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of Government Spending on Foreign Trade

GERNOT J. MÜLLER

BADIA FIESOLANA, SAN DOMENICO (FI)

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European University Institute
Badia Fiesolana
I-50016 San Domenico (FI)
Italy

Understanding the Dynamic Effects of Government Spending on Foreign Trade*

Gernot J. Müller
European University Institute

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Abstract

In order to understand the dynamic effects of government spending on foreign trade the present paper proceeds in two steps. First, using U.S. time series data for the post-Bretton-Woods period, the dynamic effects of government spending are investigated within a structural Vector Autoregression framework: the nominal exchange rate is found to depreciate, the terms of trade to appreciate and the trade balance to increase significantly after a temporary increase in government spending. In a second step, a New-Keynesian general equilibrium model is used to rationalize these effects. Two findings emerge: i) a low elasticity of substitution between home and foreign goods is necessary for the trade balance to improve after an increase in public spending. ii) an accommodating monetary policy is found to dampen the effects of government spending on foreign trade.

JEL classification: E62, F41, F42

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1 Introduction

The present paper studies the dynamic effects of a temporary increase in government spending on foreign trade. Its aim is twofold. First, I want to establish empirically how the exchange rate, the terms of trade and trade balance respond to a government spending shock. Second, I want to rationalize these responses within a stochastic general-equilibrium model which features price rigidities and thus gives an important role to monetary policy.

Empirical investigations into the dynamic effects of fiscal policy based on Vector Autoregressions and alternative identification schemes have become more numerous recently. Also, attempts have been made to account for the evidence using different versions of stochastic general-equilibrium models, e.g., Fatás and Mihov (2001), Burnside, Eichenbaum and Fisher (2004) and Galí, López-Salido and Vallés (2003). Little evidence, however, has been put forward regarding the dynamic effects of government spending on foreign trade. Exceptions are Kim and Roubini (2003) and Giuliadori and Beetsma (2004), which do not, however, explore their empirical findings within a formal theoretical framework. Also Canzoneri, Cumby and Diba (2003) provide a VAR analysis of the effects of fiscal policy on foreign trade and, while they analyze their findings within a general-equilibrium model, they make the limiting assumption that trade is always balanced.

From a more practical point of view, the recent U.S. fiscal-monetary expansionary stance with a fiscal deficit of around five percent and the federal funds rate down at one percent highlights the need to understand the dynamic effect of fiscal policy on foreign trade. It is often assumed that the recent U.S. policies are stimulating the global economy, but are contributing to the observed global imbalances, since the expansionary fiscal stance is believed to worsen the U.S. trade balance, see, e.g., the International Monetary Fund's WEO (2004).

Therefore, I take up these issues both at an empirical and a theoretical level. The main results of the empirical analysis can be summarized as follows. I find that the nominal exchange rate depreciates, the terms of trade appreciate and the trade balance improves after a temporary increase in government spending. These results are obtained from a Vector Autoregression on U.S. time series in the post-Bretton-Woods period. While somewhat surprising,¹ the result regarding the trade balance is consistent with the findings of Kim and Roubini regarding the current account.

The theoretical analysis is based on a model that belongs to a recent class of stochastic general-equilibrium models for open economies which also feature sticky prices, see Benigno and Benigno (2003), Benigno (2003) and Galí and Monacelli (2004). Therefore, monetary policy has a non-trivial role in determining the equilibrium outcome during the

¹Received wisdom has it that temporary fiscal expansions weaken the trade balance. This is an implication of the standard one-good intertemporal model of the current account and has been confirmed in a seminal study by Ahmed (1986) on the basis of U.K. data.

transmission of a shock to government spending. I follow the strategy of Linnemann and Schabert (2003), who study the transmission of fiscal shocks in a closed economy model under different monetary regimes. I distinguish the case where monetary policy is characterized by a Taylor rule from the case where monetary policy implements price stability. While the Taylor rule is of empirical interest, the second regime is particularly interesting, since in this case monetary policy is able to replicate the flexible price allocation as shown by Benigno and Benigno. Moreover, under some conditions it is shown to be the optimal monetary policy, see, e.g., Clarida, Galí and Gertler (2002). I do not consider money explicitly in the model, but use the interest rate differential between home and foreign as measure for the monetary stance under the Taylor rule and compare it with the interest rate differential that prevails if monetary policy maintains price stability. While monetary policy is endogenous in both cases, government spending is assumed to be exogenous and assumed to fall entirely on the goods produced in the domestic economy.

The main results of the theoretical analysis are as follows. First, the elasticity of substitution between home and foreign goods is key for the sign of the response of the trade balance. Only for low elasticities, the value effect of a terms of trade adjustment dominates the substitution effect. This result adds further evidence to the debate on plausible values for this elasticity, see Corsetti, Dedola and Leduc (2004). Second, the terms of trade are shown to appreciate after an increase in government spending. While the sign of the response, both of the trade balance and the terms of trade, is shown to be independent of the monetary regime, the magnitude of the response depends on the monetary regime. If monetary policy follows a Taylor rule the responses of the trade balance and the terms of trade are weaker than in case of price stability. This is also reflected in the response of the nominal exchange rate, which appreciates in the price stability case, but depreciates in case monetary policy follows a Taylor rule. Judged by its ability to replicate qualitatively the dynamic effects of an increase of government spending on the exchange rate, the terms of trade and the trade balance, the model is successful if monetary policy follows a Taylor rule and the elasticity of substitution between home and foreign goods is low.

The remainder of the paper is organized as follows. In the next section, I obtain evidence on the dynamic effects of government spending using a Vector Autoregression Regression on U.S. time series data. Section 3 describes the model and provides a linear approximation to the equilibrium dynamics. Section 4 studies the transmission of fiscal shocks and the role of monetary policy. Section 5 concludes.

2 The Evidence

So far, only few empirical studies investigated the dynamic effects of fiscal policies on foreign trade. There is some VAR-based evidence, however, that fiscal expansions may affect

relative prices and generate output spillovers. Clarida and Prendergast (1999) consider an increase in the structural deficit in Germany, Japan and the U.S. and find that the real exchange rate appreciates on impact, while this effect is reversed later. Canzoneri, Cumby and Diba (2002) also find a real appreciation of the dollar after an increase in U.S. government spending. In addition, they observe a positive effect on foreign GDP (France, Italy and the U.K.). Similar in spirit, Giuliadori and Beetsma (2004), using European data find an increase in imports after an increase in government spending. However, they do not observe a major effect on the real exchange rate. In contrast to these studies, Kim and Roubini (2003), using U.S. data, find the real exchange rate to depreciate after a fiscal expansion and the current account to improve.

Taken together, these findings point to the important effects of government spending on foreign trade. They also highlight the role of relative prices in the adjustment process that follows a fiscal shock. This provides the starting point for the following analysis and motivates the choice of variables included in the VAR model. Instead of the real exchange rate, I include both the nominal exchange rate and the terms of trade. The terms of trade are more likely to capture the cross-border substitution process induced by fiscal expansions as they provide a measure for the relative price of tradeables only. The nominal exchange rate is included to account for monetary phenomena during the transmission of fiscal shocks (which are likely to have real effects in the presence of nominal rigidities). Finally, I include the trade balance as a summary statistic for the effects of fiscal policy on foreign trade.

Specifically, I include six variables in my baseline VAR model: the log of real government spending per capita, the log of real GDP per capita, the log of the GDP deflator, the log of the nominal exchange rate, the log of the terms of trade and the trade balance.² The model includes four lags of each endogenous variable, a constant and a linear time trend. The model is estimated using U.S. quarterly data from the Post-Bretton-Woods era (1973:1 to 2003:4).³

In order to identify an exogenous shock to government spending, I assume that government spending does not respond contemporaneously to changes in the other variables in the VAR. This assumption goes back to Blanchard and Perotti (2002) and Fatà and

²Other variables considered in the analysis of fiscal policy, such as net taxes, the real exchange rate and interest rates are also considered below.

³All data, except for the nominal effective exchange rate, are from the NIPA provided by the Bureau of Economic analysis. Real government spending is the sum of government consumption expenditures (A955RC1) and gross government investment (A782RC1) and deflated with the deflator of government consumption and investment (A822RD3). Real GDP is nominal GDP (A191RC1) deflated with the GDP deflator (A191RD3). The nominal effective exchange rate, which is taken from the IFS, is inverted such that an increase corresponds to a depreciation. The terms of trade are constructed as the price index of imports (B021RG3) over the price index of exports (B020RG3). The trade balance is constructed as the ratio of exports (B020RC1) less imports (B021RC1) over GDP (A191RC1). Quarterly population figures are also provided by the NIPA tables (B230RC0).

