# The Transfer Problem Revisited: Have We Forgotten the Monetary Aspect?

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**Abstract**

This paper analyzes the famous "transfer problem" in a two country dynamic stochastic general equilibrium framework. Transfer effects include the impact of foreign aid, debt relief and huge current account reversals. More precisely, it considers the repercussions of transfers under fixed and floating exchange rate regimes. The adage that the nominal exchange rate is a shock absorber and hence the superiority of flexible exchange rate regimes can not be unambiguously accepted. This is especially the case when more realistic calibration is considered in the form of asymmetric country size. More specifically, I analyze the impact of foreign aid from a larger economy to a smaller economy under various exchange rate regimes.

## 1 Introduction

One of the most famous debates in economic history took place in the late 1920s. The Versailles Treaty that ended World War I required Germany to make large reparation payments to the victorious countries. In 1929, John Maynard Keynes initiated this famous controversy with Bertil Ohlin over the effects of such unilateral reparation payments on Germany's terms of trade (see Keynes (1929) and Ohlin (1929)). Keynes argues that the paying country would suffer a deterioration in its terms of trade that would aggravate the primary harm of making the foreign tribute in the first place. Ohlin took a different view, pointing out that the payer's terms of trade would not necessarily have to deteriorate if the recipient spent the transfer on the payer's goods. After Keynes' 1929 Economic Journal article, this debate was known as the "transfer problem".

In its modern context, the general relationship between large international payments and the real exchange rate – which encompasses the terms of trade – is now referred to as a transfer problem, and is considered to be one of the classic

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questions in international macroeconomics. Some examples of instances where the transfer problem comes in the play are the 1980s debt crisis (debt relief and/or forgiveness), the 1997 Asian crisis (sudden and huge current account reversals), and billions of dollars worth of world wealth redistributions flowing between countries (typically as aid, international construction projects[1], war reparations[2]). For economic policy, the most important transfers are aid related. IMF bailouts and projects initiated by the World Bank are forms of transfers that among others have led to a resurgence of interest on this topic, in view of the central prediction that international wealth redistribution require some degree of real exchange rate adjustment. By extension, in terms of the current policy debate concerning the exchange rate regime choices of emerging market economies, some argue that the operation of a powerful transfer effect may suggest a preference for nominal exchange rate flexibility in order to allow the real adjustment to take place as smoothly as possible.

Before moving on the more sophisticated explanations offered in the literature, I would like to provide an expository *static* example to solidify the intuition behind the transfer problem. Imagine a two country world, with countries Home and Foreign. Assume initially that both have zero trade balances. Now denoting the marginal propensity to import in the home country with $m$, and that of the foreign countries as $m^*$, consider the ramifications of a transfer from Home to Foreign of \$100 million under various circumstances. First let $m = 0.4$ and $m^* = 0.6$. Under these conditions, when Home makes the transfer, its nation income decrease by \$100 million, whereas Foreign's increase by that exact amount. This implies that Home's imports will decrease by \$40 million and Foreign's import will increase by \$60 million. Since Foreign's imports are Home's exports, this implies that Home has a trade surplus of \$100 million. The real transfer is realized without any need for the terms of trade to change. However if we now consider the case where $m = 0.2$ and $m^* = 0.5$, then Home's imports fall by \$20 million, Foreign's imports increase by \$50 million and consequently Home's trade surplus is only \$70 million, which falls short of the financial transfer by \$30 million. The transfer is incomplete, and so Home's terms of trade must deteriorate to complete the transfer. Notice in the first case $m = 0.4$ and $m^* = 0.6$ summed to unity and in the second $m = 0.2$ and $m^* = 0.5$ was less than one. In the case where the marginal propensities are greater that one, the terms of trade improves for the Home country. In the real world one can expect that the marginal propensities are less than one[3]. This is the point that Keynes argued. However as one can easy see, theoretically this need not be the case, this view was emphasized by Ohlin. In the case when the marginal propensities are less than one, a "secondary burden" of adjustment falls on the terms of trade, Home's must deteriorate to complete the transfer.

[1] e.g. The Panama Canal project

[2] United Nations Security Counsil Resolution 674 of February 29, 1991 mandated that Iraq pay war reparations, namely to Kuwait.

[3] This example was adapted from Salvatore (2001), as was the statement which supports Keynes argument that for all practical purposes the case that the marginal propensities are less than one holds in the real world. Remember this is a simple static framework.

Most of the literature regarding the transfer problem is reviewed by Brackman and van Marrewijk (1998), however their analysis is mostly theoretical and almost totally disregards any dynamics. Most of their extensions considers distortions, third parties and tied aid. In the third chapter of their book, Brakman and van Marrewijk (1998) describe the general presumption that a donor's current account will deteriorate under incomplete markets if all goods are normal in both countries. Although they make a significant contribution by using a general equilibrium framework, there analysis is for the most part static and does not consider intertemporal trade.

In intertemporal optimizing models, the transfer effect can operate in the presence of a home preference for domestic tradables, or through the impact of wealth effects on labor supply. In the former case (see, for example, Buiter (1989)), a transfer from the home to the foreign country implies a decline in global demand for home goods, and hence necessitates a fall in their relative price, i.e. the home countries terms of trade deteriorates. In the latter case (see, for example, Obstfeld and Rogoff (1995)), a transfer from the home to the foreign country reduces domestic wealth and hence raises labor supply and the supply of exportables, affecting their relative price perversely. Another alternative, presented in Obstfeld and Rogoff (1996), is a Ricardian model where due to transport costs, a range of goods is not traded. In this setting, a transfer from the home to the foreign country raises spending on foreign non-tradables: foreign wages rise, the foreign export sector declines and the home export sector expands which leads to a deterioration of the domestic economies terms of trade.

Brock (1996) is a rare modern theoretical treatment that incorporates dynamics and borrowing. In his model, he considers a small open economy with a terms of trade that is fixed, and thus focuses on the adjustment of the relative price of non-traded goods. This model is probably most appropriate for LDC's. He sets up his model in a continuous time framework, includes capital formation and includes a single internationally traded bond which facilitates current account dynamics and thus consumption smoothing. The paper then tries to explain the occurrences of the Franco - German indemnity of 1871-1873 and the war reparations Germany had to pay to the victors after World War I.

With this being said, the most sophisticated contribution made in analyzing the transfer problem is the work by Devereux and Smith (2002). In a dynamic general equilibrium framework they analyze the Franco-German war indemnity of 1871-1873. They appropriately model this phenomenon using a two country dynamic stochastic general equilibrium model, where the terms of trade is endogenized. Devereux and Smith (2002) show that consumption smoothing via international borrowing reduces the required adjustment in the terms of trade in response to a transfer by a substantial amount. More specifically, they initially replicate the static methodology of Brackman and van Marrewijk (1998) focusing on the 1871-1873 period using French and German data and find a terms-of-trade adjustment up 50 percent. Then using their dynamic stochastic general equilibrium framework, that allowing for international lending and borrowing (which naturally facilitates consumption smoothing) results in a large revision in the predicted effects of a transfer, they find after the same transfer, the adjustment that the terms-of-trade has to under go is only 5 percent, which they argue matches historical data more accurately.

This paper augments the Devereux and Smith (2002) exposition in several dimensions. First of all it adds money. The motivation to add money into the model is because many intriguing questions can be approached with its inclusion. Among these are the fact that money serves as a medium of exchange that reduces real transaction costs, as well as a store of value and a nominal unit of account. Many issues such as determinants of seignorage, the mechanics of exchange rate systems, and the long-run effects of money supply changes on prices and exchange rate can be analyzed. The main policy question I intend to address is the impact of a transfer under various exchange rate regimes. Finally, I model the non-traded sector as being composed of a myriad of monopolistic competitors. By incorporating an imperfectly competitive non-traded goods sector, I motivate nominal rigidities.

Ever since Friedman (1962) flexible exchange rates have been advocated for the fact that many argued that changes in the real exchange rate typically take place via nominal exchange rate adjustments, in other words the nominal exchange rate acts as a shock absorber. One of the unique aspects of this paper is that I consider the impact of monetary regimes one a transfer shock is realized. The key feature of a transfer is that it is an international wealth redistribution and affects both countries contemporaneously. I proceed to model the impact of a transfer under distinct exchange rate regimes when the countries have asymmetric structure. One of the novel results of the paper is that the adage that floating exchange rates should be preferred is not unambiguously the case, especially in the context of a relatively smaller country that receives aid from abroad.

The next section presents the model. Then I go over the model solution and calibration of the system. Before concluding, I examine the impact of a transfer shock under various exchange rate regimes and provide intuition.

