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The role of consumption substitutability in the international transmission of monetary shocks

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Abstract

This paper develops a general framework to analyze the impact of monetary shocks in an open economy, focusing on the role of the degree of substitutability between goods produced in different countries. We extend the contributions by Obstfeld and Rogoff [Obstfeld, M., Rogoff, K., 1995. Exchange rate dynamics redux. Journal of Political Economy 103, 624–659] and Corsetti and Pesenti [Corsetti, G., Pesenti, P., 1997. Welfare and Macroeconomic Interdependence, NBER Working Paper 6307] to show that the welfare impact differs across countries when the degree of substitutability between goods produced in different countries is different from the degree of substitutability between goods produced in the same country. A shock that would be beneficial in a closed economy can have an adverse 'beggar-thyself' effect in the country where it takes place, or an adverse 'beggar-thy-neighbor' effect on its neighbor.

Keywords: Marshall–Lerner–Robinson condition; Beggar-thy-neighbor

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1. Introduction

A central issue in open-economy macroeconomics is the transmission of shocks across countries. Of particular interest is the possibility that a policy beneficial to a

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country may adversely affect its neighbor, a feature referred to as the '*beggar-thy-neighbor*' concept.[1] Despite the central place of this concept in the debate, our understanding of it is remarkably limited, and often involves more of an intuitive exposition than a thorough analysis. Even then, the analysis is based on the standard Mundell–Fleming–Dornbusch setup which lacks an explicit welfare metric and is not well equipped to address such a *welfare* concept.

The framework introduced by Obstfeld and Rogoff (1995, 1996) allows for a more solid welfare analysis by providing a clear criterion, namely the utility of the representative household. They show that in the presence of monopolistic distortions and price rigidities, a monetary expansion improves welfare by moving the economy away from the suboptimal market equilibrium towards the competitive first best. Interestingly, there is no beggar-thy-neighbor problem as the expansion is *equally* beneficial to all countries.[2]

Their analysis is however limited as they consider that the elasticity of substitution between two goods produced in *the same country* is the same as the elasticity of substitution between two good produced in *different countries*. By restricting the international consumption switching effect of changes in the terms of trade, this assumption limits the scope of the international transmission of shocks. The empirical relevance of the restriction is also questionable: if countries specialize in the production of certain types of goods, there is likely to be less substitutability between goods produced in different countries than between goods produced in a given country.[3]

Corsetti and Pesenti (1997) relax the assumption of an identical elasticity of substitution and focus on the case where the elasticity across countries is equal to unity.[4] They analyze the role of the terms of trade in the international transmission of shocks: a monetary expansion in a country worsens its terms of trade, thereby reducing the purchasing power of its residents. They establish that this reduction can offset the beneficial move towards the first best allocation, and result in an adverse '*beggar-thyself*' welfare effect, where the residents of the expanding country are worse off. Their analysis is however limited to a particular parametrization and does not allow for dynamic effects through the current account. In addition, the worsening of the terms of trade also occurs in the contributions by Obstfeld and Rogoff, without resulting in a welfare loss. We therefore need a more

[1] The standard reference is Nurkse (1944). Concerns about the beggar-thy-neighbor problem can be found in analyses of the recent Asian crisis, such as Fernald et al. (1998).

[2] Their baseline model has been extended in several directions. For a survey of recent contributions, see Lane (1998).

[3] Although the elasticity of substitution between goods produced in different countries is difficult to estimate, Backus et al. (1994a,b) argue that it is in the range of 1–2. This is a much smaller value than the usual estimates for the elasticity of substitution between goods produced in the same country, which is about 6 as in Rotemberg and Woodford (1992).

[4] For earlier studies of the role of the degree of substitutability across goods produced in different countries, see Svensson and van Wijenbergen (1989) and Van der Ploeg (1993).

general framework to assess how the impact through the terms of trade interacts with other channels, and establish the conditions under which a monetary expansion can have adverse effects.

