

Fiscal policy and frictions

SUMMARY

This paper empirically investigates whether the theoretical conditions for government expenditure expansions to be effective, hold for the data. We ask whether the necessary conditions for fiscal effectiveness are relevant on average, and in special circumstances that capture features of the recent crisis. Fiscal policy can be an effective countercyclical tool if monetary policy accommodates the fiscal expansion, if expectations about future output growth and inflation are constant, and if structural relationships are invariant to the policy change. Recent expansions are unlikely to produce large output multipliers or have important debt or inflation effects. Credible deficit and debt reduction schemes can produce sizeable output multipliers.

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Fiscal policy, pricing frictions and monetary accommodation

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1. INTRODUCTION

The industrialized world has suffered a number of large negative shocks in the last few years, initially driven by sharp declines in house and stock prices and by a tightening of credit and financial conditions. Policy institutions responded to the collapse in output with measures that dealt with the solvency of financial institutions. Central banks, on the other hand, reduced interest rates to unprecedentedly low levels and used non-conventional quantitative or credit easing measures to reduce risk premia and to provide liquidity to the financial sector. Despite these efforts, credit remains tight and aggregate demand has weakened rapidly. There have been important spillovers to less developed countries, increasing concern that the world economy might be moving into a deep and prolonged recession.

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Given a situation where nominal interest rates approached or hit the zero bound and the banking system was malfunctioning, the scope for further monetary stimulus was limited and attention turned to fiscal policy. At the beginning of 2009, in a bid to sustain employment and growth, governments around the world announced two-year stimulus packages that were extraordinary in their breadth and size (up to 2% of national GDP). The US Congress, for example, approved \$787 billion of additional spending, transfers and tax reductions with the American Recovery and Reinvestment Act 2009 and the European Union initiated the European Economic Recovery Plan, while national governments announced their own plans, see, for example, the 'Pacchetto Fiscale' in Italy, 'Plan E' in Spain, the 'Plan de Relance' in France, the 'Konjunkturpaket I & II' in Germany and the 'Pre-Budget Report' in the UK. The legislation raised old questions about effectiveness of temporary expenditure expansions for lessening the depth and duration of a recession, but also new ones regarding the preferred mix of fiscal actions.

In Europe, expansionary impulses were considerably reduced during 2010 by the sovereign debt crisis, which followed the adjustments needed to bring fiscal solvency to Greece and Ireland and questioned the sustainability of the debt that would accumulate with the planned packages. The US legislated for additional expenditure for infrastructures, and credit for the automobile and the housing industries, but concerns emerged about the magnitude of the debt. In addition to concerns about the long-run sustainability of deteriorating fiscal positions, questions concerning the inflation consequences and the long-run crowding-out effects of debt accumulation were being asked with increasing frequency.

It has been difficult to assess the economic impact of these programmes, and the recent reversal of spending plans combined with attempts at debt consolidation have made the task even more complicated. Several authors have tried to measure the effects of these measures but findings are contradictory (see e.g. Cogan *et al.*, 2010; Cwik and Wieland, 2009; Romer and Bernstein, 2009). Proponents of fiscal stimulus typically emphasize Keynesian multiplier effects: when consumption is a function solely of after-tax income, a deficit-financed increase in government spending boosts total spending more than one for one. The increase in output produces increased revenues able to contain or even eliminate the increased government debt if the fiscal stimulus is properly phased out. Since in globally integrated economies domestic spending may be diverted partly to imports, proponents of fiscal expansions have called for coordinated action, both across the Atlantic and within Europe. Critics of fiscal stimulus argue that government spending displaces private spending and reduces domestic competitiveness. Deficit financed spending increases may drive real interest rates up, inducing increased private savings and reduced private expenditure. In addition, if the terms of trade are positively correlated with real interest rates, the foreign spending component may also be reduced. Finally, since the real interest rate increases, debt may rise quickly to an unsustainable level, requiring corrective measures. The combination of initial expenditure increases and

expenditure cuts or tax increases at later dates may generate perverse output effects. This bleak outlook is not shared by all critics of fiscal stimulus. 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 consolidation could be expansionary rather than contractionary. Unfortunately, the empirical evidence on this issue is similarly inconsistent (see e.g. Coenen *et al.*, 2008; Afonso, 2010; Forni *et al.*, 2010). In general, the uncertainty surrounding the consequences of fiscal measures reflects the lack of consensus on the likeness between developed economies and a pure Keynesian framework.

Proponents of fiscal stimulus argue also that the current conditions are special, in the sense that neither the evidence from historical data nor the predictions of theoretical models are well suited to explaining the effects of government spending increases and debt consolidation schemes in today's climate. The fact that many central banks are more likely to keep interest rates low for a protracted time period makes the existing empirical evidence less relevant, because information on the effects of fiscal stimulus emerges when central banks act more aggressively to keep down inflation and inflation expectations. Similarly, calibration exercises based on dynamic stochastic general equilibrium models may not provide reliable information about the effects of planned government spending increases, even if the models are correctly specified and policy actions appropriately designed, because the historical parameters are unlikely accurately to describe current conditions. For example, the responsiveness of the labour supply to fiscal expansion may be stronger when unemployment rates are high, as suggested by Barro and Redlick (2009), and expectations of debt sustainability may be state dependent.

Hall (2009) and Woodford (2011) use simple analytical frameworks within the mainstream New Keynesian paradigm, to understand the effects of government spending in general, and to evaluate in what sense current conditions are special relative to historical experience. Coenen *et al.* (2010) perform similar exercises in seven large-scale models used by the policy institutions in the developed world. The conclusions reached by these authors 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 for future spending cuts (but not future tax increases), if monetary policy is accommodative, if pricing frictions are important, or if price markups are strongly countercyclical. Finally, Christiano *et al.* (2009) and Erceg and Lindé (2010) show that it is the length of time over which the zero bound applies and the timing of expenditure increases, that determine the debt costs and the output effects of the measures.

This paper investigates empirically whether the theoretical conditions for government expenditure expansions to be effective, hold for the data. We take the predictions from a large class of New Keynesian models currently in use in

academic and policy institutions, at face value, and ask whether the necessary conditions for fiscal effectiveness are relevant, on average and in special circumstances that capture the features of the current situation. We want to evaluate the justification for the claim that current expansions will produce consequences different from those obtained in historical episodes and to ask whether (i) output multipliers should be larger, (ii) debt might become uncontrollable, and (iii) inflation responses might give monetary authorities room to manoeuvre nominal interest rates. Our focus is on short-run effectiveness but occasionally we discuss the long-run consequences of the current measures.

We study these questions using a structural VAR model. We apply state-of-the-art techniques to produce shocks with the required characteristics, and explicitly quantify the uncertainties 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 between normal situations and the current one by imposing additional constraints on the dynamics of tax receipts, inflation and the magnitude of the shocks. We 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 responses of the real interest rate, which is determined by the interaction of fiscal and monetary policy decisions; of the real wage and of the labour wedge, which depend, among other things, on the frictions present in the labour and goods markets.

A unique feature of our investigation is that we compare the effects of expansionary spending shocks in the US, the Euro area (EA) and the UK. While one might surmise 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 fail to draw general conclusions about the suitability of current packages because they focus on the experience of individual countries. Given the heterogeneities in size, product market regulation and labour market rigidities in the three economies we study, our analysis should shed light on whether and when fiscal policy could be used to boost aggregate demand, and also provide information about the role of market frictions and institutions in determining the magnitude of output multipliers.

Our work differs from the existing studies along a number of other dimensions. First, rather than focusing on consumption and investment responses, we study the dynamics of the real wage, real interest rate and the labour wedge since, in theory, this provides the most reliable information on the questions of interest. Second, while the policy debate focuses on the magnitude of the output effects that can be expected from current packages, we are interested in assessing whether the economic conditions for which they were designed could make fiscal expansion play a larger role than historically. Third, our focus on the interaction between fiscal and monetary policies allows us to study whether a lack of coordi-

nation has reduced the potential effectiveness of fiscal policy. Finally, since nominal rigidities, in theory, are crucial to deliver sizeable multipliers, our investigation provides an indirect test of the appropriateness of the mainstream New Keynesian paradigm.

Our analysis concentrates only on the effects of government consumption expenditure shocks – increases in government consumption account for over 60% of the total amount of the legislated packages. This restricted focus does not allow us to analyse which fiscal instrument might be more effective to lessen the current recession, for example, but has the advantage of maintaining a tight link with the current situation. There are a few other caveats. First, our analysis almost completely sets aside open economy considerations, which prevents us from studying twin deficit dynamics (see Corsetti and Muller, 2006) and related issues. Second, the analysis disregards the problem of predictability of fiscal shocks (see Leeper *et al.*, 2009; Ramey, 2009; Mertens and Ravn, 2008). This predictability, which typically is driven by legislation and implementation lags, is important and may invalidate standard empirical analyses. Since the general conclusions we obtain are maintained even when expenditure shocks are predictable, we defer discussion of predictability issues to a related work (Canova and Pappa, 2011). Finally, our empirical framework allows us to consider only certain types of consumption expenditure disturbances. Other interesting shocks, for example, fiscal disturbances that occur in combination with financial disturbances and which may generate important non-linear effects, need to be analysed with more complicated non-linear and time varying coefficient models.

The rest of the paper is organized as follows. Section 2 highlights the theoretical considerations that guide our empirical analysis and reviews the 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 argument focused initially on either the sign of the impact responses of consumption and investment or the magnitude of output multipliers. Since this literature is not concerned with normative statements, the presumption is that the larger 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 are found depending on the model specification and the exact measurement of the variables (see, e.g., Blanchard and Perotti, 2002; Burnside *et al.*, 2004; Caldara and Kamps, 2008). There is also considerable heterogeneity in the magnitude of the estimated output multipliers with values varying from 0.5 to 3 obtained (see e.g.,

Mountford and Uhlig, 2009; Barro and Redlick, 2009; Romer and Bernstein, 2009).