Mihov (2001) and is now widely used in the VAR literature on fiscal policy.⁴

Figure 1 displays the responses to an exogenous fiscal shock, i.e. a one percent increase in U.S. government spending. The crossed line gives the point estimates. The shaded area gives the 95 percent confidence interval, computed by the Hall bootstrap procedure based on 1000 replications, see Benkwitz, Lütkepohl and Wolters (2003).

Government spending rises significantly and persistently, with a half-life of about two years. GDP rises significantly on impact and is positive for almost two years. However, the output response is rather weak if compared with earlier studies, e.g., Blanchard and Perotti (2002) or Galí et al. (2003). However, it is in line with the evidence of Perotti (2004), who observes that the effects of fiscal policy have generally been weaker in the last 20 years. Prices fall after an increase in government spending (though not significantly), a finding also reported in other studies, e.g. Fatás and Mihov (2001).⁵

I now turn to dynamic effects of a temporary increase in government spending on variables which characterize external trade. The nominal exchange rate depreciates on impact and this effect becomes stronger and significant after six quarters. The terms of trade, on the other hand, appreciate sharply on impact, with the peak response in the third quarter. Then the terms of trade return quickly to the pre-shock level. The trade balance also moves on impact and, surprisingly, increases significantly in the second quarter after the shock and remains positive for an extended period. This finding is in line with the results of Kim and Roubini on the current account (which generally displays very similar short-run properties as the trade balance, see Baxter (1995)).

In order to explore the robustness of the results, I consider different specifications of the trend, the inclusion of additional/alternative variables and an alternative identification scheme. In the light of difficulties to distinguish clearly between stochastic and deterministic trends on the basis of formal tests, Blanchard and Perotti (2002) base their analysis on both specifications. Also, in case of stochastic trends, it is hard to establish clear evidence in favor of cointegration where suggested by economic theory (as in the case of taxes and government spending). Clearly, in the present case where interest is not centered on the cointegration relationship it might be sensible to resort to the level specification which can accommodate for stochastic trends as well. Against this background,

⁴The analysis of Canzoneri et al. (2002) is also based on this identifying assumption. The baseline specification of Kim and Roubini (2003), in contrast, is based on the assumption that GDP does not contemporaneously respond to changes in the fiscal balance. However, Kim and Roubini perform various robustness tests, including the identification scheme which orders government spending first. They find that the results essentially unaltered. I also consider an alternative identification scheme below.

⁵Perotti (2004) shows that it may result from assuming a zero price elasticity of real government spending (in the present identification scheme) and that the effect becomes weaker if a non-zero elasticity is assumed (as I do below). The effect of government spending on the price level ultimately depends on the relative importance of the supply (i.e. wealth) effect and the demand effect (i.e. the degree of price rigidity), see the discussion in Linnemann and Schabert (2003).

I follow Perotti (2004) and distinguish the following cases: i) linear time trend (baseline model), ii) quadratic trend, iii) levels, iv) stochastic trend⁶, and v) a stochastic trend with cointegration between spending and taxes (for that purpose taxes are included in the VAR and ordered second⁷). Figure 2 displays the results. For all specifications the qualitative responses are identical, except for the response of the terms of trade under the imposed cointegration relationship between government spending and taxes.

Next, I consider alternative variables, which have been left out under the presumption that they do not affect the response of the variables of interest to a temporary increase in public spending. I consider the following modifications of the baseline specification: i) the 10-year nominal interest rate is added to the baseline specification⁸, see Perotti (2004). ii) net taxes are added to the baseline specification. iii) instead of deflating public spending with its own deflator, I use the GDP deflator to obtain a measure for real government spending. iv) instead of the nominal exchange rate, the real exchange rate is included.

So far, a shock to government spending has been identified by the assumption that government spending does not contemporaneously respond to any other variables considered in the VAR (note that government spending does not include transfer payments). This assumption may be somewhat restrictive in case the price level is included in the VAR. Perotti (2004) argues, that depending on the degree of indexation of government spending, it might be reasonable to assume that real spending falls if the price level increases. Only if government spending were fully (and without lag) indexed to inflation, the zero restriction would not be restrictive. I follow Perotti and consider the dynamic effects of a shock to government spending based on the assumption that the price elasticity of real government spending is -0.5 (instead of zero in the baseline case). Figure 3 displays the results of all five experiments confirming the results obtained with the baseline model.

Against this background, the dynamic effects of a temporary increase in U.S. government spending during the flexible exchange rate period 1973-2003 can be summarized as follows: the nominal exchange rate depreciates, the terms of trade appreciate and the trade balance improves. The next section outlines a theoretical framework in order to rationalize these findings.

3 The Model

The following model belongs to a class of stochastic general equilibrium-models, which combine optimization behavior at the micro-level with price stickiness to address problems

⁶I take first difference of each variable and report the accumulated impulse responses. I do not, however, allow for changes in the underlying drift as discussed in Blanchard and Perotti, since a preliminary analysis showed similar results.

⁷Real net taxes, taken from NIPA, are taxes (W021RC1) less transfers (A084RC1) deflated with (A191RD3).

⁸The measure for the 10 year nominal interest rate, which is used below, is obtained from the FRED database of the St. Louis Fed.

of the open economy, see, e.g., Benigno (2003), Benigno and Benigno (2003) and Galí and Monacelli (2004). Four features of the model deserve special emphasis: i) two countries are considered and each produces a distinct good, not produced by the other country, ii) international financial markets are complete, iii) private consumption is biased towards the home good, iv) government spending falls entirely on domestic goods. To simplify the exposition, I focus on the home economy and use the following notation: foreign variables within the home economy are indexed with the subscript F , while foreign variables in foreign are indexed with a star.

3.1 Preferences and Markets

Households consume an aggregate good C_t , while providing a differentiated good $Y_{t+k}(i)$, with $i \in [0, 1]$, to the world market. The objective of a generic home household i is to maximize

$$E_t \left\{ \sum_{k=0}^{\infty} \beta [u(C_{t+k}) - v(Y_{t+k}(i))] \right\}, \quad (1)$$

where $0 < \beta < 1$ is a discount factor. The period contribution of utility u is assumed to be concave and increasing. The period contribution of disutility v is assumed to be convex and increasing. E_t denotes the expectation conditional on the information set at date t .

The consumption index C_t is defined as a composite good and the intratemporal elasticity of substitution between home and foreign goods is assumed to be constant, ε ,

$$C_t = \left[\theta^{\frac{1}{\varepsilon}} C_{H,t}^{\frac{\varepsilon-1}{\varepsilon}} + (1-\theta)^{\frac{1}{\varepsilon}} C_{F,t}^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}, \quad \varepsilon > 0$$

where $C_{H,t}$ and $C_{F,t}$ are consumption bundles of differentiated home and foreign goods, respectively. $1/2 \leq \theta \leq 1$ denotes the home bias in private consumption. Consequently, the domestic and foreign consumption baskets differ for all $\theta > 1/2$. Home and foreign goods are bundled according to the CES technology

$$C_{H,t} = \left(\int_0^1 C_{H,t}(j)^{\frac{\mu-1}{\mu}} dj \right)^{\frac{\mu}{\mu-1}}, \quad C_{F,t} = \left(\int_0^1 C_{F,t}(j)^{\frac{\mu-1}{\mu}} dj \right)^{\frac{\mu}{\mu-1}},$$

where $C_{H,t}(j)$ and $C_{F,t}(j)$ denote differentiated goods produced by household $j \in [0, 1]$ in home and foreign, respectively. $\mu > 1$ denotes the intratemporal elasticity of substitution both across domestic goods and foreign goods. $P_{H,t}(j)$ and $P_{F,t}(j)$ denote the price (denoted in home currency) of a differentiated good produced by household j in home and foreign, respectively. The price indices for home and foreign good bundles are defined as $P_{H,t} = \left(\int_0^1 P_{H,t}(j)^{1-\mu} dj \right)^{\frac{1}{1-\mu}}$ and $P_{F,t} = \left(\int_0^1 P_{F,t}(j)^{1-\mu} dj \right)^{\frac{1}{1-\mu}}$, respectively. The domestic price index (CPI) is given by

$$P_t = \left[\theta P_{H,t}^{1-\varepsilon} + (1-\theta) P_{F,t}^{1-\varepsilon} \right]^{1/(1-\varepsilon)}. \quad (2)$$

Let S_t denote the nominal exchange rate, i.e. the price of foreign currency in terms of domestic currency. While the law of one price holds, i.e. $P_{H,t} = S_t P_{H,t}^*$ and $P_{F,t} = S_t P_{F,t}^*$, purchasing power parity does not hold for $\theta > 1/2$.

