FISCAL POLICY UNDER ALTERNATIVE EXCHANGE RATE REGIMES

ON THE SPECIFICATION OF MONEY DEMAND IN NEW OPEN ECONOMY MACROECONOMICS

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Chapter 1

Introduction

... all models are wrong; the practical question is how wrong do they have to be to not be useful.

Box and Draper (1987)

Monetary and fiscal policy and their effects on the economy are an ever recurring topic in the international policy debate. Starting with the work of John Maynard Keynes and his propagation of monetary and fiscal policy to help eliminate recessions and control economic booms, politicians and economists alike paid increasing attention to active macroeconomic policy making. Expansive monetary and fiscal policy, however, came somehow out of fashion after the dreadful experiences of the seventies: The heyday of Keynesian demand management in the sixties had turned into the painful economic phenomenon of stagflation. In addition, very influential theoretical contributions like the Lucas critique deviated economic policy advice towards sound monetary policy and fiscal discipline. Nevertheless, monetary and fiscal policy have always been and will most probably always be a major influence on economies around the world. Most recently, the strong renaissance of active economic policy in the United States cannot go unnoticed - the expansionary policies of the Federal Reserve Bank and the U.S. Treasury being one of the strongest monetary and fiscal stimuli in decades. It comes at no surprise that the current international policy debate circles around the U.S. twin deficit and its implications for the global economy. In an ever more integrated world economy, macro-economic policies of the major players have substantial impact on the international FX and capital markets. Exchange rate dynamics and interest rate developments in turn do influence real trade flows and international business cycles in a non-negligible way.

The transmission of monetary and fiscal policies in an international context is one of the most prominent topics in the realm of international finance. In particular, researchers are interested in the effects of the respective policy on exchange rate movements, international price level differentials, output stimulation, and welfare effects. Since Mundell (1963) and Fleming (1962) economists try to address these issues by formal models. While well established not only in the scientific arena but also in practice, international macro-models of the Mundell-Fleming (MF) type have a severe drawback: the entire absence of microfoundations results in the use of ad-hoc welfare criteria for the evaluation of alternative policy regimes. Moreover, MF models do not account for intertemporal budget constraints which are very important for a deeper understanding of exchange rate and current account dynamics. Starting with the publication of the seminal *Redux* model of Obstfeld and Rogoff (1995a), a new promising strand in the international macroeconomics literature has emerged, that combines rigorous microfoundations with the MF assumption of nominal rigidities. This approach allows for an explicit welfare analysis on the basis of the households' preference structure. Today, the so-called New Open Economy Macroeconomics (NOEM) framework provides the standard workhorse for the analysis of international monetary and fiscal policy transmission processes.

While most of the early NOEM literature has focused on the effects of monetary policy, the formation of the European Monetary Union has stirred increased interest in the analysis of fiscal policy issues. The cost of loosing monetary policy as a potential stabilization tool is of great concern particularly among the acceding countries of the European Union when deciding whether to join the European Monetary Union or only to participate in the European Single Market. In that context, renewed attention is directed to fiscal policy as a potential stabilization instrument. Recent developments in New Open Economy Macroeconomics research may serve to reassess the effectiveness of fiscal policy under alternative exchange rate regimes in terms of output and welfare.

In this dissertation, we aim to contribute to the discussion of fiscal policy in the field of New Open Economy Macroeconomics by exploring its international transmission and the associated welfare effects under alternative exchange rate regimes. Specifically, we consider two-country general equilibrium models with either flexible exchange rates or a monetary union regime. Under flexible exchange rates, the welfare effects of fiscal policy depend crucially on the expenditure switching and terms-of-trade effects of the exchange rate response. Expenditure switching refers to changes in the international demand structure and their associated impact on the production structure as of international relative price movements, while the terms-of-trade (export prices relative to import prices) are a measure of the gains from international trade. We will demonstrate that the direction of the equilibrium exchange rate movement in the light of fiscal policy is very sensitive to the specification of money demand. This issue is addressed by adopting competing microfoundations of money demand that imply different scale variables. First, we present a flexible exchange rate model and a monetary union model with money-in-the-utility (MIU), which is standard in the NOEM literature and leads to private consumption as the scale variable of money demand. Second, we contrast the results with models where money enters via a cash-in-advance (CIA) constraint. When the CIA constraint comprises both consumption purchases and tax payments of households, the scale variable of money demand amounts to total absorption in equilibrium. The major difference between the two approaches lies in the direction of the exchange rate response in the flexible regime following a domestic fiscal expansion. While the standard MIU setting implies a depreciation of the exchange rate, the augmented CIA constraint yields an appreciation.

The welfare effects of fiscal policy hinge essentially on the direction of the equilibrium exchange rate response, but are also very sensitive to the assumptions about the pricing behavior of firms that are engaged in international trade. In the standard *Redux* model as well as in most other NOEM contributions dealing with fiscal policy, it is assumed that all producers set prices in their domestic currency. As a consequence, temporary stickiness of prices does not lead to deviations from the law of one price when the exchange rate changes. However, empirical research suggests that a failure of the law of one price is widespread even for internationally traded goods. Therefore, part of the recent theoretical research has accounted for a different type of price setting behavior, in the literature known as pricing-to-market (PTM): Firms are able to segment markets and may set prices in the currency of the consumer. In the context of NOEM models, pricing-to-market was pioneered by Betts and Devereux (2000). In times of sticky prices a surprise nominal exchange rate movement results in deviations from the law of one price if producers follow consumer currency pricing. In the present work, we follow this line of research and assume that a fraction of producers price goods to market, while the remaining producers pursue standard producer currency pricing. An evaluation of the welfare effects of fiscal policy under the different exchange rate regimes and money demand specifications reveals that the results depend both qualitatively and quantitatively on the degree of pricing-to-market.

The outline of the dissertation is as follows. In the next chapter we first present a short overview of the recent fiscal policy related NOEM literature. We then prepare the ground for our theoretical analysis by discussing competing approaches to introduce money into general equilibrium models. Chapter 3 explores the effects of fiscal policy in a money-in-the-utility framework under flexible exchange rates and in a monetary union. Chapter 4 analyzes fiscal policy under the two exchange rate regimes, when money is motivated by a cash-in-advance constraint that comprises both consumption purchases and tax payments. The final chapter gives a comprehensive summary of the main results, possible extensions of the presented models, and some concluding remarks.

Chapter 2

Preliminaries

Before we start with the strictly model based analysis of fiscal policy in an international context, we shortly review the related NOEM literature and give an introduction to the subject of money in general equilibrium models. We call the chapter "preliminaries" as we consider it an important input for our following theoretical analysis inasmuch as some of the basic concepts and model elements are introduced.

2.1 Fiscal Policy in NOEM Models

The majority of the literature on New Open Economy Macroeconomics (NOEM) emanating from the *Redux* model has concentrated on the transmission mechanisms of monetary shocks. However, recent work in the NOEM context has increasingly addressed the positive effects of asymmetric fiscal policies as well as the associated welfare implications. In this section we give a short overview of the NOEM literature that focuses on fiscal policy issues.[1] We first illustrate the implications of fiscal policy in the *Redux* model and then present the most important theoretical contributions in

[1] For more extensive surveys on fiscal policy in NOEM models, see Ganelli and Lane (2002) and Coutinho (2003).

the field. If not otherwise stated, the models reviewed in this section follow the money-in-the utility approach, which dates back to Sidrauski (1967) and implies a scale variable of money demand (private consumption) that does not account for possible cash requirements for tax payments, see section 2.2 for details on the approach.

Textbook versions of the *Redux* model by Obstfeld and Rogoff (1995a) can be found in Obstfeld and Rogoff (1999) and Walsh (2000). Obstfeld and Rogoff introduce government spending in the basic *Redux* model as a basket of consumption goods, that aggregates in the same form as the households' consumption basket over a continuum of differentiated goods. Both public and private consumption baskets are not biased towards domestically produced goods, and the authors do not account for the possibility of pricing-to-market behavior on part of the firms, either. Hence, the law of one price and purchasing power parity always hold in the basic *Redux* model. Due to the consumption smoothing motive of households, an unexpected balanced-budget increase in domestic government expenditures stimulates world production in the short run, where prices are rigid. As the tax burden falls exclusively on domestic residents, relative domestic consumption is reduced. With the scale variable of money demand amounting to private consumption and with passive monetary policy in both countries, the domestic fiscal expansion leads to a depreciation of the nominal exchange rate. Obstfeld and Rogoff (1995a) assume that government expenditures are purely dissipative. As a consequence, a domestic fiscal expansion has beggar-thyself and prosper-thy-neighbor welfare implications in the basic model. When allowing for directly utility-enhancing government expenditures, as we do in this dissertation, the beggar-thyself property of a fiscal expansion may not arise. In fact, if it is assumed that government expenditures fully increase private utility, both countries benefit symmetrically from the asymmetric fiscal expansion in the *Redux* model.

One of the important modifications of the basic *Redux* model is the fixed-exchange rate version of Caselli (2001) in which she analyzes the process of fiscal consolidations in the European Union countries. The focus of her work lies on the comparison of an asymmetric peg, where only one country is responsible for pegging the exchange rate, with a symmetric peg, where both countries cooperate and the world money supply is held constant. As the first regime implies a rise of the world money stock following an asymmetric fiscal consolidation, the real interest rate decreases and households in both countries enjoy higher welfare than under the symmetric peg. The additional welfare stimulating effects under the asymmetric peg stem from the overall increase of money supply, which is essentially the same mechanism that applies for a monetary expansion in the flexible exchange rate *Redux* model.

In a seminal contribution to the NOEM literature, Corsetti and Pesenti (2001) investigate the international transmission mechanisms of monetary and fiscal policy assuming a unitary elasticity of substitution between domestic and foreign goods. In this case, the terms-of-trade movements that are associated with macroeconomic disturbances always provide complete risk-sharing and there is no incentive for households to trade bonds on an international market. While this allows for an analytical solution without resorting to log-linearization techniques, it comes at the cost of the absence of current account imbalances, which are crucial for the understanding of international macroeconomic policy interdependencies, see Obstfeld and Rogoff (1995b). Furthermore, an asymmetric fiscal expansion does not affect the short run exchange rate and hence the short run terms-of-trade remain unchanged. Corsetti and Pesenti's (2001) welfare implications of a permanent fiscal policy hinge crucially on the assumption of a complete home bias in government spending. The increase in demand for domestic goods that is associated with higher domestic government expenditures, translates into higher relative prices of domestic goods in the long run. The resulting deterioration of the foreign country's terms-of-trade leads to a negative evolution of welfare abroad. Thus, fiscal policy is a beggar-thy-neighbor instrument in this model setup.

Tille (2001) extends the basic *Redux* model by allowing the substitutability of goods across countries to differ from the substitutability of goods within countries. He also assumes a complete home bias in government expenditures but does not rely on a unitary elasticity substitution between domestic and foreign goods. A domestic fiscal expansion is always beggar-thy-neighbor due to a world wide crowding out of private consumption and a deterioration of the foreign country's terms-of-trade. While the qualitative result of the beggar-thy-neighbor property of fiscal expansions hinges essentially on the assumption of a complete home bias in government expenditures, it is the cross-country substitutability of goods that determines the strength of this effect. With a low degree of substitutability, world wide output available for private consumption is also relatively low. Moreover, the shift towards foreign goods resulting from higher domestic relative prices in the long run is then weak and real revenues of foreign households decrease. This leads to a strong negative effect of a domestic fiscal expansion on foreign welfare.

Ganelli (2003b) analyzes the effects of useful government spending in the *Redux* model. To this aim, he uses a general preference specification on part of the households that assumes non-separability between private and public consumption. An increase in public expenditures then has a direct crowding out effect on private consumption.

As money demand in this model has both a private and a fiscal component, the depreciation of the nominal exchange rate observed in the basic *Redux* model is weakened. Obviously, the introduction of utility enhancing government spending moderates the beggar-thyself-property present in the pure waste case of Obstfeld and Rogoff (1995a).

Though fiscal policy has been studied in the realm of New Open Economy Macroeconomics, most of the contributions investigate the transmission mechanisms and welfare effects of fiscal policy either under flexible exchange rates or in a fixed exchange rate regime. Up to our knowledge, explicit analytical comparisons of alternative exchange rate regimes have not been provided. In a numerical analysis, Carré and Collard (2003) compare the flexible exchange rate case with a monetary union in a cash-in-advance economy. Their model gives some guidance on fiscal policy issues and the role of the exchange rate regime. However, the deeper mechanisms that drive the results are not very transparent due to the lack of analytical solutions.

Pitterle and Steffen (2004a) and (2004b) derive explicit closed form solutions in a simplified version of the CIA model proposed by Carré and Collard (2003), thereby highlighting the welfare driving forces of this approach under flexible exchange rates and a monetary union, respectively.

2.2 Money Demand

In this section we review some attempts to integrate money into general equilibrium models, provide some recent empirical evidence on money demand, and highlight the implications of the scale variable of money demand for the exchange rate movement. In general, any treatment of money demand has to be precise about the concept of money that is being utilized, see McCallum and Goodfriend (1987). In our subsequent analysis of fiscal policy money serves as a medium of exchange, as a store of value, and as a medium of account. We consider a money stock that is close to the definition of the monetary aggregate M1, which comprises currency held by the non-bank public, travellers checks, demand deposits, and other checkable deposits, see Walsh (2000).

2.2.1 Money in General Equilibrium Models

One of the challenging tasks in modern macroeconomics is to integrate money into general equilibrium models. It turned out to be surprisingly difficult to model money without violating the spirit of the general equilibrium approach. Up to now, there is no consensus among researchers how to model the microfoundations of money, see Obstfeld and Rogoff (1999).

One has to be clear about the additional information of monetary elements on the economic problem at issue if introducing money into general equilibrium models is complicated and comes at the cost of low tractability. Indeed, the effects of monetary elements on the real economy are in general only of second-order importance when prices are flexible. The additional insights of monetary models are then weak and money may simply blur the results of the analysis. However, once one allows for nominal rigidities the outcome of monetary models may considerably differ from the ones obtained by real models. Especially in open economy models, nominal variables like the exchange rate alter the international transmission mechanisms of monetary and fiscal policy substantially when prices are sticky. Today, even in the real business cycle literature, which focused originally on technology shocks as the explanatory factors of the business cycle, scholars try to integrate money into the analysis. Early attempts date back to Cooley and Hansen (1989). Cooley and Hansen (1995) provide an overview of advances in the analysis of money and the business cycle.

The most prominent approaches to integrate money into the general equilibrium are money-in-the-utility models, shopping-time-models, and cash-in-advance models.[2] As outlined above, the prevailing microfoundations of money demand in New Open Economy Macroeconomics are money-in-the-utility formulations that were originally proposed by Sidrauski (1967). Real balances are assumed to enhance utility directly as money facilitates transactions. Even though MIU approaches are under criticism as money yields utility by assumption while a specific transaction technology is not considered, the resulting money demand functions are well specified and extremely tractable.

Shopping-time-models that date back to Saving (1971) may illustrate the phenomenon that advocates of the direct utility approach probably have in mind, see McCallum and Goodfriend (1987). It is assumed that consumption purchases take time to be carried out such that the amount of leisure available for the household is reduced. In this setting, real balances are of value for the household because money is assumed to produce transaction services and thereby reduces shopping time.

In an early attempt to introduce money into general equilibrium models, Lucas (1980, 1982) imposes a cash-in-advance constraint on households which was originally proposed by Clower (1967). Cash-in-advance models capture mainly the role of money as a medium of exchange. Under this specification money holdings put a strict upper limit on household's expenditures during a given period. The empirical motivation

[2] Less familiar are money-in-the-production function and real resource costs models. See Walsh (2000) for a textbook treatment of alternative monetary models. Sriram (2001b) provides a survey of the literature on the theory of money demand.

for the cash-in-advance approach can be summarized by Clower's (1967) now famous phrase

> Goods buy money and money buys goods, but goods don't buy goods.

As goods do not buy goods, money serves as a transaction medium. Walsh (2000) points out, that the cash-in-advance constraint is a more direct approach than shopping-time-models to introduce money into general equilibrium models. Some economists feel more comfortable with CIA models because as Niehans (1978) puts it:

> Rather than from direct utility and production, the services of money arise from exchange, being derived from the utility of money spent.

However, cash-in-advance models also face some major criticisms. These are mainly related to the often severe restrictions in terms of timing and interval of transactions and the low sensitivity of money demand to interest rate changes, see Sriram (2001b). Before we turn to a deeper analysis of money demand specifications and their implications for the foreign exchange market, we give a short review of recent empirical evidence on money demand.

2.2.2 Empirical Studies of Money Demand

A survey of recent empirical money demand studies is provided by Sriram (2001a). In his exhaustive survey on empirical papers that deal with the demand for money using error-correction models, Sriram points to the fact that most empirical money demand research is motivated by a blend of theories. As a general consensus, the demand for real balances is given as a function $f(S, OC)$, where S denotes a scale variable and OC the opportunity cost of holding money. While today the topical issue in the empirical literature is the appropriate selection of the opportunity cost variable, the choice of the scale variable is very little controversial and is usually a measure of income such as GDP. However, Calza, Gerdesmeier, and Levy (2001) stress that this is mainly due to measurement problems associated with wealth data.

As outlined above, the choice of the scale variable is important from a theoretical point of view. In a comprehensive theoretical and empirical analysis of alternative money demand specifications, Mankiw and Summers (1986) demonstrate that in Keynesian-type models the effects of fiscal policy are quite sensitive to the choice of the scale variable.[3] The authors point out that in principal all components of GNP - including consumer expenditure, investment spending and government expenditure - may generate money demand. However, the relative significance of these components varies substantially. Mankiw and Summers's (1986) empirical study on the allocation of money to GNP components, which is based on US data of the year 1980, suggests that private consumption expenditure is by far the most important source of overall money demand. At the same time, however, the observed 20 percent share of government expenditure in GNP translates into 9 percent of M1 holdings allocated to this component. In light of the much greater importance of the public sector in European countries this finding suggests that a substantial part of money demand in Europe stems from public sources.

[3]Further empirical studies addressing the question of the right scale variable of money demand are provided by Elyasiani and Nasseh (1994) and Thornton (1988).

2.2.3 Scale Variables and the Exchange Rate Response

In order to illustrate the implications of alternative scale variables of money demand for the exchange rate movement in NOEM models, we may abstract for now from the general equilibrium apparatus that these models apply to the analysis of monetary and fiscal policy. We rather present some insights from a partial analysis of money markets under alternative money demand specifications that imply alternative scale variables, namely money-in-the-utility and a cash-in-advance economy, where taxes enter the constraint.

Money-in-the-utility models typically yield domestic and foreign money demand functions that depend positively on private consumption and negatively on the opportunity cost of holding money, which is generally the rate of return on bonds. As for the scale variable, MIU approaches do not account for possible public components of money demand. We investigate the implications of fiscal policy in a MIU model under alternative exchange rate regimes in chapter 3.

There are two major modelling strategies to overcome problems that are associated with the missing public component in the scale variable of money demand. First, one can impose cash-in-advance constraints not only on private households but also on governments, which is the most direct approach. This strategy is adopted by Sargent (1987), chapter V, Schmitt-Grohé and Uribe (2000), and Pitterle and Steffen (2004c). Second, one can take account of the public component of money demand via a specific cash-in-advance approach, where households need cash to purchase consumption goods *and* to pay taxes. The scale variable of money demand is then total absorption as private consumption and government expenditures affect money demand via its impact on the cash requirements of the household. We address the issue of fiscal policy in this latter type of cash-in-advance economy in chapter 4. For tractability, we opt for a rigid cash-in-advance constraint in the spirit of Carlstrom and Fuerst (2001), where the nominal bond price does not affect money demand.

The issue of alternative specifications of money demand and its implications for the analysis of fiscal policy has been addressed by Chang and Lai (1997) in a Mundell-Fleming framework. Especially the dynamics of the exchange rate hinge crucially on the respective scale variable of money demand. As already insinuated, this is also the case in the NOEM context. We now provide some intuition, why the scale variable of money demand is important for the understanding of exchange rate movements in the light of fiscal policy. In general, the equilibrium exchange rate response following some kind of macroeconomic disturbance is determined simultaneously on the money markets and on the real side of the model that comprises the current accounts, goods markets and labor markets of the respective countries. When modifying the money market clearing conditions, one may substantially change the outcome of the model. Basically, the equilibrium exchange rate response may be reversed when an alternative scale variable of money demand is adopted. This is especially true for the analysis of fiscal policy. In the case of monetary disturbances, the analysis of competing scale variables is of less importance because private consumption is then the only component of overall expenditure.[4]

In anticipation of the subsequent analysis, we now consider the case of an asymmetric fiscal expansion. Relative money demand then substantially differs under the two specifications: In a MIU setup, a fiscal expansion leads to lower relative money demand in the country in which the shock originates, while the opposite is true in

[4]Abstracting from investment goods and their possible cash requirements.

a tax comprising cash-in-advance model. As a result, the equilibrium exchange rate depreciates in the former setting, while it appreciates in the latter. The exchange rate response, in turn, has important implications for the transmission mechanisms and welfare effects of fiscal policy.

According to the empirical findings outlined above, the MIU specification of money demand has the advantage of providing money demand functions that depend positively on the scale variable consumption and negatively on the opportunity cost of holding money. In contrast, the rigid cash-in-advance constraint does not yield money demand functions that depend negatively on the opportunity cost of money but has the advantage of accounting for the public component of money demand. One has to keep in mind, that the opportunity cost of holding money is of low importance when it comes to the assessment of the equilibrium exchange rate. In fact, we will demonstrate in chapter 3.2, that the opportunity cost of holding money does not affect the exchange rate movement at all in the special case of logarithmic preferences over real balances, while it is of second-order influence with more general preferences. In that respect, a cash-in-advance constraint that implies a zero interest elasticity of money demand is justified from a theoretical perspective if the major driving force of the results is the exchange rate movement.

Chapter 3

Fiscal Policy in Money-in-the-Utility Models

3.1 Introduction

The most prominent and innovative feature of the NOEM approach is its rigorously microfounded model framework. While firms set prices and demand labor so as to maximize profits, households maximize intertemporal utility by deciding upon consumption and labor effort. In this chapter we introduce money directly into the utility function of households as it is standard in the NOEM literature. As pointed out in chapter 2 this may be motivated by transaction costs or shopping time requirements. We analyze the transmission mechanisms and welfare effects of asymmetric fiscal policies under both flexible exchange rates and a monetary union regime. The basic setup of the model follows Betts and Devereux (2000) which is the standard reference for NOEM models that allow for pricing-to-market. As Betts and Devereux focus on monetary policy, they identify only some of the positive results of fiscal policy in a two-country general equilibrium model. Moreover, they do not provide a thorough analysis of the welfare effects of asymmetric fiscal policies and do not consider a monetary union framework. The following extensive welfare evaluation of the two alternative exchange rate regimes allows us to highlight the important role of pricing-to-market for the international distribution of welfare gains that are associated with asymmetric fiscal policies.

3.2 MIU under Flexible Exchange Rates

In this section we analyze fiscal policy in a money-in-the-utility setup under a flexible exchange rate regime. We highlight the transmission mechanisms of fiscal shocks and provide a comprehensive welfare evaluation for the two countries. Our focus lies on the pricing behavior of firms and on the sensitivity of the results to the specific form of the MIU framework. Therefore, we retain the isoelastic specification of real balances in the utility function, though we also discuss the logarithmic formulation at length. We do so for the sake of comparability with contributions that assume that real balances enter the utility function logarithmically, as for example the textbook version of the *Redux* model of Obstfeld and Rogoff (1995a) stated in Obstfeld and Rogoff (1999), and its extensions like Tille (2001) and Ganelli (2003b).

3.2.1 The Model

We consider a world that consists of two open economies we refer to as home (h) and foreign (f). All foreign variables will be denoted with an asterisk. The countries are populated by n and $1-n$ households, respectively. World population is thus normalized to one. On the production side, there are n and $1-n$ firms that produce a single differentiated good. Domestic and foreign households interact on the bond market whereas firms trade their goods on the common goods markets. Specifically, we follow Betts and Devereux (2000) and allow for different pricing regimes. A fraction s of firms is able to segment the markets in the two countries, as consumers cannot trade these goods and arbitrage away possible price differences. Thus, the law of one price need not hold for this kind of goods. We assume that these "pricing-to-market" (PTM) firms set prices in the currency of the consumer. The remaining $(1-s)$ goods can be traded by consumers so that any price differences in the two countries are precluded. For this fraction of goods the law of one price will always hold. As the prices of these goods are set in the currency of the producer, we refer to them as PCP (Producer Currency Pricing) goods.

Households

The description of the model will be carried out in detail for the home country. Most of the equations for the foreign country are completely analogous. We assume that households in both countries are infinitely long living and that they have identical preferences, such that the concept of a representative agent can be applied. The representative domestic household maximizes her discounted utility given by

$$U = \sum_{t=0}^{\infty} \beta^t \left[log\, c_t + \frac{\gamma}{1-\epsilon} \left(\frac{m_t}{p_t} \right)^{1-\epsilon} + V(g_t) - \frac{\kappa}{2} h_t^2 \right], \tag{3.2.1}$$

where $\beta \in [0,1]$ denotes the discount factor. Thus, households derive utility from four different sources. Following Sidrauski (1967), real money balances $\frac{m_t}{p_t}$ enter the utility function directly. We integrate real money balances into the utility function in a general isoelastic form, where the parameter $\epsilon \geq 1$ determines both the interest elasticity of money demand and the consumption elasticity of money demand. Specifically, the interest elasticity of money demand is given by $-\frac{\beta}{\epsilon}$, while the consumption elasticity of money demand is $\frac{1}{\epsilon}$. For $\epsilon \to 1$ one obtains the special case of a logarithmic formulation.[1] In contrast to the literature we do not assume that government expenditures g_t are purely dissipative. Instead, they affect private utility in an additively separable way via the function $V(g_t)$, where V is assumed to be a twice differentiable convex function, which monotonously increases in g_t.[2] Households also gain utility from leisure $1 - h_t$. We opt for modelling the implied disutility of labor directly via $-\frac{\kappa}{2} h_t^2$, which is the quadratic cost of effort.[3] Finally, c_t represents a CES real consumption index, which integrates over a basket of goods produced in the domestic economy - denoted with h - and a basket of goods produced in the foreign economy that are denoted with f. Both consumption baskets consist of a fraction s of goods, which are priced to market - denoted with m - and a fraction $(1 - s)$ of goods - denoted with a - for which the law of one price always holds. For instance, $c_t^m(h)$ denotes the representative household's consumption of a domestically produced good that is priced to market. The domestic real consumption index thus reads:

[1] In many NOEM models real money balances enter the utility function logarithmically. While this assumption simplifies the analysis substantially, it has strong implications for the short run equilibrium and the welfare analysis as will be shown later on.

[2] For an analysis of fiscal policy when private and public consumption are not separable, see Ganelli (2003b).

[3] For the sake of a better empirical fit of the model, it is straightforward to extend the model for the more general convex cost of effort $-\frac{\kappa}{1+\varpi} h_t^{1+\varpi}$ as in Tille (2001) . However, the qualitative implications of the model would not change.

$$c_t = \Big[\int_0^{sn} c_t^m(h)^{\frac{\theta-1}{\theta}} dh + \int_{sn}^{n} c_t^a(h)^{\frac{\theta-1}{\theta}} dh + \int_n^{(1-n)s+n} c_t^m(f)^{\frac{\theta-1}{\theta}} df + \int_{(1-n)s+n}^{1} c_t^a(f)^{\frac{\theta-1}{\theta}} df \Big]^{\frac{\theta}{\theta-1}} \quad (3.2.2)$$

The parameter $\theta > 1$ denotes the elasticity of substitution between the differentiated goods, with higher values of θ implying a better substitutability of goods. We assume that the cross-country and within-country substitutability of goods are identical.[4] In deriving the price index p_t, which corresponds to the consumption index (3.2.2), one has to account for the different types of price setting behavior pursued by the domestic and foreign firms. Let $p_t^m(.)$ be the price of an individual PTM good and $p_t^a(.)$ the price of a PCP good. The home country price index is then obtained by minimizing the household's nominal expenditure that buys exactly one unit of the consumption index:[5]

$$p_t = \Big(\int_0^{sn} p_t^m(h)^{1-\theta}\, dh + \int_{sn}^{n} p_t^a(h)^{1-\theta}\, dh + \int_n^{(1-n)s+n} p_t^m(f)^{1-\theta}\, df + \int_{(1-n)s+n}^{1} (p_t^{a*}(f)\, e_t)^{1-\theta}\, df \Big)^{\frac{1}{1-\theta}} \quad (3.2.3)$$

where prices without (with) an asterisk are denoted in home (foreign) currency and e_t represents the nominal exchange rate.[6] Note from (3.2.3), that a pure exchange

[4] Tille (2001) examines the consequences of different elasticities of substitution within countries and between them.

[5] The consumption-based price index for the case of a continuum goods with constant elasticity of substitution is a straightforward extension of the two-good case, which is derived by Obstfeld and Rogoff (1999), p.226ff.

[6] We define the exchange rate in price notation from the perspective of the domestic country.

rate variation will affect the home country price index only through a change of the domestic price of PCP goods produced in the foreign country. The prices of imported PTM goods are directly set in the domestic currency and are therefore not subject to exchange rate fluctuations.

The terms-of-trade, which state the price of a country's exports in terms of its imports, are crucial for the gains from trade, and hence for the evaluation of welfare in models of the open economy. A rising export/import price ratio implies an improvement of the terms-of-trade.

We define the domestic terms-of-trade as follows:

$$\tau_t = \frac{\Gamma_t}{\Gamma_t^* \, e_t} \tag{3.2.4}$$

where the domestic export price index reads

$$\Gamma_t = \Big(\frac{1}{n}\int_0^{sn} (p_t^{m*}(h)\, e_t)^{1-\theta}\, dh + \frac{1}{n}\int_{sn}^{n} p_t^{a}(h)^{1-\theta}\, dh\Big)^{\frac{1}{1-\theta}} \tag{3.2.5}$$

and the foreign export price index (in foreign currency)

$$\Gamma_t^* = \Big(\frac{1}{1-n}\int_n^{(1-n)s+n} \left(\frac{p_t^{m}(f)}{e_t}\right)^{1-\theta} df + \frac{1}{1-n}\int_{(1-n)s+n}^{1} p_t^{a*}(f)^{1-\theta}\, df\Big)^{\frac{1}{1-\theta}} \tag{3.2.6}$$

Households allocate their consumption expenditures optimally between the differentiated goods. This yields the following domestic per capita demand functions for the PTM and PCP goods:[7]

$$c_t^a(h) = \left(\frac{p_t^a(h)}{p_t}\right)^{-\theta} c_t \qquad\qquad c_t^a(f) = \left(\frac{e_t\, p_t^{a*}(f)}{p_t}\right)^{-\theta} c_t \tag{3.2.7}$$

$$c_t^m(h) = \left(\frac{p_t^m(h)}{p_t}\right)^{-\theta} c_t \qquad\qquad c_t^m(f) = \left(\frac{p_t^m(f)}{p_t}\right)^{-\theta} c_t \tag{3.2.8}$$

Remember that the domestic prices of domestic PTM and PCP goods and foreign PTM goods are all set in the domestic currency, while the prices of foreign PCP goods, $p_t^{a*}(f)$, are given in the foreign currency and therefore have to be multiplied by the nominal exchange rate e_t.

We assume, that domestic firms are exclusively owned by domestic households.[8] In every period, households therefore receive profits of the domestic firms Π_t in addition to their labor income $w_t\, h_t$, where w_t denotes the nominal wage per unit of labor. They also have to pay lump-sum taxes $p_t\, T_t$ in every period. The budget constraint of the representative domestic household then reads

$$p_t\, c_t + m_t + R_t\, f_{t+1} = f_t + m_{t-1} + w_t\, h_t + \Pi_t - p_t\, T_t \tag{3.2.9}$$

[7] One obtains (3.2.7) and (3.2.8) by maximizing the consumption index (3.2.2) subject to a standard nominal budget constraint. Combining the resulting expression with the home country price index (3.2.3) gives the representative agent's demand for the different types of goods. See Obstfeld and Rogoff (1999), p.664.

[8] The basic insights of the present and the subsequent models would not change much if one allowed for cross-country ownership of firms, because households are sufficiently small and do not take into account any effects of their individual behavior on profits. The "uncontrolled" effects of short run exchange rate dynamics on wealth, however, would change when relaxing the assumption.

where f_t represents holdings of a nominal one-period bond denominated in home currency and R_t denotes the bond price, which is defined as the inverse of one plus the nominal interest rate. The nominal bond can be freely traded on an international bond market, leading to an equalization of nominal interest rates in terms of the domestic currency. As it is common in the NOEM literature, our timing convention differs for money holdings and bond holdings: Money denoted with t represents holdings of nominal balances in period t, which will be carried over to period $t+1$. Bonds denoted with $t+1$ have been acquired at the beginning of period t and mature at the beginning of period $t+1$.

The representative household maximizes her intertemporal utility described by equation (3.2.1) subject to the budget constraint (3.2.9), taking prices and nominal wages as given. The first-order condition with respect to f_{t+1} yields a standard Euler equation that reveals the household's desire to smooth consumption:

$$\beta\, p_t\, c_t = R_t\, p_{t+1}\, c_{t+1} \tag{3.2.10}$$

Marginal utility of current consumption has to match marginal utility of future consumption - discounted by the time preference β and multiplied by the real interest rate $(1+r_{t+1})$ to capture the intertemporal dimension of the consumption decision.[9]

The optimal labor supply decision is characterized by the labor-leisure trade off

$$\kappa\, h_t = \frac{w_t}{c_t\, p_t} \tag{3.2.11}$$

[9]Following the definition of the nominal bond price ($R_t = \frac{1}{1+i_{t+1}}$), one may rewrite equation (3.2.10) as $\frac{1}{c_t} = \frac{1}{c_{t+1}}\beta(1+r_{t+1})$.

Equation (3.2.11) says that the representative household increases her working time up to the point, where the marginal disutility of an extra unit of labor effort equals the marginal utility of consuming the additional income that this extra unit of labor effort yields.

Finally, we get the money demand equation by deriving the first-order condition with respect to m_t

$$\frac{m_t^d}{p_t} = \left(\frac{\gamma \, c_t}{1 - R_t} \right)^{\frac{1}{\epsilon}} \tag{3.2.12}$$

This is the standard optimality condition for money demand, m_t^d, that arises in money-in-the-utility models of the Sidrauski (1967) type. For each household it is optimal to increase real money holdings as long as the marginal utility of consumption is below the marginal utility of real money holdings. Note that the latter consist of two components: An instant utility gain as money economizes on transaction costs, and a future utility gain, as the extra money holdings may be converted back to consumption in the next period. We see that the demand for real balances depends on private consumption and on the bond price, which is inversely related to the nominal interest rate. Higher consumption levels lead ceteris paribus to an increase in the demand for real balances, as the marginal utility of consumption decreases and additional money holdings become more attractive. An increase in the nominal interest rate raises the opportunity cost of holding non-interest bearing assets and therefore lowers the demand for real balances. Equation (3.2.12) also demonstrates that the sensitivity of the demand for real money holdings to consumption and to nominal interest rates is determined by the parameter ϵ. As pointed out earlier, the calculation of the interest rate elasticity of money demand yields $-\frac{\beta}{\epsilon}$, while the consumption elasticity of money demand can be derived as $\frac{1}{\epsilon}$. Intuitively, higher values of ϵ leave the demand for real balances more insulated from changes in consumption and nominal interest rates.

Optimal behavior of households implies that they utilize their life-time wealth. From iterating the households' budget constraint (3.2.9) and ruling out Ponzi-schemes one obtains the transversality condition[10]

$$\lim_{T\to\infty}\left(\prod_{s=t}^{T} R_s\right)\left(f_{T+1}+\frac{1}{R_T}m_T\right)=0 \tag{3.2.13}$$

which closes the description of the household sector.

National Governments and Central Banks

In every period, the government purchases a bundle of goods g_t. We define the public consumption index analogously to the real consumption indexes of the households.[11] As mentioned above, we assume that households derive utility from government purchases. They enter the household's utility function in an additively separable way via the function $V(g_t)$. With Ricardian equivalence holding in this setup, we can abstract from public debt issues and assume that the government's budget is always

[10] A violation of the transversality condition would imply that individuals could either increase life-time utility by simply consuming a portion of the unused wealth or that they would not be able to pay back accumulated debt.

[11] Corsetti and Pesenti (2001) and Tille (2001) consider a complete home bias in government consumption. Under this specification, the demand stimulating effects of a fiscal expansion fall exclusively on the domestic economy, and spillover effects on the foreign country are likely to be negative.

balanced.[12] Even though the model setup is flexible enough to analyze a variety of shocks, we focus exclusively on fiscal policy and make the assumption that central banks in both countries leave money supplies unchanged:

$$m_t^s = m_{t-1}^s = \bar{m}^s \tag{3.2.14}$$

Therefore, the government cannot resort to seignorage revenues as a means of financing government expenditures, and the sole financing source are taxes. Taxes are levied on consumers in lump-sum form, such that the government budget constraint simply reads

$$g_t = T_t \tag{3.2.15}$$

Thereby, real government expenditures translate directly into real tax payments of the consumers.