The purpose of this paper is to provide such a setup in which the elasticity of substitution across countries is not restricted to a particular value. The contributions by Obstfeld and Rogoff, and Corsetti and Pesenti are particular cases of our general model. We extend Obstfeld and Rogoff by allowing for different elasticities of substitution across and within countries, and Corsetti and Pesenti by allowing for current account effects. Our main finding is that a monetary expansion can adversely affect the country where it takes place only if there is less substitutability across countries than within. In such a case, a monetary expansion boosts employment but does not allow residents to purchase enough additional consumption to offset the cost of their effort. Interestingly, the finding can be reversed if there is more substitutability across countries than within, in which case a monetary expansion can have a beggar-thy-neighbor effect.

The paper is organized as follows. The model is presented in Section 2, and Section 3 discusses some of the positive results. Section 4 presents the welfare results, illustrating them with a simple graphical apparatus. Section 5 details the conditions under which monetary shocks can adversely affect the country where they take place, or its neighbor. A numerical illustration is provided in Section 6, and extensions are discussed in Section 7. Section 8 concludes.

2. The model

Our framework builds on the model by Obstfeld and Rogoff (1995, 1996).[5] The world is made up of two countries, home and foreign, and is populated by a continuum of households. We normalize the world size to 1, and consider that households over the $[0, n)$ interval live in the home country, whereas households over the $[n, 1]$ live in the foreign country. The sizes of the home and foreign countries are therefore n and $1-n$, respectively. There are two *types* of goods in the world economy, and each country specializes in the production of one type. For each type of good, there exists a continuum of *brands*. There is some degree of substitutability across types of goods, as well as across brands. The main feature of the paper is to allow for the degree of substitutability between types to differ from the degree of substitutability between brands. Production is undertaken by households, each of which is the sole producer of a particular brand.

[5]We assume that the reader is familiar with the 'redux' model by Obstfeld and Rogoff (1995, 1996), and do not present the detailed steps leading to our results for brevity. A more detailed presentation of the analysis can be found in the working paper version of the analysis, which is available from the author on request, or can be downloaded at http://www.ny.frb.org/rmaghome/economist/tille/tille.html.

2.1. Household's objective

The intertemporal objective of a home household, indexed by k, at time t is to maximize:

$$U_{k,t} = \sum_{s=0}^{\infty} \beta^s \left\{ \frac{C_{k,t+s}^{1-1/\sigma}}{1-\frac{1}{\sigma}} + \gamma \ln\left(\frac{M_{k,t+s}}{P_{t+s}}\right) - \frac{\kappa}{1+\varpi} Y_{k,t+s}^{1+\varpi} \right\} \tag{1}$$

where σ is the intertemporal elasticity of substitution, $\varpi > 0$ is the degree of convexity of effort cost, $\beta \in (0, 1)$ is the discount rate, and γ, κ are positive scaling parameters. The first term is the utility of consumption, where C_k is a consumption basket defined below. The second term captures the utility from liquidity services, where M_k are the nominal balances and P the consumer price index. The last term represents the cost of effort, Y_k being the output of the brand produced by household k.[6]

2.2. Consumption allocation

The overall consumption basket, C_k, is a CES aggregate of the two available types of goods, namely the home and foreign goods:

$$C_k = [n^{1/\rho}(C_k^{\mathrm{h}})^{(\rho-1)/\rho} + (1-n)^{1/\rho}(C_k^{\mathrm{f}})^{(\rho-1)/\rho}]^{\rho/(\rho-1)}$$

where C_k^{h} and C_k^{f} represent the consumption of the home and foreign goods, respectively. $\rho > 0$ is the elasticity of substitution between home and foreign goods, which we refer to as the *cross-country* substitutability. C_k^{h} and C_k^{f} are in turn CES aggregates across the available brands:

$$C_k^{\mathrm{h}} = \left[n^{-1/\theta} \int_0^n (C_k^{\mathrm{h}}(z))^{(\theta-1)/\theta} \, \mathrm{d}z \right]^{\theta/(\theta-1)}$$

$$C_k^{\mathrm{f}} = \left[(1-n)^{-1/\theta} \int_n^1 (C_k^{\mathrm{f}}(z))^{(\theta-1)/\theta} \, \mathrm{d}z \right]^{\theta/(\theta-1)}$$

where $\theta > 1$ is the elasticity of substitution between two brands produced in the same country, which we refer to as the *within-country* substitutability. $C_h^{\mathrm{h}}(z)$ and $C_k^{\mathrm{f}}(z)$ denote the consumption of a particular brand z produced in the home and the foreign country respectively. The assumption that θ is larger than 1 ensures that the equilibrium solution is well defined.

