Spillover Effects of Fiscal Policy under Flexible Exchange Rates

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ABSTRACT

The paper analyzes the transmission mechanisms of fiscal shocks in a two-country general equilibrium model with sticky prices in line with the new open economy macroeconomics (NOEM) approach. Specifically, the model allows for both market segmentation and asymmetric preferences. We introduce money via a cash-in-advance constraint: Households need cash in order to purchase consumption goods *and* to pay taxes. Therefore, government expenditures are relevant for overall money demand. Providing closed form solutions, we find that a balanced budget fiscal expansion results in an appreciation of the exchange rate. This result stands in sharp contrast to standard open economy models with money-in-the-utility (MIU), that predict depreciations. The exchange rate movement is all the more pronounced, the higher the degree of pricing-to-market and the stronger the bias for domestically produced goods. As an appreciation of the short run exchange rate implies lower competitiveness of domestic firms, production is temporarily shortened. Therefore, the deterioration of the trade balance is exacerbated when compared with MIU models. We show that the terms of trade depend qualitatively and quantitatively on the degree of pricing-to-market, whereas a home bias in consumption only rules its amplitude. A rigorous welfare analysis reveals that a fiscal expansion is a "prosper-thy-neighbor" instrument. A higher share of PTM goods reinforces the prosper-thy-neighbor effect while a home bias in consumption tends to reduce the positive spillover effects.

Keywords: Fiscal Shocks, Flexible Exchange Rates, Cash-in-Advance, Pricing-to-Market, Home Bias, Prosper-thy-Neighbor

JEL Classification: F31, F32, F41 and F42

1 INTRODUCTION

What are the welfare implications of monetary and fiscal policy in a globalized world? Since Mundell (1963) and Fleming (1962) economists try to address the issue by formal models. While well established not only in the scientific arena but also in practice, Keynesian-type of international macro-models have a severe draw back: the entire absence of microfoundations results in the use of ad hoc welfare criteria. Eventually, Obstfeld and Rogoff (1995a) introduced the now famous *Redux* model into the literature on open macroeconomics. The model incorporates explicit microfoundations and thereby improves the welfare analysis of monetary and fiscal shocks substantially.

One of the most prominent topics in international finance is the potential role of fiscal shocks for exchange rate movements, international price level differentials and welfare effects. However, the vast majority of the literature on new open economy macroeconomics (NOEM) emanating from the Redux model has concentrated on the transmission mechanisms of monetary shocks, as pointed out by Ganelli and Lane (2002). There are a few notable exceptions, though. Ganelli (2003) analyzes useful government spending in the *Redux* framework while Tille (2001) focuses on the role of consumption substitutability in the international transmission of fiscal shocks. Corsetti and Pesenti (2001) stress the potential beggar-thy-neighbor property of fiscal expansions when national government purchases fall exclusively on domestically produced goods.

Following this line of research, we analyze fiscal policy in a two-country general equilibrium model with sticky prices. Specifically, we focus on the competing welfare effects of pricing-to-market (PTM) and a home bias in consumption in a cash-in-advance economy where government expenditures trigger additional money demand. Tracing back to Mankiw and Summers (1986), empirical research suggests that government purchases are relevant for money demand. Our model captures this effect as households need cash in order to purchase consumption goods *and* to pay taxes such that money demand is absorption rather than consumption based. As a consequence, expansive fiscal policy leads to an appreciation of the exchange rate, which stands in sharp contrast to the standard money-in-the-utility (MIU) approach. As both the reaction of the terms-of-trade and the expenditure switching effect depend on the exchange rate movement, the implications of PTM and a home bias in consumption are very different from those in a MIU setting. We demonstrate that a higher share of PTM goods reinforces

prosper-thy-neighbor effects of fiscal expansions while a home bias in consumption tends to reduce positive spillovers.

The role of pricing-to-market in international economics has been intensively studied in the last years. Seminal papers on pricing-to-market are Krugman (1987), and Dornbusch (1987) while empirical support for PTM is provided by Knetter (1993). In the context of NOEM with money-in-the-utility, Betts and Devereux (2000) provide an innovative study of pricing-to-market behavior and its implications for the international transmission of asymmetric shocks. However, they neither consider a home bias in consumption nor do they analyze the welfare effects of fiscal policy explicitly. As for biased preferences, recent empirical studies by Mc-Callum (1995), Helliwell (1996), and Wei (1996), that investigate so called border effects in international trade, confirm that there is a persisting home bias in consumption despite the opening up of the industrial countries. Warnock (1999) offers an analysis of fiscal policy in a MIU model against the backdrop of idiosyncratic tastes but leaves out the possibility of PTM and does not provide a detailed welfare analysis. Pitterle and Steffen (2004) investigate the effects of a home bias in consumption in a monetary union setting. The paper shows that the absence of the exchange rate channel leads to an increased importance of demand composition effects for the international transmission of fiscal policy.

The underlying model of our analysis is perhaps closest to Carré and Collard (2003) who analyze fiscal and technology shocks in cash-in-advance economy under alternative exchange rate regimes. However, our approach differs methodologically, since we provide closed form solutions. We achieve this as we leave out capital accumulation and consider exogenous price rigidities.[1] The analytical solution identifies the main mechanisms at work and provides a deeper understanding of fiscal policy interdependencies.

We find that a domestic balanced budget fiscal expansion results in an appreciation of the equilibrium exchange rate. The very reason for this lies in the feature that increased government expenditures raise overall domestic money demand because taxes have to be paid with cash and private consumption is only partially crowded out. As we do not consider an accommodating monetary policy and prices of domestically produced goods are fixed in the short run, the required increase of real balances can only be brought about through cheaper imports. This in turn implies that the exchange rate has to appreciate. As an appreciation of

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[1]The inclusion of capital accumulation and endogenous price rigidities impedes that the model economy reach a new steady state quickly after unanticipated shocks. Therefore, an analytical solution cannot be derived.

the short run exchange rate implies lower competitiveness of domestic firms, home production is shortened. Therefore, our results caution about possible output stimulating effects of expansive fiscal policy in the short run. Furthermore, the exchange rate movement rather exacerbates the deterioration of the trade balance while MIU models predict a mitigating effect.

The exchange rate response is all the more pronounced, the higher the degree of pricing-to-market and the stronger the bias for domestically produced goods. We show that the short run response of the terms of trade depends qualitatively and quantitatively on the degree of pricing-to-market, whereas a home bias in consumption only rules its amplitude. The incorporation of biased preferences implies that purchasing power parity does not hold even in the long run. This captures the empirical evidence of persistent price level deviations of countries that face similar monetary policy. A prominent example for this phenomenon is the regional inflation experience of the European Monetary Union (EMU).

The incorporation of an explicit optimization problem of the households allows us to conduct a rigorous welfare analysis. Aggregating short and long run welfare for the foreign households reveals that a domestic fiscal expansion acts as a "prosper-thy-neighbor" instrument. We identify three major transmission mechanisms: the expansion of world demand, the change of the terms of trade and expenditure switching. A detailed analysis of the competing effects demonstrates that a higher share of PTM goods reinforces the prosper-thy-neighbor effect. Even though the positive welfare effects from expenditure switching decrease with more producers pursuing pricing-to-market, the simultaneous improvement of the terms of trade dominates. In contrast, a home bias in consumption tends to reduce the positive spillover effects because of the lower relevance of international trade for both economies.

The paper is organized as follows. Section 2 gives a description of the model. Section 3 provides long run and short run solutions of the linearized system, while section 4 explores the welfare implications of fiscal shocks. Section 5 concludes.

2   MODEL SETUP

The considered model consists of two countries, home and foreign, of equal size. This feature is mandatory because households display a home bias in consumption. Different population sizes lead to a structure of world demand such that an analytical solution for the steady state is precluded. We normalize the population size in each country to one. Producers in

both countries are split into two groups. A fraction s of producers are capable of segmenting markets as arbitrage for these goods is ruled out. They set prices for home and foreign markets in the respective buyer's currency, i.e. they pursue local currency pricing. Following Betts and Devereux (2000), we call that kind of pricing behavior "pricing-to-market" (PTM). To be more precise, the pricing behavior we label PTM comprises segmenting markets *and* local currency pricing. The remaining $(1 - s)$ producers price goods in the currency of the seller. There is no restriction on trade in these goods. Hence, markets cannot be segmented, and only one price may be set by the producers. This behavior - "producer-currency-pricing" (PCP) from now on - is consistent with the law of one price that shows up in more traditional models of international macroeconomics.

2.1 Households

The description of the model will be carried out in detail for the home country. As for the foreign country, most of the equations are defined analogously, while all foreign variables are denoted with an asterisk.