2.1. Consumption and investment responses: the theory

Existing closed economy general equilibrium theories make clear predictions regarding the sign of consumption responses and the magnitude of output multipliers in response to government consumption spending shocks, but are less certain about the sign of the investment responses. With standard time additive preferences and a competitive labour 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 that are below 1. This is true for 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 with these predictions is in Appendix 1).

The reason for this outcome is simple. Increases in government consumption expenditure reduce the portion of output available for private uses. Thus, unless agents increase productive inputs considerably, either consumption or investment or both must fall. The negative wealth effect increases labour 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 a permanent income motive is in place in these models, the increase in public deficit will increase the real rate, making private savings increase to match the fall in public savings. The output effects of expenditure increases may be magnified if public consumption expenditure yields utility (see e.g. Bouakez and Rebei, 2007) or creates production externalities (see e.g., Baxter and King, 1993). The effects may 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 Devereaux *et al.*, 1996), or if a share of agents consumes a constant fraction of income (see e.g. Galí *et al.*, 2007). However, even in these cases, it is difficult simultaneously to produce output multipliers higher than 1 and consumption responses that are significantly positive.

In light of the measurement errors in consumption and output data and the contradictory empirical evidence on the 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) and 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 sectoral aggregates. These studies add valuable empirical information, but robust stylized facts are scarce, leading to inconsistent conclusions.

2.2. Real wage dynamics

Hall (2009) and Woodford (2011) examine the conditions under which government consumption expenditure shocks can have large output effects and induce positive consumption dynamics, in models featuring a variety of market arrangements and government policies. Their analyses indicate 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, rendering 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 labour supply because of a negative wealth effect. With perfect competition and diminishing returns to labour, the shift in labour supply increases hours and drives productivity and real product wages down (see first box in Figure 1). In New Keynesian models with imperfect competition, booms produce price wars lowering the price markup over marginal cost charged by monopolistic competitive firms, and raising both real wages and hours despite a productivity decline. The second box in Figure 1 indicates that labour supply and labour demand both move, making it possible for real wages to increase; if the slope of the curves and the magnitude of the movements are conventional, employment might expand more than in the first box.

Allowing for increasing returns to scale in production, a government spending increase raises real product wage, hours and productivity (see e.g. Devereaux *et al.*, 1996). The third box in Figure 1 shows that the labour demand curve is upward sloping in these models. Thus, shifts in the labour supply curve lead to substantial increases in real wages and employment without the need for the labour 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 increases in aggregate real wages in US states, and in a number of OECD countries; Nekarda and Ramey (2011) find that real wages fall at the industry level when there is an increase in government demand for the goods produced by that industry. These different conclusions appear to be related to the measurement of real wages, that is, whether nominal wages are deflated by CPI (consumption real wage) or by the GDP deflator (production real wage). Regardless of these measurement issues, the magnitude of absolute changes in real wages is generally moderate, casting doubt on the possibility of generating large multiplier effects through the 'labour supply' channel.

2.3. Efficiency wedge dynamics

Hall (2009) and Woodford (2011) indicate that expansionary government consumption expenditure shocks will have large positive effects on output and consumption

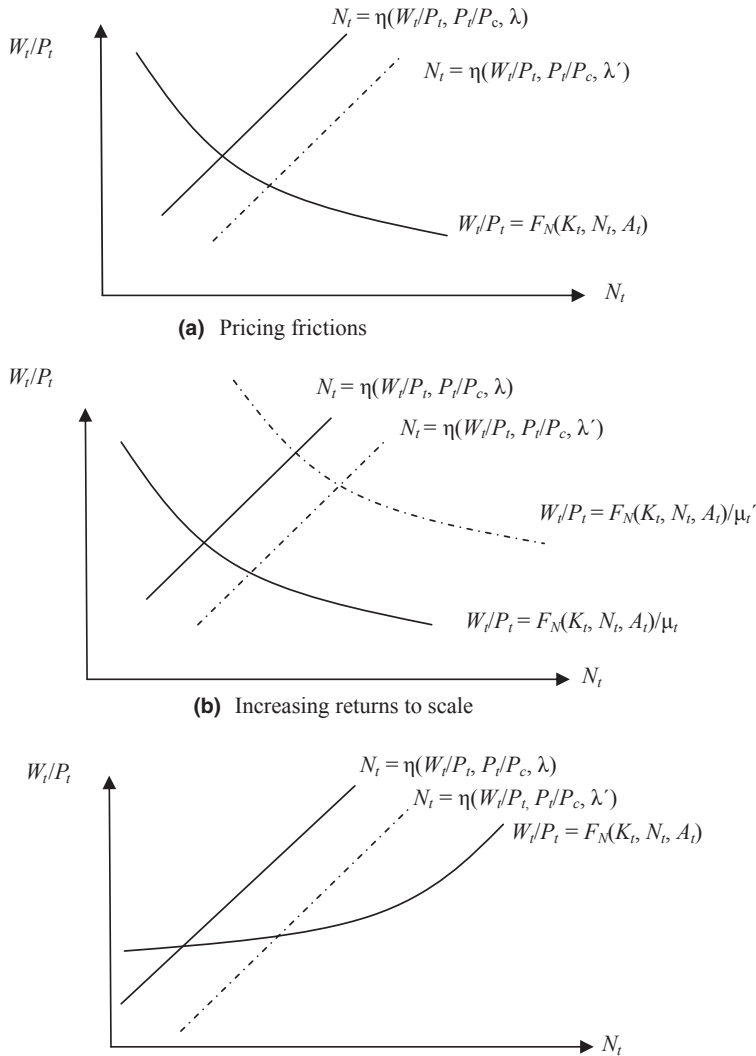


Figure 1. Labour market adjustments in response to government consumption shocks. W_t/P_t is the real product wage, P_c the consumption deflator, λ the marginal utility of wealth, F_N the marginal product of labour, K_t capital, N_t labour, A_t a technological shifter, μ_t the labour efficiency wedge

if the labour-efficiency wedge, that is, the inverse of the difference between real wages and the marginal product of labour, responds negatively to government spending shocks.

This condition is closely related, but not equivalent to the previous real wage condition since the efficiency wedge may display the correct cyclical behaviour even if the real wage does not. In standard neoclassical models, even under the assumption of monopolistic competition, the efficiency wedge is constant. To make it time varying, nominal stickiness is typically added. As already mentioned, increases in

government expenditure increase hours, reduce the marginal product of labour, and increase marginal costs. If prices cannot be adjusted instantaneously, the labour-efficiency wedge must fall to ensure that labour market equilibrium is achieved. If the sensitivity of the labour wedge to output changes is large, sizeable multipliers can be created because the aggregate demand increase is translated less into price increases and more into output expansions.

Price stickiness is sufficient, but by no means necessary to induce countercyclical movements in the labour-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 where producers have no market power, even without price stickiness. Thus, it would be incorrect to use movements in the labour-efficiency wedge in response to demand shocks to test the sticky price assumption. Similarly, evidence of procyclicality in the labour-efficiency wedge does not signal failure of the sticky price theory, since countercyclical movements are necessary only to increase output multipliers.

How does the efficiency wedge behave in response to government spending shocks? Nekarda and Ramey (2011) find that increases in government demand which raise output and hours in a sector of the industry, reduce productivity and real product wages, leaving the efficiency wedge roughly unchanged. Some interesting evidence reported by Galí *et al.* (2007) and Ramey, 2009 indicates that, in the aggregate, labour 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

Hall (2009) and Woodford (2011) indicate that an unexpected government consumption increase will induce a large output expansion if monetary policy is accommodative. Unexpected increases in government spending normally create inflation. If the monetary authority reacts strongly to inflation, as would be the case in inflation targeting regimes or when aggressive Taylor rules are in place, the real rate will increase, increasing private savings. If, 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 where the real rate is unchanged after a spending shock – this requires a one-to-one adjustment of the nominal rate to changes in inflation – the output multiplier is 1, and private spending will be unaffected by the shock.

Clearly, such a mechanism exists only in New Keynesian models. In neoclassical models without participation constraints and abstracting from situations where fiscal policy provides a nominal anchor (see e.g. Leeper, 1991), 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 is obtained from an Euler equation with pre-determined 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 the output multiplier is concerned. Whether monetary policy helps or leans against fiscal policy is an interesting empirical question which we investigate. Notice that temporary deviations from a Taylor principle do not necessarily affect the determinacy of the equilibrium if fiscal policy responsibly curbs the resulting debt increase. Also, as long as deviations 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 release monetary policy from the 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, if 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 especially when the nominal interest rate is at zero. Hall (2011) suggests that they cannot. It could be conjectured that the fiscal stimulus must be large to be able to produce such an effect and that were the recession which has driven the nominal interest rate to zero to be protracted, inflationary effects would be limited. On the other hand, if fiscal policy succeeds in generating inflation, it can give the monetary authorities room to manoeuvre the nominal interest rate. This would seem to be the view underlying many recent measures taken by the US 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 Lindé (2010) emphasize that the magnitude of the output multipliers depends on how much time the economy spends at the zero interest rate bound and on the timing of fiscal actions. In particular, output multipliers are larger when expenditure expansion is designed and implemented at the time when a shock pushes the nominal interest rate to the zero bound. In the simulations they run, implementation delays of just 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 the nominal interest rate is close to zero, unemployment is high, inflation is low, and growth prospects are dim, fiscal expansions could have larger effects than otherwise, and large fiscal actions are probably required to bring the economy back onto a growth track.

2.5. *Ceteris paribus* assumptions

Implicit in the discussion in the previous three subsections are a number of *ceteris paribus* assumptions, which it is useful to spell out in detail. The first is that inflation expectations are unaffected by government expenditure shocks. Both the aggregate supply (Phillips) curve and the aggregate demand curve, in fact, depend on inflation expectations. If they change when expenditure expands (e.g., because the policy is considered unsustainable), 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 could be neutralized by inward movements in the aggregate supply. Thus, it is important that the fiscal expansion should not create perceptions of higher future inflation. Conversely, the output effects will be maximized when inflation expectations are non-increasing in the fiscal impulse.