The central feature of this paper is to allow the cross-country and within-country

[6] For simplicity, we consider that the utility is separable in consumption and leisure. Bacchetta and van Wincoop (1998) analyze a model where this assumption is relaxed.

Table 1
Consumption allocation

$$C_k^{h}(z)=\left[\frac{P^{h}(z)}{P^{h}}\right]^{-\theta}\left[\frac{P^{h}}{P}\right]^{-\rho}C_k \qquad C_k^{f}(z)=\left[\frac{P^{f}(z)}{P^{f}}\right]^{-\theta}\left[\frac{P^{f}}{P}\right]^{-\rho}C_k$$

$$C_k^{*h}(z)=\left[\frac{P^{*h}(z)}{P^{*h}}\right]^{-\theta}\left[\frac{P^{*h}}{P^{*}}\right]^{-\rho}C_k^{*} \qquad C_k^{*f}(z)=\left[\frac{P^{*f}(z)}{P^{*f}}\right]^{-\theta}\left[\frac{P^{*f}}{P^{*}}\right]^{-\rho}C_k^{*}$$

substitutability to differ. If $\rho<\theta$, there is less substitutability across types than across brands.[7] The contributions by Obstfeld and Rogoff (1995, 1996) focus on the case where $\rho=\theta$, whereas Corsetti and Pesenti (1997) consider the case where $\rho=1<\theta$.

The allocation of consumption across the available brands is derived in the usual way and the results are presented in Table 1. Variables for the foreign country are denoted by asterisks, and are defined in a way similar to their counterparts for the home country. The prices faced by a home consumer are defined as follows: $P^{h}(z)$ and $P^{f}(z)$ are the prices of a home and foreign brand z, respectively, P^{h} and P^{f} are the price indexes of home and foreign goods, respectively, and P is the consumer price index. The price indexes are presented in Table 2, and represent the minimum expenditure required to purchase one unit of the corresponding basket. We assume that the law of one price holds for simplicity. Denoting the nominal exchange rate (units of home currency per foreign currency) by S, the law of one price implies that $P^{*h}(z)=P^{h}(z)/S$, $P^{f}(z)=SP^{*f}(z)$. It is then straightforward to show that the purchasing power parity also holds: $P=SP^{*}$.

2.3. Optimality conditions

In addition to domestic currency, each household can hold a nominal bond denominated in the home country currency, and receives a nominal interest rate i_t

Table 2
Price indexes

$$P^{h}=\left[n^{-1}\int_0^n (P^{h}(z))^{1-\theta}\,dz\right]^{1/(1-\theta)}$$

$$P^{f}=\left[(1-n)^{-1}\int_n^1 (P^{f}(z))^{1-\theta}\,dz\right]^{1/(1-\theta)}$$

$$P=[n(P^{h})^{1-\rho}+(1-n)(P^{f})^{1-\rho}]^{1/(1-\rho)}$$

[7] Consumers first allocate their consumption across types of goods and then across the various brands within each type. In our model, we assume that countries specialize, matching each country with a particular type. The analysis of a richer setup where each country produces both types, albeit to a different extent, along the lines of Faruqee (1996), is left for future work.

on her bond holdings at the beginning of period t.[8] The optimal choice with respect to bond and money holdings is given by:

$$C_{k,t}^{-1/\sigma} = \beta(1+i_{t+1})\frac{P_t}{P_{t+1}}C_{k,t+1}^{-1/\sigma} \tag{2}$$

$$\frac{M_{k,t}}{P_t} = \gamma C_{k,t}^{1/\sigma}\frac{1+i_{t+1}}{i_{t+1}} \tag{3}$$