Households derive utility from consumption and leisure. As we are interested in obtaining a manageable closed form solution of the model, we use a special case of the general isoelastic utility function: The elasticity of intertemporal substitution is set to one and equal weight is attached to consumption and leisure. Thus, households maximize their discounted utility given by

$$U = \sum_{t=0}^{\infty} \beta^t \big(log\ c_t + log(1 - h_t) \big), \tag{1}$$

where $\beta \in [0, 1]$ denotes the discount factor, $(1 - h_t)$ represents leisure enjoyed by the household, and c_t is a constant elasticity of substitution (CES) real consumption index. The latter consists of a basket of goods produced in the domestic economy, c_t^h, and a basket of goods produced in the foreign country, c_t^f:

$$c_t = \left[\omega^{\frac{1}{\theta}} c_t^{h\frac{\theta-1}{\theta}} + (1 - \omega)^{\frac{1}{\theta}} c_t^{f\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{2}$$

By determining the weight of the domestically produced goods in the consumption index,

$\omega \in [0.5, 1)$ serves as a measure of a possible home bias in consumption.[2] If $\omega > 0.5$, home and foreign households have biased demand for goods that are produced in their own country, whereas the fraction of imported goods in the consumption bundle is smaller than 0.5. The parameter $\theta > 1$ denotes the elasticity of substitution between the two consumption baskets which are defined as:

$$c_t^h = \left(\int_0^s c_t^m(h)^{\frac{\theta-1}{\theta}} \, dh + \int_s^1 c_t^a(h)^{\frac{\theta-1}{\theta}} \, dh \right)^{\frac{\theta}{\theta-1}} \tag{3}$$

$$c_t^f = \left(\int_0^s c_t^m(f)^{\frac{\theta-1}{\theta}} \, df + \int_s^1 c_t^a(f)^{\frac{\theta-1}{\theta}} \, df \right)^{\frac{\theta}{\theta-1}} \tag{4}$$

c_t^h aggregates over the consumption of individual PTM goods $c_t^m(h)$ and PCP goods $c_t^a(h)$ that are produced in the domestic economy. c_t^f aggregates over the consumption of individual PTM goods $c_t^m(h)$ and PCP goods $c_t^a(h)$ that are produced in the foreign economy. To keep the preference structure simple, we follow Obstfeld and Rogoff (1995a) and assume the same cross-country and within-country substitutability of goods.[3]

Consumption maximization yields domestic demand functions for the respective goods:

$$c_t^a(h) = \left(\frac{p_t^a(h)}{p_t} \right)^{-\theta} \omega c_t$$

$$c_t^m(h) = \left(\frac{p_t^m(h)}{p_t} \right)^{-\theta} \omega c_t$$

$$c_t^a(f) = \left(\frac{e_t p_t^{a*}(f)}{p_t} \right)^{-\theta} (1-\omega) c_t \tag{5}$$

$$c_t^m(f) = \left(\frac{p_t^m(f)}{p_t} \right)^{-\theta} (1-\omega) c_t \tag{6}$$

The demand functions are specified for goods produced at home (h) and abroad (f). A further distinction has to be made for goods of PCP producers, indicated by a, and goods offered by PTM producers, indicated by m. The difference between pricing-to-market and producer-currency-pricing shows up most clearly in the demand functions (5) and (6) for foreign goods. While foreign PCP producers set a foreign currency price that has to be multiplied by the

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[2]Warnock (2003) models a home bias in consumption using a similar specification of consumption preferences.
[3]Tille (2001) investigates the effects of differing substitutabilities on the welfare implications of fiscal and monetary shocks.

exchange rate, e_t, to yield domestic currency prices,[4] foreign PTM producers segment markets and set the price directly in the currency of the domestic consumer. Hence, in times of fixed prices and exchange rate movements it is only the prices of PCP goods that may change. The possibility of pricing-to-market thereby tends to limit the exchange rate pass-through into import prices. A home bias in consumption implies that, for any given relative price, households always demand relatively more domestic goods than foreigners do.

The price indexes that correspond to the consumption bundles (2)-(4) are obtained by expenditure minimization:

$$p_t = \left(\omega p_t^{h^{1-\theta}} + (1-\omega) p_t^{f^{1-\theta}} \right)^{\frac{1}{1-\theta}} \tag{7}$$

with

$$p_t^h = \left(\int_0^s p_t^m(h)^{1-\theta} dh + \int_s^1 p_t^a(h)^{1-\theta} dh \right)^{\frac{1}{1-\theta}} \tag{8}$$

and

$$p_t^f = \left(\int_0^s p_t^m(f)^{1-\theta} df + \int_s^1 (e_t p_t^{a*}(f))^{1-\theta} df \right)^{\frac{1}{1-\theta}} \tag{9}$$

Again, the aggregate price level (7) is a home biased function of import prices (f), and prices of domestic goods (h). The price index for domestic goods (8) and the import price index (9) aggregate over the prices of $(1-s)$ individual PCP goods, and over a fraction of s goods that are priced to market.

The household's optimization problem is constrained by

$$m_t + R_t f_{t+1} \leq f_t + p_t w_t h_t + \Pi_t \tag{10}$$

$$m_t \geq p_t(c_t + T_t) \tag{11}$$

The budget constraint (10) says that nominal expenditure on cash holdings and bond purchases cannot exceed income derived from remuneration of labor effort, profits and maturing bonds. In order to smooth consumption, households may purchase nominal one-period bonds f_{t+1}, that are denominated in domestic currency units. The bond price R_t is inversely related to

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[4]We use price notation as it is standard.

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the nominal interest rate. Our timing convention is the following: Bonds denoted with $t+1$ are acquired at the beginning of period t and mature at the beginning of period $t+1$. The specification of the budget constraint is a short cut to Helpman (1981) as money holdings are not carried over from the previous period, though it is theoretically possible to do so. As Helpman points out, households will not find it reasonable to hold money over periods in the presence of interest yielding bonds. Money thereby reduces to "money to spend". Another important aspect of the budget constraint is the timing of payments. Households receive nominal labor income, $p_t w_t h_t$, and profits, Π_t, instantaneously. As a result, neither firms nor households hold money longer than an instant. We thereby avoid an additional source of distortion that would blur our analysis of nominal rigidities.[5]

Additionally, households face a cash-in-advance constraint (11) à la Helpman (1981) and Lucas (1982). Households need money in order to carry out consumption goods purchases and tax payments. Our specification avoids possible distortions of the consumption decision by unexpected inflation as households decide on money demand *after* the occurrence of shocks. In the light of positive nominal interest rates the constraint is binding. In contrast to the NOEM literature, we are quite aware of the fact that the specification of money demand alters the outcome of our analysis substantially.[6] The effect of fiscal shocks on the exchange rate, for example, will be radically different in a standard model with money in the utility or models with CIA constraints where taxes do not have to be paid with cash. The very reason for this lies in the feature that, in our model, money demand depends not only on the consumption level, but on total absorption. Thus, tax-financed government expenditure increases ceteris paribus demand for money in equilibrium.

Households maximize their intertemporal utility (1) subject to (10) and (11). The decision variables at time t are f_{t+1}, h_t, and c_t. Optimal bond holdings yield standard Euler equations of the form

$$\beta\, p_t\, c_t = R_t\, p_{t+1}\, c_{t+1} \tag{12}$$

That is, marginal utility of consumption today equals marginal utility of future consumption, discounted by the time preference β and multiplied by the real interest rate $1 + r_{t+1} = \frac{1}{R_t} \frac{p_t}{p_{t+1}}$.

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[5]Thanks to Fabrice Collard who gave us some clarifying remarks on that subject.

[6]See for a detailed discussion Chang and Lai (1997).

Note that due to our definition of bonds, real interest rates may differ internationally. As opposed to Obstfeld and Rogoff (1995a), real bond payoffs depend on possible inflation, and in the case of the foreign country also on exchange rate movements. The optimal labor supply decision is characterized by the labor leisure trade off

$$\frac{1}{1-h_t} = \frac{w_t}{c_t}, \tag{13}$$

At the margin, an additional unit of leisure yields the same utility as the extra consumption possibilities derived from an additional unit of work that is remunerated with the current real wage.

The cash-in-advance constraint (11) may be interpreted as the money demand function

$$m_t^d = p_t(c_t + T_t)$$

Note that this implies a consumption elasticity of money demand equal to one in the absence of taxes.

2.2 Government

The government decides in every period on purchases of public goods g_t. Let the public consumption indexes be defined analogously to the real consumption indices of the households.[7] Government spending is assumed to be purely dissipative, i.e. the public good does not enter the household's utility function at all.[8] The government finances its expenditures via lump sum taxes T_t. The government budget constraint therefore reduces to

$$g_t = T_t$$

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[7]Some authors, e.g. Tille (2001) consider a complete home bias in government expenditure. However, under this specification, the demand stimulating effects of fiscal policy only fall on the home country and the foreign country is likely to be worse off.

[8]Ganelli (2003) investigates the implications of welfare enhancing government spending under the assumption of non-separability. Take Beetsma and Jensen (2002) for the general preference case. In their model, the utility of public spending is additively separable from private consumption. This is also true for Corsetti and Pesenti (2001).

As we focus exclusively on fiscal policy, we assume that the central bank leaves the money supply unchanged

$$m_t^s = m_{t-1}^s = \bar{m}^s$$

2.3 Firms

Suppose that production is linear in the only production factor labor. We abstract from technology shocks and thus define the production functions for PTM producers $h \in [0, s]$ and PCP producers $h \in [s, 1]$ in its simplest form:

$$
\begin{aligned}
y_t^a(h) &= h_t^a(h) \\
y_t^m(h) + y_t^{m*}(h) &= h_t^m(h)
\end{aligned}
$$

PCP producers maximize profits that are given by[9]

$$\max_{p_t^a(h)} \quad \Pi_t^a(h) = p_t^a(h) y_t^a(h) - p_t w_t h_t^a(h)$$

subject to

$$y_t^a(h) = \left(\frac{p_t^a(h)}{p_t}\right)^{-\theta} \omega(c_t + g_t) + \left(\frac{p_t^a(h)}{e_t \, p_t^*}\right)^{-\theta} (1 - \omega)(c_t^* + g_t^*)$$

In the PTM case, producers maximize a profit function that distinguishes explicitly between home and foreign demand:

$$\max_{p_t^m(h),\, p_t^{m*}(h)} \quad \Pi_t^m(h) = p_t^m(h) y_t^m(h) + e_t p_t^{m*}(h) y_t^{m*}(h) - p_t w_t h_t^m(h)$$

subject to

$$y_t^m(h) = \left(\frac{p_t^m(h)}{p_t}\right)^{-\theta} \omega(c_t + g_t)$$

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[9]The optimization problem of the producers is essentially static because we assume exogenous price rigidities. Models that endogenize price rigidities via explicit price adjustment costs like Hairault and Portier (1993) or use Calvo (1983) style price determination as in Kollmann (2001a, 2001b) yield more dynamic optimization problems of the firm. Though these approaches are richer in structure they hamper the finding of analytical solutions.

$$y_t^{m*}(h) = \left(\frac{p_t^{m*}(h)}{p_t^*} \right)^{-\theta} (1 - \omega)(c_t^* + g_t^*)$$

Though PTM producers are free to pursue price discrimination they will set the same domestic currency price for home and foreign consumers. To see this, we derive the optimal price setting rule of any home producer h by solving the respective maximization problems. It turns out that the optimal price is always given as a markup on nominal marginal production costs:

$$p_t^h = \frac{\theta}{\theta - 1} w_t p_t \tag{14}$$

Note that a higher θ implies a lower mark up. That is, the degree of monopolistic distortion decreases with the degree of substitutability of goods. As a result of the assumed constant elasticity of substitution (CES) consumption baskets the level of overall demand does not influence the optimal price. Therefore, PTM producers will not charge different prices across countries, even if the demand levels differed. Furthermore, both types of producers face the same marginal production costs, and will therefore set the same price. However, if prices are rigid PCP and PTM consumer prices differ when the exchange rate changes.