Firms

We assume that output of PTM and PCP firms is linear in its only production factor labor, which is immobile between countries. As it is standard in the NOEM literature, we do not consider capital as an input factor. The inherent problem of including capital accumulation in this model context consists in the fact that analytical solutions

[12] See Woodford (1997) for a discussion of the somewhat more stringent than standard assumptions under which Ricardian equivalence holds in monetary models.

cannot be derived. Recall that both types of firms sell their goods on the domestic and the foreign market. In the case of PCP firms, consumers can arbitrage away price differences, such that the law of one price always holds for this type of goods. Therefore we do not have to distinguish between output sold at home and abroad and total production of each domestic PCP firm ($h \in [s \cdot n,\, n]$) is given by

$$y_t^a(h) = h_t^a(h) \tag{3.2.16}$$

Each PCP firm solves the following optimization problem:

$$\max_{p_t^a(h)} \quad \Pi_t^a(h) = p_t^a(h) y_t^a(h) - w_t h_t^a(h) \tag{3.2.17}$$

subject to

$$y_t^a(h) = \left(\frac{p_t^a(h)}{p_t}\right)^{-\theta} n(c_t + g_t) + \left(\frac{p_t^a(h)}{e_t\, p_t^*}\right)^{-\theta} (1-n)(c_t^* + g_t^*) \tag{3.2.18}$$

Total demand of domestic PCP goods $y_t^a(h)$ is the aggregate of domestic households' demand given in equation (3.2.7), its foreign counterpart, and the respective government demand functions that are analogously defined. In contrast to PCP firms, PTM firms ($h \in [0,\, s \cdot n]$) can in principle discriminate between domestic and foreign markets such that prices for their goods - when expressed in the same currency - might differ in the two countries. Dividing total output of each domestic PTM firm into output sold at home, $y_t^m(h)$, and output sold abroad, $y_t^{m*}(h)$, gives

$$y_t^m(h) + y_t^{m*}(h) = h_t^m(h) \tag{3.2.19}$$

PTM firms therefore maximize profits by distinguishing explicitly between demand addressed to them by domestic households and demand by foreign households. For each of the locations of demand they set the profit maximizing price. The optimization problem therefore reads

$$\max_{p_t^m(h),\, p_t^{m*}(h)} \quad \Pi_t^m(h) = p_t^m(h) y_t^m(h) + e_t p_t^{m*}(h) y_t^{m*}(h) - w_t h_t^m(h) \tag{3.2.20}$$

subject to

$$y_t^m(h) = \left(\frac{p_t^m(h)}{p_t}\right)^{-\theta} n(c_t + g_t) \tag{3.2.21}$$

$$y_t^{m*}(h) = \left(\frac{p_t^{m*}(h)}{p_t^*}\right)^{-\theta} (1-n)(c_t^* + g_t^*) \tag{3.2.22}$$

Deriving the optimal price setting rules for both types of firms shows that the optimal price is always given as a markup on nominal production costs:

$$p_t^a(h) = p_t^m(h) = e_t p_t^{m*}(h) = \frac{\theta}{\theta - 1} w_t \tag{3.2.23}$$

Producers dispose of monopoly power because they all produce a single differentiated good. From equation (3.2.23) we see that all domestically produced goods have the same domestic currency price as long as producers are free to set prices. Since the elasticities of demand are the same in both markets, PTM firms will not charge different prices across countries and the law of one price also holds for their goods. Furthermore, all domestic firms face the same marginal production costs, resulting in an equalization of prices for PCP and PTM goods. Thus, when prices are flexible, purchasing power parity always holds and the differentiation between PCP and PTM firms becomes irrelevant. In the light of rigid prices, however, a variation of the nominal exchange rate results in different domestic currency prices of PTM goods sold at home and abroad. Profits in domestic currency from sales of PTM goods in the foreign country fluctuate endogenously in this case: A nominal exchange rate appreciation of the domestic currency lowers nominal revenues in the domestic currency, while a nominal depreciation raises nominal revenues.

Note that a better substitutability between the goods, i.e. a higher level of θ reduces the market power of producers and implies a smaller markup on nominal production costs. Hence, the degree of monopolistic distortion in the economy, which translates into a welfare loss for households, is a decreasing function of θ. In other words, a higher degree of substitutability of the differentiated goods requires a lower consumer price of these goods, which in turn leads to a higher equilibrium level of output.

3.2.2 Positive Analysis of Fiscal Shocks

By now, we have established the structural equations that describe the two model economies. In this section we present the steady state of the model, and the short and long run solution in the presence of nominal rigidities and fiscal shocks. Finally, we derive the output and consumption effects of fiscal policy before proceeding to an explicit welfare analysis in section 3.2.3.

Steady State

We first derive the analytical solution for the zero growth steady state of the two economies in the absence of macroeconomic disturbances. To obtain a closed-form solution we focus on an initial equilibrium, where government expenditures and initial bond holdings are zero in both countries. The derivation of the steady state equilibrium is necessary as the model is non-linear and does not yield closed-form solutions for general paths of the exogenous variables. In order to analyze the effects of fiscal policy, we therefore consider a log-linear approximation around the initial steady state.[13] At the same time, the steady state exercise yields the flexible price solution of the model. Steady state values of variables will be denoted by bars.

As we consider economies that suffer from monopolistic competition on the goods markets, there is room for shifts in aggregate demand to improve overall welfare. We may show this by comparing the steady state output and consumption levels with a social planner's optimum. The assumption of zero initial bond holdings implies that output equals consumption in the initial steady state, i.e. $\bar{h} = \bar{c}$. Combining the household's labor-leisure trade off (3.2.11) and the optimal price-setting rule (3.2.23) of firms yields:

$$\bar{h} = \bar{h}^{*} = \left(\frac{\theta - 1}{\theta\, \kappa}\right)^{\frac{1}{2}} = \bar{c} = \bar{c}^{*} \tag{3.2.24}$$

A social planner interested in maximizing individual utility derived from consumption

[13]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 Marimon and Scott (1999) for alternative approximation methods, and Judd (1998) for numerical solution techniques of dynamic general equilibrium models.

and leisure faces the optimization problem:

$$\max_h U = log\ h - \frac{\kappa}{2} h^2 \tag{3.2.25}$$

with the optimal output and hence consumption level given as:

$$h^{plan} = \left(\frac{1}{\kappa}\right)^{\frac{1}{2}} > \left(\frac{\theta - 1}{\theta\,\kappa}\right)^{\frac{1}{2}} = \bar{h} \tag{3.2.26}$$

As can be seen from equation (3.2.26), steady state production is inefficiently low in the decentralized equilibrium. When deciding on her optimal labor supply, the individual household does not consider the additional profits that arise economy wide from a marginal increase of her labor effort. In other words, the household does not internalize the positive externality which stems from the fact that part of the benefits from his work accrue to other households. From the perspective of an individual firm, it is clear, that there is no incentive to decrease its own price, as the additional sales would not compensate the lower unit revenue.

A social planner, however, could coordinate the behavior of households and firms in a way that goods prices equal marginal costs of production and output reaches its first-best level. Note that the higher is the elasticity of substitution between goods, the closer is the economy to the competitive equilibrium. For the later welfare based evaluation of fiscal policy it is important to keep in mind that a higher consumption level that comes at the price of less leisure is, in principal, welfare enhancing.

From the barred version of the Euler equation (3.2.10) we obtain the steady state relationship between the real interest rate r and the discount factor β:[14]

$$\bar{r} = \frac{1-\beta}{\beta} \tag{3.2.27}$$

We can derive the steady state exchange rate by combining the money market clearing conditions in both countries

$$\bar{e} = \frac{\bar{m}^s}{\bar{m}^{s*}} \left(\frac{\bar{c}^*}{\bar{c}}\right)^{\frac{1}{\epsilon}} \tag{3.2.28}$$

where we made use of purchasing power parity that holds in the steady state. The steady state level of the exchange rate only depends on relative money supplies and the international consumption ratio. Intuitively, higher relative money supply entails a lower relative price of the domestic currency, i.e. a weaker currency. As the money demand specification of money-in-the-utility models is consumption based, a high international consumption differential, i.e. a low $\frac{\bar{c}^*}{\bar{c}}$, implies a stronger currency regardless of the actual international production differential or the respective absorption in the two countries. While interest rates affect money demand of domestic and foreign households, they are not relevant for the determination of the steady state exchange rate. When nominal and real interest rates do not differ in the two countries – and this is the case in the steady state – interest rates cancel out in the calculation

[14]With constant prices, the real interest rate equals the nominal interest rate, which is inversely related to the bond price.

of relative money demand. We come back to the interest rate effects on the exchange rate later on, when interest rate differentials arise.

Long Run Equilibrium

In the previous section, we derived the solution for the zero growth steady state of the model in the absence of macroeconomic disturbances. In this setting, the presence of nominal rigidities only matters in the light of unanticipated macroeconomic shocks of any type. While the model setup may be used for the analysis of monetary, fiscal and technology shocks, we exclusively focus on fiscal policy. We now consider the case where producers have to fix the price of their goods before the occurrence of shocks and may fully adjust the good price in the next period. This feature may be motivated by a menu cost argument, see Obstfeld and Rogoff (1999). We opt for exogenous nominal rigidities as we are interested in analytical solutions of the model, that suffice to illustrate the main implications of fiscal policy in a two country world.[15] Under this assumption, the economies reach the new steady state in period $t+1$, if a shock occurs in period t. From now on we refer to the shock period t as “short run” while the new steady state $t+1$ is labelled “long run”.

Before we get into the analytical solution process, note that the short and long run solutions may be derived almost independently. The essential link between the two periods are nominal bond holdings, that have been accumulated in the short run. We first derive the long run solution of the model depending on endogenous bond

[15] Models that endogenize price rigidities via explicit price adjustment costs like Hairault and Portier (1993) and Carré and Collard (2003) or use Calvo (1983) style price determination as in Kollmann (2001a, 2001b) yield better empirical fits. Though these approaches are richer in structure they hamper the finding of analytical solutions.

holdings. Afterwards, the short run solution is derived taking the solutions for the long run variables as given. Finally, endogenous bond holdings are eliminated from the set of equations and each variable may be stated in terms of the parameters of the model and the exogenous shock variable. The latter will be government expenditures in our analysis. The following set of equations describes the structural equations in the long run. Imposing symmetry on firms the system can be stated in per capita terms.

Money markets

$$\frac{m^s_{t+1}}{p_{t+1}} = \left(\frac{\gamma\, c_{t+1}}{1 - R_{t+1}}\right)^{\frac{1}{\epsilon}} \tag{3.2.29}$$

$$\frac{m^{s\,*}_{t+1}}{p^*_{t+1}} = \left(\frac{\gamma\, c^*_{t+1}}{1 - R_{t+1}\dfrac{e_{t+2}}{e_{t+1}}}\right)^{\frac{1}{\epsilon}} \tag{3.2.30}$$

Equations (3.2.29) and (3.2.30) state the long run money market equilibria, where money supply equals money demand, $m^s_{t+1} = m^d_{t+1}$, and money demand, in turn, is described by the money demand function (3.2.12) and its foreign counterpart. Remember that p_{t+1} and p^*_{t+1} denote the domestic and foreign consumer price indexes expressed in the respective currencies.

Current accounts

$$p_{t+1}(c_{t+1} + g_{t+1}) + R_{t+1} f_{t+2} = p^h_{t+1} y_{t+1} + f_{t+1} \tag{3.2.31}$$

$$p^*_{t+1}(c^*_{t+1} + g^*_{t+1}) + \frac{R_{t+1}}{e_{t+1}} f^*_{t+2} = p^{f*}_{t+1} y^*_{t+1} + \frac{f^*_{t+1}}{e_{t+1}} \tag{3.2.32}$$

The current account identities are given by equations (3.2.31) and (3.2.32). The respective left-hand side sums up per capita nominal expenditure for private consumption, government purchases and bonds. On the respective right-hand side, per capita revenues and maturing bonds add up to total per capita income. The production levels of the representative domestic and foreign firms are given by y_{t+1} and y^*_{t+1}, whereas p^h_{t+1} and p^{f*}_{t+1} are the corresponding goods prices denoted in the respective producer's currency.

Goods markets

$$y_{t+1} = \left(\frac{p^h_{t+1}}{p_{t+1}}\right)^{-\theta} n(c_{t+1} + g_{t+1}) + \left(\frac{p^h_{t+1}}{p^*_{t+1}e_{t+1}}\right)^{-\theta} (1-n)(c^*_{t+1} + g^*_{t+1}) \tag{3.2.33}$$

$$y^*_{t+1} = \left(\frac{p^{f*}_{t+1}}{p^*_{t+1}}\right)^{-\theta} (1-n)(c^*_{t+1} + g^*_{t+1}) + \left(\frac{p^{f*}_{t+1}e_{t+1}}{p_{t+1}}\right)^{-\theta} n(c_{t+1} + g_{t+1}) \tag{3.2.34}$$

Equations (3.2.33) and (3.2.34) describe the long run goods market equilibria. The distinction between PTM and PCP goods becomes obsolete when prices are free to adjust, see equation (3.2.23). The production of a representative firm depends on overall domestic and foreign demand and on the relative good price in the respective market.

Euler equations

$$\beta\, p_{t+1}\, c_{t+1} = R_{t+1}\, p_{t+2}\, c_{t+2} \tag{3.2.35}$$

$$\beta\, p^*_{t+1}\, c^*_{t+1} = R_{t+1}\, \frac{e_{t+2}}{e_{t+1}} p^*_{t+2}\, c^*_{t+2} \tag{3.2.36}$$

The general economic intuition for the Euler equations (3.2.35) and (3.2.36) has already been given when we discussed the optimization problem of the domestic household, see interpretation of equation (3.2.10). As for the foreign Euler equation, we observe that the foreign real interest rate depends additionally on possible exchange rate movements. This is due to the fact that we consider nominal bonds that are denominated in the domestic currency. Foreigners therefore face an exchange rate risk when they engage in a bond trade.

Labor markets

$$\kappa h_{t+1} = \frac{\theta - 1}{\theta} \frac{p^h_{t+1}}{p_{t+1} c_{t+1}} \tag{3.2.37}$$

$$\kappa h^*_{t+1} = \frac{\theta - 1}{\theta} \frac{p^{f*}_{t+1}}{p^*_{t+1} c^*_{t+1}} \tag{3.2.38}$$

The long run labor market conditions (3.2.37) and (3.2.38) close the model. Here, the labor-leisure trade-off stated in equation (3.2.11) is combined with the pricing rule of the firm, see (3.2.23). We thereby eliminate the equilibrium nominal wage w_{t+1}.

In order to derive analytical solutions, the non-linear model is linearized around the pre-shock steady state discussed above. From a technical point of view, we first take a first-order Taylor approximation of the model and then divide the equations by the respective steady state values of the variables. From then on, only the percentage deviations from the steady state values are considered. Steady state deviations of a variable x are denoted by $\tilde{x} = \frac{dx}{\bar{x}}$, where $\bar{x}$ represents the steady state value of x. Government expenditures and bond holdings, which are both zero in the initial steady state, are scaled to steady state world consumption. We introduce the convention that we generally only use the variable name in the explanatory text instead of using the more adequate expression "the deviation of variable x". For the sake of lean exposition, the full log-linear long run system of equations is stated in appendix A.1.

Though the full set of equations is complex, it is possible to derive analytical solutions for the individual variables using the fact that any variable may be expressed as a function of the respective world aggregate and its international differential.[16] For any domestic variable x, its deviation from the initial steady state is given by $\tilde{x} = \tilde{x}^w + (1-n)(\tilde{x} - \tilde{x}^*)$ while for its foreign counterpart $\tilde{x}^* = \tilde{x}^w - n(\tilde{x} - \tilde{x}^*)$ holds.

In a first step, we derive the long run exchange rate response depending on the international consumption differential. To this end, we take differences of the log-linear long run money markets given in appendix A.1. The fundamental relation between the long run exchange rate and the international consumption differential is then given by

$$\tilde{e}_{t+1} = \tilde{p}_{t+1} - \tilde{p}^*_{t+1} = -\frac{1}{\epsilon}(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) \tag{3.2.39}$$

The exchange rate $\tilde{e}_{t+1}$ arises when replacing the difference of the log-linear domestic and foreign long run price levels that follows from the definition of the domestic price index (3.2.3), its foreign counterpart and symmetry of the producers:

$$\tilde{p}_{t+1} = n\tilde{p}^h_{t+1} + (1-n)\tilde{p}^f_{t+1} \tag{3.2.40}$$

and

$$\tilde{p}^*_{t+1} = (1-n)\tilde{p}^{f*}_{t+1} + n\tilde{p}^{h*}_{t+1} \tag{3.2.41}$$

[16] See Aoki (1985) for a detailed discussion of the solution method.

Since the law of one price holds in the long run, subtracting (3.2.41) from (3.2.40) yields the conjectured standard purchasing power parity condition:

$$\tilde{p}_{t+1} - \tilde{p}^*_{t+1} = \tilde{e}_{t+1} \tag{3.2.42}$$

According to equation (3.2.39), a negative consumption differential implies a depreciation of the long run exchange rate as long as monetary policy shocks are absent. As common in money-in-the-utility models, it is only the consumption level that matters for money demand. The nominal exchange rate, which can be interpreted as the relative price of domestic money, therefore only hinges on relative domestic consumption. Furthermore, interest rates do not affect the exchange rate due to nominal interest rate equalization in the long run.

Table 3.1 shows the log-linear differences of the long run current accounts, goods markets and labor markets where $\tilde{\tau}_{t+1} = \tilde{p}^h_{t+1} - \tilde{p}^f_{t+1}$ denotes the long run terms-of-trade.[17] The interested reader may check the equations with the help of appendix A.1. In fact, one simply subtracts the respective foreign equilibrium condition from the domestic one. In the derivation we made use of the bond market clearing condition, $n\, f_{t+1} = -(1-n)\, f^*_{t+1}$, and the steady state property of long run bond holdings implying $f_{t+1} = f_{t+2}$.

[17] The log-linear terms-of-trade follow from equation 3.2.4. A positive $\tilde{\tau}_{t+1}$ implies an improvement of the domestic terms-of-trade.

Table 3.1: Long Run Differences and Terms-of-Trade

$(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) + \frac{dg_{t+1} - dg^*_{t+1}}{\bar{c}^w} - \frac{(1-\beta)df_{t+1}}{\bar{p}\bar{c}^w(1-n)} = (\tilde{y}_{t+1} - \tilde{y}^*_{t+1}) + \tilde{\tau}_{t+1}$
$(\tilde{y}_{t+1} - \tilde{y}^*_{t+1}) = -\theta\,\tilde{\tau}_{t+1}$
$(\tilde{y}_{t+1} - \tilde{y}^*_{t+1}) = -(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) + \tilde{\tau}_{t+1}$

Firstly, the difference of the long run current accounts can be interpreted as follows. On the left-hand side, the expenditure differential is composed of the consumption differential, the government expenditure differential, and a term that captures bond holdings. While the first two components describe the international differential of absorption, the bond term represents the permanent interest payments or income that stem from possible current account imbalances in the short run. On the right-hand side, we see the total income differential that is comprised by the real production differential and the terms-of-trade. Worsening long run terms-of-trade reduce the purchasing power of real production while an improvement has a positive impact.

Secondly, the long run goods market differential gives some intuition for the evolution of the long run production differential. A deterioration of the terms-of-trade implies a rise in domestic relative production due to the associated expenditure switching: Domestic products become more attractive due to a lower relative price. Note that the degree of international substitutability of goods θ, that is attached to the terms-of-trade $\tilde{\tau}_{t+1}$, governs the size of demand deviations stemming from relative price changes.

Finally, the international labor market differential reveals the link between the long run production differential, the consumption differential, and relative price changes indicated by the terms-of-trade $\tilde{\tau}_{t+1}$. A positive production differential goes along with a negative consumption differential because of the labor-leisure trade off of the respective households where high marginal utility of consumption is matched by high marginal utility of leisure. Again, the terms-of-trade correct for price differentials as the domestic (foreign) real wage, that is relevant for the domestic (foreign) households' working effort decision, depends on the domestic (foreign) producer price and on the overall domestic (foreign) consumer price level.

The long run "real side" of the model summarized in table 3.1 is a system of three equations with four endogenous variables, which are the consumption differential, the output differential, bond holdings, and the terms-of-trade. We solve the system of equations simultaneously in order to derive semi-reduced expressions for the consumption and output differential which then read

$$\tilde{c}_{t+1} - \tilde{c}^*_{t+1} = \frac{1+\theta}{2\theta}\,\frac{(1-\beta)df_{t+1}}{\bar{p}\bar{c}^w(1-n)} - \frac{1+\theta}{2\theta}\,\frac{dg_{t+1} - dg^*_{t+1}}{\bar{c}^w} \tag{3.2.43}$$

and

$$\tilde{y}_{t+1} - \tilde{y}^*_{t+1} = -\frac{\theta}{1+\theta}(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) \tag{3.2.44}$$

The long run consumption differential depends on bond holdings and on the government expenditure differential. Negative bond holdings[18] imply permanent interest

[18] In fact, the deviation from steady state bond holdings equals the level of bond holdings as of zero bond holdings in the steady state.

rate payments and hence a negative wealth effect. In the long run flexible price equilibrium households then tend to reduce consumption and to raise effort. A positive government expenditure differential reduces the consumption differential because a greater share of the tax burden that is implied by the overall demand boost falls on domestic households. The mirroring property of the output differential is due to the long run labor-leisure trade off.

Note that equation (3.2.43) provides the necessary link of the long run and short run of the model. In the sequel, we describe the short run equilibrium, where we also derive semi-reduced form equations. A closed form solution of the model results when endogenous bond holdings are eliminated from the two sets of equations.

Short Run Equilibrium

We now turn to the analysis of the short run equilibrium, in which nominal prices are preset and cannot be changed within the period. In the case of PCP goods, prices are fixed in the respective home currency of the selling firm. An unanticipated variation of the nominal exchange rate therefore alters the consumer prices of these goods in the respective foreign country. For this type of goods the law of one price holds even when prices are rigid. On the other hand, the prices of PTM goods are assumed to be fixed in the local currency of the buyer, such that an unexpected exchange rate movement does not affect consumer prices of these goods. Instead, the returns per unit of PTM firms from sales abroad fluctuate in response to exchange rate movements. A depreciation of the producer's currency leads to an increase in revenues, while an appreciation causes a decrease. Hence, in the event of unanticipated exchange rate variations, the law of one price does not hold for PTM goods.

Optimal price setting behavior of the monopolistic firms implies that prices are fixed at a level above marginal costs of production. Therefore, it is profitable for a firm to increase production if it faces additional demand due to an unanticipated shock. Production thus becomes entirely demand determined in the short run as long as marginal revenues are not below marginal costs of production.[19] Since the output level is solely determined on the goods markets and nominal wages adjust to meet the required labor supply, the standard labor market clearing conditions do not bind. Consequently, they can be neglected in the short run equilibrium system. The following set of equations characterizes the short run equilibrium in per capita terms.

Money markets

$$\frac{m_t^s}{p_t} = \frac{m_t^d}{p_t} = \left(\frac{\gamma\, c_t}{1 - R_t}\right)^{\frac{1}{\epsilon}} \tag{3.2.45}$$

$$\frac{m_t^{s*}}{p_t^*} = \frac{m_t^{d*}}{p_t^*} = \left(\frac{\gamma\, c_t^*}{1 - R_t \dfrac{e_{t+1}}{e_t}}\right)^{\frac{1}{\epsilon}} \tag{3.2.46}$$

Current accounts

$$p_t(c_t + g_t) + R_t f_{t+1} = (1-s)p_t^a y_t^a + s(p_t^{mh} y_t^{mh} + e_t p_t^{mh*} y_t^{mh*}) \tag{3.2.47}$$

$$p_t^*(c_t^* + g_t^*) + \frac{R_t}{e_t} f_{t+1}^* = (1-s)p_t^{a*} y_t^{a*} + s(p_t^{mf*} y_t^{mf*} + \frac{p_t^{mf}}{e_t} y_t^{mf}) \tag{3.2.48}$$

Goods markets

$$y_t^a = \left(\frac{p_t^a}{p_t}\right)^{-\theta} n(c_t + g_t) + \left(\frac{p_t^a}{e_t\, p_t^*}\right)^{-\theta} (1-n)(c_t^* + g_t^*) \tag{3.2.49}$$

[19] In the subsequent analysis we concentrate on small shocks such that this case is ruled out.

$$y_t^{a*} = \left(\frac{p_t^{a*}\,e_t}{p_t}\right)^{-\theta} n(c_t + g_t) + \left(\frac{p_t^{a*}}{p_t^*}\right)^{-\theta} (1-n)(c_t^* + g_t^*) \tag{3.2.50}$$

$$y_t^{mh} = \left(\frac{p_t^{mh}}{p_t}\right)^{-\theta} n(c_t + g_t) \tag{3.2.51}$$

$$y_t^{mh*} = \left(\frac{p_t^{mh*}}{p_t^*}\right)^{-\theta} (1-n)(c_t^* + g_t^*) \tag{3.2.52}$$

$$y_t^{mf} = \left(\frac{p_t^{mf}}{p_t}\right)^{-\theta} n(c_t + g_t) \tag{3.2.53}$$

$$y_t^{mf*} = \left(\frac{p_t^{mf*}}{p_t^*}\right)^{-\theta} (1-n)(c_t^* + g_t^*) \tag{3.2.54}$$

Euler equations

$$\beta\, p_t\, c_t = R_t\, p_{t+1}\, c_{t+1} \tag{3.2.55}$$

$$\beta\, p_t^*\, c_t^* = R_t\, \frac{e_{t+1}}{e_t} p_{t+1}^*\, c_{t+1}^* \tag{3.2.56}$$

While the money market equilibrium conditions and the Euler equations resemble those of the long run system, the possibility of pricing-to-market behavior leads to a modification of current accounts and goods markets. As for the current accounts, we have to consider the above mentioned effect that a nominal exchange rate variation changes the unit revenues of PTM firms that stem from their sales abroad while unit returns of PCP producers are unaffected. In the case of PTM producers, we denote demand that originates from the foreign country with an asterisk while h and f point to the origin of production. For instance, $p_t^{mh*} y_t^{mh*}$ represents the revenues of a domestic PTM firm stemming from sales in the foreign market denoted in foreign currency. The goods markets relate the respective production levels of the firms to domestic and foreign demand. We explicitly distinguish between PCP and PTM firms in both countries.

For given long run values, linearized versions of equations (3.2.45) - (3.2.56), together with the linearized short run price indexes, allow us to derive an analytical solution of the effects of fiscal policy.[20] In the light of sticky prices, it is the response of the nominal exchange rate that governs the changes in the international competitiveness of firms and that decides upon the reaction of the terms-of-trade. For both aspects, the degree of pricing-to-market behavior plays a vital role. The short run nominal exchange rate thus turns out to be the major transmission channel of asymmetric fiscal policy. We therefore first derive the reduced form of the short run nominal exchange rate response which only depends on exogenous variables and the parameters of the model.[21] Afterwards, we compute the response of the remaining variables, making use of the solution for the equilibrium exchange rate reaction.

Inspecting the domestic price index (3.2.3) and taking into account that prices are fixed either in the currency of the producer or in the currency of the consumer, one can already deduce that short run price changes can be entirely attributed to movements of the short run nominal exchange rate. Indeed, linearizing the overall short run price indexes for both countries yields

$$\tilde{p}_t = (1-n)(1-s)\tilde{e}_t \tag{3.2.57}$$

$$\tilde{p}_t^* = -n(1-s)\tilde{e}_t. \tag{3.2.58}$$

[20]The linearized versions of equations (3.2.45) - (3.2.56) are stated in appendix A.2.

[21]In a reduced form solution all endogenous variables are eliminated. We also make extensive use of semi-reduced forms for the sake of lean and transparent exposition. The latter approach has the advantage of highlighting the economic intuition of the results.

Equations (3.2.57) and (3.2.58) show that pricing-to-market limits the pass-through of nominal exchange rate movements on price levels in times of sticky prices. In the case of full PTM, i.e. $s = 1$, consumer prices in both countries are entirely insulated from exchange rate movements, implying that both price indexes are fixed on their pre-shock levels. Combining differences of linearized price indexes and linearized money market clearing conditions, yields

$$(1-s)\tilde{e}_t = \tilde{m}_t - \tilde{m}_t^* - \frac{1}{\epsilon}(\tilde{c}_t - \tilde{c}_t^*) - \frac{1}{\epsilon\bar{r}}(\tilde{e}_t - \tilde{e}_{t+1}) \tag{3.2.59}$$

As money supplies are assumed to be constant in both countries, $\tilde{m}_t - \tilde{m}_t^*$ drops out of this equation. Using the long run equilibrium exchange rate (3.2.39) and the difference of the linearized versions of the short run Euler equations (3.2.55) and (3.2.56), gives the short run response of the nominal exchange rate depending only on the short run consumption differential:[22]

$$\big((1-s)\epsilon^2\bar{r} + \epsilon - s\big)\,\tilde{e}_t = -(\epsilon\bar{r}+1)(\tilde{c}_t - \tilde{c}_t^*) \tag{3.2.60}$$

This exchange rate equation stems from the monetary part of the model, in which a negative consumption differential acts towards a depreciation of the exchange rate. Intuitively, a negative consumption differential is associated with a negative real balance differential. This requires, in turn, a positive differential of consumer prices in

[22] The price terms can be eliminated from the difference of the Euler equations by considering the short run price indexes (3.2.57) and (3.2.58) and the long run purchasing power parity condition (3.2.42). Ultimately, the Euler equation differential reduces to $\tilde{c}_{t+1} - \tilde{c}_{t+1}^* = \tilde{c}_t - \tilde{c}_t^* - s\,\tilde{e}_t$.

times of a fixed money supply. Note that a higher degree of pricing-to-market leads to a more pronounced reaction of the exchange rate. This is a direct consequence of the effect mentioned above that pricing-to-market limits the pass-through of nominal exchange rate movements on price levels: To generate a certain differential between $\tilde{p}_t$ and $\tilde{p}_t^*$ a stronger exchange rate reaction is necessary if a higher share of the consumer goods prices is insulated from exchange rate movements.

From equation (3.2.59), it is also possible to derive the relation between the short and long run exchange rate which determines the international nominal interest rate differential.[23] The latter is in turn important for the economic intuition behind the international transmission of fiscal policy. This time, eliminating the short run consumption differential instead of the long run exchange rate response, using again the linearized short run Euler equation differential and the long run exchange rate equation (3.2.39) yields:

$$\frac{\tilde{e}_t}{\tilde{e}_{t+1}} = \frac{\epsilon + \frac{\beta}{1-\beta}}{\epsilon + \frac{\beta}{1-\beta} - (\epsilon - 1)s} \geq 1 \tag{3.2.61}$$

As a rule, expansive fiscal policy generates overshooting of the nominal exchange rate. Only in the special cases of $s = 0$ or $\epsilon = 1$ the short run exchange rate response does not differ from the long run exchange rate response. This is the second indication of our analysis, how pricing-to-market affects the dynamics of nominal exchange rates. As FX markets are generally very volatile, overshooting is a desired feature of theoretical models of the open economy. In contrast, the *Redux* model (the

[23] Remember that the internationally traded nominal bond is denominated in domestic currency. Therefore, the foreign nominal interest rate has to be corrected for a possible over- or undershooting of the exchange rate.

$s = 0$ case) and many of its extensions that stick to the assumption of the law of one price are not capable of generating exchange rate volatility via overshooting.[24] The phenomenon of exchange rate overshooting is closely related to the limited exchange rate pass-through effect of pricing-to-market and is based on quite subtle intertemporal money market equilibrium conditions. One can show that - abstracting from monetary shocks as we do here - both the long run and the short run exchange rate are directly related to the respective short and long run international consumption differential as of the link from real balances to consumption that stems from optimal money demand. The Euler equation differential in turn reveals that short and long run consumption differentials are of equal size when the law of one price holds, because ultimately purchasing power parity applies at any time. It follows, that the long run nominal exchange rate response matches the short run response, i.e. there is no overshooting, with the pass-through of the exchange rate movement into prices being complete.

Turning now to the real part of the model, we can derive a second short run exchange rate equation based on the current accounts and on the goods market clearing equations. Taking differences of the linearized versions of (3.2.47) and (3.2.48) and replacing the individual output differentials via the linearized versions of (3.2.49) - (3.2.54) we arrive at

$$((1-s)(\theta-1)+s)\tilde{e}_t = \tilde{c}_t - \tilde{c}_t^* + \frac{\beta\, df_{t+1}}{\bar{p}\bar{c}^w(1-n)} + \frac{dg_t - dg_t^*}{\bar{c}^w} \tag{3.2.62}$$

[24]Pricing-to-market is not a necessary condition for exchange rate overshooting. It also occurs in NOEM models that allow for a home bias in consumption, see Warnock (2003) and Pitterle and Steffen (2004b).

Holding f_{t+1} and $dg_t - dg_t^*$ constant, a negative consumption differential here works towards an appreciation of the domestic currency. In the case of PCP goods, the impulse towards an appreciation leads to a shift of world demand towards the foreign country, that translates into higher relative real income of foreigners. With complete pricing-to-market, relative consumer prices in both countries remain unchanged, but, at given production levels, the home currency earnings of home firms decline, while the foreign currency earnings of foreign firms increase. All in all, lower relative domestic consumption expenditures are matched by a fall in the domestic households' relative income. The same reasoning applies for debt accumulation and a negative government expenditure differential. Of course, a positive government expenditure differential acts towards a depreciation of the nominal exchange rate and the above argumentation is reversed.

In order to eliminate endogenous bond holdings from equation (3.2.62), we use the long run relationship between consumption, bonds, and government expenditures (3.2.43) derived in the previous section. Combining this equation with the linearized version of the short run Euler equations gives[25]

$$\begin{aligned} &\left((1-s)(\theta-1)+s+\frac{2\theta\, s}{\bar{r}(1+\theta)}\right)\tilde{e}_t = \\ = \; &\left(1+\frac{2\theta}{\bar{r}(1+\theta)}\right)(\tilde{c}_t-\tilde{c}_t^*)+\frac{dg_t-dg_t^*}{\bar{c}^w}+\frac{1}{\bar{r}}\left(\frac{dg_{t+1}-dg_{t+1}^*}{\bar{c}^w}\right) \end{aligned} \tag{3.2.63}$$

We have now derived two exchange rate equations (3.2.60) and (3.2.63) that depend only on the endogenous short run consumption differential and on the exogenous short

[25] We often make use of the steady state relation between the discount factor and the real interest rate stated in equation (3.2.27): $\bar{r} = \frac{1-\beta}{\beta}$.

and long-run government expenditure differentials. Combining these equations, we can eliminate $\tilde{c}_t - \tilde{c}_t^*$ and determine the equilibrium response of the short run nominal exchange rate:

$$\tilde{e}_t = \frac{\dfrac{dg_t - dg_t^*}{\bar{C}^w} + \dfrac{1}{\bar{r}}\dfrac{dg_{t+1} - dg_{t+1}^*}{\bar{C}^w}}{(1-s)(\theta-1) + s + \dfrac{2\,s\,\theta}{(1+\theta)\,\bar{r}} + \dfrac{((1-s)\,\epsilon^2\bar{r} + \epsilon - s)\,(2\,\theta + \bar{r} + \theta\,\bar{r})}{(1+\theta)\,\bar{r}\,(\epsilon\,\bar{r} + 1)}} \tag{3.2.64}$$

The model serves to analyze the effects of fiscal expansions as well as of fiscal consolidations. However, we generally address the consequences of a domestic (relative) fiscal expansion, i.e. the above government expenditure differentials are positive. As $\epsilon \geq 1$, $\theta > 1$, and $0 \leq s \leq 1$, equation (3.2.64) shows that an asymmetric positive shock to domestic government spending will always lead to a nominal *depreciation* of the exchange rate, i.e. it has a positive impulse on $\tilde{e}_t$. A permanent fiscal expansion has a stronger impact on the exchange rate movement than a pure temporary shock. This is due to the fact that households tend to reduce consumption much stronger if they know that the negative policy shock on their disposable income will be permanent. Hence, the adjustment processes described in the following will be much more intense.

To provide an intuition for the depreciation, we step back to the domestic and foreign money markets (3.2.45) and (3.2.46). As the tax burden of the fiscal expansion falls exclusively on domestic households, the short run consumption differential ($\tilde{c}_t - \tilde{c}_t^*$) turns out to be negative.[26] With money supply unchanged, the money market equilibria can be restored via changes in the respective price levels, changes in the

[26]The explicit solutions for domestic and foreign consumption will be derived in the next section.

nominal bond price, or exchange rate overshooting. An adjustment via the nominal bond price is not viable, as a rise or reduction of the equilibrium value affects both money markets in a symmetric way. As pointed out earlier, deviations of consumer price levels in the respective markets stem exclusively from exchange rate movements. In general, a rise of the domestic price level p_t calls for an exchange rate depreciation, as import prices of PCP goods then rise. On the other hand, foreign import prices will decrease thereby lowering the foreign price level. The second viable channel of adjustment is an overshooting of the exchange rate as this phenomenon allows for a nominal interest rate differential. In a world with PTM and PCP producers, i.e. $0 < s < 1$, money market equilibrium is restored via both channels. If all producers price to market, i.e. $s = 1$, consumer prices are unchanged and adjustment is achieved only via exchange rate overshooting. In the absence of pricing-to-market, exchange rate overshooting is precluded, see equation (3.2.61), and equilibrium is exclusively restored via price level changes.

We now address the question how the short run exchange rate response depends on the pricing behavior of firms and on the consumption/interest elasticity of money demand.[27] To this end we conduct a comparative statics analysis for the parameters s and ϵ. In the case of asymmetric domestic fiscal expansions, the numerator of equation (3.2.64) is positive. Then, the derivative of $\tilde{e}_t$ with respect to s is positive as long as

$$\theta^2 - 1 + 2(\epsilon - 1)\,\epsilon\,\theta + \bar{r}\,\epsilon(\theta + 1)(\theta + \epsilon - 2) > 0$$

[27] Remember that the parameter ϵ governs both the consumption and interest rate elasticity of money demand, see notes on equation (3.2.12).

For the assumed parameter space, $\epsilon \geq 1$ and $\theta > 1$, this condition always holds. Thus, a higher fraction of PTM producers amplifies the depreciation of the nominal exchange rate. Since consumer prices of PTM goods are not subject to exchange rate movements, the depreciation has to be more pronounced in order to achieve an equal change in the overall price level. Hence, the possibility of pricing-to-market implies a higher amplitude of the nominal exchange rate which is in line with empirical observations of highly volatile exchange rates in industrial countries.

