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Expansionary Fiscal Shocks and the US Trade Deficit*

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Abstract

In this paper, we use a dynamic general equilibrium model of an open economy to assess the quantitative effects of fiscal shocks on the trade balance in the United States. We examine the effects of two alternative fiscal shocks: a rise in government consumption, and a reduction in the labour income tax rate. Our salient finding is that a fiscal deficit has a relatively small effect on the US trade balance, irrespective of whether the source is a spending increase or tax cut. In our benchmark calibration, we find that a rise in the fiscal deficit of 1 percentage point of gross domestic product (GDP) induces the trade balance to deteriorate by 0.2 percentage point of GDP or less. Noticeably larger effects are only likely to be elicited under implausibly high values of the short-run trade price elasticity, or of the share of liquidity-constrained households in the economy. From a policy perspective, our analysis suggests that even reducing the current US fiscal deficit (of 3% of GDP) to zero would be unlikely to narrow the burgeoning US trade deficit significantly.

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I. Introduction

After a decade of relative inattention, there is renewed interest in assessing the relationship between fiscal policy and trade deficits. This interest has been fuelled by the steady increase in the US trade deficit to around 5% of gross domestic product (GDP) in 2004, and the more recent swing in the US fiscal balance from surplus to a large deficit (see Figure 1).

Some economists and policy makers believe that fiscal deficits have played a fairly minor role in accounting for the increase in the trade deficit, and instead have attributed the US trade balance deterioration to other factors. A proponent of this view is US Treasury Undersecretary John Taylor (2004):

> The increase of the U.S. current account deficit over more than a decade has been linked to domestic U.S. capital formation increasing more than U.S. saving. Perceived high rates of return on U.S. assets, based on strong productivity growth relative to the rest of the world, combined with an efficient and secure U.S. capital market attracts foreign investment.

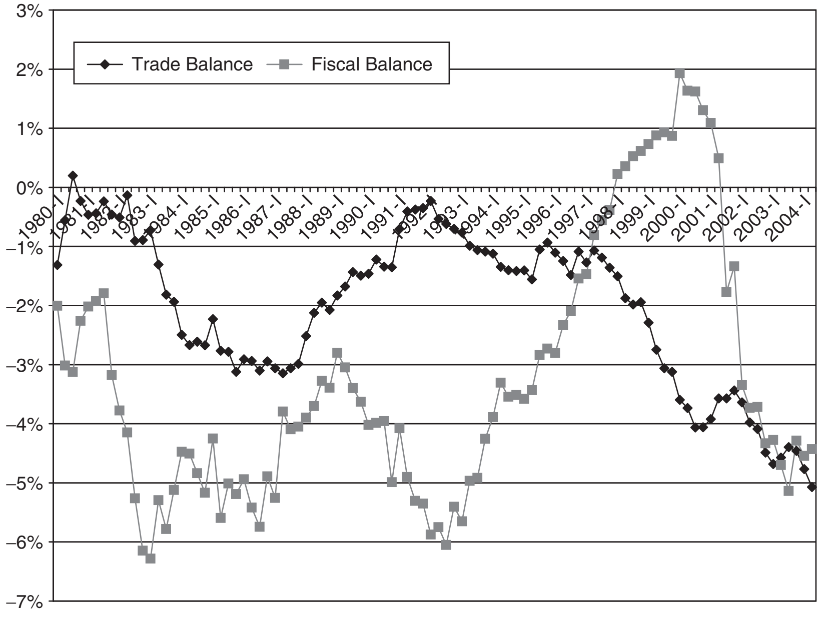

Figure 1: The US fiscal and trade balances as a share of gross domestic product

Source: NIPA.

By contrast, others have argued that fiscal deficits play a central role in explaining both the persistence and recent expansion of the trade deficit. For example, Bradford DeLong (2004) has observed that:

> We have a large trade deficit now – and did not back in 1997, [...] because (a) the federal government budget deficit is much larger now than it was then, and (b) private savings declined as a share of GDP during the bubble years of the late 1990s, and has not fully recovered.

It does not seem feasible to discriminate between these alternative views based on a simple examination of the joint evolution of the fiscal and trade balances. As seen in Figure 1, the fiscal deficits of the 1980s and the early part of this decade were indeed associated with a pronounced deterioration of the trade balance. However, the fiscal and trade balances frequently have moved in opposite directions, perhaps reflecting an endogenous component of the fiscal balance, and that other factors have played a significant role in driving the trade balance. Thus, methods more sophisticated than 'eyeball econometrics' are required to isolate the effects of fiscal policy changes on the trade balance.

In this context, it is natural to turn to the empirical literature to help assess the linkage between fiscal policy and the trade deficit. Unfortunately, the literature appears to offer widely divergent estimates, and there is even disagreement about the sign of the effect of a fiscal deficit on the trade balance. For example, Roubini (1988) and Normandin (1999) found that government budget deficits induced a fairly substantial deterioration in the trade deficit, with the latter estimating that a one-dollar increase in the fiscal deficit of the United States resulted in an increase in the external deficit between \$0.22 and \$0.98. By contrast, Evans (1990) and Bussière et al. (2004) concluded that the fiscal deficits only have a small effect on the current account, and Kim and Roubini (2003) reported the surprising finding based on structural VAR analysis that expansionary fiscal shocks tend to improve the current account.

In this paper, we adopt an alternative approach by using an open economy dynamic general equilibrium (DGE) model to assess the quantitative effect of fiscal shocks on the trade balance. Our model is a slightly modified version of a new micro-founded multi-country model named 'SIGMA' that we have developed in the International Finance Division of the Federal Reserve Board.[1] Our model builds on the framework of the workhorse New Keynesian model by incorporating many of the key nominal and real frictions that have been identified in the recent literature as playing an

[1]Here we limit our attention to two countries, and focus exclusively on fiscal shocks. For a more detailed discussion of the SIGMA model and its properties, see Erceg et al. (2005).

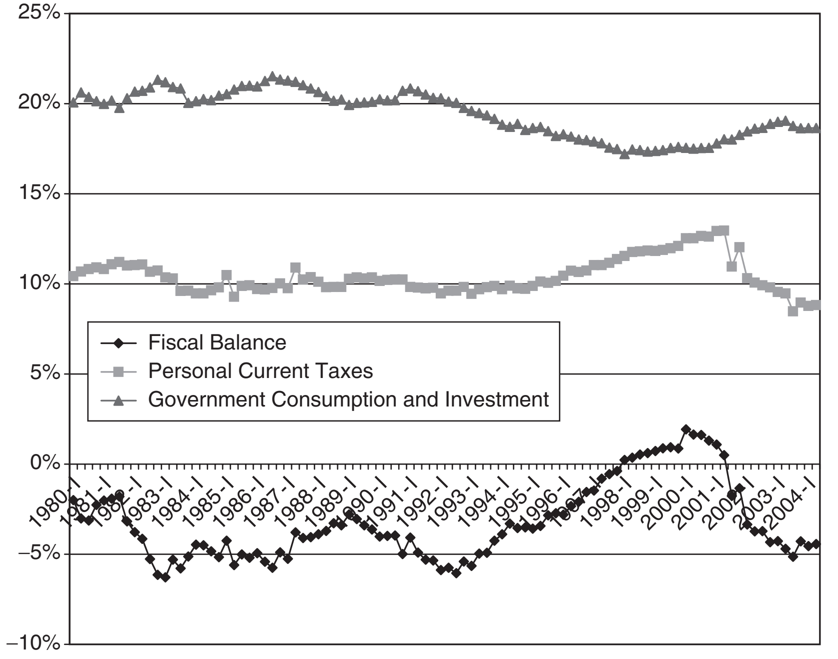

Figure 2: US government expenditures and revenues as a share of gross domestic product

Source: NIPA.

important role in accounting for the effects of both real and monetary shocks. Our model also introduces heterogeneity across households by assuming that some households simply consume their after-tax disposable income each period; such non-Ricardian behaviour has important implications for fiscal policy.

We examine the effects of two alternative fiscal shocks, including a rise in government consumption, and a reduction in the labour income tax rate. As shown in Figure 2, both higher government spending and tax reductions have contributed to the large swing in the fiscal balance from surplus to substantial deficit during the past few years.

Our salient finding is that fiscal shocks have relatively small effects on the trade balance under reasonable calibrations of our model to the US economy. In our benchmark calibration, we find that a 1 percentage point rise in the government spending share of GDP induces the ratio of nominal trade to nominal GDP (trade balance/GDP) to deteriorate 0.2 percentage point or less after two to three years (where the effect reaches a maximum). The small effect reflects that the pressure on the external sector associated with higher fiscal spending is largely alleviated through a rise in output, and by a contraction in private domestic absorption because of higher real interest rates and a negative wealth effect. Moreover, a labour tax rate cut that is scaled to induce a deterioration of the fiscal balance of about 1 percentage point of GDP (about the same as the government spending shock) also generates a trade balance deterioration of less than 0.2 percentage point of GDP.

Our small estimates of the effects of fiscal shocks on trade may appear surprising. Some previous work using micro-founded open economy models reported considerably larger effects; for instance, Baxter (1995) found that a 1 percentage point rise in the government spending/GDP share caused a trade balance deterioration equal to about 0.5 percentage point of GDP. We show that the primary difference between our analysis and this earlier work is that our baseline calibration implies a much lower short-run price elasticity of export and import demand. We corroborate that a higher trade price elasticity indeed makes the trade balance more responsive, as a higher elasticity shifts more of the adjustment towards net exports; however, we argue that short-run trade price elasticities would have to be implausibly high to yield substantially larger effects than in our benchmark calibration. The long-run price elasticity of 1.5 for exports and imports that we use in our benchmark calibration may in fact exaggerate the trade response, as it is at the upper end of estimates in the macro literature.

We conduct sensitivity analysis on several other dimensions, including the interest sensitivity of consumption and investment spending, the form of the monetary policy rule, the share of non-Ricardian households in the economy and the persistence of the shocks. We find that our estimates of the impact of the fiscal shocks on trade are fairly insensitive to the interest sensitivity of the demand components, and to the form of the monetary policy rule. Moreover, we argue that our baseline calibration, if anything, tends to overstate the effects of fiscal shocks on the trade balance through our assumption that non-Ricardian agents comprise 50% of households.

