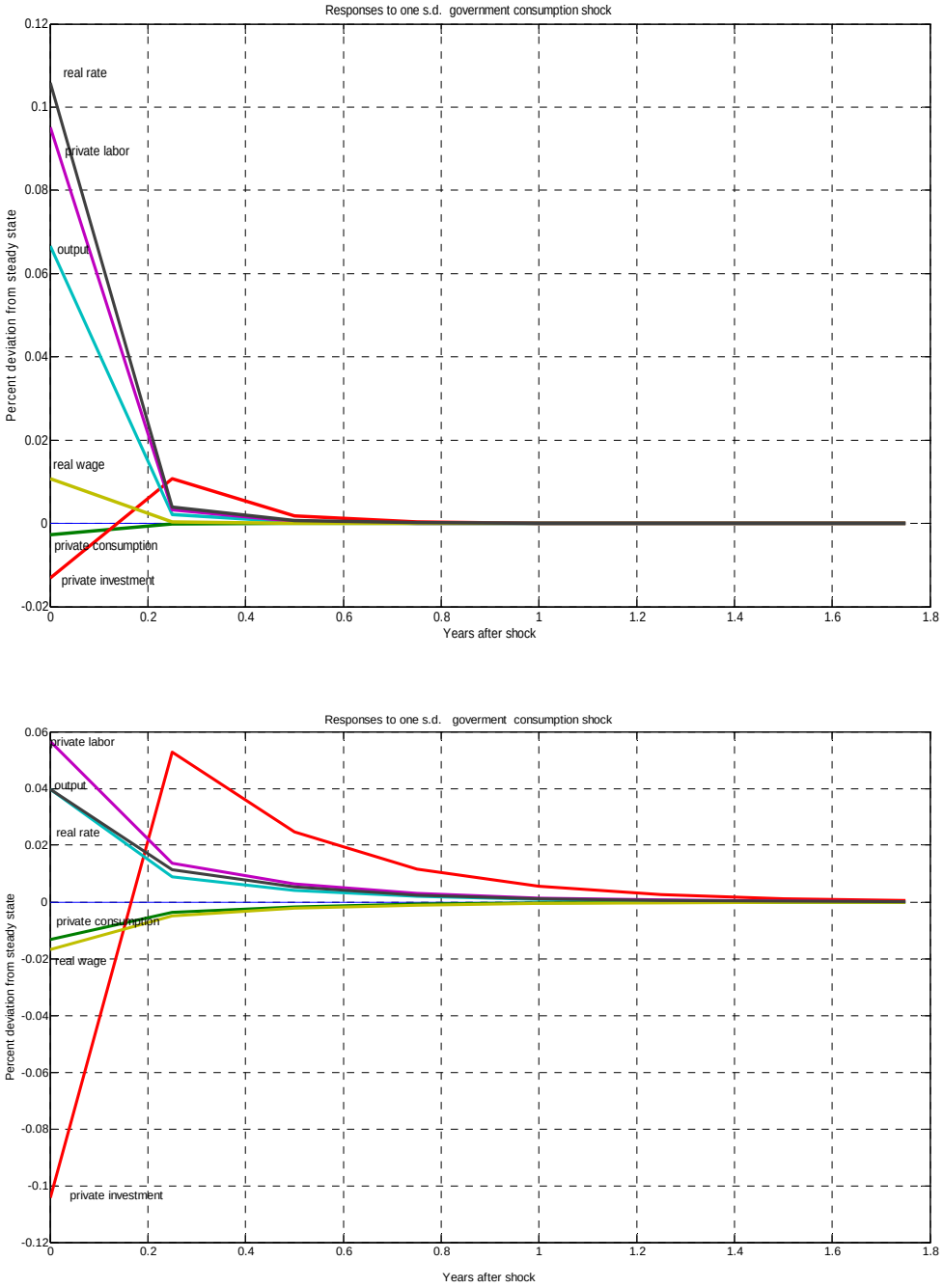


Figure A1: Responses to a government consumption spending shock. Top panel New Keynesian model, bottom panel, RBC model.

Appendix B: Data Construction

US:

1) Ratio of consumption expenditure to GDP: nominal consumption expenditure (BEA A955RC1) divided by real GDP (BEA A191RX1) times GDP deflator (BEA B191RG3).
2) Ratio of total tax receipts to GDP: total nominal receipts (BEA W066RC1) divided by real GDP (BEA A191RX1) times GDP deflator (BEA B191RG3).
3) Growth rate of real GDP per-capita: First difference of the log of real GDP (BEA A191RX1) divided by working age population 16 to 65 (FRED POP16OV), annualized.
4) Growth rate of real wages: first difference of the log of Nonfarm Business Sector Nominal Compensation per Hour (BLS COMPNFB) divided by the GDP deflator (BEA B191RG3), annualized in percentages.
5) Real interest rate: nominal 3-Month Treasury bill: Secondary Market Rate (FRED TB3MS) minus the annualized first difference of the log of GDP deflator (BEA B191RG3).
6) Profit rate: one minus the product of total non-farm employment rate (FRED CES0000000001) times Nonfarm Business Sector Nominal Compensation per Hour (BLS COMPNFB) divided by nominal GDP (BEA A191RC1)
7) Inflation rate: first difference of the log of GDP deflator (BEA B191RG3), annualized.
8) Long term yields: average yield on 10 year bonds (IMS)
9) Ratio of private consumption expenditure to GDP: real personal consumption expenditure (FRED PCECC96) to real GDP (FRED GDPC96), three digit, chained dollars.