In order to analyze the distribution of gains in international trade it is convenient to define the terms of trade which describe the relation between domestic export and import price indexes in domestic currency:

$$\tau_t = \frac{e_t \, p_t^{h*}}{p_t^f} \tag{15}$$

where the domestic import price index p_t^f is given by equation (9). The domestic export price index denominated in foreign currency may be stated as

$$p_t^{h*} = \left(\int_0^s p_t^{m*}(h)^{1-\theta} dh + \int_s^1 \left(\frac{p_t^a(h)}{e_t} \right)^{1-\theta} dh \right)^{\frac{1}{1-\theta}}$$

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3 POSITIVE ANALYSIS OF FISCAL SHOCKS

3.1 Steady state

To get a first feel for the characteristics of the model it is useful to start with the calculation of a steady state. To achieve a closed form solution we choose the most simple form of the steady state, where initial bond holdings and government expenditure equal zero. At the same time, the steady state exercise yields the flexible price version of the model which serves as a starting point for the following shock analysis in the presence of price rigidities. From a technical perspective, we need the steady state of the model as we evaluate the dynamic system around a stationary equilibrium. In fact, the propagation of shocks will be analyzed only locally. In the sequel, steady state values of the variables are barred.

One of the most important features of *Redux* style models is the incorporation of monopolistic competition. This facilitates demand driven welfare improvements in the short run, because production is inefficiently low in the initial steady state. We may derive the output level from the steady state labor markets:

$$\bar{h} = \bar{h}^* = \bar{y} = \bar{y}^* = \frac{\frac{\theta-1}{\theta}}{1 + \frac{\theta-1}{\theta}}$$

whereas the socially optimal employment (production) level would be $\frac{1}{2}$. The inverse markup $\frac{\theta-1}{\theta}$, that defines the market power of firms, enters the labor market equilibrium through the (distorted) real wage that workers receive for an hour worked, see pricing equation (14). Steady state consumption may be derived from barred versions of the current account

$$\bar{c} = \frac{\bar{p}^h}{\bar{p}}\bar{y} = \frac{\bar{p}^h}{\bar{p}}\bar{h} = \bar{h}$$

Obviously, an inefficiently low level of hours worked translates into inefficiently low production and thereby lower consumption. Barred versions of the Euler equation (12) link the steady state real interest rate to the time-preference factor β

$$\bar{r} = \frac{1 - \beta}{\beta}$$

Finally, money market clearing reveals that the steady state exchange rate hinges on relative

money supplies and the international consumption ratio

$$\bar{e} = \frac{\bar{m}}{\bar{m}^*} \frac{c^*}{c}$$

Intuitively, a loose relative monetary policy precipitates a depreciation of the exchange rate while a higher relative consumption level yields an appreciation.

3.2 Long run equilibrium

We now turn to the policy experiment of an unanticipated asymmetric fiscal shock. What will happen to the key variables if the government raises its tax-financed expenditures? For welfare analysis purposes it is crucial to determine the dynamic response of consumption and hours worked because both enter the utility function of the representative agent. The movement of the exchange rate is at the center of our analysis as it determines consumption, hours worked, and the terms of trade. The latter are in turn decisive for the distribution of gains in trade and therefore have strong implications for the welfare effects of fiscal shocks.

Though our set of equations is complex, it is possible to solve for the individual variables, because the dynamic system reaches its new steady state right after the shock period. This feature is due to the special form of price rigidities - prices have to be set before the occurrence of shocks but may be changed in the following period - and some more subtle issues such as the lack of capital accumulation. Given this special structure, we may split the algebraic problem into two parts that can be treated (almost) independently. First, we solve for the long run (post shock, flexible price) values of the international consumption differential and the exchange rate. It turns out that these depend on exogenous variables and endogenous bond holdings that are determined in the short run (post shock, rigid prices). Second, we solve for the short run equilibrium given the long run values of the variables. The combination of the short run (period t) and long run (period $t+1$) solution finally yields the solution for exchange rates, consumption levels, hours worked, price levels and so forth. The essential link between the short and long run system will be the bond holdings acquired in the shock period.[10] The following system of equations includes the market clearing and optimality conditions that define the long run equilibrium.

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[10] The importance of the current account as a main channel of international transmission of shocks is stressed by the intertemporal approach to the current account, see Obstfeld and Rogoff (1995b).

Money markets

$$\frac{m^s_{t+1}}{p_{t+1}} = \frac{m^d_{t+1}}{p_{t+1}} = c_{t+1} + g_{t+1} \tag{16}$$

$$\frac{m^{s*}_{t+1}}{p^*_{t+1}} = \frac{m^{d*}_{t+1}}{p^*_{t+1}} = c^*_{t+1} + g^*_{t+1} \tag{17}$$

Current accounts

$$p_{t+1}(c_{t+1} + g_{t+1}) + R_{t+1} f_{t+2} = p^h_{t+1} y_{t+1} + f_{t+1} \tag{18}$$

$$p^*_{t+1}(c^*_{t+1} + g^*_{t+1}) + \frac{R_{t+1}}{e_{t+1}} f^*_{t+2} = p^{f*}_{t+1} y^*_{t+1} + \frac{f^*_{t+1}}{e_{t+1}} \tag{19}$$

Goods markets

$$y_{t+1} = \left(\frac{p^h_{t+1}}{p_{t+1}}\right)^{-\theta} \omega(c_{t+1} + g_{t+1}) + \left(\frac{p^{h*}_{t+1}}{p^*_{t+1}}\right)^{-\theta} (1 - \omega)(c^*_{t+1} + g^*_{t+1}) \tag{20}$$

$$y^*_{t+1} = \left(\frac{p^{f*}_{t+1}}{p^*_{t+1}}\right)^{-\theta} \omega(c^*_{t+1} + g^*_{t+1}) + \left(\frac{p^f_{t+1}}{p_{t+1}}\right)^{-\theta} (1 - \omega)(c_{t+1} + g_{t+1}) \tag{21}$$

Euler equations

$$\beta\, p_{t+1}\, c_{t+1} = R_{t+1}\, p_{t+2}\, c_{t+2} \tag{22}$$

$$\beta\, p^*_{t+1}\, c^*_{t+1} = R_{t+1}\, \frac{e_{t+2}}{e_{t+1}} p^*_{t+2}\, c^*_{t+2} \tag{23}$$

Labor markets

$$\frac{1}{1 - h_{t+1}} = \frac{\theta - 1}{\theta} \frac{p^h_{t+1}}{p_{t+1} c_{t+1}} \tag{24}$$

$$\frac{1}{1 - h^*_{t+1}} = \frac{\theta - 1}{\theta} \frac{p^{f*}_{t+1}}{p^*_{t+1} c^*_{t+1}} \tag{25}$$

Equations (16) and (17) assure that money markets in both countries clear. The national

Table 1: Linearized long run price indexes

$$\tilde{p}_{t+1} = \omega\tilde{p}^h_{t+1} + (1-\omega)\tilde{p}^f_{t+1} \qquad\qquad \tilde{p}^*_{t+1} = \omega\tilde{p}^{f*}_{t+1} + (1-\omega)\tilde{p}^{h*}_{t+1}$$

$$\tilde{p}^h_{t+1} = s\tilde{p}^m_{t+1}(h) + (1-s)\tilde{p}^a_{t+1}(h) \qquad\qquad \tilde{p}^{f*}_{t+1} = s\tilde{p}^{m*}_{t+1}(f) + (1-s)\tilde{p}^{a*}_{t+1}(f)$$

$$\tilde{p}^f_{t+1} = s\tilde{p}^m_{t+1}(f) + (1-s)(\tilde{p}^{a*}_{t+1}(f) + \tilde{e}_{t+1}) \quad \tilde{p}^{h*}_{t+1} = s\tilde{p}^{m*}_{t+1}(h) + (1-s)(\tilde{p}^a_{t+1}(h) - \tilde{e}_{t+1})$$

budget constraints are described by (18) and (19): Nominal expenditures on private and government consumption and on home-currency denominated bonds must equal nominal income from goods sales plus pay-offs derived from maturing bonds acquired in the previous period. (20) and (21) represent the goods market clearing conditions. As prices are flexible in the long run and all producers face the same marginal production costs, we do not have to distinguish between PCP and PTM goods markets. Equations (22) and (23) are the Euler equations, describing the optimal path of consumption growth in both countries. Finally, (24) and (25) represent the labor markets, which combine the households' optimal labor supply decision and the firms' pricing rule, i.e. the optimal price as a markup over wages.

