New Views on the Transatlantic Transmission of Fiscal Policy and Macroeconomic Policy Coordination*

by

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ABSTRACT

We present empirical evidence, based on structural VARs, suggesting that shocks to U.S. government purchases have sizeable and persistent effects on output and consumption in France, Great Britain and Italy. Positive realizations of these shocks also lead to large real appreciations of the U.S. dollar. Our results also link a positive tax shock in the U.S. to a decrease in consumption and output in the European economies we study. By contrast, the prototype model of the new theoretical literature suggests that fiscal and monetary policies do not interact in a significant way across regions. We provide an exposition of the prototype model and discuss the implications of our empirical evidence for both future modeling efforts and more practical policy concerns.

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I. Introduction

The formation of the euro area has rekindled interest in transatlantic transmission and coordination of fiscal and monetary policies. A new ("second-generation") literature on international coordination of monetary policies has already emerged.[1] And a number of studies have begun to revisit issues related to the international transmission of fiscal policy.[2] In this paper, we provide an overview of the new theoretical models that are being used to analyze fiscal and monetary spillovers and present some empirical evidence on the transmission of U.S. fiscal shocks to three European economies– France, Great Britain and Italy. Our main goal is to highlight directions for research on fiscal policy interactions that seem most relevant from a policy-oriented perspective.

The academic literature on the interactions of fiscal and monetary policies within Europe has emphasized the potentially strategic nature of the interactions between the discretionary policies of multiple fiscal authorities and the stabilization efforts of a common central bank. If we were to extend this literature to a transatlantic setting, our focus would be on how U.S. and European fiscal and monetary policies may interact in a Nash equilibrium, and how transatlantic policy coordination may improve on the Nash outcome.

Over the last few years, however, the concerns of European policy makers seem to have shifted away from the academic literature's emphasis on discretionary changes in fiscal policies and

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[1]Contributions include: Obstfeld and Rogoff (2000), Corsetti and Pesenti (2001b), Benigno (2001b), Benigno and Benigno (2000, 2001), Clarida, Gali and Gertler (2001), Canzoneri, Cumby and Diba (2001b).

[2]See, for example, Corsetti and Pesenti (2001a), Ghironi (2000), Obstfeld and Rogoff (1996), and Tille (1999).

their strategic interactions.[3] The current concerns of European policy makers seem to be largely about automatic stabilizers.[4] In Canzoneri, Cumby and Diba (2002), we argue that discretionary changes in U.S. fiscal policy cannot be usefully modeled from the perspective of stabilization policy either. We are hardly the first economists to express these views. In particular, Taylor (2000) has argued forcefully that discretionary fiscal policy has not played, and indeed should not play, an active (or strategic) counter cyclical role in the U.S.[5] And European Commission studies (2001, 2002) reach broadly the same conclusion about the efficacy of discretionary fiscal policy in Europe.[6]

Our doubts about the practical relevance of game theoretic models of fiscal and monetary interactions arise from the frequency of decision making within the context of the persistence of nominal inertia. Monetary policy decisions are made on at least a quarterly basis. Fiscal budgets are drawn up annually, and typically go into effect with a significant delay. Moreover, major shifts in spending and tax policy tend to be associated with elections and new governments. Setting aside a few attempts to use discretionary fiscal policy for stabilization purposes in the 1960s and 70s, postwar shifts in U.S. fiscal policy have largely reflected shifts in the political mood of the

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[3]These assertions are based on conversations with economists at various official institutions. They are consistent with discussions in Alesina et al. (2001) and European Commission (2002).

[4]Cross country differences in automatic stabilizers lead to cross country differences in the cyclical sensitivity of government budgets. To avoid a risk of violating the three-percent deficit cap imposed by the Maastricht Treaty and the Stability and Growth Pact, different countries need to position themselves at different levels in terms of their structural budget balances. While the process of adjusting structural balances seems complete or well under way in some countries it has been delayed by various obstacles in a number of countries. Chapter 3 of European Commission (2002) contains an analysis of the current situation in the euro area.

[5]Also, see the interview with John Taylor in Snowdon and Vane (1999).

[6]These studies, however, do suggest that the efficacy of discretionary policy may hinge on the specific origins of the shocks that fiscal policy aims to offset.

electorate, and in the balance of power between political parties.[7] It seems doubtful, from a U.S. perspective anyway, that strategic fiscal decisions are made at a business cycle frequency.

How should we then think about the implications of U.S. fiscal policy for the euro area? Our inclination is to think of U.S. fiscal policy as one, among many, sources of shocks that may have to be offset by the ECB, and by automatic fiscal stabilizers in Europe. Changes in U.S. fiscal policy, of course, may have a stabilizing effect on the euro area. Whether or not this is the case depends on three factors: (1) the extent to which fiscal policy is countercyclical (intentionally or by coincidence) within the US; (2) the extent to which European business cycles lag behind U.S. cycles; and (3) the time lags in transmission of U.S. fiscal changes to the euro area.

Our discussion above presumes that U.S. fiscal shocks are sizeable, and that their transmission to Europe is significant. The strength of the transatlantic transmission mechanism is an empirical question that we address below. We can only speculate about the likely size of future swings in the U.S. fiscal stance. European Commission (2002, Box 1.2) notes that the U.S. fiscal response to the last recession was larger than the total (discretionary plus automatic) fiscal response in the euro area, even though the budgetary elasticity associated with automatic stabilizers in the euro area is twice the size of the same elasticity in the U.S. Although our inclination is to view the link between the last recession and the Economic Growth and Tax Relief Reconciliation Act (EGTRRA) of 2001 as coincidental, the fact that the fiscal expansion legislated by EGTRRA was large seems indisputable.

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[7] In some cases– such as the Economic Growth and Tax Relief Reconciliation Act of 2001-- the rhetoric of the U.S. political process may have emphasized the risk of a recession as an argument for a fiscal expansion. The fiscal agenda of U.S. administrations, however, is typically set before elections– and in the case of the 2001 Act, well before the onset of a (very mild) recession.

Moreover, much of the expansion legislated by EGTRRA will go into effect in years to come; so, even larger U.S. expansions between now and 2010 (when EGTRRA "sunsets") are quite likely.[8] But liberal economists and policy makers are already characterizing the U.S. tax cuts of 2001 as "unsustainable."[9] So, a major U.S. fiscal contraction in 2010, or even earlier, is also a distinct possibility. By comparison, discretionary fiscal changes in the euro area are likely to remain small-- large fiscal expansions seem unlikely in view of the current interpretations of the Stability and Growth Pact; and once the current round of requisite fiscal contractions is complete, there may well be little political appetite for further tax hikes or expenditure cuts. As such, and given the sheer size of the U.S. economy, the U.S. fiscal stance may be a more important source of uncertainty for the ECB in years to come, than the fiscal stance in any single European country.

European Commission (2002, Box 1.2) also notes that the Fed's response to the last recession was stronger than the ECB's response. This partly reflects the fact that the Fed under Alan Greespan has responded to risks of recession and booms vigorously. But it also seems likely that the ECB's response to the last recession was muted, in part because inflation in the euro area was running above the two percent upper limit of the ECB's target range. The extent to which the policy stance in the U.S. may create inflationary pressures in Europe raises interesting questions that we do not address directly in this paper. We will, however, examine the effects of U.S. fiscal policy on real exchange rates; the inflationary effects of dollar appreciations seem to have been a source of concern in Europe.

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[8]For a description and critical analysis of the fiscal changes legislated by EGTRRA, see Gale and Potter (2002).

[9]Gale and Potter (2002) articulate this view.

In Section II below, we begin by identifying stylized facts about the international transmission of fiscal policy. Bryant et al. (1988) provide simulations from a variety of well known models, but this type of analysis has attracted some criticism recently. As Blanchard and Perotti (1999) note, "large scale econometric models provide estimates of dynamic fiscal multipliers. Because of their very structure, however, they largely postulate rather than document an effect of fiscal policy on activity." Blanchard and Perotti develop a structural way of identifying tax and spending innovations in VARs, and assess the impact of U.S. fiscal shocks on U.S. output, consumption and investment. In Section II, we extend Blanchard and Perotti's VAR's to study the impact of U.S. fiscal shocks on three European countries – France, Great Britain and Italy.[10]

To anticipate our results, we find spillovers to output and consumption that are large, but in line with those found in Bryant et al. (1988). Our results suggest longer lag lengths in the transmission of U.S. fiscal shocks to European economies than our casual priors would suggest. And the effects of U.S. fiscal shocks on real exchange rates are sizeable, according to our findings.

In Section III, we provide an exposition of a prototype model that can be viewed as a point of reference for the new theoretical literature on international policy coordination and spillovers.[11] The new models are emerging from the New Neoclassical Synthesis (NNS).[12] The synthesis blends

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[10]We did not include Germany because of the structural break in the data that occurred with reunification.

[11]What we call "the prototype model of the literature" is a stochastic version of Corsetti and Pesenti's (2001a) model with logarithmic utility from consumption.

[12]Goodfriend and King (1997) describe the New Neoclassical Synthesis; indeed, they gave it the name. Early contributions to the closed- economy literature include Ireland (1996), Yun (1996), Rotemberg and Woodford (1997, 1999). Recent topics include a debate on the efficiency of price level targeting [see King and Wolman (1999), Erceg, Henderson and Levin (2000), Benigno (2001a), Aoki (2001), and Goodfriend and King (2001)] and the study of interest rate rules [see Giannoni and Woodford (2000)].

elements of the Real Business Cycle Model with elements of an earlier Keynesian literature: monopolistically competitive wage and price setters, along with some form of nominal inertia, replace the RBC model's perfectly competitive agents, and demand determination of output and employment replaces market clearing. A key feature making NNS models particularly attractive for policy analysis is their natural (utility based) criterion for welfare analysis.

For reasons of analytical tractability, the prototype model of international policy coordination adds a number of simplifying features to the general NNS framework. The prototype model (incorporating these simplifying features) suggests that fiscal and monetary policies do not interact in a significant way across regions. According to the model, the Fed can focus on stabilizing the price level in the US, and the ECB can safely focus on stabilizing the price level in the euro area. And the outcome of these uncoordinated policies is both a Nash equilibrium and the fully optimal solution to the model under international monetary policy coordination. As to interactions of fiscal policies, the prototype model suggests an excess spending bias that may exist at the international level in a Nash equilibrium.

But the prototype model that implies international policy interactions are minimal is rather rudimentary: the current account is continuously balanced under the model's simplifying assumptions, exchange rate determination is purely monetary, and fiscal policy is Ricardian. These strong implications raise a legitimate concern that the prototype model may not capture important elements of the international transmission mechanism. In particular, our empirical results in section II serve to highlight how the Ricardian nature of the prototype model limits its use.[13] In section III,

[13]Most of the models currently being studied are Ricardian. Two notable exceptions are Woodford (1998) and Leith and Wren-Lewis (2002).

we will also refer to various attempts to go beyond the prototype model. But the practical importance of the issues raised in the new theoretical literature remains a topic for future research.