# 2 The Model

The theoretical analysis will be conducted using a comprehensive dynamic stochastic general equilibrium model. There are two countries that produce two distinct goods each. Each country produces a non-traded good (transportation costs prohibit the trade of this good internationally) and a traded good. I will assume that each country specializes in the production of its own traded good. This implies that we have four distinct goods which allows relative price dynamics within countries (the relative price of non-traded goods) and between countries (the terms of trade). Thus although there are four goods produced globally, each country consumes three of those goods, the two traded goods and its own non-traded good. There are two sectors in each country. Firms in the traded sector operate under a perfectly competitive environment, where as those in the non-traded good sector operate in an imperfectly competitive setting. Capital accumulation is modelled with adjustment costs thus allowing for real rigidities. This captures the realistic feature that capital cannot switch industries instantaneously. Labor however is perfectly mobile between sectors, but not internationally. A single foreign currency denominated bond exists, which allows for intertemporal borrowing and also current account dynamics. The government in each country levies a lump sum tax to satisfy is budget constraint every period. Monetary and fiscal policy is initially modeled as a purely exogenous process. The transfer will be made among countries and is taken to be a one time shock from one country to the other. The consequences of a transfer under various exchange rate regimes will be considered after the benchmark model is presented. In the following exposition, the home country is modelled, the foreign country is analogous, except where noted otherwise. An asterisks superscript will always denote the foreign country.

## 2.1 Households

I build on the setup of Lubik (2001), where each country is assumed to have a representative household that solves a four tier optimization problem. In the first stage, the evolution of aggregate consumption, leisure, capital, bond holdings and real money balances are determined. Taking these as given, the household then proceeds to the second step, where the consumption expenditure in each period is allocated between the aggregate non-traded good and aggregate traded good. In the third stage, the household then splits expenditure between the export good that is manufactured domestically and the import good produced abroad. In the final stage, non-traded expenditure is divided among a myriad of goods provided domestically. This multiple good set up allows for rich price dynamics. Different goods produced within each country allow the analysis of the relative price of non-traded goods, whereas goods traded among countries allows us to analysis the terms of trade. These two distinct components constitute the real exchange rate, which is this model is a distinct entity from the terms of trade.

### 2.1.1 Stage One: Intertemporal Optimization

The representative household's utility function is defined over sequences of aggregate consumption $C$, hours worked, $L$ and real money balances $M/P$. The household earns income in three ways. First it sells the services of capital in both sectors $(K_X, K_N)$ for rental rates $(r_X, r_N)$ respectively[4]. It can earn the common wage $w$ for the hours employed in the two sectors $(L_X, L_N)$. Finally, it can earn foreign currency denominated interest $r$ by lending internationally. Thus, wealth is held in the form of domestic real money balances $(\frac{M}{P})$, a foreign currency denominated bond $B^*$ and physical capital $K$. Real money balances are necessary for transactions purposes.

[4] The subscript $X$ is a mnenonic for the domestically produced export good. The foreign countries export good has a subscript $M$, because it is the home countries import good. The subscript $N$ is used for home non-traded goods, and $N^*$ is for the foreign countries non-traded goods.

International linkages between the countries have two channels of operation. First of all each country produces a tradeable good that is consumed domestically but can also be exported to the other country. Also, households demand the foreign traded good for consumption purposes. Secondly, trade in international bonds allows the household to smooth consumption over time. Via this channel, international interest rates and the real exchange rate are determined by demand and supply in the bond and traded goods market respectively. The price of non-traded goods is determined domestically.

Hence the household optimizes the objective function below subject to constraints specified in equations 3 through 7 in the first stage of the multi-tier program:

$$\max_{\{C_t, B_t^*, L_t, K_{Xt}, K_{Nt}, \frac{M_t}{P_t}, I_{Xt}, I_{Nt}\}} E_0 \sum_{t=0}^{\infty} \beta^t U_t \tag{1}$$

$$U_t = \left\{ \frac{C_t^{1-\sigma}}{1-\sigma} + \eta \frac{(1-L_t)^{1-\kappa}}{1-\kappa} + \frac{\chi}{1-\xi} \left( \frac{M_t}{P_t} \right)^{1-\xi} \right\} \tag{2}$$

$$P_t C_t + e_t B_t^* + P_{Xt} I_{Xt} + P_{Nt} I_{Nt} + P_t \tau_t + M_t \tag{3}$$

$$= M_{t-1} + w_t L_t + r_{Xt} K_{Xt} + r_{Nt} K_{Nt} + e_t R_{t-1} B_{t-1}^* + \Pi_{Xt} + \int \Pi_{Nt}(z) dz \tag{4}$$

$$L_t = L_{Xt} + L_{Nt} \tag{5}$$

$$K_{Xt} = \Phi\left( \frac{I_{Xt-1}}{K_{Xt-1}} \right) K_{Xt-1} + (1-\delta) K_{Xt-1} \tag{6}$$

$$K_{Nt} = \Phi\left( \frac{I_{Nt-1}}{K_{Nt-1}} \right) K_{Nt-1} + (1-\delta) K_{Nt-1} \tag{7}$$

Here $P_t$ is the aggregate price level, $e_t$ is the nominal exchange rate, $B_t^*$ is the internationally traded nominal bond denominated in foreign currency, $R_t = (1 + r_t)$ is the foreign currency denominated nominal gross return for the home country, and $\tau_t$ is a lump sum tax collected by the government[5]. $I_t$ is investment, and is subject to a real rigidity in the form of adjustment costs in investment in both sectors. More precisely, one unit of investment $I_t$ only contributes $\Phi\left(\frac{I_t}{K_t}\right) K_t$ units to the following period's capital stock $K_t$. It also serves to model the fact that capital reallocation occurs sluggishly. With $\delta$ denoting depreciation, this technology has the following properties: $\delta = (\frac{I}{K})$, $\Phi(\delta) = \delta$, $\Phi(0) = 0$, $\Phi'(\delta) = 1$, $\Phi'(\cdot) > 0$, $\Phi''(\cdot) < 0$.

[5] The foreign country can borror and lend subject to rate $r_t^*$, both are denominated in foreign currency with the following equilibrium condition that will be elaborated on later:

$$(1 + r_t) = (1 + r_t^*)\Psi(B_t^* - B^*)$$

The household chooses the time paths of aggregate consumption, aggregate labor hours supplied and how much capital to accumulate in each sector. The first order condition that dictates the evolution of consumption is a familiar Euler equation:

$$C_t^{-\sigma} = \beta R_t \left[ E_t C_{t+1}^{-\sigma} \frac{P_t}{P_{t+1}} \frac{e_{t+1}}{e_t} \right] \tag{8}$$

The Euler equation above conveys the preference to smooth consumption. It also contains a factor for expected changes in the nominal exchange rate and inflation, where $\pi_t = \frac{P_t}{P_{t-1}}$.

The total number of hours worked is chosen such that it satisfies the following first order condition:

$$\eta(1 - L_t)^{-\kappa} = C_t^{-\sigma} \frac{w_t}{P_t} \tag{9}$$

This Euler equation represents the standard labor-leisure trade-off the representative agent faces.

Capital in the export and non-tradeables sector is chosen optimally as follows:

$$\frac{C_t^{-\sigma}}{\Phi'\left(\frac{I_{Xt}}{K_{Xt}}\right)} \frac{P_{Xt}}{P_t} = \beta E_t \left\{ C_{t+1}^{-\sigma} \frac{P_{Xt+1}}{P_{t+1}} \left( \frac{r_{Xt+1}}{P_{Xt+1}} + \frac{\Xi_{Xt}}{\Phi'\left(\frac{I_{Xt+1}}{K_{Xt+1}}\right)} \right) \right\} \tag{10}$$

$$\Xi_{Xt} = \left[ (1-\delta) - \frac{I_{Xt+1}}{K_{Xt+1}} \Phi'\left(\frac{I_{Xt+1}}{K_{Xt+1}}\right) + \Phi\left(\frac{I_{Xt+1}}{K_{Xt+1}}\right) \right] \tag{11}$$

where $\frac{P_{Xt}}{P_t} / \Phi'\left(\frac{I_{Xt}}{K_{Xt}}\right)$ is the price of a unit of capital in the export sector, in terms of the composite consumption good, and $\frac{r_{Xt+1}}{P_{Xt+1}}$ is the rental rates on capital in their respective sectors. There exists a similar condition for the non-traded sector, which implies there are two distinct rental rates in each economy.

Finally, desired real money balances are chosen to satisfy the following Euler equation:

$$\chi \left( \frac{M_t}{P_t} \right)^{-\xi} = C_t^{-\sigma} E_t \left[ 1 - \beta \left( \frac{C_t}{C_{t+1}} \right)^{\sigma} \frac{P_t}{P_{t+1}} \right] \tag{12}$$

Money demand is Fisherian in that desired real money balances are related to expected inflation, and consumption, the variable that transactions are based upon.