Since the model we consider is non-linear we have to recur to a method of linearization before proceeding. As it is standard in the NOEM literature we log-linearize the model around the steady state.[11] From now on, let the percentage deviation[12] of a variable x from its steady state value $\bar{x}$ be defined as $\tilde{x} = \frac{dx}{\bar{x}}$. As we assume zero bond holdings and no government expenditure in the initial steady state, the respective deviation of these variables will be related to steady state domestic consumption $\bar{c}$.

An important feature of our model are the long run implications of fiscal shocks for the price levels. Due to the home bias in private and public consumption, changes in the marginal production cost differential are reflected in a deviation from purchasing power parity. To derive this effect, consider the linearized versions of the domestic price indices (7), (8), (9), and its foreign counterparts, that are stated in Table 1.

[11]This implies that we may not consider shocks to the system that are "too big" as the approximation error would grow too much once you leave the steady state. See Corsetti and Pesenti (2001) for a NOEM model that does not rely on log-linearization. However, the applied Cobb-Douglas specification of the consumption baskets rules out current account imbalances.

[12]For the sake of lean exposition, we will always refer to the deviation of a variable, if not otherwise stated.

In the long run, producers are free to set their prices and PTM producers may still segment markets. Anyhow, the law of one price will hold for all types of goods, because the optimal price across producers is derived as a markup on marginal production costs. Therefore, PTM producers will set prices for foreign markets in the same way as PCP producers do. That is, they calculate the optimal price in the producer's currency and then multiply (divide) it by the exchange rate. The law of one price, though, does not imply purchasing power parity, as marginal production costs across countries may differ. For example, if the real wage at home is higher than abroad, domestic producers - PTM and PCP types alike - will set a higher price than their foreign competitors. Then, it is not only the exchange rate, but also the mix of domestic and foreign goods in the consumption bundles that governs the international price level differential:

$$\tilde{p}_{t+1} - \tilde{p}^*_{t+1} = \tilde{e}_{t+1} + (2\omega - 1)(\tilde{p}^h_{t+1} - \tilde{p}^f_{t+1}) \tag{26}$$

Obviously, in a world of symmetric preferences, i.e. $\omega = 0.5$, equation (26) reduces to the familiar log-linear form of purchasing power parity, $\tilde{p}_{t+1} - \tilde{p}^*_{t+1} = \tilde{e}_{t+1}$.

Following Obstfeld and Rogoff (1995a) and Aoki (1981) we now solve for the differences of the linearized variables and then calculate the individual variables. Combining the difference of the linearized long run money markets, (16) and (17), and remembering that both central banks leave the money supply unchanged, we can derive the following expression for the long run exchange rate:

$$\tilde{e}_{t+1} = -(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) - \frac{dg_{t+1} - dg^*_{t+1}}{\bar{c}} - (2\omega - 1)(\tilde{p}^h_{t+1} - \tilde{p}^f_{t+1}) \tag{27}$$

Equation (27) reveals that the endogenous price differential of home and foreign goods only enters the exchange rate equation if there is a home bias in consumption. As already mentioned, the reason for this lies in the lack of purchasing power parity in the long run. Once we set ω to 0.5 we arrive immediately at an exchange rate equation that only depends on exogenous variables and the long run consumption differential.

Using linearized versions of equations (18)-(25) we may derive the long run consumption

differential following some deviations from the steady state in the short run:[13]

$$\tilde{c}_{t+1} - \tilde{c}_{t+1}^* = \frac{\theta}{2\theta - 1} \frac{2(1-\beta)df_{t+1}}{\bar{p}\bar{c}} + \left(\frac{2\omega - 1}{2\omega(\theta - 1) + 1} - \frac{\theta}{2\theta - 1}\right) \frac{dg_{t+1} - dg_{t+1}^*}{\bar{c}} \qquad (28)$$

The evolution of the long run consumption differential is governed by nominal bond holdings f_{t+1} and long run government expenditure g_{t+1}. The sign of domestic bond holdings will be determined by the short run solution of the model. Assume domestic households acquire debt in the short run responding to a domestic fiscal expansion. Negative domestic bond holdings then reduce the consumption differential as home residents face permanent interest payments that allow for a higher relative consumption of foreign residents. A positive long run government spending differential yields a further reduction of the consumption differential.[14] This is due to the permanent reduction of disposable income in the home country as government expenditures are tax-financed. Once we abstract from home bias concerns, the coefficient that determines the impact of government spending on consumption reduces to $-\frac{\theta}{\theta + (\theta - 1)}$, which is always less than one. This illustrates the model feature of limited crowding out of private consumption, i.e. domestic households reduce their consumption by less than the increased tax burden.[15] Thus, a domestic fiscal expansion stimulates overall domestic demand.

Finally, we may take a look at the effects of a home bias in private consumption and government spending on the long run consumption differential. While the coefficient of bond holdings remains unaffected, the coefficient of the public spending differential depends on the size of ω. With $\frac{dg_{t+1} - dg_{t+1}^*}{\bar{c}} > 0$, the partial derivative of the consumption differential with respect to ω is positive, $\frac{\partial(\tilde{c}_{t+1} - \tilde{c}_{t+1}^*)}{\partial \omega} > 0$. Therefore, a rising home bias mitigates the negative effect of an asymmetric domestic fiscal expansion on the consumption differential. The explanation for this kind of smoothing is straightforward, once you consider the goods markets. Domestic demand increases relatively to foreign demand because of the limited crowding out effect of the fiscal expansion. As both, public and private demand, are ruled by a home bias, the overall increase in world demand falls primarily on home goods, thereby increasing domestic relative income compared with a situation of symmetric preferences.

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[13]See Appendix A for details.

[14]To see this, we may rewrite the government expenditure term as $-\frac{\theta - 1}{2\theta - 1} + \frac{2(1-\omega)\theta}{(2(\theta-1)\omega+1)(2\theta-1)}$.

[15]This behavior is reinforced by the way we model government consumption as private utility remains unaffected.

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3.3 Short run equilibrium

We can now proceed to the analysis of the short run (period t) equilibrium, which is characterized by sticky prices. Producers fix their prices before the occurrence of the fiscal shock and cannot change them but in the next period. Consequently, production becomes entirely demand determined. This in turn implies that we do not have to consider labor markets in the short run equilibrium system, which can be described by the following equations:

Money markets

$$m_t = (c_t + g_t)p_t \tag{29}$$

$$m_t^* = (c_t^* + g_t^*)p_t^* \tag{30}$$

Current accounts

$$p_t(c_t + g_t) + R_t f_{t+1} = (1 - s)p_t^a(h)y_t^a(h) + s\big(p_t^m(h)y_t^m(h) + e_t p_t^{m*}(h)y_t^{m*}(h)\big) \tag{31}$$

$$p_t^*(c_t^* + g_t^*) + \frac{R_t}{e_t} f_{t+1}^* = (1 - s)p_t^{a*}(f)y_t^a(f) + s\Big(p_t^{m*}(f)y_t^{m*}(f) + \frac{p_t^m(f)}{e_t}y_t^m(f)\Big) \tag{32}$$

Goods markets

$$y_t^a(h) = \left(\frac{p_t^a(h)}{p_t}\right)^{-\theta}\omega(c_t + g_t) + \left(\frac{p_t^a(h)}{e_t p_t^*}\right)^{-\theta}(1 - \omega)(c_t^* + g_t^*)$$

$$y_t^a(f) = \left(\frac{p_t^{a*}(f)}{p_t^*}\right)^{-\theta}\omega(c_t^* + g_t^*) + \left(\frac{p_t^{a*}(f)e_t}{p_t}\right)^{-\theta}(1 - \omega)(c_t + g_t)$$

$$y_t^m(h) = \left(\frac{p_t^m(h)}{p_t}\right)^{-\theta}\omega(c_t + g_t)$$

$$y_t^{m*}(h) = \left(\frac{p_t^{m*}(h)}{p_t^*}\right)^{-\theta}(1 - \omega)(c_t^* + g_t^*)$$

$$y_t^m(f) = \left(\frac{p_t^m(f)}{p_t}\right)^{-\theta}(1 - \omega)(c_t + g_t)$$

$$y_t^{m*}(f) = \left(\frac{p_t^{m*}(f)}{p_t^*}\right)^{-\theta}\omega(c_t^* + g_t^*)$$

17

Euler equations

$$\beta \, p_t \, c_t = R_t \, p_{t+1} \, c_{t+1}$$

$$\beta \, p_t^* \, c_t^* = R_t \, \frac{e_{t+1}}{e_t} p_{t+1}^* \, c_{t+1}^*$$

The short run equilibrium system differs in two main aspects from the long run equilibrium. First, there are separated goods market clearing conditions for PCP and PTM goods. In case of the latter, a further distinction has to be made between demand that stems from the respective domestic markets and demand faced in the foreign markets. Second, as usual in this type of model, the labor market clearing condition is not binding because, as explained above, firms adjust production somehow passively to the demand consistent with the previously fixed prices. The linearized version of the short run equilibrium is stated in Appendix B.

We are now ready to derive the short run exchange rate response. Using short term versions of the linearized price indexes stated in Table 1 and remembering that prices are sticky in the short run, it becomes clear that a change in the overall price index can only be brought about through a variation of the exchange rate:

$$\tilde{p}_t = (1 - \omega)(1 - s)\tilde{e}_t \tag{33}$$

$$\tilde{p}_t^* = -(1 - \omega)(1 - s)\tilde{e}_t. \tag{34}$$

Obviously, the overall price indexes do not respond to an exchange rate movement if there is either full pricing to market ($s = 1$) or a very strong home bias ($\omega \to 1$). Taking linearized differences of the money market equations (29) and (30), substituting for the price levels and keeping in mind that money supplies do not vary, we get the following expression for the exchange rate:

$$\tilde{e}_t = \frac{-(\tilde{c}_t - \tilde{c}_t^*) - \left(\frac{dg_t - dg_t^*}{\bar{c}}\right)}{2(1 - \omega)(1 - s)} \tag{35}$$

Thus, the movement of the exchange rate depends on the interaction of the government expenditure differential and the endogenous private consumption differential.