The second implicit assumption is that, in response to expenditure changes, the sensitivity of private spending to the real interest rate and output changes is unaffected. For example, all the exercises assume that, following 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, because consumers 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 the magnitude and the direction of the output changes.

Finally, future output growth expectations are assumed to be 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 partially undone by the expected fall in future output growth. Thus, even if the theoretical conditions for fiscal effectiveness are satisfied, output multipliers could be small, zero, or even negative.

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

2.6. A summary and empirical implications

For government spending disturbances to have substantial output effects the following three conditions should hold: (a) real wages should increase substantially; (b) the labour-efficiency wedge should fall considerably; (c) the real interest rate should fall considerably. It is unclear which condition is the most important. The first two requirements are likely to boost the supply-side effects of the shock, making the aggregate supply flatter; the last determines the magnitude of the aggregate demand shift. In the last case, non-negative movements in private expenditure are necessary for output to increase following government expenditure shocks. However, unless the real wage increases sufficiently to motivate agents to supply the labour 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 expenditure will simply crowd out private demand or increase inflation.

To the best of our knowledge, the literature does not examine whether these three conditions hold in the data, whether they are necessary for making output multipliers large, whether they are more likely to hold in the special conditions characterizing today's world economy and, more generally, whether the predictions of models with pricing frictions find sufficient support in the data. Auerbach and Gorodnichenko (2010) study the effects of fiscal policy in recessions and expansions and find them to be different. Kirchner *et al.* (2010) examine whether the nature of the transmission of fiscal shocks has changed over time and note that the size of the long-run output multipliers has declined. However, neither of these studies addresses the questions of interest in this paper, nor do they provide evidence on the interaction between labour markets, pricing frictions and monetary policy in determining the outcomes of government spending disturbances.

Most theoretical analyses assume that increases in government consumption expenditure are financed with lump sum taxes or, if debt is generated, that eventually it will be scaled back via lump sum taxation. Furthermore, it is typically assumed that such policy does not affect government credibility or expectations of fiscal sustainability. Uhlig (2010) highlights an old, but often overlooked issue: the financing of government expenditure matters. 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 dominate the employment and output gains induced by the shocks. Furthermore, the speed with which the government seeks to return the debt to its original level affects the magnitude and the sign of the multipliers. An alternative policy, potentially inducing large positive output effects, is one that cuts distorting taxes now and increases them in the future. Such a policy produces Laffer curve type dynamics, making deficit and debt accumulation much smaller. In general, who

finances the deficit (domestic or foreign residents), how debt consolidations are performed and what instrument is used, are all crucial for understanding the effects of fiscal changes.

Lastly, it should be remembered that fiscal expansions are unlikely to exercise an instantaneous effect on the economy. Apart from gestation and legislative delays, there is 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 a small fraction of output variability at business cycle frequencies – the opposite is true for monetary policy. Thus, the fiscal lever may take much longer than the monetary lever to exercise its effects; the lack of noticeable output growth effects in many OECD countries, despite the large fiscal impulse in 2009, is consistent with this fact.

3. THE DATA AND THE EMPIRICAL FRAMEWORK

We use quarterly series for the US, the EA and the UK. US data come from the Federal Reserve Bank of Saint Louis FRED database, the Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS); EA data are from the Area-wide Model Database (version 9), and data for the UK are from the OECD, and IFS statistics of the IMF. For each country, the variables included in the VAR are: log ratio of government consumption expenditure to output; log ratio of total tax receipts to output; log of 1 plus the annualized quarter-on-quarter growth rate of real per-capita output; log of 1 plus the annualized quarter-on-quarter growth rate of real wages; log of 1 plus the *ex-post* annualized real interest rate; log of the efficiency wedge; log of 1 plus the annualized inflation rate; log of 1 plus the yield on long-term government bonds; and the log of personal consumption expenditure to output ratio. Variables are scaled to ensure that the VAR is roughly free from low frequency movements. Appendix 2 describes the construction of each variable from the available raw series. For the EA we also consider the fiscal databases in Paredes *et al.* (2009) and Forni *et al.* (2009). The series for government consumption expenditure and for total tax receipts in the 1970s differ in the three data bases, primarily because of different interpolation procedures used to transform annual into quarterly data. From the early 1990s, the series largely overlap and their correlation is above 0.9. Thus, for the more recent period, which dataset is used is immaterial.

Since there is no central EA fiscal authority, one might wonder what EA fiscal shocks represent. While this is a legitimate question, it should be remembered that discretionary fiscal policy in the EA region has commoved strongly over the last 20 years (see e.g. Giuliadori and Beetsma, 2008). In addition, since EA fiscal variables are weighted averages of the corresponding country specific variables, the shocks we construct can be interpreted as disturbances occurring in the countries with the highest weights in the EA.

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

To measure the labour-efficiency wedge we considered two different series. One is profit share, that is, the difference between 1 and the labour share in output. This proxy is very rough 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 labour productivity. While these two measures have different levels, they display similar cyclical fluctuations. Thus, we present only the results obtained using the first measure.

For computational convenience, in the VAR we employ the *ex-post* real rate and the inflation rate rather than the nominal interest rate and the inflation rate. The results we present are unchanged if the dynamics of the *ex-ante* real rate (constructed using VAR based inflation expectations) are considered instead. The yield on long-term government bonds is not of direct interest in the investigation and is used primarily to assess deviations from the *ceteris paribus* assumptions.

The sample periods used to estimate the VAR depend on the country considered. For the US we start in 1984Q1 and end in 2009Q4, for the EA we start at 1993Q1 and end in 2008Q4 and for the UK we start in 1993Q1 and end in 2009Q4. The start dates are chosen to maintain as much time homogeneity as possible. For comparability, we also examine the sample 1993Q1–2009Q4 for the US: the results we report are unaffected by this change. In addition, since data for the US are available since the early 1950s, but only since the early 1970s for the EA and the UK, we examine whether conclusions change when a longer sample is considered. The qualitative features of the results are insensitive to the sample period, but 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, ch. 9) and is described in Appendix 3; it 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. To identify fiscal shocks, sign restrictions are preferable to more traditional restrictions because they can be made consistent with the theory that is used to interpret the results – for example, the model in Appendix 1 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, have different representations (see e.g., Pappa, 2009). Perhaps more important 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. Only contemporaneous restrictions are imposed because existing theories have fragile dynamic predictions for the response of government deficit and output growth. To ensure that sign restrictions hold sufficiently often, for each draw of the coefficient vector, we draw up to 5,000 orthonormal matrices rotating the covariance matrix of the reduced form shocks – Appendix 3 explains the method. Thus, we perform up to 10,000,000 Monte Carlo extractions 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 should stress that, since the log of government consumption expenditure to output and the log of output per-capita are used in the VAR, the multipliers we construct are consistent with the theoretical multipliers when population is exogenously growing and output growth, on average, is positive, but not directly comparable to those in the empirical literature, which typically employ the log of government consumption expenditure and the log of output. To give an idea of how to compare them, suppose that population is constant and that the partial derivative and the log operators are interchangeable – which is not necessarily the case. Then, as a first approximation the multipliers in the literature are the square root of the numbers we present here.

4. THE EVIDENCE

To facilitate presentation of our results, we split the discussion into parts. First, we describe the average responses of the three variables of interest, and of the per-capita output multipliers to government consumption expenditure shocks; averages are computed allowing for coefficient and identification uncertainty. Second, to evaluate the importance of the three theoretical conditions, we compare output multipliers with the imposition of additional constraints. Third, we examine the responses of the three variables of interest and of per-capita output multipliers in scenarios that mimic the current economic situation, and discuss the debt and inflation consequences of fiscal expansion. Finally, we study the dynamics induced by expenditure expansions, which are accompanied by future deficit and debt consolidation provisions.

4.1. Sample average responses

Figure 2 shows the average responses of the real wage, the real rate of interest, the labour-efficiency wedge and the per-capita output multiplier for horizons of up to

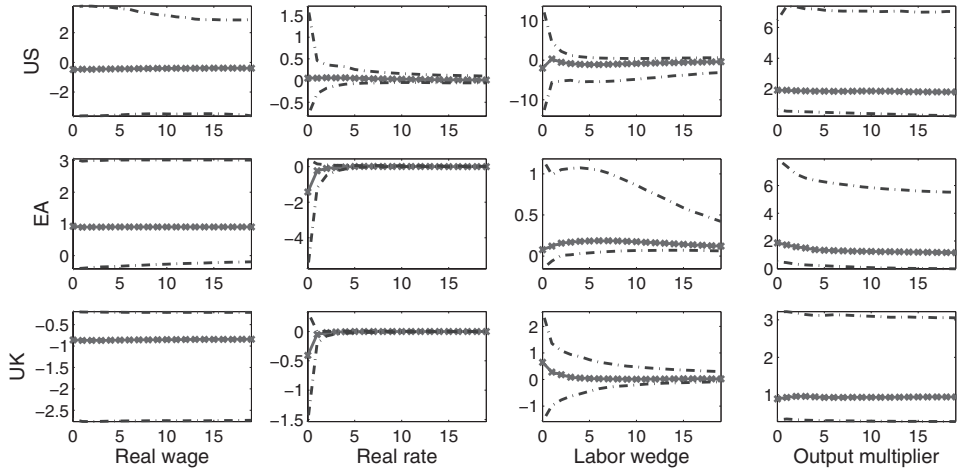


Figure 2. Responses to a deficit financed government consumption expenditure shock and per-capita output multipliers. The horizontal axis reports the horizon in quarters

20 quarters. We report the point-wise median response (red circled line) and the point-wise one standard error posterior interval (blue dashed line) at each horizon; row 1 refers to the US, row 2 to the EA, and row 3 to the UK.