#### 2.1.2 Stage Two: Intratemporal Optimization of Aggregate Consumption

In the second step, given the level of aggregate consumption, households proceed to decide how to allocate this level $C_t$ among tradeables and the composite non-traded good. Since this is a static framework within a period, time subscripts are suppressed. The program the household faces is to maximize a consumption sub-utility function subject to the appropriate constraint. More explicitly the problem is as follows:

$$\max_{\{C_T,C_N\}} C = \left[\gamma^{\frac{1}{\theta}} C_T^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} C_N^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{1-\theta}} \tag{13}$$

$$s.t. \quad P_T C_T + P_N C_N = PC \tag{14}$$

Aggregate consumption a nonlinear function of the aggregate tradeables consumption and the domestic non-traded good. The parameters have the standard interpretation that is common to $CES$ functions, and will be interpreted in the calibration section. From this program, the demand function for these two goods can be obtained as functions of their relative prices and the total consumption expenditure $PC$. The demand functions for traded and non-traded goods are as follows:

$$C_T = \gamma \left(\frac{P_T}{P}\right)^{-\theta} C \tag{15}$$

$$C_N = (1-\gamma) \left(\frac{P_N}{P}\right)^{-\theta} C \tag{16}$$

Substituting these demands into the objective function, one obtains the consumption based price index[6]:

$$P = \left[\gamma P_T^{1-\theta} + (1-\gamma) P_N^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{17}$$

Equation 17 is a preference weighted aggregate price index. This is more formally referred to as the consumption-based price index, which is the minimum expenditure required to obtain a single unit of the aggregate consumption bundle $C$.

### 2.1.3 Stage Three: Intratemporal Optimization of Tradeable Consumption

In the third stage of the households four tier optimization program, I disaggregate consumption of traded goods into demand for the export and import good.

[6] An alternative and perhaps more intutive method is to solve the following program:

$$\min_{\{C_T,C_N\}} P_T C_T + P_N C_N = PC$$

$$s.t. \quad C = \left[\gamma^{\frac{1}{\theta}} C_T^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} C_N^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{1-\theta}}$$

where you set $C = 1$ thus $PC = P$, which is the because you want to minimum expenditure that allows the consumption of a single unit of $C$, which yields:

$$P = \left[\gamma P_T^{1-\theta} + (1-\gamma) P_N^{1-\theta}\right]^{\frac{1}{1-\theta}}$$

The optimization scheme is virtually the same as the one presented above. As in the second step, given the level of aggregate tradeables consumption from the second stage, households then proceed to decide how to allocate this level $C_T$ among the exportable good $C_X$ and importable good $C_M$. This is again a static framework within a period, so time subscripts are omitted. The program the household faces is to maximize the tradeables consumption sub-utility function subject to the appropriate constraint. More explicitly the problem is as follows:

$$\max_{\{C_X, C_M\}} C_T = \left[\mu^{\frac{1}{\lambda}}\omega^{\frac{1}{\lambda}}C_X^{\frac{\lambda-1}{\lambda}} + (1-\omega)^{\frac{1}{\lambda}}C_M^{\frac{\lambda-1}{\lambda}}\right]^{\frac{\lambda}{1-\lambda}} \tag{18}$$

$$s.t. \quad P_X C_X + P_M C_M = P_T C_T \tag{19}$$

The aggregate traded bundle is also a nonlinear function of the domestically produced good and the imported good. From this program, the demand function for these two goods can be obtained as functions of their relative prices and the total expenditure on traded goods $P_T C_T$. The demand functions for exported and imported goods are as follows:

$$C_X = \omega\mu\left(\frac{P_X}{P_T}\right)^{-\lambda} C_T \tag{20}$$

$$C_M = (1-\omega)\left(\frac{P_M}{P_T}\right)^{-\lambda} C_T \tag{21}$$

Using the same methodology in stage two, the price index for tradeable goods is:

$$P_T = \left[(1-\omega)P_M^{1-\lambda} + \mu\omega P_X^{1-\lambda}\right]^{\frac{1}{1-\lambda}} \tag{22}$$

Equation 22 is the consumption-based price index for the traded goods, and is the minimum expenditure, such that one obtains a single unit of the composite traded good $C_T$.

It will be convenient to define several terms that are of interest in international finance. The first and one of the crucial variables that this paper concentrates on is the terms of trade, $q \equiv \frac{P_X}{P_M}$. Which is the relative price of the home economies exports in terms of its imports. The second is the relative price of non-traded goods, here defined as $s \equiv \frac{P_N}{P_M}$. Using these two newly defined variables, we can rewrite the consumption demands and define real price indices. Let $P_T = P_M P_{TR}$ and $P_T = P_M P_{TR}$ where $P_{TR}$ and $P_R$ are the real price indices for the traded consumption bundle and the aggregate consumption good. More explicitly they are defined as:

$$P_{TR} = \left[(1-\omega) + \mu\omega q^{1-\lambda}\right]^{\frac{1}{1-\lambda}} \tag{23}$$

$$P_R = \left[\gamma P_{TR}^{1-\theta} + (1-\gamma)s^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{24}$$

Hence, consumption demands can be rewritten using these real price indices:

$$C_T = \gamma \left( \frac{P_{TR}}{P_R} \right)^{-\theta} C \tag{25}$$

$$C_N = (1-\gamma) \left( \frac{s}{P_R} \right)^{-\theta} C \tag{26}$$

$$C_X = \mu\omega \left( \frac{q}{P_{TR}} \right)^{-\lambda} C_T \tag{27}$$

$$C_M = (1-\omega) \left( \frac{1}{P_{TR}} \right)^{-\lambda} C_T \tag{28}$$

Notice that these demand equations are expressed solely in terms of real variables.

#### 2.1.4 Stage Four: Intratemporal Optimization of the Non-Traded goods

In this economy there is a composite good that is preference weighted bundle of traded and non-traded goods. In the first stage the optimal path of this aggregate basket was derived. In stage two, the optimal allocation of traded and non-traded goods was clarified. In stage three, this intratemporal problem was further refined, and it was shown how the agent chooses between the home good versus the foreign good. I now turn to how the household allocates its expenditure on the composite non-traded good which is composed of a myriad of individual products. More precisely, there is a continuum of monopolistically competititve firms that produce the non-traded goods available in the economy. In other words an arbitrary firm produces its unique good indexed with variable $z \in [0,1]$. I assume that households have a taste for variety over these non-traded goods. More specifically, I postulate that consumers evaluate these goods via a Dixit and Stiglitz (1997) type $CES$ - aggregator. So in this final stage of the multi-tier optimization problem, the household solves the following program:

$$\max_{\{C_N(z):z\in[0,1]\}} C_N = \left[ \int C_N(z)^{\frac{\varsigma-1}{\varsigma}} dz \right]^{\frac{\varsigma}{\varsigma-1}} \tag{29}$$

$$s.t. \quad P_N C_N = \int P_N(z) C_N(z) dz \tag{30}$$

To recapitulate, the household divides expenditure on the non-traded bundle among the goods and services produced by the many firms in the non-traded sector of the economy. Given the total expenditure allocated to the non-traded sector from stage two, the inverse demand function for differentiated good $z$ is as follows:

$$P_{Nt}(z) = \left(\frac{C_{Nt(z)}}{C_{Nt}}\right)^{-\frac{1}{\varsigma}} P_{Nt} \tag{31}$$

The intuition behind equation 31 will become clear after a moments reflection. The demand for good $z$ depends on its price and the amount of income allocated to all non-traded goods. Since firms face downward sloping demand curves they enjoy a certain degree of monopoly power. Producers can in principle charge different prices since the good they offer is sufficiently different from their competitors'. The extent to which firms use this market power is elaborated in the next section.

## 2.2 Firms

Production in the home country occurs in two sectors. Traded goods are produced in a perfectly competitive environment. One reason for this assumption is because they operate in the global market. However, the non-traded goods sector is populated by a multitude of monopolistically competitive firms, each which produces its own differentiated product. Following Lubik (2001) I motivate the assumption of differentiated suppliers by the presence of fixed costs in the production function which can be interpreted as a payment to 'set up shop'. In other words there is a sunk cost associated with market entry. Thus each firm's production benefits from increasing returns to scale, consequently giving these firms the opportunity to choose there profit maximizing price along a downward-sloping demand curve. The fact that they are sheltered from foreign competition further supports the assumption of imperfect competition.