The derivative of the short run exchange rate response $\tilde{e}_t$ with respect to ϵ is negative as long as

$$(1 + \bar{r}((1-s)\,\epsilon(2 + \bar{r}\,\epsilon) + s)(\bar{r} + \theta(2 + \bar{r})) > 0$$

which also holds for the assumed parameter space. A lower consumption elasticity of money demand, i.e. a higher ϵ, reduces the exchange rate response. If due to the tax burden of fiscal policy domestic consumption is reduced, the required rise of the price level is relatively small for a high value of ϵ. The link between consumption and money demand is then weakened. Keep in mind that, at the same time, the sensitivity of money demand to changes in the opportunity cost of holding money, i.e. changes in the nominal interest rate, becomes lower.

To summarize, an asymmetric domestic fiscal expansion always leads to a depreciation of the short run nominal exchange rate in a standard money-in-the-utility framework. The exchange rate movement required by the money market equilibrium is stronger with permanent expansions, as the crowding out of private consumption is much higher than with only temporary expansions. Second, pricing-to-market increases the amplitude of the exchange rate movement and leads to overshooting basically because of its limiting effect on the exchange rate pass-through to consumer prices. Finally, a high consumption elasticity of money demand implies a strong link of consumption paths and exchange rate movements and thereby also strengthens the short run nominal exchange rate response.

So far, our findings are in line with Betts and Devereux (2000), as we presented an analysis framework that differs only slightly from the authors' model. However, the presented results are quite different to models that build on Obstfeld and Rogoff (1995a) and keep either the very symmetric model setup or do not allow for deviations of the law of one price. Prominent examples for *Redux* style models are Ganelli (2003b, 2003a) for the flexible exchange rate case and Caselli (2001) for fixed exchange rates. While in the former models, exchange rate overshooting simply does not occur, as purchasing power parity always holds, and the amplitude of the nominal exchange rate movement is much lower, the same is obviously true for the later model (exchange rates are fixed!). However, there is also a difference in the fixed exchange rate model, as the respective intervention schemes to fix rates would have to be stronger in the presence of pricing-to-market. Keep in mind that we may approximate the *Redux* style findings by setting the number of PTM firms to zero, i.e. $s = 0$.

Consumption and Ouput Responses

So far, we have derived the implications of an unanticipated domestic fiscal expansion for the short run exchange rate, which provides a convenient basis for the calculation of the responses of the remaining home and foreign variables. From now on, we simplify the exposition of the model by setting foreign government expenditure in every period to zero, $dg^* = 0$. We describe the positive results of the analysis in a twofold manner. While stating the analytical solutions in a semi-reduced form, i.e. depending on the exchange rate response, we also provide a numerical simulation of the model. Every variable will be graphed against the degree of PTM. This allows us to give a general picture of the effects of an asymmetric domestic fiscal expansion and to analyze the role of the firms' pricing behavior.

World Aggregates

Recall that any variable can be expressed through a combination of the respective world aggregate and its international differential. Therefore, we first derive the responses of the short and long run world variables. Deriving world aggregates is also illustrative for the potential of fiscal policy to stimulate production. In general, world aggregates are given as the population weighted sum of the respective home and foreign variables. In levels, the definition of a world variable reads $x^w = n\,x + (1-n)x^*$. With symmetry across countries, one can use the steady state relation $\bar{x}^w = \bar{x} = \bar{x}^*$ to derive $\tilde{x} = n\tilde{x} + (1-n)\tilde{x}^*$. As we have normalized the world population to one, world aggregates correspond with individual averages. It is important to stress that the pricing behavior of firms does not affect the responses of world aggregates. According to the price indexes (3.2.40), (3.2.41), (3.2.57) and (3.2.58), short and long run average prices,[28] that govern world real balances and the average real interest rate, do not depend on the degree of pricing-to-market. As a consequence, neither world consumption nor world production hinge on the assumption about the pricing

[28] For instance, the "world" short run average price index (or more correctly its deviation) would be $\tilde{p}_t^w = n\tilde{p}_t + (1-n)\tilde{p}_t^* = n(1-n)(1-s)\tilde{e}_t + (1-n)(-n(1-s)\tilde{e}_t) = 0$.

behavior of firms.

We start by adding up the population weighted domestic and foreign money market equilibrium conditions in both periods given in appendix A.1 and A.2. Then we combine the resulting equations with the weighted sum of the linearized short run Euler equations. With the average short run price level unchanged, we get the following relation between short run and long run world consumption:

$$\tilde{c}_t^w = \frac{1}{1+\bar{r}} \frac{\epsilon - 1}{\epsilon} \tilde{c}_{t+1}^w \qquad (3.2.65)$$

From (3.2.65), we see that $\tilde{c}_t^w$ and $\tilde{c}_{t+1}^w$ are positively related if $\epsilon > 1$. In the special case of a unit consumption elasticity of money demand ($\epsilon = 1$), the link between short and long run world consumption vanishes and $\tilde{c}_t^w$ remains unchanged. As money supply is fixed in both countries, a variation of short run world consumption can only result from a change of the nominal interest rate or an overshooting of the exchange rate. For $\epsilon = 1$, however, the nominal interest rate does not change and overshooting is precluded, such that the unchanged world money supply translates into unchanged short run world consumption. As pointed out in the beginning of the chapter, logarithmic preferences over real balances are very common in the NOEM literature, see for instance Ganelli (2003b). As will become clear in the subsequent analysis, fiscal expansions have its greatest effect on the economy with logarithmic preferences as there is no crowding out of short run world consumption at all.

Combining population weighted sums of the linearized long run labor markets and current accounts given in appendix A.1 yields the response of long run world production:

$$\tilde{y}^w_{t+1} = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} \tag{3.2.66}$$

Thus, a permanent fiscal expansion stimulates output in the long run. The major mechanism behind this result is that in times of flexible prices domestic households respond to the increased tax burden by supplying more labor. As the labor-leisure trade-off is binding in the long run, they also reduce consumption. Since global demand, which is the sum of private and public consumption, equals global supply, long run world consumption reads

$$\tilde{c}^w_{t+1} = \tilde{y}^w_{t+1} - \frac{n\,dg_{t+1}}{\bar{c}^w} = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} \tag{3.2.67}$$

Technically, this relation can be derived when taking the population weighted sum of the linearized goods markets stated in appendix A.1. In the long run, a permanent fiscal expansion in the domestic economy always leads to a partial crowding out of world private consumption, while temporary expansions leave world consumption on its steady state level. From (3.2.65) and (3.2.67), the response of short run world consumption is

$$\tilde{c}^w_t = -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} \tag{3.2.68}$$

We see that $\tilde{c}^w_t$ is only a function of long run government expenditure. In the case of a temporary fiscal expansion, short run world consumption is not crowded out at all because the model is completely demand-driven in the short run. That is, goods prices are fixed at their pre-shock level and and firms simply satisfy demand as long as they do not run losses. The demand stimulating impact of fiscal policy is therefore not dampened by price increases of firms. If the fiscal expansion is permanent, $\tilde{c}_t^w$ is reduced as long as $\epsilon \neq 1$. With $\epsilon = 1$ however, short run world consumption is not crowded out regardless of the persistence of the shock. This is also reflected in the then stronger reduction of the average or "world" real interest rate,[29] which can be derived from the population weighted sum of the short run linearized Euler equations:

$$\tilde{r}_{t+1}^w = -\frac{n}{2}\left(1 + \frac{1}{\epsilon\,\bar{r}}\right)\frac{dg_{t+1}}{\bar{c}^w} \tag{3.2.69}$$

Permanent fiscal expansions always lead to a reduction in the world interest rate, because it reconciles different short and long run output levels available for consumption in an optimizing framework. In the short run, output is much higher than in the long run because firms may not use their monopolistic power to shorten supply with prices being fixed.

Finally, we can use short run world consumption given by equation (3.2.68) and add short run world government expenditures $n\frac{dg_t}{\bar{c}^w}$ to determine the reaction of short run world production:

$$\tilde{y}_t^w = -\frac{n(\epsilon - 1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + n\frac{dg_t}{\bar{c}^w} \tag{3.2.70}$$

[29]See Warnock (1999) for an analogous result.

The first component on the right-hand side represents the reduction of private world consumption and the second component the rise in domestic government expenditure. A domestic fiscal expansion always stimulates short run world production. The higher the consumption elasticity of money demand, the stronger the expansive effect of fiscal policy.

Before proceeding to the derivation of the individual variables we summarize the major effects of domestic fiscal expansions on world aggregates: A temporary shock only stimulates short run production. Except for $\epsilon = 1$, a permanent shock always leads to a crowding out of both short and long run private consumption thereby limiting the output stimulating effects of fiscal expansions.

Country Specific Effects: Short Run

By combining the responses of the different world aggregates with the respective differentials we can now determine the evolution of consumption and production in both countries. Using (3.2.60) and (3.2.68), we derive the short run responses of domestic and foreign consumption as

$$\begin{aligned} \tilde{c}_t &= \tilde{c}_t^w + (1-n)(\tilde{c}_t - \tilde{c}_t^*) \\ &= -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} - \frac{(1-n)[(1-s)\,\epsilon^2\,\bar{r} + \epsilon - s]}{1+\epsilon\,\bar{r}}\,\tilde{e}_t \end{aligned} \tag{3.2.71}$$

and

$$\begin{aligned} \tilde{c}_t^* &= \tilde{c}_t^w - n(\tilde{c}_t - \tilde{c}_t^*) \\ &= -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + \frac{n[(1-s)\,\epsilon^2\,\bar{r} + \epsilon - s]}{1+\epsilon\,\bar{r}}\,\tilde{e}_t \end{aligned} \tag{3.2.72}$$

where $\tilde{e}_t$ is given by equation (3.2.64). Intuitively, relative domestic consumption declines due to the tax burden of a domestic fiscal expansion that falls exclusively on domestic households. We may also provide an explanation of the consumption responses from a money market perspective. According to (3.2.71) and (3.2.72), we can decompose the responses of home and foreign consumption into a symmetric world effect and a price effect stemming from the exchange rate response, that drives a wedge between domestic and foreign short run consumption. When analyzing the relation between the exchange rate movement and the consumption responses in equilibrium, we may distinguish between the pure PCP ($s = 0$) and the pure PTM ($s = 1$) case. For $s = 0$, the short run depreciation of the exchange rate causes an increase of the domestic consumer price level and a fall of the foreign consumer price level. By the money market equilibrium conditions, the lower (higher) level of real balances of domestic (foreign) households implies a decrease (increase) of domestic (foreign) consumption. For $s = 1$, consumer price levels in both countries are unaffected by the exchange rate movement (all prices are fixed in the currency of consumers!), yet the overshooting of the short run exchange rate in the presence of pricing-to-market leads to a relatively lower nominal interest rate in the domestic economy. Money market equilibrium again requires a fall in relative domestic consumption. In the polar case of full pricing-to-market and a unit consumption elasticity of money demand, the money market equilibrium conditions lead to the extreme case of symmetric consumption responses following asymmetric fiscal policy.

In order to assess the overall effects on short run consumption we resort to a numerical simulation of the model. We consider a one percent *permanent* increase in domestic government expenditure and graph the respective variable of interest against the degree of pricing-to-market, which is captured by the parameter s.[30] For simplicity, the two countries are assumed to be of the same size, i.e. $n = 0.5$. The remaining parameters of the model are specified so as to be in line with the literature on open economies. Specifically we follow Sutherland (1996) and Warnock (1999) in assuming an elasticity of substitution between individual goods of $\theta = 6$ and a discount factor $\beta = 0.95$, that implies an annual real rate of return of $\bar{r} \approx 0.05$. In our benchmark case, we set $\epsilon = 9$, which yields an interest elasticity of money demand of $-\frac{\beta}{\epsilon} \approx -0.1$. While this choice of ϵ matches the empirical consensus on very low interest elasticities of money demand, see e.g. Mankiw and Summers (1986), the implied consumption elasticity is below the values reported in the empirical literature on money demand. We will discuss the sensitivity of the model to the choice of ϵ in more detail in section 3.2.3.

In figure 3.1, domestic and foreign short run consumption responses are graphed against the degree of PTM (s) for the case that domestic government expenditures rise permanently by one percent, i.e. $\frac{dg_t}{\bar{c}^w} = \frac{dg_{t+1}}{\bar{c}^w} = 1\%$. To be more precise, the percentage deviation of domestic and foreign consumption from their respective steady state levels are plotted on the axis of ordinates, while each tick on the abscissae implies a different degree of PTM ($s \in [0, 1]$). Figure 3.1 illustrates that a permanent domestic fiscal expansion reduces short run domestic consumption while foreign consumption is raised regardless of the degree of pricing-to-market. A higher degree of PTM implies less reduction of domestic short run consumption and a lower increase of foreign consumption.

[30] If not otherwise stated, the subsequent graphical illustrations all refer to permanent domestic fiscal expansions.

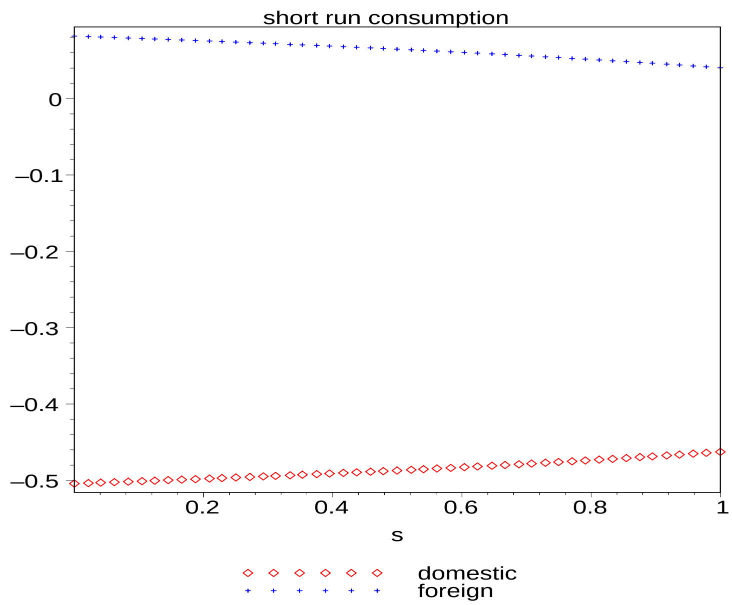


Figure 3.1: Effect of $s \in [0, 1]$ on short run consumption.

From the linearized short run current accounts and goods markets stated in appendix A.2 one can derive the international production differential:[31]

$$\tilde{y}_t - \tilde{y}_t^* = \theta(1 - s)\tilde{e}_t \tag{3.2.73}$$

Combining (3.2.70) and (3.2.73) then gives the response of short run production in both countries:

$$\tilde{y}_t = -\frac{n(\epsilon - 1)}{2\,\epsilon(1 + \bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + n\,\frac{dg_t}{\bar{c}^w} + \theta(1 - s)(1 - n)\,\tilde{e}_t \tag{3.2.74}$$

$$\tilde{y}_t^* = -\frac{n(\epsilon - 1)}{2\,\epsilon(1 + \bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + n\,\frac{dg_t}{\bar{c}^w} - \theta(1 - s)\,n\,\tilde{e}_t \tag{3.2.75}$$

[31] The calculations are not very difficult. However, it takes some time and discipline to eliminate the respective production and price terms to arrive at the very simple solution stated in the text.

Equations (3.2.74) and (3.2.75) illustrate very nicely that short run production is completely demand driven. Initially, both the reduction of world private consumption and the increase in world government expenditures fall symmetrically on both countries. The depreciation of the exchange rate, however, gives rise to an expenditure switching effect. As domestic PCP goods become relatively cheaper for consumers located in the foreign country and foreign PCP goods relatively more expensive for domestic consumers, world demand is redirected towards domestic firms. In the short run, domestic output thus always exceeds foreign output except for $s = 1$. The magnitude of the expenditure switching effect hinges both on the fraction of PCP firms and on the degree of substitutability between the goods. The evolution of short run production depending on the degree of PTM is depicted in figure 3.2. As postulated, pricing-to-market narrows the gap between domestic and foreign short run production.

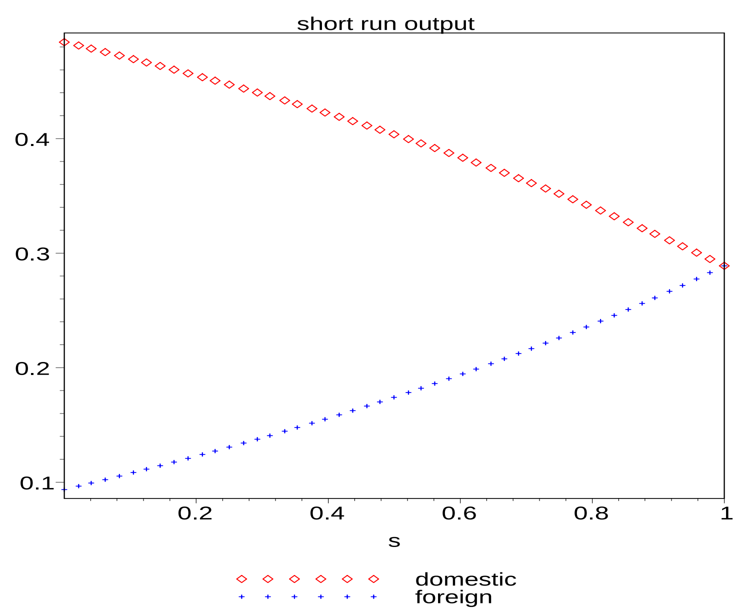


Figure 3.2: Effect of $s \in [0, 1]$ on short run output.

Linkage between Long and Short Run: The Trade Balance

When analyzing the long run equilibrium, we have stressed the role of bond holdings as the essential linkage between the short and the long run. Hence, before turning to the long run responses of consumption and production, we determine the reaction of the trade balance. Analogously to the derivation of the short run exchange rate that stems from the current accounts and goods markets, see equation (3.2.63), we combine the long run consumption differential (3.2.43) with the short run Euler equations and the short run consumption differential implicitly given by equation (3.2.62). After some manipulations, the response of the trade balance can be stated in terms of the endogenous short run exchange rate response and exogenous government spending:

$$\frac{df_{t+1}}{\bar{p}\bar{c}^w} = -\frac{(1-n)2\theta(1+\bar{r})\epsilon(1+\bar{r}s+\bar{r}\epsilon(1-s))}{(1+\theta)\bar{r}(1+\bar{r}\epsilon)}\tilde{e}_t + \frac{(1-n)(1+\bar{r})}{\bar{r}}\frac{dg_{t+1}}{\bar{c}^w} \quad (3.2.76)$$

Equation (3.2.76) shows that in the case of a temporary fiscal expansion, i.e. $\frac{dg_{t+1}}{\bar{c}^w} = 0$, the trade balance always deteriorates, as domestic individuals finance part of their short run consumption by selling bonds to foreigners. With permanently higher government expenditures in the domestic country the situation is more complicated. The depreciation of the nominal exchange rate is then stronger and amplifies the negative response of bond holdings. However, the second term on the right-hand side of equation (3.2.76) reveals the fact that the need of consumption smoothing of domestic households is lower than with a temporary government spending shock, which leads to a weaker reaction of the trade balance. Loosely speaking, households face a similar income situation in the short and long run if the tax burden is permanent. In our benchmark case of $\epsilon = 9$, which is depicted in figure 3.3, the effect on the trade balance is negative for any degree of pricing-to-market. A higher fraction of

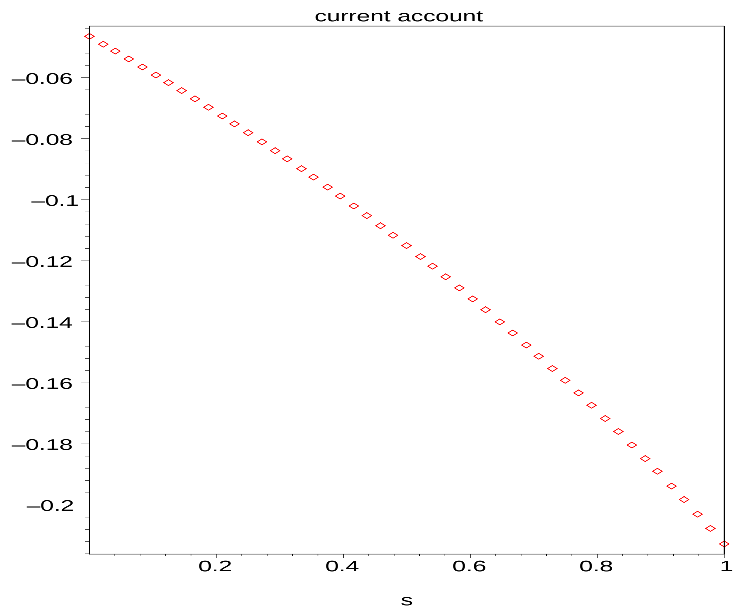


Figure 3.3: Effect of $s \in [0, 1]$ on the short run trade balance.

PTM goods implies less expenditure switching towards domestic goods. Intuitively, domestic households then resort to higher debt financing of consumption purchases.

Country Specific Effects: Long Run

Having established the effect of a domestic fiscal expansion on the short term trade balance response, we can proceed to the derivation of the long run consumption and output effects. From the long run consumption differential (3.2.43), long run world consumption (3.2.67), and the trade balance response (3.2.76) we can derive the long run responses of domestic and foreign consumption

$$\tilde{c}_{t+1} = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} - \frac{(1-n)[(1-s)\,\epsilon^2\,\bar{r} + \epsilon + s\bar{r}\epsilon]}{1+\epsilon\,\bar{r}}\,\tilde{e}_t \tag{3.2.77}$$

and

$$\tilde{c}^*_{t+1} = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} + \frac{n[(1-s)\,\epsilon^2\,\bar{r} + \epsilon + s\bar{r}\epsilon]}{1+\epsilon\,\bar{r}}\,\tilde{e}_t \tag{3.2.78}$$

With the fiscal expansion being permanent, domestic long run consumption is below steady state as illustrated in figure 3.4(a). Even in the case of a temporary shock domestic households reduce long run consumption, as they have to pay interests on bonds that have been accumulated in the short run. In the foreign country, long run consumption is always higher than in the steady state, see figure 3.4(b). A higher share of PTM producers raises foreign long run consumption, as the positive wealth effect on foreign households, that is implied by the trade balance response, becomes stronger.

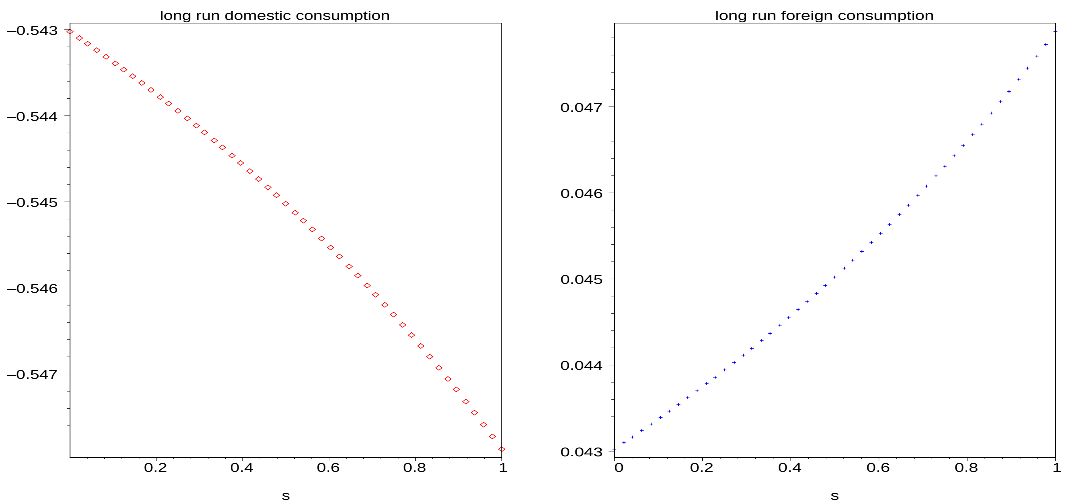
Finally, we can calculate long run production in both countries by combining the long run output differential (3.2.44) with the correspondent world aggregate (3.2.66) as

$$\tilde{y}_{t+1} = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} + \frac{(1-n)\,\theta\,[(1-s)\,\epsilon^2\,\bar{r} + \epsilon + s\bar{r}\epsilon]}{(1+\theta)(1+\epsilon\,\bar{r})}\,\tilde{e}_t \tag{3.2.79}$$

and

$$\tilde{y}^*_{t+1} = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} - \frac{n\,\theta\,[(1-s)\,\epsilon^2\,\bar{r} + \epsilon + s\bar{r}\epsilon]}{(1+\theta)(1+\epsilon\,\bar{r})}\,\tilde{e}_t \tag{3.2.80}$$

Figures 3.5(a) and 3.5(b) show the evolution of domestic and foreign production. In the long run, domestic households face a negative wealth effect. In the case of a

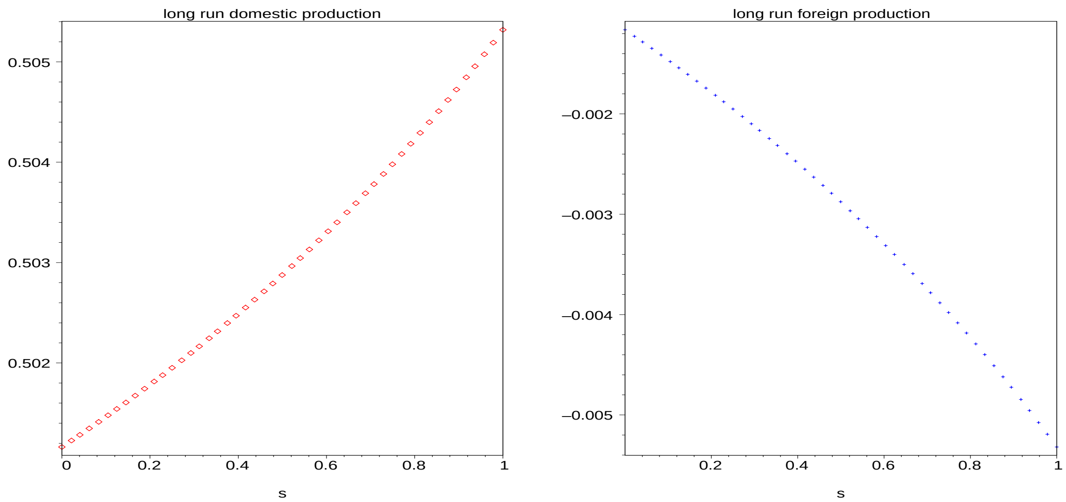


(a) Long run domestic consumption

(b) Long run foreign consumption

Figure 3.4: Effect of $s \in [0, 1]$ on long run consumption.

permanent shock, they are confronted with both a higher tax burden and interest payments to foreigners. According to the labor-leisure trade-off they respond by increasing labor supply. Domestic production is therefore always higher in the long run than in the initial steady state. In the foreign country, the permanent interest income has a negative effect on labor supply and hence production. If the fiscal shock is permanent, however, foreign producers also face higher demand for their products due to the stimulation of world demand. This is reflected by the first term on the left-hand side of equation (3.2.80). All in all, the competing effects under permanent expansions are almost offsetting and the response of foreign long production is only slightly negative. Having established the positive effects of a domestic fiscal expansion, we now turn to an explicit welfare evaluation of the consumption and output responses.



(a) Long run domestic production (b) Long run foreign production

Figure 3.5: Effect of $s \in [0, 1]$ on long run production.

3.2.3 Welfare Analysis of Fiscal Shocks

As our model is based on explicitly optimizing agents, the welfare analysis of fiscal policy does not rely on ad hoc welfare criteria like in Mundell-Fleming-type models, but on the specified utility function of the households. For tractability and for the sake of a lean exposition, we first derive the welfare implications of a domestic fiscal expansion for a utility function where real balances enter in a logarithmic formulation, that is $\epsilon = 1$. Later on, we check for the robustness of the results allowing for higher values of ϵ so as to get closer to empirical estimates of the interest elasticity of money demand.

Welfare Effects in the Logarithmic Case

When real balances enter the utility function logarithmically, the positive analysis is greatly simplified. Table 3.2 states the equilibrium values of consumption and output in the short and long run as well as the trade balance response and the short run exchange rate. As for output stimulation, domestic fiscal policy has full impact

Table 3.2: Positive Analysis for $\epsilon = 1$

$\tilde{c}_t^w = 0$	$\tilde{y}_t^w = n\,\frac{dg_t}{\bar{c}^w}$
$\tilde{c}_{t+1}^w = -\frac{n}{2}\,\frac{dg_{t+1}}{\bar{c}^w}$	$\tilde{y}_{t+1}^w = \frac{n}{2}\,\frac{dg_{t+1}}{\bar{c}^w}$
$\tilde{c}_t = -(1-n)(1-s)\,\tilde{e}_t$	$\tilde{c}_t^* = n(1-s)\,\tilde{e}_t$
$\tilde{y}_t = n\,\frac{dg_t}{\bar{c}^w} + \theta(1-n)(1-s)\,\tilde{e}_t$	$\tilde{y}_t^* = n\,\frac{dg_t}{\bar{c}^w} - \theta\,n(1-s)\tilde{e}_t$
$\tilde{c}_{t+1} = -\frac{n}{2}\,\frac{dg_{t+1}}{\bar{c}^w} - (1-n)\,\tilde{e}_t$	$\tilde{c}_{t+1}^* = -\frac{n}{2}\,\frac{dg_{t+1}}{\bar{c}^w} + n\,\tilde{e}_t$
$\tilde{y}_{t+1} = \frac{n}{2}\,\frac{dg_{t+1}}{\bar{c}^w} + \frac{(1-n)\,\theta}{1+\theta}\,\tilde{e}_t$	$\tilde{y}_{t+1}^* = \frac{n}{2}\,\frac{dg_{t+1}}{\bar{c}^w} - \frac{n\,\theta}{1+\theta}\,\tilde{e}_t$
$\frac{df_{t+1}}{\bar{p}\bar{c}^w} = -\frac{(1-n)(1+\bar{r})}{\bar{r}}\left(\frac{2\theta}{1+\theta}\,\tilde{e}_t - \frac{dg_{t+1}}{\bar{c}^w}\right)$	$\tilde{e}_t = \frac{\bar{r}(1+\theta)\frac{dg_t}{\bar{c}^w} + (1+\theta)\frac{dg_{t+1}}{\bar{c}^w}}{\bar{r}\left((1-s)\theta^2+\theta+s\right)+2\theta}$

on short run world output with $\epsilon = 1$ no matter if the expansion is temporary or permanent. This follows from the fact that short run world consumption is not crowded out at all. Since output is suboptimally low due to monopolistic distortions, short run world welfare is likely to be improved. In the long run, world output and consumption are only affected if the fiscal expansion is permanent. Then, only half of a permanent fiscal expansion translates into additional output while world consumption is subdued. Hence, the expansive effects are substantially lower in the long run, when the fiscal expansion is anticipated and prices are free to adjust.

As it is standard in the literature of NOEM models with money-in-the-utility, we focus on the real components of utility as the monetary component is likely to be small.[32] That is, possible shifts in real balances, that may arise via price changes, do not enter our welfare analysis of fiscal policy. Furthermore we follow Tille (2001) in assuming that government expenditure yields the same utility as steady state consumption at the margin, i.e. $V'(g_t) = (\bar{c})^{-1} = (\bar{c}^w)^{-1}$. If government expenditure were purely dissipative as for example in Betts and Devereux (2000), the tax-induced negative welfare effect on domestic households would always dominate the welfare effects of pricing-to-market, that are at the focus of the analysis. Although our approach is a polar case, it simply scales the results without loss of information because government expenditures enter the utility function additively. Importantly, the welfare results for the foreign country are independent of this specification. Totally differentiating the household's utility function (3.2.1) yields for any period t:

$$\begin{aligned} dU_t &= \tilde{c}_t - \kappa\,\bar{h}^2\,\tilde{h}_t + V'(g_t)dg_t \\ &= \tilde{c}_t - \frac{\theta-1}{\theta}\,\tilde{h}_t + \frac{dg_t}{\bar{c}^w} \end{aligned} \tag{3.2.81}$$

where we made use of the steady state value of output given by equation (3.2.24).[33]

[32]See for instance Obstfeld and Rogoff (1995a).

[33]Models like the one employed by Betts and Devereux (2000), where leisure enters the utility

As opposed to the positive results, we derive the absolute deviation of welfare from its steady state value dU instead of the usual relative formulation. This approach greatly simplifies the exposition of our results. It is important to note that the degree of monopolistic competition, that is represented by the elasticity of substitution of goods (θ), decides upon the relative weight of leisure in the process of utility evaluation. Intuitively, a low substitutability of the differentiated goods implies a low steady state output level and hence a low marginal disutility of labor. At the same time, marginal utility of consumption will be high.

Before deriving the welfare effects of fiscal policy on the individual countries we state the effects on world welfare. This approach turns out to be advantageous, since world aggregates are independent of the pricing behavior of firms. The asymmetric distribution of world welfare among the respective countries in turn hinges crucially on the degree of pricing-to-market. Taking weighted averages of equation (3.2.81) and its foreign counterpart yields the world welfare equation for any period t:

$$dU_t^w = \tilde{c}_t^w - \frac{\theta - 1}{\theta} \tilde{h}_t^w + n \, \frac{dg_t}{\bar{c}^w} \tag{3.2.82}$$

Hence, world welfare in every period can be expressed exclusively in terms of world consumption, world labor effort, and world government spending. Plugging in the respective solutions for output and consumption stated in table 3.2 we get the effects on short and long run world welfare:[34]

function in the form $\eta \log(1 - h_t)$, yield exactly the same total utility differential in log-linear form.

[34] Remember that country specific and hence world labor effort equals the respective output level as output is a linear function of labor effort, see equations (3.2.16) and (3.2.19). Therefore, we get the direct link $\tilde{h}_t^w = \tilde{y}_t^w$.

$$dU_t^w = \frac{1}{\theta}\, n\, \frac{dg_t}{\bar{c}^w} \tag{3.2.83}$$

$$dU_{t+1}^w = \frac{1}{\theta}\, \frac{n}{2}\, \frac{dg_{t+1}}{\bar{c}^w} \tag{3.2.84}$$

Due to the stimulation of output, a permanent domestic fiscal expansion raises world welfare both in the short and in the long run, while a temporary shocks has a positive effect only on short run world welfare. As crowding out of private consumption is lower in the short run than in the long run, the expansive effect of fiscal policy on world output is larger in the former case. With rigid prices the expansive effect of fiscal policy is not counteracted by supply side adjustments, namely producers accept a suboptimally low mark-up on marginal costs. Therefore, the positive effect on world welfare is more pronounced in the short run than in the long run.

As the new steady state is reached in period $t+1$, the long run solution of the model is also valid for the subsequent periods. Discounted overall world welfare Ω_t^w is then given by:

$$\begin{aligned} d\Omega_t^w &= dU_t^w + \frac{1}{\bar{r}}\, dU_{t+1}^w \\ &= \frac{n}{\theta} \frac{dg_t}{\bar{c}^w} + \frac{n}{2\,\theta\,\bar{r}} \frac{dg_{t+1}}{\bar{c}^w} \end{aligned} \tag{3.2.85}$$

Equation (3.2.85) reveals that a domestic fiscal expansion always raises world welfare regardless of the pricing behavior of firms.[35] A higher degree of substitutability between the differentiated goods (θ) implies lower world welfare gains. The monopolistic

[35] Note, that world welfare actually declines if government expenditures are purely dissipative as in Obstfeld and Rogoff (1995a).

distortion in the steady state is then lower and there is less room for welfare improving policies. From (3.2.85) it is also clear that the welfare gains are much larger if the fiscal expansion is not only temporary but permanent. In the case of a temporary shock, world production already drops in period $t+1$ to its inefficiently low initial steady state level. In contrast, if the fiscal shock is permanent, world output remains persistently above the initial steady state level.

We now turn to the question, how the overall world welfare gain is distributed among the domestic and the foreign country, and how welfare is accrued to the respective periods. We start by analyzing the short and long run welfare implications for both countries before proceeding to the overall welfare impact of fiscal policy. Using the definition of welfare (3.2.81) and replacing the respective home and foreign short run output and consumption responses given in table 3.2 we derive

$$dU_t = -\frac{n(\theta-1)}{\theta}\,\frac{dg_t}{\bar{c}^w} - (1-n)(1-s)\,\theta\,\tilde{e}_t + \frac{dg_t}{\bar{c}^w} \tag{3.2.86}$$

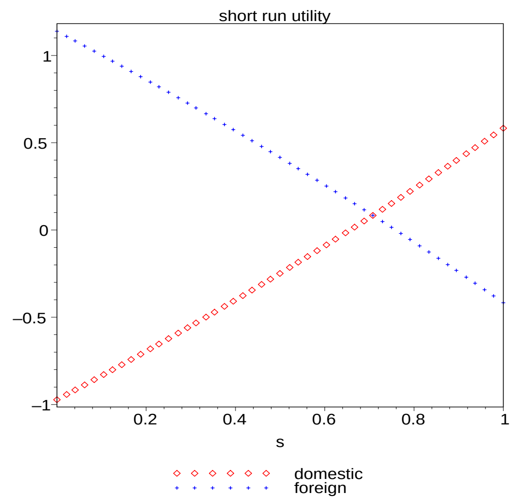
and

$$dU_t^* = -\frac{n(\theta-1)}{\theta}\,\frac{dg_t}{\bar{c}^w} + n\,(1-s)\,\theta\,\tilde{e}_t \tag{3.2.87}$$

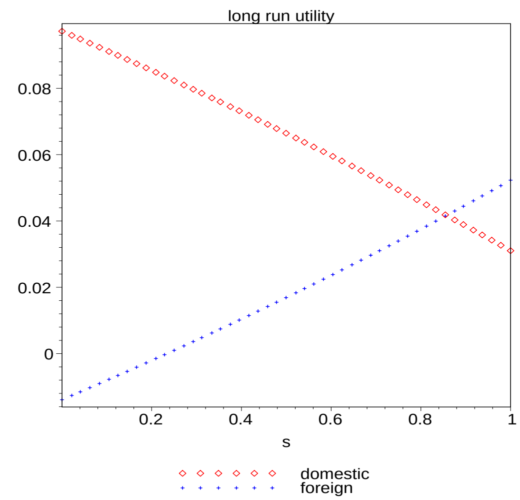
where the exchange rate response is also stated in table 3.2. We may decompose the short run welfare effects into symmetric and asymmetric components. For given prices, the increase in aggregate world demand translates into equally higher production in both countries. The first term on the respective right-hand-side of equations (3.2.86) and (3.2.87) reflects the negative welfare effects of the associated higher labor effort. The exchange rate terms of the above equations capture the expenditure switching effect towards domestic goods and the short run consumption effects of the fiscal expansion. As domestic (foreign) households then have to work more (less) and reduce (raise) consumption because the tax burden falls exclusively on domestic households, the exchange rate movement lowers (increases) domestic (foreign) welfare. For $s = 1$, neither expenditure switching occurs nor do domestic and foreign consumption deviate from their steady state values, see table 3.2. In this special case, domestic households finance the increased tax burden entirely via the issuance of bonds instead of increased working effort. This leads to the fact that short run domestic welfare is at its maximum with complete pricing-to-market. Obviously, the consequence are higher welfare losses in the long run because of higher permanent interest payments. We will come back to the intertemporal welfare pattern later on. Finally, the increase in domestic government expenditures $\frac{dg_t}{\bar{c}^w}$ has a direct positive effect on domestic welfare.