EU (1)-7) and 9) from the AW9 database).

1) Ratio of consumption expenditure to GDP: nominal government consumption expenditure to nominal GDP.
2) Ratio of total tax receipts to GDP: total nominal government revenues to nominal GDP.
3) Growth rate of real GDP per-capita: First difference of the log of real GDP, scaled by the labor force, annualized.
4) Growth rate of real wages: first difference of the log of the nominal wage per head scaled by the GDP deflator, annualized.
5) Real interest rate: nominal short term interest rate minus the annualized first difference of the log of GDP deflator
6) Profit rate: one minus the product of nominal wage per head and number of persons employed, scaled by nominal GDP.
7) Inflation rate: first difference of the log of GDP deflator annualized.
8) Long term yields: average yield on 10 year bonds (IFS)
9) Total real private consumption expenditure divided by real GDP

UK

1) Ratio of consumption expenditure to GDP: nominal seasonally adjusted consumption expenditure (from the IFS) divided by nominal seasonally adjusted GDP (from the IFS).
2) Ratio of total tax receipts to GDP: sum of seasonally adjusted direct and indirect taxes (from the OECD) divided by nominal GDP (from the IFS).
3) Growth rate of real GDP per-capita: First difference of the log of nominal GDP (from the IFS) divided by the GDP deflator and total population (both from IFS), annualized.

4) Growth rate of real wages: first difference of the log of nominal employee compensation (AR) CURA (from the OECD) divided by the seasonally adjusted GDP deflator (from the IFS), annualized.
5) Real interest rate: nominal 3-Month Treasury bill rate (from the IFS) minus the first annualized difference of the log of GDP deflator (from the IFS).
6) Profit rate: one minus the product of real UK employee compensation (AR) CURA (from the OECD) and number of persons employed (from IFS) scaled by real GDP (from IFS).
7) Inflation rate: first difference of the log of GDP deflator (from IFS) annualized.
8) Long term yields: average yield on 10 year bonds (from IFS)
9) Ratio of consumption to GDP: Real private consumption expenditure to real GDP (both from IFS).

Acronyms: BEA: Bureau of Economic Analysis, National Income and product Accounts; BLS: Bureau of Labor Statistics, FRED: Fed of St. Louis, IFS: International Finance Statistics, OECD: Organization of Economic Cooperation and Development.

Appendix C: The Bayesian prior and the algorithm to identify shocks.

The Bayesian prior we use assumes that the VAR coefficients are random and that the covariance matrix of the shocks is fixed. Letting A denote the vectorized version of the coefficients of the VAR, we assume that A is normally distributed with mean M and covariance S. Furthermore, we assume that M is vector of zeros except for the first own lag of the variables entering in logs in the VAR (i.e. G/Y, T/Y, R, Profit, Inflation). The covariance matrix S depends on four hyperparameters: s(1) regulates the general tightness of the prior; s(2) regulates the importance of lags of other variables in one equation; s(3) regulates the tightness of the constant term; s(4) regulates the lag decay of the prior.
Values for the hyperparameters are obtained using a simple grid search and maximizing the in-sample predictive power of the model over the training sample preceding the estimation sample and the interpretability of the results for each country. For the US s=[0.0005, 0.5, 0.1,2], for the EU and the UK s=[0.0001, 0.1, 0.1,2]. Given the OLS estimates of A, posterior estimates are obtained combining sample and prior information using a Theil-mixed type estimator – see Canova (2007) for details. Denote the posterior distribution of A, by P(A). Such a distribution is normal with mean and variance which weight sample and prior information with weights given by the relative precision of the two types of information. Given P(A), we draw vectors A(1),….A(m) using Monte Carlo methods.

Government expenditure shocks are identified using the following approach. Let HH'=I, and let Q(j, k) be the impulse response matrix at horizon j produced by some orthogonal decomposition of S and the draw k from the posterior distribution of the coefficient vector and let Q(1,j,k) the response vector for the k-th draw produced at horizon j by the first orthogonal shock. We compute R(j,k)=Q(j,k)H and check whether the signs of the elements of R(1,j,k) for the appropriate variables are correct. If they are, R(1, j, k) is stored, if they are not the resulting impulse responses are tossed. To generate H, we draw n times n random normal matrices with zero mean and unit variance, perform a QR decomposition for each draw and select H as H=Q.

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