### 2.2.1 Non-Traded Goods Sector

As emphasized in Lubik (2001), the emerging consensus in international macroeconomics is that some form of nominal stickiness is required to reconcile the data, with standard monetary open economy models. As shown by Rotemberg and Woodford (1995), equilibrium models with imperfectly competitive product markets can plausibly explain a wide variety of business cycle facts. A particularly attractive way to introduce monetary non-neutralities is to postulate the existence of price adjustment costs. Following Lubik (2001) and Hairault and Portier (1993) who build on Blanchard and Kiyotaki (1987), I assume that firms which want to change product prices face menu costs in the form of a penalty payable in output units. Thus, for example, as a response to a monetary surprise it is optimal not to adjust prices immediately, but to distribute the output loss over time and to implement price changes only gradually. The resulting price differential, when compared to the expected price path, creates additional demand for its product which is satisfied by expanding production. Therefore in the short-run output becomes demand determined.

Each firm behaves as a price taker in the factor markets, where it employs labor and capital from the household. It faces demand for its product only from domestic consumers and from its own government. As is common in the literature, I also assume that investment and government demand for non-traded goods is analogous to the consumers. So the demand functions are:

$$C_{Nt}(z) = \left(\frac{P_{Nt}(z)}{P_{Nt}}\right)^{-\varsigma} C_{Nt} \tag{32}$$

$$I_{Nt}(z) = \left(\frac{P_{Nt}(z)}{P_{Nt}}\right)^{-\varsigma} I_{Nt} \tag{33}$$

$$G_{Nt}(z) = \left(\frac{P_{Nt}(z)}{P_{Nt}}\right)^{-\varsigma} G_{Nt} \tag{34}$$

Total demand for good $z \in [0,1]$ is denoted $y^D_{Nt}(z)$ and given by:

$$y^D_{Nt}(z) = C_{Nt}(z) + I_{Nt}(z) + G_{Nt}(z) \tag{35}$$

From which an aggregate inverse demand function can be derived:

$$P_{Nt}(z) = \left(\frac{y^D_{Nt}(z)}{y^D_{Nt}}\right)^{-\frac{1}{\varsigma}} P_{Nt} \tag{36}$$

This demand function is taken as given and an optimal point is chosen on this schedule to maximize profits.

The full blown optimization problem faced by the monopolist in non-traded sector is as follows[7]:

$$\max_{\{L_{Nt}(z), K_{Nt}(z)\}} E_0 \left[\sum_{t=0}^{\infty} \rho_t \Pi_{Nt}(z)\right] \tag{37}$$

$$\Pi_{Nt}(z) = P_{Nt}(z)Y_{Nt}(z) - w_{Nt}L_{Nt}(z) - r_{Nt}K_{Nt}(z) \tag{38}$$

$$-\frac{\varphi}{2} \cdot \left(\frac{P_{Nt}(z)}{P_{Nt-1}(z)} - \pi_N\right)^2 P_{Nt}Y_{Nt} \tag{39}$$

$$Y_{Nt}(z) = K^{\nu}_{Nt}(z)L^{1-\nu}_{Nt}(z) - \Gamma \tag{40}$$

$$y^D_{Nt}(z) \leqslant Y_{Nt}(z) \tag{41}$$

where $\rho_t$ is a stochastic pricing kernel which the firm uses to evaluate the stream of profits and $\Gamma$ is the fixed cost associated with entry. Here we use 36 to substitute out the firm's product price and the equilibrium condition that the firm satisfies demand at every level, so equation 41 holds with equality. Thus the problem is reduced to one where the firm simply chooses its factors of production. Optimal quantities of labor and capital are chosen to satisfy the following equations:

[7] I borrow the exposition form Lubik (2001) which is based on Kim (1996).

$$r_{Nt} = \nu P_{Nt}(z)\frac{(Y_{Nt}(z)+\Gamma)}{K_{Nt}(z)}\left(1-\frac{1}{\Omega_t(z)}\right) \tag{42}$$

$$w_t = (1-\nu)P_{Nt}(z)\frac{(Y_{Nt}(z)+\Gamma)}{L_{Nt}(z)}\left(1-\frac{1}{\Omega_t(z)}\right) \tag{43}$$

$$\frac{1}{\Omega_t(z)} = \frac{1}{\varsigma}\left\{\begin{array}{c} 1-\varphi\cdot\left(\frac{P_{Nt}(z)}{P_{Nt-1}(z)}-\pi_N\right)\frac{P_{Nt}}{P_{Nt}(z)}\frac{Y_{Nt}}{Y_{Nt}(z)} \\ +E_t\left[\frac{\rho_{t+1}}{\rho_t}\varphi\cdot\left(\frac{P_{Nt+1}(z)}{P_{Nt}(z)}-\pi_N\right)\frac{P_{Nt+1}}{P_{Nt}(z)}\frac{P_{Nt+1}(z)}{P_{Nt}(z)}\frac{Y_{Nt+1}}{Y_{Nt}(z)}\right]\end{array}\right\} \tag{44}$$

where $\Omega_t(z)$ is the output elasticity augmented by the adjustment cost[8]. The markup of prices over marginal costs is thereby inversely proportional to $(1-1/\Omega_t(z))$. With infinite elasticity of substitution between the differentiated good, i.e. $\varsigma \to \infty$, the markup is constant at unity so that firms do not enjoy any pricing power and the monopolistically competitive sector reverts to the perfectly competitive scenario. If the parameter $\varphi$ is set to zero, then the firm's problem loses its intertemporal aspect, and so price adjustment occurs instantaneously. Although the existence of a positive markup influences the dynamics of the model, monetary disturbances are no longer transmitted to the real economy via this channel.

### 2.2.2 Traded Goods Sector

Firms operating in the traded goods sector make all decision in a perfectly competitive environment and face no adjustment costs. The problem they face is a standard static optimization program to maximize profits:

$$\max_{\{L_{Xt},K_{Xt}\}} E_0\left[\sum_{t=0}^{\infty}\rho_t \Pi_{Xt}\right] \tag{45}$$

$$\Pi_{Xt} = P_{Xt}Y_{Xt} - w_t L_{Xt} - r_{Xt}K_{Xt} \tag{46}$$

$$Y_{Xt} = K_{Xt}^{\alpha} L_{Xt}^{1-\alpha} \tag{47}$$

First order conditions are thus[9]:

$$r_X = \alpha P_{Xt} K_X^{\alpha-1} L_X^{1-\alpha} \tag{48}$$

$$w = (1-\alpha) P_{Xt} K_X^{\alpha} L_X^{-\alpha} \tag{49}$$

[8] Please refer to Kim (1996) for further details.

[9] A minor detail concerns Balassa-Samuelson style effects on the real exchange rate. Since technology has not been model explicitly, this assumes that both sectors share the same exogenous growth trend, as does the foreign country. Thus technology does not influence exchange rate dynamics in this model.

## 2.3 Government

Government spending is on both non-traded and traded goods, an activity which yields no utility for the households. Above on beyond this, the home country must make a tribute, the unilateral transfer to the foreign government, or in the case of aid, receive a wealth transfer from abroad. This total expenditure is financed by issuing money and levying a lump-sum tax on households, which is paid in terms of the aggregate consumption good. Thus the government budget constraint takes the form:

$$P_t G_t + M_{t-1} + T_t = M_t + P_t \tau_t \tag{50}$$

Fiscal policy follows a simple autoregressive process:

$$G_t = (1 - \varrho)G + \varrho G_{t-1} + \varepsilon_{Gt} \tag{51}$$

For now, monetary policy is a simple money growth rule in both countries, which implies a flexible exchange rate regime:

$$M_t = M_{t-1} + \varepsilon_{Mt} \tag{52}$$

## 2.4 The Foreign Country

The foreign economy is analogous to the home country, except that their preferences over the export good and import good is switched around. All foreign variables are denoted with an asterisks, and hence the other countries real price index for tradeable goods is as follows[10]:

$$P^*_{TR} = \left[\mu(1 - \omega) + \omega q^{1-\lambda}\right]^{\frac{1}{1-\lambda}} \tag{53}$$

In other words the countries have identical preferences in the sense that each desires its own traded good by the same proportion, there is a bias towards domestically produced goods in both countries. Home bias is captured by and additional parameter $\mu$, when it exceeds unity then home bias exists.