Aggregating the competing effects gives the evolution of short run welfare which is depicted in figure 3.6(a).[36] Due to the combined effects on output and consumption domestic (foreign) welfare is a positive (negative) function of the degree of pricing-to-market (s). Thus, the pricing behavior of firms decides upon the short run distribution of welfare. With complete pricing-to-market, the domestic country is better off than the foreign country. Intuitively, domestic income rises due to the positive effect of the exchange rate depreciation on domestic revenues without increasing domestic labor effort. For smaller values of s, the distribution of welfare is reversed because of the stronger welfare effects of the exchange rate depreciation.

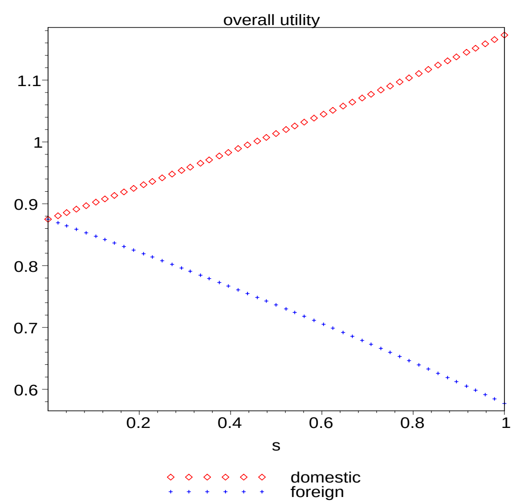
[36]Note that we stress the effects of pricing-to-market on the welfare implications of fiscal expansions. Therefore we always give graphical illustrations of the variable at stake depending on the parameter s which rules the degree of PTM. Furthermore, keep in mind that the graphical illustrations are generally given for permanent fiscal expansions if not otherwise stated.



(a) Short run utility



(b) Long run utility



(c) Overall utility

Figure 3.6: Welfare effects of a permanent shock, $\epsilon = 1$ (MIU)

Analogously to equations (3.2.86) and (3.2.87), we can calculate the absolute deviation of long run domestic and foreign welfare from their steady state value as:

$$dU_{t+1} = -\frac{n(2\theta-1)}{2\theta}\frac{dg_{t+1}}{\bar{c}^w} - \frac{2\,\theta\,(1-n)}{\theta+1}\,\tilde{e}_t + \frac{dg_{t+1}}{\bar{c}^w} \tag{3.2.88}$$

and

$$dU^*_{t+1} = -\frac{n(2\theta-1)}{2\theta}\frac{dg_{t+1}}{\bar{c}^w} + \frac{2\,\theta\,n}{\theta+1}\,\tilde{e}_t \tag{3.2.89}$$

In the case of a temporary expansion ($\frac{dg_{t+1}}{\bar{c}^w} = 0$) domestic households suffer a welfare loss while foreign households are better off. The driving force for this result is the reaction of the trade balance given in table 3.2. With unit consumption elasticity of money demand and temporary shocks, the trade balance always deteriorates which implies a negative wealth effect on domestic households in the long run via permanent interest payments.

In general, a permanent domestic fiscal expansion improves long run welfare in both countries, see figure 3.6(b). This is mainly a consequence of the demand stimulating effect of long run government expenditures. However, the evolution of long run welfare also depends on the short run trade balance response which is governed by the degree of pricing-to-market. The numerical illustration given in figure 3.7 reveals that, in contrast to temporary shock, a permanent fiscal expansion yields in general a positive response of the trade balance except for very high fractions of PTM producers.[37]

[37] The trade balance effect is unambiguously negative in our benchmark case, where $\epsilon = 9$.

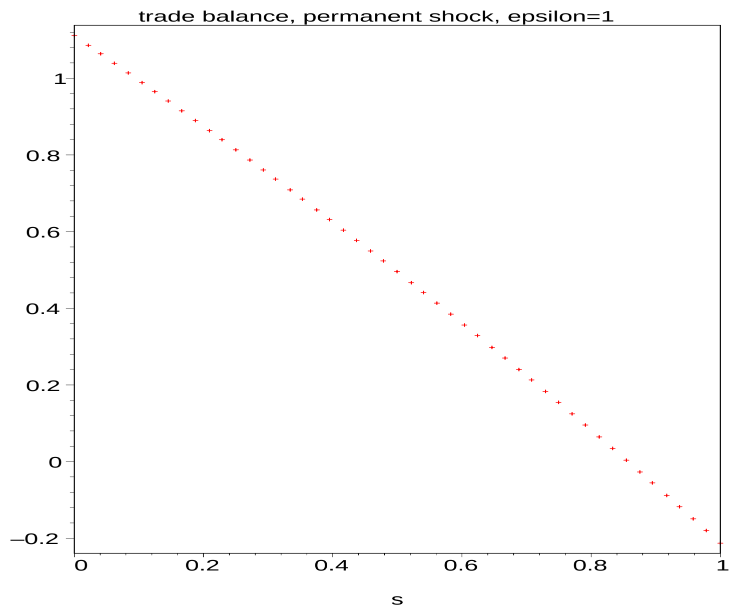


Figure 3.7: Effect of $s \in [0, 1]$ on the trade balance.

Take the case of $s = 1$: Short run domestic consumption is then unchanged and domestic production rises by $\frac{n\, dg_t}{\bar{c}^w}$. As the real tax burden amounts to $\frac{dg_t}{\bar{c}^w}$, domestic households are in the need of issuing bonds – hence the deficit.[38] A decreasing share of PTM producers raises domestic production in real and nominal terms via expenditure switching. At the same time, nominal consumption expenditure remains unchanged as price and quantity effects of the exchange rate depreciation are exactly offsetting. One can derive this result from the short run "real" consumption response $\tilde{c}_t$ given in table 3.2 and the short run domestic price level deviation from the steady state given in equation (3.2.57). Therefore, with lower values of s the domestic country runs a trade balance surplus which translates into long run welfare gains of domestic households.

[38]As a second order effect, the depreciation of the exchange rate raises nominal income from exports whereby the financing gap is smoothed.

With the evolution of short and long run welfare at hand, we can now calculate the overall welfare results of a domestic fiscal expansion. It is important to stress that from an overall perspective, it is only the net present value of production in terms of consumption that matters for welfare. For instance, a strong increase in short run production may yield a strong short run welfare loss due to the implied higher labor effort. However, if the higher short run income translates into high bond holdings, long run welfare will be improved via the associated wealth effect and compensates the short run welfare loss.

Remember that overall welfare in the domestic country is given by $d\Omega_t = dU_t + \frac{1}{\bar{r}}\, dU_{t+1}$, where an analogous expression holds for the foreign country. Using equations (3.2.86) - (3.2.89) and the short run exchange rate response, we now derive closed-form solutions for the full impact of a permanent fiscal expansions on domestic and foreign welfare. With $dg_t = dg_{t+1} = dg_p$, the overall welfare impact of a permanent expansion reads

$$d\Omega_t = n \left(\frac{1 + 2\,\bar{r}}{2\,\bar{r}\,\theta} \right) \frac{dg_p}{\bar{c}^w} + (1-n) \left(\frac{s(1+\bar{r})(1+\theta)}{\bar{r}((1-s)\theta^2 + \theta + s) + 2\theta} \right) \frac{dg_p}{\bar{c}^w} \tag{3.2.90}$$

and

$$d\Omega_t^* = n \left(\frac{1 + 2\,\bar{r}}{2\,\bar{r}\,\theta} \right) \frac{dg_p}{\bar{c}^w} - n \left(\frac{s(1+\bar{r})(1+\theta)}{\bar{r}((1-s)\theta^2 + \theta + s) + 2\theta} \right) \frac{dg_p}{\bar{c}^w} \tag{3.2.91}$$

The overall effect of a domestic fiscal expansion on domestic welfare is unambiguously positive. Be aware that this result hinges crucially on the assumption of full utility enhancing government expenditure and should therefore not be overstated. If government spending was assumed to be purely dissipative, i.e. $V'(g)dg = 0$, as in the *Redux* model and in many of its extensions, a fiscal expansion would be a beggar-thyself instrument. The first term on the right-hand side of equation (3.2.90) is equivalent to the overall world welfare increase, which is given by equation (3.2.85). This effect, which falls symmetrically on both countries, reflects the short and long run demand stimulation of fiscal policy. Furthermore, equation (3.2.90) displays the positive impact of short run price movements on domestic welfare, which depends crucially on the degree of pricing-to-market. In the foreign country, the positive world effect is dampened by the negative price effect. However, according to figure 3.6(c) there is always a welfare gain for foreign households when $\epsilon = 1$.

While the world welfare effect is independent of the pricing behavior of firms, the price effects vary significantly with the degree of pricing-to-market. For $s = 0$, the price effects are offsetting and the welfare gains of a domestic expansion are entirely symmetric. The higher the share of PTM producers, the more asymmetric the distribution of welfare gains: Domestic households enjoy higher utility at the expense of foreigners. Note that the asymmetric effects of fiscal expansions on welfare in the light of pricing-to-market are substantially different to Obstfeld and Rogoff (1995a) and other "symmetric" fiscal models of the NOEM type, see Ganelli (2003b) and Caselli (2001). In these models, asymmetric welfare effects of fiscal expansions only occur because government expenditures are purely dissipative. Once individual households derive utility from public spending - as we model it here - fiscal policy has symmetric welfare effects across countries.[39]

As already insinuated, we may identify two effects as the major driving forces of the international distribution of overall welfare both of them stemming from the short run

[39]Basically, this case can be replicated by our model by setting the degree of PTM to zero ($s = 0$).

depreciation of the exchange rate: an *expenditure switching effect* and a *terms-of-trade effect*. From our above reasoning we know that pricing-to-market plays a dominant role in the determination of both effects in the short run. In the long run, prices are flexible, terms-of-trade and expenditure switching effects are fully anticipated, and the distinction between PTM and PCP producers becomes obsolete. Therefore, we do not find the parameter s related to a long run government expenditure term in the long run and hence overall welfare equations.

Recall that the depreciation of the short run exchange rate increases the competitiveness of domestic firms and stimulates production in the domestic country. From our above reasoning, the monopolistic distortion is then abated and there is a positive welfare impulse on domestic households. For $s = 0$, the expenditure switching effect is at its maximum, while it vanishes with complete pricing-to-market. At the same time, however, the purchasing power of additional production varies with the evolution of the terms-of-trade, which we derive by linearizing equation (3.2.4):

$$\tilde{\tau}_t = (2\, s - 1)\, \tilde{e}_t \tag{3.2.92}$$

Against the backdrop of an exchange rate depreciation and rigid prices, the domestic terms-of-trade deteriorate as long as $s < 0.5$ and improve for $s > 0.5$. To give some intuition for this result, consider the two polar cases $s = 0$ and $s = 1$. Without pricing-to-market, domestic households face higher import prices, while export prices in domestic currency remain unchanged. In that case, households do benefit from higher domestic production activity, but they also face a loss in their purchasing power because imported goods become more expensive, i.e. the terms-of-trade deteriorate.

In the opposite case of full pricing-to-market, domestic import prices are unchanged whereas export prices rise, i.e. the terms-of-trade improve and do increase domestic welfare while domestic productive activity is not stimulated via the exchange rate depreciation. To summarize: While the expenditure switching effect decides upon the international production structure via relative price changes, the terms-of-trade determine the consumption possibilities arising from the productive activity.

Combining both effects, we can give a comprehensive analysis of the role of pricing-to-market for overall welfare given in equations (3.2.90) and (3.2.91). With $s = 0$, the strong expenditure switching effect, which is positive for the domestic country and negative for the foreign country, is exactly offset by the evolution of the terms-of-trade, that favors the foreign country and is detrimental to the domestic country. The overall welfare effect is then independent of the short term change in relative prices. Hence, an asymmetric fiscal expansion has symmetric effects on welfare in the two countries when the law of one price holds for all goods.[40] With $s = 0.5$, the terms-of-trade are unchanged and expenditure switching is lower but still positive for the domestic country. Therefore, the price effect has a positive (negative) impact on domestic (foreign) welfare. With $s = 1$, expenditure switching disappears as relative prices are unchanged. However, the terms-of-trade work strongly in favor of domestic households. In a world of complete pricing-to-market, there is a very asymmetric distribution of welfare gains following a domestic fiscal expansion. Table 3.3 summarizes the competing effects on overall welfare. While each sign refers to the qualitative effect on the respective welfare level, the number of signs indicates its intensity. Note that we always find a demand stimulating effect of fiscal expansions

[40]This symmetry property holds in *Redux* style models that do not allow for pricing-to-market or asymmetries between countries.

(first terms on the respective left-hand sides of equations (3.2.90) and (3.2.91) that is positive and enhances welfare in both countries in a symmetric manner.

Table 3.3: Effects on overall welfare

	$s = 0$		$s = 0.5$		$s = 1$	
	domestic	foreign	domestic	foreign	domestic	foreign
expenditure switching	$++$	$--$	$+$	$-$	0	0
terms-of-trade	$--$	$++$	0	0	$++$	$--$
demand stimulus	$+$	$+$	$+$	$+$	$+$	$+$

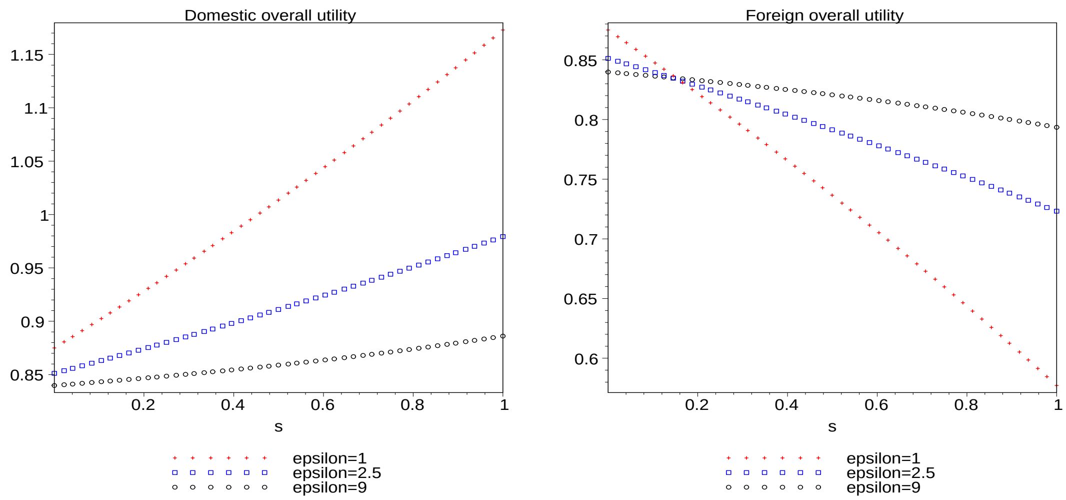
Our reasoning demonstrates that an expansion of production, that stems from expenditure switching, is associated with a negative evolution of welfare as it goes hand in hand with a deterioration of the terms-of-trade. Even though the monopolistic distortion renders output stimulation per se beneficial, policy makers have to account for possible adverse purchasing power effects. Intuitively, a depreciation of the exchange rate is most beneficial to domestic households in the case of complete pricing-to-market behavior as income from trade then rises without any higher labor effort.

We also investigated the effects of a temporary domestic fiscal expansion on overall welfare both analytically and numerically. Temporary domestic expansions lead to lower overall welfare increases in both countries, because of the lack of a long run overall demand stimulation. The qualitative effects of pricing-to-market on relative welfare are the same as in the case of a permanent shock, however quantitatively less important.

Robustness of the Results

So far, we have concentrated on the analysis of a simplified version of the two-country model by setting $\epsilon = 1$. While the major transmission mechanisms and welfare effects are already highlighted by the simple model, it is still necessary to check for the robustness of the results. When real money balances are integrated into the additively separable utility function in an isoelastic way, the parameter ϵ affects at the same time the interest elasticity of money demand, which is here given by $-\frac{\beta}{\epsilon}$, and the consumption elasticity of money demand, here $\frac{1}{\epsilon}$. Assuming $\epsilon = 1$ thus implies a unit consumption elasticity and an interest elasticity close to -1. Empirical studies, however, suggest that the consumption elasticity of money demand is much higher in absolute values than the interest elasticity. Estimates of the consumption elasticity vary from 0.27 reported in Lieberman (1980) to 1 in Mankiw and Summers (1986).[41] In contrast, the estimated values of the interest elasticity range from -0.39, reported by Chari, Kehoe, and McGrattan (2002) in their well known calibration exercise, to -0.05, reported by Mankiw and Summers (1986). As Mulligan and Sala-i-Martin (1997) point out, the interest elasticity of money demand is not a stable function over time, but tends to be much lower in times of low nominal interest rates than in times

[41] Chari, Kehoe, and McGrattan (1997) manage to generate both high volatility and persistence of nominal and real exchange rates by setting the consumption elasticity of money demand to the low level reported by Lieberman (1980). Note that the effects of the consumption elasticity on exchange rate volatility are nontrivial. When discussing the equilibrium exchange rate response, we pointed out that a lower consumption elasticity of money demand requires less of an exchange rate adjustment. At the same time, however, a very high consumption elasticity, e.g. $\epsilon = 1$, rules out exchange rate overshooting as derived in equation (3.2.61), which tends to dampen volatility.



(a) ϵ effect on domestic overall welfare (b) ϵ effect on foreign overall welfare

Figure 3.8: Overall utilities, permanent shock (MIU)

of high nominal interest rates.

Against the background of these empirical estimates, the case of $\epsilon = 1$ can be regarded as an upper limit of the consumption elasticity of money demand, but it implies a much too high absolute value of the interest elasticity. Therefore, we now allow for values of ϵ larger than one and analyze the consequences of this choice for our model results. Specifically, we will consider the cases $\epsilon = 9$ and $\epsilon = 2.5$. In our benchmark simulation we have set $\epsilon = 9$, thereby matching the consensus estimate of the interest elasticity. As pointed out earlier, this bears the consequence of a too low consumption elasticity of money demand. In order to resolve the intrinsic trade-off when choosing ϵ, we also analyze the $\epsilon = 2.5$ case. This yields an interest elasticity at the higher bound of the empirical estimates and a consumption elasticity at the lower bound.

Figure 3.8 depicts the effects of a permanent domestic fiscal expansion on domestic and foreign overall welfare for alternative values of the parameter ϵ. Higher values of ϵ always reduce the positive effect on domestic welfare. In the foreign country, overall welfare increases except for very low levels of s. The economic intuition for these results lies exclusively in the short run dynamics of the model. In the long run, the monetary components of the model are separated from the real adjustment process due to flexible prices. Hence, world aggregates of consumption and output do not depend on ϵ. Even though the long run international differentials of consumption and output are functions of ϵ, this is only due to short run current account imbalances.[42] As the latter are irrelevant for the overall welfare effects of fiscal policy, because they only determine the intertemporal utility pattern, we can focus exclusively on the short run effects.

Above we identified three welfare driving forces in the short run: a world demand stimulus, an expenditure switching effect and a terms-of-trade effect. The latter effects depend crucially on the magnitude of the exchange rate depreciation. In the analysis of the short run exchange rate we have shown that a higher ϵ implies a lower depreciation which dampens both the expenditure switching and the terms-of-trade effect. Independently of the degree of pricing-to-market, the stimulation of short run world demand is decreasing in ϵ which has a negative impact on overall welfare in both countries. As outlined above, the two price effects do depend on the pricing behavior of firms. Therefore, we carry out the analysis for the two polar cases $s = 0$ and $s = 1$.[43] Recall that for $s = 0$, the expenditure switching effect

[42] This result can be validated by setting $f_{t+1} = 0$ in the long run system. The differences of consumption and output then only depend on government expenditure and on the parameter θ.

[43] In the synopsis at the end of the paragraph we also include the $s = 0.5$ case, that rules out terms-of-trade effects.

is strongly positive (negative) for the domestic (foreign) country while the terms-of-trade effect is negative (positive) for the domestic (foreign) country. For $s = 1$, there is no expenditure switching and the terms-of-trade effect is positive (negative) for the domestic (foreign) country. The dampening effect of higher values of ϵ on the exchange rate depreciation implies overall welfare effects on the respective countries with a reversed sign. Table 3.4 gives the sign of the three effects on overall welfare when moving from a low to a high value of ϵ. Hence the given signs do not refer to the direction of the actual welfare effects but to the ϵ induced change of these effects.

Table 3.4: $\epsilon \uparrow$ driven effects on overall welfare

	$s = 0$		$s = 0.5$		$s = 1$	
	domestic	foreign	domestic	foreign	domestic	foreign
expenditure switching	$--$	$++$	$-$	$+$	0	0
terms-of-trade	$++$	$--$	0	0	$--$	$++$
demand stimulus	$-$	$-$	$-$	$-$	$-$	$-$

As a rule, the effects on expenditure switching and the terms-of-trade are offsetting for $s = 0$. Hence, the negative effect of a higher ϵ on demand stimulation makes both countries worse off. For $s = 1$, the domestic country suffers from both a negative demand stimulation effect and a negative effect stemming from lower positive terms-of-trade. In the foreign country the dampened exchange rate movement alleviates the negative terms-of-trade effect. The resulting positive effect on foreign overall welfare dominates the negative effect from lower demand stimulation.

Finally, a robustness check for a temporary domestic fiscal expansion yields the same results for the domestic country. However, in the foreign country higher values of ϵ are then always beneficial independently of the pricing behavior of firms. This results from the fact that the demand stimulating effect of fiscal policy is independent of ϵ when the expansion is temporary.

The robustness analysis has demonstrated that the consumption elasticity of money demand is quantitatively significant for the international welfare distribution of a domestic fiscal expansion. In general, the relevance of the pricing behavior of firms is higher with high consumption elasticities of money demand.

3.2.4 Conclusion

In this section we have analyzed the international transmission mechanisms and welfare effects of asymmetric fiscal policy in a model of the New Open Economy Macroeconomics approach. Specifically, we have rationalized money demand via a money-in-the-utility specification where the scale variable of money demand is private consumption. An asymmetric domestic fiscal expansion then leads to a depreciation of the short exchange rate due to a decline in domestic relative consumption. A detailed analysis of the pricing behavior of producers has demonstrated that pricing-to-market raises the amplitude of the exchange rate movement basically due to a limited pass-through to consumer prices. Furthermore, a high consumption elasticity of money demand also leads to a higher depreciation of the exchange rate.

The positive analysis revealed the increased potential of expansive fiscal policy to stimulate demand and hence production in a world of monopolistic competition and nominal rigidities. In the short run, expenditure switching reinforces the increase of domestic relative to foreign production. It is also important to stress that even a temporary fiscal expansion has permanent effects on the international consumption and production structure via wealth effects stemming form short run current account imbalances.

The subsequent welfare analysis has demonstrated the crucial role of the pricing behavior of firms. The degree of pricing-to-market determines the magnitude of expenditure switching, and both the sign of the terms-of-trade and their size. Domestic overall welfare is increasing in the degree of PTM. At the same time the depreciation of the short run exchange rate has adverse effects on foreigners, which are stronger the higher the degree of PTM. However, a domestic fiscal expansion is always prosper-thy-neighbor as the stimulation of world demand outweighs the negative welfare effects that result from the exchange rate movement. Importantly, a stimulation of production that comes at the price of worsening terms-of-trade is not welfare enhancing. Finally, a sensitivity analysis has pointed to the quantitative relevance of the consumption elasticity of money demand for the international distribution of welfare gains associated with fiscal policy.

3.3 MIU in a Monetary Union

This chapter analyzes the transmission mechanisms of fiscal policy when the world consists of two countries that engage in a monetary union. The countries thereby give up monetary sovereignty in favor of a supranational central bank. The abandonment of the flexible exchange rate regime implies different international transmission mechanisms of asymmetric fiscal shocks. With nominal rigidities on the goods markets, relative prices are temporarily unchanged because consumer and producer prices are not subject to unanticipated fluctuations anymore. Therefore, neither expenditure switching nor terms-of-trade effects occur in the short run. In fact, our analysis will reveal that the welfare effects of fiscal policy in a monetary union are totally symmetric.

In these respects, our model is closely related to Caselli (2001), who investigates fiscal policy under fixed exchange rates, but in a different institutional setting. In her analysis of a bilateral exchange rate peg, the two countries maintain monetary sovereignty and cooperate to fix the bilateral exchange rate while keeping the world money stock unchanged. As a consequence, the role of seignorage is quite different under the two exchange rate regimes: In a monetary union model, seignorage does simply not occur if the central bank keeps the money supply constant. Under a bilateral exchange rate peg one central bank expands money supply (positive transfers to households) so as to match money demand, while its foreign counterpart has to embark on a restrictive monetary strategy (negative transfers to households). Despite these differences on the monetary side of the model, the implications for the real adjustment processes are very similar to the ones we will derive in the present chapter.

However, Caselli does not provide any comparative results of alternative exchange rate regimes that are at the focus here and in the next chapter.

The framework used in our analysis is basically the one described in the previous chapter 3.2, but for an institutional change of the money markets and the introduction of a common currency. For brevity, the description of the model mainly focuses on the innovative elements of the monetary union case relative to the flexible exchange rate version. As for the producers, the distinction between PTM and PCP producers is now irrelevant because both types of producers set prices in the common currency. Therefore, the law of one price holds for both types of goods and purchasing power parity applies even in the short run.

3.3.1 The Model

Again, the world consists of two countries populated by n and $1 - n$ households respectively. On the production side, n firms are located in the domestic country and $(1 - n)$ firms in the foreign country. Analogously to chapter 3.2 we first derive the optimality conditions of the households and then describe the behavior of national governments and the supranational central bank. Finally, we give a description of the optimal pricing behavior of firms that face demand stemming from private households and the governments.

Households

The infinitely long living representative household of the domestic economy maximizes its life-time utility which is described by the following utility function:[44]

$$U = \sum_{t=0}^{\infty} \beta^t \left[log\, c_t + \frac{\gamma}{1-\epsilon} \left(\frac{m_t}{p_t} \right)^{1-\epsilon} + V(g_t) - \frac{\kappa}{2} h_t^2 \right] \tag{3.3.1}$$

As before, utility of the household depends on consumption, real balances, government expenditure, and labor effort. Let consumption be defined as a real CES consumption index which reads

$$c_t = \left[\int_0^n c_t(h)^{\frac{\theta-1}{\theta}} dh + \int_n^1 c_t(f)^{\frac{\theta-1}{\theta}} df \right]^{\frac{\theta}{\theta-1}} \tag{3.3.2}$$

When compared with the real consumption index under flexible exchange rates (see equation 3.2.2) the index is less complex because the distinction between PTM and PCP goods becomes obsolete in the monetary union case. The price index of the domestic economy follows from expenditure minimization:

$$p_t = \left(\int_0^n p_t(h)^{1-\theta}\, dh + \int_n^1 p_t(f)^{1-\theta}\, df \right)^{\frac{1}{1-\theta}} \tag{3.3.3}$$

Since the law of one price always holds in a monetary union and the households' consumption baskets do not display a home bias in consumption purchasing power

[44] Foreign equations are analogously defined and indicated with an asterisk.

parity applies in every period. Therefore, p_t denotes not only the domestic overall price index but also the foreign counterpart. Consumption maximization yields the per capita demand functions for the respective goods:

$$c_t(h) = \left(\frac{p_t(h)}{p_t}\right)^{-\theta} c_t \qquad\qquad c_t(f) = \left(\frac{p_t(f)}{p_t}\right)^{-\theta} c_t \tag{3.3.4}$$

The representative household maximizes life-time utility (3.3.1) subject to the budget constraint which reads

$$p_t\, c_t + m_t + R_t\, f_{t+1} = f_t + m_{t-1} + w_t\, h_t + \Pi_t - p_t\, T_t \quad , \tag{3.3.5}$$

in every period t. Note that nominal bonds f_t are now denominated in the common currency. In a standard fashion, nominal expenditures on consumption, money holdings, and bond purchases (left-hand side of the above equation) match nominal income from maturing bonds, money holdings from the previous period, labor income, and profits less tax payments (right-hand side of the above equation). The implied optimality conditions of domestic and foreign households are stated in table 3.5. Analogously to chapter 3.2, households behave according to the Euler equations (intertemporal consumption decision), the labor-leisure trade-offs (intratemporal working decision), and to the money demand functions (optimal money holdings at given opportunity costs).

In order to fully characterize the equilibrium on part of the households, the transversality condition (3.2.13) stated in the previous chapter still has to be met.

Table 3.5: Domestic and foreign optimality conditions

$\beta\, p_t\, c_t = R_t\, p_{t+1}\, c_{t+1}$	$\beta\, p_t\, c_t^* = R_t\, p_{t+1}\, c_{t+1}^*$
$\kappa\, h_t = \dfrac{w_t}{c_t\, p_t}$	$\kappa\, h_t^* = \dfrac{w_t^*}{c_t^*\, p_t}$
$\dfrac{m_t^d}{p_t} = \left(\dfrac{\gamma\, c_t}{1 - R_t}\right)^{\frac{1}{\epsilon}}$	$\dfrac{m_t^{d*}}{p_t} = \left(\dfrac{\gamma\, c_t^*}{1 - R_t}\right)^{\frac{1}{\epsilon}}$

An Independent Central Bank and National Governments

In a monetary union with an independent central bank, money market equilibrium requires

$$m_t^{w\,s} = n\, m_t^d + (1 - n)\, m_t^{d*} \tag{3.3.6}$$

where $m_t^{w\,s}$ denotes the central bank's world money supply and m_t^d and m_t^{d*} the respective domestic and foreign per capita money demand, all of which are denominated in the common currency. Since our focus is on fiscal policy, we assume that the central bank pursues a passive monetary policy. Specifically, money supply remains unchanged, i.e. $m_t^{w\,s} = m_{t-1}^{w\,s}$. This assumption does not alter the implications of fiscal policy because shocks to real government expenditures and money supply shocks are additive in our model. Equation (3.3.6) implies that money supply cannot be controlled separately for the individual countries.

National governments are assumed to pursue independent fiscal policies. In order to finance real per capita purchases g_t, the domestic government levies real lump sum taxes T_t on consumers. Again we assume that governments face a consumption index that is identical with the consumption preferences of the households and is described by equation (3.3.2). Hence, the public demand functions for domestic and foreign goods can be derived analogously to equation (3.3.4). Without loss of generality, we rule out financing via public debt since Ricardian equivalence holds. The budget constraint of the domestic government is then given by

$$g_t = T_t \tag{3.3.7}$$

Note that we do not have to consider seignorage as a financing source of government purchases because the independent central bank leaves money supply unchanged.

Firms

In chapter 3.2 we generated pricing-to-market by assuming that some goods prices are sticky in the currency of the importer. Unanticipated exchange rate movements then led to deviations of the law of one price for PTM goods. As pricing-to-market is of relevance only if a combination of rigid prices and unanticipated exchange rate movements occurs, the distinction between PTM firms and standard PCP firms is redundant in a monetary union. This is comparable to the flexible price case (long run) of the flexible exchange rate model. Therefore, producers are now assumed to be identical concerning their pricing behavior. Let the production function of a domestic producer $h \in [0, n]$ be defined as

$$y_t(h) = h_t(h) \tag{3.3.8}$$

Domestic producers solve the optimization problem

$$\max_{p_t(h)} \quad \Pi_t(h) = p_t(h)y_t(h) - w_t h_t(h) \tag{3.3.9}$$

subject to the demand function

$$y_t(h) = h_t(h) = \left(\frac{p_t(h)}{p_t}\right)^{-\theta} \left(c_t^w + g_t^w\right) \tag{3.3.10}$$

In contrast to the flexible exchange rate version of the model, demand addressed to the producers only hinges on the relative price of the respective good $\frac{p_t(h)}{p_t}$, world consumption $c_t^w = n\, c_t + (1-n)\, c_t^*$, and world government expenditures $g_t^w = n\, g_t + (1-n)\, g_t^*$.[45] The optimal price of producers across the domestic economy is then given as

$$p_t(h) = \frac{\theta}{\theta - 1} w_t \tag{3.3.11}$$

Every producer sets the optimal price as a markup on nominal production costs reflected in the nominal wage w_t. Remember that the optimal markup depends on the substitutability of goods captured by the parameter θ.

[45]The very compact "world" formulation of the demand function follows from the population weighted sum of the respective individual demand functions of households and governments.

3.3.2 Positive Analysis of Fiscal Shocks

In chapter 3.2, the solution vehicle of the model has been the short run exchange rate response. In a monetary union setting, it is also useful to express the variables of interest first in a semi-reduced form. The exchange rate being absent, we opt for stating the model solution in terms of nominal bond holdings, which link the short run solution of the model to the long run. After establishing the steady state of the model, we adopt again the backward solution approach and start with a description of the long run properties of the model.

Steady State

The steady state of the monetary union version of the model resembles the flexible exchange rate case, but for some differences in the definition of the nominal variables. From steady state money market clearing follows $\bar{m}^{w\,s} = \bar{m}^d = \bar{m}^{d*}$. Furthermore, prices do not differ in the two countries, hence $\bar{p}(h) = \bar{p}(f) = \bar{p}$, where $\bar{p}$ denotes the steady state price level in the two countries.

Long Run Properties of the Model

The long run solution of the model may be stated in terms of exogenous real government purchases and endogenous bond holdings that stem from possible short run current account imbalances. Starting with the monetary side of the model, the long run per capita money demand equations read

$$m_{t+1}^{d} = \left(\frac{\gamma\, c_{t+1}}{1 - R_{t+1}}\right)^{\frac{1}{\epsilon}}\; p_{t+1} \tag{3.3.12}$$

$$m_{t+1}^{d*} = \left(\frac{\gamma\, c_{t+1}^{*}}{1 - R_{t+1}}\right)^{\frac{1}{\epsilon}}\; p_{t+1} \tag{3.3.13}$$

Long run money market equilibrium requires that world money supply match the weighted sum of the respective national money demands:

$$m_{t+1}^{w\,s} = n\left(\frac{\gamma\, c_{t+1}}{1 - R_{t+1}}\right)^{\frac{1}{\epsilon}}\; p_{t+1} + (1-n)\left(\frac{\gamma\, c_{t+1}^{*}}{1 - R_{t+1}}\right)^{\frac{1}{\epsilon}}\; p_{t+1} \tag{3.3.14}$$

Equation (3.3.12) shows that a change in domestic consumption can only be brought about by a change in the bond price R_{t+1}, a change in the union-wide price level p_{t+1} or a change in the domestic money demand. As the union-wide money supply is fixed, a variation of domestic money demand has to be matched by a diametrical change in foreign money demand, see equation (3.3.14). Differing long run consumption profiles in the two countries thus imply an adjustment of the regional pattern of money demand. This can be seen most clearly by taking differences of the linearized versions of (3.3.12) and (3.3.13):

$$\tilde{m}_{t+1}^{d} - \tilde{m}_{t+1}^{d*} = \frac{1}{\epsilon}\left(\tilde{c}_{t+1} - \tilde{c}_{t+1}^{*}\right) \tag{3.3.15}$$

Again, it is the consumption elasticity of money demand $\frac{1}{\epsilon}$ that determines how long run consumption differentials translate into variations of the regional money demand structure.