Government spending G_t falls entirely on domestic goods, while private consumption expenditure is allocated optimally across home and foreign goods, such that total demand for home goods is given by

$$Y_t^D = \left(\frac{P_{H,t}}{P_t} \right)^{-\varepsilon} (\theta C_t + (1 - \theta) C_t^* + G_t)$$

Moreover, an optimal intratemporal allocation of expenditure across differentiated goods implies the following demand functions for a generic home good

$$Y_t^D(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}} \right)^{-\mu} Y_t^D. \quad (3)$$

Financial markets are complete, both at the domestic and the international level. The set of state-contingent assets is denoted in domestic currency. The absence of arbitrage opportunities requires that there exist a stochastic discount factor $Q_{t,t+1}$ which is used to price the portfolio A_{t+1} in period t .⁹

While monopolistic competition and the limited ability to adjust prices introduces heterogeneity at the household level, the assumption of complete markets at the domestic level allows to consider the intertemporal budget constraint of a representative home household

$$P_t C_t + E_t \{Q_{t,t+1} A_{t+1}\} = A_t + (1 - \chi) P_{H,t} Y_t + T_t, \quad (4)$$

where χ denotes the constant tax rate and T_t denotes lump sum taxes. The government budget constraint is assumed to be balanced in each period

$$\chi P_{H,t} Y_t + T_t = P_{H,t} G_t,$$

where an exogenous process for G_t is specified below.

The maximization of (1) subject to (4) gives

$$\beta \frac{u'(C_{t+1})}{u'(C_t)} \frac{P_t}{P_{t+1}} = Q_{t,t+1}. \quad (5)$$

⁹As discussed in Woodford (2003, Ch. 2), A_{t+1} denotes the *state-contingent* value of the household portfolio at the beginning of period $t + 1$. Thus, at the time of the portfolio decision A_{t+1} is a random variable, but the household chooses its complete specification, i.e., the return in each state. As of date t , $Q_{t,t+1}$ remains also a random variable and depends of the realization of the state in $t + 1$. To simplify the notation, I omit the state dependence of these variables, see also the discussion in Galí and Moncelli (2003) and for an explicit consideration of state-dependence in a similar framework Chari, Kehoe and McGratten (2002).

This condition holds for each possible state. Defining the short-term nominal interest rate as $(1 + i_t)^{-1} = E_t \{Q_{t,t+1}\}$ and taking expectations of (5) gives the Euler equation

$$\beta E_t \left\{ \frac{u'(C_{t+1})}{u'(C_t)} \frac{P_t}{P_{t+1}} \right\} = \frac{1}{1 + i_t}. \quad (6)$$

Analogous relationships hold for the foreign economy. Because of complete financial markets the stochastic discount factor links home and foreign financial markets. The foreign equivalent to (5) is given by

$$\beta \frac{u'(C_{t+1}^*)}{u'(C_t^*)} \frac{P_t^* S_t}{P_{t+1}^* S_{t+1}} = Q_{t,t+1}.$$

Combining this expression with (5) and iterating gives the risk sharing condition

$$u'(C_t^*) = k \frac{S_t P_t^*}{P_t} u'(C_t) \quad (7)$$

where $k = \frac{U'(C_0^*)}{U'(C_0)} \frac{P_0}{P_0^* S_0}$. This condition plays a crucial role in the international transmission of fiscal shocks. The assumption of complete asset markets guarantees that an efficient allocation is implemented: marginal utility of consumption, weighted by the real exchange rate, is equalized across countries. A rise in the price of domestic goods, for example, requires that resources are transferred from home to foreign if $\theta > 1/2$. If home and foreign goods have equal weight in private consumption purchasing power parity holds, the real exchange rate is constant and consumption is equal across countries.

Given monopolistic competition in the goods market and the resulting downward sloping demand functions (3), the price setting mechanism plays a crucial role for the real allocation of goods. I assume that households take $P_t, P_{F,t}, P_{H,t}$ as given when they decide on $P_{t,H}(j)$. Moreover, I assume that price setting is constraint exogenously by a discrete time version of the mechanism suggested by Calvo (1983). Each household has the opportunity to change its price with a given probability $1 - \alpha$. In setting a price $P_{H,t}(j)$ in period t a generic household j seeks to maximize

$$E_t \sum_{k=0}^{\infty} \left\{ \alpha^k Q_{t,t+k} \left[\frac{u'(C_{t+k})}{P_{t+k}} (1 - \chi) P_{H,t}(j) Y_{t+k}^D(j) - v(Y_{t+k}^D(j)) \right] \right\},$$

subject to the demand function (3). Note that revenues $(1 - \chi) P_{H,t}(j) Y_{t+k}^D(j)$ are evaluated using the marginal utility of nominal income $u'(C_{t+k})/P_{t+k}$, which is identical to all households as a result of complete income insurance.

The first order condition to this problem is given by

$$E_t \sum_{t=k}^{\infty} \left\{ \alpha^k Q_{t,t+k} Y_{t+k}^D(j) \left[\frac{P_{H,t}(j) u'(C_{t+k})}{P_{t+k}} - \frac{\mu}{(\mu - 1)(1 - \chi)} v'(Y_{t+k}^D(j)) \right] \right\} = 0. \quad (8)$$

In case prices are fully flexible, i.e. $\alpha = 0$, condition (8) implies that prices $P_{H,t}(j)$ (which - in symmetric equilibrium - correspond to $P_{H,t}$ in the case of price flexibility) are set to satisfy the following condition

$$\frac{P_{H,t} u'(C_{t+k})}{P_{t+k}} = \frac{\mu}{(\mu-1)(1-\chi)} v' \left[\left(\frac{P_{H,t}}{P_{H,t}} \right)^{-\mu} Y_t^D \right], \quad (9)$$

which relates prices to marginal costs of the household (measured in utility terms).

Let $Y_t = \left[\int_0^1 Y_t(j)^{\frac{\mu-1}{\mu}} dj \right]^{\frac{\mu}{\mu-1}}$ represent an index for aggregate domestic output. Then market clearing for home and foreign goods implies

$$Y_t = \left[\left(\frac{P_{H,t}}{P_t} \right)^{-\varepsilon} \theta C_t + \left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\varepsilon} (1-\theta) C_t^* + G_t \right], \quad (10)$$

$$Y_t^* = \left[\left(\frac{P_{F,t}^*}{P_t^*} \right)^{-\varepsilon} \theta C_t^* + \left(\frac{P_{F,t}}{P_t} \right)^{-\varepsilon} (1-\theta) C_t + G_t^* \right]. \quad (11)$$

In addition, the trade balance is defined as the value of exports less the value of imports, expressed in domestic consumer prices

$$TB_t = \frac{P_{H,t}}{P_t} \left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\varepsilon} (1-\theta) C_t^* - \frac{P_{F,t}}{P_t} \left(\frac{P_{F,t}}{P_t} \right)^{-\varepsilon} (1-\theta) C_t \quad (12)$$

3.2 Log-Linear Equilibrium Dynamics

To study equilibrium fluctuations, I approximate the model around a symmetric steady state. I assume moreover that foreign government spending is constant. In the following, small letters indicate the log-deviation of a variable from its steady state value. Also, to simplify the numerical analysis, the economy is written such that prices appear only in first-differences, i.e. $\pi_{H,t} = \log(P_{H,t}/P_H)$, $\Delta s_t = \log(S_t/S_{t-1})$, $i_t \simeq \log(1+i_t)$. A *rational expectations equilibrium* is then defined by a sequence of prices

$$\left\{ \pi_{H,t}, \pi_{F,t}, \pi_{H,t}^*, \pi_{F,t}^*, \pi_t, \pi_t^*, i_t, i_t^*, \Delta s_t, \tau_t \right\}_{t=0}^{\infty},$$

and quantities

$$\left\{ c_t, c_t^*, y_t, y_t^*, g_t, \hat{t}b_t \right\}_{t=0}^{\infty}$$

which, given a sequence $\{u_t\}_{t=0}^{\infty}$ of exogenous shocks to government spending, satisfy the following sets of conditions.