(2) is the Euler condition for the intertemporal allocation of consumption and (3) is the money demand. Turning to the optimal price setting by a household for the brand she sells, a home [foreign] household k chooses a price $P^{\mathrm{h}}(k)$ $[P^{*\mathrm{f}}(k)]$ denominated in her own currency. As brands are imperfect substitutes, she has some monopoly power, which she takes into account in her optimal choice. The demand for her brand is obtained by aggregating private purchases across all households worldwide:

$$Y_k = \left[\frac{P^{\mathrm{h}}(k)}{P^{\mathrm{h}}}\right]^{-\theta}\left[\frac{P^{\mathrm{h}}}{P}\right]^{-\rho}C^w, \qquad Y_k^* = \left[\frac{P^{*\mathrm{f}}(k)}{P^{*\mathrm{f}}}\right]^{-\theta}\left[\frac{P^{*\mathrm{f}}}{P^*}\right]^{-\rho}C^w \tag{4}$$

where $C^w = \int_0^n C_k\,\mathrm{d}k + \int_n^1 C_k^*\,\mathrm{d}k$ is the worldwide consumption. (4) shows that the elasticity of the demand faced by a household with respect to her own price is the within-country elasticity of substitution θ, and not the cross-country elasticity of substitution ρ. The first order condition for the optimal prices is derived as:

$$\frac{P^{\mathrm{h}}(k)}{P} = \frac{\theta\kappa}{\theta-1}Y_k^{\varpi}C_k^{1/\sigma}, \qquad \frac{P^{*\mathrm{f}}(k)}{P^*} = \frac{\theta_\kappa}{\theta-1}Y_k^{*\varpi}C_k^{*1/\sigma} \tag{5}$$

(5) shows that the marginal utility of one dollar spent on consumption, $C_k^{-1/\sigma}P^{-1}$ exceeds the marginal cost of generating it through producing and selling output, $\kappa Y_k^{\varpi}(P^{\mathrm{h}}(k))^{-1}$, by a markup equal to $\theta(\theta-1)^{-1}>1$. The markup is determined by θ, the elasticity of demand with respect to the household's own price.

2.4. Current account

We abstract from government spending, and consider that in each country the government repays the seignorage revenue in the form of a lump sum transfer to households. All households within a country being identical, we drop the subscript k and interpret the variables in per capita terms. We denote the bond holdings by home households at the beginning of period t by B_t. As the nominal bond is in zero net supply worldwide, we can write the current-account equations as:

[8] The results would be identical if we were to consider a real bond, as in Obstfeld and Rogoff (1995, 1996), or a nominal bond denominated in the foreign currency.

$$\frac{B_{t+1}}{P_t} + C_t = (1 + i_t)\frac{B_t}{P_t} + \frac{P_t^{\mathrm{h}}}{P_t} Y_t \tag{6}$$

$$-\frac{n}{1-n}\frac{B_{t+1}}{S_t P_t^*} + C_t^* = -(1 + i_t)\frac{n}{1-n}\frac{B_t}{S_t P_t^*} + \frac{P_t^{*\mathrm{f}}}{P_t^*} Y_t^* \tag{7}$$

2.5. Methodology and dynamics

Our model being nonlinear, we first derive the solution for a symmetric steady state, and then analyze the model in terms of percentage deviations around it. In the symmetric steady state, no country has any net claims on the other: $B = B^* = 0$, the interest rate reflects the discount factor, and is equal to $\beta^{-1} - 1$. All households worldwide are identical and consume and produce an amount C_0. This amount given by the optimal price setting (5) and is suboptimally low as the marginal utility of consumption exceeds the marginal cost of production, because of monopolistic competition.

Our analysis is undertaken in terms of log linear approximations around the symmetric steady state, and lowercase letters denote percentage deviations from the symmetric steady state: $x = (X - X_0)/X_0$. The only exception is bond holdings, which are scaled by nominal consumption: $b = B/(P_0 C_0)$.

The economy is initially at the symmetric steady state. At time t, it is affected by a permanent monetary shock ($m_{t+s} = \bar{m}$, $m^*_{t+s} = \bar{m}^*$ $\forall s \geq 0$). We focus on monetary shocks as they play a non-negligible role in the short run exchange rate volatility (Rogers, 1997). The economy is characterized by nominal rigidities, as prices cannot instantaneously adjust to the shock. Instead, we consider that prices are set for period t (the *short run*), and can be adjusted only at period $t + 1$. From period $t + 1$ on, the economy is in a new steady state the we refer to as the *long run*. The long run values are denoted by an upper bar. For example, c^* and $\bar{c}^*$ denote foreign consumption in the short and the long run respectively. We find it convenient to present some of our results in terms of the overall discounted effect over the short and long run. We therefore define overall (net present value) variables as:

$$x_{npv} = x + \frac{\beta}{1-\beta}\bar{x}$$

We also define the worldwide value of a variable as a weighted sum of the values in the home and foreign countries: $x^w = nx + (1 - n)x^*$.