We also confront the question of whether our benchmark model offers an empirically realistic framework for assessing the effects of fiscal policy shocks. While our model's implications for the evolution of output, consumption and investment are qualitatively consistent with the structural VAR evidence reported by Blanchard and Perotti (2002), our benchmark model implies significantly more rapid adjustment of output and the expenditure components. Accordingly, we consider an alternative information structure in which agents have incomplete information about the persistence of the government spending shock. This framework allows our model to come much closer to matching the highly persistent responses of output and the expenditure components derived from the empirical VAR analysis, and also from large-scale policy models in which expectations are formed adaptively.[2] Interestingly, the effects of a government spending shock on the trade balance under imperfect information are somewhat smaller than in our benchmark calibration with full information.

Applying our framework to the current situation, our analysis suggests that while stimulative fiscal policy has probably contributed to the large and widening US trade deficit, its quantitative role has been modest. Even assuming that the structural US government deficit has deteriorated by 5 percentage points of GDP because of spending increases and tax cuts – and thus making the rather extreme assumption that most of the swing in the fiscal position is because of policy shocks – our estimates suggest that such a stimulus would generate a trade deficit of less than 1 percentage point of GDP. Moreover, our analysis casts doubt on the contention advanced by some observers that the recent US fiscal deficits have had particularly large effects on the trade balance because of the accommodative stance of monetary policy during the past few years. Even if this characterization of monetary policy was appropriate, our analysis indicates that the effects of the fiscal expansion on the trade balance would not be much different under a highly accommodative policy than under our estimated historical benchmark. Taken together, our results suggest that the US trade deficit has been driven by factors other than the fiscal expansion, including possibly shifts in portfolio preferences towards US assets, the continued strength in labour productivity growth and tepid growth abroad.

The remainder of this paper is organized as follows: Section II presents our basic open economy model. The calibration is discussed in Section III. Section IV reports our simulation results. Section V concludes the paper.

II. The Model

Our model consists of two countries that differ in size, but are otherwise isomorphic. Hence, our exposition below focuses on the 'home' country. Each country in effect produces a single domestic output good, although we adopt a standard monopolistically competitive framework to rationalize stickiness in the aggregate price level. While household utility depends on consumption of both the domestic output good and imported goods, it is convenient to assume that a competitive distribution sector purchases both inputs, and simply resells a final consumption good to households. Similarly,

[2]In the paper, we compare our model's implications with those of the FRB/Global model, a workhorse model used for policy simulations at the Federal Reserve.

we assume that competitive distributors combine the domestic output good with imports to produce a final investment good.

To introduce non-Ricardian consumption behaviour, we assume that there are two types of households in each country. 'Optimizing' households maximize welfare subject to an intertemporal budget constraint. These households own the entire capital stock, accumulate capital subject to adjustment costs, and exhibit habit persistence in their consumption decisions. They also are regarded as monopolistic competitors in the labour market in order to account for aggregate wage stickiness. The other type of households ('rule-of-thumb' households) simply consume their entire after-tax disposable income.

A. Firms and Price Setting

Production of domestic intermediate goods

There is a continuum of monopolistically competitive firms in the home country (indexed by $i \in [0, 1]$), each of which produces a differentiated intermediate good. As in Betts and Devereux (1996), intermediate goods producers set prices in advance in the buyer's currency and thus may charge different prices at home and abroad (that is, they practice local currency pricing). In the home market, firm i faces a demand function that varies inversely with its output price $P_{Dt}(i)$ and directly with aggregate demand at home Y_{Dt}:

$$Y_{Dt}(i) = \left[\frac{P_{Dt}(i)}{P_{Dt}}\right]^{\frac{-(1+\theta_p)}{\theta_p}} Y_{Dt}, \tag{1}$$

where $\theta_p > 0$, and P_{Dt} is an aggregate price index defined below. Similarly, in the foreign market, firm i faces the demand function:

$$X_t(i) = \left[\frac{P^*_{Mt}(i)}{P^*_{Mt}}\right]^{\frac{-(1+\theta_p)}{\theta_p}} M^*_t, \tag{2}$$

where $P^*_{Mt}(i)$ denotes the price that firm i sets in the foreign market (denominated in foreign currency), while P^*_{Mt} is the foreign import price index, and M^*_t is aggregate foreign imports (we use an asterisk to denote foreign variables).

Each producer utilizes capital services $K_t(i)$ and a labour index $L_t(i)$ (defined below) to produce its respective output good. The production function is assumed to have a constant elasticity of substitution (CES) form

$$Y_t(i) = \left(\omega_K^{\frac{\rho}{1+\rho}} K_t(i)^{\frac{1}{1+\rho}} + \omega_L^{\frac{\rho}{1+\rho}} (Z_t L_t(i))^{\frac{1}{1+\rho}}\right)^{1+\rho}. \tag{3}$$

The production function exhibits constant-returns-to-scale in both inputs, and Z_t is a deterministic trend in the level of technology that grows at the same rate g_z in both countries. Firms face perfectly competitive factor markets for hiring capital and the labour index. Thus, each firm chooses $K_t(i)$ and $L_t(i)$, taking as given both the rental price of capital R_{Kt} and the aggregate wage index W_t (defined below). Firms can costlessly adjust either factor of production. Thus, the standard static first-order conditions for cost minimization imply that all firms have identical marginal cost per unit of output, MC_t.

We assume that the home and foreign prices of the intermediate goods are determined by Calvo-style staggered contracts (see Calvo 1983). In each period, a firm faces a constant probability, $1 - \xi_p$, of being able to reoptimize its price at home ($P_{\mathrm{D}t}(i)$) and $1 - \xi_{p,x}$ probability of being able to reoptimize its price abroad $\left(P^*_{Mt}(i)\right)$. These probabilities are assumed to be independent across firms, time and countries. If a firm is not allowed to reoptimize its prices, we follow Christiano et al. (2005) and assume that the firm resets its home price based on lagged aggregate inflation. Prices are updated according to $P_{Dt}(i) = \pi_{t-1} P_{Dt-1}(i)$, where $\pi_t = P_{Dt}/P_{\mathrm{D}t-1}$.[3] Similarly, in foreign markets, if a firm cannot reoptimize its price, the price is changed according to the rule $P^*_{Mt}(i) = \pi^*_{Mt-1} P^*_{Mt-1}(i)$, where $\pi^*_{Mt} = P^*_{Mt}/P^*_{Mt-1}$. This form of lagged indexation is a mechanism for introducing inflation inertia into the key price-setting equations.

When a firm is allowed to reoptimize its price in the domestic market in period t, the firm maximizes

$$\tilde{\mathbb{E}}_t \sum_{j=0}^{\infty} \xi_p^j \psi_{t,t+j} \left[V_{Dt+j} P_{Dt}(i) Y_{Dt+j}(i) - MC_{t+j} Y_{Dt+j}(i) \right]. \tag{4}$$

The operator $\tilde{\mathbb{E}}_t$ represents the conditional expectation based on the information available to agents at period t. The firm discounts profits received at date $t + j$ by the state-contingent discount factor $\psi_{t,t+j}$; for notational simplicity, we have suppressed all of the state indices.[4] Also,

[3]In alternative calibrations of SIGMA, we also consider the specification used by Yun (1996) and Erceg et al. (2000) where $P_{Dt}(i) = \pi P_{Dt-1}(i)$ so that $V_{Dt+j} = \pi^j$ in the profit functional defined below; similarly, prices are updated according to $P_{Mt}(i) = \pi^* P_{Mt-1}(i)$ in foreign markets. Given this form of static indexing, the price-setting equation is purely forward looking, so that there is no intrinsic inflation inertia.

[4]We define $\xi_{t,t+j}$ as the price in period t of a claim that pays one dollar if the specified state occurs in period $t + j$ (see the household problem below); then the corresponding element of $\psi_{t,t+j}$ equals $\xi_{t,t+j}$ divided by the probability that the specified state will occur.

V_{Dt+j} is defined by

$$V_{Dt+j} = \prod_{h=1}^{j} \pi_{t+h-1}. \tag{5}$$

We define a separate profit functional for a firm's optimal choice of its price in the foreign market at date t, which mimics equation (4).

Production of the domestic output index

Because households have identical Dixit–Stiglitz preferences, it is convenient to assume that a representative aggregator combines the differentiated intermediate products into an aggregate for home-produced goods Y_{Dt}:

$$Y_{Dt} = \left[\int_0^1 Y_{Dt}(i)^{\frac{1}{1+\theta_p}} \, di \right]^{1+\theta_p}. \tag{6}$$

The aggregator chooses the bundle of goods that minimizes the cost of producing Y_{Dt}, taking the price $P_{Dt}(i)$ of each intermediate good $Y_{Dt}(i)$ as given. The aggregator is also a price taker in the output market and sells its output at P_{Dt}, which can be regarded as the aggregate price index for the domestically produced good. Similarly, an aggregator combines the differentiated import goods into a composite import index, M_t, which it sells at a price, P_{Mt}.