A first set of conditions holds both for home and foreign. The Euler equations (6) are approximated by:

$$c_t = E_t c_{t+1} - \frac{1}{\sigma} (i_t - E_t \pi_{t+1}), \quad c_t^* = E_t c_{t+1}^* - \frac{1}{\sigma} (i_t^* - E_t \pi_{t+1}^*), \quad (13)$$

where $\sigma = -u''C/u'$, is the elasticity of the marginal utility of consumption, where $\omega = v''H/v'$ is the elasticity of the marginal disutility of labor. A log-linear approximation to (8) gives the New Keynesian Phillips Curve:

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa ((1 - \theta) \tau_t + \omega y_t + \sigma c_t), \quad (14)$$

$$\pi_{F,t}^* = \beta E_t \pi_{F,t+1}^* + \kappa (-(1 - \theta) \tau_t + \omega y_t^* + \sigma c_t^*), \quad (15)$$

where $\kappa = (1 - \alpha)(1 - \alpha\beta)/(\alpha(1 + \mu\omega))$ and $\tau_t = \log(P_{F,t}/P_{H,t})$ denotes the terms of trade.

The second set of conditions concerns the interdependence between home and foreign. The cross-country risk sharing condition (7) is approximated as

$$\sigma(c_t - c_t^*) = (2\theta - 1) \tau_t. \quad (16)$$

Using a log-linear approximation, the terms of trade and the law of one price can be defined as follows:

$$\tau_t = \tau_{t-1} + \pi_{F,t} - \pi_{H,t}, \quad (17)$$

$$\pi_{H,t} = \Delta s_t + \pi_{H,t}^*, \quad \pi_{F,t} = \Delta s_t + \pi_{F,t}^*. \quad (18)$$

The market clearing conditions (10) and (11) are approximated as

$$y_t = \theta(1 - g)c_t + (1 - \theta)(1 - g)c_t^* + gg_t + 2\varepsilon\theta(1 - g)(1 - \theta)\tau_t, \quad (19)$$

$$y_t^* = \theta(1 - g)c_t^* + (1 - \theta)(1 - g)c_t - 2\varepsilon\theta(1 - g)(1 - \theta)\tau_t. \quad (20)$$

Here $g \equiv G/Y$ denotes the steady state ratio of government spending. Finally, (2) implies that domestic and foreign CPI inflation can be approximated as

$$\pi_t = \theta\pi_{H,t} + (1 - \theta)\pi_{F,t} \quad \pi_t^* = (1 - \theta)\pi_{H,t}^* + \theta\pi_{F,t}^* \quad (21)$$

Additional conditions specifying fiscal and monetary policy are necessary to determine the equilibrium. They are discussed in the next section.

4 Fiscal Shocks and Monetary Regime

The present model allows to study the effects of fiscal policy on foreign trade. Also, due to the presence of price rigidities, monetary policy plays an important role for the transmission of fiscal shocks. While government spending is assumed to be purely exogenous and to follow an AR(1) process

$$g_t = \rho g_{t-1} + u_t,$$

monetary policy is assumed to respond endogenously to the state of the economy. This way of modelling the interaction between fiscal and monetary policies follows Linnemann

and Schabert (2003). I consider two distinct monetary regimes. In the first case, monetary policy implements producer price stability, which implies formally

$$\pi_{H,t} = 0, \quad \pi_{F,t}^* = 0.$$

This monetary regime is of particular interest for two reasons. First, from a positive point of view, this regime gives rise to the allocation that would prevail if prices were completely flexible, see Benigno and Benigno (2003). Second, some authors have shown that this policy is optimal in case there is no international cooperation of monetary policies, e.g., Clarida, Galí and Gertler (2002).¹⁰ In the following, I refer to this monetary regime as the price stability case.

As an alternative specification of monetary policy, I consider a simple interest rate feedback rule, such that

$$i_t = \phi_\pi \pi_{H,t} + \phi_{\hat{y}} \hat{y}_t, \quad i_t^* = \phi_\pi \pi_{F,t}^* + \phi_{\hat{y}} \hat{y}_t^*, \quad (22)$$

where $\hat{y}_t = y_t - y_t^f$ denotes the output gap, i.e., the difference between actual output and the flexible price output. The characterization of monetary policy through such an interest rate feedback rule is motivated by its empirical success. In the following, I refer to this case as the Taylor rule case, see Taylor (1993).

For means of comparisons, it is useful to have a measure for the monetary stance that is implied by both monetary regimes during the transmission of a government spending shock. Specifically, what matters for the impact of government spending on foreign trade is the *relative* monetary stance in home and foreign.

Therefore, I compare the nominal interest rate differential between home and foreign under both regimes. In case of price stability the nominal interest rate is equal to the natural rate of interest, i.e. the interest rate that would prevail in case of complete price flexibility, see Woodford (2003). Therefore the interest rate differential implied by this regime represents a natural benchmark, or resorting to the terminology established in the closed economy literature, the *natural* interest rate differential. It is then possible, to compare the interest rate differential under the Taylor rule regime with the natural interest rate differential in order to measure the relative monetary stance during the transmission of the fiscal shock.

4.1 Relative prices and relative monetary stance

In order to understand the dynamic effects of government spending on foreign trade, I first solve the model for the response of the terms of trade and the exchange rate under both monetary regimes.

¹⁰Regarding the optimality of such a policy in a two country model, see also the qualifications in Benigno and Benigno.

In case of price stability a solution of the model is straightforward, because the dynamics implied by the New Keynesian Phillips curves (15) and (14) are eliminated. Subtracting them from each other and imposing the risk-sharing condition (16) gives

$$y_t^D = -\frac{1}{\omega}\tau_t, \quad (23)$$

where the y_t^D denotes the difference between home and foreign output. Intuitively, (23) describes the relative supply conditions under price stability. An increase in the terms of trade (relative price of foreign goods), increases - ceteris paribus - foreign output relative to home output. This effect is stronger the smaller the elasticity of the marginal disutility of labor ω .

Relative demand can be characterized by subtracting the goodmarket clearing condition for the foreign good (20) from its home counterpart (19) and imposing the risk-sharing condition (16)

$$y_t^D = \left[4\varepsilon\theta(1-g)(1-\theta) + \sigma^{-1}(2\theta-1)^2(1-g) \right] \tau_t + gg_t. \quad (24)$$

Combining (23) and (24) gives the solution for the terms of trade

$$\tau_t = -\frac{g}{\xi}g_t, \quad (25)$$

where

$$\xi \equiv \omega^{-1} + 4\varepsilon\theta(1-g)(1-\theta) + \sigma^{-1}(2\theta-1)^2(1-g) \quad (26)$$

is unambiguously positive. Hence, the terms of trade fall in response to an increase government spending g .

Note that the smaller the elasticity of the marginal disutility of labor, ω , the weaker the response of the terms of trade. Similarly, the smaller the elasticity of the marginal disutility of consumption, σ , the weaker the response of the terms of trade. Intuitively, if these elasticities are low, the adjustment is more through quantities than through prices. On the other hand, if the elasticity between home and foreign goods, ε , is low, the response of the terms of trade is stronger.

Next, I consider the response of the nominal exchange rate under price stability. The law of one price implies $S_t = P_{F,t}/P_{F,t}^*$. Extending this expression with $P_{H,t}$ and considering log-deviations gives

$$s_t = \tau_t + p_{H,t} - p_{F,t}^*, \quad (27)$$

such that in the price stability case, the nominal exchange rate displays the same dynamics as the terms of trade

$$s_t = \tau_t = -\frac{g}{\xi}g_t.$$

Intuitively, in case prices are stable, any change in the terms of trade can only be realized through a change in the nominal exchange rate.

As discussed above, a measure for the relative monetary stance is given by the interest rate differential, which is obtained from the Euler equations (13) after imposing the risk sharing condition (16)¹¹

$$i_t^{D,PS} = (1 - \rho) \frac{g}{\xi} g_t. \quad (28)$$

I now turn to the Taylor rule case. In this case the model is more difficult to solve because of the dynamics implied by the New Keynesian Phillips curve. Therefore, I make the simplifying assumptions that monetary policy does not adjust the interest rate in response to the output gap, i.e., $\phi_y = 0$ and that fiscal shocks are not autocorrelated, i.e., $\rho = 0$. Both assumptions are relaxed in the numerical analysis below. I refer to the case where $\phi_y = 0$ as the simplified Taylor rule.