The data are not very informative about the dynamics of the real wage, real rate of interest and labour-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 labour wedge falls in the US and increases in the EA and the UK. However, in all three regions, responses are insignificant at all horizons. We can suggest three potential reasons for this outcome. First, the shocks we identify combine structural shocks of different types. It is difficult to conceive of meaningful theoretical disturbances whose impact implications for government consumption expenditure, and deficit and output growth are identical to the ones considered here. Second, measurement errors dominate. While this is a possible explanation for the labour wedge measure, it is difficult to believe that it is relevant for the real rate of interest. Moreover, since both the consumption real wage and the product real wage display similar responses, measurement error cannot be the main reason for 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 from each of the three variables, as well as episodes where responses are negative. In other words, the identification restrictions we employ are not sufficient to provide a precise view of the dynamics of these variables. Labour markets, monetary policy and markups can react both ways, depending on circumstances which the analysis has not controlled for.

The dynamics of the real wage in the US are at odds with the characterization of the empirical evidence in Ramey, 2009. She claims that in the US, the real wage increases when expenditure shocks are identified with 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, our figure indicates that, unless other restrictions are imposed, the response of the real wage cannot be signed with high probability at any horizon.

Perhaps unsurprisingly, given that we are unable to sign the response of the three variables that the theory singles out as crucial for understanding the magnitude of the output effects of government expenditure shocks, we can also not say much about the magnitude of the per-capita output multipliers. 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 it 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 1 at any horizon, for any of the three countries.

4.2. Adding identification restrictions

Since the patterns in Figure 2 are quite robust to standard specification changes analysed in the literature (e.g., they are robust to changes in the sample period, lag length and transformation of the variables entering the VAR, etc.), it could be concluded that the data are unable to provide clear conclusions regarding the relevance of the theory. However, rather than abandoning the investigation, we study whether inference is sharpened with the addition of identification restrictions. Thus, in addition to the constraints on the impact responses of government consumption expenditure, deficit and output growth, we restrict also the impact response of the real wage, or the real rate, or the labour wedge, or all three responses jointly. To ensure that the *ceteris paribus* conditions roughly hold, we require the responses of bond yields to be also instantaneously unchanged. Adding identification restrictions slices the response intervals of Figure 2, eliminating some scenarios. We want to determine whether the data could be consistent with certain constraints on real wage, real interest rate, and the labour wedge and whether these restrictions provide a better measure of the output multipliers.

Table 1, which reports the instantaneous output per-capita multiplier obtained in each exercise we conduct and the posterior credible 68% intervals in parentheses, displays some interesting facts. First, imposing any of the three restrictions sharpens the inference considerably and enables a better measurement of the magnitude of the multipliers: the posterior intervals are much smaller in all cases. Second, including the restriction that the real rate falls in response to government consumption expenditure disturbances makes the median output multiplier for all countries large relative to the average output multiplier. Thus, an accommodative

Table 1. Contemporaneous per-capita output multipliers

	Average	Adding restrictions			
		$r < 0$	$w > 0$	Wedge < 0	All
US	1.93 (0.65, 6.47)	2.20 (2.03, 2.22)	0.33 (0.28, 0.35)	3.26 (3.13, 3.28)	4.84 (4.70, 4.98)
EA	1.86 (0.56, 7.92)	2.62 (2.55, 2.69)	0.15 (0.11, 0.16)	0.54 (0.51, 0.58)	3.64 (3.56, 3.73)
UK	0.89 (0.33, 3.21)	1.90 (1.86, 1.94)	0.22 (0.18, 0.25)	0.08 (0.05, 0.09)	2.20 (2.15, 2.24)
	Large spending constant R	Recessions	Spending reversals	Debt consolidation	
US	1.20 (1.15, 1.24)	0.80 (0.73, 0.86)	1.20 (1.18, 1.23)	1.32 (1.30, 1.36)	
EA	0.60 (0.75, 0.86)	1.25 (1.23, 1.26)	4.80 (4.70, 4.85)	5.70 (5.65, 5.73)	
UK	0.64 (0.61, 0.65)	0.35 (0.34, 0.36)	1.10 (1.08, 1.12)	2.70 (2.67, 2.74)	

Note: Median estimates and standard errors are in parentheses.

monetary policy is very important for expenditure expansions to be effective. The gain is considerable in the case of the UK which was experiencing an inflation targeting regime during the period considered. Third, restricting real wages to be positive is insufficient to obtain large instantaneous per-capita output multipliers. In fact, in our case, the multipliers obtained are the smallest and are in the tail of the average multipliers distribution. In other words, increases in the real wage are necessary, but by no means sufficient to produce large output expansions. Fourth, imposing that the labour-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 1. 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, making the slope of the Phillips curve much flatter. Alternatively, the marginal product of labour reacts to changes in fiscal variables in the US, but not in Europe, thus making it possible to produce a larger output at a given marginal cost. Finally, imposing that all three conditions are satisfied increases the magnitude of per-capita output multipliers in all countries. The gain is largest in the US; in the UK imposing all the restrictions increases per-capita multipliers only marginally relative to the case where restrictions are imposed only on the real rate. The numbers in the last column in Table 1 are large based on the standards in the literature (the range is [0.6, 1.0]) and underline the importance of taking account of theoretical considerations to obtain meaningful empirical results.

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

smaller per-capita multipliers than these other two areas. However, other idiosyncrasies seem to matter less. For example, consider labour market institutions: it is well known that in the EA the real wage adjustment to shocks is much slower than in the US due to the nature of labour market arrangements (especially the strength of unions and the high replacement costs in the former). Thus, one would expect that imposing a fast response of the real wage to expenditure shocks (as it is done in Table 1, column 3) would make output multipliers larger in the EA relative to the other two countries. Clearly, this is not the case. Furthermore, as indicated, for example, in Galí (1994), the larger the size of government, the stronger are the stabilization properties of expenditure shocks and, therefore, the larger are the output multipliers. On average, output multipliers in the EA, which has the largest government size, and in the US, which has the smallest government size, are similar. Thus, when the theoretical conditions we highlight are satisfied, having a large public sector is irrelevant for explaining magnitude differences.

To summarize, sticky-price New Keynesian models appear 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 labour efficiency wedge are satisfied, expenditure increases may make output expansions large. Of the three theoretical conditions identified, accommodative monetary policy appears the most relevant. Cross-country differences in the magnitude of per-capita output multipliers are driven by the cyclical nature of the labour wedge and trade openness. Other things being equal, the more open the country and the less reactive the markup to cyclical conditions, the smaller will be the per-capita output multiplier generated by an expenditure expansion.

4.3. Are the conditions of 2009–2010 different?

It is often claimed in policy circles that the current conditions are different from those that have prevailed in the past on average. Many commentators claim that the current recession is deeper than any other post-World War II 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 is occurring in a truly unique environment, it is impossible to use past data to determine its macroeconomic consequences. However, if episodes with similar features could have occurred in the past – in the sense that there was some probability that the current conditions could have materialized in the sample – we can study whether the necessary conditions for fiscal effectiveness are more likely to hold in these situations, and analyse whether the perception 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, the scope of our exercise is limited. However, we can mimic two important aspects of the current situation. First, we can analyse the dynamics of macroeconomic variables when the size of the consumption expenditure shock (or the size of the 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 that take place in recessions, by which we mean expenditure shocks accompanied by a simultaneous fall in tax revenues and inflation, are different from those recovered on average. To produce the first set of circumstances, in addition to restrictions on the impact response of expenditure, deficit and output growth, we impose the constraints that the government expenditure to output ratio (deficit to output ratio) increases on impact by at least 1% (0.5%) and that the nominal rate is unchanged. We also consider the scenario where the nominal interest rate is fixed at zero rather than at the steady state. Since this scenario has a negligible probability to have materialized in the past, there is little to learn from it for the current situation. In the second case, we add the restrictions that tax revenues and the inflation rate fall contemporaneously in response to the shock. Given that restrictions on the magnitude of the impact response of the government expenditure to output or the deficit to output ratios produce qualitatively similar dynamics, we only report results obtained restricting the former. We summarize the constraints used in the third and fourth columns in Table 2. Figure 3 reports the responses of some variables of interest in the ‘large spending’ scenario; Figure 4 reports similar responses for the ‘recessions’ scenario. In both figures, the rows correspond respectively to the US, the EA and the UK. The first and second columns in the second panel of Table 1 summarize the magnitude of the impact output multipliers in these two scenarios.

The occurrence of large expenditure shocks when the nominal rate is fixed results in real rate falls of roughly the same amount in all countries. The pattern of

Table 2. Contemporaneous identifying restrictions employed, different scenarios

	Basic	Conditional	Large spending	Recession	Spending reversals	Debt consolidation
G spending	>0	>0	>>0	>0	>0 and <0	>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				
Labour wedge		<0				
Nominal rate			=0			
Tax revenues				<0		
Inflation				<0		
Bond yield		=0				

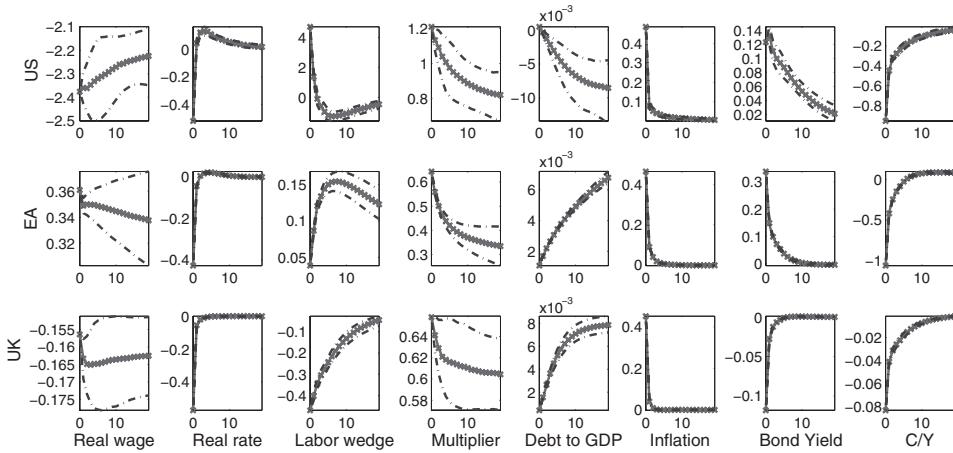


Figure 3. Dynamics in response to deficit financed large expenditure shocks when the nominal rate is fixed

responses of the other two variables is heterogeneous: the real wage falls in the US and UK, and increases in the EA; the labour efficiency wedge increases in the US and in the EA, and falls in the UK. Per-capita output multipliers are roughly similar in size and significantly less than 1 in the EA and the UK; in the US they are about three times larger and significantly above 1, at least on impact. Thus, in this scenario, the dynamics of the real wage, the real rate and the labour efficiency wedge do not fully determine the magnitude of the output effects of the expenditure expansion. Since in all countries the real interest rate falls by roughly the same amount, it is highly unlikely that differences in the way the IS curve shifts, are responsible for the cross-country differences observed.