As prices are pre-set in the short run, the optimal pricing condition (5) does not necessarily hold. Instead, households meet the demand they face at the pre-set price. Output is therefore demand determined by (4) in the short run.[9] In the long

[9] As we consider small shocks, producers always accommodate an additional demand, because their price is above their marginal cost.

run, prices can be adjusted and (5) holds. Following Obstfeld and Rogoff (1995, 1996), we assume that in the short run prices are set in the producer's currency. This results in a complete exchange rate pass-through, as the consumer price of imported goods fluctuate due to variations in the exchange rate.

3. The positive impact of monetary shocks

We start by analyzing the positive results of the model. As shown in the Appendix, the cross-country substitutability ρ affects the distribution of a shock's impact across countries, but not the worldwide impact. The results in the next two sections are therefore presented and discussed in terms of *cross-country differences* for brevity. This aspect should be kept in mind in interpreting our results.[10]

The cross-country substitutability ρ captures the sensitivity of the consumption allocation between home and foreign goods with respect to the terms of trade.[11] It determines whether the consumption switching towards home goods following a worsening of the home terms of trade ($p^h - p^f < 0$) is large enough to increase the sales revenue of home households, relative to foreign households. Appendix A shows that ρ equals the sum of the exports and imports elasticities, with respect to the terms of trade. If $\rho > 1$, the Marshall–Lerner–Robinson condition holds and an exchange rate depreciation generates a trade (current account) surplus. To highlight this point, we divide the range of possible values of ρ in two intervals:

- $\rho > 1$: goods produced in different countries are close substitutes. The Marshall–Lerner–Robinson condition holds and we refer to this case as MLR. A worsening of the terms of trade increases the sales revenue.
- $\rho < 1$: goods produced in different countries are poor substitutes and the Marshall–Lerner–Robinson condition does not hold, a case referred to as NON-MLR. A worsening of the terms of trade reduces the sales revenue.[12]

3.1. The exchange rate and the current account

The exchange rate and the current account are given by:

$$s = \bar{s} = \left[1 - \frac{\rho - 1}{\sigma}(1 - \beta)D^{-1}\right](\bar{m} - \bar{m}^*) \tag{8}$$

[10]For example, the mention of an increase in output in the home country should be interpreted as an increase *relative* to output in the foreign country, and not necessarily an increase in absolute terms.

[11]The terms of trade are the relative price of home and foreign goods: $p^h - p^f$.

[12]If $\rho = 1$ a worsening of the terms of trade is exactly offset by the switching towards home goods.

$$\frac{b}{1-n} = \beta(\rho-1)\left[1+\frac{\rho-1}{\sigma}\frac{1}{1+\varpi\rho}\right]D^{-1}(\bar{m}-\bar{m}^*) \tag{9}$$

where $D = 1+(\rho-1)/\sigma[1-\beta\varpi\rho/(1+\varpi\rho)] > 0$, assuming that $\rho > 1-\sigma$. The cross-country substitutability ρ affects the sensitivity of the exchange rate to monetary shocks. (8) shows that the smaller ρ, the larger the magnitude of the exchange rate effect of a given monetary shock.[13] The lack of substitutability between home and foreign goods is then a source of exchange rate volatility. Intuitively, a monetary expansion in the home country induces home households to increase their consumption of all goods, including imports. This generates a higher demand for foreign currency, resulting in a depreciation of the home currency. This depreciation in turn induces households to switch their demand towards home goods. If home and foreign goods are poor substitutes, a given switch of demand requires a sizable change in the relative price of home and foreign goods through the exchange rate. Note that in the NON-MLR case, the magnitude of the exchange rate effect exceeds the relative monetary shock $\bar{m}-\bar{m}^*$.