Subtracting the Phillips Curves (15) and (14), imposing the risk sharing (16) and the goodmarket clearing conditions (20), (19) gives

$$\hat{\pi}_t^D = \beta E_t \hat{\pi}_{t+1}^D + \kappa \omega \xi \tau_t + \kappa \omega g g_t, \quad (29)$$

where $\hat{\pi}_t^D \equiv \pi_{H,t} - \pi_{F,t}^*$ denotes the difference between home and foreign producer price inflation.

Relative demand is characterized by the difference of the Euler equations (13). Imposing the risk sharing condition (16) and the interest rate feedback rule (22) with $\phi_{\hat{y}} = 0$, gives

$$\tau_t + \phi_\pi \hat{\pi}_t^D = E_t \tau_{t+1} + E_t \hat{\pi}_{t+1}^D. \quad (30)$$

Equations (30) and (29) define a linear system of expectational difference equations with two endogenous forward-looking variables

$$\underbrace{\begin{bmatrix} 1 & 1 \\ \beta & 0 \end{bmatrix}}_{=:A} \underbrace{\begin{bmatrix} E_t \hat{\pi}_{t+1}^D \\ E_t \tau_{t+1} \end{bmatrix}}_{=:B} = \underbrace{\begin{bmatrix} \phi_\pi & 1 \\ 1 & -\kappa \omega \xi \end{bmatrix}}_{=:B} \underbrace{\begin{bmatrix} \hat{\pi}_t^D \\ \tau_t \end{bmatrix}}_{=:C} + \underbrace{\begin{bmatrix} 0 \\ -\kappa \omega g \end{bmatrix}}_{=:C} g_t. \quad (31)$$

If both eigenvalues of $\Omega^{-1} = A^{-1}B$ are outside the unit circle the rational expectations equilibrium is determinate. This condition is satisfied if the Taylor principle holds, i.e., if

¹¹Also the definition of CPI inflation (21), the law of one price (18), and the definition of the terms of trade (17), which implies $\Delta s_t = \hat{\pi}_t^D + \tau_t - \tau_{t-1}$ are used.

$\phi_\pi > 1$, see Woodford (2001).¹² Define $z_t \equiv [\hat{\pi}_t^D \quad \tau_t]'$ and rewrite the system as

$$z_t = \underbrace{B^{-1}A}_{=: \Omega} E_t z_{t+1} - \underbrace{B^{-1}C}_{=: \Gamma} g_t.$$

This system can be solved forward using the law of iterated expectations and the properties of Ω^{-1} which imply that $\lim_{T \rightarrow \infty} \Omega^T = 0$. A solution for z_t is given by

$$z_t = - \sum_{k=0}^{\infty} \Omega^k \Gamma E_t \{g_{t+k}\}.$$

Under the assumption that there is no persistence in the exogenous shock, i.e. if $\rho = 0$, the solution for the producer price inflation differential and the terms of trade simplifies to

$$\begin{bmatrix} \hat{\pi}_t^D \\ \tau_t \end{bmatrix} = -\Gamma g_t = \frac{\kappa\omega g}{\phi_\pi \kappa\omega\xi + 1} \begin{bmatrix} 1 \\ -\phi_\pi \end{bmatrix} g_t. \quad (32)$$

Rewriting gives for the terms of trade

$$\tau_t = - \frac{g}{\xi + 1/(\omega\kappa\phi_\pi)} g_t, \quad (33)$$

which is to be compared with the response of the terms of trade in case of price stability (25): for any value of ϕ_π , the response of the terms of trade is weaker in case of the interest rate feedback rule. Only for $\phi_\pi \rightarrow \infty$, the response of the terms of trade are identical.

Next, I consider how the nominal exchange rate responds in the Taylor rule case. Taking first difference of (27) gives

$$\Delta s_t = \tau_t - \tau_{t-1} + \hat{\pi}_t^D. \quad (34)$$

While in the price stability case the inflation differential is zero, i.e. $\hat{\pi}_t^D = 0$, and the exchange rate moves one-to-one with the terms of trade, the inflation differential is positive in the Taylor rule regime. Rewriting (32) gives

$$\hat{\pi}_t^D = \frac{\kappa\omega g}{\phi_\pi \kappa\omega\xi + 1} g_t. \quad (35)$$

This, in turn, may off-set the appreciation of the terms of trade in (34) and even lead to a depreciation of the nominal exchange rate. A measure for the relative monetary stance

¹²This can be easily verified. Note that

$$\begin{aligned} \det \Omega^{-1} &= (1 + \phi\kappa\omega\xi) / \beta \\ \text{tr} \Omega^{-1} &= 1 + (1 + \kappa\omega\xi) / \beta \end{aligned}$$

such that, iff $\phi > 1$,

$$\begin{aligned} \det \Omega^{-1} + \text{tr} \Omega^{-1} &> -1 \\ \det \Omega^{-1} - \text{tr} \Omega^{-1} &> -1 \end{aligned}$$

These conditions are sufficient for both eigenvalues being outside the unit circle, see Woodford (2003, Add. to Ch. 4).

in the simplified Taylor rule case is given by

$$i_t^{D,TR} = \phi_\pi \hat{\pi}_t^D = \frac{g}{\xi + 1/(\phi_\pi \kappa \omega)} g_t. \quad (36)$$

To understand the adjustment of relative prices in response to a government spending shock it is necessary to compare the relative monetary stance during transmission under both regimes. As argued above, a measure for how accommodating home monetary policy is (relative to foreign) can be obtained by comparing (36) with the interest rate differential under price stability (28). It can be shown that the interest rate differential is always positive, but always smaller in the Taylor rule case

$$i_t^{D,PS} > i_t^{D,TR} \Leftrightarrow \frac{g}{\xi} g_t > \frac{g}{\xi + 1/(\phi_\pi \kappa \omega)} g_t.$$

In this sense, the home monetary policy is accommodating relative to foreign during the transmission of a government spending shock in the simplified Taylor rule case. This explains the depreciation of the nominal exchange rate and the dampened response of the terms of trade in the simplified Taylor rule case.

4.2 The response of the trade balance

I now turn to the response of the trade balance. Defining $\hat{tb} \equiv TB_t/Y$, an approximation of (12) around a symmetric (balanced trade) steady state is given by

$$\frac{1}{(1-\theta)(1-g)} \hat{tb}_t = (2\varepsilon\theta - 1) \tau_t - c_t^D. \quad (37)$$

Intuitively, a fall in the terms of trade reduces the price of imports and increases the price of exports ($-\tau_t$). This value effect improves the trade balance. On the other hand, an increase in the relative price of home goods switches expenditure towards foreign goods. The magnitude of this effect depends on $\varepsilon\theta$, the joint effect of the intratemporal elasticity of substitution and the home bias in private consumption. The Marshall-Lerner-Robinson (MLR) condition in this model is satisfied if $2\varepsilon\theta > 1$.¹³ In this case, holding consumption constant, the volume (substitution) effect dominates the value effect. If $2\varepsilon\theta < 1$, on the other hand, a fall in τ_t will, ceteris paribus, raise the trade balance. Substituting for the consumption differential using the risk sharing condition (16) implies

$$\frac{1}{(1-\theta)(1-g)} \hat{tb}_t = \underbrace{[(2\varepsilon\theta - 1)]}_{MLR\text{-condition}} - \underbrace{(2\theta - 1)\sigma^{-1}}_{risk\text{-sharing}} \tau_t. \quad (38)$$

Hence, given a fall in the terms of trade, the trade balance improves only if

$$(2\varepsilon\theta - 1) < (2\theta - 1)\sigma^{-1}. \quad (39)$$

¹³For a derivation of this condition in a model without home bias, see Tille (2001).

This condition is key for the international transmission of shocks. Consider the special case without home bias, $\theta = 1/2$. (Note that terms on the r.h.s vanishes, because without home bias, purchasing power parity holds and consumption is equalized across countries). In this case $\varepsilon < 1$ is sufficient for the trade balance to improve after an improvement of the terms of trade. Tille (2001) analyzes the role of ε for the transmission of monetary shocks in a model without home bias and incomplete financial markets. Cole and Obstfeld (1991) and Corsetti and Pesenti (2001) assume that $\varepsilon = 1$. The former show that in this case the allocation of a two-country endowment economy yields the same allocation under autarky and complete financial markets. The latter use a bonds-only economy and show that income and substitution effects of terms of trade changes off-set each other in this case.