Production of consumption and investment goods

Final consumption goods are produced by a representative 'consumption good distributor'. This firm combines purchases of the domestically produced composite good with the composite imported good to produce a final consumption good (C_t) according to a constant-returns-to-scale CES production function:

$$C_t = \left(\omega_C^{\frac{\rho_C}{1+\rho_C}} C_{Dt}^{\frac{1}{1+\rho_C}} + (1-\omega_C)^{\frac{\rho_C}{1+\rho_C}} (\varphi_{Ct} M_{Ct})^{\frac{1}{1+\rho_C}} \right)^{1+\rho_C}, \tag{7}$$

where M_{Ct} is an index of imported goods, and φ_{Ct} reflects the costs of adjusting consumption imports. The quasi-share parameter ω_C may be interpreted as determining the degree of home bias in household consumption expenditure. The adjustment cost term φ_{Ct} is assumed to take on the quadratic form:

$$\varphi_{Ct} = \left[1 - \frac{\varphi_{M_C}}{2} \left(\frac{M_{Ct}/C_{Dt}}{M_{Ct-1}/C_{Dt-1}} - 1 \right)^2 \right]. \tag{8}$$

This specification implies that it is costly to change the share of the imported good in total consumption. It has the attractive feature that the import share in consumption is relatively unresponsive in the short run to changes in the relative price of imported goods, even while allowing the level of imports to jump costlessly in response to changes in the overall consumption demand.[5]

Given the presence of adjustment costs, the representative consumption goods distributor chooses (a contingency plan for) C_{Dt} and M_{Ct} to minimize its discounted expected costs of producing the aggregate consumption good:

$$\min_{C_{Dt},\,M_{Ct}} \tilde{\mathbb{E}}_t \sum_{k=0}^{\infty} \psi_{t,\,t+k} \Bigg\{ (P_{Dt+k}C_{Dt+k} + P_{Mt+k}M_{Ct+k}) \\ + P_{Ct+k}\left[C_{t+k} - \left(\omega_C^{\frac{\rho_C}{1+\rho_C}} C_{Dt+k}^{\frac{1}{1+\rho_C}} + (1-\omega_C)^{\frac{\rho_C}{1+\rho_C}} (\varphi_{Ct+k}M_{Ct+k})^{\frac{1}{1+\rho_C}} \right)^{1+\rho_C} \right] \Bigg\}. \tag{9}$$

The distributor sells the final consumption good to households at a price P_{Ct}, which may be interpreted as the consumption price index (or equivalently, as the shadow cost of producing an additional unit of the consumption good).

We model the production of final investment goods in an analogous manner. We allow for costs φ_{It} that reflect costs of adjusting imports of investment goods and for a degree of home bias that may differ from that in the consumption aggregator. Investment goods distributors solve an intertemporal cost minimization problem isomorphic to that of consumption goods distributors. The distributor sells the final investment good to households at a price of P_{It}.

B. Households and Wage Setting

We assume a continuum of households (indexed on the unit interval), each of which supplies a differentiated labour service to the intermediate goods-producing sector (the only producers demanding labour services in our framework). It is convenient to assume that a representative labour aggregator (or 'employment agency') combines households' labour hours in the same proportions as firms would choose. Thus, the aggregator's demand for each household's labour is equal to the sum of firms' demands. The aggregate labour index L_t has the Dixit–Stiglitz form:

$$L_t = \left[\int_0^1 (\zeta N_t(h))^{\frac{1}{1+\theta_w}}\, dh \right]^{1+\theta_w}, \tag{10}$$

[5]These adjustment costs allow the model to be consistent with the empirical evidence of Hooper et al. (2000) and McDaniel and Balistreri (2003), who find that the short-run trade price elasticity is smaller than the long-run elasticity.

where $\theta_w > 0$ and $N_t(h)$ is the hours worked by a typical member of household h. Also, ζ is the size of a household of type h and determines the size of the population. The aggregator minimizes the cost of producing a given amount of the aggregate labour index, taking each household's wage rate $W_t(h)$ as given, and then sells units of the labour index to the production sector at their unit cost W_t:

$$W_t = \left[\int_0^1 W_t(h)^{-\frac{1}{\theta_w}}\, dh\right]^{-\theta_w}. \tag{11}$$

It is natural to interpret W_t as the aggregate wage index. The aggregator's demand for the labour services of a typical member of household h is given by

$$N_t(h) = \left[\frac{W_t(h)}{W_t}\right]^{-\frac{1+\theta_w}{\theta_w}} L_t. \tag{12}$$

The utility functional of a typical member of household h takes the following additively separable form:

$$\begin{aligned}\tilde{\mathbb{E}}_t \sum_{j=0}^{\infty} \beta^j \Bigg\{ &\frac{1}{1-\sigma}\left(C_{t+j}(h) - \kappa C_{t+j-1}\right)^{1-\sigma} \\ &+ \frac{\chi_0 Z_t^{1-\sigma}}{1-\chi}\left(1 - N_{t+j}(h)\right)^{1-\chi} + m_0 \log\left(\frac{MB_{t+j+1}(h)}{P_{Ct+j}}\right)\Bigg\},\end{aligned} \tag{13}$$

where the discount factor β satisfies $0<\beta<1$. As in Smets and Wouters (2003), we allow for the possibility of external habits, so that an individual cares about his consumption relative to the lagged aggregate consumption of similar-type households (defined below), with a sensitivity determined by the parameter κ. The period utility function depends on current leisure $1 - N_t(h)$ and an individual's end-of-period real money balances, $MB_{t+1}(h)/P_{Ct}$. We allow for a deterministic shift in preferences over leisure so that the model is consistent with balanced growth, even if the subutility function over consumption is not logarithmic ($\sigma \neq 1$).[6]

We assume that there are two types of households: households that make intertemporal consumption, labour supply and capital accumulation decisions in a forward-looking manner by maximizing utility subject to an

[6]The time endowment is normalized to unity. The parameter σ in the subutility function for consumption influences the sensitivity of consumption to the real interest rate, while the parameter χ is inversely proportional to the Frisch elasticity of labour supply (in a perfectly competitive labour market, this would determine the sensitivity of aggregate labour supply to the real wage). The parameter χ_0 allows us the flexibility to set the fraction of time spent working in steady state to one-third of the time endowment. We assume that the parameter m_0 in the subutility function for real balances in arbitrarily small, so that real balances have essentially no effect on model dynamics.

intertemporal budget constraint (optimizing households), and rule-of-thumb (RT) households that simply consume their after-tax disposable income, and choose to set their wage to be the average wage of optimizing households. The latter type of households receive no capital rental income or profits. We denote the fixed share of optimizing households by ς.[7]

We first consider the problem faced by optimizing households. Each member of household h faces a flow budget constraint that states that his combined expenditure on goods and on the net accumulation of financial assets must equal his disposable income:

$$\begin{aligned}
&P_{Ct}C_t(h) + P_{It}I_t(h) + MB_{t+1}(h) - MB_t(h) + \int_s \xi_{t,t+1}B_{Dt+1}(h) \\
&\qquad - B_{Dt}(h) + P_{Bt}B_{Gt+1} - B_{Gt} + \frac{e_t P^*_{Bt} B_{Ft+1}(h)}{\phi_{bt}} - e_t B_{Ft}(h) \\
&\quad = (1-\tau_{Nt})W_t(h)N_t(h) + \Gamma_t(h) + TR_t(h) - T_t(h) + (1-\tau_K)R_{Kt}K_t(h) \\
&\qquad + \tau_K \delta P_{It} K_t(h) - P_{Dt}\phi_{It}(h).
\end{aligned} \tag{14}$$

Final consumption goods are purchased at a price P_{Ct}, and final investment goods at a price P_{It}. Investment in physical capital augments the (end-of-period) capital stock $K_{t+1}(h)$ according to a linear transition law of the form:

$$K_{t+1}(h) = (1-\delta)K_t(h) + I_t(h). \tag{15}$$

Financial asset accumulation of a typical member of an optimizing household h consists of increases in nominal money holdings $(MB_{t+1}(h) - MB_t(h))$ and the net acquisition of bonds. We assume that agents within a country can engage in frictionless trading of a complete set of contingent claims, while trade in international assets is restricted to a non-state-contingent nominal bond. The term $P_{Bt}B_{Gt+1} - B_{Gt}$ represents net purchases of domestic government bonds, while $\int_s \xi_{t,t+1}B_{Dt+1}(h) - B_{Dt}(h)$ are net purchases of state-contingent domestic bonds. We denote $\xi_{t,t+1}$ as the price of an asset that will pay one unit of domestic currency in a particular state of nature at date $t+1$, while $B_{Dt+1}(h)$ represents the quantity of such claims purchased by a member of household h at time t. Thus, the gross outlay on new state-contingent domestic claims is given by integrating over all states at time $t+1$, while $B_{Dt}(h)$ indicates the value of existing claims given the realized state of nature.

In equation (14), $B_{Ft+1}(h)$ represents the quantity of a non-state-contingent bond purchased at time t that pays one unit of foreign currency in

[7]Mankiw (2000) stresses the importance of including rule-of-thumb behaviour in models for analysing fiscal policy. Mankiw cites estimates suggesting that consumption smoothing is far from perfect and that many households have net worth near zero. Galí et al. (2003) also incorporate rule-of-thumb households into their model to account for a rise in aggregate consumption in response to a government spending shock.

the subsequent period, P_{Bt}^{*} is the foreign currency price of the bond, and e_t is the exchange rate expressed in units of home currency per unit of foreign currency. We follow Turnovsky (1985) and Benigno (2001) by assuming that there is an intermediation cost ϕ_{bt} paid by households in the home country for purchases of foreign bonds, which ensures that net foreign assets are stationary in the model.[8] The intermediation costs depend on the ratio of economy-wide holdings of net foreign assets to nominal output and are given by

$$\phi_{bt} = \exp\left(-\phi_b\left(\frac{e_t B_{Ft+1}}{P_{Dt} Y_t}\right)\right).$$

Each member of an optimizing household h earns after-tax labour income, $(1-\tau_{Nt})W_t(h)N_t(h)$, where τ_{Nt} is a stochastic tax on labour income. The household leases capital to firms at the after-tax rental rate $(1-\tau_K)R_{Kt}$, where τ_K is a tax on capital income. The household receives a depreciation writeoff of $\tau_K P_{It}\delta$ per unit of capital (where δ is the depreciation rate of capital). Each member also receives an aliquot share $\Gamma_t(h)$ of the profits of all firms and a government lump-sum transfer $TR_t(h)$, and pays a lump-sum tax $T_t(h)$.

We allow for costs associated with adjusting the capital stock. As in Christiano et al. (2001), it is costly to change the level of gross investment from the previous period, so that the change in investment is penalized:

$$\phi_{It}(h) = \frac{1}{2}\phi_I \frac{(I_t(h) - I_{t-1}(h))^2}{I_{t-1}(h)}. \tag{16}$$

In every period t, each member of an optimizing household h maximizes the utility functional (13) with respect to his consumption, investment, (end-of-period) capital stock, money balances, holdings of contingent claims, and holdings of domestic and foreign bonds, subject to his labour demand function (12), budget constraint (14) and transition equation for capital (15). In doing so, a household takes as given prices, taxes, transfers, and aggregate quantities such as the lagged aggregate consumption of optimizing households and the aggregate net foreign asset position.