In a next step, we solve for the linearized difference between the home and foreign budget

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constraints (31) and (32). Substituting for the resulting differences between goods demands and for the difference between the overall price levels, we obtain the following expression for the exchange rate:

$$\tilde{e}_t = \frac{(\tilde{c}_t - \tilde{c}_t^*) + \frac{\beta df_{t+1}}{\bar{p}\bar{c}(1-\omega)} + \frac{dg_t - dg_t^*}{\bar{c}}}{2s - 1 + 2\omega\theta(1-s)} \tag{36}$$

These two exchange rate equations contain two endogenous terms, $\tilde{c}_t - \tilde{c}_t^*$ and df_{t+1}, and the exogenous government expenditure differential $dg_t - dg_t^*$. In the following, we have to eliminate the short run consumption differential and the international bond holdings from the exchange rate equations. For this purpose, we first solve the long run consumption differential (28) for $\frac{df_{t+1}}{\bar{p}\bar{c}}$. Next, we use linearized versions of the Euler equations in order to eliminate the long run consumption differential. Then, substituting for the international bond holdings in (36) and combining it with exchange rate equation (35) so as to eliminate the short run consumption differential, gives us the short run response of the exchange rate to an unanticipated fiscal shock.[16]

As we are mainly interested in the impact of a permanent shock, we assume here that $dg_{t+1} = dg_t = dg_p$:[17]

$$\tilde{e}_t = -\frac{\dfrac{\theta(\theta-1)2\omega}{(\theta-1)2\omega+1}}{r\big((\theta-1)(1-s)2\omega+1\big)\big(2\omega-1+2(1-\omega)\theta\big)+2\theta-1}\frac{dg_p - dg_p^*}{\bar{c}} \tag{37}$$

From now on, we consider an asymmetric domestic fiscal expansion where $dg_p > 0$ and $dg_p^* = 0$. For the parameter range given above, an unanticipated permanent positive shock to home government expenditure will lead to a nominal *appreciation* of the exchange rate. The driving force behind this result is an increase in the relative domestic demand for real balances.

Consider the following adjustment process: A higher level of government expenditure is financed by an increase in taxes. Therefore, the disposable income of domestic households decreases, which forces them to reduce consumption, leading to a higher marginal utility of consumption. In the short run, output and consequently hours worked are completely demand determined. In the long run, however, home residents are inclined to work more so as to achieve

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[16]Appendix B provides a detailed description of the solution process.

[17]Following a temporary fiscal shock, the exchange rate appreciation would be more pronounced because the long run government spending differential enters the short run exchange rate equation with a positive sign.

the optimal labor leisure trade off. The marginal utility of leisure rises while the additional income spent on consumption lowers the marginal utility of consumption until equilibrium is restored. In that case, the long run labor market will clear at a higher equilibrium work effort facilitating a re-increase of consumption. Via the Euler equations that describe the households' desire for consumption smoothing - abstracting from real interest rate effects - a higher long run consumption level implies higher short run consumption. Then, due to the cash in advance constraint[18] domestic households are in the conjectured need of extra real balances in order to finance the re-increase of consumption. As both money supply and domestic prices are fixed in the short run, an increase of real balances can only be brought about through cheaper imports. This requires an appreciation of the exchange rate.

We can now proceed to analyze how the degree of PTM and the home bias affect the response of the nominal exchange rate in the light of a domestic fiscal expansion. In the case of PTM, it is easy to see via the partial derivative, $\frac{\partial e_t}{\partial s}$, that a higher value of s leads to a larger appreciation. A higher share of PTM goods implies that less goods are affected by a variation of the exchange rate. Consequently, the prices of the goods not subject to PTM have to change more strongly to restore equilibrium, which means that the appreciation of the exchange rate has to be more pronounced.

Likewise, a higher value of ω, representing a stronger bias for domestically produced goods, should reinforce the appreciation of the exchange rate. Again, the explanation is straightforward: A smaller proportion of imported goods in the consumption basket of the household implies that the prices of these goods have to change more strongly to obtain the required change of the overall price level. Yet, the sign of the partial derivative of the exchange rate with respect to ω is not unique. However, for reasonable parameter values our reasoning is validated. Figure 1 illustrates the effect of a variation in ω on the exchange rate for different values of s when domestic government expenditure $\frac{dg_p}{\bar{c}}$ is increased by one percent. For the numerical simulation we picked standard parameter values, namely $\theta = 6$ and $\beta = 0.95$.[19] The value of θ yields a relatively high mark up rate suitable for countries that are less competitive than the United States, see Hairault and Portier (1993).

We are now prepared to solve the model for the consumption and output responses. Starting

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[18]Remember that government expenditures leave domestic money demand unchanged if there is full crowding out of private consumption.

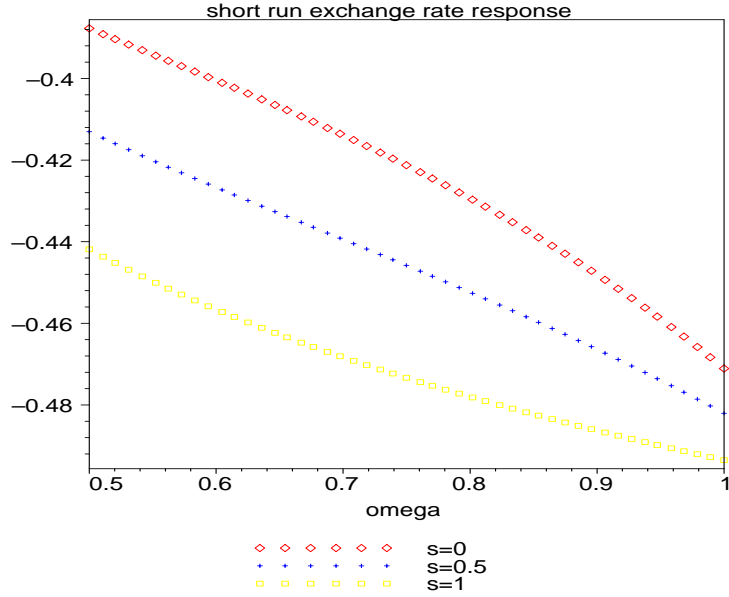[19]See for example Warnock (2003).

Figure 1: Effect of $\omega \in [0.5, 1)$ on the short run exchange rate.

with the short run world consumption response, we add up linearized versions of the short run money markets (29) and (30):

$$\tilde{c}_t^w = -\frac{1}{2}\frac{dg_t}{\bar{c}}$$

Note that price deviations cancel out by (33) and (34). The effect of fiscal expansions on overall world consumption is unambiguously negative and it does not matter whether the expansion is temporary or permanent.[20] This is due to the fact that overall world demand has to remain unchanged as world real money balances are fixed in the short run. The level of any individual variable may be stated as a combination of its world aggregate and its differential:

$$
\begin{aligned}
\tilde{c}_t &= \tilde{c}_t^w + \frac{1}{2}(\tilde{c}_t - \tilde{c}_t^*) \\
&= \tilde{c}_t^w - \frac{1}{2}\frac{dg_t}{\bar{c}} - (1-\omega)(1-s)\tilde{e}_t \\
&= -\frac{dg_t}{\bar{c}} - (1-\omega)(1-s)\tilde{e}_t
\end{aligned}
\tag{38}
$$

where the consumption differential is deduced from exchange rate equation (35), that stems

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[20]In Betts and Devereux (2000) the short run world consumption level is affected if and only if fiscal expansions are permanent.

from money market clearing. We see that the effect of a government spending shock on short run consumption at home can be decomposed into two parts. As mentioned before, the direct effect of an increase in tax financed government spending is - ceteris paribus - a complete crowding out of private consumption. At the same time, however, there is an indirect price effect through the response of the exchange rate. An appreciation lowers the home price level, which allows - through the money market conditions - consumption to fall by less than the amount of taxes paid. In the same way, we derive the foreign consumption response:

$$
\begin{aligned}
\tilde{c}_t^* &= \tilde{c}_t^w - \frac{1}{2}(\tilde{c}_t - \tilde{c}_t^*) \\
&= \tilde{c}_t^w + \frac{1}{2}\frac{dg_t}{\bar{c}} + (1-\omega)(1-s)\tilde{e}_t \\
&= (1-\omega)(1-s)\tilde{e}_t
\end{aligned}
$$

The only effect on foreign's short run consumption stems from the movement of the nominal exchange rate. The appreciation reduces the amount of real balances available to households, which in turn requires a fall in consumption.

The indirect effects on the consumption responses hinges both on the degree of pricing to market and on the home bias in consumption. It can be shown that a higher degree of PTM always reduces domestic consumption and raises foreign consumption. This is due to the fact that the limited pass-through effect associated with PTM dominates the amplified appreciation of the exchange rate. The PTM reasoning also applies for the home bias effect.