In a recession, unexpected increases in government spending drive up the real rate in all countries while the response of the other two variables is heterogeneous: the real wage increases in the US and the EA, and decreases in the UK; the efficiency wedge increases in the US and the UK and decreases in the EA. Interestingly, in this scenario, monetary policy is tight in all countries – in the US and the EA the nominal rate falls but less than inflation, in the UK it increases despite the decrease in inflation – and this tight monetary policy could be responsible for the modest per-capita output multipliers we obtain. The slightly larger per-capita output multipliers in the EA appear to be due to the real wage responses, which are considerably larger than in the other countries.

Comparing the rows in Figures 3 and 4, we can see that although the two scenarios are designed to capture aspects of the current situation, they have different implications for the real wage, the real rate and the labour efficiency wedge. Note also that, although 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, to understand the pattern we obtain, we need to consider the dynamics of other variables.

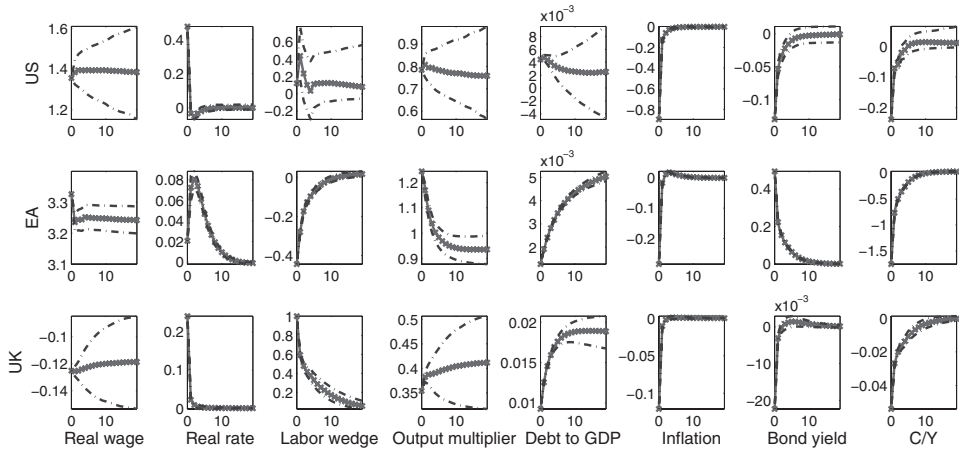


Figure 4. Dynamics in response to deficit financed expenditure shocks taking place in recession

Three important conclusions can be drawn from the evidence reported in this subsection. Per-capita output multipliers generated in situations similar to those prevailing in 2009–2010 are unlikely to be larger than those obtained on average in the past, primarily because the conditions for fiscal expansions to be effective are either not applicable or not necessary in these scenarios. Also, it is unclear which of the conditions characterizing the current situations matters more in the US the per-capita multiplier is larger when the size of the shocks is large and the nominal rate is unchanged, but is larger in the EA when a recession is ongoing. Interestingly, the role of fiscal policy in the US during a recession is small: the per-capita output multiplier produced is among the smallest we obtained. 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 most interesting is the pattern of responses obtained, which is somewhat difficult to explain within the New Keynesian paradigm. For example, in the EA, an accommodative monetary policy is insufficient to produce large output expansions, and the conditions that would make the aggregate supply curve flatter are generally violated. What then is driving these results? One possibility is that some of the *ceteris paribus* conditions do not hold in some of these scenarios or may hold in some scenarios, for some countries but not others. Another possibility is that the New Keynesian framework we used as our organizing principle to interpret the evidence cannot account for the extreme events we consider. In the next subsection we investigate which hypothesis is likely to be true.

4.4. The effects on debt and inflation

An important part of the public debate following the extraordinary fiscal packages legislated in 2009, has to do with the size of the debt, the increased perception of

default and the inflation effects produced. Many commentators believed that the legislation would generate explosive debt dynamics, and financial markets agreed and reacted in 2010 and 2011 by increasing the spread between countries' bond yields and potentially unsustainable debt. On the other hand, many policymakers believed that the fiscal packages would not impair sustainability of the debt if they could generate sufficient output expansion and some inflation, which in turn would produce an important side effect. Higher inflation would provide the central banks with room for manoeuvre, the traditional monetary policy instrument, but a possibility that retreated 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 in the two scenarios previously considered. The fifth and sixth columns in Figures 3 and 4 show 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 in 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 future horizon. Thus, the debt to output dynamics we present are those that would obtain if government completely disregarded the effects of a temporary shock on consumption expenditure for future debt, and expectations were constant.

In the US, shocks that increase expenditure by large amounts when the nominal rate is unchanged, leave the debt to output ratio unchanged in the short run and decrease it in the medium run. After eight quarters, one could expect a median fall of about 1% from the steady state level. Our calculations suggest that if the shock lasts for six quarters rather than one, the debt to output ratio effect at the eight quarters horizon would be roughly five times larger (in absolute value). Thus, the fact that shocks are large does not necessarily induce uncontrolled debt dynamics. There are two explanations for 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 temporarily increase inflation. 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. In the median, a deficit financed government consumption expansion adds two percentage points to the debt to output ratio after eight quarters. Afterwards, the effect becomes insignificant.

In the EA, the debt to output ratio increases modestly but significantly in both scenarios. Quantitatively, it is expected to increase by about one percentage point after eight quarters and to reach its new steady state of about 2% higher after

5 years. As in the US, the inflation rate increases with large spending shocks, but the effect is short lived. In the UK, large expenditure shocks occurring when the nominal rate is instantaneously unchanged induce debt and inflation dynamics similar to the EA: debt to GDP is positive, it reaches a new steady state about 2% higher after 4.5 years, and inflation temporarily increases. Since the magnitudes 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 useful to study why the dynamics of inflation differ in these two scenarios. The last two columns of Figures 3 and 4 show the dynamics of yield on long-term government bonds and of the consumption to output ratio. Recall that when deriving our theoretical predictions, we assumed implicitly that the responses of long-term yields are negligible. In practice, this appears not to be the case.

In the 'large expenditure' scenario the yield on long-term government bonds increases in the US and the EA and decreases in the UK; in the 'recession' scenario it increases in the EA and falls in the US and UK. 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 is the same in both scenarios, in the US the sign changes and this could explain the dynamics of the real rate, the real wage and of the per-capita multiplier in the two scenarios. In general, the aggregate supply curve appears to shift when aggregate demand moves, making the outcome of fiscal expansion somewhat unpredictable.

Per-capita consumption increases in both scenarios, in the US and UK, shown by summing the responses in columns 8 and 4 in each figure. However, the consumption to output ratio falls in the US, the EA and the UK. Thus, the sensitivity of consumption to current income decreases in response to the shock. If agents are more prudent in their spending, or lose confidence in the future evolution of the economy in these situations, savings may increase or dissavings may fall when output increases. There is plenty of evidence that consumers adopt more prudent spending habits in recessions or when the economic environment is less favourable. Hence, an increase in government spending in these scenarios not only shifts the aggregate demand curve, but also changes its slope and may even twist it backward if the investment to output ratio 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 state dependent and the signs of the revenue responses shape both their magnitude and their sign. The inflation effects of large expansionary shocks are temporary and similar across countries. Thus, while in the-

ory fiscal expansions may give monetary policy some lever to move nominal rates, in practice this remains wishful thinking. Finally, in the two scenarios we consider, increases in government spending 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 labour efficiency wedge neither necessary nor sufficient for effective fiscal expansions.

4.5. Consolidation schemes

The tensions in the markets for sovereign debt since 2009 have refocused public attention on the question of the sustainability of public debt and the need for fiscal consolidation schemes driving debt back to manageable levels. We have seen that fears about uncontrolled debt dynamics have no strong empirical foundation. Nevertheless, it is useful to analyse consolidation schemes since this might shed important light on the nature of the adjustments occurring in these situations.

Since the study by Giavazzi and Pagano (1990), the folk wisdom in the profession is that consolidation schemes could be expansionary. The underlying 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 (for a review, see Alesina and Ardagna, 2009). Afonso (2010) shows that effects of this type were present in the EA when consolidation schemes considerably reduced the real rate of interest and thus debt financing costs. Coenen *et al.* (2008), on the other hand, using the estimated ECB new area-wide model, show that fiscal consolidations are always contractionary in the short run, a conclusion confirmed by Forni *et al.* (2010). A variety of opinions about the macroeconomic consequences of consolidation schemes coexist in the policy arena and, following the G-20 meeting in summer 2010, for example, many US officials believed that the measures adopted by the EA would lead to a new great depression – cutting expenditure when economic activity had not recovered would be 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 (achieved through future expenditure cuts or future revenue increases). Corsetti *et al.* (2009) claim that, other things being equal, spending reversals can make output multipliers larger by signalling to agents the temporary nature of the measures and the commitment of government to return to the fiscal orthodoxy as soon as the negative circumstances requiring the stimulus are removed. Uhlig (2010), however, warns against deficit consolidation schemes carried out too rapidly, since expectations about future increases distorting taxation may make output multipliers negative. Canova and Pappa (2006) show that unexpected expenditure increases, rapidly matched by increases in distorting tax revenues,

historically have had large and negative effects in US states required by constitution or legislation to balance their budgets at the end of the fiscal cycle.