[8]This structure is adopted for the technical reason of ensuring that net foreign assets are stationary, although it does imply some asymmetry in the structure of domestic and foreign asset markets. Thus, the financial intermediation cost is only paid by residents of the home country. While foreign households are restricted to holding only foreign-denominated securities, they collect monopoly rents associated with the intermediation costs paid by home residents. Although these financial intermediation costs involve wealth transfers between countries, our calibration implies that these transfers are extremely small for plausible levels of steady-state net foreign assets. In fact, given that steady-state net foreign assets are set to zero, they have no influence on the dynamics of the log-linearized model.

Optimizing households set nominal wages in staggered contracts that are analogous to the price contracts described above. In particular, with probability $1-\xi_w$, each member of a household is allowed to reoptimize his wage contract. If a household is not allowed to optimize its wage rate, we assume that each household member must reset his price according to

$$W_t(h) = \omega_{t-1} W_{t-1}(h), \tag{17}$$

where $\omega_t = W_t/W_{t-1}$ and $\omega = \pi g_z$ in steady state (as noted above, g_z is the steady-state growth rate of technology). Each member of household h chooses the value of $W_t(h)$ to maximize his utility functional (13).

Finally, we consider the determination of consumption and labour supply of the RT households. These households simply equate their nominal consumption spending to their current after-tax disposable income, which consists of labour income plus net lump-sum transfers from the government:

$$P_{Ct} C_t(h) = (1-\tau_{Nt}) W_t(h) N_t(h) + TR_t - T_t(h). \tag{18}$$

The RT households set their wage to be the average wage of the optimizing households. As RT households face the same labour demand schedule as the optimizing households, each RT household works the same number of hours as the average for optimizing households.

C. Monetary Policy

We assume that the central bank follows an interest rate reaction function similar in form to the historical rule estimated by Orphanides and Wieland (1998) over the Volcker–Greenspan period. Thus, the short-term nominal interest rate is adjusted so that the ex post real interest rate rises when inflation exceeds its constant target value, or when output *growth* rises above some target value. With some allowance for interest rate smoothing, monetary policy is described by the following interest rate reaction function:

$$i_t = \gamma_i i_{t-1} + \bar{r} + \bar{\pi} + \gamma_\pi (\pi_t^{(4)} - \bar{\pi}) + \gamma_y (y_t - y_{t-1} - g_z). \tag{19}$$

In the above, i_t is the annualized nominal interest rate, $\pi_t^{(4)}$ is the four-quarter inflation rate of domestically produced goods (that is $\pi_t^{(4)} = \sum_{j=0}^{3} \pi_{t-j}$), and $\bar{r}$ and $\bar{\pi}$ are the steady-state real interest rate and the central bank's constant inflation target (both expressed at annual rate). Also, $y_t - y_{t-1}$ is the (annualized) quarterly growth rate of total output.

D. Fiscal Policy

Some of the domestically produced good is purchased by the government. Government purchases (G_t) are assumed to have no direct effect on the utility of a household.[9] We also assume that government purchases as a fraction of total output, $g_t = G_t/Y_t$, follow an exogenous stochastic process.

The government can issue debt B_{Gt+1} to finance a deficit so that its budget constraint is given by

$$P_{Bt}B_{Gt+1} - B_{Gt} = P_{Dt}G_t + TR_t - T_t - \tau_{Nt}W_tL_t + \tau_K(R_{Kt} - \delta P_{It})K_t - (MB_{t+1} - MB_t). \tag{20}$$

In equation (20) all variables are in per-capita terms.

Capital tax rates and real transfer rates (defined as $TR_t/P_{Dt}Y_t$) are held constant. Given that the monetary authority uses the nominal interest rate as its policy instrument, the levels of seigniorage revenues are determined by nominal money demand.

Lump-sum taxes are adjusted in a manner that the government satisfies an intertemporal solvency constraint, requiring that the present discounted value of the government debt stock tends towards zero in the long run. In particular, we assume that the real lump-sum tax rate, $\tau_t = T_t/P_{Dt}Y_t$, is determined according to the following reaction function:

$$\tau_t = \tau_{t-1} + \nu_1(b_{Gt+1} - b_G) + \nu_2(b_{Gt+1} - b_{Gt}), \tag{21}$$

where $b_{Gt+1} = B_{Gt+1}/P_{Dt}Y_t$ and b_G is the government's target value for the ratio of government debt to nominal output.

Government purchases as a fraction of total output, g_t, evolve according to a first-order autoregressive process:

$$g_t = \rho_g g_{t-1} + \varepsilon_{gt}, \tag{22}$$

where ε_{gt} is an identically and independently distributed innovation. Similarly, the labour tax rate, τ_{Nt}, evolves according to a first-order autoregression with persistence parameter ρ_N.

E. Resource Constraint and Net Foreign Assets

Domestic aggregate demand for the home-produced goods (Y_{Dt}) can be divided into the following sources: consumption demand, investment demand, government spending and investment adjustment costs. Thus,

$$Y_{Dt} = C_{Dt} + I_{Dt} + G_t + \phi_{It}. \tag{23}$$

[9] We could assume instead that government purchases enter separably in the utility function. This would not alter the model's equilibrium outcome but would have different welfare consequences.

In turn, the home economy's aggregate resource constraint can be written as

$$Y_t = Y_{Dt} + M_t^*, \tag{24}$$

where $M_t^* = M_{Ct}^* + M_{It}^*$, representing total exports.

The evolution of net foreign assets is derived from the budget constraint of the optimizing households after imposing the government budget constraint, the consumption rule of the RT households, the definition of firm profits, and the condition that domestic bonds are in zero net supply.

Finally, we assume that the structure of the foreign economy (the 'rest of the world') is isomorphic to that of the home country.

III. Solution Method and Calibration

We solve the model by log-linearizing the equations around the steady state. To obtain the reduced-form solution of the model, we use the numerical algorithm of Anderson and Moore (1985), which provides an efficient implementation of the method proposed by Blanchard and Kahn (1980) (see also Anderson 1997).[10]

The model is calibrated at a quarterly frequency. Structural parameters are set at identical values for each of the two countries, except for the parameters determining population size (as discussed below).

The utility functional parameter σ is set equal to 2, while the parameter determining the degree of habit persistence in consumption $\kappa = 0.8$. We assume that the discount factor $\beta = 0.997$ and $g_z = 1.0037$, which is consistent with a steady-state annualized real interest rate $\bar{r}$ of roughly 4% and trend output growth of about 1.5% per year. We set $\chi = 10$, implying a Frisch elasticity of labour supply of 1/5, which is considerably lower than if preferences were logarithmic in leisure, but well within the range of most empirical estimates. The utility parameter χ_0 is set so that employment comprises one-third of the household's time endowment. Following Campbell and Mankiw (1989), we choose $\varsigma = 0.5$ so that 50% of the households are optimizing agents and the rest are RT agents. Our calibrated share is on the high range of estimates surveyed by Weber (2002).[11]

The depreciation rate of capital $\delta = 0.025$ (consistent with an annual depreciation rate of 10%). The wage mark-up parameter $\theta_w = 0.10$, which is

[10]We evaluated the robustness of our solution procedure by using a non-linear Newton–Raphson algorithm that does not rely on linearization around an initial steady state, and found that the results were nearly identical to those reported.

[11]As indicated below, a smaller share would imply that fiscal deficits induce an even smaller deterioration in the trade balance than under our benchmark parametrization.

reasonably similar to the value estimated by Amato and Laubach (2003) of 0.13 (the price mark-up parameter θ_p has no effect on the linearized dynamics). We set ξ_p and ξ_w to be consistent with four-quarter contracts (subject to full indexation). The parameter $\xi_{p,x}$ is chosen to be consistent with two-quarter contracts, so that the pass-through of exchange rate changes to import prices occurs relatively quickly.[12] We set the steady-state inflation rate π to yield an annual inflation rate of 4%.

The parameter ρ in the CES production function of the intermediate goods producers is set to -2, implying an elasticity of substitution between capital and labour of 1/2. Thus, capital and labour are less substitutable than the unitary elasticity case implied by the Cobb–Douglas specification. The quasi-capital share parameter ω_K is chosen to imply a steady-state investment to output ratio of 16%. The private consumption to output ratio is 66%, while government consumption is 18% of steady-state output. We set the investment adjustment cost parameter $\phi_I = 4$, close to the value used by Christiano et al. (2001).

The parameter ω_C is chosen to match the estimated average share of imports in total US consumption of about 9% (according to NIPA data for the 1995–2003 period), while the parameter ω_I is chosen to match the average share of imports in a total US investment of about 38%. Given that trade is balanced in steady state, this parametrization implies an import or export to GDP ratio for the home country (the United States) of about 12%. We choose population levels ζ and ζ^* so that the home country constitutes about 25% of the world output. This implied an import (or export) share of output of the foreign country of about 4%.

We assume that $\rho_C = \rho_I = 2$, consistent with a long-run price elasticity of demand for imported consumption and investment goods of 1.5. This estimate is towards the higher end of estimates derived using macroeconomic data, which are typically in the range of unity; nevertheless, this voluminous literature has produced a wide range of estimates, with the upper bound in the vicinity of 3.[13] We set the adjustment cost parameter $\varphi_{M_C} = \varphi_{M_I} = 10$, implying a price elasticity of slightly less than unity after

[12]The rapid adjustment of import prices is consistent with the evidence that Campa and Goldberg (2004) derived from a panel of OECD countries, notwithstanding their finding that long-run pass-through is generally well below 100% for OECD countries.