In the present case, the assumption of home bias and complete markets make the requirements on ε more or less restrictive, depending on σ . In case $\sigma = 1$, a strong home bias requires that after a fall in the terms of trade, consumption and thus resources are transferred to the foreign economy. However, it also increases the substitution effects. In case $\sigma > 1$, a strong home bias will require ε to be even smaller for the trade balance to increase after a fall in the terms of trade.

More generally, low values of ε will limit the substitution effects resulting from a change in the terms of trade and therefore the trade balance improves in response to a fall in the terms of trade. Note that the sign of the effect of government spending on the trade balance does not depend on monetary policy, but only on condition (39). Moreover, given that there is limited variability in plausible values for θ and σ , the sign of the response of the trade balance depends on the elasticity between home and foreign goods.

However, the monetary regime matters for the strength of the response of the terms of trade and therefore indirectly for the quantitative effect of government spending on the trade balance. From the above it follows that the looser the monetary stance the smaller the effect on the terms of trade and the trade balance.

4.3 Numerical Analysis

So far, the analysis has been limited to the case where $\phi_{\hat{y}} = 0$ and $\rho = 0$ (in the Taylor rule case). Therefore, I consider a numerical solution of the model to gauge whether the result carries over to more common values of these policy parameters. Specifically, I set $\phi_{\pi} = 1.51$ and $\phi_{\hat{y}} = 0.77$, i.e., the original estimates by Taylor (1993). Note, however, that in the present model the Taylor rule responds to producer price and not to CPI inflation. The degree of autocorrelation in public spending is set to $\rho = 0.9$, which is suitable to capture the persistence of the spending shock displayed in the upper-left panel of Figure 1.

Other parameter values have to be assigned. I assume that a time period in the model

corresponds to one quarter and set $\beta = .99$. According to the NIPA, the average real government spending share in GDP was 20 percent in the period 1973:1-2002:4. I thus set $g = 0.2$. The share of imports in U.S. GDP was approximately 10 percent in the period 1973:1-2003:4. Given that government spending falls only on domestic goods in the model, I set $\theta = 0.875$.

There is little consensus, however, regarding ω which can be interpreted as the inverse of the Frisch labor supply elasticity; for the variety of values see Woodford (2003, Ch. 5). I chose $\omega = 1$ and also set $\sigma = 1$, values typically considered in the literature. Regarding the Calvo parameter, I set $\alpha = 0.75$, a value implying that prices are adjusted on average once a year.

In the section above, I showed that the intratemporal elasticity between home and foreign goods is the key parameter for the dynamic effects of government spending on foreign trade (see condition (39)). Unfortunately, there is little agreement in the literature on what sensible values for this parameters are. While Obstfeld and Rogoff (2000) use a value of six, Backus Kehoe and Kydland (1995) use a value of 1.5 and Cole and Obstfeld (1991), Stockman and Tesar (1995), and Corsetti and Pesenti (2001) use a unit-elasticity. Heathcote and Perri (2002) report estimates of $\varepsilon = 0.9$ and Corsetti, Dedola and Leduc (2004) explore the role of this elasticity using both a value of 0.99 and 1.11.¹⁴ I set $\varepsilon = 0.9$. The elasticity across differentiated home goods μ is set to 6.

Figure 4 displays the response of key variables to a fiscal shock (upper left panel) both for the price stability and the Taylor rule case. The response of output is quantitatively similar to the empirical response displayed in Figure 1. The consumer price index falls in case of the price stability case and increases substantially in the Taylor rule case. If monetary policy implements producer price stability during the government spending increase, the appreciation of the nominal exchange rate induces CPI to fall. Note that a fall in the price level is also observed in the data.

With respect to foreign trade, the model seems to perform better in the Taylor rule case, since only in this case the nominal exchange rate depreciates (at least after 8 quarters). This is in line with the analytical results above. Also the results regarding the response of the terms of trade are unaltered in the present case of $\rho > 0$. The response of the terms of trade and the trade balance is weaker in the Taylor rule regime, because monetary policy allows a positive response of the price level and thus engineers a depreciation of the nominal exchange rate. Therefore, the exchange rate channel operates and shifts expenditures towards the home good (relative to the case of price stability). Finally, it

¹⁴Note that in Corsetti et al. (2004) these values are chosen to match the volatility of the real exchange rate relative to output in the presence of distributive trade. Without distributive trade values as low as 0.33 and 0.41 are necessary to match the real exchange rate volatility. Incidentally, Collard and Dellas (2002) show that a low elasticity between home and foreign good can account for the fall in hours after a positive technology shock. They consider values of 1.5 and 0.5.

should be noted that the positive response of the trade balance is driven by a large value effect.

5 Conclusion

In this paper, I tried to establish empirically the dynamic effects of a temporary increase in government spending on the nominal exchange rate, the terms of trade and the trade balance. The main finding proved to be robust across various specifications of the VAR model: the exchange rate depreciates, the terms of trade appreciate and the trade balance improves after an increase in government spending. While the positive response of the trade balance is in line with the findings of Kim and Roubini (2003), the responses of the relative prices provide a guideline for the theoretical exploration of the empirical evidence.

Specifically, I studied whether a stochastic general-equilibrium model with price rigidities can, and if so under what conditions, rationalize the evidence. It turned out that independently of monetary policy, a low elasticity between home and foreign goods is sufficient for a government spending shock to increase a trade surplus. The reason is as follows. Under the assumption that government falls entirely on home goods, an increase in government spending induces an appreciation in terms of trade, such that home goods become more expensive relative to foreign goods. If substitution effects are small, the value effect dominates the volume effect and the trade balance improves. Also, efficient risk sharing under complete markets shifts consumption towards foreign if private consumption is home biased.

Monetary policy cannot alter the sign of the response of trade balance, but can dampen the trade surplus if it is accommodating during the transmission of the fiscal shock. A natural measure for the relative monetary stance is provided by the interest rate differential in home and foreign, while the benchmark is given by the interest rate differential that prevails if both monetary authorities implement producer price stability. In this sense monetary policy is shown to be accommodating during the transmission if both home and foreign monetary policy follow a Taylor rule. This is reflected in the nominal depreciation of the exchange rate and also dampens the effects of government spending on the terms of trade and the trade balance.

This interpretation of the dynamic effects of government spending on foreign trade, allows to draw a tentative conclusion regarding the recent U.S. fiscal expansion. Contrary to widely held views, the fiscal expansion, as far as its spending part is concerned, might not have contributed to the U.S. trade deficit. On the other hand, a rather accommodating monetary policy might have reduced possible positive effects on the trade balance.

Clearly, qualifications are required. First, there is little consent that the elasticity between home and foreign goods is as low as necessary for the present interpretation to go through. Also, the recent U.S. fiscal expansion is in large parts the result of tax cuts,

which have not been investigated in the present paper. Further investigations into both issues appear to be promising. Finally, it may be instructive to establish more evidence using data for smaller countries, where government spending may have little impact on the terms of trade. Lane and Perotti (2003), for example, use a small country model and suggest that fiscal expansions induce a loss in competitiveness, because they increase costs while prices are fixed on world markets. In this scenario, a trade deficit rather than a surplus might be the effect of a fiscal expansion.