The last two columns in Table 2 display the identification restrictions used in these two scenarios and Figures 5 and 6 show the dynamic responses of the variables of interest: the first, second and third rows in the figures refer respectively to the US, the EA and the UK. We present expenditure schemes 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 spending reversal and the deficit consolidation programmes are assumed to be known to agents when government consumption expenditure unexpectedly increases.

Government expenditure reversal schemes induce positive real wage response and negative labour efficiency wedge responses in all countries. However, while the real rate decreases in the EA, it increases in the US and the UK. Per-capita output multipliers are only slightly above one in the US and the UK, and considerably above that in the EA. Thus, in this scenario too, the dynamics of the real rate are crucial to determine the magnitude of the real effects of government spending shocks. Note that inflation falls in the US and the UK, but increases strongly in the EA, and monetary policy significantly deviates 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 also unchanged despite the increase in inflation; in the UK a fall in inflation is accompanied by a fall of a smaller magnitude in the nominal rate.

To understand why the dynamics of inflation differ in the US, EA and UK, it is worth examining the behaviour of long-term government bond yields, which in this scenario provide information about long-term inflation expectations. In the UK, inflation falls because the programme shifts both aggregate demand and the aggregate supply curve. As already mentioned, the aggregate supply curve depends on expected future inflation. Since the reversal scheme reduces long-term inflation expectations, it moves the aggregate supply curve to the right and the combined shift in aggregate demand and the aggregate supply schedules cause current inflation to fall. In the EA, the shift in the aggregate demand curve is accompanied instead by an increase in long-term inflation expectations. Thus, the aggregate supply shifts inward creating considerable inflation. The US pattern is difficult to interpret since inflation falls and long-term inflation expectations increase. One explanation might be that the reversal is perceived as temporary, making aggregate supply move outward temporarily, and then overshoot inward over the long run. Alternatively, the shock may alter the steady state markup, for example, causing the aggregate supply curve to rotate.

The dynamics of the private consumption to output ratio are useful to interpret the results. Recall that this variable tells us whether the sensitivity of consumption to income changes with the policy and the scenario considered, and how the IS curve shifts in response to expenditure increases. The response of the consumption

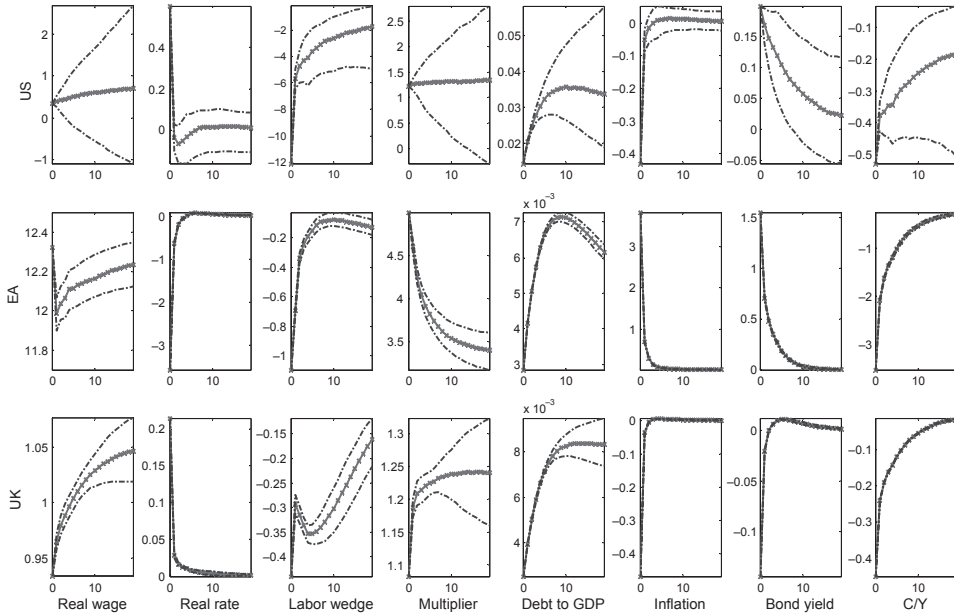


Figure 5. Dynamics in response to deficit financed spending shock which is reversed after two periods

to output ratio is qualitatively similar across countries: it falls instantaneously then slowly returns to its steady state. However, the magnitude of the changes is considerably larger in the EA. Thus, following government expenditure shocks that are expected to be reversed in the near future, consumers act in a more neoclassical and less Keynesian manner, in the sense that the sensitivity of consumption to current income falls, making the dynamics of the real interest rate more relevant 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 larger than in the other two regions.

The consolidation scenario presents similar features. Unexpected increases in government consumption expenditure known to produce deficit reductions in the future, increase the real wage and decrease the labour efficiency wedge, while the real interest 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 multipliers in the two scenarios is roughly similar for the US; for the EA it is slightly larger in the consolidation scenario, primarily because of the larger responses of the real wage and the efficiency wedge; and it is larger in the UK in the consolidation scenario. Given that the dynamics of inflation and long-term inflation expectations are similar in the two programmes, the differences in the magnitude of the UK per-capita multiplier must be due to different consumer responses in the consolidation scenario. The last column in Figure 6 shows that, indeed, the private consumption to output ratio sharply increases (it falls in the

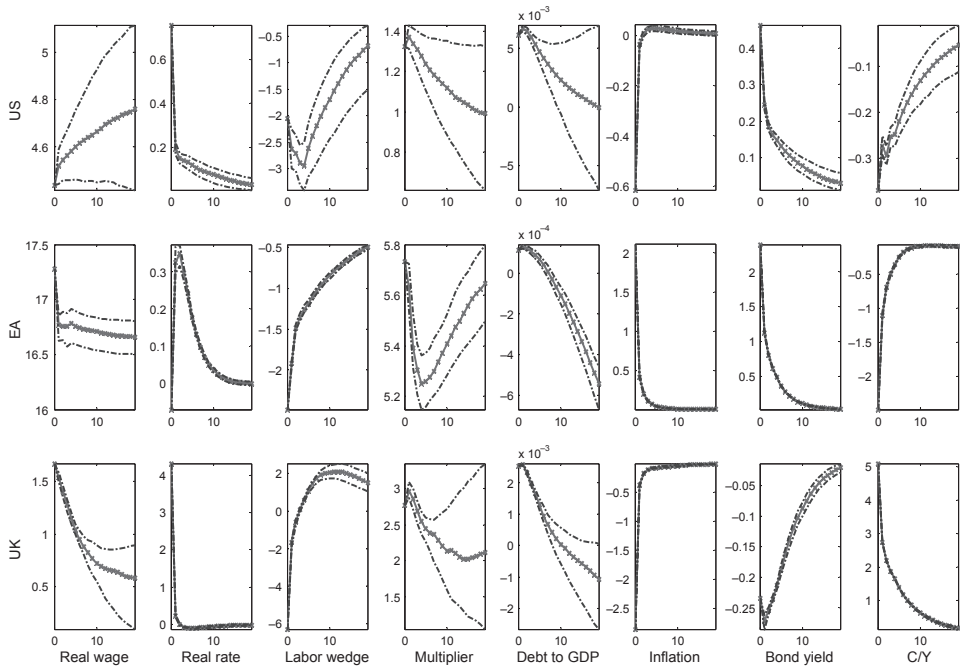


Figure 6. Dynamics in response to a deficit financed government expenditure shock which is consolidated after two periods

reversal scenario, see Figure 5). Thus, consumer spending becomes more Keynesian boosting output more in the consolidation scenario.

What have we learned from these two exercises? Neither Uhlig's (2010) pessimistic view about debt consolidation programmes nor Corsetti *et al.*'s (2009) optimistic view about spending reversals is fully supported by the data. There is some evidence that well-designed and well-understood, reversible expansionary expenditure schemes could lead to output expansions larger than those obtained with an expansionary expenditure scheme that is not expected to be reversed in the future. However, for this to happen one of two conditions needs to be satisfied. A consolidation programme that is accompanied by a fall in the real rate of interest has more chance of being output effective in the short run. Similarly, given a real rate response, a consolidation programme that alters the sensitivity of consumption expenditure to income may deliver larger output multipliers. Thus, regardless of the detail of the containment scheme, the short-run effectiveness of fiscal expansions depends on what monetary policy does and what agents perceive the future will bring in terms of output and inflation.

5. CONCLUSIONS

What conclusions can be drawn from our study? First, the class of sticky-price New Keynesian models popular in academic and policy circles, in normal times, provides

useful guidance to understand the mechanisms leading to effective fiscal expansion. The conditions identified by the theory as necessary to deliver large output effects have different importance in practice: how monetary policy responds to fiscal expansion is crucial; the sensitivity of real wages to demand conditions appears to be minor. If the three conditions are satisfied, per-capita multipliers can be large in absolute terms and larger than the average estimated in the literature. Cross-country differences can be related to the cyclical nature of the markup and to trade openness. Other things being equal, the more open the country and the less reactive the markup to cyclical conditions, the smaller will be the per-capita output multiplier generated by a given expenditure expansion. The 'size' of the government sector or the extent of labour market regulation seems to be much less important in accounting for cross-country differences in per-capita output multipliers.