[13]While it is unsurprising that the vast empirical literature estimating trade price elasticities has reported a range of estimates, the level of aggregation used in estimation seems to be of crucial importance. Estimates of the long-run elasticity derived from aggregate data are typically in the range of unity, e.g., Hooper and Marquez (1995). By contrast, estimates using disaggregated data are frequently in the range of 3 or even higher; see Obstfeld and Rogoff (2001) for a concise review or McDaniel and Balistreri (2003) for a more detailed survey.

four quarters.[14] We choose a small value (0.0001) for the financial intermediation cost ϕ_b.

We estimated the parameters of the monetary policy rule using US data from 1983:1 to 2003:4.[15] Our estimates implied that $\gamma_\pi = 0.6$, $\gamma_y = 0.28$ and $\gamma_i = 0.8$. For the tax rate reaction function, we chose $v_1 = 0.001$, $v_2 = 0.01$ and $b_G = 0$. We set the steady-state capital and labour tax rates equal to 0.3 and 0.2, respectively.

IV. Rise in Government Spending Share

Figure 3 shows the effects of an exogenous rise in the US government spending share of GDP of 1 percentage point. Given the high persistence of the shock ($\rho_g = 0.975$), the government spending share still remains about 0.6 percentage point above the steady state after five years (lower right panel). Initially, the primary government budget deficit rises by about 0.8 percentage point of GDP.[16] The deficit is still 0.4 percentage point higher than the baseline level five years after the shock, reflecting that lump-sum tax rates increase very gradually given our parametrization of the tax-rate reaction function. While it may seem unrealistic to assume that government purchases can be financed solely through adjusting lump-sum taxes, our results for the trade balance would be nearly unchanged if we instead assumed slow adjustment of the labour tax rate.

The rise in government spending induces an immediate expansion of output. The government spending multiplier exceeds unity in the impact period of the shock because of the sharp rise in consumption of the RT households. However, rising real interest rates quickly crowd out private investment and the consumption of the interest-sensitive optimizing households.[17] The consumption of optimizing households is also depressed

[14]While estimates from aggregate data tend to produce long-run trade elasticities higher than estimates from disaggregated data, there is broad consensus that the short-run elasticity is significantly lower than the long-run one. See Hooper et al. (2000) for an example of an aggregate study and McDaniel and Balistreri (2003) for a disaggregate study.

[15]We estimated the rule using instrumental variables with lags of inflation and output growth as instruments.

[16]The deficit-to-GDP ratio rises by less than 1 percentage point because of an endogenous rise in government receipts from taxes on labour and capital income.

[17]Given the presence of nominal rigidities in price and wage adjustment, the output response clearly depends on monetary policy. Under our benchmark policy rule, real interest rates rise initially by somewhat less than would occur under fully flexible prices and wages. As a consequence, the output gap (the difference between output and its level under flexible prices and wages) is significantly positive for almost two years. We provide a graphical comparison of model responses under the benchmark rule and under fully flexible prices and wages in Figure 8 below.

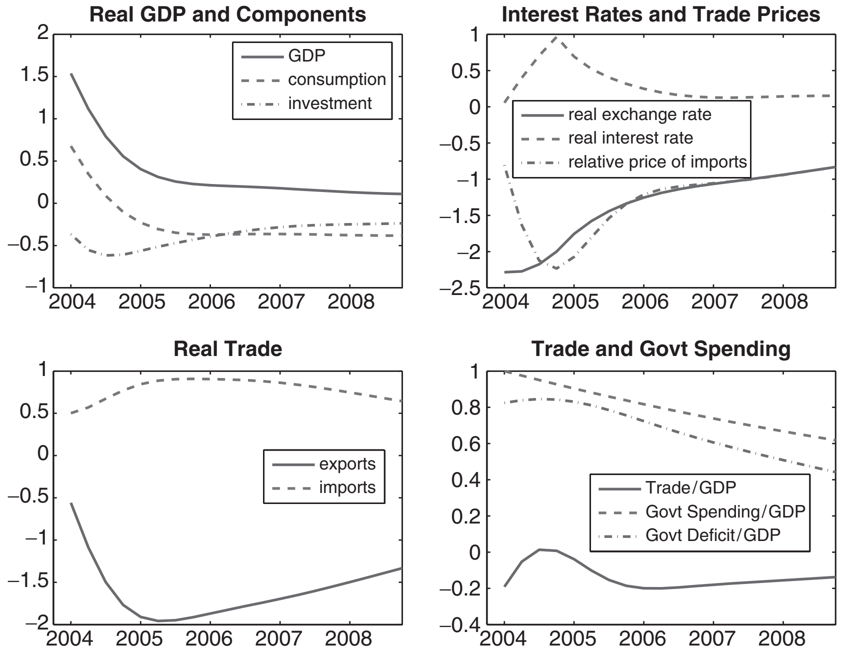

Figure 3: Rise in government spending (benchmark calibration)

because of a negative wealth effect, reflecting that these households take account of the higher future tax burden associated with the government spending increase (such tax adjustments are implied by the fiscal rule, and ensure that the government's intertemporal solvency constraint is satisfied). Thus, the overall private consumption falls below baseline after only a few quarters, and most of the output expansion is reversed. The small but more persistent component of the output increase reflects a rise in labour supply that is induced by the negative wealth effect.

It is interesting to note that the responses of GDP, consumption and investment are broadly consistent with the empirical VAR evidence of Blanchard and Perotti (2002). These authors find that after a government spending shock, consumption and GDP rise, while investment falls. The peak responses of these variables from their VAR estimates are reasonably in line with those in Figure 3. For example, their point estimates for the peak response of the government spending output multiplier range from 0.9 to 1.3 in alternative specifications, slightly smaller than the 1.5% peak response in our model. However, the VAR evidence suggests that the responses of GDP and consumption are more persistent than in our benchmark specification.

We next consider the effects of the government spending shock on the external sector, which is the primary focus of our analysis. Because higher real interest rates induce an appreciation of the real exchange rate (shown by a movement downwards in Figure 3), the relative price of imported goods falls, while the price of exports rises in foreign markets.[18] These relative price changes boost real import demand and reduce export demand, although the response to price changes is moderated in the short run by adjustment costs.[19] The positive effect on imports because of the relative price change is partly offset by a decline in private consumption and investment spending.

The magnitude of the responses of real exports and real imports depends crucially on (i) the magnitude of real exchange rate appreciation, (ii) the price elasticities of export and import demand and (iii) factors that determine the response of private consumption and investment spending. In our benchmark calibration, our assumptions about the degree of substitutability between home and foreign goods imply that the price elasticities of export and import demand are each about 1 after a year and 1.5 in the long run (which is nearly attained after two years). Given that the relative price of imports in the foreign country rises about 1.25% after two years (essentially the reverse of the response of home import prices shown in the upper right panel of Figure 3), exports fall by about 2%. Real imports rise by a somewhat more modest amount, because the relative price effect is partly offset by a contraction in consumption and investment.

These expenditure-switching effects on trade associated with changes in import and export prices eventually give rise to a deterioration in the ratio of nominal trade to nominal GDP that peaks at about 0.2 percentage points after two years. However, in the short run, the nominal trade/GDP ratio exhibits a hump-shaped pattern. Because imports can respond immediately to private absorption and the latter shows a short-lived increase, the trade balance initially deteriorates. This initial deterioration is followed by a transient improvement associated with a progressive fall in import prices; given that it is costly to adjust imports and exports in response to relative price changes, this price decline is the dominant determinant of the nominal trade response at horizons of about 2–4 quarters. At longer horizons, real imports and exports respond fully to the relative price changes, which

[18]In principle, both the appreciation of the real exchange rate and the trade balance deterioration could be augmented if the model incorporated a shift in portfolio preferences associated with the increase in government spending that raised the demand for US assets. However, the VAR evidence of Kim and Roubini (2003) suggests that fiscal shocks have small effects on the real exchange rate.

[19]The effect of the change in the exchange rate on import and export prices is muted initially given our assumption of local currency pricing; however, exchange rate pass-through is nearly complete after a couple of quarters.

accounts for a persistent deterioration of the trade balance.[20] Interestingly, almost all of the longer-term deterioration in the nominal trade balance is attributable to a fall in real exports; nominal imports/GDP actually decline slightly, as the rise in real imports is more than offset by a decline in their relative price.

Finally, it is also helpful to consider trade adjustment from the saving–investment perspective embodied in the national accounts identity:

$$\frac{TB_t}{P_t} = \left(Y_t - \frac{P_{Ct}}{P_t} C_t - \frac{NT_t}{P_t} \right) + \left(\frac{NT_t}{P_t} - G_t \right) - \frac{P_{It}}{P_t} I_t, \tag{25}$$

where TB_t is the nominal trade balance, P_t is the GDP deflator, and NT_t denotes taxes net of transfers. This relation expresses the real trade balance as the sum of real private and public saving (the first and second terms in parentheses, respectively), minus real investment.[21] *Ceteris paribus*, a rise in government spending would induce government saving and the real trade balance to deteriorate by a corresponding amount. However, in our model, this aggregate demand pressure on the external balance is largely offset by a rise in private saving (as output rises and consumption eventually contracts), and by a fall in investment spending. The output expansion, consumption decline and investment decline all play important roles in alleviating the pressure on the external balance because of the government spending hike.

A. Sensitivity Analysis

We have shown that government spending shocks have quite modest effects on the trade balance in our benchmark calibration. In this section we consider the sensitivity of this result to the price elasticity of import/export demand, the interest rate sensitivity of consumption and investment, the persistence of the shocks, the fraction of RT agents, the information structure and the monetary policy rule. This analysis is helpful in comparing

[20]Local currency pricing has only a transient initial effect on the response of the trade balance. In an alternative with 'producer currency pricing' – implying an immediate adjustment of import prices to exchange rate changes – the trade balance behaviour would be very similar, except for the response during the first period or two following the shock. Under this alternative, the initial decline in import prices would be large enough to induce an immediate improvement in the trade balance, as it would dominate the effect of higher private absorption on nominal imports. Thus, the trade balance would exhibit a monotonic deterioration after its initial improvement (that is, a J-curve pattern) rather than the hump shape apparent in our benchmark with local currency pricing.

[21]Because we assume adjustment costs on investment, the national accounts identity in equation (25) only holds to a first-order approximation in our model.