The real side of the model can be described by the following set of equations that includes the long run current accounts, goods markets, Euler equations and labor markets:

Current accounts

$$p_{t+1}\left(c_{t+1}+g_{t+1}\right)+R_{t+1}f_{t+2}=p^h_{t+1}y_{t+1}+f_{t+1} \tag{3.3.16}$$

$$p_{t+1}\left(c^*_{t+1}+g^*_{t+1}\right)+R_{t+1}f^*_{t+2}=p^f_{t+1}y^*_{t+1}+f^*_{t+1} \tag{3.3.17}$$

Goods markets

$$y_{t+1}=\left(\frac{p^h_{t+1}}{p_{t+1}}\right)^{-\theta}\left(c^w_{t+1}+g^w_{t+1}\right) \tag{3.3.18}$$

$$y^*_{t+1}=\left(\frac{p^f_{t+1}}{p_{t+1}}\right)^{-\theta}\left(c^w_{t+1}+g^w_{t+1}\right) \tag{3.3.19}$$

Euler equations

$$\beta\, p_{t+1}\, c_{t+1}=R_{t+1}\, p_{t+2}\, c_{t+2} \tag{3.3.20}$$

$$\beta\, p_{t+1}\, c^*_{t+1}=R_{t+1}\, p_{t+2}\, c^*_{t+2} \tag{3.3.21}$$

Labor markets

$$\kappa h_{t+1}=\frac{\theta-1}{\theta}\frac{p^h_{t+1}}{p_{t+1}c_{t+1}} \tag{3.3.22}$$

$$\kappa h^*_{t+1}=\frac{\theta-1}{\theta}\frac{p^f_{t+1}}{p_{t+1}c^*_{t+1}} \tag{3.3.23}$$

As classical dichotomy still holds in the long run, the real side of the model is entirely unaffected by the monetary regime of the domestic and foreign economy. Hence, the long run solution of the real part of the model is exactly the same as in the flexible exchange rate case. Taking linearized version of equations (3.3.16)-(3.3.23) and solving the resulting system of equations simultaneously leads to the long run consumption differential

$$\tilde{c}_{t+1} - \tilde{c}^*_{t+1} = \frac{1+\theta}{2\theta} \frac{(1-\beta)df_{t+1}}{\bar{p}\bar{c}^w(1-n)} - \frac{1+\theta}{2\theta} \frac{dg_{t+1} - dg^*_{t+1}}{\bar{c}^w} \tag{3.3.24}$$

which depends on bond holdings that have been accumulated in the short run and the long term government expenditure differential.[46] Analogously we derive the long run output differential:

$$\tilde{y}_{t+1} - \tilde{y}^*_{t+1} = -\frac{\theta}{1+\theta}(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) \tag{3.3.25}$$

Due to the long run labor-leisure trade-off, a negative long run consumption differential is accompanied by a positive output differential. Intuitively, domestic households respond to (negative) fiscal shocks by reducing consumption and simultaneously increasing labor effort. The opposite is true for foreign households and hence the mirroring property of the consumption and output differentials. Note that the long run consumption and output differentials are exactly the same as the ones derived under flexible exchange rates, compare equations (3.2.43) and (3.2.44).

[46] The inclined reader may check the solution with the help of appendix A.1 which states the log-linear version of the flexible exchange rate model. Setting $\tilde{e}_{t+1}$ to zero and applying the same solution process as in the flexible exchange rate case yields solutions given in the text. Furthermore, the system of long run linearized differences under flexible exchange rates stated in table 3.1 are of help as of classical dichotomy.

Short Run Equilibrium

In the case of a monetary union the short run equilibrium system is almost identical with the long run system just derived. Still, there is only one type of producers. The only differences are the non-binding property of the labor market clearing conditions because of rigid prices and the fact that initial bond holdings are zero. The demand driven short run equilibrium system is then described by the following set of equations.

Equilibrium Money Demands

$$\frac{m_t^d}{p_t} = \left(\frac{\gamma\, c_t}{1 - R_t}\right)^{\frac{1}{\epsilon}} \tag{3.3.26}$$

$$\frac{m_t^{d*}}{p_t^*} = \left(\frac{\gamma\, c_t^*}{1 - R_t}\right)^{\frac{1}{\epsilon}} \tag{3.3.27}$$

Money Markets

$$m_t^{w\,s} = n\left(\frac{\gamma\, c_t}{1 - R_t}\right)^{\frac{1}{\epsilon}}\, p_t + (1-n)\left(\frac{\gamma\, c_t^*}{1 - R_t}\right)^{\frac{1}{\epsilon}}\, p_t \tag{3.3.28}$$

Current accounts

$$p_t(c_t + g_t) + R_t f_{t+1} = p_t^h\, y_t \tag{3.3.29}$$

$$p_t(c_t^* + g_t^*) + R_t\, f_{t+1}^* = p_t^f\, y_t^* \tag{3.3.30}$$

Goods markets

$$y_t = \left(\frac{p_t^h}{p_t}\right)^{-\theta} (c_t^w + g_t^w) \tag{3.3.31}$$

$$y_t^* = \left(\frac{p_t^f}{p_t}\right)^{-\theta} (c_t^w + g_t^w) \tag{3.3.32}$$

Euler equations

$$\beta\, p_t\, c_t = R_t\, p_{t+1}\, c_{t+1} \tag{3.3.33}$$

$$\beta\, p_t\, c_t^* = R_t\, p_{t+1}\, c_{t+1}^* \tag{3.3.34}$$

The linearized versions of equations (3.3.26) - (3.3.34) are given in appendix A.3. In contrast to the flexible exchange rate case, consumer prices are now entirely fixed in the short run, i.e. $\tilde{p}_t = \tilde{p}_t^h = \tilde{p}_t^f = 0$. As a consequence, the adjustment process to a fiscal shock is radically different because relative short run prices do not change.

Some insights can already be gained from the international differences of the linearized equilibrium equations. Taking differences of the linearized money demand equations yields[47]

$$(\tilde{m}_t^d - \tilde{m}_t^{d*}) = \frac{1}{\epsilon}\,(\tilde{c}_t - c_t^*) \tag{3.3.35}$$

As in the long run, the international money demand differential is exclusively driven by the consumption differential, where ϵ determines the sensitivity of this relation. The goods market and current account differences read[48]

$$\tilde{y}_t - \tilde{y}_t^* = 0 \tag{3.3.36}$$

[47]The solution process is straightforward. For instance, the respective money demand equations read $\tilde{m}_t^d - \tilde{p}_t = \frac{1}{\epsilon}\,\tilde{c}_t + \frac{1}{\epsilon\,\bar{r}}\tilde{R}_t$ and $\tilde{m}_t^{d*} - \tilde{p}_t = \frac{1}{\epsilon}\,\tilde{c}_t^* + \frac{1}{\epsilon\,\bar{r}}\tilde{R}_t$. Subtracting the equations eliminates the bond price deviations while short run prices are unchanged anyway, i.e. $\tilde{p}_t = 0$.

[48]Again, the respective linearized version can be found in appendix A.3.

and

$$\tilde{c}_t - \tilde{c}_t^* = \underbrace{(\tilde{y}_t - \tilde{y}_t^*)}_{=0} - \frac{dg_t - dg_t^*}{\bar{c}^w} - \frac{\beta df_{t+1}}{\bar{p}\bar{c}^w(1-n)} \tag{3.3.37}$$

With relative prices fixed, world demand falls symmetrically on domestic and foreign producers, hence the zero production differential. As for the current accounts, relative domestic consumption is reduced by a positive government expenditure differential. However, domestic households may increase relative consumption by accumulating debt in the short run.

The difference of the respective Euler equations yields

$$\tilde{c}_t - \tilde{c}_t^* = \tilde{c}_{t+1} - \tilde{c}_{t+1}^* \tag{3.3.38}$$

In a monetary union, the short and long run consumption differentials are of the same size, as real interest rate differentials are ruled out. Remember that this is also true for the standard "law of one price" case under flexible exchange rates ($s = 0$).

So far we have stated the short and long run consumption differentials and the long run production differential in terms of endogenous bond holdings. Short run production in both countries depends only on world demand which is independent of equilibrium bond holdings. To get the full impact of fiscal shocks on consumption we therefore derive the short run trade balance response. The Euler equation differential (3.3.38) decides upon the intertemporal structure of the consumption differentials. Plugging in the long and short run consumption differentials given by equations (3.3.24) and (3.3.37) yields after some manipulation

$$\frac{df_{t+1}}{\bar{p}\bar{c}^w} = (1-n)(1+\bar{r}) \left(-\frac{2\theta}{\bar{r}+\theta\bar{r}+2\theta} \frac{dg_t - dg_t^*}{\bar{c}^w} + \frac{1+\theta}{\bar{r}+\theta\bar{r}+2\theta} \frac{dg_{t+1} - dg_{t+1}^*}{\bar{c}^w} \right) \quad (3.3.39)$$

From now on we focus again on an asymmetric fiscal expansion, where $dg > 0$ and $dg^* = 0$. The short run government expenditure differential then has a negative effect on the domestic trade balance, whereas the long run differential, that only arises when fiscal policy shocks are permanent, acts towards an improvement. Temporary fiscal shocks thus lead to a strong negative response of the trade balance. Anticipating the higher future income, domestic households - which exclusively bear the tax burden associated with the fiscal expansion - increase their short run consumption level considerably by selling bonds to foreign households. In the case of a permanent fiscal expansion domestic households face a similar income situation in the short and long run, such that consumption smoothing is less relevant. However, we see from (3.3.39) that a permanent domestic fiscal expansion also prompts domestic households to run a short run trade balance deficit, since the denominator of both differential terms is identical and 2θ is always greater than $1 + \theta$ as $\theta > 1$.

Consumption and Ouput Responses

We now turn to the question, how fiscal policy affects the consumption paths in the two countries, and whether production is stimulated. In the next section, these positive results are evaluated by the utility function of the households so as to provide a thorough policy analysis in welfare terms. Having established the semi-reduced differentials of consumption and output, and the reduced form of the trade balance, we now provide closed form solutions for the respective individual variables. We do so by stating the individual variable as a function of the respective world aggregate and its international differential.

The world aggregates of consumption and output turn out to be independent of the exchange rate regime because short run world real balances are identical and long run world aggregates are entirely determined by the real side of the model - current accounts, goods markets, and labor markets - which is independent of the monetary regime.[49] Table 3.6 restates the world effects of a domestic fiscal expansion.

Table 3.6: World aggregates depending on ϵ

$\tilde{c}^w_t = -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w}$	$\tilde{y}^w_t = -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + n\frac{dg_t}{\bar{c}^w}$
$\tilde{c}^w_{t+1} = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w}$	$\tilde{y}^w_{t+1} = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w}$

Short run domestic consumption in a monetary union is defined as

$$\begin{aligned}
\tilde{c}_t &= \tilde{c}^w_t + (1-n)(\tilde{c}_t - \tilde{c}^*_t) \\
&= \tilde{c}^w_t - (1-n)\left(\frac{dg_t}{\bar{c}^w} + \frac{\beta df_{t+1}}{\bar{p}\bar{c}^w(1-n)}\right) \\
&= -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} - \frac{(1-n)(1+\theta)}{\bar{r}+\theta\bar{r}+2\theta}\left(\frac{\bar{r}\,dg_t}{\bar{c}^w} + \frac{dg_{t+1}}{\bar{c}^w}\right) \qquad (3.3.40)
\end{aligned}$$

where we made use of the trade balance response given by equation (3.3.39). In the

[49] The respective world aggregates in a monetary union can be derived in the same way as equations (3.2.65) to (3.2.68) under flexible exchange rates.

short run, domestic consumption is always lower than in the initial steady state, no matter if the fiscal expansion is temporary or permanent. However, equation (3.3.40) also reveals that domestic consumption is only partially crowded out by the fiscal expansion.[50] As debt financing is much stronger for a temporary shock because of consumption smoothing, short run domestic consumption is higher than in the case of a permanent expansion.

In the same way, we can derive the short run response of foreign consumption following a domestic fiscal expansion:

$$\begin{aligned}
\tilde{c}_t^* &= \tilde{c}_t^w - n(\tilde{c}_t - \tilde{c}_t^*) \\
&= \tilde{c}_t^w + n\left(\frac{dg_t}{\bar{c}^w} + \frac{\beta df_{t+1}}{\bar{p}\bar{c}^w(1-n)}\right) \\
&= -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + \frac{n(1+\theta)}{\bar{r}+\theta\bar{r}+2\theta}\left(\frac{\bar{r}\,dg_t}{\bar{c}^w} + \frac{dg_{t+1}}{\bar{c}^w}\right) \qquad (3.3.41)
\end{aligned}$$

Both a temporary and a permanent fiscal expansion lead to a short run increase of foreign consumption.[51] Though foreign households forgo present consumption by acquiring bonds from domestic households, they are still able to raise consumption above the steady state level due to the strong expansion of overall demand. The latter translates into equally higher production in both countries:

$$\tilde{y}_t = \tilde{y}_t^* = \tilde{y}_t^w = -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + n\frac{dg_t}{\bar{c}^w} \qquad (3.3.42)$$

[50] In the case of a temporary shock this can directly be seen from (3.3.40) by setting $\frac{dg_{t+1}}{\bar{c}^w} = 0$. For a permanent shock, the limited crowding out effect can be shown by setting $\frac{dg_t}{\bar{c}^w} = \frac{dg_{t+1}}{\bar{c}^w}$ and simplifying the resulting expression.

[51] Factorizing and noting that $dg_t = dg_{t+1}$ one can show that short run foreign consumption also increases with permanent expansions.

Hence, a domestic fiscal expansion always has an output stimulating effect on both countries in the short run. Permanent fiscal expansions, however, have a substantially lower impact on output, as short production is entirely demand driven. Following the above reasoning on consumption, households increase consumption less because of the anticipated permanent nature of the shock.[52]

As for the long run, we identify two major driving forces of the international structure of consumption and production: a potential permanent component of the fiscal expansion and bond holdings that have been accumulated in the short run. We derive the solution for domestic and foreign long run consumption using the long run consumption differential (3.3.24) and the trade balance response given by equation (3.3.39):

$$\tilde{c}_{t+1} = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} - \frac{(1-n)(1+\theta)}{\bar{r}+\theta\bar{r}+2\theta}\left(\frac{\bar{r}\,dg_t}{\bar{c}^w} + \frac{dg_{t+1}}{\bar{c}^w}\right) \tag{3.3.43}$$

and

$$\tilde{c}^*_{t+1} = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} + \frac{n(1+\theta)}{\bar{r}+\theta\bar{r}+2\theta}\left(\frac{\bar{r}\,dg_t}{\bar{c}^w} + \frac{dg_{t+1}}{\bar{c}^w}\right) \tag{3.3.44}$$

While domestic consumption is unambiguously reduced in the long run, foreign households consume more because they enjoy a positive income effect from bonds and a positive effect from the long run demand expansion when the shock is permanent.

A more intuitive explanation for the long run effects on consumption may be derived from the linearized short run Euler equations stated in appendix A.3. Rearranging terms yields the response of the short term real interest rate depending on

[52] As the individual household cannot control her labor effort directly, short run production is lower than in the case of a temporary shock despite the obvious incentive to work more.

the difference between short and long run consumption:

$$\tilde{r}_{t+1} = \frac{1+\bar{r}}{\bar{r}}(\tilde{c}_{t+1} - \tilde{c}_t) = \frac{1+\bar{r}}{\bar{r}}(\tilde{c}^*_{t+1} - \tilde{c}^*_t) \tag{3.3.45}$$

Plugging in the solutions for the respective short and long run consumption responses we arrive at

$$\tilde{r}_{t+1} = -\frac{1+\epsilon\bar{r}}{2\epsilon\bar{r}}\frac{dg_{t+1}}{\bar{c}^w} \tag{3.3.46}$$

A temporary fiscal expansion leaves the real interest rate unchanged and short run equals long run consumption. With the expansion being permanent, the real interest rate drops below its steady state value and drives a wedge between short run and long run consumption. The reduction of domestic short run consumption is then lower than in the long run, which also implies that fiscal expansions are more effective in terms of demand stimulation when prices are rigid and firms may not counteract the policy by increasing prices. This finding corresponds to the insights we gained already in the flexible exchange rate model.

Finally, we calculate the responses of long run production in both countries:

$$\tilde{y}_{t+1} = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} + \frac{(1-n)\theta}{\bar{r}+\theta\bar{r}+2\theta}\left(\frac{\bar{r}\,dg_t}{\bar{c}^w} + \frac{dg_{t+1}}{\bar{c}^w}\right) \tag{3.3.47}$$

and

$$\tilde{y}^*_{t+1} = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} - \frac{n\theta}{\bar{r}+\theta\bar{r}+2\theta}\left(\frac{\bar{r}\,dg_t}{\bar{c}^w} + \frac{dg_{t+1}}{\bar{c}^w}\right) \tag{3.3.48}$$

In the domestic economy, households work more than in the initial steady state. This results from both the necessity to generate trade balance surpluses in order to pay interests on the accumulated debt and from higher world demand. Foreign households, in contrast, reduce their working time as the positive interest effect outweighs the effect stemming from an increase of world demand.[53]

So far, we have derived the positive effects of a domestic fiscal expansion in a monetary union regime with an independent central bank and a common currency. As opposed to the flexible exchange rate case, the distinction between the alternative producer types is essentially irrelevant as short run prices are fixed in the common currency anyway. Instead of the exchange rate channel, money adjustments are now achieved via direct money demand redistributions. It is important to note that the presented monetary union model is very symmetric in the sense that the short run production pattern following fiscal disturbances is not affected by relative price differentials. Hence, fiscal expansions raise short run production in both countries at the same scale. Moreover, the short run consumption differential equals the long run counterpart as real interest rate differentials may not occur across countries. Importantly, the trade balance effect on the short and long run equilibrium is unambiguous in a monetary union as the domestic balance always deteriorates. As for the world consumption and output aggregates, they display exactly the same deviations from the steady state as under flexible exchange rates - a result which may come as a surprise at first sight. However, the deeper reasons are that, first, real balances are identical under both exchange rate regimes (determinant of short run aggregates), and, second, classical dichotomy applies with flexible prices which is the case in the

[53]One can show that foreign households reduce long run working effort also with permanent expansions noting that $n\bar{r}\theta > n\bar{r}\frac{1+\theta}{2}$.

respective long run equilibria.

To prepare the ground for the following welfare analysis we recapitulate the effect of a domestic fiscal expansion on the individual consumption and output responses: (1) domestic short run consumption is only partially crowded out (especially true in the case of temporary expansions); (2) foreign short run consumption actually rises despite positive bond holdings as the real interest rate falls below steady state (permanent expansion) or remains unchanged (temporary expansion); (3) short run production rises symmetrically in both countries and even more so with temporary expansions; (4) long run domestic (foreign) consumption decreases (rises); and finally (5) long run domestic (foreign) production is stimulated (dampened) by the domestic fiscal expansion.

3.3.3 Welfare Analysis of Fiscal Shocks

We now turn to a welfare evaluation of the positive results derived in the previous section. Analogously to equation (3.2.81) in chapter 3.2, the absolute utility deviation from the steady state following a domestic fiscal expansion is given by

$$\begin{aligned} dU_t &= \tilde{c}_t - \kappa \, \bar{h}^2 \, \tilde{h}_t + V'(g_t) dg_t \\ &= \tilde{c}_t - \frac{\theta - 1}{\theta} \tilde{h}_t + \frac{dg_t}{\bar{c}^w} \end{aligned} \tag{3.3.49}$$

which holds in every period t. Plugging in the semi-reduced forms of the short run consumption and output differentials yields the evolution of short run utility in both countries:

$$\begin{aligned} dU_t &= \tilde{c}_t^w - \frac{(\theta-1)}{\theta}\tilde{h}_t^w - (1-n)\frac{dg_t}{\bar{c}^w} - \frac{df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})} + \frac{dg_t}{\bar{c}^w} \\ &= \frac{1}{\theta}\,\tilde{h}_t^w - \frac{df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})} \end{aligned} \tag{3.3.50}$$

and

$$\begin{aligned} dU_t^* &= \tilde{c}_t^w - \frac{(\theta-1)}{\theta}\tilde{h}_t^w + n\left(\frac{dg_t}{\bar{c}^w} + \frac{df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})(1-n)}\right) \\ &= \frac{1}{\theta}\,\tilde{h}_t^w + \frac{n\,df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})(1-n)} \end{aligned} \tag{3.3.51}$$

The first term on the right-hand side of equations (3.3.50) and (3.3.51) reveals the beneficial effect of world output stimulation which falls symmetrically on both countries. Note that $\frac{1}{\theta}\,\tilde{h}_t^w = \frac{1}{\theta}\,\tilde{y}_t^w$ captures the net effect on short run welfare from less leisure, higher consumption possibilities and - in the case of the domestic country - direct utility from government expenditures. The magnitude of this welfare gain is governed by the elasticity of substitution θ: Higher values of θ imply a lower monopolistic distortion in the initial steady state and are thus associated with lower welfare gains. Moreover, the rise in world production, see table 3.6, depends on the persistence of the fiscal expansion and the consumption elasticity of money demand. As explained in section 3.2.2 the stimulation of output is maximal if either the shock is temporary or in the special case of a unit consumption elasticity, i.e. $\epsilon = 1$. The second term on the right-hand side of equations (3.3.50) and (3.3.51) drives a wedge between domestic and foreign utility. While domestic households sell bonds in order to finance additional consumption, foreigners are willing to give up short run consumption possibilities in exchange for future income.

The evolution of long run utility in the two countries is given by

$$
\begin{aligned}
dU_{t+1} &= \tilde{c}^{w}_{t+1} - \frac{(\theta-1)}{\theta}\tilde{h}^{w}_{t+1} - (1-n)\frac{dg_{t+1}}{\bar{c}^{w}} + \frac{\bar{r}df_{t+1}}{\bar{p}\bar{c}^{w}(1+\bar{r})} + \frac{dg_{t+1}}{\bar{c}^{w}} \\
&= \frac{1}{\theta}\,\tilde{h}^{w}_{t+1} + \frac{\bar{r}\,df_{t+1}}{\bar{p}\bar{c}^{w}(1+\bar{r})}
\end{aligned}
\tag{3.3.52}
$$

and

$$
\begin{aligned}
dU^{*}_{t+1} &= \tilde{c}^{w}_{t+1} - \frac{(\theta-1)}{\theta}\tilde{h}^{w}_{t+1} + n\left(\frac{dg_{t+1}}{\bar{c}^{w}} - \frac{\bar{r}df_{t+1}}{\bar{p}\bar{c}^{w}(1+\bar{r})(1-n)}\right) \\
&= \frac{1}{\theta}\,\tilde{h}^{w}_{t+1} - \frac{n\,\bar{r}\,df_{t+1}}{\bar{p}\bar{c}^{w}(1+\bar{r})(1-n)}
\end{aligned}
\tag{3.3.53}
$$

World production increases in the long run only in the case of a permanent fiscal expansion. The resulting welfare gains are again equally shared by domestic and foreign households. In contrast to short run utility, the consumption elasticity of money demand has no impact on the magnitude of the welfare gains in the long run.[54] The utility effects of bond holdings now mirror those of the short run: Domestic households face a utility loss as they have to pay interests on debt accumulated in the short run, whereas foreign households benefit from additional consumption possibilities.

Aggregating short run utility and discounted long run utility in both countries yields

$$
d\Omega_t = d\Omega^{*}_t = \frac{1}{\theta}\left(\tilde{h}^{w}_{t} + \frac{1}{\bar{r}}\tilde{h}^{w}_{t+1}\right) \tag{3.3.54}
$$

[54] Neither world production nor bond holdings depend on the parameter ϵ.

In a monetary union, an asymmetric fiscal expansion has a positive impact on overall welfare in both countries. The welfare gains, that arise from output stimulation and the resulting abatement of the monopolistic distortion on the goods markets, are equally shared by domestic and foreign households. This result hinges essentially on our assumption of full utility enhancing government expenditure. Once fiscal spending yields less marginal utility than consumption, i.e. $V'(g_t) < (\bar{c})^{-1} = (\bar{c}^w)^{-1}$, a domestic fiscal expansion is less beneficial – or even detrimental – to domestic households while foreign welfare is unchanged. Remember that foreign welfare is unaffected by our assumptions on V because utility derived from public spending enters the domestic utility function in an additive way. Therefore, it has no effect on the decisions of domestic or foreign households which could in principle affect foreign utility.

From table 3.6 we conclude that the short run and long run world output responses read $\tilde{y}_t^w = \tilde{h}_t^w = -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + n\frac{dg_t}{\bar{c}^w}$ and $\tilde{y}_{t+1}^w = \tilde{h}_{t+1}^w = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w}$, respectively. Hence by equation (3.3.54) overall welfare depends positively on the consumption elasticity of money demand, i.e. it decreases with ϵ. The effect of ϵ on overall utility (absolute deviation from the steady state) is depicted in figure 3.9, where we maintain the parameter choice of section 3.2 and again assume that the domestic fiscal expansion is permanent.

While the pattern of bond holdings determines the intertemporal utility profile, it does not enter overall welfare. The optimal bond holding decision of households is characterized by the trade-off between present and future consumption possibilities. Foreign households are only willing to finance domestic short run consumption if they are entirely compensated via permanent interest income in the future. The net

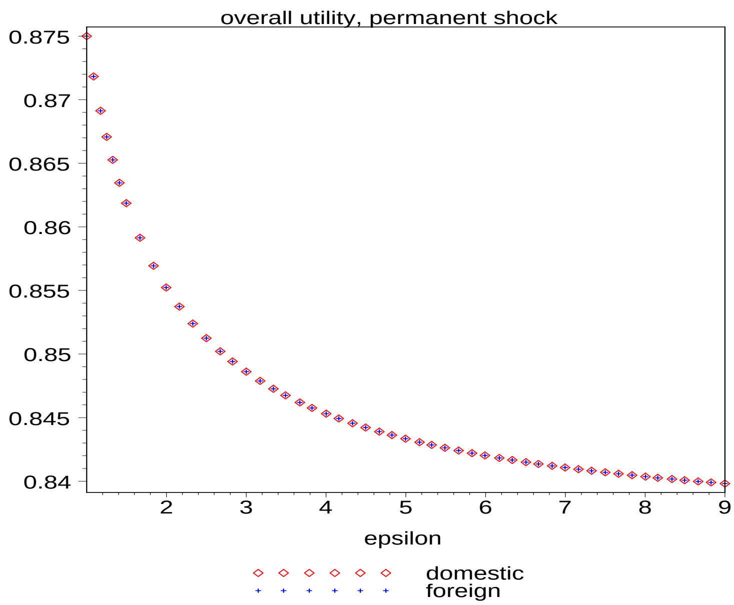


Figure 3.9: Effect of ϵ on overall welfare.

present value of bonds in terms of welfare is therefore zero.[55] All in all, an asymmetric fiscal expansion is always prosper-thy-neighbor in a monetary union, while the welfare effect on domestic households depends on the utility specification of government expenditures.

3.3.4 Conclusion

In this section we have analyzed the effects of an asymmetric fiscal expansion in a monetary union setting. The transmission mechanisms display a higher degree of symmetry because relative prices are unchanged in the short run. In contrast to the flexible exchange rate case, the short run trade balance response is always negative, with temporary expansions leading to a stronger reaction than permanent ones. Short

[55] This model outcome changes if one accounts for a home bias in consumption, see Pitterle and Steffen (2004a) for a discussion.

run production only depends on world demand, which is identical to world demand under flexible exchange rates. Moreover, relative short and long run consumption responses are identical in a monetary union as real interest rate differentials do not arise.

The subsequent welfare analysis revealed that the short run trade balance response determines the intertemporal pattern of welfare in the two countries. From an overall perspective, both countries benefit symmetrically from short and possibly long run output stimulating effects of fiscal policy. However, this symmetry property only holds if domestic households are fully compensated in terms of utility for the tax burden that they bear exclusively. Importantly, we find a full prosper-thy-neighbor property of fiscal expansions under a monetary union regime that is not offset by adverse welfare effects stemming from unanticipated exchange rate movements. We now turn to a more explicit welfare comparison of the two alternative exchange rate regimes.

3.4 Comparison of Exchange Rate Regimes

Based on the results of the previous sections we now compare the welfare effects of fiscal policy under the two alternative exchange rate regimes. Thereby we shed light on the decisive role of the pricing behavior of firms for the welfare evaluation of a transition to a monetary union. We start with the analysis of the short and long run welfare implications and then assess the overall effects of a domestic fiscal expansion. The subsequent analytical treatment is valid for both temporary and permanent shocks. The numerical illustration of the results, however, is only given for a permanent expansion.[56]

Before turning to the comparison of domestic and foreign short run welfare under the two exchange rate regimes, we state the short run utility responses under flexible exchange rates in semi-reduced form:[57]

$$dU_t^{Flex} = \frac{1}{\theta}\,\tilde{y}_t^w - \frac{df_{t+1}^{Flex}}{\overline{pc}^w(1+\bar{r})} + s(1-n)\tilde{e}_t \tag{3.4.1}$$

$$dU_t^{*\,Flex} = \frac{1}{\theta}\,\tilde{y}_t^w + \frac{n\,df_{t+1}^{Flex}}{\overline{pc}^w(1+\bar{r})(1-n)} - s\,n\,\tilde{e}_t \tag{3.4.2}$$

As in the monetary union case, output stimulation is welfare enhancing for both countries as households enjoy higher consumption possibilities. The trade in bonds

[56] A temporary expansion yields the same qualitative results, however of less quantitative importance. This is due to the then lower exchange rate depreciation and hence less unanticipated relative price effects under flexible exchange rates.

[57] In this alternative solution process, the following equations are involved: The semi-reduced short run consumption differential that follows from exchange rate equation (3.2.62), the short run production differential (3.2.73), the respective definitions of world and individual variables as well as the short run welfare equation (3.2.81).

leads in general to higher domestic and lower foreign short run utility. However, if households have logarithmic preferences for real balances, the short run trade balance response is positive following a permanent fiscal expansion. In that special case, the utility effects derived from trade in bonds are reversed. For the following comparison of exchange rate regimes, it is important to point out that bond holdings in the flexible exchange rate case differ from those under a monetary union. Moreover, the exchange rate depreciation redirects short run utility from the foreign to the domestic economy.

In order to obtain the welfare effects of a transition from a flexible exchange rate system to a monetary union, we define the domestic welfare differential for all periods t as

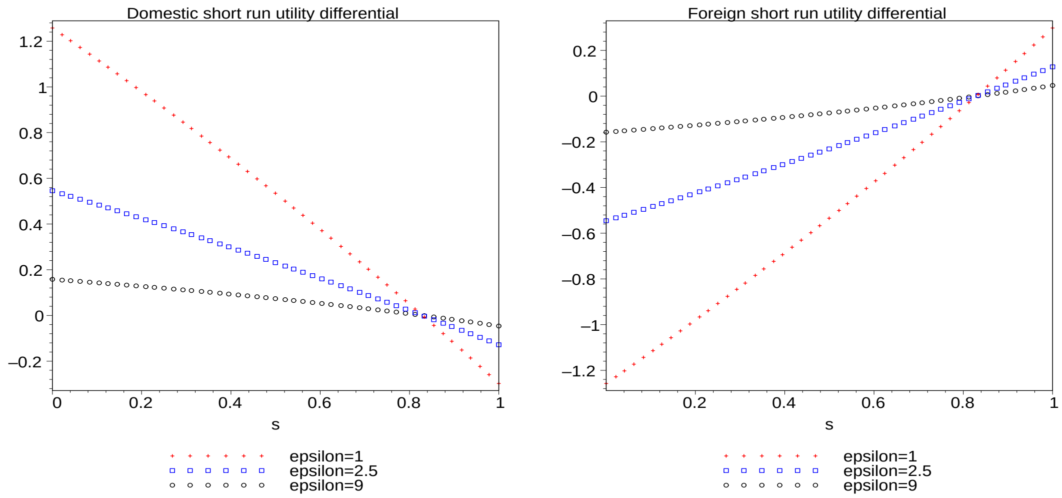
$$dU_t^{\Delta} = dU_t^{MU} - dU_t^{Flex} \tag{3.4.3}$$

with an analogous expression holding for the foreign country. Hence, if $dU_t^{\Delta} > 0$, a transition to a monetary union is beneficial for domestic households. Using short run utilities stated in equations (3.3.50) and (3.4.1) and the foreign counterparts (3.3.51) and (3.4.2) we arrive at

$$dU_t^{\Delta} = -\frac{df_{t+1}^{MU} - df_{t+1}^{Flex}}{\bar{p}\bar{c}^w(1+\bar{r})} - (1-n)s\tilde{e}_t \tag{3.4.4}$$

$$dU_t^{*\Delta} = \frac{n(df_{t+1}^{MU} - df_{t+1}^{Flex})}{\bar{p}\bar{c}^w(1-n)(1+\bar{r})} + ns\tilde{e}_t \tag{3.4.5}$$

Note that this very general formulation captures both temporary and permanent fiscal



(a) Domestic (b) Foreign

Figure 3.10: Short run utility differentials

expansions. As the world output stimulation is independent of the monetary regime the respective terms cancel out when taking differences. Thus, the short run welfare differential only depends on the difference in bond holdings and on the exchange rate effect under flexible exchange rates. Figures 3.10(a) and 3.10(b) give the numerical results of the short run utility differential in the respective countries for different values of ϵ against the background of a permanent fiscal expansion. The domestic utility differential is in general positive except for high degrees of pricing-to-market. For $s = 0$, a transition to a monetary union implies that domestic households do not suffer anymore from the negative terms-of-trade effect under flexible exchange rates. Moreover, expenditure switching raises relative production and hence labor effort under flexible exchange rates which translates into a short run welfare loss. With complete pricing-to-market, i.e. $s = 1$, expenditure switching is absent under both regimes, while the positive terms-of-trade effect under flexible exchange rates vanishes in a monetary union; hence the negative short run welfare differential. The evolution of the foreign short run welfare differential mirrors the effects on the domestic economy as expenditure switching and terms-of-trade effects work in the opposite direction.

As can be seen from figures 3.10(a) and 3.10(b), the results are qualitatively robust to variations of the consumption elasticity of money demand. However, lower values of the consumption elasticity yield smaller welfare differentials of the two monetary regimes. As in the previous chapters ϵ scales down the welfare effects of expansionary fiscal policies from both a national and an international perspective.

Turning to the long run welfare effects, the semi-reduced forms of long run utility under flexible exchange rates read[58]

$$dU_{t+1}^{Flex} = \frac{1}{\theta}\,\tilde{h}_{t+1}^{w} + \frac{\bar{r}\,df_{t+1}}{\bar{p}\bar{c}^{w}(1+\bar{r})} \tag{3.4.6}$$

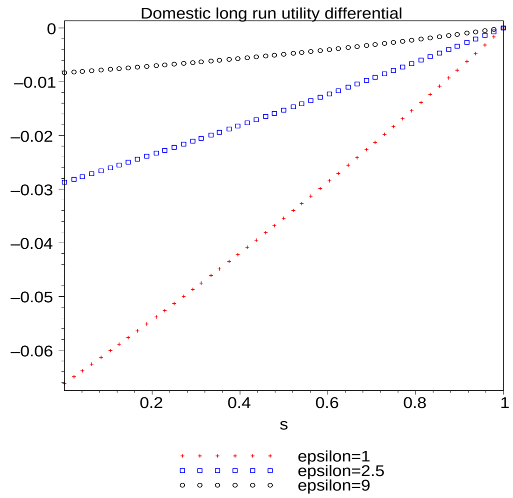
$$dU_{t+1}^{*\,Flex} = \frac{1}{\theta}\,\tilde{h}_{t+1}^{w} - \frac{n\,\bar{r}\,df_{t+1}}{\bar{p}\bar{c}^{w}(1+\bar{r})(1-n)} \tag{3.4.7}$$

Using long run utilities stated in equations (3.3.52) and (3.4.6) and the foreign counterparts (3.3.53) and (3.4.7) we arrive at

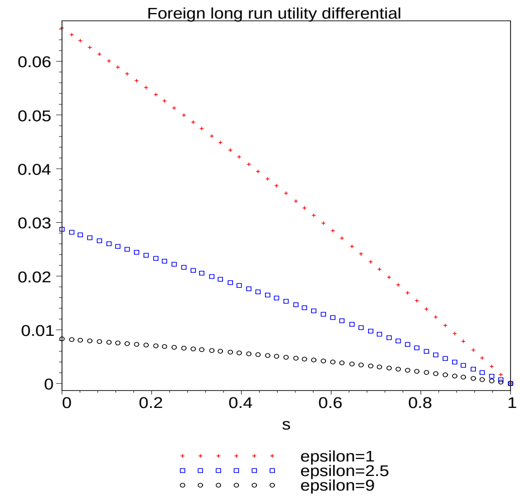
$$dU_{t+1}^{\Delta} = \frac{\bar{r}\,(df_{t+1}^{MU} - df_{t+1}^{Flex})}{\bar{p}\bar{c}^{w}(1+\bar{r})} \tag{3.4.8}$$

$$dU_{t+1}^{*\Delta} = -\frac{n\,\bar{r}\,(df_{t+1}^{MU} - df_{t+1}^{Flex})}{\bar{p}\bar{c}^{w}(1-n)(1+\bar{r})} \tag{3.4.9}$$

[58]This time the following equations are involved: The semi-reduced long run consumption differential (3.2.43), the long run production differential (3.2.44), the respective definitions of world and individual variables as well as the long run version of welfare equation (3.2.81).



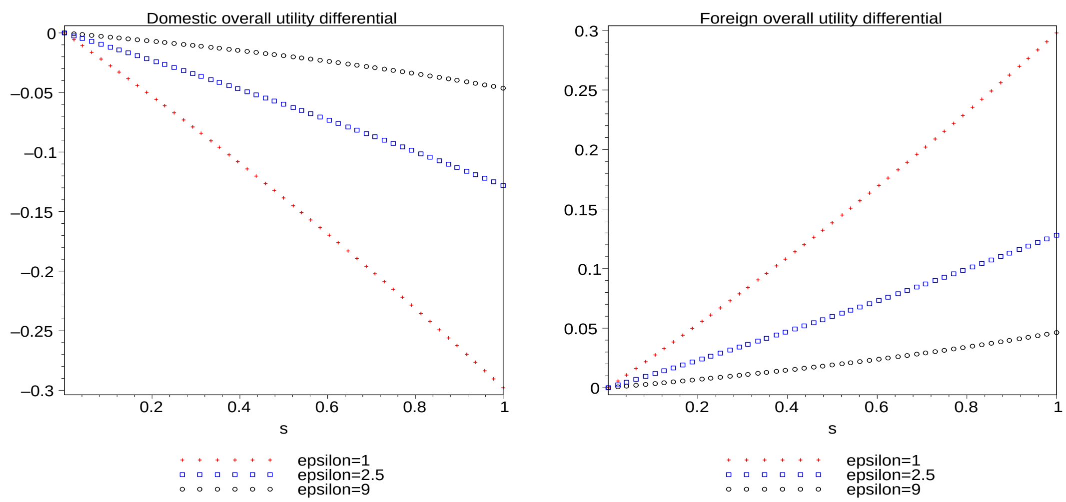
(a) Domestic



(b) Foreign

Figure 3.11: Long run utility differentials

For both countries, long run welfare under the two exchange rate regimes only differs due to a possibly different reaction of the trade balance. Figures 3.11(a) and 3.11(b) depict the long run utility differential in the respective countries. In the case of complete pricing-to-market, the trade balance response is identical under a monetary union and a flexible exchange rate, such that there is no long run difference of the two systems in terms of welfare. This follows from the lack of expenditure switching under both monetary regimes. For values of s below unity, the differential of bond holdings $df^{MU}_{t+1} - df^{Flex}_{t+1}$ is always negative. Due to expenditure switching, domestic production is higher under flexible exchange rates and thus domestic households resort less to debt financing when smoothing consumption. As a consequence, domestic households are in the long run better off under a flexible exchange rate regime than in a monetary union, while the opposite is true for foreign households.