Turning to the current account, (9) shows that a monetary expansion in the home country leads to a current account surplus only in the MLR case. If $\rho = 1$, as in Corsetti and Pesenti (1997), the current account effect is zero and monetary shocks have no real effects beyond the short run. The condition that ρ exceeds unity for a current account surplus has the following intertemporal interpretation. In both the MLR and NON-MLR case, the terms of trade improve in the long run, relative to the short run ($\bar{p}^h - \bar{p}^f > -s$).[14] In the MLR case, a worsening of the terms of trade increases the sales revenue. The revenue of home households is then higher in the short run than in the long run, inducing them to smooth consumption through a current account surplus. By contrast, a worsening of the terms of trade reduces sales revenue in the NON-MLR case, and home households borrow to smooth consumption, as their revenue is lower in the short run than in the long run.

3.2. Employment

Employment (output) is affected by two mechanisms, as in Svensson and van Wijenbergen (1989). A monetary expansion anywhere in the world reduces the short run real interest rate by generating future inflation. This induces households to switch consumption from the long run to the short run. The strength of this channel depends the intertemporal elasticity of substitution, and it is captured in the solution for worldwide employment: $y^w = \sigma\bar{m}^w$, $\bar{y}^w = 0$. The second channel reflects the reallocation of consumption across different types of goods. A monetary expansion in the home country ($\bar{m}-\bar{m}^* > 0$) generates an exchange rate

[13] We can show that $[\partial s/(\bar{m}-\bar{m}^*)]/[\partial\rho] < 0$.

[14] We can show that: $\bar{p}^h - \bar{p}^f + s = (1+(\rho-1)\sigma^{-1}(1+\varpi\rho)^{-1})D^{-1} > 0$.

depreciation, which induces a consumption switching towards home goods in the short run: $y - y^* = \rho s > 0$.

Home employment increases relative to foreign employment in the short run. In the long run, home employment can increase or decrease, but never by enough to offset the short run impact ($y_{npv} - y^*_{npv} > 0$). The monetary expansion then clearly boosts absolute home employment in the short run and overall ($y > 0$, $y_{npv} > 0$).

The impact on foreign employment is different. In the long run, absolute foreign employment increases if the home country runs a current account surplus: $\bar{y}^* \propto b$, where $\propto$ denotes a relation of proportionality. In the short run, the two mechanisms outlined above have conflicting effects. The intertemporal substitution tends to increase absolute foreign employment, whereas the intratemporal consumption switching tends to decrease it. The net impact depends on the relative strength of the two channels. Setting $\bar{m}^* = 0$, we write:

$$y^* = \left[(\sigma - \rho)\left(1 + \frac{\rho - 1}{\sigma}\frac{\beta}{1 + \varpi\rho}\right) + (\rho - 1)(1 - \beta) \right] D^{-1} n \bar{m}$$

The first term in brackets clearly shows that foreign absolute employment tends to decrease in the short run when the intratemporal effect dominates the intertemporal one ($\rho > \sigma$).[15]

Our model is consistent with the traditional view of the transmission of monetary shocks. In the MLR case, a monetary expansion in the home country increases absolute home employment, reduces foreign employment and generates a current account for the home country.[16] From these findings, we may infer that the home country benefits at the expense of its neighbor. This would however be misleading: in the short run (and overall[17]) the terms of trade worsen for home residents, thereby reducing their purchasing power, the opposite being true for foreign residents. A change in employment does not necessarily results in an identical change in consumption, in contrast to the case of a closed economy. Assessing the welfare effects therefore requires the use of a well founded criterion.

4. The welfare impact of monetary shocks

This section derives the welfare impact of monetary shocks, illustrating the results with a simple graphical apparatus in terms of *cross-country differences.* We

[15] Our assumption that $\rho > 1 - \sigma$ ensures that $1 + (\rho - 1)\sigma^{-1}\beta(1 + \varpi\rho)^{-1} > 0$. The short run foreign output is also affected by the $(\rho - 1)(1 - \beta)$ term which captures a feedback through the long run effect. As the discount rate β is close to 1 however, the influence of that term is small and the short run foreign output essentially reflects the difference between σ and ρ.

[16] Considering the case of a log utility of consumption for simplicity ($\sigma = 1$), we can show that in the MLR case: $y > 0$, $y_{npv} > 0$, $y^* < 0$, $y^*_{npv} < 0$, $b > 0$.