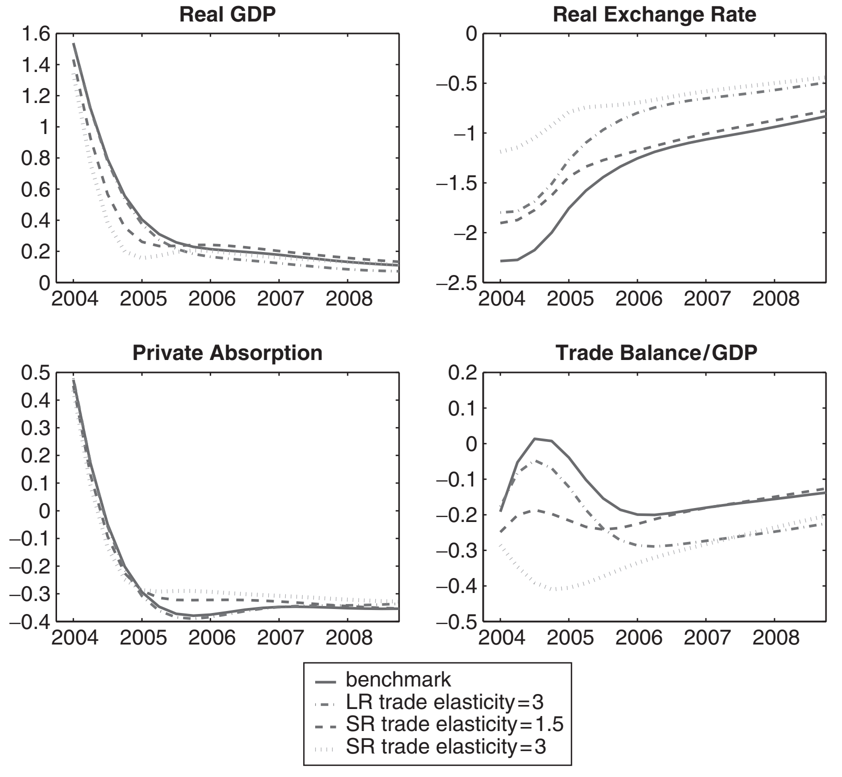

Figure 4: Rise in government spending (alternative trade price elasticities)

our estimates of the effects on trade of government spending shocks with those of the related literature.

While the parameter ρ_C in equation (7) determines the long-run trade price elasticity $(1 + \rho_C/\rho_C)$, the parameter φ_{MC} in equation (8) influences the short-run trade price elasticity. Costs of adjustment on trade effectively lower the short-run trade price elasticity below the long-run level. Figure 4 compares the responses with a government consumption shock under our benchmark calibration (the solid line) with three alternative calibrations. The first alternative (the dash-dotted line) increases the long-run trade price elasticity to 3 without varying the parameter determining adjustment costs in trade; this implies that the trade elasticity after four quarters is about 1.5, rather than slightly below unity as in our baseline.[22] Increasing the long-run trade elasticity stimulates greater substitution towards imports in the domestic market, and a larger fall in domestic exports, even allowing for a

[22] As noted in the calibration section, this choice of a long-run trade price elasticity is at the upper bound of estimates derived from macro data.

smaller real appreciation of the domestic currency. Nevertheless, it is interesting that the magnitude of nominal trade balance deterioration only rises to about 0.25 percentage point of GDP under this alternative, even though the implied dynamic path of the trade price elasticity is much higher than typically estimated using macro data.

The remaining variants are helpful in elucidating the effects of adjustment costs on trade. The dashed line shows a case in which adjustment costs are removed, but the long-run elasticity is held at our benchmark (in this case, the short-run elasticity is 1.5). Clearly, there is a much larger near-term deterioration in this case than in the benchmark, with the trade balance shifting to a deficit that averages around 0.2 percentage point of GDP in the year following the shock. This shows that in the absence of adjustment costs, both the absorption and relative price component of real import demand respond rapidly to the shock (whereas in the benchmark, the relative price component responds sluggishly because of adjustment costs, so that the import price decline translates into a transient improvement in the trade balance). However, it is clear that the peak impact in this case is only slightly larger than in our benchmark.

The final variant in Figure 4 – depicted by the dotted line – combines the assumption of no adjustment costs with a higher trade price elasticity of 3 (so that the short-run elasticity equals 3). In this case, the government spending shock induces the trade balance/GDP ratio to deteriorate by about 0.4 percentage point, which is similar in magnitude to the large trade responses reported in the open economy RBC literature (as Baxter 1995). However, short-run trade elasticities of this magnitude seem implausibly high. Moreover, in interpreting these results, it is important to keep in mind that our model implies a nearly full exchange rate pass-through to import prices after a few quarters. In the more plausible case of incomplete pass-through, the same trade price elasticities would generate smaller effects on the trade balance.

Figure 5 considers the effects of varying model parameters that influence the short-run interest sensitivity of private domestic absorption. In our first alternative (denoted by the dashed line), we decreased the intertemporal elasticity of substitution in consumption by raising σ in equation (13) from 2 to 3, and also markedly increased investment adjustment costs. With a lower interest sensitivity of private absorption, domestic interest rates increase by a larger amount (not shown), inducing a larger initial appreciation of the real exchange rate: thus, more of the burden of adjustment to the government spending shock is shifted to the external sector.[23] Nevertheless, even though our alternative calibration would imply short-run interest rate elasticities at the low end of the macroeconomic literature, the trade balance

[23]However, this effect is partially offset by the effect of higher real rates on private domestic absorption, as the policy rule acts to choke off higher growth in nominal demand.

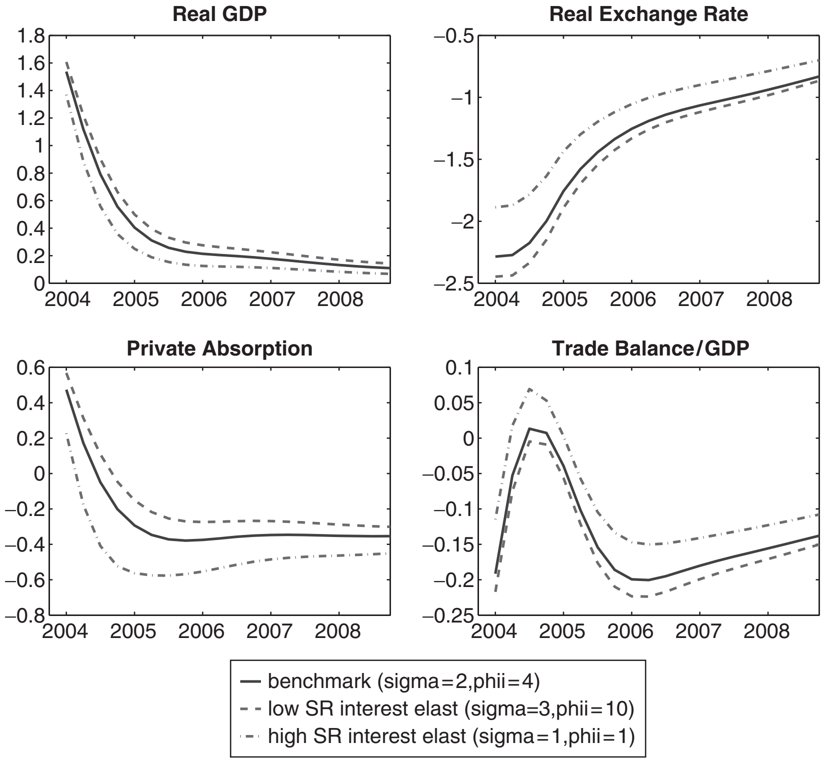

Figure 5: Rise in government spending (different interest elasticities)

only deteriorates about 0.22 percentage point of GDP, or slightly more than that in the benchmark calibration. Conversely, Figure 5 shows that with a logarithmic subutility function over consumption and relatively low investment adjustment costs, the trade balance only deteriorates about 0.15 percentage point of GDP.

Figure 6 examines the effects of varying the fraction of optimizing agents, and also the persistence of the government consumption shocks. The dash-dotted line shows the response to a persistent government consumption shock when all households choose their consumption path by optimizing their utility function. In this case, domestic consumption falls on impact, which accounts for the negative initial response of private absorption. Given a larger contraction in private absorption and smaller appreciation of the real exchange rate than in the benchmark, the trade balance deterioration is considerably smaller.[24]

[24]In a DGE model that assumes that all households are optimizers, Müller (2004) shows that a lower import price elasticity of substitution than the one used here could even lead to an improvement in the trade balance following a rise in government spending. Under these conditions, our model could also generate an improvement.