In Section IV, we put some of our conclusions in a broader perspective. We will return to the practical issues we raised above and will also discuss the apparent need – both theoretical and empirical – to introduce non-Ricardian elements in future modeling efforts. These new elements need not be the ones identified by the New Fiscal Theory of the Price Level. Introducing finite lived agents, borrowing constraints and liquidity services for government bonds are alternative approaches that we think are worth pursuing. In fact, for purposes of policy analysis, the most practical approach may be the rather casual modeling of liquidity-constrained consumers that is incorporated in the Commission services' QUEST model.[14]

Section II. An Empirical Analysis of Fiscal Spillovers

In this section, we examine the effects of shocks to U.S. fiscal policy on aggregate output and consumption in the United States and three European countries (France, Italy, and Great Britain), as well as the real effective exchange rate of these three countries. We use quarterly data in vector autoregressions with quarter-dependent coefficients. We consider each of the European countries individually rather than as a group. Our sample begins in 1975 and contains data from only the post-Bretton-Woods era.[15] We find that the spillover effect of a shock to government

[14]This model assumes that some consumers are forward looking and behave as the permanent-income hypothesis predicts, while other consumers follow a rule of thumb and base their current consumption on their current disposable income.

[15] We choose this sample for two reasons. First, both the behavior of real exchange rates and the transmission mechanism by which U.S. fiscal shocks affect foreign output depend on the (nominal) exchange rate regime. Second, we use the IMF's relative unit labor costs in

spending in the United States is quite large for all three countries.

We consider the effects of net taxes (taxes net of transfers, including net interest payments) and spending (government consumption and investment) separately, allowing the effects of the two to differ. The typical vector autoregression we estimate is then,

$$X_t = \sum_{j=1}^{4} A_j X_{t-j} + u_t, \tag{1}$$

where $X_t = (T_t, G_t, Y_t, Y^*_t, q_t)'$, T_t is the log of real, per capita U.S. net taxes, G_t is the log of real, per capita U.S. government consumption and investment, Y_t is the log of real, per capita U.S. GDP, Y^*_t is the log of foreign (either French, Italian, or British) real, per capita GDP, and q_t is the real effective exchange rate of the foreign country. The reduced form disturbances in the vector autoregression, u_t, will be correlated and $E(u_t u_t') = \Sigma$. As a result, these disturbances cannot be interpreted as fiscal shocks.

IIa. Identifying U.S. Fiscal Shocks

In order to identify shocks to U.S. fiscal policy, we need to impose some structure on the covariance matrix of the reduced form disturbances. The standard approach to doing so is to choose a "causal ordering" in which variables earlier in the ordering are assumed to exert a contemporaneous effect on variables later in the ordering, but the reverse is assumed not to be true. This has the effect of decomposing the covariance matrix Σ into GG', where G is triangular and is then used to recover the effects of orthogonal, structural shocks. ($G^{-1}u_t = v_t$, where the structural

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manufacturing series for the real effective exchange rate, and those data begin only in 1975. This measure of the real exchange rate has the advantage of not including non-traded goods.

shocks, v_t, are uncorrelated).

Rather than adopting this standard approach, we follow Blanchard and Perotti (1999) and identify the shocks using institutional features of the U.S. tax and transfer systems and the timing of revenue collections to identify the "automatic" responses of net taxes and spending to changes in GDP in a structural VAR. These automatic responses are then subtracted from the reduced form disturbances to identify structural tax shocks. Spending shocks are then identified by the assumption that the timing of spending decisions is such that there is no response of spending to GDP within a quarter.

More formally, Blanchard and Perotti (1999) identify structural shocks to U.S. fiscal policy in a three-equation vector autoregression in net taxes, spending, and GDP by relating the reduced form disturbances, u_t to the unobserved structural shocks, v_t as follows. They relate the reduced form disturbances and structural shocks by,

$$(2)\quad \begin{bmatrix} 1 & 0 & -a_1 \\ 0 & 1 & -b_1 \\ -c_1 & -c_2 & 1 \end{bmatrix} \begin{bmatrix} u_t^T \\ u_t^G \\ u_t^Y \end{bmatrix} = \begin{bmatrix} 1 & a_2 & 0 \\ b_2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} v_t^T \\ v_t^G \\ v_t^Y \end{bmatrix}$$

and recover the structural shocks, v_t, by estimating the unknown parameters. To do so, they first estimate the GDP elasticity of five components of net taxes and compute the share-weighted average of these elasticities to determine a_1. Next, they assume that there is no discretionary response of spending to GDP within a quarter so that b_1=0. They estimate the parameters c_1 and c_2 with an instrumental variables regression of "cyclically adjusted" net taxes and spending ($u_t^T - a_1 Y_t$ and $u_t^G - b_1 Y_t$) on u_t^Y. Finally, they estimate a_2 assuming $b_2 = 0$ (and vice versa), noting that the "ordering" of these two variables has no discernable impact on the results.

Using quarterly data from 1960 to 1997, they find that both tax and spending shocks have

a significant effect on U.S. GDP. A one-dollar tax shock (a tax increase) reduces output initially by about 70 cents. The effect rises slightly, with the peak effect – a decline in GDP of about 80 cents – occurring about 5 quarters after the shock. After that, output returns gradually to trend.[16] A one-dollar spending shock (an increase in spending) raises GDP by about 84 cents within a quarter. The effect of the shock grows and is quite persistent, reaching a peak effect on GDP of about 1.3 dollars about 15 quarters after the shock.

Because our sample period differs from that used by Blanchard and Perotti, we reestimate their structural VAR and compute the impulse response. For comparability with Blanchard and Perotti, we plot the impulse responses plus and minus one standard error. Our estimated standard errors, which are based on a bootstrap procedure, are fairly large; Blanchard and Perotti's estimates are similar.

In Figure 1, we show the effect of a one-dollar increase in net taxes (the top panel) and a one-dollar increase in spending (the bottom panel) on U.S. GDP.[17] Although the samples differ, the impulse responses computed from the structural VAR are fairly similar. A one-dollar increase in taxes reduces GDP by about 60 cents on impact. The effect grows, reaching a peak effect on GDP of about -90 cents three quarters after the shock. Output then gradually returns to its trend. The impact of a spending shock is both greater and more persistent than the impact of a tax shock. A

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[16] Blanchard and Perotti (1999) look at two specifications of trends, one deterministic and the other stochastic. The effects described above are for the deterministic trend specification. The effects of a tax shock are greater with stochastic trends, with a peak effect on GDP of -1.33 occurring after 7 quarters.

[17] Because the VAR is estimated in logs, we need to transform the impulse responses to get the multipliers that we plot. We do so by multiplying by the (ratio of the) levels of the variables at the end of the sample (more precisely, their average values during 1999).

one-dollar increase in spending raises GDP by about 90 cents on impact. The effect grows, reaching a peak effect on GDP of about 1.3 dollars around 12 quarters after the shock. The return toward trend is then quite gradual.

Blanchard and Perotti (1999) also add real, per capita private consumption to their VAR and consider the dynamic effects of tax and spending shocks. A one-dollar tax shock (an increase in taxes) reduces private consumption, with a peak effect of about -35 cents occurring five quarters after the shock. As is the case with the response of GDP, a spending shock elicits a response of private consumption that is both larger and more persistent than to a tax shock. A one-dollar spending shock increase private consumption by about 50 cents on impact. The response of consumption then rises, reaching a peak effect of about 1.3 dollars about 14 quarters after the shock.

In Figure 2 we present the responses of real per capita private U.S. consumption to a tax shock (top panel) and a spending shock (bottom panel) obtained from a four-variable VAR estimated over our sample. The shape of the responses of consumption and GDP to a tax shock are very similar. A one-dollar tax shock reduces consumption by about 25 cents on impact. Consumption continues to decline and a peak effect of about -50 cents is reached three quarters after the shock. Consumption then returns slowly to trend.

The impact effect of a one-dollar spending shock on consumption is somewhat smaller than on GDP. Consumption rises by about 35 cents on impact and fluctuates until the effect of the shock begins to build after one year. The peak effect of about 1.5 dollars is reached after about three years.[18] The fact that the consumption response is only slightly smaller than the GDP response

[18] The peak effect on GDP in Figure 1 is slightly smaller than the peak effect on GDP in Figure 2. This apparent anomaly is explained by the fact that the effect of the spending shock on GDP increases somewhat once consumption is added to the VAR. The peak effect on GDP in

implies that other components of GDP must be crowded out by the increase in spending.

IIb. Estimating the Spillover Effect of U.S. Fiscal Shocks

To determine the extent to which U.S. fiscal shocks affect output abroad we add real GDP and the real exchange rate for three European countries (France, Italy, and Great Britain) one-country-at-a-time to the three equation VAR used by Blanchard and Perotti. We continue to use the Blanchard-Perotti identification of the shocks. As a result we assume that foreign GDP and the foreign country's real exchange rate do not affect U.S. taxes, spending, or GDP. The first three equations in our VAR are therefore identical to those in Blanchard and Perotti. We further reduce the number of parameters we need to estimate by assuming that U.S. taxes and spending do not affect GDP in the foreign country directly. Any impact of U.S. fiscal policy on foreign GDP is the result of its impact on U.S. GDP and the real exchange rate. We therefore estimate a five-variable (near) VAR in which foreign variables do not enter the three equations for the U.S. variables and U.S. taxes and spending do not enter the equation for foreign GDP.

Our interest focuses on the impact of U.S. tax and spending shocks, so identifying the remaining structural shocks is of secondary interest. Because we keep to the Blanchard-Perotti identification scheme, we recover exactly the same shocks in our five-equation system as we do in the three-equation system. In order to identify the rest of the shocks, we combine the Blanchard-Perotti identification of the U.S. fiscal shocks with a fairly standard causal ordering. In particular, we assume that the U.S. block of three equations is prior to the two foreign variables. And we recover the remaining shocks by assuming that there is no within-quarter effect of the real exchange rate on foreign output. More formally, we assume

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the four-variable VAR is about 1.8 dollars and occurs around 3 to 3 ½ years following the shock.

$$(3)\quad \begin{bmatrix} A_{B-P} & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^{US} \\ u_t^{Y*} \\ u_t^{q} \end{bmatrix} = \begin{bmatrix} B_{B-P} & 0 & 0 \\ f_1 & 1 & 0 \\ g_1 & g_2 & 1 \end{bmatrix} \begin{bmatrix} v_t^{US} \\ v_t^{Y*} \\ v_t^{q} \end{bmatrix}$$

where $A_{B\text{-}P}$ and $B_{B\text{-}P}$ are the 3x3 matrices in equation (2), f_1 is a 1x3 vector in which the first two elements are zero, and g_1 is a 1x3 vector.

Figure 3 shows the effects of a U.S. tax and spending shocks on French GDP and France's real effective exchange rate. We plot the impulse responses plus and minus one standard error. The responses of GDP are scaled so that they are expressed as the impact, measured in French francs, of a one-dollar shock. The real exchange rate responses are expressed as percentage change in the real exchange rate resulting from a one percent increase in net taxes or a one percent increase in spending. A decrease in the real exchange rate is a real depreciation of the French franc.

The effect of a U.S. tax shock on French GDP is relatively small – a one-dollar tax shock (an increase in U.S. taxes) reduces French GDP by less than one franc. The peak effect occurs about 10 quarters after the shock, with French GDP declining by about one-half of a franc. The real exchange rate effect is also relatively small. An increase in U.S. taxes results in a real appreciation of the franc, but the magnitude is negligible.