References

- [1] Ahmed, Shagil (1986), "Temporary and Permanent Government Spending in an Open Economy," *Journal of Monetary Economics* 17, 197-224.
- [2] Backus, David K., Patrick J. Kehoe, and Finn E. Kydland (1995), International Business Cycles: Theory and Evidence, in Thomas F. Cooley (ed.) *Frontiers of Business Cycle Research*, Princeton University Press, Princeton, 331-56.
- [3] Baxter, Marianne (1995), International Trade and Business Cycles, in: Ronald W. Jones and Peter B. Kenen (eds.), *Handbook of International Economics*, Vol. 3, Elsevier.
- [4] Benigno, Gianluca and Pierpaolo Benigno (2003), Price Stability in Open Economies, *Review of Economic Studies* 70, 743-764.
- [5] Benigno, Pierpaolo (2003), Optimal Monetary Policy in a Currency Area, *Journal of International Economics*, forthcoming.
- [6] Benkwitz, Alexander, Helmut Lütkepohl and Jürgen Wolters (2001), Comparison of Bootstrap Confidence Intervals for Impulse Responses of German Monetary Systems, *Macroeconomic Dynamics*, 5, 81-100.
- [7] Burnside, Craig, Martin Eichenbaum and Jonas Fisher (2004), Fiscal Shocks and their Consequences, *Journal of Economic Theory* 115,1, 89-117.
- [8] Blanchard, Olivier J. and Roberto Perotti (2002), An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output, *Quarterly Journal of Economics* 117, 4, 1329-1368.
- [9] Calvo, Guillermo A. (1983), Staggered Prices in Utility-Maximizing Framework, *Journal of Monetary Economics* 12, 383-398.
- [10] Canzoneri, Matthew B., Robert E. Cumby and Behzad T. Diba (2003), New Views on the Transatlantic Transmission of Fiscal Policy and Macroeconomic Policy Coordination, in Marco Buti (ed.), *Monetary and Fiscal Policies in EMU: interactions and coordination*, Cambridge University Press.
- [11] Chari, V. V., Patrick J. Kehoe and Ellen R. McGrattan (2002), Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?, *Review of Economic Studies* 69, 533-563.
- [12] Clarida, Richard and Joe Prendergast (1999), Fiscal Stance and the Real Exchange Rate: Some Empirical Estimates, NBER Working Paper 7077.

- [13] Clarida, Richard, Jordi Galí and Mark Gertler (2002), A simple Framework for International Monetary Policy Analysis, *Journal of Monetary Economics*, 49, 879-904.
- [14] Cole, Harold L. and Maurice Obstfeld (1991), Commodity Trade and International Risk Sharing: How much do Financial Markets Matter?, *Journal of Monetary Economics* 28, 3-24.
- [15] Collard, Fabrice and Harris Dellas (2002), Technology Shocks and Employment, GREMAQ-CNRS, mimeo.
- [16] Corsetti, Giancarlo and Paolo Pesenti (2001), Welfare and Macroeconomic Interdependence, *Quarterly Journal of Economics*, 421-445.
- [17] Corsetti, Giancarlo, Luca Dedola and Sylvain Leduc (2004), International Risk-Sharing and the Transmission of Productivity Shocks, ECB Working Paper 308.
- [18] Fatás, Antonio and Ilian Mihov (2001), The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence, INSEAD, mimeo.
- [19] Galí, Jordi, J. David López-Salido and Javier Vallés (2003), Understanding the Effects of Government Spending on Consumption, CREI, mimeo.
- [20] Galí, Jordi and Tommaso Monacelli (2004), Monetary Policy and Exchange Rate Volatility in a Small Open Economy, mimeo.
- [21] Giuliodori, Massimo and Roel Beetsma (2004), What are the Spill-Overs from Fiscal Shocks in Europe? An Empirical Analysis. University of Amsterdam, mimeo.
- [22] Heathcote, Jonathan and Fabrizio Perri (2002), Financial Autarky and International Business Cycles, *Journal of Monetary Economics* 49, 601-627.
- [23] International Monetary Fund (2004), World Economic Outlook, April.
- [24] Kim, Soyoung and Nouriel Roubini (2003), Twin Deficits or Twin Divergence? Fiscal Policy, Current Account, and Real Exchange Rate in the US, mimeo.
- [25] Lane, Philip R. and Roberto Perotti (2003), The Importance of Composition of Fiscal Policy: Evidence from different Exchange Rate Regimes, *Journal of Public Economics* 87, 2253-2279.
- [26] Linnemann, Ludger and Andreas Schabert (2003), Fiscal Policy and the New Neoclassical Synthesis, *Journal of Money, Credit and Banking*, 35(6), 911-929.
- [27] Obstfeld, Maurice and Kenneth Rogoff (2000), The Six Major Puzzles in International Macroeconomics: Is there a Common Cause?, NBER Working Paper 7777.

- [28] Obstfeld, Maurice and Kenneth Rogoff (1995), Exchange Rate Redux, *Journal of Political Economy* 103, 3, 624-660.
- [29] Perotti, Roberto (2004), Estimating the Effects of Fiscal Policy in OECD Countries, mimeo.
- [30] Stockman, Alan C. and Linda L. Tesar (1995), Tastes and Technology in a Two-Country Model of the Business Cycles: Explaining International Comovements, *American Economic Review* 85, 168-185.
- [31] Taylor, John B. (1993), Discretion versus Policy Rules in Practice, *Carnegie-Rochester Conference Series on Public Policy* 39, 195-214.
- [32] Tille, Cédric (2001), The Role of Consumption Substitutability in the International Transmission of Monetary Shocks, *Journal of International Economics* 53, 421-444.
- [33] Woodford, Michael (2003), Interest and Prices, Foundations of a Theory of Monetary Policy, Princeton University Press.
- [34] Woodford, Michael (2001), The Taylor Rule and Optimal Monetary Policy, *American Economic Review, Papers and Proceedings*, 91, 2, 233- 237.