Before moving on, I must emphasize a technicality. The model as it stands has an undesirable property about it because there is a unit root in the world wealth distribution. Any shock that results in wealth redistributions, has the consequence that one country is permanently rich and the other poor. To alleviate this problem, I refer to the recent developments in open economy macroeconomics (Schmitt-Grohé and Uribe 2001, Kollman 2001), where I assume that a debt elastic interest rate differential exists between the home and foreign rates

[10] This price index is derived from the following problem:

$$\max_{\{C_X, C_M\}} C^*_T = \left[\omega^{\frac{1}{\lambda}} {C^*_X}^{\frac{\lambda-1}{\lambda}} + \mu^{\frac{1}{\lambda}}(1-\omega)^{\frac{1}{\lambda}} {C^*_M}^{\frac{\lambda-1}{\lambda}}\right]^{\frac{\lambda}{1-\lambda}}$$

$$s.t. \quad P^*_X C^*_X + P^*_M C^*_M = P^*_T C^*_T$$

of interest. Thus denoting the foreign currency denominated home and foreign rates of interest as $r$ and $r^*$ respectively, the relation between these interest rates is given by the following condition:

$$(1 + r_t) = (1 + r_t^*)\Psi(B_t^* - B^*) \tag{54}$$

where the function $\Psi(B_t^* - B^*)$ satisfies $\Psi(0) = 1$, and $\Psi^{'}(\cdot) < 0$, where $B^*$ is the steady state level of net foreign assets for the home country, denominated in foreign currency. This condition captures the idea of an upward sloping supply curve of foreign credit. When the economy is a net borrower, it will be faced with a relatively higher interest rate with respect to its partner. When it is a lender the rate will naturally be relatively lower. Besides eliminating the unit problem previously mentioned, this condition also has some intuitive appeal. It models the presence of international capital market frictions. As these frictions become larger and larger, captured by a larger absolute value of $\Psi^{'}$, the effect of the transfer is more and more contained within the period of the transfer, and the use of international capital markets to smooth out the impact of the transfer diminishes. Another way to think about this equation is that it creates a wedges between the two interest rates which depends on the amount each country is indebted, which can be interpreted as a risk premium. In other words a country has to pay an increasingly greater rate to borrow from international financial markets as its international debt accumulates.

## 2.5 Equilibrium

In the description of the equilibrium, I follow the literature and restrict attention to the case in which all monopolistically competitive firms act symmetrically so that I do not have to keep track of the distribution of prices among the otherwise disparate firms. This basically introduces the concept of a representative monopolist[11]. I assume that households are the sole recipient of firm profits. The stochastic discounting factor of the firm is thus valued according to the household's subjective discount factor[12]. Implying the imposition of the following condition:

$$\frac{\rho_t}{\rho_{t+1}} = \beta\frac{\lambda_t}{\lambda_{t+1}} \tag{55}$$

Equilibrium in the factor markets is straight forward and basically necessitates that demand equals supply. Thus in the non-traded sector:

$$\int L_{Nt}(z)dz = L_{Nt} \tag{56}$$

$$\int K_{Nt}(z)dz = K_{Nt} \tag{57}$$

[11] This amounts to dropping the indexation of the firms, thus setting the number of firms to unity.

[12] See Kim (1996) for further details.

where as usual $z \in [0,1]$. For the economy in general, equilibrium in the labor and capital markets requires:

$$L_t = L_{Xt} + L_{Nt} \tag{58}$$
$$K_t = K_{Xt} + K_{Nt} \tag{59}$$

Since non-traded goods are consumed domestically only, the equilibrium condition for this market is:

$$C_{Nt} + I_{Nt} + G_{Nt} = K_N^{\nu} L_N^{1-\nu} \left[ 1 - \frac{\varphi}{2} \left( \frac{P_{Nt}(z)}{P_{Nt-1}(z)} - \pi_N \right)^2 \right] = Y_{Nt}^{net} \tag{60}$$

Adjustment costs are specified in such a way that the steady state allocation does not depend on their specific functional form, implying $Y_N^{net} = Y_N$. Rewritten with aggregate variables, the equilibrium condition takes the form:

$$Y_{Nt}^{net} = (1-\gamma) \left( \frac{P_{Nt}}{P_t} \right)^{-\theta} (C_t + I_t + G_t) \tag{61}$$

The foreign countries equilibrium condition is analogous.

The equilibrium conditions for the traded goods has one clearing condition for each good. In each country, only the domestically produced exportable can be used for investment in the export sector[13]. The domestically produced goods equilibrium condition is as follows:

$$Y_{Xt} = K_X^{\alpha} L_X^{1-\alpha} = (C_{Xt} + I_{Xt} + G_{Xt}) + (C_{Xt}^* + G_{Xt}^*) \tag{62}$$

The condition for the importable good is similar:

$$Y_{Mt} = K_M^{\alpha} L_M^{1-\alpha} = (C_{Mt} + G_{Mt}) + (C_{Mt}^* + I_{Mt} + G_{Mt}^*) \tag{63}$$

Both which can be rewritten in terms of aggregate variables as follows:

$$K_X^{\alpha} L_X^{1-\alpha} = \mu\omega \left( \frac{P_{Xt}}{P_{Tt}} \right)^{-\lambda} \gamma \left( \frac{P_{Tt}}{P_t} \right)^{-\theta} (C_t + I_t + G_t) \tag{64}$$
$$+\omega \left( \frac{P_{Xt}^*}{P_{Tt}^*} \right)^{-\lambda} \gamma \left( \frac{P_{Tt}^*}{P_t^*} \right)^{-\theta} (C_t^* + G_t^*) \tag{65}$$

$$K_M^{\alpha} L_M^{1-\alpha} = (1-\omega) \left( \frac{P_{Mt}}{P_{Tt}} \right)^{-\lambda} \gamma \left( \frac{P_{Tt}}{P_t} \right)^{-\theta} (C_t + G_t) \tag{66}$$
$$+\mu(1-\omega) \left( \frac{P_{Mt}^*}{P_{Tt}^*} \right)^{-\lambda} \gamma \left( \frac{P_{Tt}^*}{P_t^*} \right)^{-\theta} (C_t^* + I_t^* + G_t^*) \tag{67}$$

[13] Lubik (2001) specifies a production function where domestic and foreign goods are used to manufacture a composite good that can be used for investment purposed.

The intuition behind these last two equations is as follows. Both traded goods are desired by the households in each country. So the supply of the exportable has to equal the combined demand for that good by all countries, the same logic applies to the importable good.

Because of Walras' Law only one of the households' budget constraints is necessary for deriving the equilibrium allocation. First integrate equation 38, profits in the non-traded goods sector, over all firms, to get aggregate quantities. Then use equations 56 and 57 which yields:

$$\int \Pi_{Nt}(z)dz = -wL_{Nt} - r_N K_{Nt} + P_{Nt}Y_{Nt}\left[1 - \frac{\varphi}{2}\cdot\left(\frac{P_{Nt}(z)}{P_{Nt-1}(z)} - \pi_N\right)^2\right] \quad (68)$$

Substituting equations 50, 46, 60 and equation 68 with the following:

$$P_tC_t = P_{Xt}C_{Xt} + P_{Mt}C_{Mt} + P_{Nt}C_{Nt} \quad (69)$$

results in the following equation:

$$P_{Xt}C_{Xt} + P_{Mt}C_{Mt} + P_{Xt}I_{Xt} + P_{Nt}I_{Nt} + e_tB_t = (1 + r_{t-1})e_tB_{t-1} + P_{Xt}Y_{Xt} \quad (70)$$

Finally, denoting the demand for real balances by $\left(\frac{M_t}{P_t}\right)^D$, and the supply of money as $M_t^S$, equilibrium in the money market is described by the following innocuous equation, where the money stock is exogenous:

$$\left(\frac{M_t}{P_t}\right)^D = M_t^S/P_t \quad (71)$$

which determines the price level. Given the aggregate price levels in both countries, the law of one price $P_{Mt} = e_tP_{Mt}^*$ determines, the nominal exchange rate. One of the crucial aspects of this paper is that the exchange rate is not, as in many models of the monetary approach to the balance of payments, simply the ratio of domestic and foreign money supplies. Instead it is a complicated function of relative prices between and within countries[14]. The real exchange rate is defined as the ratio of foreign and domestic price indices denominated in the same currency:

$$rer_t = \frac{e_tP_t^*}{P_t} \quad (72)$$

which can be rewritten using the law of one price and the real price indices in both countries as[15]:

[14] Lubik (2001) emphasizes this point and argues the such an exchange rate specification reconciles internation business cycles facts.

[15] Just use $P_{Mt} = e_tP_{Mt}^*$:

$$rer_t = \frac{e_tP_t^*}{P_t} = \frac{e_tP_{Mt}^*P_{Rt}^*}{P_{Mt}P_{Rt}} = \frac{P_{Rt}^*}{P_{Rt}}$$

$$rer_t = \frac{P_{Rt}^*}{P_{Rt}}$$

Again, the real exchange rate is a complicated function of relative prices between countries – the terms of trade – and within countries, the relative price of non-tradeables. Movements in the real exchange rate as measured by the ratio of $CPI$'s therefore stem in a non-trivial manner from a variety of disturbances to supply and demand, both at a global and national level.