In contrast, U.S. spending shocks appear to have a sizeable impact on French GDP and on France's real exchange rate. A one-dollar spending shock has essentially no effect on French output for about the first year after the shock. The impact then begins to increase substantially, reaching a peak effect of about 6.25 francs between 2 ½ and 3 years following the shock. If we convert this peak effect at the end-1999 exchange rate of 6.5 francs per dollar, the peak effect on French GDP is just under 75 percent of the peak effect on U.S. GDP.

The real exchange rate effect of a spending shock is similarly noticeable. After an initial small real appreciation that lasts about two quarters (and is difficult to explain), a one percent U.S. spending shock results in a real depreciation of the franc that peaks at about 0.7 percent around two years after the shock.

In Figure 4 we plot the responses of Italian GDP and Italy's real effective exchange rate to U.S. fiscal shocks. A one-dollar U.S. tax shock is followed by a temporary decline in Italian GDP. The peak effect of about -200 lira is reached five quarters after the shock. The effect of a tax shock on Italy's real exchange rate is somewhat larger than is seen in Figure 3. A one percent U.S. tax shock has little initial impact on Italy's real exchange rate, but following a short-lived real depreciation, the lira appreciates in real terms. The peak effect is about a 0.3 percent real appreciation around two years following the shock. After that, the real exchange rate effect dies out.

As is the case in Figure 3, the effect of a spending shock is considerably greater than the effect of a tax shock. A one-dollar shock to U.S. government consumption and investment has essentially no effect on Italian GDP in the quarter that the shock occurs. The effect builds for several quarters, reaching a peak of just under 1000 lira around 3 ½ years after the shock. This amounts to about 38 percent of the peak effect on U.S. GDP if we convert from lira to dollars using the end-1999 exchange rate of 1913 lira per dollar. The lira depreciates in real terms on impact and the size of the real depreciation increases for two more quarters.

In Figure 5 we plot the impact of U.S. fiscal shocks on British GDP and on Britain's real exchange rate. Tax shocks appear to have a more persistent effect in the British data than in the other two. A one-dollar U.S. tax shock has essentially no effect on British GDP in the quarter of the shock or in the subsequent quarter. After that, the effect builds until it reaches its peak of about -

0.15 pounds around three years after the shock. GDP then returns to its trend. The U.S. tax shock also appears to have a substantial effect on Britain's real exchange rate. A one percent U.S. tax shock results in a sustained real appreciation of the pound. The effect is negligible in the quarter of the shock, but it grow quickly thereafter. The peak effect is a real appreciation of about 0.7 percent and it is reached around two years after the shock.

The impact of a U.S. spending shock once again exceeds that of a U.S. tax shock of the same size. A one-dollar spending shock has no effect on British GDP in the quarter of the shock or in the subsequent quarter. The effect then grows quickly for several quarters and reaches a peak of about 0.55 pounds between 2 and 2 ½ years after the shock. If we convert this peak effect to dollars using the end-1999 exchange rate of 0.62 pounds per dollar, it corresponds to just under 70 percent of the peak effect on U.S. GDP.

The estimated real exchange rate effects are also substantial. The consequences of a U.S. spending shock are uneven for a few quarters but then lead to a sustained real depreciation of the pound. A one percent U.S. spending shock is estimated to result in a real depreciation of the pound of about 1.25 percent between 2 and 2 ½ years after the shock.

The three spillover effects of a shock to U.S. government spending on foreign GDP are quite large. The peak effect in the Italian data is just under 40 percent of the peak effect on U.S. GDP. The peak effects in British and French data are 70 to 75 percent of the peak effect on U.S. GDP. Our estimates of large spillovers cannot be attributed to a large direct effect of U.S. fiscal policy on France, Great Britain and Italy. Rather, the spillovers are large because U.S. fiscal shocks have a fairly large and persistent effect on U.S. GDP (and consumption), and there seems to be sizable effects of U.S. GDP on GDP in France, Great Britain and Italy. Similarly, the long time lags

reflected in our estimated effects arise from long lags in the effects of U.S. fiscal shocks on U.S. GDP, and the stylized fact that European business cycles seem to lag behind U.S. cycles.

How do our results compare to those found in more traditional, multi-country macroeconometric models? Perhaps surprisingly, the estimated spillover effects are fairly similar despite substantial difference in methods and samples. Bryant, Hotham, and Hooper (1988) describe the results of a cooperative effort to compare the predicted responses of twelve multi-country macroeconometric models to a common set of policy shocks. The U.S. fiscal shock they consider is somewhat different from the one we consider here – they look at a permanent change in spending, we allow the degree of persistence to be determined by the data.[19] In addition, they consider two policy responses by the foreign monetary authorities – one in which monetary aggregates are held fixed and one in which interest rates are held fixed. Three years after a shock to U.S. government spending the spillover effect on foreign (rest of OECD) GDP is just under one half of the effect on U.S. GDP when foreign monetary aggregates are held constant and about three-fourths of the effect on U.S. GDP when foreign interest rates are held constant.

Section III: New Models of Monetary and Fiscal Policy Coordination

In this section, we present a prototype model of international policy interactions, discuss some extensions of this model in the emerging literature, and (drawing on the empirical results of the preceding section) highlight areas for future research.[20] As we noted in section I, it seems

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[19] The effect of a spending shock decays slowly over time in the Blanchard-Perotti VAR. In our sample, spending is about 60 cents above trend three years after a one-dollar shock.

[20] What we call the prototype model is a stochastic version of Corsetti and Pesenti's (2001a) model, which is a variation on Obstfeld and Rogoff's (1996) New Open Economy

doubtful to us that fiscal and monetary policies interact with each other in a strategic way at a business-cycle frequency. Therefore, we will proceed in this way: in a sticky price version of our model, we will view changes in spending as stochastic shocks that are part of the monetary policy game; then, in a flexible price version of the model, where monetary policy plays no role, we will model public spending as a strategic decision.

The model consists of two countries supplying different goods to world markets. The home country has a continuum of households indexed by $h \in [0, 1]$, and the foreign country has a continuum of households indexed by $f \in [0, 1]$. Each household produces a differentiated product using a linear and stochastic technology. Home households produce $Y_H(h) = Z_H N_H(h)$, where Z_H is a productivity shock affecting all home households; foreign household produce $Y^*_F(f) = Z^*_F N^*_F(f)$, where Z^*_F is the foreign productivity shock. The home good, Y_H, is a composite of the households' products: $Y_H = [\int_0^1 Y_H(h)^{(\theta-1)/\theta} dh]^{\theta/(\theta-1)}$ (where $\theta > 1$); similarly, the foreign good, Y^*_F, is a composite of the foreign households' products: $Y^*_F = [\int_0^1 Y^*_F(f)^{(\theta-1)/\theta} df]^{\theta/(\theta-1)}$. Both home and foreign households consume a composite of the two national goods: $Y = Y_H^{½} Y^{*½}_F$.

The utility of home household-h in period t is:

(4) $U_t(h) = E_t \sum_{j=t}^{\infty} \beta^{t-j} \{\log[C_j(h)] - ½N_j(h)^2 + \log(M_{j+1}(h)/P_j) + w(G_j)\}$

where $C_t(h)$ is consumption of the composite good, Y, and P_t is its price; $M_t(h)$ are beginning of period money balances; and G_t is home government spending, which is assumed to fall entirely on the home good, Y_H. The household's intertemporal budget constraint is:

(5) $M_{j+1}(h) + B_{j+1}(h)/I_j + P_j C_j(h) + T_j(h) = M_j(h) + B_j(h) + P_{Hj}(h) Y_{Hj}(h)$

where $B_{j+1}(h)$ are beginning of period bond holdings, bought at discount I_j; $T_j(h)$ is a tax levied by

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Macroeconomics framework.

the home government; and $P_{Hj}(h)$ is the price set by household-h for its own product. The foreign household is modeled in an analogous way.

The household's maximization problem can be separated into an intertemporal problem and an intratemporal problem. In it's intratemporal problem, household-h chooses the mix of home and foreign goods that maximizes its consumption index, $C_t(h)$, for a given level of expenditure. To simplify the discussion of composite goods, we follow Chari, Kehoe and McGrattan (2000) in treating the differentiated products of households as intermediate goods and assuming that a competitive industry bundles these into national goods.[21] The zero-profit condition of competitive bundlers implies that the prices of the national goods, Y_{Ht} and Y^*_{Ft}, are:

(3) $P_{Ht} = [\int_0^1 P_{Ht}(h)^{(1-\theta)}dh]^{1/(1-\theta)}$ and $P^*_{Ft} = [\int_0^1 P^*_{Ft}(f)^{(1-\theta)}df]^{1/(1-\theta)}$.

This bundler's demands for the household products are:

(7) $Y_{Ht}(h) = (P_{Ht}(h)/P_{Ht})^{-\theta}Y_{Ht}$ and $Y^*_{Ft}(f) = (P^*_{Ft}(f)/P^*_{Ft})^{-\theta}Y^*_{Ft}$.

National goods are bundled together (also in a competitive industry) into final consumption goods, $C_t = C_{Ht}^{½}C_{Ft}^{½}$ and $C_t^* = C_{Ht}^{*\,½}C_{Ft}^{*\,½}$, and are sold to the households for prices:

(8) $P_t = 2P_{Ht}^{½}P_{Ft}^{½}$ and $P_t^* = 2P_{Ht}^{*\,½}P_{Ft}^{*\,½}$

Th e demands for the national goods are:

(9) $P_{Ht}C_{Ht} = P_{Ft}C_{Ft} = ½P_tC_t$ and $P^*_{Ht}C^*_{Ht} = P^*_{Ft}C^*_{Ft} = ½P_t^*Ct^*$.

The Cobb-Douglass aggregator for final goods implies that a fixed share of total expenditure goes to each of the national goods.

In its intertemporal problem, household-h chooses $P_{Ht}(h)$, $C_t(h)$, $M_{t+1}(h)$, and $B_{t+1}(h)$ to

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[21]A more detailed discussion of what follows can be found in Canzoneri, Cumby and Diba (2001a).

maximize (4) subject to (5) and (7). Foreign households face an analogous intertemporal problem. In the appendix, we show that there is no international borrowing or lending in equilibrium; the current account is always balanced. The key assumption shutting down the current account is that the aggregator for the final consumption good is Cobb-Douglass – $Y = Y_H^{½} Y_F^{*½}$.[22] From here on, we will take that result as given, and drop time subscripts.

It turns out that all of the home households have the same first order conditions; so, we can derive a symmetric equilibrium in which $C_H(h) = C_H$, $C_F(h) = C_F$, $Y_H(h) = Y_H$, and $P_H(h) = P_H$. Similarly, in the foreign country, $C_H^*(f) = C_H^*$, $C_F^*(f) = C_F^*$, $Y_F^*(f) = Y_F^*$, and $P_F^*(f) = P_F^*$. Moreover, letting S be the nominal exchange rate (the price of the foreign currency in units of the home currency), we can express the home currency price of home imports as $P_F = SP_F^*$, and the foreign currency price of home exports as $P_H^* = P_H/S$.[23] So, (8) implies $P = SP^*$. PPP holds for the aggregate consumption goods (which are identical), but the terms of trade, SP_F^*/P_H, may fluctuate with productivity shocks and changes in monetary and fiscal policy.