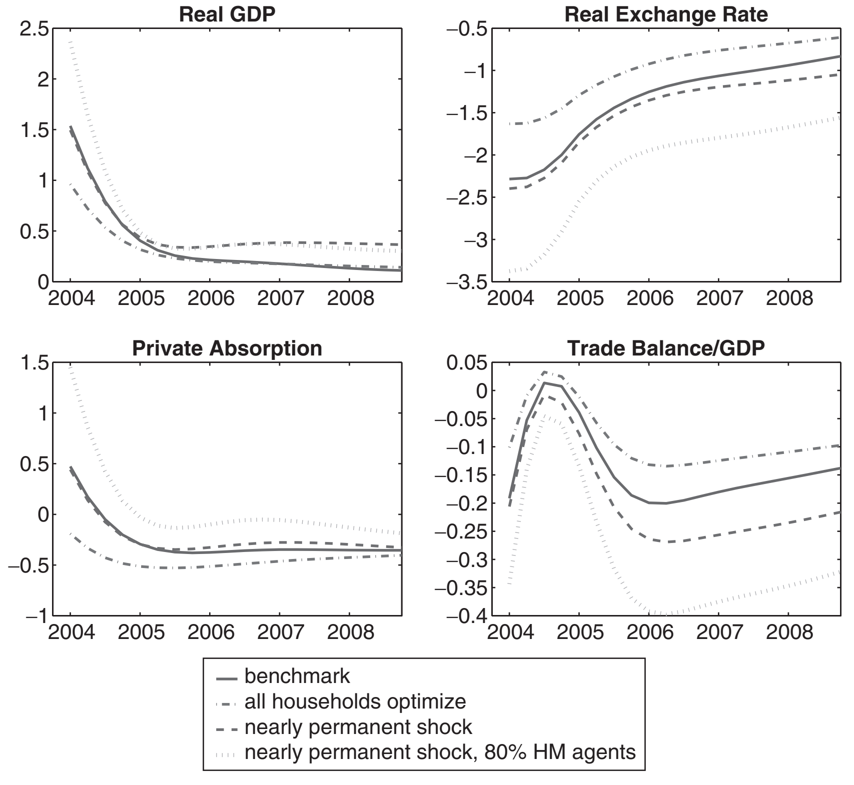

Figure 6: Rise in government spending (alternative calibrations)

The dashed line considers an (unrelated) alternative in which the government spending rise is nearly permanent ($\rho_g = 0.995$, relative to 0.975 in our benchmark). This shock induces a more persistent appreciation of the real exchange rate, which contributes to a modestly larger deterioration of the trade balance. In the case in which the permanent shock is combined with a much higher fraction of RT agents of 80% (relative to 50% in our benchmark), the effects on the trade balance would be significantly larger – roughly 0.4 percentage point of GDP. However, we think that even the 50% calibration in our benchmark probably overstates the fraction of households that can be characterized as consuming their after-tax income rather than making optimal consumption – saving decisions. As noted above, empirical estimates suggest that 50% is closer to an upper bound for the fraction of RT households. But insofar as these estimates rely on historical data, they probably overstate the current fraction of RT households in the US economy, given rapid increases in home and stock ownership, and innovations that have markedly increased household access to financial markets. Thus, the 80% characterization seems highly implausible.

Next, we consider a case in which agents have imperfect information about whether the shock to government consumption is highly persistent or transitory. As noted above, our benchmark model implies significantly more rapid adjustment of output and the expenditure components to a fiscal expansion than is implied by estimates from structural VARs, or by large-scale policy models such as the FRB/Global model (see Levin et al. 1997, for a description of this model). Accordingly, we introduce an 'information friction' as a mechanism for eliciting more gradual responses, and to help evaluate whether such changes in model structure have important implications for the response of the trade balance.

More specifically, we assume that while agents can observe the current shock to government consumption, they are unsure whether the shock is to the highly persistent component (which has an autocorrelation parameter of 0.975, as in the benchmark), or to a transitory component (which has an autocorrelation parameter of only 0.5). Accordingly, agents solve a signal extraction problem by using the Kalman filter.

Figure 7 compares the case with imperfect information (the dash-dotted line) with the benchmark case. Because agents initially perceive that the

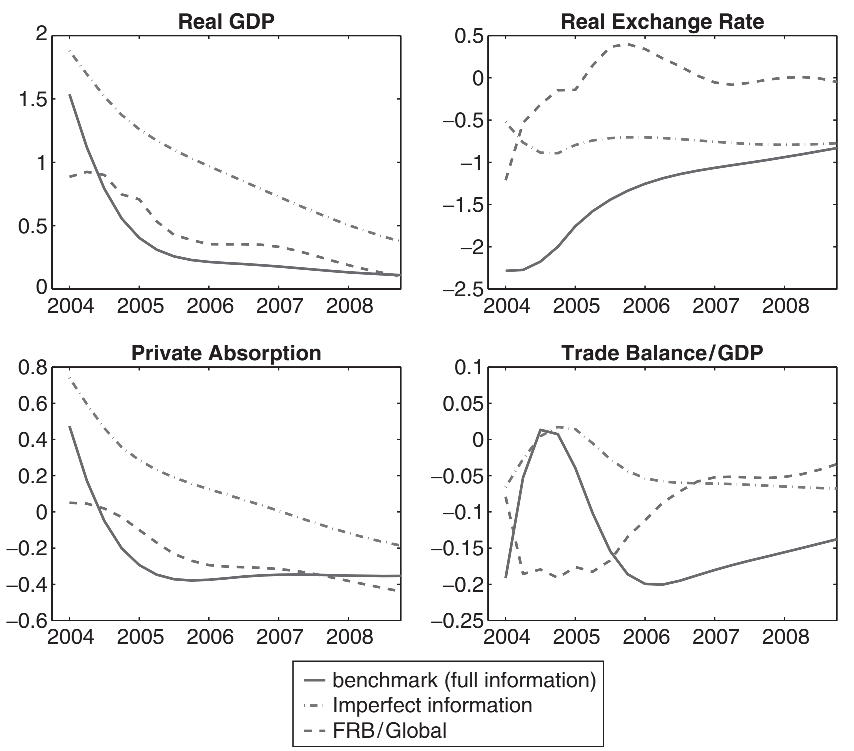

Figure 7: Rise in government spending (imperfect information)

increase in government spending is temporary under imperfect information, there is a larger increase in GDP in this case than in the benchmark. Long-term real interest rates rise by less than under the benchmark, and there is less crowding out of consumption and investment spending. Furthermore, the rise in GDP is more persistent, as agents only slowly update their beliefs about the persistence of the shock and are continually surprised by the higher-than-expected levels of government spending. Interestingly, this version of our model comes closer than the benchmark to matching the gradual response of output (dashed line) and private absorption implied by the FRB/Global model to the same shock.

Given that agents expect the government spending rise to die out more quickly under imperfect information, there is less pressure on the exchange rate to appreciate, and correspondingly, a smaller deterioration of the trade balance. Importantly, a rise in private saving plays a key role in offsetting the pressure on the external balance under either information structure, with the subtle difference that persistently higher output rather than a decline in consumption plays a relatively larger role in accounting for the private saving expansion under imperfect information.

Finally, given the presence of nominal rigidities in our model, it is of interest to consider the sensitivity of our results to the monetary policy rule. The dashed line in Figure 8 shows the effects of a government spending rise under a more aggressive rule. Under this alternative, the coefficients on inflation and output growth in the monetary policy reaction function are three times as large as in the benchmark. Because real interest rates (not shown) rise more more abruptly than under the benchmark, real GDP exhibits a smaller and less persistent rise, while private absorption dips below the baseline after only a couple of quarters. While our benchmark rule allows output and private absorption to rise persistently above the levels that would prevail under fully flexible prices and wages (the dotted line), the more aggressive rule keeps the responses of these variables much closer to those of the flexible price economy.[25] By contrast, we also consider a much less aggressive rule that implies a sizeable initial decline in real interest rates (under this rule, nominal interest rates react only to inflation, and with a much longer lag than under the benchmark, that is $\gamma_i = 0.99$ and $\gamma_\pi = 1.01$). This latter rule induces a large and persistent output expansion that is buoyed by a sustained rise in private absorption.

The monetary rule influences the trade balance response through its effect on private absorption and the real exchange rate. Given that the monetary

[25]While nominal rigidities clearly influence model responses to the government spending shock, the presence of nominal price and wage indexation appears to have relatively little influence on the responses of real variables to this shock.

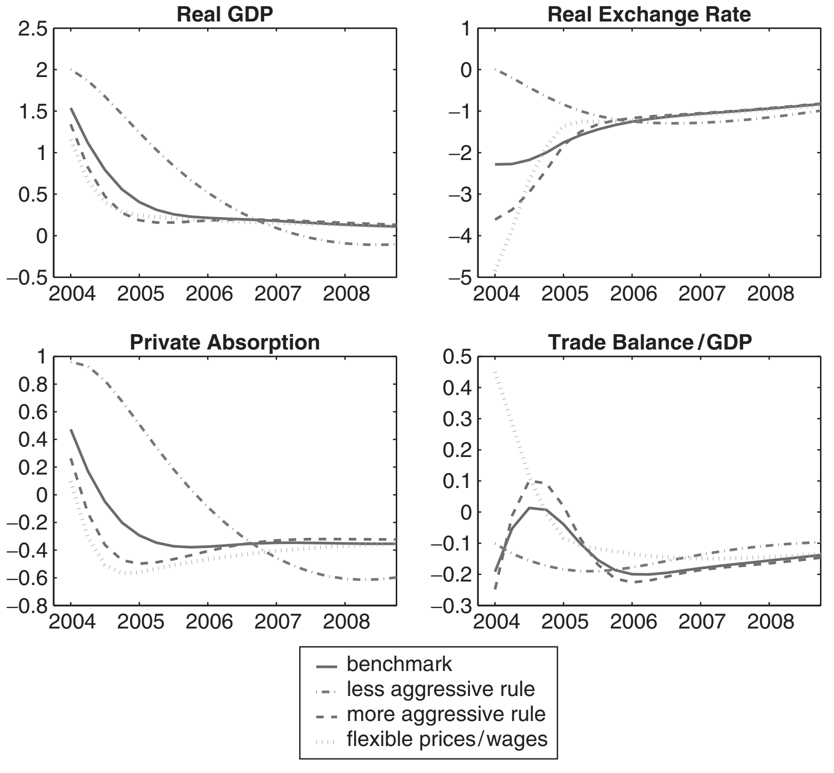

Figure 8: Alternative monetary policy rules

rule has little influence on the responses of these variables at horizons beyond three years, it is unsurprising that the longer-term trade balance responses are nearly identical across the alternative rules (note that all of the model responses are close to those under flexible prices at horizons beyond three years). However, even at shorter horizons between roughly one and three years, the trade balance responses turn out to be quite similar across the different rules, even though the rules have noticeably different effects on private absorption and the real exchange rate. The roughly commensurate effects on the trade balance reflect that while a more aggressive rule induces a relatively larger real exchange rate appreciation – which would itself imply a somewhat greater deterioration of the trade balance – it also implies a more rapid and pronounced decline in private absorption, which tends to reduce the magnitude of the trade balance deterioration. It is only at very short horizons that the trade balance exhibits much sensitivity to the rule, with the less aggressive rule producing a larger initial deterioration because it elicits an initial surge in private spending; by contrast, the more aggressive rule induces a larger drop in import prices that generates a transient improvement in the trade balance.[26]

B. A Reduction in Labour Taxes

As shown in Figure 2, reductions in personal taxes have played an even larger role than government spending hikes in accounting for the recent deterioration in the fiscal deficit; moreover, most of the tax declines because of policy changes reflect successive reductions in tax rates on labour income. Accordingly, it is of interest to consider whether fiscal deficits induced by labour tax cuts have effects on the trade balance that are broadly comparable with those of government spending shocks.