For the above reasons world demand and consequently world production are not affected by a domestic fiscal expansion in the short run. As for the respective individual output responses, domestic employment is determined by the condition $h_t = (1-s)y_t^a(h) + s(y_t^m(h) + y_t^{m*}(h))$, and foreign employment analogously by $h_t^* = (1-s)y_t^a(f) + s(y_t^{m*}(f) + y_t^m(f))$. Linearizing these conditions and substituting for the respective demands via the linearized goods market equilibria we get

$$
\tilde{h}_t = \omega\,\tilde{c}_t + (1-\omega)\tilde{c}_t^* + \omega\frac{dg_t}{\bar{c}} + (1-s)(1-\omega)2\omega\theta\,\tilde{e}_t \tag{39}
$$

and

$$
\tilde{h}_t^* = \omega\,\tilde{c}_t^* + (1-\omega)\tilde{c}_t + (1-\omega)\frac{dg_t}{\bar{c}} - (1-s)(1-\omega)2\omega\theta\,\tilde{e}_t \tag{40}
$$

Furthermore, substituting for the individual consumption variables $\tilde{c}_t$ and $\tilde{c}_t^*$ we arrive at:

$$\tilde{h}_t = (1 - s)(1 - \omega)(2\omega(\theta - 1) + 1)\,\tilde{e}_t \tag{41}$$

and

$$\tilde{h}_t^* = -(1 - s)(1 - \omega)(2\omega(\theta - 1) + 1)\,\tilde{e}_t$$

In the short run, hours worked only depend on the movement of the exchange rate which determines the competitiveness of the respective goods. An appreciation of the exchange rate lowers demand for home goods as the relative price tends to rise. Home consumers face cheaper imports whereas home exports become less attractive for foreign consumers. The opposite is true for foreign goods, hence the reduction (rise) of home (foreign) production and hours worked. Again, an increasing fraction s of PTM goods and a stronger home bias limit the expenditure switching effect as a greater share of good prices are not subject to exchange rate movements.

Solving the exchange rate equation (36) for the trade balance response yields:

$$\frac{\beta df_{t+1}}{\bar{p}\bar{c}} = (1 - \omega)\left([2s - 1 + 2\omega\theta(1 - s)]\tilde{e}_t - (\tilde{c}_t - \tilde{c}_t^*) - \frac{dg_t}{\bar{c}}\right) \tag{42}$$

As can be seen from (42), the appreciation of the exchange rate and a positive domestic fiscal expansion work in the same direction, whereas a negative consumption differential mitigates the deterioration of the trade balance. Replacing the short run consumption differential defined by the exchange rate equation (35) we get a trade balance effect that only depends on the exchange rate movement:

$$\frac{\beta df_{t+1}}{\bar{p}\bar{c}} = (1 - \omega)\left[(1 - s)2\,\omega(\theta - 1) + 1\right]\tilde{e}_t$$

Thus, altogether a permanent government expenditure shock causes a deterioration of the trade balance via the exchange rate appreciation. With output temporarily falling due to a decline in competitiveness, and the sum of private and government consumption demand rising, domestic households resort to selling bonds so as to finance the gap between net short run income and consumption expenditures. A higher degree of PTM or of the home bias dampen this effect.

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4 WELFARE ANALYSIS

So far, we have established the effects of an unanticipated permanent fiscal shock on the short run variables of interest. Remember the main short run results: The driving force of the model is the exchange rate which appreciates. Domestic consumption decreases, but by less than the increased tax burden, while foreign consumption decreases by the domestic re-increase. Domestic households work less whereas foreign households work more in spite of the demand composition effects. Totaling these effects, the home country runs a current account deficit.

In this section we analyze the welfare implications of this adjustment process. With the microfoundations of our model at hand, we do not have to rely any longer on ad hoc welfare criteria as for example output stimulation per se. However, due to suboptimally low steady state production levels, fiscal policy may improve welfare when production is stimulated and the net present value of production in consumption units exceeds the accompanying loss of utility stemming from a higher working effort. We identify three welfare driving effects which depend both on the degree of PTM and on the home bias in consumption: an overall demand effect, a terms-of-trade effect, and an expenditure switching effect.

To the end of a thorough short, long run and overall welfare quantification we totally differentiate the utility function (1):

$$dU_t = \tilde{c}_t - \frac{\theta - 1}{\theta}\tilde{h}_t$$

Short run domestic utility depends positively on consumption of the households, and negatively on their working effort. Substituting for $\tilde{c}_t$ and $\tilde{h}_t$ using equations (38) and (41) we arrive at:

$$dU_t = -\frac{dg_t}{\bar{c}} - (1-\omega)(1-s)\left(\frac{2\theta-1}{\theta} + \frac{2\omega(\theta-1)^2}{\theta}\right)\tilde{e}_t \tag{43}$$

The fiscal expansion reduces domestic welfare via the amount of taxes paid. On the other hand, the appreciation of the exchange rate has an unambiguously positive effect on welfare as it leads to the aforementioned re-increase in consumption and a reduction of hours worked. With total PTM or $\omega \to 1$, there is no mitigating effect of the exchange rate at all.

We may carry out the same exercise for the foreign country. Then, the change of foreign

utility in the short run is given by

$$dU_t^* = (1 - \omega)(1 - s) \left(\frac{2\theta - 1}{\theta} + \frac{2\omega(\theta - 1)^2}{\theta} \right) \tilde{e}_t \qquad (44)$$

Comparing (43) and (44) reveals that the home country - while still suffering the tax induced welfare loss - may raise short run utility at the expense of the foreign country. Adding up the individual changes in welfare we deduce that the total effect on world welfare is $-\frac{dg_t}{\bar{c}}$. The interesting aspect of the short run model lies in the international distribution of the welfare loss that is associated with a tax-financed domestic fiscal expansion.

Obviously, while welfare enhancing in the short run, the current account deficit of the home country has negative welfare implications in the long run via permanent interest rate payments. Additionally, a permanent fiscal expansion raises long run overall demand and affects the long run terms of trade. In order to assess the overall welfare impact, we have to calculate welfare effects for subsequent periods $t + i$ with $i = 1, 2, ..., \infty$. From the long run home and foreign current accounts and labor markets we derive the world consumption response

$$\tilde{c}_{t+i}^w = - \left(\frac{\theta - 1}{2\theta - 1} \right) \frac{1}{2} \frac{dg_{t+i}}{\bar{c}}$$

and the response of world hours worked

$$\tilde{h}_{t+i}^w = \left(\frac{\theta}{2\theta - 1} \right) \frac{1}{2} \frac{dg_{t+i}}{\bar{c}}$$

In the subsequent periods, world consumption of the private sector will be reduced while world output is stimulated. As both effects are welfare reducing, world utility will decrease in the long run. Calculating the long run consumption differential and the differential of hours worked, and combining these results with the respective world responses, we arrive at the following expression for the change of home utility from period $t + 1$ onwards:

$$dU_{t+i} = - \left(\frac{\theta - 1}{2\theta - 1} + \frac{\omega\theta - 2\omega + 1}{2\omega\theta - 2\omega + 1} \right) \frac{dg_{t+i}}{\bar{c}} + r(1 - \omega)\Big((1 - s)2\omega(\theta - 1) + 1 \Big) \tilde{e}_t$$

In the same manner, we can show that the long run impact on foreign utility is given as

$$dU_{t+i}^* = \left(\frac{\theta(1 - \omega)}{(2\theta - 1)(2\omega\theta - 2\omega + 1)} \right) \frac{dg_{t+i}}{\bar{c}} - r(1 - \omega)\Big((1 - s)2\omega(\theta - 1) + 1 \Big) \tilde{e}_t$$

As can easily be seen, the permanent fiscal expansion lowers domestic welfare from period $t+1$ on, and increases foreign welfare. Domestic households consume less and work more in the long run than in the initial steady state in order to finance government expenditure and to meet the permanent interest payments on debt accumulated in the short run. In the foreign country, the situation is the other way around: Employment decreases, while consumption increases. All in all, the foreign households are better off in the long run.

To obtain the full impact of the fiscal shock we now combine the short and long term utility effects. Using $dV_t = dU_t + (1/r)dU_{t+1}$ and the analogous expression for the foreign country, we get the overall welfare effects for the households in the two countries:

$$dV_t = -\frac{dg_t}{\bar{c}} - \frac{1}{r}\left(\frac{\theta-1}{2\theta-1} + \frac{\omega\theta-2\omega+1}{2\omega\theta-2\omega+1}\right)\frac{dg_{t+1}}{\bar{c}} + (1-\omega)\left(2s-1+\frac{1}{\theta}(1-s)(2\omega\theta-2\omega+1)\right)\tilde{e}_t$$

$$dV_t^* = \frac{1}{r}\frac{\theta(1-\omega)}{(2\theta-1)(2\omega\theta-2\omega+1)}\frac{dg_{t+1}}{\bar{c}} - (1-\omega)\left(2s-1+\frac{1}{\theta}(1-s)(2\omega\theta-2\omega+1)\right)\tilde{e}_t$$

For the range of parameter values we consider, the term preceding the exchange rate variation is always positive. The overall welfare effects of the fiscal expansion are thus unambiguous: Households in the home country suffer a welfare loss, whereas the foreign households' welfare improves. A fiscal expansion becomes a "prosper-thy-neighbor" instrument in our model. Figure 2 illustrates the welfare effects of a one percent increase of domestic government expenditure $\frac{dg_p}{\bar{c}}$ depending on ω for different values of s. For the numerical simulation we picked the parameter values stated above. A permanent fiscal expansion always lowers domestic welfare as the domestic households have to finance the overall expansion of demand while the welfare effects stemming from the international transmission of the fiscal shock are second order. The evolution of foreign welfare (Figure 2(b)) gives a clearer picture of the underlying adjustment process because foreign government expenditures are unchanged and do not blur the analysis. It is helpful to distinguish between the anticipated and the unanticipated component of the permanent fiscal shock. The dominating effect on foreign overall welfare is the anticipated stimulation of world demand in the long run (**Overall Demand Effect**), which explains the rough picture given in Figure 2(b). Increased world demand translates either in higher foreign production or higher relative foreign producer prices both of which are welfare enhancing. A

stronger home bias in consumption reduces the positive impact of overall demand on foreign welfare as world demand falls primarily on domestic goods.[21]

Figure 2(b) also shows the effects of different levels of s on foreign welfare.[22] A higher share of PTM goods leads to higher foreign overall welfare levels. This effect is associated with the unanticipated component of the fiscal expansion. Against the backdrop of rigid prices, the share of PTM producers determines the direction of the short run terms of trade response (**Terms of Trade Effect**) and governs the international structure of production via its impact on the degree of expenditure switching (**Expenditure Switching Effect**).