(a) Domestic (b) Foreign

Figure 3.12: Overall utility differentials

As explained above, the pattern of bond holdings only determines the intertemporal utility structure, but has no impact on the net present value of welfare in the two countries. Combining the short and long run welfare differentials, we can therefore express the overall welfare differential only depending on the short run exchange rate response in the flexible exchange rate case:

$$d\Omega_t^{\Delta} = -(1-n)\, s\, \tilde{e}_t \tag{3.4.10}$$

$$d\Omega_t^{*\Delta} = n\, s\, \tilde{e}_t \tag{3.4.11}$$

Figures 3.12(a) and 3.12(b) illustrate the overall utility differential in the respective countries. From equation (3.4.10) we conclude that a domestic fiscal expansion is more beneficial to domestic households under flexible exchange rates than in a monetary union as long as some of the firms follow pricing-to-market behavior. When the law of one price holds for all goods households in both countries are indifferent to the monetary regime. A higher share of PTM producers renders a monetary union less attractive for domestic households. Though expenditure switching is then reduced under flexible exchange rates, domestic households benefit substantially from improved terms-of-trade. For households in the foreign country a transition to a monetary union is welfare improving against the background of a fiscal expansion abroad, because the combined adverse expenditure switching and terms-of-trade effects are then absent.

As outlined above, lower consumption elasticities of money demand yield a weaker depreciation of the exchange rate. As a consequence, the welfare differentials in both countries are much smaller in the case of $\epsilon = 9$ than with a unit elasticity of money demand.

3.5 Conclusion

In this chapter we have analyzed the effects of an asymmetric fiscal expansion under alternative monetary regimes when money enters the utility function directly. A comparison of the welfare results of the flexible exchange rate case with those in a monetary union reveals that the two monetary regimes provide exactly the same distribution of the associated welfare gains when pricing-to-market behavior is completely absent. This would be the case in standard NOEM models that closely follow Obstfeld and Rogoff (1995a) where the law of one price always holds.[59] Once only a small share of firms fixes prices in the currency of the consumer, however, domestic households are better off under the flexible exchange rate regime than in a monetary union. The basic economic mechanism behind these results can be found in a combination of expenditure switching and terms-of-trade effects that are associated with the exchange rate depreciation in the flexible exchange rate regime. Interestingly, welfare of domestic households is at its maximum level when there is no output stimulating expenditure switching at all. This is true even though output stimulation via fiscal policy is per se beneficial when goods markets are characterized by monopolistic distortions. In fact, domestic households enjoy windfall profits from the exchange rate movement as long as at least some pricing-to-market is at play. Against conventional wisdom, the exchange rate depreciation is most beneficial if it does not lead to a simultaneous increase in production towards full employment.

In a monetary union, foreigners do not suffer from any adverse welfare effects that stem from unanticipated exchange rate movements as for instance negative terms-of-trade effects. Hence, countries that face expansionary fiscal policies abroad are

[59] Provided that welfare losses of domestic households are fully compensated.

generally better off if they establish a monetary union with their trading partners. As usual, this kind of policy conclusions have to be taken with caution as they are based on a ceteris paribus scenario. For instance, monetary policy is assumed to be passive, even though expansive fiscal policy is often accommodated by central banks. Moreover, we will show throughout the dissertation that some of the model implications rely heavily on our assumptions about money demand.

A straightforward extension of the model would be the inclusion of a home bias in consumption as proposed by Warnock (2000) and Pitterle and Steffen (2004a), (2004b). In that case, the composition of world demand is relevant for the international structure of production and the prosper-thy-neighbor property of fiscal expansions is weakened. If government purchases fall exclusively on domestic goods, as proposed by Corsetti and Pesenti (2001), fiscal expansions may become a beggar-thy-neighbor policy under both exchange rate regimes.

Chapter 4

Fiscal Policy in a Cash-in-Advance Economy

4.1 Introduction

As pointed out in chapter 2, the specification of money demand is crucial for the determination of the equilibrium exchange rate response, which in turn drives the major welfare results of fiscal policy. In the money-in-the-utility setup of the previous chapters, the scale variable of money demand is private consumption while tax payments that arise from a balanced-budget fiscal expansion are considered non-cash transactions. Following Diamond and Rajan (2003) we now introduce a broader concept of the demand for money: Households face a cash-in-advance constraint where they need cash to purchase consumption goods *and* to pay taxes. We refer to the tax component of the CIA-constraint as the fiscal demand for money while the consumption component corresponds to the transaction demand for money. The inclusion of taxes in the money demand function is a standard practice in models that consider consumption taxes as the major financing source of public spending.[1] Our specification follows most closely Carré and Collard (2003) who postulate a cash-in-advance constraint where lump sum taxes have to be paid with cash. We abstract from consumption taxation in order to avoid an additional source of distortion. The inclusion of taxes in the cash-in-advance constraint implies that government expenditures affect the equilibrium demand for money.[2] In a comprehensive theoretical and empirical review of money demand Mankiw and Summers (1986) stress that all components of GNP may in principal generate money demand. Though government expenditures tend to be less important than private consumption for money demand, they are still quantitatively significant. As Mankiw and Summers' empirical description of the money allocation to GNP is based on U.S. data, the greater importance of the public sector in European countries suggests that government expenditure is of even more relevance for money demand in Europe.

Analogously to chapter 3 we first address fiscal policy in a flexible exchange rate framework and then proceed to the monetary union version of the model.

4.2 CIA under Flexible Exchange Rates

In this section we explore the implications of a cash-in-advance constraint for the international transmission mechanism of fiscal policy under flexible exchange rates. We also provide a detailed welfare evaluation of fiscal policy in this setting. The

[1] See Guidotti and Végh (1993) for a shopping-time model where taxes enter the money demand function rather implicitly via payments of VAT. In Auerbach and Obstfeld (2004) taxes enter the CIA-constraint also due to a consumption tax.

[2] In fact, one could alternatively model public money demand directly by imposing a cash-in-advance constraint on governments. This approach is adopted by Pitterle and Steffen (2004c) among others.

description of the model focuses on the innovative elements relative to the money-in-the-utility model of chapter 3.2. As a consequence, the equation derivations may not always be obvious for the reader. However, the solution process is straightforward once you step back to the previous chapters as the structure of the considered models is very similar. Where necessary, we will explicitly point to the respective prior sections that may be useful for readers interested in the technical details.

4.2.1 The Model

As money is introduced via a cash-in-advance constraint, real balances do not enter the representative household's utility function that now reads

$$U = \sum_{t=0}^{\infty} \beta^t \left[log\, c_t + V(g_t) - \frac{\kappa}{2} h_t^2 \right], \tag{4.2.1}$$

The representative household faces two restrictions for his optimization problem: a cash-in-advance constraint and an intertemporal budget constraint. As pointed out above, we now assume that households need cash in order to carry out consumption purchases and to pay part of their taxes. The cash-in-advance constraint then reads in every period t

$$m_t \geq p_t(c_t + \lambda T_t) \tag{4.2.2}$$

where the parameter $\lambda \in [0, 1]$ denotes the fraction of the tax bill that has to be paid with cash. For $\lambda = 0$ we obtain the standard CIA variant where money demand depends exclusively on consumption, whereas $\lambda = 1$ yields the case, where tax payments are fully relevant for money demand. In the sequel, the latter case is at the center of the analysis. Our timing of the cash-in-advance constraint follows Carlstrom and Fuerst (2001): At the beginning of period t the household enters the asset markets where she acquires cash for her projected consumption and tax transactions and engages in bond trading. We assume that the household has full information about the state of the economy, i.e. possible shocks always occur before the asset markets open. The CIA constraint (4.2.2) implies a unit consumption and tax elasticity of money demand. The interest elasticity of money demand, however, is zero. While this is a somewhat unappealing feature of the CIA approach, it can be tolerated against the background of very low empirical estimates of the interest sensitivity of money demand, see section 2.2.

Furthermore, the household's optimization problem is restricted by the following intertemporal budget constraint:

$$m_t + R_t f_{t+1} + (1-\lambda) T_t p_t \leq m_{t-1} + f_t + w_t h_t + \Pi_t \tag{4.2.3}$$

The left-hand side of equation (4.2.3) comprises the household's expenditures on money, interest yielding nominal bonds, and on the amount of taxes that is not paid with cash. The right-hand side describes the household's income from maturing bonds, labor effort, profits, and cash that has not been spent in the previous period. However, if the nominal interest rate on bonds is positive, the cash-in-advance constraint (4.2.2) binds in every period and agents will only hold the amount of money that is necessary to conduct their transactions. Hence, they do not hold money between periods and m_{t-1} in equation (4.2.3) is zero. See Helpman (1981) for an early treatment of this issue.

The representative household maximizes her intertemporal utility (4.2.1) subject to the cash-in-advance constraint (4.2.2) and the budget constraint (4.2.3). While the resulting Euler equation and the optimal labor supply decision are identical to those in the MIU setup of chapter 3, the household's demand for money is now directly given by the cash-in-advance constraint (4.2.2). The behavior of firms, government, and the central bank is completely analogous to the flexible exchange rate model with money-in-the-utility. For the sake of efficient exposition, we will not restate the equations describing the respective sectors.[3]

4.2.2 Positive Analysis of Fiscal Shocks

We now turn to the positive analysis of fiscal policy. The steady state of the model is basically unchanged because classical dichotomy between the real and the monetary part of the model applies when prices are flexible. As for the steady state exchange rate, equation (3.2.28) now amounts to

$$\bar{e} = \frac{\bar{m}^s}{\bar{m}^{s*}} \left(\frac{\bar{c}^*}{\bar{c}} \right) \tag{4.2.4}$$

where relative money supplies and relative absorption in the two countries determine the steady state exchange rate. As we consider a steady state with zero government expenditures steady state absorption reduces to steady state consumption.

[3]See chapter 3.2 for the detailed description of the omitted model parts.

Long Run Equilibrium

The long run equilibrium in the CIA specification differs from the one in the MIU setup only in the money market equilibrium conditions. As prices are fully flexible in the long run, classical dichotomy applies as in the steady state of the model. Hence, a change of the money demand specification does not affect the real side of the model. The long run current accounts, goods markets, labor markets, and Euler equations given by equations (3.2.31) - (3.2.38) are thus unchanged and the semi-reduced forms of the long run consumption and output differential still read

$$\tilde{c}_{t+1} - \tilde{c}^*_{t+1} = \frac{1+\theta}{2\theta} \frac{(1-\beta)df_{t+1}}{\bar{p}\bar{c}^w(1-n)} - \frac{1+\theta}{2\theta} \frac{dg_{t+1} - dg^*_{t+1}}{\bar{c}^w} \tag{4.2.5}$$

and

$$\tilde{y}_{t+1} - \tilde{y}^*_{t+1} = -\frac{\theta}{1+\theta}(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) \tag{4.2.6}$$

which corresponds to equations (3.2.43) - (3.2.44) in section 3.2.

On the monetary side of the model, however, the long run money market equilibria are now given by

$$m^s_{t+1} = m^d_{t+1} = p_{t+1}(c_{t+1} + \lambda g_{t+1}) \tag{4.2.7}$$

and

$$m^{s\,*}_{t+1} = m^{d\,*}_{t+1} = p^*_{t+1}(c^*_{t+1} + \lambda g^*_{t+1}) \tag{4.2.8}$$

where we used the respective binding cash-in-advance constraints and the government budget constraints $g_{t+1} = T_{t+1}$ and $g^*_{t+1} = T^*_{t+1}$.[4] The difference of the linearized money market equilibrium conditions yields the long run response of the nominal exchange rate:

$$\tilde{e}_{t+1} = -(\tilde{c}_{t+1} - \tilde{c}^*_{t+1}) - \frac{\lambda\left(dg_{t+1} - dg^*_{t+1}\right)}{\overline{c}^w} \tag{4.2.9}$$

In contrast to the MIU setup, the long run exchange rate is now not based on consumption but on cash-financed absorption. As long as a part of the tax bill is paid with cash a positive government expenditure differential, i.e. $\frac{dg_{t+1}-dg^*_{t+1}}{\overline{c}^w} > 0$, acts towards an appreciation of the long run exchange rate.

Short Run Equilibrium

Again, the equilibrium system is identical to the one under the MIU specification[5] except for the money markets that are now given by

$$m^s_t = m^d_t = p_t(c_t + \lambda g_t) \tag{4.2.10}$$

and

$$m^{s\,*}_t = m^{d\,*}_t = p^*_t(c^*_t + \lambda g^*_t) \tag{4.2.11}$$

[4] Remember that we still investigate a balanced-budget fiscal expansion just like in the previous chapters.

[5] Compare equations (3.2.47) - (3.2.56) in section 3.2.

We stick to our usual solution method and first derive the short run response of the exchange rate before computing the reaction of the remaining variables of interest in the next section. Subtracting linearized versions of equations (4.2.10) and (4.2.11) yields

$$\tilde{m}_t - \tilde{m}_t^* = \tilde{p}_t - \tilde{p}_t^* + \tilde{c}_t - \tilde{c}_t^* + \lambda \frac{dg_t - dg_t^*}{\bar{c}^w} \tag{4.2.12}$$

With fixed money supplies in both countries, i.e. $\tilde{m}_t - \tilde{m}_t^* = 0$, and the short run price differential given as before by $\tilde{p}_t - \tilde{p}_t^* = (1-s)\tilde{e}_t$, the exchange rate equation from the monetary part of the model can then be calculated as

$$(1-s)\tilde{e}_t = -(\tilde{c}_t + \lambda \frac{dg_t}{\bar{c}^w}) + (\tilde{c}_t^* + \lambda \frac{dg_t^*}{\bar{c}^w}) \tag{4.2.13}$$

On the monetary side of the model, the exchange rate reaction now hinges on the differential between domestic and foreign cash-financed absorption. If the sum of domestic private consumption and cash-financed taxes exceeds the foreign equivalent, the nominal exchange rate tends to appreciate. As current accounts and goods markets do not differ under the two money demand specifications, the exchange rate equation that stems from the real part of the model is the same as in the MIU setting, see equation (3.2.62)[6]:

$$((1-s)(\theta-1)+s)\tilde{e}_t = \tilde{c}_t - \tilde{c}_t^* + \frac{df_{t+1}}{\bar{p}\bar{c}^w(1-n)(1+\bar{r})} + \frac{dg_t - dg_t^*}{\bar{c}^w} \tag{4.2.14}$$

[6]Remember the steady state relation $\beta = \frac{1}{\bar{r}}$.

By combining the two exchange rate equations and eliminating endogenous bond holdings via equation (4.2.5) and the linearized Euler equation differential we obtain the short run response of the nominal exchange rate in the CIA model:

$$\tilde{e}_t = \frac{(\bar{r}\,\theta(1-\lambda) + \bar{r}(1-\lambda) - 2\theta\lambda)\dfrac{dg_t - dg_t^*}{\bar{c}^w} + (1+\theta)\dfrac{dg_{t+1} - dg_{t+1}^*}{\bar{c}^w}}{2\theta + ((1-s)\theta + s)\,\bar{r}\,(1+\theta)} \tag{4.2.15}$$

Whether a fiscal expansion leads to an appreciation or a depreciation of the exchange rate depends on the persistence of the shock and on the amount of taxes that is paid with cash. Both in the case of a temporary and a permanent shock, the exchange depreciates when cash is only required for consumption ($\lambda = 0$), while $\lambda = 1$, where all taxes are paid with cash, causes an appreciation.[7] For intermediate values of λ we have to distinguish between a temporary and a permanent shock. A temporary shock leads to an appreciation of the exchange rate for a broad range of λ values, whereas a permanent shock brings about a depreciation even when a high fraction of taxes is paid with cash.

It is noteworthy that the limiting case of $\lambda = 0$ in the CIA setup generates exactly the same exchange rate response as in the MIU specification when real balances enter the utility function logarithmically ($\epsilon = 1$).[8] This result is due to the formal equivalence of the money market equilibria under the two settings. With $\lambda = 0$, money demand in the CIA setup is consumption based as in the MIU model. Moreover, with $\epsilon = 1$ both specifications result in a unit consumption elasticity of money demand.

[7] You can easily derive this result, when setting λ to one or zero, respectively. While the denominator is independent from λ and always positive, the enumerator reduces to the unique positive or negative values claimed in the text. For instance, with $\lambda = 1$ and permanent shocks, the enumerator reduces to $(1-\theta)\frac{dg_p - dg_p^*}{\bar{c}^w}$ which is always negative for a positive public spending differential as $\theta > 1$.

[8] Compare with the short run exchange rate equation given in table 3.2, section 3.2.

The only difference between the two money demand variants lies in the interest elasticity: While the CIA constraint implies that money demand is entirely independent of the interest rate, the $\epsilon = 1$ case assumes an interest elasticity of money demand of $\frac{\beta}{\epsilon} \approx 1$. However, as exchange rate overshooting is precluded in the latter case, see equation (3.2.61), the nominal interest rate cancels out of the money market differential and does not affect the equilibrium response of the exchange rate. Intuitively, domestic and foreign money demand are then subject to the same nominal interest rate and relative money demand is then obviously independent of the interest rate. Hence, the two specifications of money demand are identical with respect to their implications for the exchange rate response that follows an asymmetric fiscal expansion. In fact, we may show that not only the exchange rate response but also the remaining results are identical under the two money demand regimes. This result is quite astonishing as the solution of the MIU model is far more complicated than the CIA approach. Our CIA framework therefore not only serves to address the subtle question of alternative money demand specifications against the background of fiscal policy but also boils down the standard *Redux* setup without losing any relevant information.

In order to explain the sensitivity of the exchange rate response to the assumed value of λ, we compare the two polar cases $\lambda = 1$ and $\lambda = 0$. If all taxes have to be paid with cash ($\lambda = 1$), the scale variable of money demand is the sum of private consumption and government expenditures. According to the CIA constraint, higher tax-financed government expenditures require a fall of private consumption or an increase of the household's real balances. Due to the households' desire to smooth consumption over time, a full reduction of private consumption is not optimal. Hence, domestic households wish to increase their demand for real balances. With fixed money supplies and rigid prices, this can only be brought about by an appreciation of the exchange rate, that leads to lower prices of imports. In contrast, if taxes do not enter the CIA constraint ($\lambda = 0$) the scale variable of money demand reduces to private consumption and there is no direct crowding out effect of the fiscal expansion due to the CIA constraint. However, as domestic households exclusively bear the higher tax burden, they reduce their short run consumption level, which leads to a lower demand for real balances. This in turn implies that the nominal exchange rate has to depreciate in equilibrium. Figure 4.1 provides a numerical illustration of the exchange rate responses for the two polar cases $\lambda = 0$ and $\lambda = 1$ based on the parameterization of the model given in chapter 3.2 for a permanent domestic fiscal expansion.

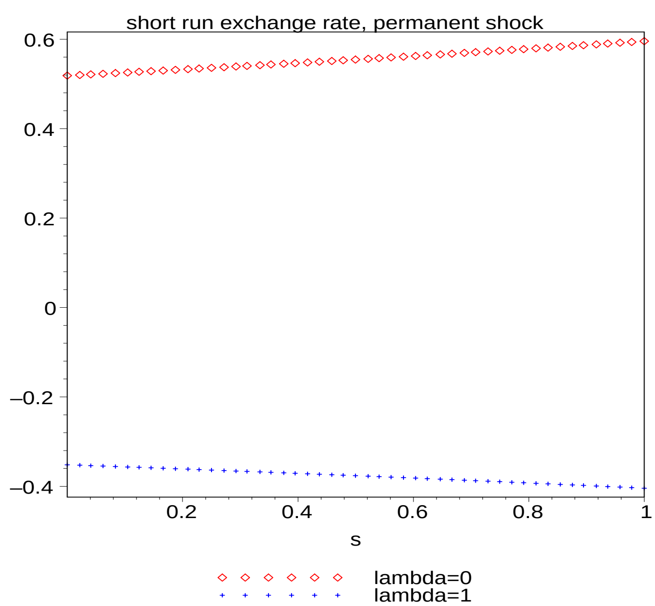


Figure 4.1: Short run exchange rate in a CIA economy

As in the MIU model of chapter 3.2, the magnitude of the exchange rate response is governed by the pricing behavior of firms. Higher values of s imply that a smaller share of the prices of imported goods is subject to exchange rate movements and therefore the reaction of the exchange rate has to be more pronounced.

For our later analysis it is important to stress that the exchange rate appreciation with $\lambda = 1$ is stronger if the fiscal expansion is only temporary. This result stands in sharp contrast to the MIU model, where temporary expansions lead to weaker exchange rate depreciations. Intuitively, the domestic short run consumption response to temporary shocks is weaker in both cases as of consumption smoothing. However, this behavior requires less exchange rate adjustment in a MIU setup as short run consumption gets closer to the initial steady state value, but more exchange rate adjustment in the CIA model as total domestic absorption - private consumption plus public spending - gets farther away from the steady state!

Consumption and Ouput Responses

Up to now we have derived the impact of fiscal policy on the response of the short run exchange rate. In this section we first derive the semi-reduced forms of the individual country variables and then provide closed form solutions. A numerical illustration is provided where necessary. We follow the methodology of the previous chapters in that we derive the effects of an asymmetric domestic fiscal expansion on world aggregates before proceeding to the country-specific variables.

World Aggregates

Table 4.1 summarizes the responses of world consumption and output in the short and long run when $dg \geq 0$ and $dg^* = 0$. The long run implications for world consumption

Table 4.1: World aggregates depending on λ

$\tilde{c}^w_t = -\lambda\, n\, \dfrac{dg_t}{\bar{c}^w}$	$\tilde{y}^w_t = (1-\lambda)\, n\, \dfrac{dg_t}{\bar{c}^w}$
$\tilde{c}^w_{t+1} = -\dfrac{n}{2}\dfrac{dg_{t+1}}{\bar{c}^w}$	$\tilde{y}^w_{t+1} = \dfrac{n}{2}\dfrac{dg_{t+1}}{\bar{c}^w}$

and output are the same as in the money-in-the-utility models of the previous chapter due to the aforementioned classical dichotomy when prices are flexible.[9] World consumption is reduced while world output rises by the same amount as long as the fiscal expansion is permanent. The derivation of the short run world consumption and output aggregates is now much simpler since the short run money markets display no intertemporal link via interest rates. Hence we simply add up population weighted linearized versions of equations (4.2.10) and (4.2.11) to arrive at the results stated in table 4.1. In the short run, it is the parameter λ that rules the expansionary effects of fiscal policy. Once only consumption goods have to be paid with cash, i.e. $\lambda = 0$, private world consumption is not crowded out at all as in the $\epsilon = 1$ case in the MIU setting. In the polar case of $\lambda = 1$, where the whole tax bill enters the cash-in-advance constraint, complete crowding out of private consumption leaves world production unchanged.

[9]Compare equations (3.2.66) and (3.2.67) and their derivation.

These effects illustrate a general property of cash-in-advance constraints: Money establishes a strict ceiling for the goods to be consumed, see Sriram (2001b). As we extend the standard consumption based CIA constraint by a tax component, that captures the fiscal demand for money, the effectiveness of fiscal policy in terms of output stimulation hinges crucially on the fraction of taxes that has to be paid with cash. In the following analysis of the country-specific variables we focus on the $\lambda = 1$ case with full crowding out of private consumption from a world perspective.

Country Specific Effects: Short Run

We may derive two alternative formulations of the short run consumption differential. The first expression can be derived from exchange rate equation (4.2.13), which stems from the short run money market differential:

$$\tilde{c}_t - \tilde{c}_t^* = -\lambda \frac{dg_t}{\bar{c}^w} - (1-s)\tilde{e}_t \tag{4.2.16}$$

From the second exchange rate equation (4.2.14), which stems from short run current accounts and goods markets, follows

$$\tilde{c}_t - \tilde{c}_t^* = -\frac{dg_t}{\bar{c}^w} - \frac{df_{t+1}}{\bar{p}\bar{c}^w(1-n)(1+\bar{r})} + ((1-s)(\theta-1)+s)\tilde{e}_t \tag{4.2.17}$$

While the derivation of the money market driven consumption differential is preferable for the sake of tractability and highlights the limited crowding out of private consumption, the current account driven formulation gives more intuitive insights into the individual financing channels behind the international consumption profiles. The first component of the left-hand side of equation (4.2.17) is equivalent to the tax burden of a domestic fiscal expansion that falls exclusively on domestic households. The second term describes the possibility of consumption smoothing via bonds. Negative domestic bond holdings, i.e. accumulated debt, narrow the consumption differential. Finally, the exchange rate term captures the combined effects of expenditure switching and consumer price changes on consumption.

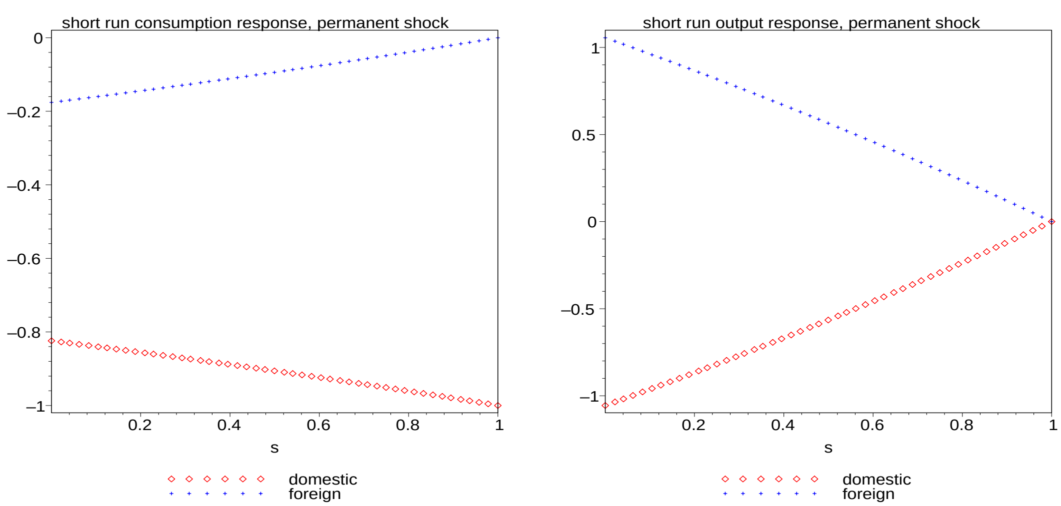
Having established the short run world consumption response and the international consumption differential the country-specific consumption responses can now be calculated as follows

$$\begin{aligned}
\tilde{c}_t &= \tilde{c}_t^w + (1-n)(\tilde{c}_t - \tilde{c}_t^*) \\
&= -\lambda\, n\, \frac{dg_t}{\overline{c}^w} + (1-n)\left(-\lambda\, \frac{dg_t}{\overline{c}^w} - (1-s)\tilde{e}_t\right) \\
&= -\lambda\, \frac{dg_t}{\overline{c}^w} - (1-n)(1-s)\tilde{e}_t \qquad (4.2.18)
\end{aligned}$$

and

$$\begin{aligned}
\tilde{c}_t^* &= \tilde{c}_t^w - n(\tilde{c}_t - \tilde{c}_t^*) \\
&= n\,(1-s)\tilde{e}_t \qquad (4.2.19)
\end{aligned}$$

In the case of $\lambda = 1$, which is at the focus of this section, equation (4.2.18) illustrates the limited crowding out of private consumption in the light of domestic fiscal expansions. From equation (4.2.15) in the previous section follows an appreciation of the short run exchange rate for both temporary and permanent fiscal expansions. Hence, the exchange rate term enters the domestic consumption equation with a positive sign. As illustrated in the numerical simulation of the model in figure 4.2, domestic consumption is always below steady state. However, domestic households reduce consumption by less than the tax burden as long as $s < 1$. In the special case of full pricing-to-market, private consumption is entirely crowded out by the fiscal expansion. Intuitively, money market equilibrium imposes a maximal transaction volume, which is given by $\tilde{c}_t + \frac{dg_t}{\bar{c}^w} = 0$, when real money balances cannot change.[10] The latter is the case with $s = 1$ as all consumer prices are fixed in the consumer's currency and monetary policy is passive. As for the foreign country, equation (4.2.19) implies an unambiguous reduction of short run consumption for all $s \neq 1$. Foreigners are willing to forgo short run consumption in exchange for future consumption possibilities.



(a) Short run consumption

(b) Short run production

Figure 4.2: Permanent Fiscal Expansion, CIA, $\lambda = 1$

[10] Take a closer look at the money market equation (4.2.10) to see the connection.

We now derive the implications of a domestic fiscal expansion for the international production structure. As the goods markets are equivalent under the two specifications of money demand we may restate the short run output differential (3.2.73) of section 3.2 that still applies in the cash-in-advance setting:

$$\tilde{y}_t - \tilde{y}_t^* = \theta(1-s)\tilde{e}_t \tag{4.2.20}$$

The appreciation of the short run exchange rate drives a wedge between domestic and foreign production as long as $s \neq 1$. The country-specific output responses are then given by

$$\tilde{y}_t = (1-\lambda)\, n\, \frac{dg_t}{\bar{c}^w} + (1-n)(1-s)\,\theta\,\tilde{e}_t \tag{4.2.21}$$

and

$$\tilde{y}_t^* = (1-\lambda)\, n\, \frac{dg_t}{\bar{c}^w} - n(1-s)\,\theta\,\tilde{e}_t \tag{4.2.22}$$

where we made use of short run world production stated in table 4.1, the short run production differential (4.2.20), and the usual definition of individual variables as a function of the world aggregate and its country differential. As long as $\lambda < 1$, the fiscal expansion stimulates world production (first term on the respective right-hand side), which is beneficial for domestic and foreign producers. With $\lambda = 1$ short run domestic production is lower than in the steady state while foreign production rises, see figure 4.2(b). As opposed to the MIU model in section 3.2 and to the $\lambda = 0$ case, world production then remains unchanged and it is only the exchange rate movement that decides upon the international production structure. As a domestic fiscal expansion induces an appreciation of the exchange rate the relative price of domestic goods rises as long as some producers do not price to market, i.e. $s < 1$. Hence, domestic producers face a loss of competitiveness and world demand is directed towards foreign goods. The striking result of this adjustment process is that an expansive fiscal policy is not only weak in terms of output stimulation but has even negative effects on domestic production in the short run.

Linkage between Long and Short Run: The Trade Balance

Before deriving the long run consumption and output responses we calculate the reaction of the trade balance which links the short run to the long run system:

$$\frac{df_{t+1}}{\bar{p}\bar{c}^w} = -(1-\lambda)(1-n)(1+\bar{r})\frac{dg_t}{\bar{c}^w} + (1-n)(1+\bar{r})((1-s)\theta + s)\tilde{e}_t \qquad (4.2.23)$$

In the derivation we made use of the exchange rate equations (4.2.13) and (4.2.14). Figure 4.3 graphs the trade balance response against the degree of PTM for $\lambda = 0$ and $\lambda = 1$ for a permanent domestic fiscal expansion.

If all taxes enter the CIA constraint, the trade balance response is always negative. This is due to the fact that short run domestic production is reduced while overall domestic expenditures on consumption and taxes rise. A higher fraction of PTM producers ameliorates the trade balance as expenditure switching towards foreign goods is subdued and the income situation of domestic households improves.

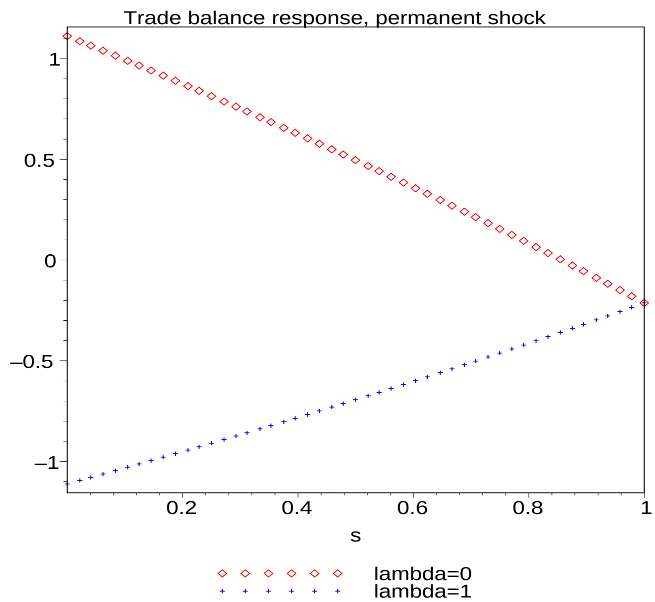


Figure 4.3: Short run trade balance in a CIA economy

For $\lambda = 0$, which corresponds to the $\epsilon = 1$ case under the MIU specification, the trade balance effect is mainly positive because the depreciation of the exchange rate stimulates domestic production as explained in section 3.2. Interestingly, the trade balance response is identical under both regimes in the case of complete pricing-to-market. The economic intuition for this lies in the fact that relative producer price changes, which determine nominal unit revenues, exactly offset the differences of the consumption and production profiles in the two settings.

Country Specific Effects: Long Run

The semi-reduced form of the long run consumption responses in the two countries can be derived via the world aggregate stated in table 4.1 and the long run consumption differential (4.2.5):

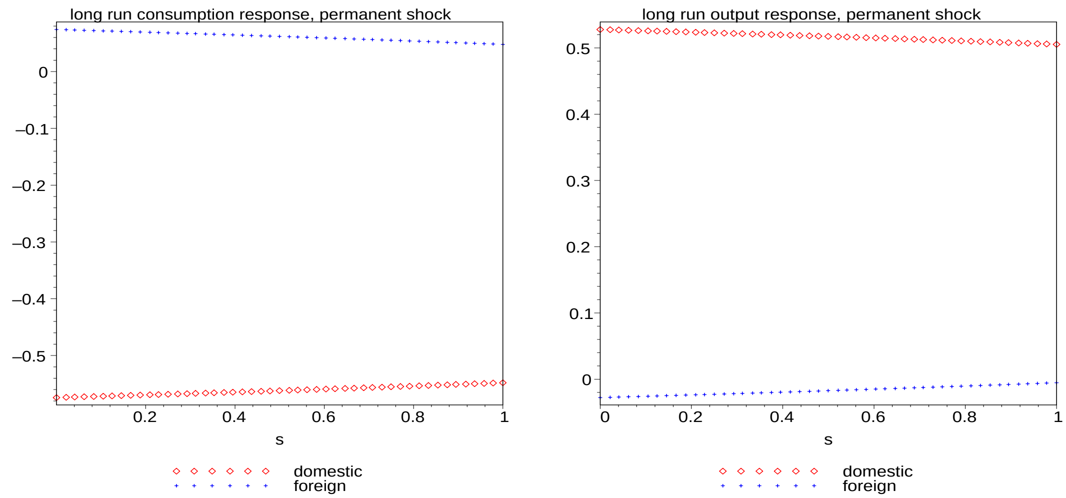
$$\tilde{c}_{t+1} = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} + (1-n)\left(\frac{1+\theta}{2\theta}\frac{\bar{r}\,df_{t+1}}{\bar{p}\bar{c}^w(1-n)(1+\bar{r})} - \frac{1+\theta}{2\theta}\frac{dg_{t+1}}{\bar{c}^w}\right) \quad (4.2.24)$$

and

$$\tilde{c}^*_{t+1} = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} - n\left(\frac{1+\theta}{2\theta}\frac{\bar{r}\,df_{t+1}}{\bar{p}\bar{c}^w(1-n)(1+\bar{r})} - \frac{1+\theta}{2\theta}\frac{dg_{t+1}}{\bar{c}^w}\right) \quad (4.2.25)$$

As illustrated in figure 4.4(a) domestic long run consumption is reduced while foreign consumption rises in the light of a permanent fiscal expansion.[11] A higher fraction of PTM producers narrows the difference between domestic and foreign consumption because of the smoothing effect on the short run trade balance. As already evidenced throughout the dissertation, the pricing behavior of firms is irrelevant in the long run, where prices are flexible. Hence, we can conclude that the effect of the parameter s stems exclusively from the short run accumulation of bonds. In short, the lower the debt load of domestic households the higher the long run consumption possibilities.

[11] We can show that this is also true for a temporary expansion.



(a) Long run consumption (b) Long run production

Figure 4.4: Permanent Fiscal Expansion, CIA, $\lambda = 1$

The semi-reduced forms of long run production now read

$$\tilde{y}_{t+1} = \frac{1}{2}\frac{dg_{t+1}}{\bar{c}^w} - \frac{1}{2}\left(\frac{\bar{r}\,df_{t+1}}{\overline{pc}^w(1+\bar{r})}\right) \tag{4.2.26}$$

and

$$\tilde{y}^*_{t+1} = \frac{1}{2}\left(\frac{n\,\bar{r}\,df_{t+1}}{\overline{pc}^w(1-n)(1+\bar{r})}\right) \tag{4.2.27}$$

where we made use of the long run output differential (4.2.6) and long run world production, which is stimulated only with a permanent expansion. From figure 4.4(b) follows that domestic production rises. This is due to the negative wealth effects of accumulated debt and the tax burden, that both raise the domestic households' working effort.