The current account which describes the accumulation of foreign assets over time is simply defined as:

$$CA_t = B_t^* - B_{t-1}^* \tag{73}$$

Measured in terms of foreign currency, it describes, in the case of a deficit, the amount of foreign exchange required to retire outstanding foreign debts. Finally $GDP$ and real $GDP$ are just the price weighted average of output produced in both domestic sectors:

$$GDP_t = P_{Xt}Y_{Xt} + P_{Nt}Y_{Nt} \tag{74}$$

$$\text{real}\, GDP_t = \frac{P_{Xt}Y_{Xt} + P_{Nt}Y_{Nt}}{P_t} \tag{75}$$

# 3 Calibration and Model Solution

To analyze the dynamic impact of a transfer, the model has to be calibrated. Initially I calibrate the model in such a way that the home country is reasonably representative of a large developed economy. As in many two-country investigations, e.g. Backus, Kehoe and Kydland (1992), Baxter and Crucini (1995), Devereux and Smith (2002), Lubik (2001) and Stockman and Tesar (1995), I initially assume that the foreign country is identical to the domestic economy. Momentarily suppressing country specific characteristics in consumption, production and driving processes allow the researcher to focus on international linkages without having to disentangle the influences of asymmetries in the model specification. However, asymmetric country size is explicitly been accounted for with parameter $\omega$. When $\omega = 0.5$, the countries are of the same economic size. Later is choose $\omega = 0.05$, this allows me to examine the dynamics under asymmetric conditions. In the context of aid transfer, this will be a more appropriate calibration. Parameters are chosen following the methodology of Deveruex and Smith (2002) and Lubik (2001). The calibrated parameters are listed in Table 1.

The subjective discount rate $\beta$ is chosen such that the steady state annual real interest rate is 5.26%, which implies $\beta = 0.95$. Annual capital depreciation $\delta$ is 0.01. The inverse of the elasticity of substitution in consumption $\sigma$ is set at 2, which is in line with the literature and implies that the elasticity of intertemporal substitution is 0.5[16]. The elasticity of substitution between both non-traded and traded goods, and between imports and exports is set to three halves, i.e. $\theta = \lambda = 1.5$[17]. The parameter $\gamma$ determines the share of expenditure falling on non-traded goods in this model. Following the above mentioned references, this value is set to 0.5. This implies that non-traded goods represent around half of $GDP$. The parameter that captures the affect of home bias is $\mu$. When this parameter equals unity, there is no bias, when it is greater than one, than there is a home bias for domestically produced goods[18]. The share parameter of real balances in the utility function $\chi$ is determined by the level of real balances in the steady state as a fraction of consumption, so that $\chi = 0.02$. As stated in Lubik (1998), selecting the inverse elasticity of real money balances is not trivial. Following Bergin (1997), I choose $\xi = 2$. Since real money balances comprise a small fraction of aggregate consumption the model is not sensitive to its calibration. The share parameter of leisure in the utility function and the inverse elasticity of leisure is chosen in light of previous work thus $\eta = 1$ and $\kappa = 2$ respectively. The elasticity parameter $\varsigma$ in the utility function for differentiated goods can be determined by reference to the size of fixed costs in the non-traded sector, I follow Lubik (1998) and set $\varsigma = -0.91$.

Observed average capital shares in developed countries pin down the share of capital in the sector production functions, I set $\alpha = \nu = 0.36$. The capital accumulation equation was elaborated in the consumers optimization problem. Important properties were that adjustment costs are assumed to be zero in steady state and adjustment costs affect the dynamics of the model near the steady state. Speed of adjustment and investment volatility are determined by the elasticity of the marginal adjustment cost function $\frac{\Phi'}{\delta\Phi''}$. Following the literature, I choose a value that generates realistic investment volatility, so this value is set to 0.3.

The most controversial parameter is $\varphi$, which dictates the magnitude of price adjustment costs in the non-traded sector. Following Lubik (2001), I choose values from one and a half to fifty, which serves to fully understand the consequences of nominal rigidities. This range of values mimics the observed volatility of the relative price of non-traded goods. Last but not least, I initially let $\Gamma = 0$, which captures the realism that super-normal profits in the non-traded sector is equal to zero[19].

The model is solved by log-linearizing the equations describing the equilibrium around a steady state which is conditional on the level of outstanding net foreign assets $B$. To avoid the common problem of incomplete market model in international macroeconomics where an infinite number of steady states exist, I treat the initial wealth distribution between the two countries as a parameter

[16] However I do consider other values, namely $\sigma = 1$, which implies that the $CRRA$ utility function for consumption approaches *log* utility.

[17] Here again I occasionally use $\theta = 1.25$, as in Devereux and Smith (2002).

[18] Devereux and Smith (2002) argue that in 1870, French exports were 16.5% of GDP so choose $\mu = 8$.

[19] There are many possible explanations why $\Gamma = 0$, one is that when profits are zero, there is no incentive to enter the non-traded industry.

that is calibrated zero, i.e. $B = 0$. The consequence of this is that the revaluation effects of nominal foreign debt is not accounted for, which is actually a channel through which shocks propagate. Likewise the transfer in the steady state – just like the fiscal and monetary shocks – is equal to zero.

After log-linearization, the model is a first order vector stochastic difference equation, which can be solved by the method described in Sims (1996). The solution of the model describes a system of stable difference equations and associated exogenous processes which is easily amenable for simulation and impulse response analysis.

# 4 Foreign Aid and Exchange Rate Regimes

In this section I present the main results of the dynamic framework depicted above. In reality I have two models. In the first model each country independently determines its own monetary policy. In the second model, the foreign country takes the role of a leader and decides on monetary policy independently, whereas the home country acts as a follower and it chooses it money supply endogenously so as to keep the nominal exchange rate constant. I concentrate on the incident where the home country receives aid from the foreign country, since this is the case most relevant for policy decisions. I initially assume equal country size, but then consider the more realistic situation where the foreign country is modelled as an economically larger country. This is novel in the sense that I explicitly analyze this asymmetric structure. Above and beyond that, it serve to more accurately capture the reality that a smaller country is receiving aid from a larger economy that also influences global economic policy.

In the flexible exchange rate regime, each country conducts its own independent monetary policy. I model this simply as:

$$M_t = M_{t-1} + \varepsilon_{Mt} \tag{76}$$

$$M_t^* = M_{t-1}^* + \varepsilon_{Mt}^* \tag{77}$$

Under fixed exchange rate regimes, there will be a leader who determines monetary policy taking into consideration domestic issues and then there will be a follower. The follower's money supply will be determined endogenously, so as to keep the nominal exchange rate fixed, i.e. $e_t = \overline{e}$.[20]

Before a more detailed exposition of the results, some intuition on the impact of the aid transfer is merited. When the domestic economy receives the transfer, just as the life cycle/permanent income hypothesis dictates, the household has a strong incentive to spread this one time windfall over time This is the saving for a rainy day intuition in an international context. So although consumption increases, it does not increase one-for-one with the amount of the transfer. Instead some of the aid is spent on international assets, thus the home country becomes

[20] The follower's money supply is determined endogenously throug its real balances equation.

an international lender and hence it runs a current account surplus[21]. As with consumption, leisure to increases, which has the consequence that the number of labor hours supplied to the two sectors decreases, which implies that output in the traded sector declines. So the supply of the home exportable decreases. On the other hand, since aggregate consumption has increased, so will consumption of the home exportable by the domestic household. Basically on the supply side, the amount of the home traded goods has diminished, whereas demand for the home countries good has increased, which both unambiguously imply that the relative price of homes traded goods must increase, i.e. a terms-of-trade improvement.

In all the experiment below, I consider the implications on the home country after it receives foreign aid. Of the many interesting features about a transfer shock, the more unique is the fact that this shock occurs in both countries simultaneously. One country donates real resources, while the other receives them. I now investigate the consequences of aid transfers under flexible and fixed exchange rate regimes.

Figure 1 presents the benchmark scenario. In this case both countries are of the same size and nominal rigidities are not in play yet. The home country receives an aid payment and spends this income in three ways. First, as expected, consumption increases, but less than the amount of the transfer. Some of the aid is saved and foreign assets are accumulated, thus the home country runs a current account surplus[22]. Again, it is the strong incentive to smooth consumption that is driving these dynamics. Finally, some of the windfall is spent on leisure, which implies that the labor hours supplied to both sectors will decrease, implying that output declines. These results are in-line with previous work[23].

I now add nominal rigidities to the model, results are shown in Figure 2. The evolution of the variables are roughly the same as in the case without price stickiness. The terms-of-trade increase due to supply and demand factors. Some of the aid is spent on consumption but most is saved. What is really interesting is that in this case, the decline in output is larger in magnitude that the percentage decrease in labor hours. This is because price adjustment is costly. As the systems reverts to the steady state, it uses up valuable resources. Although firms in the non-traded sector to conserve as much of the output as possible by gradually adjusting prices, there is never the less significant dead weight loss.