Several results follow directly from budget constraints. Since there is no international borrowing or lending, international trade must be balanced:

(10) $SP_F^*C_F = P_HC_H^*$,

and household expenditure must equal disposable income:[24]

(11) $PC = P_H(Y_H - G)$ and $P^*C^* = P_F^*(Y_F^* - G_F^*)$.

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[22]The basic result is due to Corsetti and Pesenti (2001a).

[23]We assume producer currency pricing: households set prices in their home currencies and let foreign currency prices fluctuate with the exchange rate. For alternative assumptions, see Devereux and Engel (2000, 2001) and Corsetti and Pesenti (2001b).

[24]This follows from the market clearing and trade balance: $P_HY_H = P_HC_H + P_HC_H^* + P_HG = P_HC_H + SP_F^*C_F + P_HG = (P_HC_H + P_FC_F) + P_HG = PC + P_HG$; so, $PC = P_HY_H - P_HG$.

A number of results follow directly from trade balance, (10), and fixed expenditure shares, (9):[25]

(12) $C = C^* = C_H^{½}C_F^{½} = ½(Y_H - G_H)^{½}(Y_F - G_F^*)^{½}$, $C_H = C_H^* = ½(Y_H - G_H)$, $C_F = C_F^* = ½(Y_F^* - G_F^*)$

(13) $SP_F^*/P_H = C_H/C_F = C_H^*/C_F^*$

(14) $S = PC/P^*C^*$

There are two observations worth making at this point. The first is that all of the results in equations (10) through (14) follow from one basic assumption: the Cobb-Douglass aggregator of the final consumption good – $Y = Y_H^{½}Y_F^{*½}$. The Cobb-Douglass aggregator gives the fixed expenditure shares, (9), and (as shown in the appendix) trade balance, (10). Then, fixed expenditure shares and trade balance imply that total consumption equalizes across countries, $C = C^*$, and that the consumption of each national good equalizes across countries, $C_H = C_H^*$ and $C_F = C_F^*$. Moreover, fixed expenditure shares and trade balance imply a very rudimentary theory of exchange rate determination; the nominal exchange rate is just equal to the ratio of nominal expenditures. We will see that this has very strong implications of policy coordination. The second observation is that all of these results hold for any assumption about how prices are determined; prices can be fixed, flexible, or even competitively determined.

Most of the two-country modeling that followed Corsetti and Pesenti (2001a) has assumed a Cobb-Douglass aggregator for the final consumption good, and for a very obvious reason: it makes an inherently complex model quite easy to solve. However, as we shall see, this may also have the effect of "throwing the baby out with the bath water". The Cobb-Douglass aggregator is truly

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[25] $½PC = P_FC_F = SP_F^*C_F = P_HC_H^* = SP_H^*C_H^* = ½SP^*C^*$ implies $PC = SP^*C^*$ and $C = C^*$. $2P_HC_H = PC = SP^*C^* = 2SP_H^*C_H^* = 2P_HC_H^*$ implies $C_H = C_H^*$, and similarly $C_F = C_F^*$. $P_HC_H = P_FC_F = SP_F^*C_F$ implies $SP_F^*/P_H = C_H/C_F = C_H^*/C_F^*$. $Y_H = C_H + C_H^* + G_H$ and $C_H = C_H^*$ implies $C_H = C_H^* = ½(Y_H - G_H)$, and similarly, $C = C_H^{½}C_F^{½} = ½(Y_H - G_H)^{½}(Y_F - G_F^*)^{½} = C^*$

marvelous and also rather restrictive.

Given the fixed expenditure shares, (9), it has been thought natural to take nominal private expenditure as the instrument of monetary policy: the home central bank sets $\Omega = PC$, and the foreign central bank sets $\Omega^* = P^*C^*$.[26] The choice of instruments should not be taken lightly in a game theoretic setting, but we will follow the existing literature.[27] This means of course that the nominal exchange rate is wholly determined by monetary policy; (14) implies:

(15) $S = \Omega/\Omega^*$.

IIIa. The Flexible Price Solution

We begin with the flex-price solution. The flex-price solution is of interest in its own right, and it will serve as a normative benchmark in our discussion of the fixed-price solution. First, we have to discuss the households' price setting behavior.

In the appendix, we show that the households' price setting behavior results in:

(16) $N_H = (1/\mu)P_H Z_H \lambda$ and $N_F^* = (1/\mu)P_F^* Z_F^* \lambda^*$

here λ (= 1/PC) and λ^* (= 1/P*C*) are the home and foreign marginal utilities of income, and $\mu \equiv \theta/(\theta - 1) > 1$. The LHS of (16) is the disutility of another "hour's" work; the RHS is the utility of spending the proceeds. To see the latter, note that if a home household works one more hour, it

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[26]In Obstfeld and Rogoff's (2000) model, the money supply is equal to nominal income, since they suppress the interest rate; our assumption amounts to making money the instrument of monetary policy. By contrast, Corsetti and Pesenti (2001b) interpret our assumption as an interest rate rule: the home Euler equation can be written as: $(1/I_t) = E_t[P_{t+1}C_{t+1}]/P_tC_t = E_t[\Omega_{t+1}]/\Omega_t$; letting $I_t = 1+i_t$, and taking logs, $i_t = \log(\Omega_t) - \log E_t[\Omega_{t+1}]$. Either approach would seem to be somewhat problematic.

[27]For example, we know that Bertrand price setting and Cournot quantity setting imply different outcomes in duopoly games. For an example in the monetary policy coordination literature, see Canzoneri and Henderson (1989).

produces Z_H more output; the increase in income would be $P_H Z_H$, except that the household faces a downward sloping demand curve, (7). μ is the "markup factor" associated with monopolistic competition.[28] If the household works one more hour, its income only goes up by $(1/\mu)P_H Z_H$; the monopolistic distortion, $\mu - 1$, makes the household set its price too high, and work too little. In summary, (16) reflects the home and foreign households' labor-leisure tradeoffs.

Multiplying both sides of (16) by N_H (= Y_H/Z_H), recalling $PC = P_H Y_H - G_H$ and rearranging: $Y_H^2 - G_H Y_H = (1/\mu)Z_H^2$ and $Y_F^{*2} - G_F^* Y_F^* = (1/\mu)Z_F^{*2}$. Solving these quadratic equations, we have:

$$(17)\quad Y_H = \tfrac{1}{2} G_H + \tfrac{1}{2}\sqrt{G_H^2 + \frac{4Z_H^2}{\mu}} \quad \text{and} \quad Y_F^* = \tfrac{1}{2} G_F + \tfrac{1}{2}\sqrt{G_F^{*2} + \frac{4Z_F^{*2}}{\mu}}$$

$$N_H = \tfrac{1}{2}\frac{G_H}{Z_H} + \tfrac{1}{2}\sqrt{\frac{G_H^2}{Z_H^2} + \frac{4}{\mu}} \quad \text{and} \quad N_F^* = \tfrac{1}{2}\frac{G_F^*}{Z_F^*} + \tfrac{1}{2}\sqrt{\frac{G_F^{*2}}{Z_F^{*2}} + \frac{4}{\mu}}$$

In the flex-price solution, productivity shocks and government spending determine employment and output, via (17), and then consumption and the terms of trade, via (12) and (13).[29] Monetary policy only affects nominal magnitudes, like the exchange rate in (15).[30]

A negative home productivity shock (a fall in Z_H) is like throwing some home output away. If home households do not work more in response, home (and foreign) consumption will fall. (17) implies that households do choose to work more, but not enough more to restore output to it's pre-shock level. So, the utility maximizing home household response to a negative productivity shock is to work a little more and consume a little less.

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[28]Note that as $\theta \to \infty$, the demand curves become infinitely elastic and $\mu \to 1$.

[29]Note also that a decrease in the monopolistic distortion, $\mu - 1$, would increase employment, output and consumption.

[30]$P = \Omega/C = 2\Omega/[(Y_H - G_H)^{1/2}(Y_F - G_F^*)^{1/2}]$; $P^* = 2\Omega^*/[(Y_H - G_H)^{1/2}(Y_F - G_F^*)^{1/2}]$

There is, of course, a coordination failure or inefficiency here. When the home household decides how much more to work, it does not take into account the fall in foreign consumption. Suppose, for example, that there was a negative world productivity shock (Z_H and Z_F^* both fall). In the flex-price solution, home and foreign households would both increase their work effort, but not enough to maximize world welfare. Both home and foreign households would be better off if they could agree to work more. Monetary policy can not address this coordination problem, since it is ineffective in the long-run, flexible price equilibrium. Fiscal policy might be used, but as we shall see there is also a coordination issue with fiscal policy.

Home government spending falls entirely on the home good; so, an increase in home government spending means there is less of the home good available for private consumption, at home or abroad. In this, an increase in G_H is like a negative productivity shock, except that the utility function, (4), attributes some benefit to an increase in G_H. (17) implies that home households respond by working more, but not enough more to restore private consumption to its original level; that is: $Y_H - G_H$ falls. Home households respond to the increase in public spending by working a little more, and consuming a little less.[31]

A World Public Spending Bias? –

Now, consider the strategic setting of government spending. Suppose the home government sets G_H to maximize the utility of home households, while the foreign government sets G_F^* to maximize the utility of foreign households. The home government will set G_H at a level where the marginal cost of an increase in G_H – the disutility of the increase in home work effort and the

[31]And once again, they do not take foreign consumption into account when they make their work decisions; so, they work too little to maximize world welfare.

decrease in home consumption – is equal to marginal benefit – $w'(G_H)$. In a Nash solution, the home government would not take into account the marginal disutility of the fall in foreign consumption. Similar arguments hold for the foreign government.

Here again, we have a coordination failure. If public spending has any social value, and if governments take into account the private sector consequences of their actions, then there is a clear bias in the Nash solution. Public spending is too high; a world "pact" to lower public spending would be mutually beneficial according to the model.

Explaining the Stylized Facts –

The VARs in Section II showed that an increase in U.S. spending produced a sustained increase in U.S. output and consumption, an appreciation in the U.S. terms of trade, and with a delay, an increase in European output and consumption. Here, we ask whether these stylized facts are consistent with the flex-price version of the rudimentary NNS model outlined in this section.

An increase in G_H does indeed increase home output. It also appreciates the home terms of trade, but it does so by decreasing the supply of home goods available for private consumption. Both home and foreign consumption fall, and this is at odds with our stylized facts.[32]

It is possible that, in the data, government spending shocks are responding to some factor that was not included in the VARs. Earlier, we suggested that fiscal policy might respond to a negative productivity shock, which would cause consumption to be too small (from a global point

[32]Fatas and Mihov (2001) also used VARs (with a different identification scheme) to show that an increase in government spending would increase domestic consumption. They went on to argue that this fact can not be explained by RBC models. The flex-price version of our NNS model is essentially an RBC model with monopolistic competition added on; so, our arguments here are quite consistent with theirs. We have added the response of foreign consumption the set of stylized facts that can not be explained by the current models.

of view). However, government spending would have to be lowered, not raised, to increase consumption. Adding non-Ricardian elements would seem to be the only way to make the flex-price version of our NNS model consistent with the stylized facts; we will return to this possibility later in the section.