To begin with, we derive the welfare effects which stem from a change of the short run terms of trade. Linearizing equation (15) yields:

$$\tilde{\tau}_t = (2\,s - 1)\,\tilde{e}_t$$

Both pricing-to-market and a home bias in consumption affect the terms of trade via their impact on the exchange rate. However, the direction of the terms of trade response exclusively depends on the degree of PTM. From a foreign perspective the short run exchange rate depreciates. Then, the foreign terms of trade improve as long as more than half of the goods are priced to market. With $s = 0.5$ the terms of trade remain unaffected, while $s < 0.5$ yields a worsening. Thus, when purchasing power parity holds, i.e. $s = 0$, the foreign terms of trade deteriorate following an unanticipated permanent fiscal shock.[23] Therefore, a higher degree of PTM has a positive impact on overall foreign welfare via the terms of trade. When assessing the quantitative relevance of the terms of trade effect one has to take into account the implications of a possible home bias in consumption. A higher home bias implies less integration of goods markets, i.e. the importance of relative price changes in international trade declines. On account of this, a home bias in consumption mitigates the respective terms of trade effects.

The second major short run channel of transmission is the expenditure switching effect associated with the appreciation of the exchange rate. The international structure of production hinges primarily on relative prices.[24] As the relative price of foreign goods falls, foreign

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[21]Remember that the composition of world demand is biased towards the domestic country.

[22]The reasoning also applies for domestic welfare, but with the opposite effect, see Figure 2(a).

[23]The implications of PTM for the foreign terms of trade stated in Betts and Devereux (2000) are reversed, because, in their model, the equilibrium exchange rate appreciates from a foreign point of view.

[24]As long as there is a home bias in consumption, the structure of short run production also displays a demand composition effect. However, the expenditure switching effect always dominates the latter. See Pitterle

production is stimulated while domestic production is shortened. Abstracting from terms of trade changes, expenditure switching has a positive effect on foreign welfare. As for the pricing behavior of producers, PTM limits the expenditure switching effect and reduces foreign welfare because less goods are subject to price changes originating in exchange rate movements. If $s = 1$, there are no changes in short run relative prices at all and foreign and domestic production remain unchanged. From the short run output equations (39) and (40) it follows that a stronger home bias in consumption also reduces the expenditure switching effect because of the diminished importance of imports in the consumption index.

Hence, pricing to market has opposing effects on the terms of trade and expenditure switching. For $s = 1$, there is a strong positive terms of trade effect and no expenditure switching. Moving towards $s = 0$, the terms of trade continuously deteriorate while expenditure switching towards foreign production becomes more and more pronounced. All in all, the adverse evolution of the terms of trade dominates the positive expenditure switching effect.

The opposing terms of trade and expenditure switching effects become most evident when the overall demand effect is absent. Therefore, we extend our analysis to a temporary fiscal expansion. Figures 2(c) and 2(d) depict the overall welfare effects for both countries. The prosper-thy-neighbor property of domestic fiscal expansions is strongest when all producers pursue pricing to market and consumption is not biased. In this case, the only welfare relevant effect stems from an improvement of the short run foreign terms of trade. For $s = 0.5$, the terms of trade effect is zero while expenditure switching has a positive impact on foreign production and welfare. If $s = 0$, expenditure switching is maximal, whereas the foreign terms of trade are at its worst level.

In the case of $s = 1$ and $s = 0.5$, a higher home bias in consumption lowers foreign overall welfare as the respective positive effects are dampened. If purchasing power parity holds, the welfare effect of the home bias in consumption is ambiguous. Initially, a higher ω increases foreign welfare because the mitigation of the negative terms of trade effect dominates the weakening of the positive expenditure switching effect. For high levels of ω, however, the situation is the other way around and an increasing home bias lowers foreign welfare.

All in all, we can conclude that the magnitude of the prosper-thy-neighbor effect depends on the interplay of pricing to market and the home bias in consumption. A greater share of

and Steffen (2004) for the monetary union case, where the demand composition effect is the major welfare driving force.

PTM goods tends to reinforce the prosper-thy-neighbor effect while a stronger home bias in consumption reduces the positive spillover of expansive domestic fiscal policy.

5 CONCLUDING REMARKS

This paper has analyzed the effects of fiscal shocks in a two-country general equilibrium model with sticky prices. We have established that introducing money via a cash-in-advance constraint, where households need cash both to purchase consumption goods and to pay taxes, has important implications for the exchange rate movement and for the associated welfare effects. In contrast to standard NOEM models with money in the utility, our model yields an appreciation of the exchange rate following an unanticipated domestic fiscal expansion. Via the implied expenditure switching domestic production declines in the short run and the deterioration of the current account is exacerbated. Aggregating short and long run welfare for the foreign households reveals that a domestic fiscal expansion acts as a "prosper-thy-neighbor" instrument. In addition, we have derived the effects of market segmentation and asymmetric preferences which both amplify the movement of the exchange rate. As for the welfare implications of a domestic fiscal expansion we identified three major transmission mechanisms: the expansion of world demand, the change of the terms of trade and expenditure switching. A detailed analysis of the competing effects has demonstrated that a higher share of PTM goods reinforces the prosper-thy-neighbor effect while a home bias in consumption tends to reduce the positive spillover effects.

Our contribution sheds light on the sensitivity of NOEM models to the specification of money demand. Future theoretical research may focus on more explicit comparisons of the competing approaches to model money demand. Furthermore, empirical research has to provide guidance for the right policy implications by supplying evidence on both the exchange rate effects of fiscal policy and the determinants of money demand.
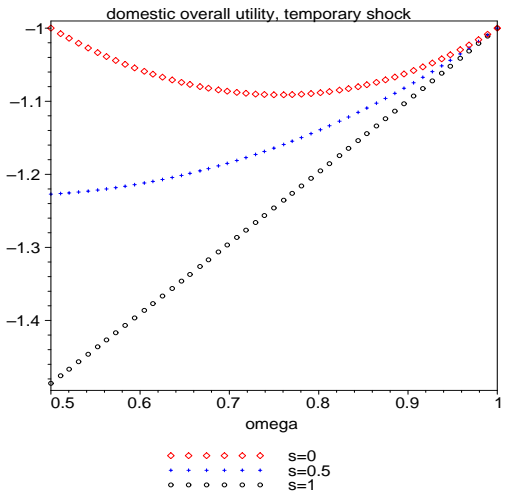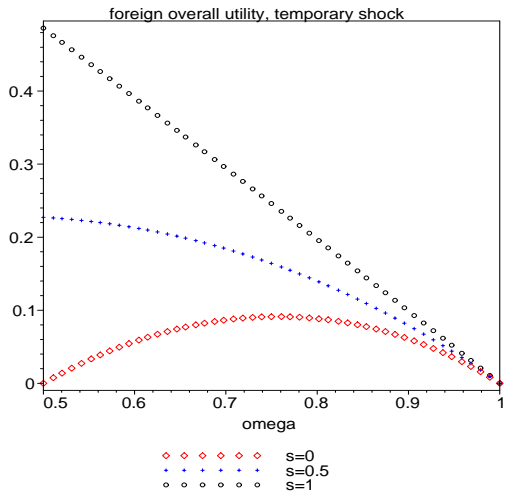
Figure 2: Overall Welfare
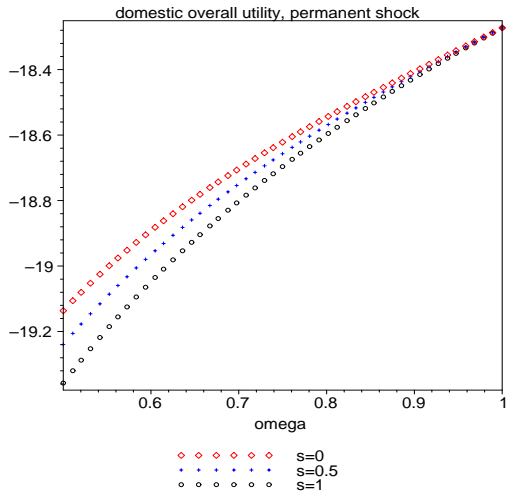
(a) domestic, permanent shock
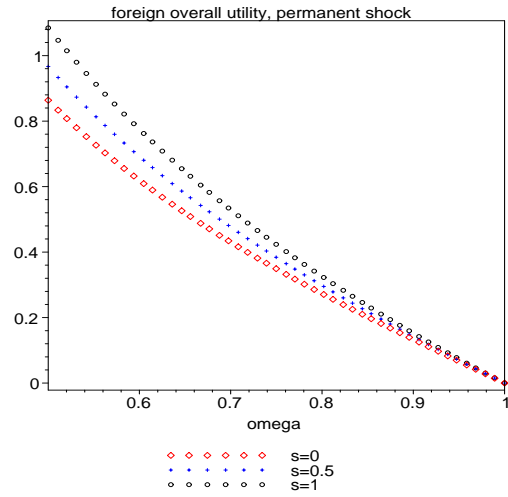
(b) foreign, permanent shock

(c) domestic, temporary shock

(d) foreign, temporary shock

A Derivation of the Long Run Consumption Differential

We begin with the log-linearization of the long run current accounts (18) and (19), the international difference of which is given by

$$(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) + \frac{dg_{t+1} - dg^*_{t+1}}{\bar{c}} = (\tilde{y}_{t+1} - \tilde{y}^*_{t+1}) + \frac{2(1-\beta)df_{t+1}}{\bar{p}\bar{c}} + 2(1-\omega)(\tilde{p}^h_{t+1} - \tilde{p}^f_{t+1})$$

Here, we made use of the very simple long run Euler equations (22) and (23) which reduce to $R_{t+1} = \beta$. This is due to the fact that the new steady state is reached in $t+1$. Hence, the long run deviation of the bond price is zero. Additionally, keep in mind that bond holdings that have been accumulated in the short run represent the new steady state stock, that is $df_{t+1} = df_{t+2}$. Besides, $df = -df^*$ must hold in every period to assure bond market clearing.