Figure 9 shows the effects of a cut in labour tax rates that is scaled so that labour taxes would fall by 1 percentage point of GDP if pre-tax labour income and output were unaffected. The shock is assumed to be highly persistent, with the autoregressive parameter ρ_N set to 0.975. This labour tax cut induces the fiscal deficit to follow nearly the same path as in the case of the government spending rise considered in Figure 3, with the initial fiscal deficit of nearly 1% of GDP falling to around 1/2% after five years. As above, we assume that lump-sum taxes are raised very gradually to bring the government debt/GDP level back to its target level.[27]

The cut in labour taxes induces a sharp rise in output. The initial rise in output reflects that the RT households immediately increase their consumption as their after-tax income expands. The high level of persistence of aggregate consumption reflects that the consumption of the RT households remains high for an extended duration (given that the cut to labour taxes is very persistent, and lump-sum taxes adjust slowly). Output declines from its initial peak as rising real interest rates crowd out investment spending and the consumption of optimizing households; however, output remains persistently above its pre-shock level because lower tax rates induce households to work more by raising the cost of leisure.

The channel through which the labour tax cut affects the external sector is broadly similar to the case of the government spending shock. In particular,

[26]As a more general point, the sensitivity of the trade balance response to the monetary policy rule will depend on some of the structural parameters considered above, including on the price elasticities of imports and exports. A more aggressive rule tends to induce larger effects on the trade balance than a less aggressive rule if trade price elasticities are calibrated to be higher than in our benchmark, while a less aggressive rule tends to generate larger effects if trade price elasticities are lower.

[27]We verified that the implications for the trade deficit reported below would be virtually unaffected if we assumed instead that the endogenous tax adjustment occurred through a gradual increase in labour tax rates.

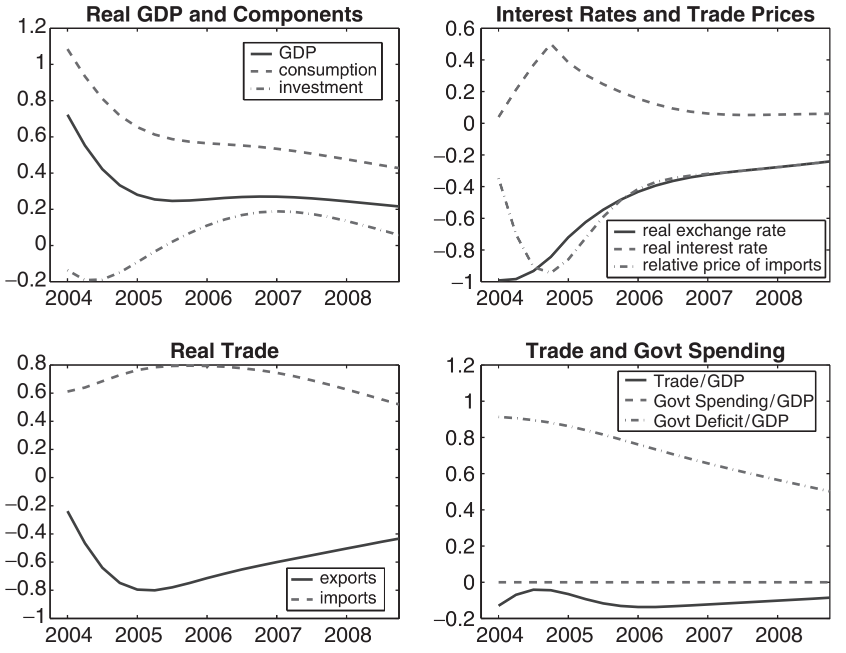

Figure 9: Fall in labour tax rate (baseline calibration)

higher real interest rates induce the real exchange rate to appreciate, which reduces the relative price of imports at home, and boosts it abroad. These relative price movements generate a decline in real exports, and a rise in imports. The associated deterioration of the nominal trade balance of about 0.15 percentage point of GDP is only slightly smaller than the decline in the case of the government spending shock; the smaller decline in the former case reflects that the labour supply shock stimulates output in the longer term, which dampens the initial appreciation of the real exchange rate.[28]

The quantitative effects of the labour tax cut on the trade balance are slightly augmented under an alternative calibration that imposes a higher Frisch elasticity of labour supply. Figure 10 compares the effects of the tax cut under the benchmark calibration in which the Frisch elasticity is 0.2 with an alternative in which the Frisch elasticity is set equal to unity. The latter value is much higher than estimates from most microeconomic studies, but has frequently been utilized in the RBC literature. It is clear that the response of output and domestic absorption is much larger with a high labour supply

[28]The positive supply-side effects of the labour tax cut dampen the magnitude of the real interest rate increase, and also cause the real exchange rate to depreciate in the longer term; given the uncovered interest parity condition, these effects serve to dampen the initial appreciation relative to the case of the goverment spending shock.

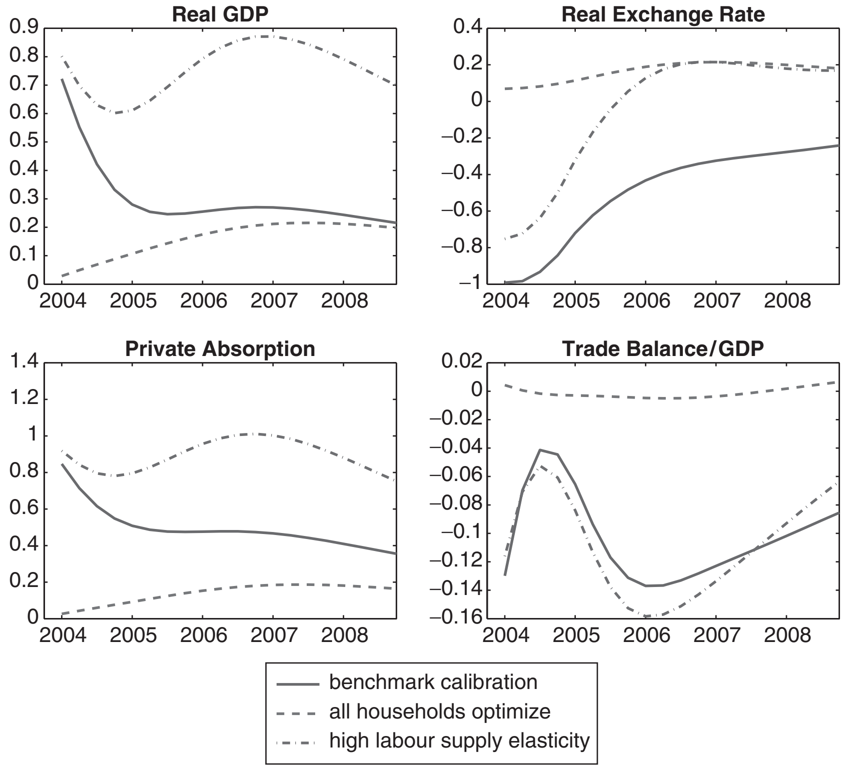

Figure 10: Fall in labour tax rate (alternative calibrations)

elasticity, reflecting that more substitution into work induces a higher demand for capital, and directly boosts output. However, the quantitative effect on the trade balance is only slightly larger than in our benchmark case. While a greater surge in investment demand has the partial effect of stimulating import demand by more, the larger supply-side effects of the shock dampen the initial appreciation of the exchange rate.

Figure 10 also shows the implications of assuming that all agents are optimizers. Interestingly, the effects of the labour tax cut on the trade balance under this alternative are virtually nil. In the absence of RT households, there is much less upward pressure on real interest rates, so that the real exchange rate exhibits a slight initial depreciation. Thus, the size of the trade balance deterioration in our benchmark is even more sensitive to our assumption about the share of RT households than in the case of the government spending shock.

As in the case of the government spending shock, the magnitude of the effects of the labour tax cut on the trade balance also depends on the trade price elasticity. However, for an economy with structural characteristics such as the United States, implausibly high trade price elasticities would be required to elicit trade balance deteriorations significantly larger than in our benchmark case. For example, even with a long-run trade price elasticity of 6 (consistent with an elasticity of 2 after four quarters), the trade balance would only deteriorate by 0.2 percentage point of GDP. We regard this estimate as a firm upper bound on the impact of a labour tax cut of the magnitude considered, because sensible modifications to our model structure, such as a lower share of RT households or incomplete exchange rate pass-through, would be likely to reduce the effects we are reporting.[29]

V. Conclusions

Our model-based analysis suggests that changes in fiscal policy have fairly small effects on the US trade balance, irrespective of whether the source is a spending increase or tax cut: in our benchmark calibration, a rise in the fiscal deficit of 1 percentage point of GDP causes the trade balance to deteriorate by 0.2 percentage point of GDP or less. Most of the pressure on the external balance because of expansionary fiscal policy is offset by a combination of higher output, and/or a fall in private consumption and investment.

From a policy perspective, our results suggest putting little credence in the idea that fiscal policy changes are likely to exert large effects on the US trade balance. Accordingly, fiscal contraction in the United States is unlikely to be instrumental in narrowing the burgeoning US trade deficit, even if it might be desirable on other grounds.

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[29]Tax cuts directed at stimulating investment spending may have somewhat larger effects on the trade balance than the labour tax cuts considered here, reflecting the relatively high import intensity of investment. In a recent working paper, Erceg et al. (2005) found that a reduction in the capital income tax rate equal to one percentage point of GDP induced a trade balance deterioration of nearly 0.25 percentage point of GDP. However, given that capital taxes comprise only a few percentage points of GDP, the change in statutory capital tax rates required to elicit a change in the fiscal balance of one percentage point of GDP would be very large. Hence, capital tax rate changes would seem an unlikely candidate for driving substantial movements in the trade balance.

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