IIIb. The Fixed-Price Solution.

In the fixed-price solution, households set their prices one period in advance, and output and employment are demand determined. The home good price is set at $\overline{P}_H$, in units of home currency, and the foreign good price is set at $\overline{P}^*_F$, in units of foreign currency. The actual values of $\overline{P}_H$ and $\overline{P}^*_F$ are determined in the appendix.

The fixed expenditure shares, (9), imply:

(18) $\Omega = PC = 2\overline{P}_H C_H = 2S\overline{P}^*_F C_F$ and $\Omega^* = P^*C^* = 2\overline{P}^*_F C^*_F + (2/S)\overline{P}_H C^*_H$.

But, since $S = \Omega/\Omega^*$, we have:

(19) $C_H = C^*_H = \Omega/2\overline{P}_H$ and $C_F = C^*_F = \Omega^*/2\overline{P}^*_F$

An expansionary home monetary policy (an increase in Ω) increases home private expenditure, PC, and this raises home expenditures on both the home good and the foreign good in proportion. Since $\overline{P}_H$ is fixed, C_H has to increase. The exchange rate, S, depreciates (rises) in proportion with Ω. So, the home currency price of the foreign good – $S\overline{P}^*_F$ – rises enough that no change in C_F is necessary. The depreciation also lowers the foreign currency price of the home good – $\overline{P}^*_F/S$. So, if foreign private expenditure is held constant (no change in Ω^*), C^*_H also rises. The bottom line is that home monetary policy (Ω), controls home and foreign consumption of the home good, foreign monetary policy (Ω^*) controls home and foreign consumption of the foreign good, and the real exchange rate,

$S\overline{P}^*_F/\overline{P}_H$, also depends on monetary policy (or the ratio, Ω/Ω^*).[33]

Aggregate demand and productivity determine the levels of employment and output:[34]

(20) $Y_H = \Omega/\overline{P}_H + G_H$ and $Y^*_F = \Omega^*/\overline{P}^*_F + G^*_F$

$N_H = (\Omega/\overline{P}_H + G_H)/Z_H$ and $N^*_F = (\Omega^*/\overline{P}^*_F + G^*_F)/Z^*_F$.

Explaining the Stylized Facts –

The VARs in Section II suggested that an increase in government spending should produce an increase in home output and consumption, an improvement in the terms of trade, and an increase in foreign output and consumption. Now, we ask whether these stylized facts are consistent with the fixed-price version of our NNS model.

An increase in G_H does indeed increase home output and household income. However, an increase in G_H does not affect private expenditure, which is in any case being held fixed by monetary policy. Home households just work more to produce the required increase in G_H. Their incomes go up, but their tax liabilities go up by the same amount; we have, in effect, the text book balanced budget multiplier of one. Households would not want to increase their expenditure, even if it were not being constrained by monetary policy. The increase in G_H has no effect on home or foreign consumption, or on the terms of trade.

There is, however, the possibility that it is the monetary policy reaction to public spending shocks, rather than the shocks themselves, that is causing the observed movements in consumption and the terms of trade. If, for example, home monetary policy responded in an expansionary way

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[33]These strong results follow directly from the fixed expenditure shares, (9), and the rudimentary theory of exchange rate determination, (14), and once again, (9) and (14) trace back to the Cobb-Douglass aggregator for the final consumption good.

[34]To see this, note that $Y_H = C_H + C^*_H + G_H = 2C_H + G_H = 2(\Omega/2\overline{P}_H) + G_H$.

to an increase in public spending, then both home and foreign consumption would rise, as suggested by the VARs. However, a monetary expansion would cause the terms of trade to worsen, and the VARs of Section II showed an improvement. If home monetary policy contracted in response to an increase in public spending, then the model would get the terms of trade effect right, but consumption would move in the wrong direction. A foreign monetary expansion in response to an increase in home government spending would get both the consumption effect and the terms of trade effect right. However, a foreign monetary expansion is hard to motivate in our rudimentary NNS model, since an increase in G_H has no affect on the foreign economy. Monetary policy reactions would appear to be an unlikely resolution to the problem.

At this point, we can only speculate as to how future modeling might make NNS models fit the stylized facts. It seems likely that we will have to break the current practice of taking private expenditure as the instrument of monetary policy. But, even if we do, we need to model some reason for an increase in government spending to increase private expenditure; we have to break the logic of the old balanced budget multiplier. It would appear that we need to add a non-Ricardian element, such as a borrowing constraint or finite lived households.

IIIc. Monetary Policy Coordination?

The prototype model implies that the floating exchange rate effectively insulates each country from changes in the other country's monetary policy. The domestic central bank can set Ω, the foreign central bank can set Ω^*, and the exchange rate ($S = \Omega/\Omega^*$) will adjust to make aggregate expenditures in each country independent of the other country's policy. As we noted above, however, this implication can be traced to the model's simplifying assumptions.

A number of recent studies consider extensions of the prototype model that imply monetary-

policy dependence. Obstfeld and Rogoff (2000) show that adding non-traded goods to the model and making the intertemporal elasticity of substitution different from one lead to a need for international risk sharing and, thus a scope for monetary policy coordination. But their results suggest that these effects are small in terms of welfare implications. Benigno (2001b) shows that the effects highlighted by Obstfeld and Rogoff may well be large when one country is indebted to the other. Corsetti and Pesenti (2001b) show that if exports are partially priced to market, there is some scope for monetary policy coordination.

In Canzoneri, Cumby and Diba (2001b), we discuss the new models of monetary policy coordination in more detail. We also show that there are potentially large gains to coordination if traded and non-traded goods sectors have different productivity shocks or asymmetric forms of nominal inertia; some of these sectoral asymmetries are only recently being explored in the closed economy literature and have yet to be brought to the policy coordination literature; see for example Erceg, Henderson and Levin (2000). At present, however, it remains to be seen if any of the above extensions of the prototype model lead to clear cut implications for the practical coduct of monetary policies.

IV. Conclusion

The prototype model of the new theoretical literature (presented in section III) suggests that fiscal and monetary policies do not interact in a significant way across regions. According to this model, the Fed and the ECB can focus on stabilizing the price levels within their own currency areas without coordinating their policies with each other. The only policy coordination issue that arises in this setup has to do with an excess spending bias in the Nash equilibrium of the game between fiscal authorities. Various attempts to go beyond the prototype model are in progress in the theoretical literature. But it remains to be seen if these attempts uncover arguments for international policy coordination that seem of sufficient practical relevance to policy makers.

At any rate, we see no political momentum in Europe or in the U.S. to pursue more coordinated fiscal or monetary policies. For example, in a recent speech, Dr. Willem Duisenberg (the president of the ECB) emphasized the "limitations of international policy co-ordination" and asserted that "asking monetary policy to do more than maintain price stability ... risks creating illusions about what monetary policy can do."[35]

Although both the theoretical case and the political momentum for transatlantic policy coordination seem to be lacking at present, the U.S. policy stance does seem to affect European economies. Our empirical results (in section II) suggest that shocks to U.S. government spending increase output and consumption in France, Great Britain and Italy, and produce a real dollar appreciation. Our results for the effects of tax hikes in the U.S. are less clear cut in terms of effects on real exchange rates. The results, however, generally link a positive tax shock in the U.S. to a

[35]The statements are from Dr. Duisenberg's opening address at the International Research Forum on Monetary Policy held in Frankfurt on July 5, 2002.

decrease in consumption and output in the European economies we have studied.

The fixed-price version of the NNS model we outlined in Section III is incapable of explaining any of these stylized facts. So, how should future modeling efforts proceed? The Cobb-Douglass aggregator for final goods is an obvious place to start. It results in continuous current account balance and a separation in the demand for home and foreign (or traded and non-traded) goods that might be thought unrealistic. However, the Cobb-Douglass aggregator does not account for the lack of fiscal effects on consumption, at home or abroad.[36] That, we have argued, comes from the absence of non-Ricardian elements in the current batch of models. An increase in home government spending just causes home households to work more; they work more to produce the public goods required and to pay the increased tax liability that is implied by the increase in public spending. Something has to be added to get around this "balanced budget multiplier" logic. Adding borrowing constraints, finite lived households, or liquidity services for bonds would be avenues worth exploring. Indeed, we suspect that adding non-Ricardian elements is more important to the discussion of fiscal policy coordination than generalizing the Cobb-Douglass aggregator.

Turning to more practical policy concerns, our empirical results suggest that the effects of U.S. fiscal policy on European economies are large and occur with very long time lags. These findings suggest that U.S. fiscal shocks may have destabilizing effects on the euro area. A potentially important limitation of the work we report in this paper, and of Blanchard and Perotti's work on the U.S. data, is that our analyses do not control for the reaction of financial markets or the stance of monetary policy. We are in the process of rectifying this limitation in current work on U.S. data [Canzoneri, Cumby and Diba (2002)]. We find that controlling for financial-market reactions

[36]In fact, this is a problem in closed economy models as well.

and the stance of monetary policy does not affect our results about the overall magnitude of the effects of fiscal shocks on GDP, but changes in long-term interest rates make the estimated lag lengths somewhat shorter.

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APPENDIX

This appendix presents the full intertemporal version of our model and shows that there is an equilibrium solution in which the current account is continually balanced, as claimed in the main text. Our discussion is based on earlier work by Benigno (2001a), Cole and Obstfeld (1991), Corsetti and Pesenti (2001a), and Obstfeld and Rogoff (1998).

Home household-h maximizes expected utility (A1) subject to the budget constraint (A2), given the production function (A3), and facing the demand function (A4):

$$(A1) \quad U_t(h) = E_t \sum_{j=t}^{+\infty} \beta^{j-t} \left\{ \log[C_j(h) - \tfrac{1}{2}[N_j(h)]^2 + v\left[\frac{M_{j+1}(h)}{P_j}\right] + w[G_j] \right\}$$

$$(A2) \quad M_{t+1}(h) + B_{H,t+1}(h)/I_t + P_t C_t(h) + T_t(h) = M_t(h) + B_{Ht}(h) + P_{Ht}(h) Y_{Ht}(h),$$

$$(A3) \quad Y_{Ht}(h) = Z_{Ht} N_{Ht}(h),$$

$$(A4) \quad Y_{Ht}(h) = (P_{Ht}(h)/P_{Ht})^{-\theta} Y_{Ht}$$

where C_t and P_t are the consumption and price indexes defined in the text: $C = C_H^{\frac{1}{2}} C_F^{\frac{1}{2}}$ and $P = 2P_H^{\frac{1}{2}} P_F^{\frac{1}{2}}$. In (A2), M_{t+1} represents money balances carried from date t to date t+1; $B_{H,t+1}$ is the home household's position in home-currency bonds maturing at t+1; I_t is the gross nominal interest rate on these bonds; and $T_t(h)$ represents lump-sum taxes paid to the home government.