From the definition of the long run price levels stated in Table 1 we get the price relation $(\tilde{p}_{t+1} - \tilde{p}^*_{t+1} - \tilde{p}^h_{t+1} + \tilde{p}^{f*}_{t+1}) = 2(\omega - 1)(\tilde{p}^h_{t+1} - \tilde{p}^f_{t+1})$ which we use so as to match the endogenous price differentials that show up in the further equations. Taking differences of the linearized goods markets (20) and (21) we arrive at

$$(\tilde{y}_{t+1} - \tilde{y}^*_{t+1}) = -4\theta\omega(1-\omega)(\tilde{p}^h_{t+1} - \tilde{p}^f_{t+1}) + (2\omega - 1)(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) + (2\omega - 1)\frac{dg_{t+1} - dg^*_{t+1}}{\bar{c}} \quad \text{(A-1)}$$

Finally, the difference of the linearized labor markets (24) and (25) may be stated as

$$\frac{\theta - 1}{\theta}(\tilde{y}_{t+1} - \tilde{y}^*_{t+1}) = -(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) + 2(1-\omega)(\tilde{p}^h_{t+1} - \tilde{p}^f_{t+1}) \quad \text{(A-2)}$$

where we made use of the fact that $\tilde{y}_{t+1} - \tilde{y}^*_{t+1} = \tilde{h}_{t+1} - \tilde{h}^*_{t+1}$. All in all, we get three equations in the four endogenous terms $(\tilde{c}_{t+1} - \tilde{c}^*_{t+1})$, $\frac{2(1-\beta)df_{t+1}}{\bar{p}\bar{c}}$, $(\tilde{y}_{t+1} - \tilde{y}^*_{t+1})$, and $(\tilde{p}^h_{t+1} - \tilde{p}^f_{t+1})$. Elimination of the output and price differential yields the long run consumption differential (28) that only depends on the exogenous long term government expenditure differential, and on bond holdings that are determined in the short run. In the presence of temporary shocks, it is only bond holdings that determine the consumption differential in the long run.

B Linearized Short Run Equilibrium

The log-linear version of the short run equilibrium simplifies substantially as individual prices are fixed and drop out of the system of equations.

$$\tilde{m}_t = \tilde{p}_t + \tilde{c}_t + \frac{dg_t}{\bar{c}}$$

$$\tilde{m}_t^* = \tilde{p}_t^* + \tilde{c}_t^* + \frac{dg_t^*}{\bar{c}}$$

$$\tilde{p}_t + \tilde{c}_t + \frac{dg_t}{\bar{c}} + \frac{\beta\, df_{t+1}}{\bar{p}\,\bar{c}} = (1-s)\tilde{y}_t^a(h) + s\,\omega\,\tilde{y}_t^m(h) + s(1-\omega)\tilde{y}_t^{m*}(h) + s(1-\omega)\tilde{e}_t$$

$$\tilde{p}_t^* + \tilde{c}_t^* + \frac{dg_t^*}{\bar{c}} + \frac{\beta\, df_{t+1}^*}{\bar{p}\bar{c}} = (1-s)\tilde{y}_t^a(f) + s\,\omega\,\tilde{y}_t^{m*}(f) + s(1-\omega)\tilde{y}_t^m(f) - s(1-\omega)\tilde{e}_t$$

$$\tilde{y}_t^a(h) = \omega\tilde{c}_t + (1-\omega)\tilde{c}_t^* + \omega\frac{dg_t}{\bar{c}} + (1-\omega)\frac{dg_t^*}{\bar{c}} + (1-\omega)\theta\tilde{e}_t + \omega\,\theta\,\tilde{p}_t + (1-\omega)\theta\tilde{p}_t^*$$

$$\tilde{y}_t^{\,a}(f) = \omega\tilde{c}_t^* + (1-\omega)\tilde{c}_t + \omega\frac{dg_t^*}{\bar{c}} + (1-\omega)\frac{dg_t}{\bar{c}} - (1-\omega)\theta\tilde{e}_t + \omega\,\theta\,\tilde{p}_t^* + (1-\omega)\theta\tilde{p}_t$$

$$\tilde{y}_t^{\,m}(h) = \theta\tilde{p}_t + \tilde{c}_t + \frac{dg_t}{\bar{c}}$$

$$\tilde{y}_t^{\,m*}(h) = \theta\tilde{p}_t^* + \tilde{c}_t^* + \frac{dg_t^*}{\bar{c}}$$

$$\tilde{y}_t^{\,m}(f) = \theta\tilde{p}_t + \tilde{c}_t + \frac{dg_t}{\bar{c}}$$

$$\tilde{y_t^{m*}}(f) = \theta\tilde{p}_t^* + \tilde{c}_t^* + \frac{dg_t^*}{\bar{c}}$$

$$\tilde{c}_{t+1} = \tilde{p}_t - \tilde{p}_{t+1} + \tilde{c}_t - \tilde{R}_t \tag{B-1}$$

$$\tilde{c}_{t+1}^* = \tilde{p}_t^* - \tilde{p}_{t+1}^* + \tilde{c}_t^* - \tilde{R}_t + \tilde{e}_t - \tilde{e}_{t+1} \tag{B-2}$$

In the sequel, we present the derivation of the short run exchange rate (37) in detail. We first solve the long run consumption differential (28) for the endogenous bond holdings:

$$\frac{df_{t+1}}{\bar{p}\bar{c}} = \frac{(2\theta-1)}{2(1-\beta)\theta}(\tilde{c}_{t+1} - \tilde{c}_{t+1}^*) + \frac{(2\omega\theta^2 - 6\omega\theta + 3\theta + 2\omega - 1)}{2(1-\beta)\theta(2\omega\theta - 2\omega + 1)}\left(\frac{dg_{t+1} - dg_{t+1}^*}{\bar{c}}\right) \tag{B-3}$$

In order to eliminate the long run consumption differential from this equation, we calculate

the difference of the linearized Euler equations (B-1) and (B-2):

$$\tilde{c}_{t+1} - \tilde{c}_{t+1}^* = \tilde{c}_t - \tilde{c}_t^* + \tilde{p}_t - \tilde{p}_t^* - \tilde{p}_{t+1} + \tilde{p}_{t+1}^* - \tilde{e}_t + \tilde{e}_{t+1}$$

Using the linearized price levels (26), (33), (34) and the long run labor market difference (A-2) to substitute for the price differentials, we obtain

$$\frac{1}{2(1-\omega)}(\tilde{c}_{t+1} - \tilde{c}_{t+1}^*) = \tilde{c}_t - \tilde{c}_t^* + [2(1-\omega)(1-s) - 1]\,\tilde{e}_t - \frac{(2\omega-1)(\theta-1)}{2(1-\omega)\theta}(\tilde{h}_{t+1} - \tilde{h}_{t+1}^*) \quad \text{(B-4)}$$

Combining linearized versions of the long run goods and labor market differences (A-1) and (A-2), we arrive at the long run differential of hours worked:

$$(\tilde{h}_{t+1} - \tilde{h}_{t+1}^*) = -(\tilde{c}_{t+1} - \tilde{c}_{t+1}^*) + \frac{2\,\omega - 1}{2\,\omega\,\theta - 2\,\omega + 1}\frac{dg_{t+1} - dg_{t+1}^*}{\bar{c}} \quad \text{(B-5)}$$

A negative consumption differential increases the domestic relative work effort. This effect stems from the standard labor leisure trade-off, compare equation (13). With a home bias in consumption, a positive government expenditure differential works in the same direction. Plugging (B-5) into (B-4), we get the following relationship between short-run and long-run consumption:

$$(\tilde{c}_{t+1} - \tilde{c}_{t+1}^*) = \frac{2(1-\omega)\theta}{2\theta + 2\omega - 2\omega\theta - 1}(\tilde{c}_t - \tilde{c}_t^*) + \frac{2(1-\omega)\theta(2\omega s - 2\omega - 2s + 1)}{2\theta + 2\omega - 2\omega\theta - 1}\tilde{e}_t$$
$$+ \frac{(2\omega - 1)^2(\theta - 1)}{(2\theta + 2\omega - 2\omega\theta - 1)(2\omega - 2\omega\theta - 1)}(\frac{dg_{t+1} - dg_{t+1}^*}{\bar{c}})$$

Finally, we are able to eliminate the long run consumption differential from equation (B-3):

$$\frac{df_{t+1}}{\bar{p}\bar{c}} = \frac{(2\theta - 1)(1 - \omega)}{(1 - \beta)(2\theta + 2\omega - 2\omega\theta - 1)}(\tilde{c}_t - \tilde{c}_t^*) + \frac{(2\theta - 1)(1 - \omega)(2\omega s - 2\omega - 2s + 1)}{(1 - \beta)(2\theta + 2\omega - 2\omega\theta - 1)}\tilde{e}_t$$

$$+ \frac{(2\theta - 1)(2\omega - 1)^2(\theta - 1) + (2\omega\theta^2 - 6\omega\theta + 2\omega + 3\theta - 1)(2\omega\theta - 2\theta - 2\omega + 1)}{2\theta(1 - \beta)(2\omega\theta - 2\theta - 2\omega + 1)(2\omega\theta - 2\omega + 1)}(\frac{dg_{t+1} - dg_{t+1}^*}{\bar{c}})$$

Then, substituting for the international bond holdings in (36) and combining it with exchange rate equation (35) so as to eliminate the short run consumption differential, gives us the short run response of the exchange rate to an unanticipated fiscal shock. The final exchange rate equation (37) describes the impact of a permanent shock, that is for $dg_{t+1} = dg_t = dg_p$.

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