In the foreign country, long run production is below steady state due to permanent interest income. As for the stimulus of world demand when the domestic fiscal expansion is permanent, it is exactly offset by higher foreign relative goods prices which can be seen from equation (4.2.27).

4.2.3 Welfare Analysis of Fiscal Shocks

With the short and long run responses of consumption and output at hand, we can now analyze the welfare effects of fiscal shocks under the cash-in-advance specification. As before, we start by deriving the effects on world welfare and then turn to the analysis of domestic and foreign welfare in the respective periods. The welfare evaluation focuses mainly on the $\lambda = 1$ case, when all taxes enter the CIA constraint. As explained above, setting $\lambda = 0$ corresponds to the $\epsilon = 1$ case in the MIU setting, for which the welfare analysis was conducted in section 3.2.3.

World welfare in the short and in the long run can be calculated by plugging the responses of world consumption and output stated in table 4.1 into the world welfare equation (3.2.82) under the MIU specification that is still valid:[12]

$$dU_t^w = \frac{1}{\theta}(1-\lambda)\, n\, \frac{dg_t}{\bar{c}^w} \tag{4.2.28}$$

and

$$dU_{t+1}^w = \frac{1}{\theta}\, \frac{n}{2}\, \frac{dg_{t+1}}{\bar{c}^w} \tag{4.2.29}$$

In the long run, a permanent domestic fiscal expansion leads to higher world welfare, independently of the amount of taxes that is paid with cash. This is due to the

[12]Remember that we still assume that government spending is fully utility enhancing.

stimulation of world output, that results from the higher working effort of households. In the short run, world private consumption is not fully crowded out as long as $\lambda < 1$, such that world demand and hence world output are higher than in the initial steady state and world welfare increases. Our special interest lies on the $\lambda = 1$ case where a fiscal expansion has no effect on short run world welfare.

The net present value of world welfare follows from (4.2.28) and (4.2.29):

$$d\Omega_t^w = \frac{n}{\theta}\,(1-\lambda)\,\frac{dg_t}{\bar{c}^w} + \frac{n}{2\,\theta\,\bar{r}}\,\frac{dg_{t+1}}{\bar{c}^w} \tag{4.2.30}$$

An asymmetric fiscal expansion raises overall world welfare as the higher level of production reduces the distortion on the goods markets except for the special case of a temporary shock with $\lambda = 1$. In the latter case, short run world production is not stimulated due to the rigid CIA constraint. Furthermore, long run world production remains on its initial steady state level due to the temporary nature of the fiscal expansion. It now remains to be clarified how the welfare gains accrue to the different periods and to the two countries.

Short run welfare in the two countries is given in semi-reduced form by

$$\begin{aligned} dU_t &= \frac{1}{\theta}\,\tilde{h}_t^w - \frac{df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})} + s(1-n)\tilde{e}_t \\ &= \frac{1}{\theta}\,(1-\lambda)\,n\,\frac{dg_t}{\bar{c}^w} - \frac{df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})} + s(1-n)\tilde{e}_t \end{aligned} \tag{4.2.31}$$

and

$$dU_t^* = \frac{1}{\theta}\,(1-\lambda)\,n\,\frac{dg_t}{\bar{c}^w} + \frac{n\,df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})(1-n)} - n\,s\,\tilde{e}_t \tag{4.2.32}$$

where the reaction of the trade balance and of the exchange rate are stated in section 4.2.2. Both countries benefit symmetrically from possible welfare gains that arise if world production is stimulated and consumption possibilities increase (first term on the respective right-hand side). As the trade balance response is unambiguously negative in the $\lambda = 1$ case, short run domestic welfare rises at the expense of foreign welfare.

The welfare effects that stem from the short run movement of the exchange rate are now by and large diametrical to those explored in section 3.2.3. The appreciation of the nominal exchange rate reduces the competitiveness of domestic firms and causes expenditure switching towards foreign goods. Naturally, this effect is stronger the smaller the degree of pricing-to-market. At the same time, the appreciation now leads to an improvement of the domestic terms-of-trade as long as less than half of the goods are priced to market, i.e. $s < 0.5$, and to a deterioration of the terms-of-trade for $s > 0.5$.[13] As a consequence, domestic short run welfare is at its maximum and foreign welfare at its minimum when the law of one price holds for all goods ($s = 0$). In this case, there is no direct welfare impact of the exchange rate appreciation, as can be seen from equations (4.2.31) and (4.2.32). However, the exchange rate appreciation affects short run welfare via its impact on the trade balance. Intuitively, households resort much stronger to debt financing with low pricing-to-market due to the adverse effects of expenditure switching on domestic production. From a short run welfare perspective, the associated higher level of leisure translates into welfare gains. This effect is reinforced by the implied strong positive terms-of-trade.

[13] Remember that the short term linearized terms-of-trade read $\tilde{\tau}_t = (2\,s - 1)\,\tilde{e}_t$, see equation (3.2.92).

Complete pricing-to-market behavior, in contrast, implies that expenditure switching does not occur, while the terms-of-trade worsen for domestic households and improve for foreigners. In this case, the negative terms-of-trade effect on domestic welfare is exactly offset by the positive short run effect of debt accumulation. The overall impact of a permanent fiscal expansion on short run welfare in the two countries is depicted in figure 4.5(a). As before, the figure depicts the absolute deviation from the respective steady state utility level and we maintain the parameter choice of section 3.2. We can conclude that in the short run domestic households are always better off, while foreign households suffer welfare losses.

We now turn to the long run welfare implications of an expansive fiscal policy in the CIA setting. Combining the long run responses of consumption and output, we obtain the semi-reduced forms of domestic and foreign long run welfare as

$$dU_{t+1} = \frac{1}{\theta}\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} + \frac{\bar{r}\, df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})} \tag{4.2.33}$$

and

$$dU^*_{t+1} = \frac{1}{\theta}\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w} - \frac{n\,\bar{r}\, df_{t+1}}{\bar{p}\bar{c}^w(1+\bar{r})(1-n)} \tag{4.2.34}$$

The numerical illustration of the long run welfare effects is given in figure 4.5(b). In the case of a permanent shock, there is a symmetric positive effect on welfare in the two countries as production remains persistently above the initial steady state level. Domestic households are now obliged to pay interests on the previously accumulated debt. As the level of debt depends negatively on the degree of pricing-to-market,

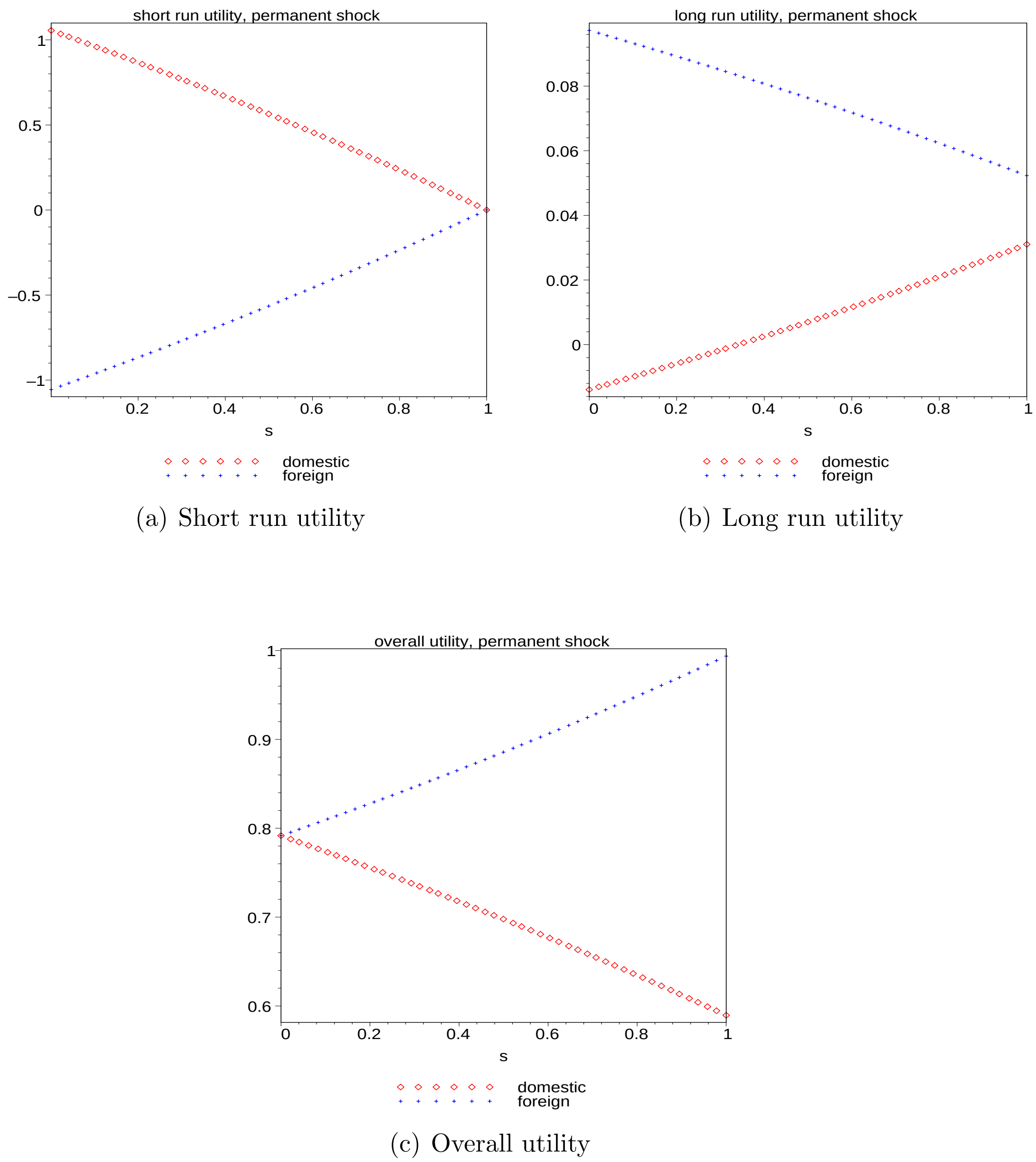


Figure 4.5: Welfare effects of a permanent shock, $\lambda = 1$ (CIA)

long run domestic welfare is maximal and foreign welfare minimal if $s = 1$. While foreign households derive long run welfare gains for all degrees of pricing-to-market, domestic households are worse off if s is small. In this case, the positive effect of the output expansion is outweighed by the high interest payments to foreign households. In contrast, for higher degrees of PTM domestic households are also better off in the long run as the positive output expansion effect dominates the negative wealth effect.

Combining the impact on short and long run welfare we obtain the overall effect on welfare in the two countries:

$$d\Omega_t = \frac{1}{\theta}\left((1-\lambda)\, n\, \frac{dg_t}{\bar{c}^w} + \frac{n}{2\,\bar{r}}\,\frac{dg_{t+1}}{\bar{c}^w}\right) + (1-n)\, s\, \tilde{e}_t \tag{4.2.35}$$

and

$$d\Omega_t^* = \frac{1}{\theta}\left((1-\lambda)\, n\, \frac{dg_t}{\bar{c}^w} + \frac{n}{2\,\bar{r}}\,\frac{dg_{t+1}}{\bar{c}^w}\right) - n\, s\, \tilde{e}_t \tag{4.2.36}$$

Figure 4.5(c) illustrates the overall welfare effects of a permanent shock in the $\lambda = 1$ case. As pointed out earlier, bond holdings are neutral when taking the net present value of welfare. Hence, the impact on overall welfare hinges only on the level of the symmetric output stimulation effect and the asymmetric effects stemming from the short run movement of the nominal exchange rate.

In the case of $s = 0$, expenditure switching and terms-of-trade effects are exactly offsetting such that households in both countries benefit symmetrically from the domestic fiscal expansion. We are already acquainted with this result from our earlier MIU analysis: Once the law of one price always holds - the *Redux* case - the welfare effects of asymmetric fiscal expansions are entirely symmetric if domestic households are compensated via fully utility enhancing public spending.

With higher degrees of pricing-to-market behavior, the overall welfare gain becomes more biased towards foreign households. This is due to the fact, that higher levels of PTM imply more favorable terms-of-trade for the foreign country, which outweighs the reduction of the positive expenditure switching effects. Table 4.2 summarizes the competing effects on overall welfare for different degrees of pricing-to-market.

Table 4.2: Effects on overall welfare, $\lambda = 1$, permanent expansion

	$s = 0$		$s = 0.5$		$s = 1$	
	domestic	foreign	domestic	foreign	domestic	foreign
expenditure switching	$--$	$++$	$-$	$+$	0	0
terms-of-trade	$++$	$--$	0	0	$--$	$++$
demand stimulus	(+)	(+)	(+)	(+)	(+)	(+)

The reasoning behind the choice of the three effects follows closely the one of the welfare analysis of fiscal policy in section 3.2.3. The described terms-of-trade and expenditure switching effects refer to the short run, where prices are fixed and relative price changes are driven by the exchange rate movement. Even though expenditure switching and changes in the terms-of-trade are also present in the long run, these effects are fully anticipated and are simply a byproduct of the usual adjustment process under flexible prices. Therefore, the long run exchange rate does not enter the overall utility formulae (4.2.35) and (4.2.36) explicitly. As for the demand stimulus effect stated in table 4.2, it is only positive in the case of a permanent expansion, while a temporary fiscal expansion leaves short and long run world demand and hence world production unchanged.

Importantly, domestic overall welfare falls below steady state in the latter case for $s \neq 0$. Fiscal policy becomes beggar-thyself due to the adverse combined terms-of-trade and expenditure switching effects of the appreciation of the exchange rate. These welfare losses are not compensated because of the missing overall demand stimulation when the fiscal expansion is temporary. Remember that this result applies despite the assumed welfare compensation of private households where government expenditures have full additive impact on private utility. Beggar-thyself effects of temporary fiscal expansions are even more likely in a model where public expenses are realistically less relevant for the utility of the households.

4.2.4 Conclusion

In this section we have investigated the effects of fiscal policy in cash-in-advance economies under flexible exchange rates. In a setting, where households need cash in order to purchase consumption goods and to pay the entire tax bill, a domestic fiscal expansion yields an appreciation of the short run exchange rate. The intuition for this result lies in the rise of relative domestic money demand, which is a consequence of the fact that the scale variable of money demand is now total absorption. Higher domestic government expenditures and intertemporal consumption smoothing lead to a rise in relative domestic absorption and hence relative money demand. The latter can only be brought about by a decrease in the domestic consumer price level, which requires an appreciation of the exchange rate.

When all taxes have to be paid with cash, a fiscal expansion has no stimulating effect on world output if prices are rigid because private consumption is fully crowded out. The appreciation of the exchange rate leads to expenditure switching towards foreign goods, except for the case of full pricing-to-market. As a consequence domestic production temporarily falls even below the initial steady state level. The short run trade balance is then strongly negative.

All in all, asymmetric domestic fiscal expansions are always beneficial for the foreign country in a cash-in-advance economy. Foreign households benefit from both a possible stimulation of world demand and from the combined expenditure switching and terms-of-trade effects of the exchange rate appreciation. Domestic households only derive utility gains when the stimulation of world output is large enough to compensate the adverse effects of the exchange rate movement. Beggar-thyself effects of fiscal policy are most likely to occur if many producers follow pricing-to-market.

Our findings stand in sharp contrast to the standard New Open Economy Macroeconomics literature that tends to prefer money-in-the-utility setups. As evidenced throughout the chapter, the main difference is the movement of the short run nominal exchange rate following an asymmetric domestic fiscal expansion. The standard MIU framework yields in general a depreciation of the exchange rate while the proposed alternative cash-in-advance model that accounts for the fiscal component of money demand leads to an appreciation. As the welfare analysis of fiscal policy in the NOEM model class is mainly driven by exchange rate dynamics, the welfare and policy implications are very different in our setup. We come back to this issue in section 4.4 where we carry out a comparative summary of fiscal policies under the two alternative monetary frameworks.

4.3 CIA in a Monetary Union

This section explores the transmission mechanisms and welfare implications of a domestic fiscal expansion in a monetary union model where households face a cash-in-advance constraint. The description of the model setup will be rather short given the analogy to the models presented so far. For more detailed information the reader is referred to the previous sections.

4.3.1 The Model

Households, firms, and governments behave as in section 4.2. The structural equations of the current accounts, goods markets, and labor markets are taken from the monetary union version of the MIU-model presented in section 3.3. The common money market now pools the cash-in-advance constraints of the domestic and foreign households, which represent the respective money demand functions:

$$m_t^{w\,s} = n\,p_t(c_t + \lambda g_t) + (1-n)p_t(c_t^* + \lambda g_t^*) \tag{4.3.1}$$

This money market equilibrium condition holds in the short and long run of the model, the only difference being possible changes of the overall price level in the long run. In the short run, prices are entirely fixed because of the absence of the exchange rate channel. Even though individual money holdings may now rise in one country, this is only viable if money demand decreases by the same amount in the other country. The linearized money demand differential now reads

$$(\tilde{m}_t^d - \tilde{m}_t^{d*}) = (\tilde{c}_t - c_t^*) + \lambda \frac{dg_t - dg_t^*}{\overline{c}^w} \tag{4.3.2}$$

As opposed to the money demand differential under flexible exchange rates, see equation (4.2.12), $(\tilde{m}_t^d - \tilde{m}_t^{d*})$ is not necessarily zero. Different nominal money holdings now rather reflect relative transaction volumes in the two countries. Once again, with $\lambda = 0$ equation (4.3.2) matches the $\epsilon = 1$ case of the money demand differential in a money-in-the-utility setup. That is, the scale variable of money demand reduces to private consumption with an implied unit consumption elasticity of money demand. Due to the analogy of the remaining structural equations to the money-in-the-utility model presented in section 3.3 we directly proceed to the positive analysis of the model.

4.3.2 Positive Analysis of Fiscal Shocks

We restate the effects of a domestic fiscal expansion on world consumption and output so as to stress the essential difference between the two considered microfoundations of money demand. Remember that the exchange rate regime does not affect world aggregates. Table 4.3 summarizes the respective aggregates which can be found in chapter 3.2 and chapter 4, equations (3.2.66) - (3.2.70) and table 4.1 respectively.

According to table 4.3 long run world aggregates are invariant to the specification of money demand. This is due to the classical dichotomy property of the long run model: Differing money market conditions only affect nominal long run variables, particularly the overall price level. In the short run, however, world consumption and output do respond differently to a domestic fiscal expansion due to the differing

Table 4.3: World aggregates depending on money demand specification

Cash-in-advance	
$\tilde{c}_t^w = -\lambda\, n\, \frac{dg_t}{\bar{c}^w}$	$\tilde{y}_t^w = (1-\lambda)\, n\, \frac{dg_t}{\bar{c}^w}$
$\tilde{c}_{t+1}^w = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w}$	$\tilde{h}_{t+1}^w = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w}$
Money-in-the-utility	
$\tilde{c}_t^w = -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w}$	$\tilde{y}_t^w = -\frac{n(\epsilon-1)}{2\,\epsilon(1+\bar{r})}\frac{dg_{t+1}}{\bar{c}^w} + n\frac{dg_t}{\bar{c}^w}$
$\tilde{c}_{t+1}^w = -\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w}$	$\tilde{h}_{t+1}^w = \frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w}$

restrictions of world real balances on the global transaction volume. As pointed out above, world aggregates do not differ for $\lambda = 0$ and $\epsilon = 1$ in the respective CIA and MIU settings where fiscal policy has its maximal impact on world production. A rising share of taxes that have to be paid with cash on the one hand, and a decreasing consumption elasticity of money demand on the other hand imply less of a demand stimulation and hence less stimulation of production. In the case of $\lambda = 1$, where all taxes have to be paid with cash, short run world demand is not stimulated at all as the cash-in-advance constraint imposes a strict ceiling on the transaction volume which is then comprised by consumption and taxes. Recall that the latter of which equal government expenditures as the fiscal expansion is entirely tax-financed.

Taking world aggregates and the respective differentials, which are given explicitly in the previous section, we arrive at the individual consumption and output responses in our CIA monetary union model. The domestic and foreign short run consumption responses then read

$$\begin{aligned}
\tilde{c}_t &= \tilde{c}_t^w + (1-n)(\tilde{c}_t - \tilde{c}_t^*) \\
&= \tilde{c}_t^w - (1-n)\left(\frac{dg_t}{\bar{c}^w} + \frac{df_{t+1}}{\bar{p}\bar{c}^w(1-n)(1+\bar{r}}\right) \\
&= -\lambda\, n\, \frac{dg_t}{\bar{c}^w} - \frac{(1-n)(1+\theta)}{\bar{r}+\theta\bar{r}+2\theta}\left(\frac{\bar{r}\, dg_t}{\bar{c}^w} + \frac{dg_{t+1}}{\bar{c}^w}\right) \qquad (4.3.3)
\end{aligned}$$

and

$$\tilde{c}_t^* = -\lambda\, n\, \frac{dg_t}{\bar{c}^w} + \frac{n(1+\theta)}{\bar{r}+\theta\bar{r}+2\theta}\left(\frac{\bar{r}\, dg_t}{\bar{c}^w} + \frac{dg_{t+1}}{\bar{c}^w}\right) \qquad (4.3.4)$$

where we made use of the short run trade balance response given by equation (3.3.39) under the monetary union regime in the MIU setting.[14] Domestic short run consumption is always reduced by the domestic fiscal expansion while the sign of the foreign consumption response depends on the parameter λ. If all taxes have to be paid with cash, i.e. $\lambda = 1$, foreign consumption is also below steady state because overall demand is then not stimulated.

Figure 4.6 shows the implications of the establishment of a monetary union for the short run consumption responses in the two countries. The respective differences of short run consumption, i.e. $\tilde{c}_t^{MU} - \tilde{c}_t^{FLEX}$, are graphed against the degree of pricing-to-market. Again, we consider a permanent fiscal expansion. $\tilde{c}_t^{MU}$ is given by equation

[14] We discuss the identical response of the trade balance under the two alternative money demand settings in the sequel.

(4.3.3) while $\tilde{c}_t^{FLEX}$ is described by equation (4.2.18) in the previous section. In

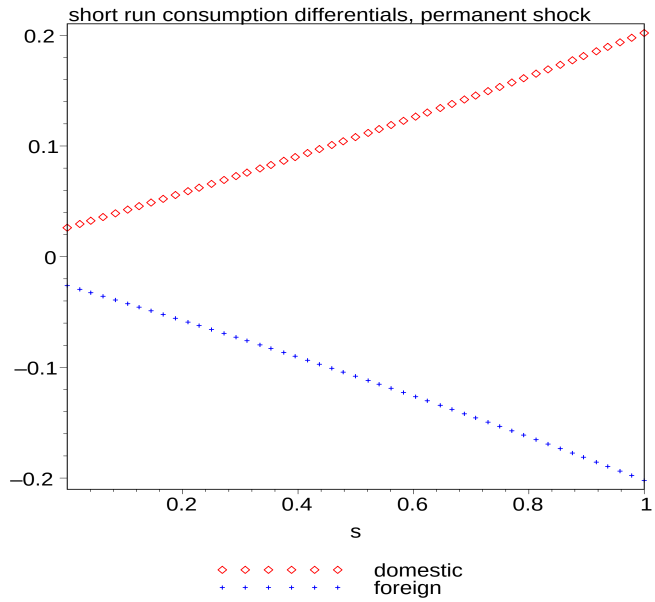


Figure 4.6: Short run consumption differentials, $\tilde{c}_t^{MU} - \tilde{c}_t^{FLEX}$

a monetary union, short run domestic consumption is higher than under flexible exchange rates while the opposite result applies for the foreign country. The absent appreciation of the exchange rate allows in general for a more (less) favorable domestic (foreign) consumption path.

As in the monetary union case under the MIU specification, short run production depends exclusively on world demand:

$$\tilde{y}_t = \tilde{y}_t^* = \tilde{y}_t^w = (1 - \lambda)\, n \, \frac{dg_t}{\bar{c}^w} \tag{4.3.5}$$

Domestic and foreign short run production evolve symmetrically following a domestic fiscal expansion. In the case of $\lambda = 1$, fiscal policy does not serve as a stabilization tool in the short run because world production is not stimulated. Intuitively, short run domestic production is always higher in a monetary union because relative prices are unchanged. Under flexible exchange rates, producers across countries face the same (possible) stimulation of world demand while the appreciation of the exchange rate favors foreign producers via its effect on relative prices.

The above postulated identical trade balance response under the two specifications of money demand in a monetary union regime deserves further explanation. While the money market equilibrium condition has strong impact on the international structure of consumption and production under flexible exchange rates, it only affects the respective world aggregates in a monetary union regime. By definition, the trade balance depends exclusively on the international nominal production and consumption differential and remains unaffected by differing world aggregates. Specifically, the trade balance response is independent of the parameter λ as it affects only world aggregates in a CIA monetary union setting. When compared with current account imbalances under flexible exchange rates, the trade balance response is in general less pronounced in a monetary union as depicted in figure 4.7.[15] This has important consequences for the long run effects of fiscal policy as long run consumption and production depend on the wealth effects that are associated with short run debt.

The respective semi-reduced forms of long run consumption and output are identical to those under flexible exchange rates given by equations (4.2.24) - (4.2.27) in section 4.2.2. Since in the monetary union setting domestic households face lower interest payments stemming from short run imbalances, long run domestic consumption

[15]The figure draws upon the CIA trade balance response under flexible exchange rates given by equation (4.2.23) and its monetary union counterpart given by equation (3.3.39), that holds for the MIU and the CIA model as outlined in the text.

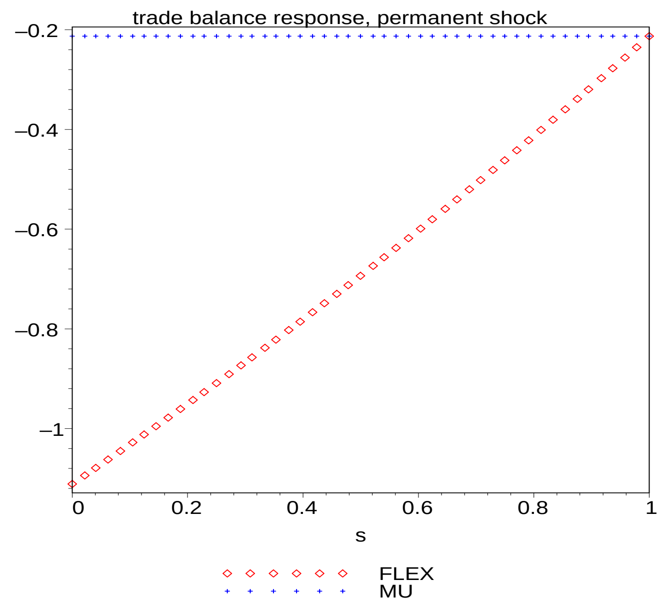


Figure 4.7: Comparison of the trade balance response in CIA economies

is higher while domestic production is lower than under flexible exchange rates. The opposite is true for the foreign country. Obviously, the trade balance effect translates into diverging welfare patterns under the two exchange rate regimes. We will quantify the respective welfare impact of a domestic fiscal expansion in the following section.

4.3.3 Welfare Analysis of Fiscal Shocks

In this section we shortly review the welfare effects of the respective consumption and output responses to a domestic fiscal expansion in the proposed CIA monetary union model. The utility analysis rather serves as an input for the subsequent welfare comparison of exchange rate regimes presented in the next section. That is why the explanatory text will be quite parsimonious. For the sake of completeness we state the semi-reduced forms of the welfare formulae. Domestic and foreign short run utility read

$$\begin{aligned} dU_t &= \frac{1}{\theta}\,\tilde{h}_t^w - \frac{df_{t+1}}{\overline{p}\overline{c}^w(1+\bar{r})} \\ &= \frac{1}{\theta}\,(1-\lambda)\,n\,\frac{dg_t}{\bar{c}^w} - \frac{df_{t+1}}{\overline{p}\overline{c}^w(1+\bar{r})} \end{aligned} \tag{4.3.6}$$

and

$$dU_t^* = \frac{1}{\theta}\,(1-\lambda)\,n\,\frac{dg_t}{\bar{c}^w} + \frac{n\,df_{t+1}}{\overline{p}\overline{c}^w(1+\bar{r})(1-n)} \tag{4.3.7}$$

When compared with the semi-reduced utility equations (4.2.31) and (4.2.32) under flexible exchange rates it is only the missing exchange rate term that differs in a monetary union setting.

The semi-reduced forms of the long run utility responses are identical under both exchange rate regimes:

$$dU_{t+1} = \frac{1}{\theta}\,\frac{n}{2}\,\frac{dg_{t+1}}{\bar{c}^w} + \frac{\bar{r}\,df_{t+1}}{\overline{p}\overline{c}^w(1+\bar{r})} \tag{4.3.8}$$

and

$$dU_{t+1}^* = \frac{1}{\theta}\,\frac{n}{2}\,\frac{dg_{t+1}}{\bar{c}^w} - \frac{n\,\bar{r}\,df_{t+1}}{\overline{p}\overline{c}^w(1+\bar{r})(1-n)} \tag{4.3.9}$$

The first term on the respective right-hand side indicates the positive welfare effect of the permanent component of fiscal expansions, which falls symmetrically on domestic and foreign households because domestic households are fully compensated for tax induced welfare losses. The second term captures permanent interest payments that drive a wedge between domestic and foreign long run utility. As the short run trade balance is always negative in a monetary union setting, domestic long run utility is lower than its foreign counterpart for both temporary and permanent domestic fiscal expansions.

Finally, overall welfare in the two countries may be stated as

$$d\Omega_t = d\Omega_t^* = \frac{1}{\theta}\left(\tilde{h}_t^w + \frac{1}{\bar{r}}\tilde{h}_{t+1}^w\right) = \frac{1}{\theta}\left((1-\lambda)\,n\,\frac{dg_t}{\bar{c}^w} + \frac{1}{\bar{r}}\frac{n}{2}\frac{dg_{t+1}}{\bar{c}^w}\right) \tag{4.3.10}$$

Like in the monetary union model with money-in-the-utility, overall welfare is symmetrically enhanced in both countries due to the output stimulating effect of fiscal policy. The parameter λ rules the extent of the short run world production effect, while the long run stimulation only depends on the persistence of the shock. Figure 4.8 illustrates the overall welfare effects of a permanent domestic fiscal expansion depending on the specification of money demand.

A higher fraction of taxes that has to be paid with taxes reduces overall welfare in both countries because the cash-in-advance constraint then imposes a more restrictive ceiling on overall expenditure in the short run. The stimulation of production on a global scale via expansive fiscal policy is therefore limited with high values of the parameter λ. As output stimulation is generally a positive in economies that suffer from monopolistic competition, overall welfare is then lower.

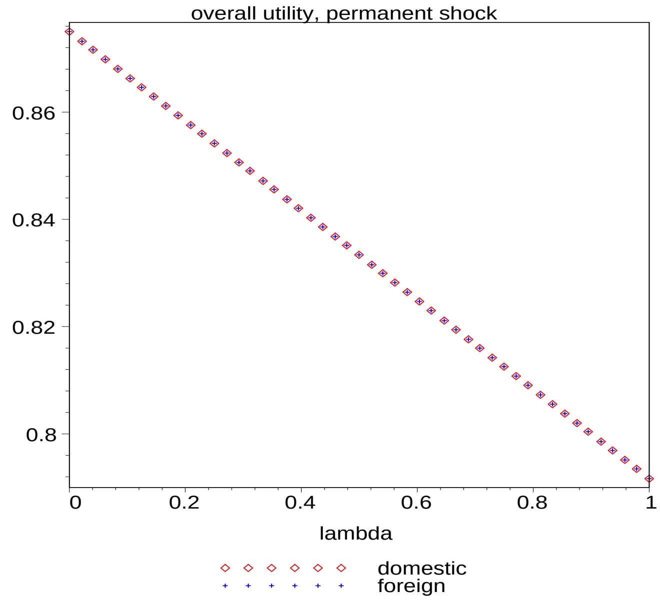


Figure 4.8: Effect of λ on overall welfare

4.3.4 Conclusion

In this section we have presented the implications of a cash-in-advance constraint in a monetary union setting. As in the money-in-the-utility model, relative prices are fixed in the short run due to the absence of the exchange rate channel. The international short run production pattern is then entirely symmetric and the individual production levels only depend on world demand. A cash-in-advance constraint, where taxes are fully relevant, implies that short run world production is unchanged and hence domestic and foreign production are not stimulated. The only viable channel for consumption smoothing is then the international bond market. However, the trade balance response is less pronounced in a monetary union because expenditure switching under a flexible exchange rate regime reduces domestic production. Moreover, we have highlighted that domestic consumption is higher in a monetary union because of the more favorable income situation. A welfare analysis has demonstrated that the domestic and foreign households benefit symmetrically from a domestic fiscal expansion. The extent of the welfare enhancing effect of fiscal policy hinges on the fraction of taxes that have to be paid with cash and on the persistence of the fiscal shock.

The welfare results of the CIA monetary union model are in line with our findings from the MIU monetary union analysis in section 3.3. The results of the fiscal policy analysis are thus quite robust to the specific money demand modelling approach in a monetary union setting, the only difference being the efficiency of expansive fiscal policy to stimulate production on a global scale. As stressed in our prior analysis, however, cash-in-advance approaches with fiscal money demand components may yield very different results than money-in-the-utility frameworks under flexible exchange rates. Therefore, a comparison of fiscal policy under alternative exchange rate regimes is very sensitive to the money demand issues that are at the focus of the present dissertation. We will now address the issue of alternative exchange rate regimes in our preferred cash-in-advance setup.

4.4 Comparison of Exchange Rate Regimes

Following our approach of section 3.4 we now compare the welfare effects of fiscal policy under the flexible exchange rate regime and the monetary union in the cash-in-advance setting. Again, we start by analyzing the short and long term welfare differentials before turning to an assessment of the overall effects of the fiscal expansion.

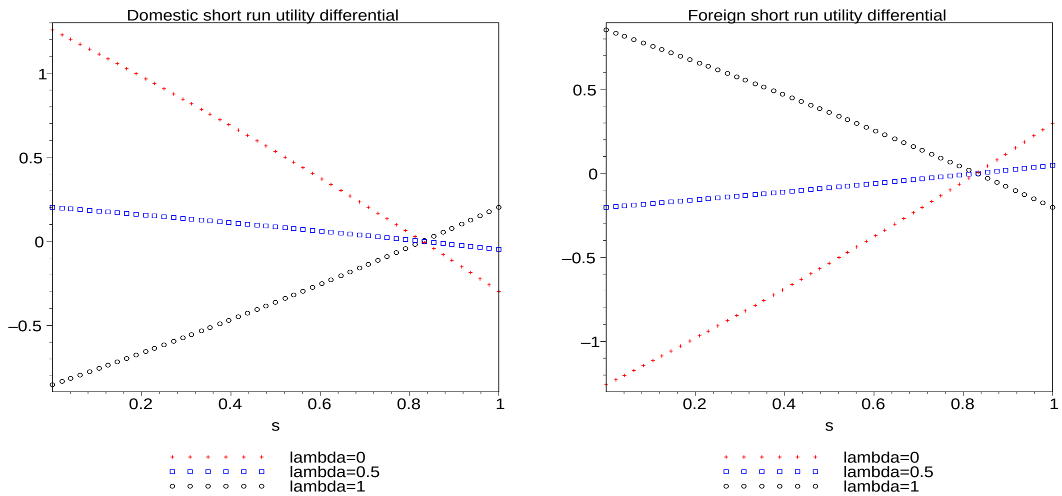
Recall that the domestic welfare differential of the two alternative exchange rate regimes is defined in all periods t as $dU_t^{\Delta} = dU_t^{MU} - dU_t^{Flex}$, where an analogous expression holds for the foreign country. Making use of the domestic and foreign short run utility responses under the two exchange rate systems given by (4.2.31), (4.2.32), (4.3.6) and (4.3.7) we obtain the semi-reduced welfare differentials for both temporary and permanent shocks as

$$dU_t^{\Delta} = -\frac{df_{t+1}^{MU} - df_{t+1}^{Flex}}{\bar{p}\bar{c}^w(1+\bar{r})} - (1-n)s\tilde{e}_t \tag{4.4.1}$$

and

$$dU_t^{*\Delta} = \frac{n(df_{t+1}^{MU} - df_{t+1}^{Flex})}{\bar{p}\bar{c}^w(1-n)(1+\bar{r})} + ns\tilde{e}_t \tag{4.4.2}$$

While the semi-reduced forms of the welfare differentials are identical to those in the money-in-the-utility approach, the endogenous responses of the short run exchange rate and the trade balance differential are now different. Figures 4.9(a) and 4.9(b) depict the numerical results of the short run utility differential in the two countries for alternative values of λ and a permanent fiscal expansion. Recall that we look at



(a) Domestic (b) Foreign

Figure 4.9: Short run utility differentials, permanent expansion

the difference between the respective absolute deviations of welfare from the steady state which are given on the y-axis of the figures.

It becomes evident that the welfare implications of a fiscal shock hinge crucially on the assumptions about the amount of taxes that has to be paid with cash and on the pricing behavior of firms. If $\lambda = 0$, we obtain the same result as in the $\epsilon = 1$ case under the MIU specification. In that case the absence of exchange rate responses in a monetary union makes domestic households better off, except for very high degrees of pricing-to-market. For $\lambda = 1$, the short run welfare implications are completely reversed: For a broad range of s, domestic households suffer welfare losses when moving from a flexible exchange rate regime to a monetary union, while foreign households are better off. This is due to the fact that for low values of s the appreciation of the exchange rate in the flexible regime has a positive (negative) impact on short run domestic (foreign) welfare. On the one hand, expenditure switching leads to lower (higher) domestic (foreign) production and hence less labor effort, which results in short run welfare gains (losses) for domestic (foreign) households. On the other hand, values of s below 0.5 also imply a positive (negative) terms-of-trade effect for domestic (foreign) households under flexible exchange rates, which is absent in the monetary union case. For very high levels of pricing-to-market behavior, in contrast, domestic households are better off under a monetary union as they suffer from a negative terms-of-trade effect under flexible exchange rates. In the polar case of $s = 1$, expenditure switching vanishes under flexible exchange rates and the trade balance response is identical under both regimes as pointed out in the previous section. The positive domestic welfare differential therefore reflects exclusively the different terms-of-trade under the two regimes.