Using (A3) and (A4) to eliminate $N_{Ht}(h)$ and $Y_{Ht}(h)$, and letting $\lambda_{Ht}(h)$ denote the marginal value of nominal wealth – i.e., the Lagrange multiplier on (A2) – we get the following first-order conditions for consumption (A5), bond holdings (A6), and money holdings (A7):

$$(A5) \quad P_{Ht} C_{Ht}(h) = P_{Ft} C_{Ft}(h) = 2/\lambda_{Ht}(h)$$

$$(A6) \quad \lambda_{Ht}(h)/I_t = \beta E_t \lambda_{H,t+1}(h)$$

$$(A7) \quad (1/P_t)\, v'(M_{t+1}(h)/P_t) = \lambda_{Ht}(h) - \beta E_t \lambda_{H,t+1}(h)$$

The first-order condition for setting $P_{Ht}(h)$ depends on when the price is set. In the fixed-price version of the model, this price is set at date t-1, and the first-order condition is

$$\text{(A8)}\quad E_{t-1}\left\{\theta\left(\frac{Y_{Ht}(h)}{Z_{HT}}\right)\left(\frac{Y_{Ht}}{Z_{Ht}}\right)\left(P_{Ht}\right)^{\theta}\left[P_{Ht}(h)\right]^{-\theta-1}\right\}$$

$$= E_{t-1}\left\{(\theta-1)\lambda_{Ht}(h)\left(P_{Ht}\right)^{\theta}\left[P_{Ht}(h)\right]^{-\theta}Y_{Ht}\right\}$$

In equilibrium, with $Y_{Ht}(h) = Y_{Ht}$ and $P_{Ht}(h) = P_{Ht}$, (A8) simplifies to

$$\text{(A9)}\quad P_{Ht} = \left(\frac{\theta}{\theta-1}\right)\left[\frac{E_{t-1}(Y_{Ht}/Z_{Ht})^2}{E_{t-1}(\lambda_{Ht}Y_{Ht})}\right]$$

In the flexible price version, prices are set based on current information; so E_t replaces E_{t-1} in (A9), and we get

$$\text{(A9}'\text{)}\quad Z_{Ht}P_{Ht}\lambda_{Ht} = \left(\frac{\theta}{\theta-1}\right)\left(\frac{Y_{Ht}}{Z_{Ht}}\right),$$

which is equation (16) in the main text.

Since our model exhibits Ricardian Equivalence, budget deficits will not play a role on our analysis. Therefore, we simply assume that governments maintain balanced budgets. The home government's flow budget constraint is

$$\text{(A10)}\quad M_{t+1} + T_t = M_t + P_{Ht}G_t$$

Foreign preferences, constraints, and optimizations are modeled in an analogous way. We also assume that the foreign government maintains balanced budgets.

We can link domestic and foreign financial markets via foreign holdings of domestic-currency bonds. The flow budget constraint of foreign household-f is

$$\text{(A11)}\quad M^*_{t+1}(f) + B_{F,t+1}(f)/S_tI_t + P^*_t C^*_t(f) + T^*_t = M^*_t(h) + B_{Ft}(f)/S_t + P^*_{Ft}(f)Y^*_{Ft}(f)$$

Note that we use the superscript * on nominal variables to indicate that they are denominated in units of foreign currency, and on real variables to link them to foreign residents–for example, $C^*_t(f)$ is the consumption index of foreign household f.

Denoting the Lagrange multiplier on (A11) by $\lambda^*_{Ft}(f)$, household-f's first-order conditions for consumption and bond holdings are

(A12) $P^*_{Ht}C^*_{Ht}(f) = P^*_{Ft}C^*_{Ft}(f) = 2/\lambda^*_{Ft}(f)$

(A13) $\lambda^*_{Ft}(f)/S_tI_t = \beta E_t\,[\lambda^*_{F,t+1}(f)/S_{t+1}]$

It will be convenient to work below with the foreign household's marginal valuation for one unit of home currency, denoted by λ_{Ft}. We have

(A14) $\lambda_{Ft}(f) = \lambda^*_{Ft}(f)/S_t$

Although future interest rates are random variables with respect to the information set of date t, home and foreign households will face the same interest rate in any given state. So, in equilibrium, (A6), (A13), (A14) and their analogues for all future dates and states imply

(A15) $$\frac{\lambda_{Ht}}{\lambda_{Ft}} = \frac{E_t\lambda_{H,t+j}}{E_t\lambda_{F,t+j}}, \qquad \text{for } j > 0$$

The equilibrium conditions in the markets for goods and bonds are

(A16) $C_{Ht} + C^*_{Ht} + G_t = Y_{Ht}$

(A17) $C_{Ft} + C^*_{Ft} + G^*_t = Y_{Ft}$

(A18) $B_{Ht} + B_{Ft} = 0$

Combining the home household and government budget constraints (A2) and (A10), with the goods market equilibrium condition (A16), we get

$$B_{H,t+1}/I_t + P_{Ft}C_{Ft} = B_{Ht}(h) + P_{Ht}C^*_{Ht}$$

Multiplying by λ_{Ht}, using (A6), and noting that $B_{H,t+1}$ is in the information set of date t, we have

$$\lambda_{Ht}B_{Ht} = \beta E_t\lambda_{H,t+1}B_{H,t+1} + \lambda_{Ht}\,[P_{Ft}C_{Ft} - P_{Ht}C^*_{Ht}]$$

Using (A5) and (A12), we get

(A19) $\lambda_{Ht}B_{Ht} = \beta E_t\lambda_{H,t+1}B_{H,t+1} + 2[1 - \lambda_{Ht}/\lambda_{Ft}]$

Solving (A19) forward, and applying the transversality condition

(A20) $\lim_{j\to+\infty} \beta^j E_t[\lambda_{H,t+j}B_{H,t+j}] = 0$

we obtain

(A21) $$\frac{\lambda_{Ht}B_{Ht}}{2} = E_t\sum_{j=0}^{+\infty}\beta^j\left(1 - \frac{\lambda_{H,t+j}}{\lambda_{F,t+j}}\right)$$

If $\lambda_{H,t+j} = \lambda_{F,t+j}$, then (A5) and (A12) imply that the current account is always balanced. In any equilibrium, bond holdings and marginal valuations of home currency must satisfy (A15) and (A21). So, we want to find the conditions in which $\lambda_{H,t+j} = \lambda_{F,t+j}$ can be a solution to (A15) and (A19).

Consider the model under the initial condition $B_{H0} = 0$. It is straightforward to check that (A15) and (A21) have a solution, with $\lambda_{H,t+j} = \lambda_{F,t+j}$, in which the ratio of marginal valuations of home currency is not stochastic. Moreover, this solution would Pareto dominate any other equilibrium (if there were one) with stochastic variation in the ratio of marginal valuations of home currency, as noted in Cole and Obstfeld (1991).[37] The intuition for this result is that stochastic variations in the ratio would create a need for sharing consumption risk.

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[37] Cole and Obstfeld consider two stochastic exchange economies under asset-market autarky. They show that under assumptions about preferences, etc. that encompass our assumptions, the autarkic equilibrium is Pareto efficient. In our model, the derivations of Cole and Obstfeld would directly apply, but the equilibrium is only constrained Pareto efficient, given our monopoly distortion.

Since the implied current-account balance is potentially important for our theoretical discussion of policy coordination and spillovers, it is worthwhile to consider what changes in the model would or would not preserve this implication. First, Benigno (2001a) shows that in a model with two traded goods the implication holds even if the utility functions are not logarithmic, as long as aggregate consumption is a Cobb-Douglas index of foreign and domestic goods. He also provides a proof that the equilibrium with zero current account is the only equilibrium–that is, there is no equilibrium with stochastic variation in the ratio of marginal valuations of home currency, if present-value budget constraints are assumed to hold for every sequence of states. We think Benigno's results can be expressed in terms of the standard Marshall-Lerner condition: with a Cobb-Douglas aggregator the sum of import and export elasticities equals one.

Second, the argument we presented above would also apply in a setup with non-traded goods, but only if the utility functions are logarithmic (or otherwise separable between traded and non-traded goods). To see this note that consumption and production of non-traded goods would cancel out from the two sides of the household's budget constraint in equilibrium and (with log utility) equations (A5) and (A12) would still hold. Third, we conjecture that the zero-current-account implication would not hold if we allowed for a traded good produced by both countries.[38]

Finally, the current account would not be zero in our model if we assumed $B_{H0} \neq 0$. But this would not lead to interesting current-account dynamics. In this case, the country that has initial debt would run a current account deficit whose size relative to outstanding debt remains constant over time. The ratio of nominal consumption of each good to assets (debt) would also be constant (and independent of all shocks) over time.

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[38] Our conjecture is based on our unpublished work and on Cole and Obstfeld (1991). They show that the autarkic equilibrium in their pure exchange setup is not Pareto efficient if both countries have endowments of a common good.