I now consider a fixed exchange rate regime. In this setup, one country leads – it conducts monetary policy independently – and the other country follows, its money supply chosen to keep the nominal exchange rate fixed. Figure 3 depicts the case when the foreign country leads and Figure 4 shows the case when the home country leads. Although both graphs are similar, there are some subtle differences. After careful inspection, there exists a consumption-leisure trade-

[21] As is standard in the literature, it is assumed that in the steady state the current account is in balance in both countries.

[22] Although the dynamics of the current account has not been depicted, it intuitively increases contemporenously with the transfer.

[23] c.f. Devereux and Smith (2001).

off. Labor hours decrease more when the home country leads, hence output decreases more in this case. When the foreign country leads, the increase in the terms-of-trade is relatively more pronounced, the household uses this fact to increase consumption relatively more than in the case when the home country leads. When the flexible and fixed exchange rate regimes are compared, there is a trade-off between terms-of-trade volatility – which impedes competitiveness – consumption and output. Although under the fixed exchange rate regime, the terms-of-trade increases more than under the flexible regime, the consumption and output increases are relatively larger. This foreshadows results to come, but so far the superiority of either regime is shrouded with ambiguity.

One might suggest easing monetary policy at the time of the transfer shock. The implications of expansionary monetary policy are now well known in international settings[24]. Figure 5 depicts the case when both shocks are combined. The main difference is that output shoots up tremendously, but later swings back down until it eventually reverts back to the steady state. The fact that such a concurrent policy mix will severely destabilize the economy, makes it very unattractive.

I now move to the crux of the paper. I consider a more realistic calibration, where the home country is assumed to be a much smaller than the foreign country. This is another one of this papers contributions, explicit analysis of asymmetric country structure. The smaller home country is also a follower, which obviously captures reality better than the previous calibrations. Figure 6 shows a the small home economy after it receives aid under the flexible regime and Figure 7 shows that of a fixed exchange rate regime. These two sets of impulse responses show clear differences between both regimes. Under fixed exchange rates, the consumption and leisure increase are about one half the amount of those under the flexible regime. The relatively greater in the terms-of-trade under the flexible regime is one of the factors that drives the greater consumption binge. There is however one fundamental difference. The decrease in output under flexible exchange rates is five times greater than that of the fixed regime and dramatically more persistent. There is a very severe and long lasting recession under flexible exchange rate regimes[25].

# 5 Conclusion

I use a comprehensive framework to accurately model one of the classic issues in international finance, namely the transfer problem. However this topic is not just an artefact of economic history. Transfers impacts come in many forms, war reparations, current account reversals, debt relief and aid are some key examples. The impact of unilateral transfers lead to changes in the current account which creates pressure on the real exchange rate, which can have negative consequences. I use a two country dynamic stochastic general equilibrium model

[24] c.f. Lubik (2001).

[25] It makes relatively little difference if we consider a thought experiment were the home country leads, conclusions carry through in this case as well.

that endogenizes the terms-of-trade and consider the implications of monetary policy in an environment with real and nominal rigidities. The repercussions of such transfer shocks are analyzed under fixed and floating exchange rates. This especially concentrates on the policy considerations of how foreign aid affects the receiving country. Some countries hesitate to accept aid due to the fact that it will probably cause a terms-of-trade improvement, which will perversely affect competitiveness, this is especially pertinent for countries that are very sensitive to commodity price movements. Ever since Friedman (1953), it has been argues that flexible exchange rates are the ideal setup. The basic intuition is that the nominal exchange rate acts as a shock absorber. However, when I consider a relatively smaller country that fixes the exchange rate, this old adage does not seem to be the case. The argument for flexible exchange rates does not unambiguously generalize to smaller open economies. To make a more rigorous conclusion, further research on the exact welfare implications is warranted.

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| Parameter | Value | Description |
|---|---|---|
| $\sigma$ | 2 | Inverse elasticity of substitution in consumption |
| $\beta$ | 0.95 | Discount factor, annual interest rate is $\frac{1-\beta}{\beta}$ |
| $\eta$ | 1 | Weight on labor supply in period utility |
| $\omega$ | 0.5 and 0.05 | Inverse elasticity of labor supply |
| $\chi$ | 0.02 | Weight on real money balances in period utility |
| $\xi$ | 2 | Inverse elasticity of real money balances |
| $\delta$ | 0.1 | Annual rate of capital depreciation |
| $\gamma$ | 0.5 | Share of nontraded goods in consumption |
| $\theta$ | 1.25 | Elasticity of substitution between $C_T$ and $C_N$ |
| $\mu$ | 1 | Home bias in traded goods consumption |
| $\lambda$ | 1.5 | Elasticity of substitution between $C_X$ and $C_M$ |
| $\varsigma$ | -0.91 | Elasticity for $C_N(z)$ |
| $\nu$ | 0.36 | Share of capital in nontraded sector production |
| $\alpha$ | 0.36 | Share of capital in export sector production |
| $\Psi'$ | -0.01 | Elasticity of real interest rate to $B^*$ |
| $\varphi$ | 50 | Price adjustment costs in non-traded sector |
| $\frac{\Phi'}{\delta\Phi''}$ | 0.3 | Elasticity of q with respect to $\left(\frac{I}{K}\right)$ |
| $\Gamma$ | 0 | Sunk cost necessary to enter non-traded sector |

Table 1: Parameter Calibration

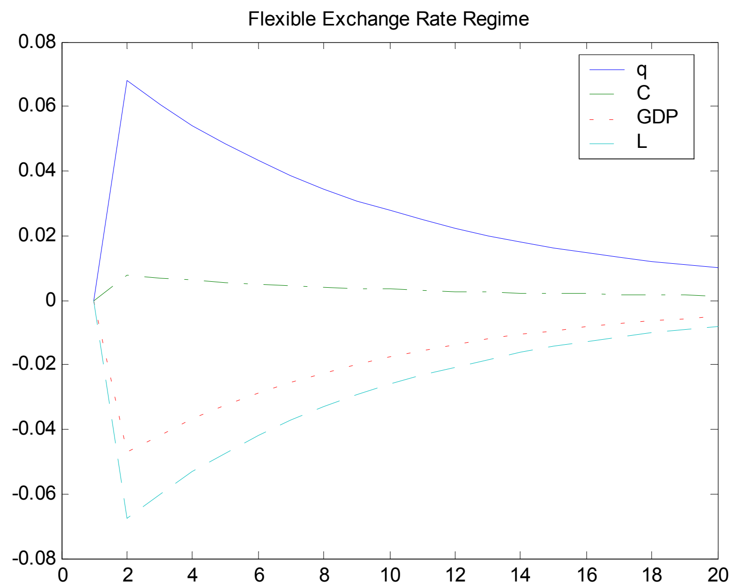


Figure 1: Flexible Exchange Rates and Prices, Symmetric Countries.

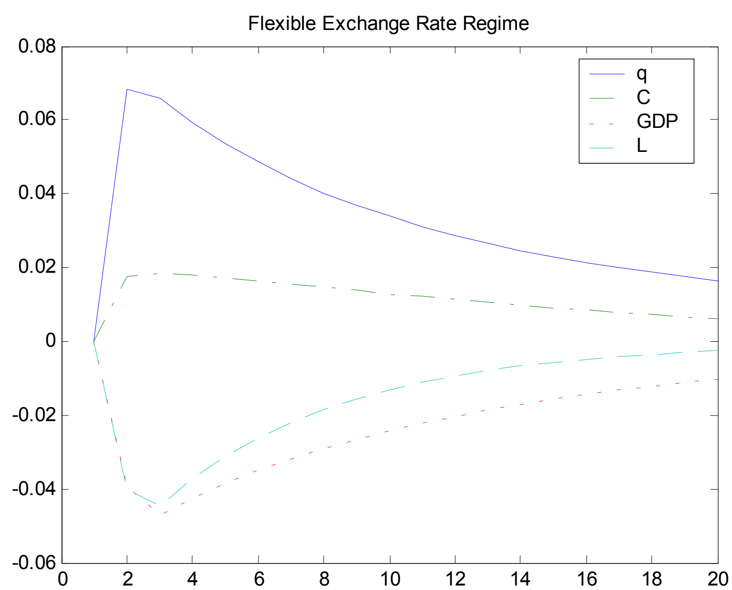


Figure 2: Flexible Regime with Nominal Rigidities, Symmetric Countries.