In the intermediate case of $\lambda = 0.5$ the domestic short run utility differential is mainly positive but for high values of s. As noted above, a permanent shock leads in this case to a weak depreciation of the short run exchange rate. Qualitatively, we therefore obtain the same results as for $\lambda = 0$ but of less quantitative relevance.

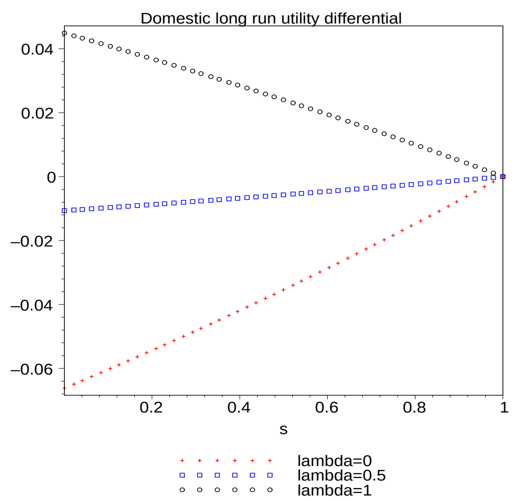
Using our results of the previous sections, we can derive the semi-reduced long run welfare differentials in both countries:

$$dU_{t+1}^{\Delta} = \frac{df_{t+1}^{MU} - df_{t+1}^{Flex}}{\bar{p}\bar{c}^{w}(1+\bar{r})} \tag{4.4.3}$$

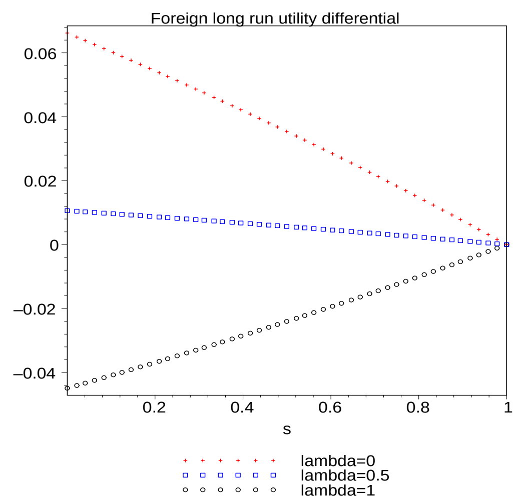
and

$$dU_{t+1}^{*\Delta} = -\frac{n(df_{t+1}^{MU} - df_{t+1}^{Flex})}{\bar{p}\bar{c}^{w}(1-n)(1+\bar{r})} \tag{4.4.4}$$

which reveals again the importance of bond holdings for the long run welfare evaluation of exchange rate regimes. As with our MIU exchange rate comparison, world welfare effects cancel out from our regime differential perspective because these effects are independent of the exchange rate regime. The numerical solutions of the long run welfare differentials are depicted in figures 4.10(a) and 4.10(b).



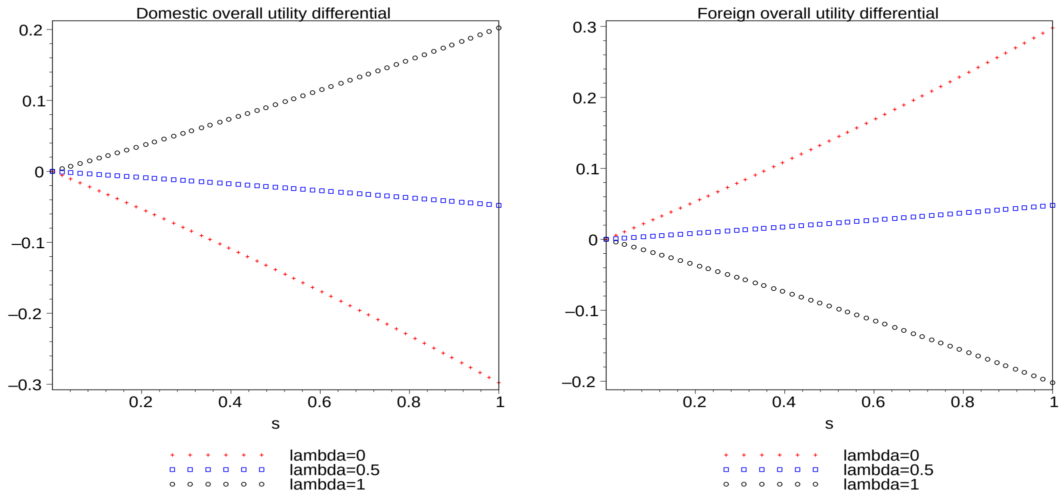
(a) Domestic



(b) Foreign

Figure 4.10: Long run utility differentials, permanent expansion

For $\lambda = 1$, domestic long run utility is higher in a monetary union due to the lower short run trade balance response except for the case of $s = 1$. Domestic households then face lower permanent interest payments to foreigners. For the special case of complete pricing-to-market, however, the trade balance response is identical under both regimes and no long run utility differential arises. For $\lambda = 0.5$ and $\lambda = 0$, the domestic trade balance differential is always negative, hence the negative long run welfare differential. The opposite reasoning applies for the foreign country.



(a) Domestic (b) Foreign

Figure 4.11: Overall utility differentials, permanent expansion

Combining the short and long run utility differentials (4.4.1) - (4.4.4) yields the overall welfare differentials which are valid for both temporary and permanent expansions

$$d\Omega_t^{\Delta} = -(1-n)\, s\, \tilde{e}_t \tag{4.4.5}$$

and

$$d\Omega_t^{*\Delta} = n\, s\, \tilde{e}_t \tag{4.4.6}$$

As depicted in figures 4.11(a) and 4.11(b) domestic households are in general better off in a monetary union regime with $\lambda = 1$ while foreign households are worse off in this case.

For the sake of brevity, we do not present the welfare results of a temporary expansion. It turns out, that the qualitative results are the same as in the case of a permanent expansion except for a small range of intermediate values of λ, where the direction of the exchange rate response and hence the international welfare pattern is reversed.

From an overall welfare perspective, the difference between the two exchange rate regimes lies in the combined expenditure switching and terms-of-trade effects prevailing in the flexible exchange rate regime. As pointed out in section 4.2.3 the two effects are exactly offsetting when the law of one price holds for all goods. Hence, the exchange rate regime then does not matter for the welfare implications of an asymmetric fiscal expansion. The irrelevance of the monetary regime in the $s = 0$ case is closely related to the intrinsic symmetry property of the baseline *Redux* model, where the origin of the macroeconomic disturbance does not affect the international pattern of overall welfare. In the light of fiscal policy this result only holds if government expenditures fully enter the households' utility function.

As long as a fraction of producers pursue pricing-to-market an appreciation of the short run exchange rate favors foreign households. When taxes are paid entirely with cash ($\lambda = 1$), the establishment of a monetary union is therefore welfare enhancing for the domestic country and welfare reducing for the foreign country. With complete pricing-to-market, the respective welfare differentials are maximal. Expenditure switching is then absent even under flexible exchange rates while the terms-of-trade effect of the appreciation exerts a strong negative effect on domestic welfare and a strong positive effect on foreign welfare. A monetary union is thus beneficial for the domestic economy and detrimental to the foreign country.

Figures 4.11(a) and 4.11(b) also show the overall welfare implications of a domestic fiscal expansion in the case of $\lambda = 0.5$ and $\lambda = 0$. Recall that the latter case is equivalent to the logarithmic specification of the MIU setting. The welfare analysis of the two monetary regimes then yields just the opposite outcome!

In fact, the overall welfare equations (4.4.5) - (4.4.6), which are identical to equations (3.4.10) - (3.4.11) in the proposed money-in-the-utility model of chapter 3, summarize the major welfare story of the present thesis. We especially like this outcome because the quite complicated model setup can be reduced to two simple semi-reduced equations that nicely isolate the main welfare driving channel of our analysis of fiscal policy, which is the short run nominal exchange rate movement under the flexible regime. Once the exchange rate deviation $\tilde{e}_t$ in the above equations is positive, which implies a depreciation, domestic households prefer a flexible exchange rate regime in the light of domestic fiscal expansions. This would be the case of a standard NOEM model with money-in-the-utility. On the other hand, when the short run exchange rate deviation $\tilde{e}_t$ is negative, domestic households favor a monetary union in order to avoid the adverse welfare effects of the appreciation, which is the case in the tax augmented cash-in-advance model presented in this chapter. All in all, we have established a generalized analysis framework that allows us to boil down the model to very tractable semi-reduced welfare equations. The solution approach may also be of use for the welfare analysis of other topics in international macroeconomics.

4.5 Conclusion

In this chapter we have presented a flexible exchange rate and a monetary union model of the New Open Economy Macroeconomics approach with money demand motivated via a cash-in-advance constraint. We have extended the standard consumption based CIA model by including tax payments in the constraint. The scale variable of equilibrium money demand then amounts to total cash-financed absorption. If all taxes have to be paid with cash, the scale variable is the sum of private consumption and government expenditures. Under a flexible exchange rate regime a domestic fiscal expansion then leads to an appreciation of the exchange rate when prices are temporarily rigid. The movement of the exchange rate is more pronounced the higher the degree of pricing-to-market. Due to the associated expenditure switching towards foreign goods, domestic short run production is lower than in a monetary union. In fact, short run domestic production remains on its initial steady state level in a monetary union, while an expansive fiscal policy has even negative effects on domestic production under flexible exchange rates.

As for current account imbalances, domestic households resort more to debt financing under flexible exchange rates with the implied consequences for the intertemporal pattern of welfare. From an overall welfare perspective, domestic households prefer in general a monetary union when domestic fiscal expansions are the main macroeconomic disturbance and a large fraction of taxes has to be paid with cash. This is due the fact that domestic households suffer from adverse welfare effects of expenditure switching and terms-of-trade responses that arise from the appreciation of the short run exchange rate. If pricing-to-market is completely absent, however, domestic and foreign households are indifferent to the exchange rate regime as it was the case in the money-in-the-utility framework.

We have demonstrated that the cash-in-advance setup is formally equivalent to the logarithmic preference case of the money-in-the-utility approach if taxes do not enter the CIA constraint. This facilitated a direct comparison of the major positive results and welfare consequences of fiscal policy in a common model framework. As claimed already in the introduction and as demonstrated throughout the dissertation, the modification of money demand related elements in fiscal policy NOEM models leads to significant qualitative changes of the model implications. Since the direction of the equilibrium exchange rate may be reversed, the remaining positive and welfare results that are related to exchange rate dynamics are not robust to changes in the monetary setup, either. Due to the severe differences of the flexible exchange rate analyses, the comparative analysis of fiscal policy under alternative exchange rate regimes also hinges on the exact monetary setup: Against the background of domestic fiscal expansions domestic households are better off under flexible exchange rates in the MIU model while they benefit from the introduction of a monetary union in the CIA model (the opposite is true for foreign households). Our contribution is even more disturbing once you think of the fact that we did not demonstrate the potential weaknesses of a single model but of an entire model class, which is the New Open Economy Macroeconomics literature that closely follows the *Redux* model introduced by Obstfeld and Rogoff (1995a). To be fair, however, the differences between the MIU and the CIA setup are not decisive when monetary policy is at stake because the scale variable of money demand is then private consumption under both specifications. We now proceed to the concluding chapter where we give a roundup of our major findings.

Chapter 5

Conclusion

5.1 Main Results

In the preceding chapters, we have explored the international transmission mechanisms and welfare effects of fiscal policy in theoretical models of the New Open Economy Macroeconomics approach. Recently, NOEM models have replaced the traditional Mundell-Fleming framework as the standard workhorse for the analysis of macroeconomic policy in an international context. The major innovation of NOEM models is the strictly microfounded model setup which not only provides an adequate basis to analyze the international transmission of macroeconomic disturbances but also allows for an explicit evaluation of the associated welfare effects.

A substantial extension of the *Redux* model has been the inclusion of pricing-to-market behavior of firms. We adopted a special form of pricing-to-market along the lines of Betts and Devereux (2000), where some producers set prices in the currency of the consumer while the remaining producers set prices in their respective local currency. Pricing-to-market is then generated via exchange rate movements against the background of sticky prices. Being not only empirically relevant, pricing-to-market has also important theoretical consequences, namely for the terms-of-trade and expenditure switching effects of the exchange rate response.

The implications of alternative money demand specifications for the comparison of a flexible exchange rate regime with a monetary union have been at the center of the analysis. Specifically, we have introduced money via a money-in-the-utility specification in chapter 3 and via a cash-in-advance constraint in chapter 4. In the former case, the scale variable of money demand amounts to private consumption, while in a cash-in-advance economy, where taxes have to be paid with cash, the scale variable becomes total absorption.

We have shown that a comparative welfare analysis of exchange rate regimes against the background of asymmetric fiscal expansions depends essentially on the direction of the short run exchange rate response under the flexible regime. When the scale variable is private consumption like in the money-in-the-utility models of chapter 3, a domestic fiscal expansion yields a depreciation of the exchange rate. As the associated expenditure switching and terms-of-trade effects are beneficial to the domestic country, domestic households prefer a flexible exchange rate regime to a monetary union. However, when the scale variable of money demand is total absorption like in the cash-in-advance models of chapter 4, we obtain an appreciation of the exchange rate and the results of the welfare comparison are reversed.

We now turn to a more detailed summary of the major positive results and welfare implications of the competing models. First of all, a domestic fiscal expansion has very different stimulating effects on short run output under the alternative specifications of money demand when prices are rigid and production is entirely demand determined. In the long run, where prices are flexible, the implications of fiscal policy for world consumption and production are independent of the monetary part of the model. In a money-in-the-utility setting, the short run expansionary effect of fiscal policy is maximal with a unit consumption elasticity of money demand. In this case, world private consumption is not crowded out at all due to a strong drop in real interest rates. Tax-including cash-in-advance constraints, in contrast, impose a strict ceiling on total absorption which leads to complete crowding out of world private consumption and world production is not stimulated at all. In a monetary union, short run production in the two countries only depends on world production. Under flexible exchange rates, however, it is the expenditure switching effect of the exchange rate response that determines the international short run production structure. The depreciation of the short run exchange rate in the MIU setting favors domestic production while the appreciation in the CIA setting redirects world demand towards foreign goods. In the latter case, the short run impact of a domestic fiscal expansion on domestic production is even negative.

Higher production levels may in general improve utility of households because of monopolistic distortions on the goods markets. While the stimulation of world demand is always beneficial to domestic and foreign households, a rise in production that stems from expenditure switching has to be assessed more carefully. First of all, the degree of pricing-to-market governs both the size of the expenditure switching effects and the direction of the terms-of-trade response under flexible exchange rates. We demonstrated that in the MIU setup the depreciation of the exchange rate favors in general domestic households. Importantly, domestic welfare is at its maximum in a world of complete pricing-to-market, even though short run production is then not stimulated by expenditure switching. However, the domestic country then receives windfall profits in form of higher income stemming from strongly positive terms-of-trade. If all producers set prices in their own currency, the positive welfare effect of expenditure switching is exactly offset by the associated strong negative terms-of-trade response. All in all, domestic households prefer a flexible exchange rate regime to a monetary union in the light of domestic fiscal expansions as long as a fraction of firms pursues pricing-to-market. Obviously, the opposite reasoning applies for foreign households. It has to be stressed that a domestic fiscal expansion is always prosper-thy-neighbor and also prosper-thyself in a MIU setting when government spending is fully utility enhancing.

The welfare comparison of exchange rate regimes in a cash-in-advance setting has revealed that domestic households are better off under a monetary union while foreigners prefer flexible exchange rates. The very reason for this result lies in the appreciation of the exchange rate following a domestic fiscal expansion, which has a negative (positive) impact on domestic (foreign) utility via the combined expenditure switching and terms-of-trade effects under flexible exchange rates if some producers pursue pricing-to-market. While an expansive fiscal policy is always prosper-thy-neighbor, it has a beggar-thyself effect if the expansion is temporary.

In general, a higher degree of pricing-to-market reinforces the respective welfare differentials between the two exchange rate regimes. If pricing-to-market behavior is completely absent, domestic and foreign households are indifferent to the exchange rate regime.

5.2 Possible Extensions

Given the great variety of modifications of the *Redux* model, the presented analysis of fiscal policy under alternative exchange rate regimes can be extended in several directions. We shortly sketch possible additional features that can be included in the general model specification of our comparative analysis.

The model economies of the previous chapters do not allow for a home bias in private consumption or in government expenditure. Substantial research has been done in that respect. Pitterle and Steffen (2004a, 2004b) stress that a fiscal expansion tends to be more beneficial for domestic households if preferences are biased towards domestically produced goods due to demand composition effects. In a cash-in-advance economy, an asymmetric fiscal expansion may then become a beggar-thy-neighbor policy. This property of fiscal policy is even more likely if government purchases exclusively fall on domestic goods, a case which has been investigated by Corsetti and Pesenti (2001) and Tille (2001) among others.

Another strand of the NOEM literature explores the implications of differing cross-country and within-country substitutability of goods. Tille (2001) points out that in the case of a complete home bias in government expenditures the beggar-thy-neighbor property of fiscal expansions is stronger if there is little substitutability of goods across countries.

Our analysis has concentrated on balanced-budget fiscal expansions. An investigation of debt-financed fiscal expansions - which are of great practical relevance - has been conducted by Ganelli (2003a) in an overlapping generations model. The effectiveness of fiscal policy is then generally enhanced in terms of both output stimulation and welfare as of lower crowding out of private consumption. A fruitful extension of this approach would be the inclusion of pricing-to-market and the modification of the money demand function.

The strategic implications of fiscal policy and the associated spillover effects on third countries are highly topical in New Open Economy Macroeconomics. We have presented a thorough analysis of the welfare spillover effects of fiscal expansions, which may serve as an input for the assessment of the potential welfare gains of pursuing non-cooperative or cooperative fiscal stabilization policies. For recent surveys on strategic fiscal policy issues see Canzoneri, Cumby, and Diba (2002) and Coutinho (2003).

5.3 Final Remarks

In the light of recent developments in the European Union, the analysis of fiscal policy has received ever more interest from both academics and policy makers. Especially for the acceding countries, the effects of asymmetric fiscal policies under different exchange rate regimes are crucial when assessing the pros and cons of joining the European Monetary Union. Against the background of the European Growth and Stability Pact the question how national fiscal policies are transmitted among the member countries is of great relevance. We have shown that models of the New Open Economy Macroeconomics approach may contribute to a deeper understanding of this issue.

Our analysis cautions for the specific choice of the money demand modelling if fiscal policy is the predominant source of macroeconomic disturbances. Given the importance of the public sector in most European countries a money demand function that does not account for a fiscal component may yield misleading welfare implications of alternative exchange rate regimes. While standard money-in-the-utility models predict that domestic households prefer flexible exchange rates when they experience expansionary fiscal policies, the alternative cash-in-advance model predicts the opposite.

Naturally, one has to be very cautious when deriving explicit policy conclusions from highly stylized economic models. Following the basic themes of our analysis, however, the call for excessive fiscal discipline seems to be somehow overzealous as, irrespectively of the exchange rate regime, countries tend to benefit from expansionary policies of their trading partners. This is especially true for an environment that is characterized by monopolistically distorted goods markets where the stimulation of demand is generally a positive for welfare.

Appendix A

Appendix to Chapter 3

A.1 Log-Linear Long Run System (FLEX)

We present the entire log-linear long run equilibrium in order to provide the interested reader with a more transparent exposition of the model than the often very compact versions that can be found in the NOEM literature. We start with the log-linearization of the long run money market equations (3.2.29) and (3.2.30).

Money markets

$$\tilde{m}_{t+1} - \tilde{p}_{t+1} = \frac{1}{\epsilon}\,\tilde{c}_{t+1} \tag{A-1}$$

$$\tilde{m}^*_{t+1} - \tilde{p}^*_{t+1} = \frac{1}{\epsilon}\,\tilde{c}^*_{t+1} \tag{A-2}$$

Note that the long run bond price R_{t+1} falls back to the steady state level $\bar{R} = \beta$ because in period $t+1$ the new steady state is reached and no further changes in consumption, prices and exchange rate arise. Hence, the log-linear versions of the long run Euler equations (3.2.35) and (3.2.36) reduce to $\tilde{R}_{t+1} = 0$.

Current accounts

$$\tilde{p}_{t+1} + \tilde{c}_{t+1} + \frac{dg_{t+1}}{\bar{c}^w} - \frac{(1-\beta)\, df_{t+1}}{\bar{p}\, \bar{c}^w} = \tilde{p}^h_{t+1} + \tilde{y}_{t+1} \tag{A-3}$$

$$\tilde{p}^*_{t+1} + \tilde{c}^*_{t+1} + \frac{dg^*_{t+1}}{\bar{c}^w} - \frac{(1-\beta)\, df^*_{t+1}}{\bar{p}\bar{c}^w} = \tilde{p}^{f*}_{t+1} + \tilde{y}^*_{t+1} \tag{A-4}$$

When calculating the log-linear versions of the long run current accounts (3.2.31) and (3.2.31), we make use of the steady state relation $df_{t+1} = df_{t+2}$. A permanent increase of debt is ruled out by the no Ponzi scheme condition we impose on households.

Goods markets

$$\begin{aligned} \tilde{y}_{t+1} \quad = \quad & n\tilde{c}_{t+1} + (1-n)\tilde{c}^*_{t+1} + n\frac{dg_{t+1}}{\bar{c}^w} + (1-n)\frac{dg^*_{t+1}}{\bar{c}^w} \\ & + n\,\theta\,\tilde{p}_{t+1} + (1-n)\theta\tilde{p}^*_{t+1} - \theta\,\tilde{p}^h_{t+1} + (1-n)\,\theta\,\tilde{e}_{t+1} \end{aligned} \tag{A-5}$$

$$\begin{aligned} \tilde{y}^*_{t+1} \quad = \quad & n\tilde{c}_{t+1} + (1-n)\tilde{c}^*_{t+1} + n\frac{dg_{t+1}}{\bar{c}^w} + (1-n)\frac{dg^*_{t+1}}{\bar{c}^w} \\ & + n\,\theta\,\tilde{p}_{t+1} + (1-n)\theta\tilde{p}^*_{t+1} - \theta\,\tilde{p}^{f*}_{t+1} - n\,\theta\,\tilde{e}_{t+1} \end{aligned} \tag{A-6}$$

The detailed log-linear versions of the long run goods markets (3.2.33) and (3.2.34) reveal that any component of world demand as well as individual and overall prices may change in the long run.

Labor Markets

$$\tilde{y}_{t+1} = \tilde{h}_{t+1} = \tilde{p}^h_{t+1} - \tilde{p}_{t+1} - \tilde{c}_{t+1} \tag{A-7}$$

$$\tilde{y}^*_{t+1} = \tilde{h}^*_{t+1} = \tilde{p}^{f*}_{t+1} - \tilde{p}^*_{t+1} - \tilde{c}^*_{t+1} \tag{A-8}$$

Finally, log-linearizing the long run labor markets (3.2.37) and (3.2.38) gives the long run relationship of firms' labor demand and households' labor supply.

A.2 Log-Linear Short Run System (FLEX)

The log-linear version of the short run equilibrium under flexible exchange rates is described by the following set of equations:

Money markets

$$\tilde{m}_t - \tilde{p}_t = \frac{1}{\epsilon}\left(\tilde{c}_t + \frac{1}{\bar{r}}\tilde{R}_t\right) \tag{A-9}$$

$$\tilde{m}^*_t - \tilde{p}^*_t = \frac{1}{\epsilon}\left(\tilde{c}^*_t + \frac{1}{\bar{r}}\tilde{R}_t - \frac{1}{\bar{r}}\left(\tilde{e}_t - \tilde{e}_{t+1}\right)\right) \tag{A-10}$$

Current accounts

$$\tilde{p}_t + \tilde{c}_t + \frac{dg_t}{\overline{c}^w} + \frac{\beta\, df_{t+1}}{\bar{p}\,\overline{c}^w} = (1-s)\tilde{y}^a_t + s\,n\,\tilde{y}^{mh}_t + s\,(1-n)\,\tilde{y}^{mh*}_t + s\,(1-n)\,\tilde{e}_t \tag{A-11}$$

$$\tilde{p}^*_t + \tilde{c}^*_t + \frac{dg^*_t}{\overline{c}^w} + \frac{\beta\, df^*_{t+1}}{\bar{p}\,\overline{c}^w} = (1-s)\tilde{y}^{a*}_t + s\,(1-n)\,\tilde{y}^{mf*}_t + s\,n\,\tilde{y}^{mf}_t - s\,n\,\tilde{e}_t \tag{A-12}$$

Goods markets

$$\tilde{y}^a_t = \theta n\tilde{p}_t + n\left(\tilde{c}_t + \frac{dg_t}{\overline{c}^w}\right) + \theta(1-n)\tilde{e}_t + \theta(1-n)\tilde{p}^*_t + (1-n)\left(\tilde{c}^*_t + \frac{dg^*_t}{\overline{c}^w}\right) \tag{A-13}$$

$$\tilde{y}^{a*}_t = \theta n\tilde{p}_t + n\left(\tilde{c}_t + \frac{dg_t}{\overline{c}^w}\right) - \theta n\tilde{e}_t + \theta(1-n)\tilde{p}^*_t + (1-n)\left(\tilde{c}^*_t + \frac{dg^*_t}{\overline{c}^w}\right) \tag{A-14}$$

$$\tilde{y}^{mh}_t = \theta\tilde{p}_t + \tilde{c}_t + \frac{dg_t}{\overline{c}^w} \tag{A-15}$$

$$\tilde{y}^{mh*}_t = \theta\tilde{p}^*_t + \tilde{c}^*_t + \frac{dg^*_t}{\overline{c}^w} \tag{A-16}$$

$$\tilde{y}^{mf}_t = \theta\tilde{p}_t + \tilde{c}_t + \frac{dg_t}{\overline{c}^w} \tag{A-17}$$

$$\tilde{y}^{mf*}_t = \theta\tilde{p}^*_t + \tilde{c}^*_t + \frac{dg^*_t}{\overline{c}^w} \tag{A-18}$$

Euler Equations

$$\tilde{c}_{t+1} + \tilde{p}_{t+1} = \tilde{c}_t + \tilde{p}_t - \tilde{R}_t \tag{A-19}$$

$$\tilde{c}^*_{t+1} + \tilde{p}^*_{t+1} = \tilde{c}^*_t + \tilde{p}^*_t - \tilde{R}_t + \tilde{e}_t - \tilde{e}_{t+1} \tag{A-20}$$

A.3 Log-Linear Short Run System (MU)

In a monetary union, the log-linear version of the short equilibrium is given by the following set of equations:

Equilibrium money demands

$$\tilde{m}_t^d - \tilde{p}_t = \frac{1}{\epsilon}\,\tilde{c}_t + \frac{1}{\epsilon\,\bar{r}}\tilde{R}_t \tag{A-21}$$

$$\tilde{m}_t^{d*} - \tilde{p}_t = \frac{1}{\epsilon}\,\tilde{c}_t^* + \frac{1}{\epsilon\,\bar{r}}\tilde{R}_t \tag{A-22}$$

Current accounts

$$\tilde{p}_t + \tilde{c}_t + \frac{dg_t}{\bar{c}^w} + \frac{\beta\,df_{t+1}}{\bar{p}\,\bar{c}^w} = \tilde{p}_t^h + \tilde{y}_t \tag{A-23}$$

$$\tilde{p}_t + \tilde{c}_t^* + \frac{dg_t^*}{\bar{c}^w} + \frac{\beta\,df_{t+1}^*}{\bar{p}\bar{c}^w} = \tilde{p}_t^f + \tilde{y}_t^* \tag{A-24}$$

Goods markets

$$\tilde{y}_t = \tilde{c}_t^w + \tilde{g}_t^w + \theta\,\tilde{p}_t - \theta\,\tilde{p}_t^h \tag{A-25}$$

$$\tilde{y}_t^* = \tilde{c}_t^w + \tilde{g}_t^w + \theta\,\tilde{p}_t - \theta\,\tilde{p}_t^f \tag{A-26}$$

Euler equations

$$\tilde{c}_t + \tilde{p}_t = \tilde{c}_{t+1} + \tilde{p}_{t+1} + \tilde{R}_t \tag{A-27}$$

$$\tilde{c}_t^* + \tilde{p}_t = \tilde{c}_{t+1}^* + \tilde{p}_{t+1} + \tilde{R}_t \tag{A-28}$$

Bibliography

Aoki, M. (1985): "Misadjustment to Anticipated Shocks: An Example of Exchange-Rate Response," *Journal of International Money and Finance*, 4, 415–420.

Auerbach, A. J., and M. Obstfeld (2004): "The Case for Open-Market Purchases in a Liquidity Trap," *mimeo*, University of California, Berkeley.

Betts, C., and M. Devereux (2000): "Exchange Rate Dynamics in a Model of Pricing-to-Market," *Journal of International Economics*, 50, 215–244.

Box, G., and N. Draper (1987): *Empirical Model Building and Response Surfaces.* John Wiley and Sons, New York.

Calvo, G. (1983): "Staggered Contracts in a Utility-Maximizing Framework," *Journal of Monetary Economics*, 12, 383–398.

Calza, A., D. Gerdesmeier, and J. Levy (2001): "Euro Area Money Demand: Measuring the Opportunity Costs Appropriately," *IMF Working Paper*, 01/179.

Canzoneri, M., R. Cumby, and B. Diba (2002): "The Need for International Policy Coordination: What's Old, What's New and What's Yet to Come," *NBER Working Paper Series*, 8765.

Carlstrom, C. T., and T. S. Fuerst (2001): "Real Indeterminacy in Monetary Models with Nominal Interest Rate Distortions," *Review of Economic Dynamics*, 4, 767–789.

Carré, M., and F. Collard (2003): "Monetary Union: A Welfare Based Approach," *European Economic Review*, 47, 521–552.

Caselli, P. (2001): "Fiscal Consolidation under Fixed Exchange Rates," *European Economic Review*, 45, 425–450.

Chang, W., and C. Lai (1997): "The Specification of Money Demand, Fiscal Policy, and Exchange Rate Dynamics," *Journal of Macroeconomics*, 19(1), 79–102.

Chari, V., P. Kehoe, and E. McGrattan (1997): "Monetary Shocks and Real Exchange Rates in Sticky Price Models of International Business Cycles," *NBER Working Paper Series*, 5876.

——— (2002): "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?," *Review of Economic Studies*, 69, 533–563.

Clower, R. (1967): "A Reconsideration of the Microfoundations of Monetary Theory," *Western Economic Journal*, 6(1), 1–9.

Cooley, and G. D. Hansen (1989): "The Inflation Tax in a Real Business Cycle Model," *American Economic Review*, 79, 733–748.

Cooley, T., and G. Hansen (1995): "Money and the Business Cycle," in *Frontiers of Business Cycle Research*, ed. by T. Cooley, chap. 7, pp. 175–216. Princeton University Press.

Corsetti, G., and P. Pesenti (2001): "Welfare and Macroeconomic Interdependence," *The Quarterly Journal of Economics*, 116(2), 421–445.

Coutinho, L. (2003): "Fiscal Policy in the New Open Economy Macroeconomics and Prospects for Fiscal Policy Coordination," *ENEPRI Working Paper Series*, 21.

Diamond, D. W., and R. G. Rajan (2003): "Money in a Theory of Banking," *NBER Working Paper Series*, 10070.

Elyasiani, E., and A. Nasseh (1994): "The Appropriate Scale Variable in the U.S. Money Demand: An Application of Nonnested Tests of Consumption versus Income Measures," *Journal of Business and Economics Statistics*, 12, 47–55.

Fleming, M. (1962): "Domestic Financial Policies under Fixed and under Floating Exchange Rates," *International Monetary Fund Staff Papers*, 9, 369–79.

Ganelli, G. (2003a): "The New Open Economy Macroeconomics of Government Debt," *Trinity Economic Papers*, 14.

——— (2003b): "Useful Government Spending, Direct Crowding-out and Fiscal Policy Interdependence," *Journal of International Money and Finance*, forthcoming.

Ganelli, G., and P. Lane (2002): "Dynamic General Equilibrium Analysis: The Open Economy Dimension," *Trinity College Dublin and CEPR*, mimeo.

Guidotti, P. E., and C. A. Végh (1993): "The Optimal Inflation Tax when Money Reduces Transaction Costs: A Reconsideration," *Journal of Monetary Economics*, 31, 189–205.

Hairault, J.-O., and F. Portier (1993): "Money, New-Keynesian Macroeconomics, and the Business Cycle," *European Economic Review*, 37, 1533–1568.

Helpman, E. (1981): "An Exploration of the Theory of Exchange Rate Regimes," *Journal of Political Economy*, 89, 865–90.

Judd, K. (1998): *Numerical Methods in Economics.* MIT Press, Cambridge.

Kollmann, R. (2001a): "The Exchange Rate in a Dynamic-Optimizing Business Cycle Model with Nominal Rigidities: A Quantitative Investigation," *Journal of International Economics*, 55, 243–262.

——— (2001b): "Explaining international comovements of output and asset returns: The role of money and nominal rigidities," *Journal of Economic Dynamics & Control*, 25, 1547–1583.

LIEBERMAN, C. (1980): "The Long-run and Short-run Demand for Money, Revisited," *Journal of Money, Credit, and Banking*, 12, 43–57.

LUCAS, R. E. (1980): "Equilibrium in a Pure Currency Economy," *Economic Inquiry*, 18, 203–220.

LUCAS, R. E. J. (1982): "Interest Rates and Currency Prices in a Two-Country World," *Journal of Monetary Economics*, 10, 336–60.

MANKIW, G., AND L. SUMMERS (1986): "Money Demand and the Effects of Fiscal Policies," *Journal of Money, Credit and Banking*, 18, 415–429.

MARIMON, R., AND A. SCOTT (1999): *Computational Methods for the Study of Dynamic Economies*. Oxford University Press, Oxford, 1st edn.

MCCALLUM, B. T., AND M. S. GOODFRIEND (1987): "Money: Theoretical Analysis of the Demand for Money," *NBER Working Paper Series*, 2157.

MULLIGAN, C. B., AND X. X. SALA-I-MARTIN (1997): "The Optimum Quantity of Money: Theory and Evidence," *Journal of Money, Credit, and Banking*, 29/4, 687–715.

MUNDELL, R. (1963): "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates," *Canadian Journal of Economics and Political Science*, 29, 475–85.

NIEHANS, J. (1978): *The Theory of Money*. Johns Hopkins University Press, Baltimore.

Obstfeld, M., and K. Rogoff (1995a): "Exchange Rate Dynamics Redux," *Journal of Political Economy*, 103, 624–660.

Obstfeld, M., and K. Rogoff (1995b): "The Intertemporal Approach to the Current Account," in *Handbook of International Economics*, ed. by G. Grossman, and K. Rogoff, vol. III, chap. 34, pp. 1731–1799. Elsevier.

Obstfeld, M., and K. Rogoff (1999): *Foundations of International Macroeconomics*. MIT Press, Cambridge, 4th edn.

Pitterle, I., and D. Steffen (2004a): "Fiscal Policy in a Monetary Union Model with Home Bias in Consumption," *mimeo*, University of Frankfurt.

——— (2004b): "Spillover Effects of Fiscal Policy under Flexible Exchange Rates," *mimeo*, University of Frankfurt.

——— (2004c): "Welfare Effects of Fiscal Policy under Alternative Exchange Rate Regimes: The Role of the Scale Variable of Money Demand," *Tübinger Diskussionsbeiträge*, 284.

Sargent, T. J. (1987): *Dynamic Macroeconomic Theory*. Harvard University Press, Cambridge.

Saving, T. R. (1971): "Transaction Costs and the Demand for Money," *American Economic Review*, 61, 407–420.

Schmitt-Grohé, S., and M. Uribe (2000): "Price Level Determinacy and Monetary Policy under a Balanced-Budget Requirement," *Journal of Monetary Economics*, 45, 211–246.

Sidrauski, M. (1967): "Rational Choice and Patterns of Growth in a Monetary Economy," *American Economic Review*, 2, 534–544.

Sriram, S. S. (2001a): "A Survey of Recent Empirical Money Demand Studies," *IMF Staff Papers*, 47, 334–365.

——— (2001b): "Theory of the Demand for Money: a Survey of the Literature," *The Indian Economic Journal*, 49(1), 103–115.

Sutherland, A. (1996): "Exchange Rate Dynamics and Financial Market Integration," *CEPR Discussion Paper*, 1337.

Thornton, D. (1988): "Should Consumer Expenditures be the Scale Variable in Empirical Money Demand Equations?," *Federal Reserve Bank of St. Louis Working Papers*, 88-003.

Tille, C. (2001): "The Role of Consumption Substitutability in the International Transmission of Monetary Shocks," *Journal of International Economics*, 53(2), 421–444.

Walsh, C. (2000): *Monetary Theory and Policy*. MIT Press, Cambridge, 2nd edn.

Warnock, F. E. (1999): "Idiosyncratic Tastes in a Two-Country Optimizing Model: Implications of a Standard Presumption," *International Finance Discussion Papers*, 631.

——— (2000): "Exchange Rate Dynamics and the Welfare Effects of Monetary Policy in a Two-Country Model with Home-Product Bias," *International Finance Discussion Papers*, 667.

——— (2003): "Exchange Rate Dynamics and the Welfare Effects of Monetary Policy in a Two-Country Model with Home-Product Bias," *Journal of International Money and Finance*, 22, 343–363.

Woodford, M. (1997): "Control of the Public Debt: A Requirement for Price Stability?," in *Debt Burden and Monetary Policy*, ed. by G. Calvo, and M. King. Macmillan, London.