Figure 1: Response of Real U.S. GDP to Fiscal Shocks

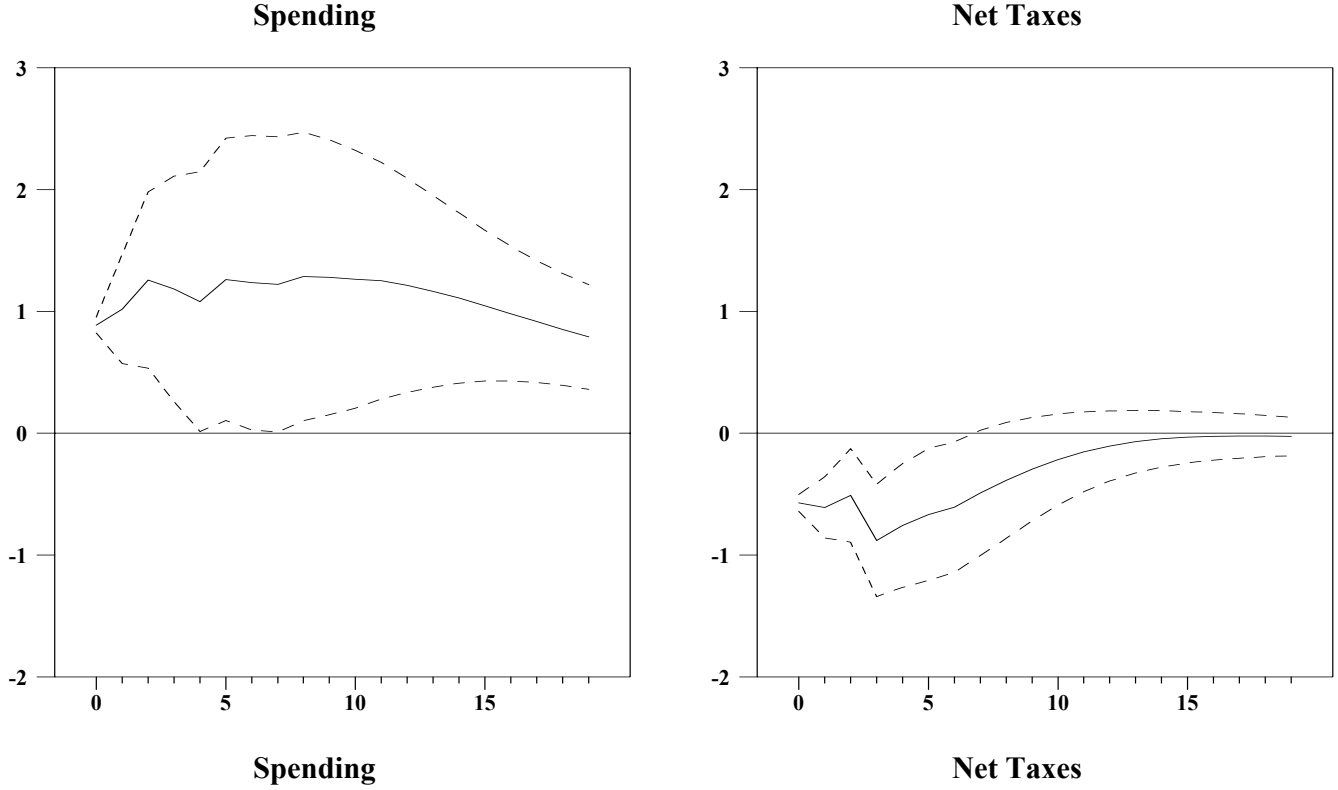

Figure 2: Response of Real U.S. Consumption to Fiscal Shocks

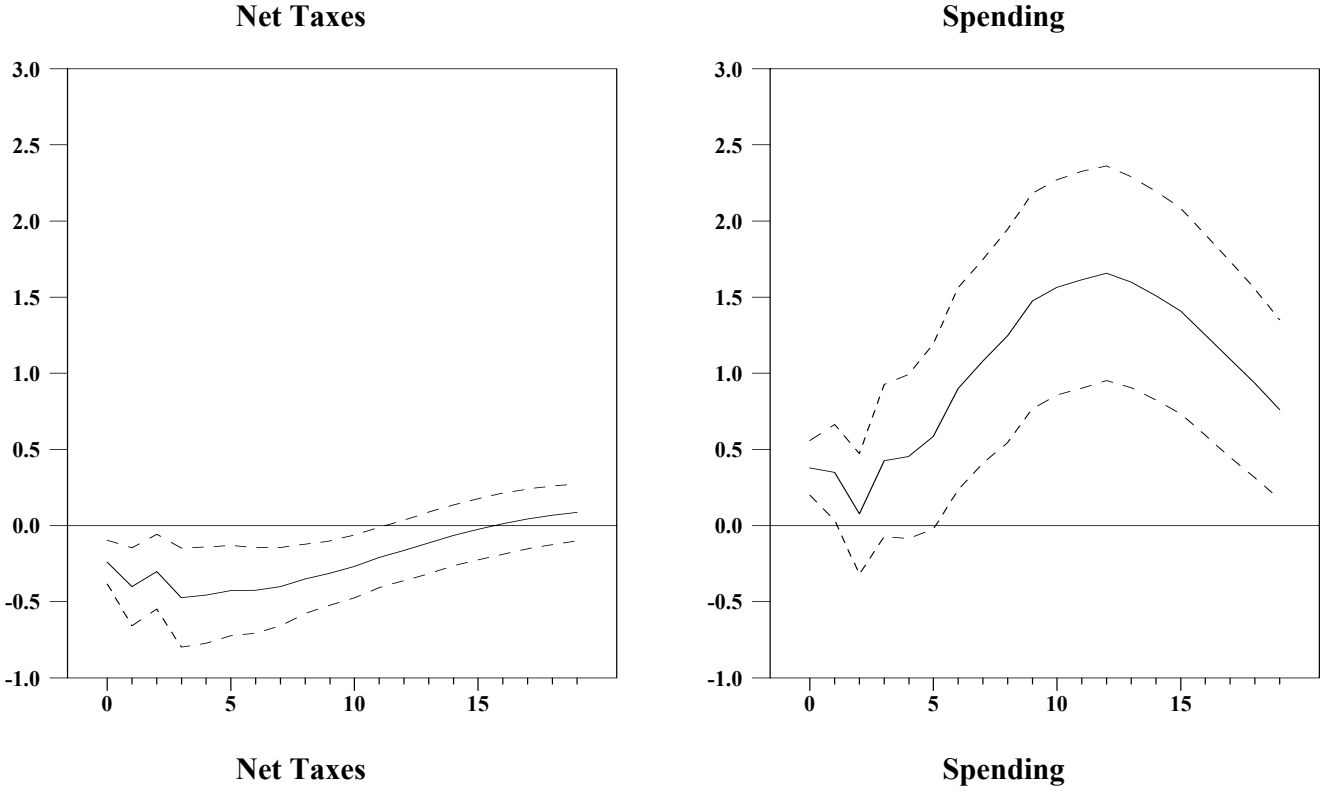

Figure 3:Impulse Responses for French Data

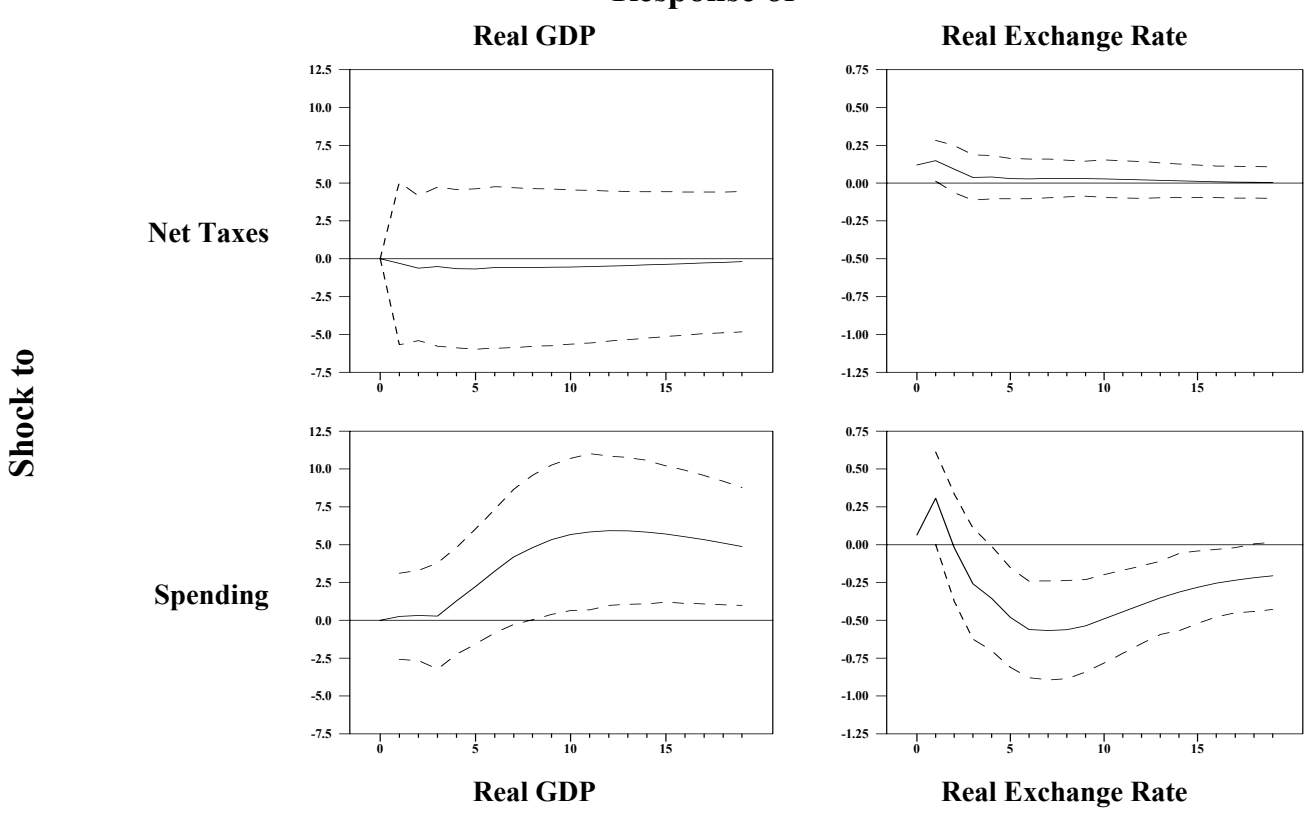

Figure 4:Impulse Responses for Italian Data