Figure 1: Dynamic Effects of U.S. Government Spending Shock

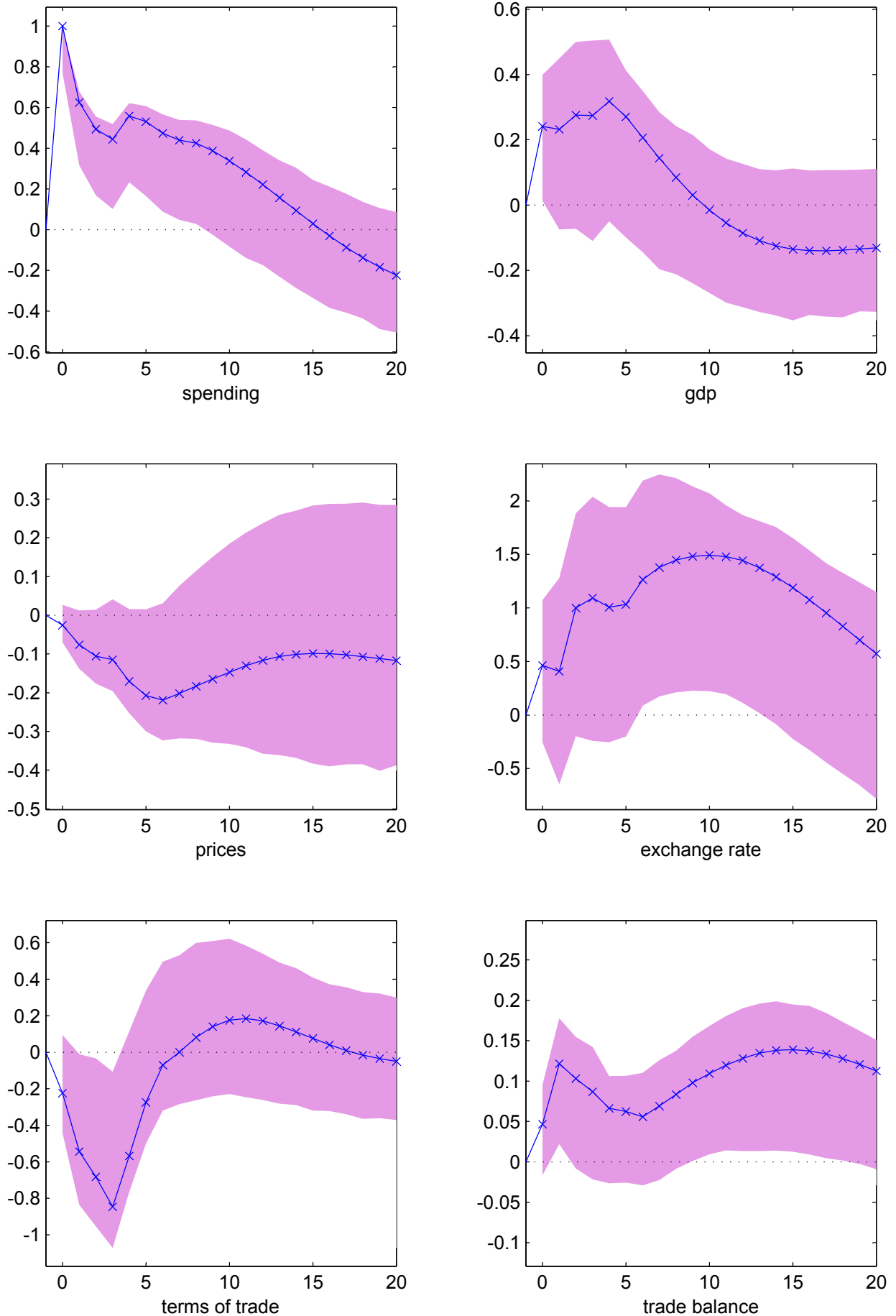


Figure 2: Dynamic Effects on Key Variables - Alternative Trend Specifications

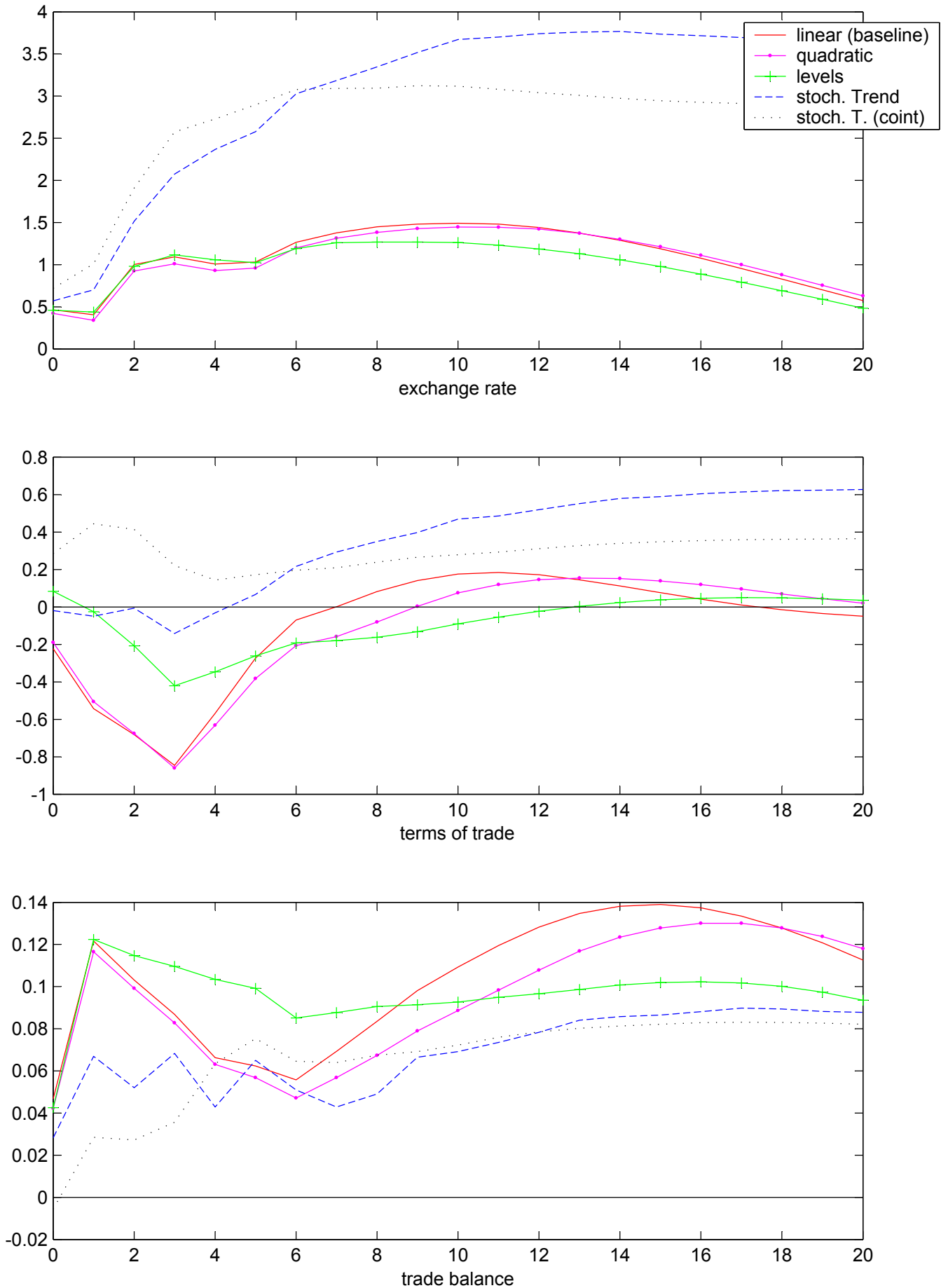
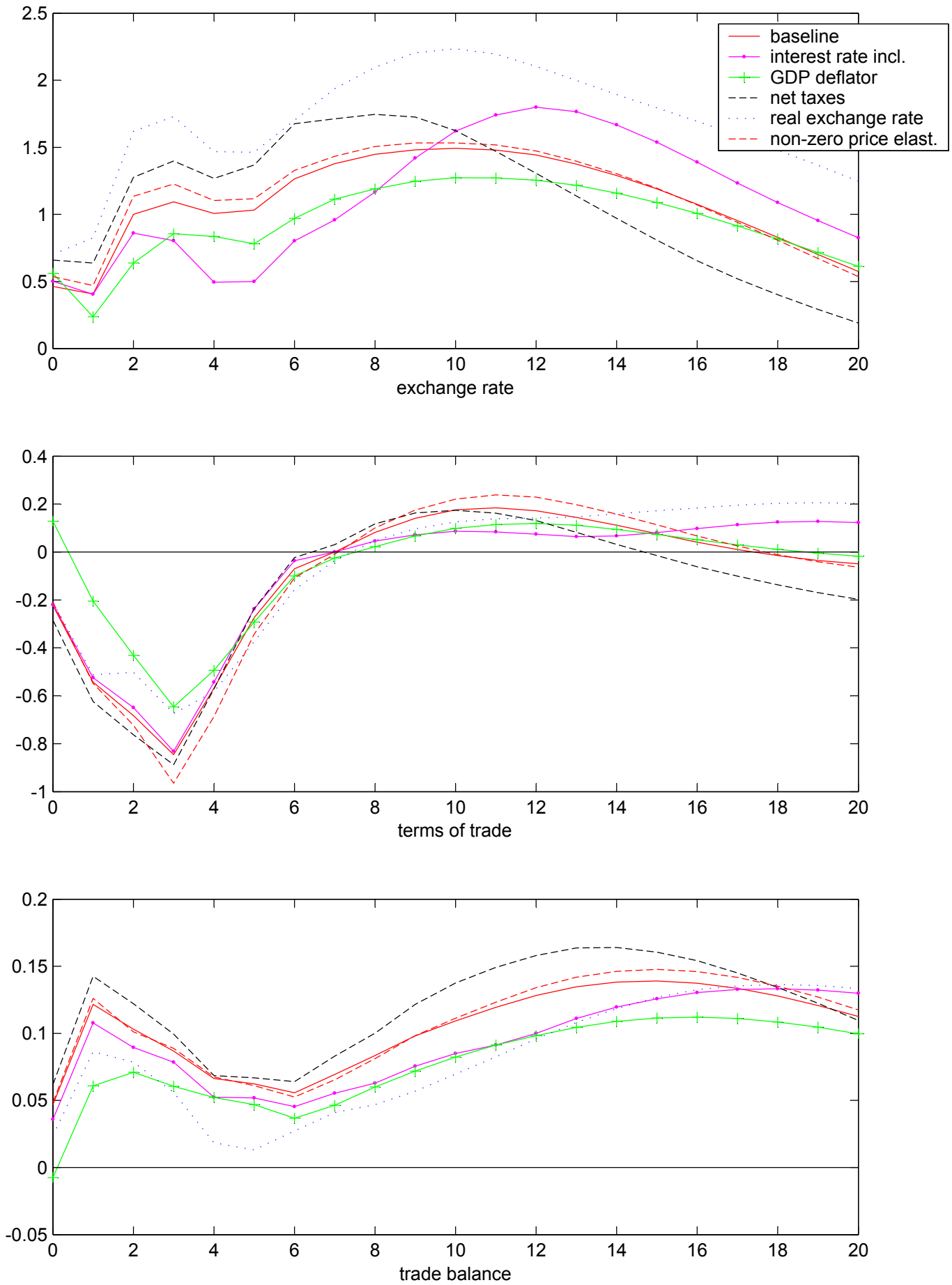


Figure 3: Dynamic Effects on Key Variables - Alternative Trend Specifications



Understanding the Dynamic Effects of Government Spending on Foreign Trade
Figure 4: Dynamic Effects of Government Spending Shock