Second, per-capita output multipliers generated in situations such as those prevailing in 2009–2010 are unlikely to be larger than those obtained on average in the past. Our conclusions differ from those provided by previous studies because, historically, in the scenarios we consider, the *ceteris paribus* assumptions are unlikely to hold, making the conditions for the effectiveness of fiscal expansions either inapplicable or less necessary. In particular, expectations turn out to be substantially affected and parameters, which typically are regarded as structural, may instead be state dependent. To fully understand the implications of fiscal expansions in situations of deep economic crisis we need a more complex model. Note also that the scenarios we consider may not be capturing well the fact that the nominal interest rate is stuck at zero, because the probability that this happened in the past is negligible. Thus, extrapolation of the implications of our analysis should be made with care. While per-capita output multipliers are unlikely to be large, there are differences in the ability of fiscal policy to affect output in different countries and different conditions. Explaining these heterogeneities requires detailed analysis of the structural differences in the three economies, displayed in these scenarios, which is beyond the scope of this paper. In general, the cross-country variations we detect indicate the need for caution in using the predictions of the class of models we consider in special conditions, not only because these conditions are outside the norm, but also because different countries may react differently to the same fiscal impulses.

Third, the debt consequences of the expenditure programmes we consider are small. Thus, neither the fact that the current packages are large as a percentage of output, nor the fact that output growth is currently low, appears to threaten fiscal sustainability in the US, the EA or the UK. Our calculations are conditional on future expectations being roughly constant. However, even if we consider shifts in expectations consistent with the dynamics of government bond yields, debt effects appear to be limited. To justify the recent pressures in the bond markets, expectations would need to have shifted considerably more than in the past in response to the expansion. To analyse the consequences of fiscal expansions when considerable

swings in the future perceptions of the state of the economy are possible, requires an alternative theoretical framework, in which expectations may not necessarily be rational. Studying the implications of spending shocks in these frameworks is 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 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 not considered in this analysis might affect our conclusions.

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 needs to be credible in the sense that future inflation expectations will be unchanged. When monetary policy is restrictive, consolidation policies that 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 less crucial for determining the quality of the outcome; what does appear to matter is that the policy is well understood and the commitment to return to the fiscal orthodoxy is solid.

Our results generally stress that fiscal policy could be an effective countercyclical tool and that the output multipliers it generates may be significantly larger than 1. For this to happen, monetary policy should facilitate fiscal expansion; expectations about future output growth and inflation should not be affected; and structural relationships, such as the sensitivity of consumption to output or the real interest rate, should be invariant to the policy change.

Discussion

Paolo Surico

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This is a very well-written paper that uses structural VARs identified via sign restrictions to evaluate the dynamic effects of a government expenditure shock on real activity, real wages, real short-term interest rates, debt and inflation in the United States, the Euro area and the United Kingdom.

The topic could have not been more timely. The use of sign restrictions is interesting and well suited for the task at hand. The reason is that New Keynesian and neoclassical models emphasize so different channels for the transmission of fiscal policy that estimating a structural model in each of the two camps necessarily

requires to take a stand – prior to estimation – on what features, New Keynesian or neoclassical, are relatively more important in the data. Sign restrictions do not require any dogmatic position. In fact, the strategy in Canova and Pappa is to identify a set of inequality predictions on the effects of an expansionary government spending shock that are common to both settings while leaving unrestricted the responses of those variables on which the two families of models do not speak with one voice. The robust sign restrictions are used to identify the fiscal shocks. The response of the unconstrained variables can be used to discriminate between the competing theories. This also includes the possibilities that one class of models might be empirically more successful than the other only in a particular dimension.

To study whether the effects of fiscal policy have changed under the macroeconomic conditions prevailing during the recent financial crisis, the authors add a twist to the ‘standard’ sign restrictions identification scheme. They progressively increase the number of sign restrictions on key variables, such as real interest rate and real wage, to replicate those conditions that in theory are associated with the largest fiscal multipliers. In so doing, the authors are able to assess the extent to which the Great Recession was indeed special, also for the aggregate impact of fiscal interventions.

The punch line of the paper is that accommodative monetary policy – in the form of negative real rate – gives fiscal policy the best chance to have large effects on the real economy. On the other hand, an increase in real wages, which has also been identified as one of the conditions to improve the effectiveness of fiscal policy in theory, seems to play only a minor role in the data to generate large fiscal multipliers. Furthermore, there is pervasive evidence of heterogeneity across countries in the way that fiscal policy transmits to the macroeconomy. Not only the estimates change significantly across identification schemes for each country but also they tend to do so across countries even when using the same sign restrictions. Assumptions about the timing, anticipation and consolidation of a country’s fiscal position map into structural VAR estimates that are quantitatively and qualitatively different from country to country. The authors conclude that no fiscal strategy is superior everywhere and at all times, though large government spending expansions are unlikely to generate high inflation and deficit/debt reduction programmes are likely to amplify the short-run effects of fiscal policy.

I will develop my comments around three themes: (i) modelling monetary accommodation, (ii) country heterogeneity and quality of data for the Euro area and (iii) the possibly time-varying effects of fiscal policy.

Modelling (large) monetary accommodation

A number of alternative strategies have been proposed in the literature to simulate the impact of the zero lower bound on the short-term nominal interest rate. The main difficulty is that very low nominal interest rates have been virtually unprece-

mented in the post-World War II sample period and therefore fixing the nominal interest rate at zero in a time-invariant VAR would be a counterfactual with little empirical content: it is not possible to learn from the data about something that virtually never happened. In their Great Recession scenario, the authors' strategy is to keep the nominal interest rate constant following a fiscal policy shock. Under this scenario, the output multipliers are not significantly different from (and in fact they are smaller than) the estimates of the average scenario in which no monetary accommodation is imposed. A possible reason for this result is that keeping the nominal interest rate constant amounts to keep it fixed to its sample average, which in the United States, United Kingdom and the Euro area has ranged between 3% and 5% over the sample periods. With inflation typically lower than these figures during the Great Moderation, this scenario implicitly imposes a positive response of the short-term real rate. An alternative strategy, proposed by Faccini *et al.* (2011) to test for cross-country fiscal spillovers during a crisis, is to impose the additional restrictions that the response of the real rate is within the bottom 5% of its empirical distribution conditional on the sign restrictions imposed in the baseline case. This alternative strategy has the advantage of getting closer to the monetary conditions prevailing during the great recession while being still empirically plausible. It is interesting to note that by implicitly pushing the real rate into largely negative territory, Faccini *et al.* (2011) are able to find significantly larger multipliers for the real GDP of both the United States and some of its main trade partners following an increase in US government spending. This implies that extreme – but still empirically plausible – circumstances have the potential to make the effects of fiscal policy on the real economy even larger.

Country heterogeneity and quality of data for the Euro area

Political ideologies and unsynchronized electoral cycles suggest that federal fiscal policies may have very heterogeneous effects in a monetary union depending, among other things, upon the size of the intervention, the transmission on the real economy and business cycle conditions. This is true for the United States where most of the discussion has focused on national rather than state fiscal interventions (see Nakamura and Steinsson, 2011, for an exception). But the case for heterogeneity seems even stronger for the Euro area where governments significantly differ in terms of size, orientation to market economy and desire for fiscal policy coordination. The heterogeneity seems apparent not only from a historical perspective but also looking at the responses to the financial crisis with the government interventions in Germany and France, for instance, being significantly larger in both size and breadth than those in Italy. Notwithstanding the concern about heterogeneity, it seems unfortunate that there exists 'reliable' fiscal data on the monetary union as a whole (as prepared by the European Central Bank) but there are no 'reliable' counterparts at the level of the individual countries upon which the synthetic Euro

area fiscal data are constructed. Further transparency on the way this data are adjusted at the national level to turn possibly lesser unreliable single country time series into possibly more reliable area-wide time series would greatly improve the confidence on the inference one can draw from the estimates of the effects of fiscal policy in the Euro area.

The possibly time-varying effects of fiscal policy

The strategy of Canova and Pappa to identify in the data the macroeconomic conditions that in theory may magnify the fiscal multiplier is to expand the set of sign restrictions by imposing that the short-term real interest rate is negative and real wages are positive on impact following a government spending shock. As the authors use a fixed coefficients VAR over 17–26 years of data (depending on the country), this can be thought as if they were drawing from the portion of the empirical distribution more likely to be associated with episodes of negative real rate and positive real wages. An alternative strategy to look at heterogeneity in the effects of fiscal policy would be to apply the baseline sign restrictions on the estimates from a VAR with time-varying parameters. The higher flexibility of this alternative specification is likely to make it possible to identify the specific historical episodes in which the theoretical conditions for larger multipliers are more likely to be satisfied in the data. This seems even more relevant in the light of recent empirical work by Auerbach and Gorodnichenko (2010) and Kirchner *et al.* (2010) who emphasize that the dynamic effects of fiscal policy on real GDP may vary with the business cycle and the ratio of private credit to GDP, respectively. The main challenge for future research in this context would be to find an effective strategy to shrink the variables space and therefore make it operational an empirical time-varying coefficients model to study the evolving effects of fiscal policy shocks.

Panel discussion

Cedric Tille asked for clarification on the result that current fiscal action would have limited consequences for debt accumulation. He noted that this seemed to contradict data from the IMF and other organizations. Michalis Haliassos noted that the findings on the size of the fiscal multiplier rely on the assumption that the fiscal authority correctly anticipates the action taken by monetary authorities. He wondered could the authors extend their analysis to show that the interaction between monetary policy and fiscal policy was more important during recessionary periods compared to times of more stable economic activity.

A number of panellists raised questions regarding the modelling approach pursued by the authors. Refet Gürkaynak noted that the interest rate was fixed in the

model but wondered if it mattered when this restriction was imposed in order to identify the effectiveness of fiscal policy. Simon Wren-Lewis questioned the authors' approach to modelling the recent crisis. It was not clear why in theory the size of the shock should matter and argued that the authors should only focus on the monetary policy response in order to characterize the crisis.