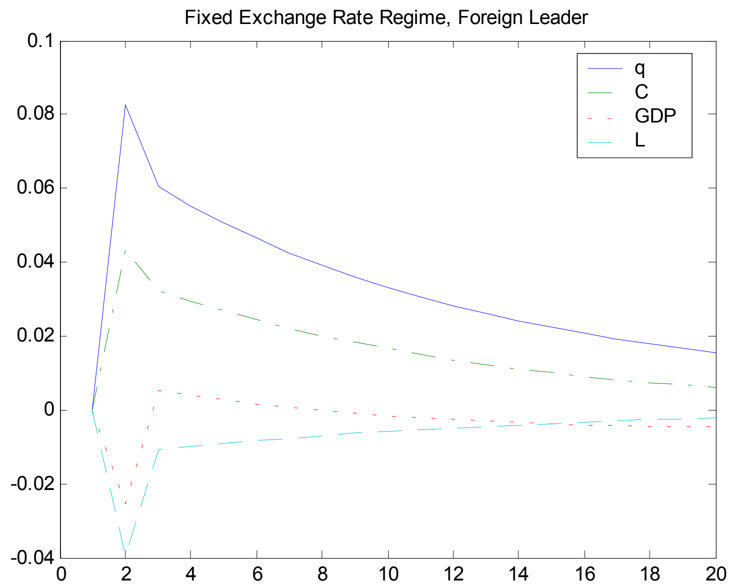


Figure 3: Fixed Regime with Nominal Rigidities, Foreign Country Leads, Symmetric Countries.

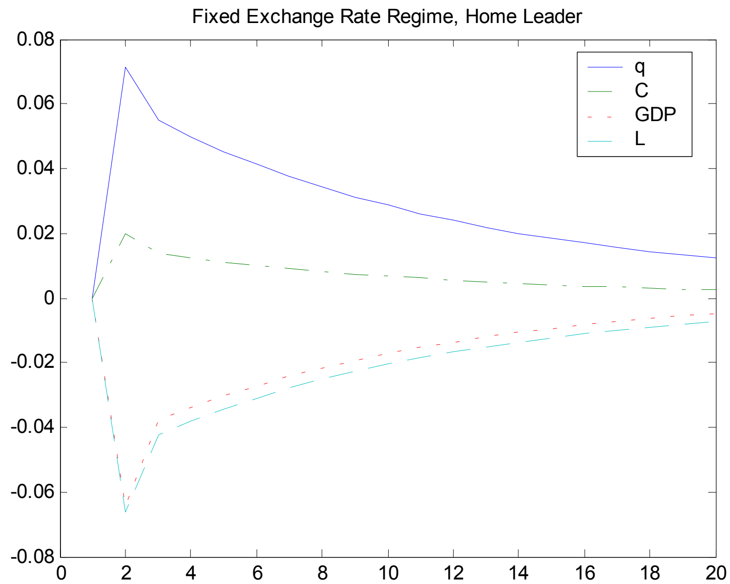


Figure 4: Fixed Regime with Nominal Rigidities, Home Country Leads, Symmetric Countries.

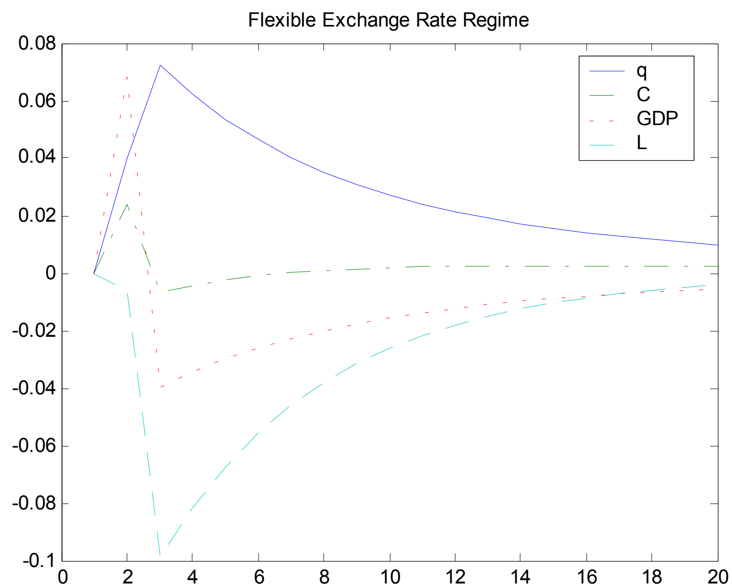


Figure 5: Simultaneous Expansionary Monetary Shocks and Transfer Shock Under Flexible Regime with Nominal Rigidities, Symmetric Countries.

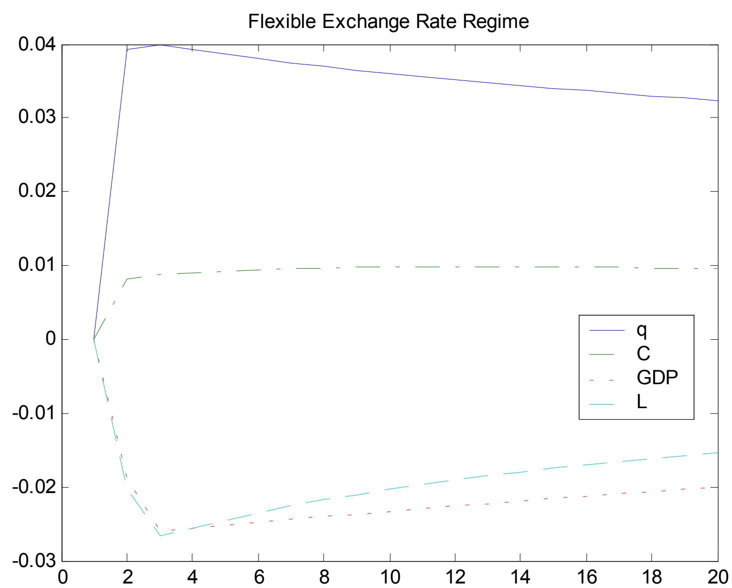


Figure 6: Flexible Regime with Nominal Rigidities, Home is a Relatively Small Country.

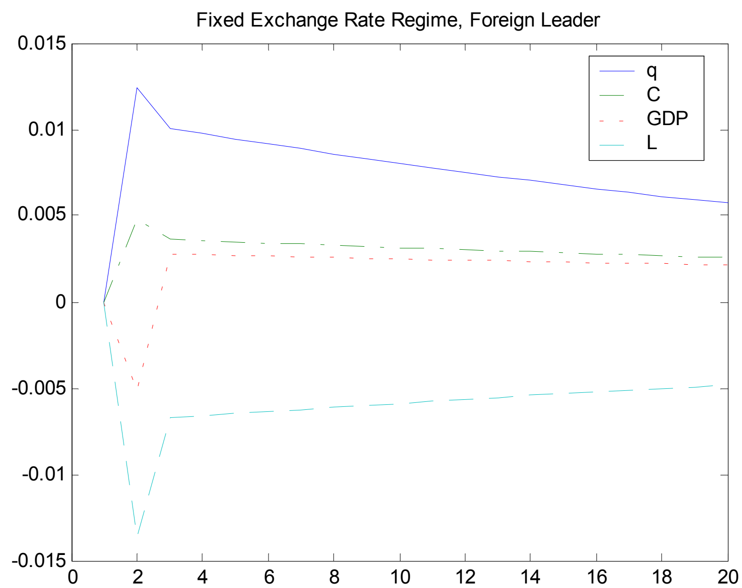


Figure 7: Fixed Regime with Nominal Rigidities, Home is a Relatively Small Follower.

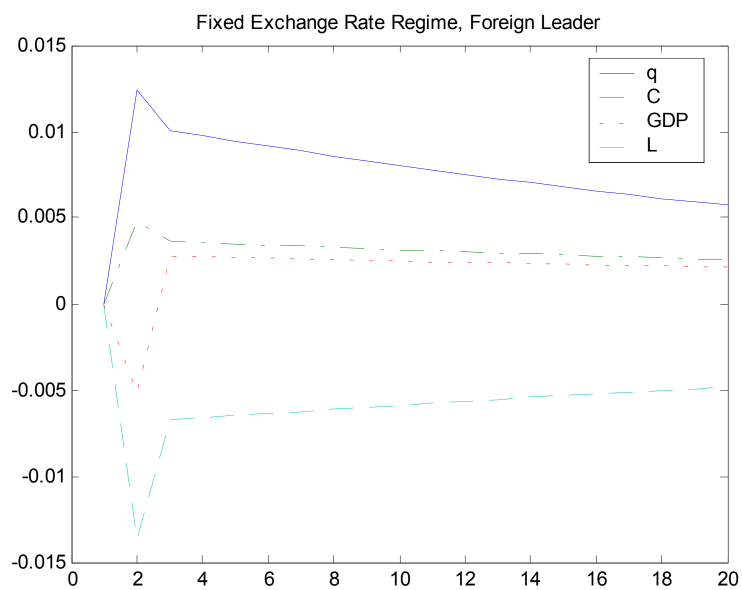


Figure 8: Flexible Regime with Nominal Rigidities, Home is a Relatively Small Leader.