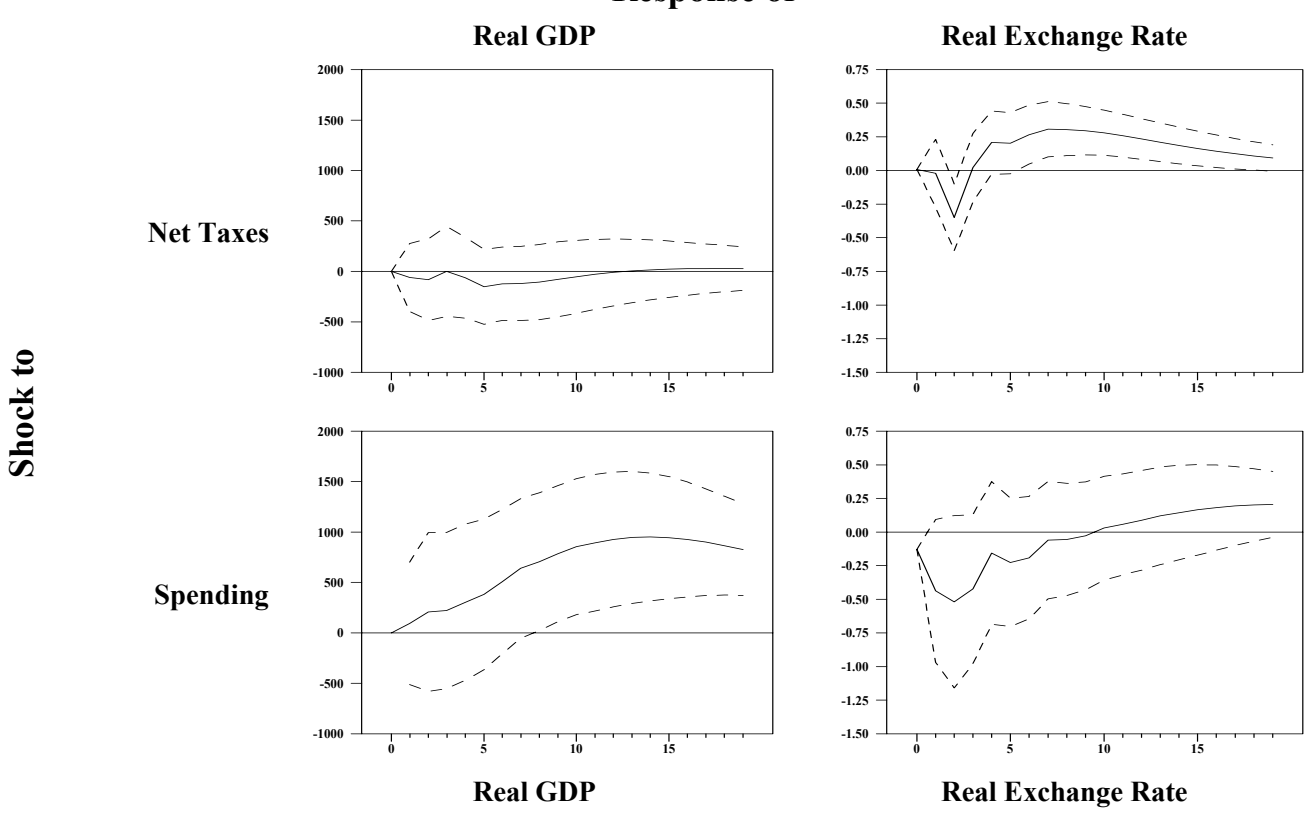

Figure 5:Impulse Responses for British Data

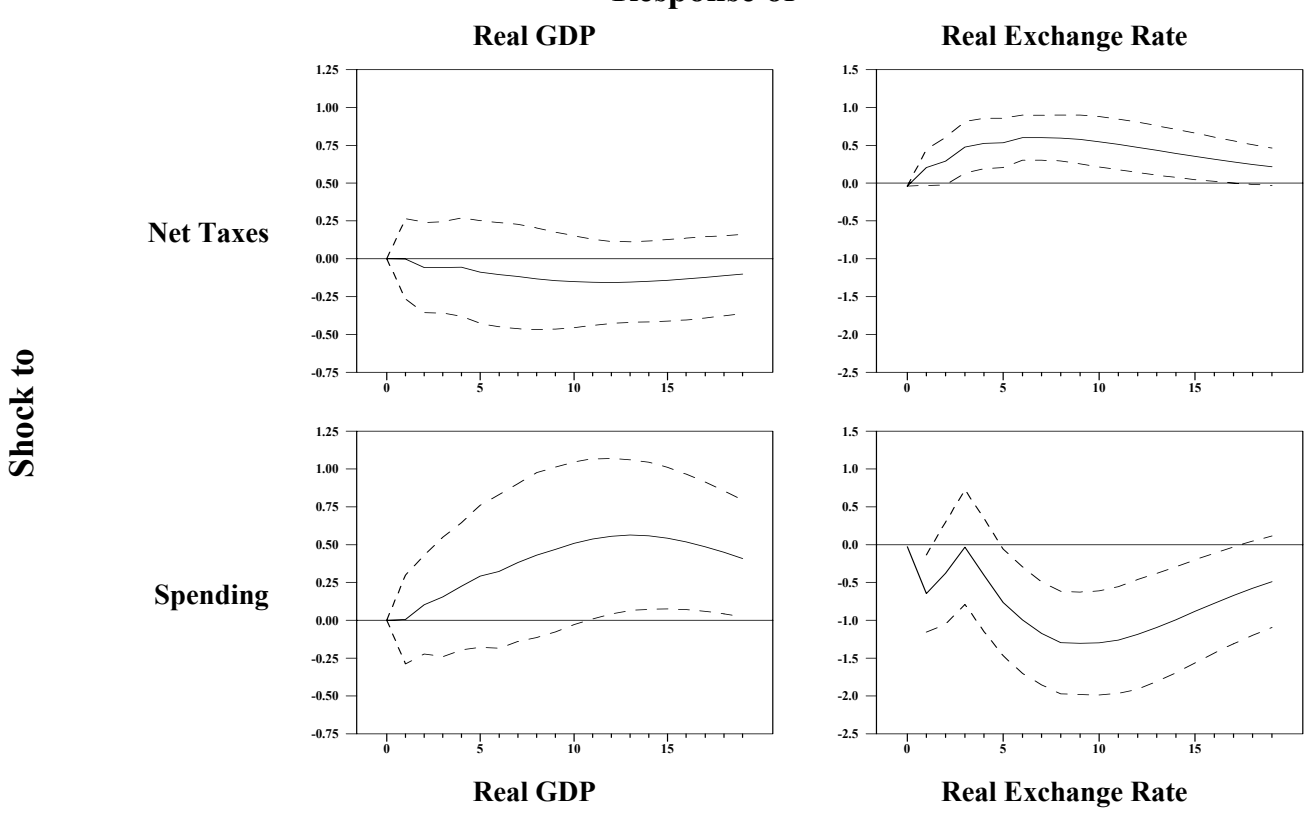

Figure 6:Impulse Responses for French Data

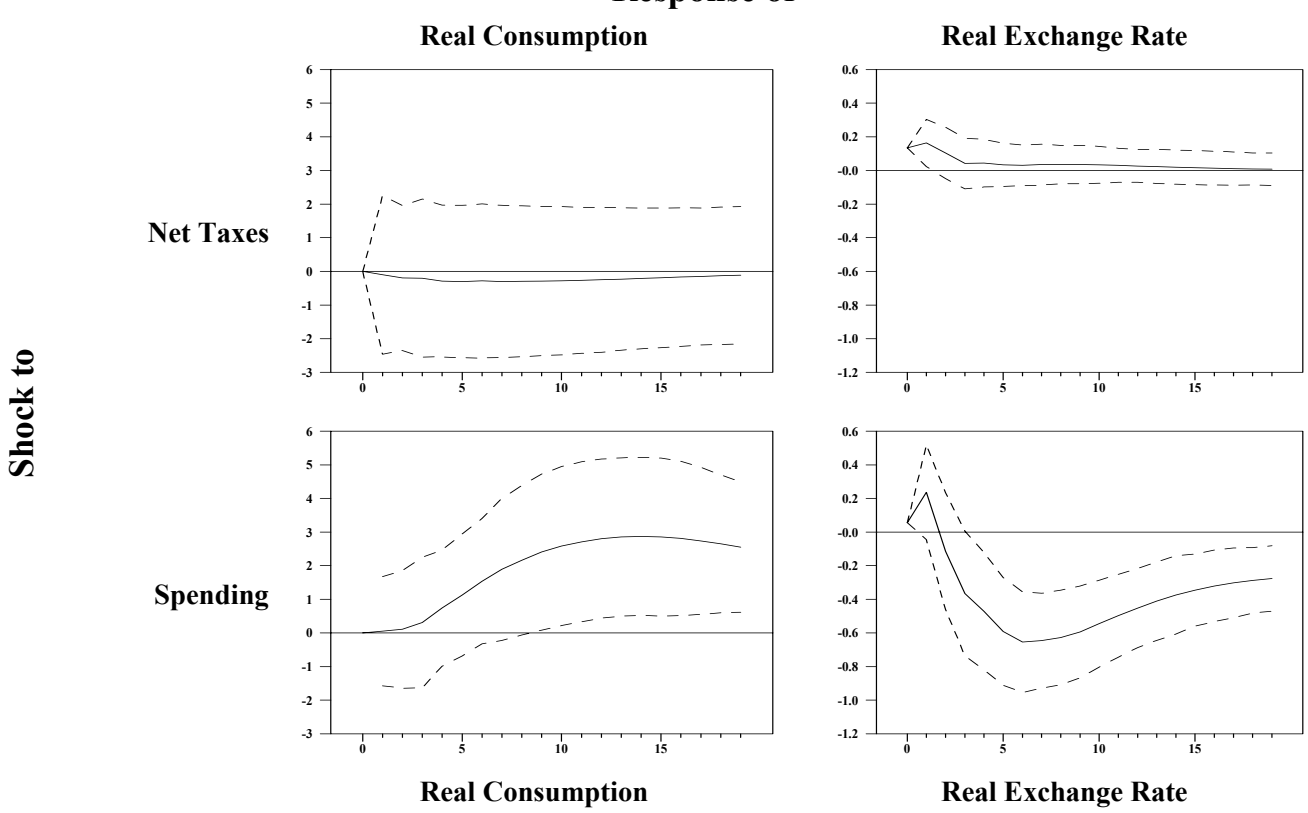

Figure 7:Impulse Responses for Italian Data

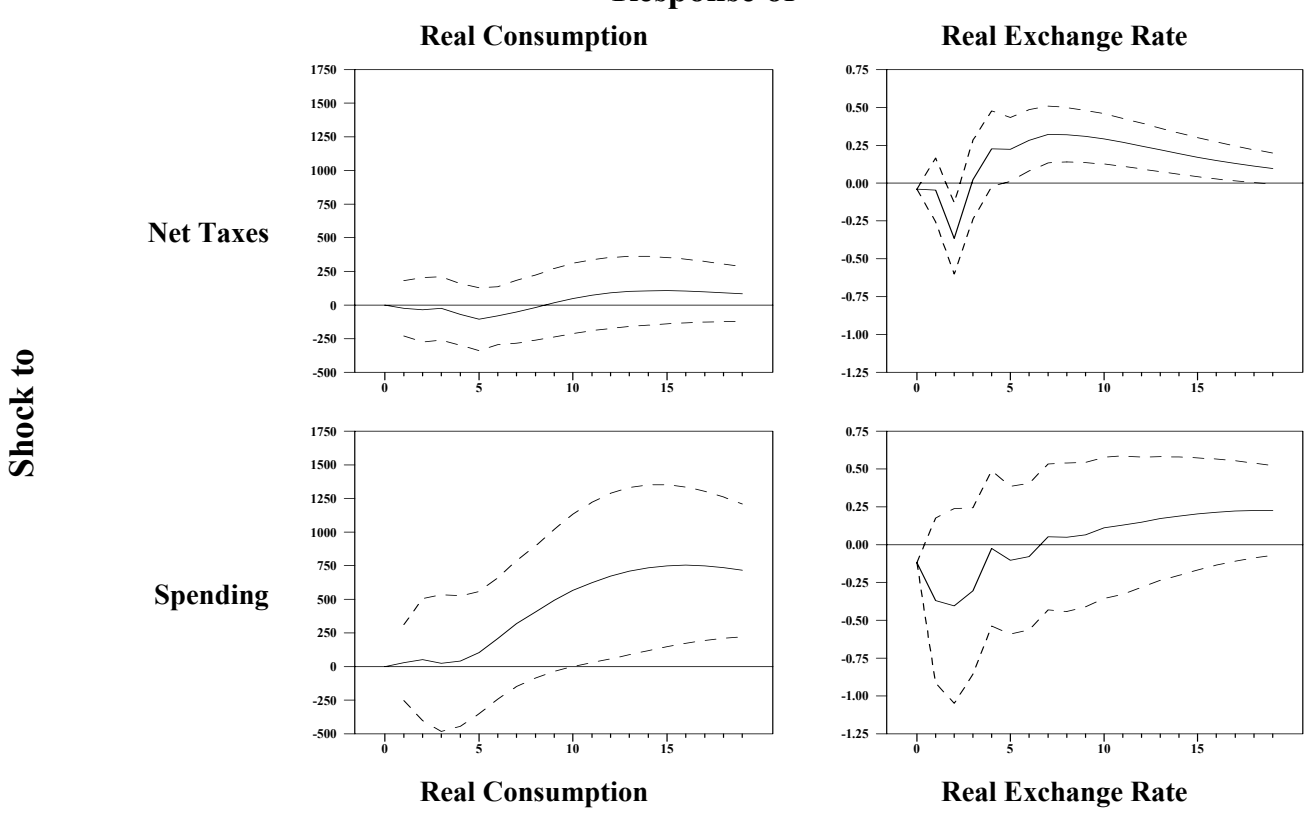

Figure 8:Impulse Responses for British Data