In response to the discussant's comments on the movement of consumption in the model, Fabio Canova explained that they use the ratio of consumption to output and find that under the various experiments considered, consumption continues to rise but it declines as a proportion of output. In reply to Cedric Tille's comments, he noted their measure of debt is constructed using the government budget constraint which depends on the response of the real interest rate, output and revenue to the shock. The accumulated effect on debt appears to be small but this finding is based on the assumption that expectations remain constant. He noted their results may be very different if expectations were allowed to change in the model. He informed the panel that fixing the interest rate in the model is done to simulate the situation where monetary policy is not able to immediately react to a shock. As there is no record of zero interest rates in the sample, they cannot set the nominal interest rate to zero in their model. In reply to Simon Wren-Lewis's comment, he stated that the motivation for the inclusion of the large shocks in their model was to mimic the events of the recent crisis and the extraordinary fiscal action taken in 2009. In response to Livio Stracca's concern on whether fiscal policy shocks are correctly identified in model, he explained that fiscal shocks are modelled differently to monetary policy shocks and noted that the combination of restrictions imposed to identify the fiscal shock would not match a monetary policy shock. He agreed with Paolo Surico that the use of more disaggregated Euro area data would be a useful way to extend their analysis and address issues concerning cross-country differences in financial market restrictions and channels through which monetary policy is implemented.

APPENDIX 1: A PROTOTYPICAL NEW KEYNESIAN MODEL

The model we present is a simplified version of the one considered in Pappa (2009) and illustrates the typical predictions of New Keynesian models regarding the effects of deficit financed government expenditure shocks on macroeconomic variables.

The preferences of representative consumers are represented by the utility function

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

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, $\chi > 0$ is a constant and E_0 is the expectation

operator, conditional on time zero information. 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, Ξ_t are profits from owning the intermediate goods firms, τ is the income tax rate, δ is the capital depreciation rate and v controls the (quadratic) costs of adjusting capital.

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, that is, $Y_t = C_t + I_t + G_t$.

There is a continuum of firms producing intermediate goods. Each intermediate firm j produces output according to the technology: $Y_t(j) = (A_{jt} N_{t(j)})^{1-\alpha} K_{t(j)}^\alpha$ where A_{jt} is a technological disturbance and α the share of capital. These firms are 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 inputs. Cost minimization implies that relative factor prices determine the relative use of capital and labour and that the common real marginal costs are:

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

In the output market intermediate firms 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 its price is set equal to $(1 - \gamma)$. When a producer receives a signal to change its price, it chooses a new price to maximize expected profits. The solution to the profit-maximizing problem produces:

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

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

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

When prices are flexible the fraction of firms that can reset their prices at each t is equal to 1 ($\gamma = 0$) and prices are set as a constant mark-up over marginal costs:

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

Government 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:

$$R_t^{-1} B_{t+1} = P_t G_t + B_t - T_t P_t - \tau (P_t w_t N_t - P_t (r_t - \delta) K_t)$$

There is an independent monetary authority setting the nominal interest rate as:

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

where ζ_{π} a feedback parameter and π_t the inflation rate. There are several options for closing the model. The first is to assume a balanced budget in each period (i.e. $B_t = 0$ for all t) and the absence of distorting taxation ($\tau = 0$). 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 to let the debt grow without limits or use a debt targeting rule of the form:

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

where \bar{T} is a constant, \bar{B} is some target level of debt and ζ_b a feedback parameter. When only distorting taxes are available, the rule becomes: $\tau_t = \bar{\tau} \exp(\zeta_b (B_t - \bar{B}))$.

Pappa (2009) shows that expansionary government consumption expenditure shocks financed by 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 ($\sigma, \chi, \varphi, v, \delta, \varepsilon, \alpha, \gamma, \zeta_{\pi}, \zeta_b$) are allowed to vary within a reasonable range.

To highlight the differences between the New Keynesian and the neoclassical versions of the model we assume that ($\beta = 0.99, \sigma = 1, \chi = 1, \varphi = 2, v = 2, \delta = 0.25, \varepsilon = 7, \alpha = 0.3, \zeta_{\pi} = 1.5, \zeta_b = 0.2, \tau = 0$) and simulate the responses of consumption, investment, real wage, the real rate, hours and output when an impulse

in government expenditure shock lasts one period in the log-linearized model solution. The top panel in Figure A1 presents the responses when $\gamma = 0.75$; the bottom panel the responses when $\gamma = 0$.

APPENDIX 2: DATA CONSTRUCTION

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.

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: 1 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: annualized first difference of the log of GDP deflator (BEA B191RG3).
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), 3-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.

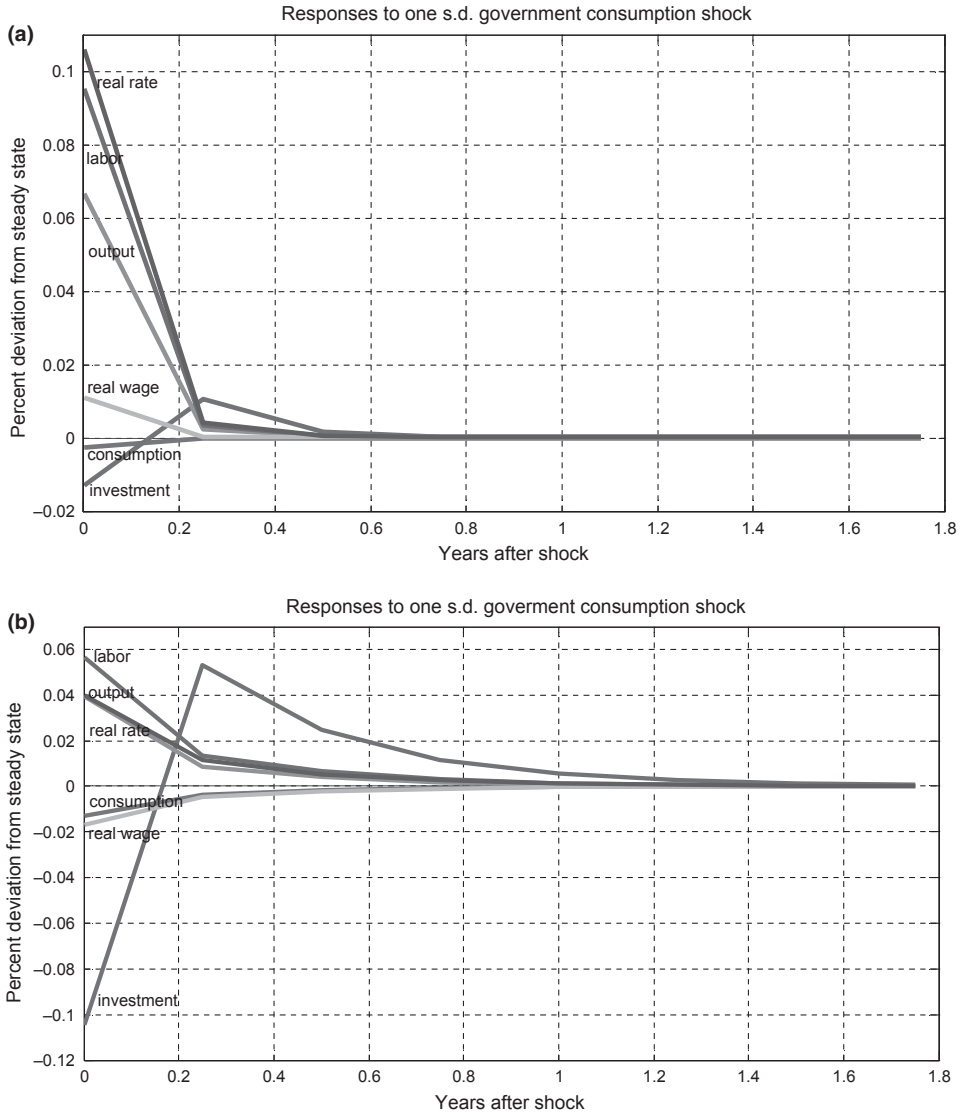


Figure A1. Responses to a government consumption spending impulse (a) New Keynesian model; (b) RBC model.

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 labour 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: 1 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: 1 minus the product of real employee compensation (AR) CURA (from the OECD) and number of 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).

APPENDIX 3: THE BAYESIAN PRIOR AND THE ALGORITHM TO IDENTIFY SHOCKS

The prior we use assumes that the VAR coefficients are random and that the covariance matrix of the shocks is fixed. Letting \mathbf{A} denote the vectorized version of the VAR coefficients, we assume that \mathbf{A} is normal with mean \mathbf{M} and covariance \mathbf{S} where \mathbf{M} is the vector of zeros except for the first own lag of the variables entering in logs (i.e. G/Y , T/Y , R , $Profit$, $Inflation$). The matrix \mathbf{S} depends on four hyperparameters: $s(1)$ regulates the general tightness; $s(2)$ the importance of lags of other variables in one equation; $s(3)$ the tightness of the constant term; $s(4)$ the lag decay. Values for s are obtained using a simple grid search and maximizing the in-sample predictive power of the model over a 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 $s = [0.0001, 0.1, 0.1, 2]$. Posterior estimates are obtained combining sample and prior information using a Theil-mixed type estimator – see Canova (2007) for details. The posterior distribution of \mathbf{A} , denoted by $P(\mathbf{A})$, is normal and its moments combine sample and prior information with weights given by the relative precision of the two types of information. Given $P(\mathbf{A})$, we draw vectors $\mathbf{A}(1), \dots, \mathbf{A}(m)$ using Monte Carlo methods.

Government expenditure shocks are identified as follows. Let $HH' = I$, and let $Q(j, k)$ be the response matrix at horizon j produced by the orthogonal decomposition of the covariance matrix of the shocks obtained with the k th draw of \mathbf{A} 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 $R(1, j, k)$ for the appropriate variables are correct. If they are, $R(1, j, k)$ is stored, if they are not the 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 and, for each draw, select $H = Q$.

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