[17] We can show that: $-s + \beta(1 - \beta)^{-1}(\bar{p}^h - \bar{p}^f) < 0$.

assess the welfare impact. of shocks by balancing the effects on consumption and output through a welfare metric.[18] Our setup provides us with an explicit criterion in the form of the representative consumer's utility. Taking a linear approximation of (1) we write the welfare effect for a home resident as:

$$u = (U - U_0)C_0^{(1-\sigma)/\sigma} = c_{npv} - \frac{\theta - 1}{\theta} y_{npv} \tag{10}$$

where the direct welfare impact of real balances is omitted, following Obstfeld and Rogoff (1995, 1996).[19] (10) shows that the determinants of welfare are overall consumption, which is beneficial, and output, which reduces welfare. The negative impact of output (employment) can seem odd if we think of an economy experiencing unemployment.[20] Note however that higher employment is not valued per se, but because is allows workers to consume more. In a closed economy, consumption and employment are equal, hence an increase in employment is mirrored by a beneficial increase in consumption. In an open economy however, consumption and employment can differ due to changes in the terms of trade. It is therefore important to distinguish their specific impacts on welfare.

4.1. Graphical apparatus

We start by illustrating the overall impact on output and consumption using a simple graphical apparatus. In equilibrium, overall consumption and output reflect the interaction of two relations, one of which is shifted by monetary shocks.[21] The first is a negative relation between overall consumption and output:

[18]Note that by welfare analysis we mean whether a shock has a beneficial impact, given the initial circumstances, and not whether the possibility of shocks has a detrimental effect ex ante. The later approach requires a more complex analysis in an explicitly stochastic model, and is undertaken by Obstfeld and Rogoff (1998, 2000) and Devereux and Engel (1998).

[19]In theory, including the direct welfare impact of real balances may generate a 'beggar-thy-neighbor' effect from a monetary expansion, as the real balances increase by more in the country where the expansion takes place ($\bar{m} - \bar{m}^* - s$ is of the same sign as $\bar{m} - \bar{m}^*$). Empirically however, the magnitude of this effect is too small to affect our results. An algebraic analysis available upon request shows that the direct welfare impact through real balances is of the form $(1-\beta)M_0(P_0C_0)^{-1}(\bar{m} - \bar{m}^*)$. This term is small as the discount rate β is close to 1 and the ratio between nominal balances and nominal GDP is small (on the order of 13% in the US using M1).

[20]Our setup considers a monopolistic distortion instead of unemployment. The interpretation is however similar. The market allocation under monopolistic competition is suboptimal as an additional unit of employment generates more benefit through consumption than cost through effort. This is close to an unemployment allocation, where the value of the output produced by an additional worker exceeds the opportunity cost of her work. Of course, unemployment also entails a redistibutive issue, but its main cost is the suboptimal equilibrium allocation in aggregate terms. A model explicitly comparing labor and product market distortions is left for future work.

[21]Appendix A outline the steps leading to both relations.

$$y_{npv} - y^*_{npv} = -\frac{\rho}{\sigma}\left(1 - \beta\frac{\varpi\rho}{1+\varpi\rho}\right)(c_{npv} - c^*_{npv}) + \rho(\bar{m} - \bar{m}^*) \tag{11}$$

(11) captures the fact that consumption is positively related to real balances in the short run and leisure in the long run, both of which are negatively related to output. In any period, (4) implies that output is negatively related to the terms of trade, a feature that we refer to as the *consumption switching* effect:

$$y - y^* = -\rho(p^h - p^f), \qquad \bar{y} - \bar{y}^* = -\rho(\bar{p}^h - \bar{p}^f)$$

Intuitively, an improvement in the terms of trade makes home goods more expensive relative to foreign goods in all countries, inducing consumers to substitute foreign goods for home goods. A given change in the terms of trade has a larger consumption switching effect the more substitutable home and foreign goods are (the higher ρ).

The negative relation between output and consumption (11) reflects two mechanisms. The first, which operates in the short run, is the *real balances* effect through the money demand (3) and its foreign counterpart:

$$\bar{m} - \bar{m}^* - s = \sigma^{-1}(c - c^*)$$

Holding nominal balances constant, a rise in consumption requires a fall in the price level which occurs through an appreciation of the home currency. This appreciation in turn improves the terms of trade (as $p^h - p^f = s$), thereby reducing output through the consumption switching effect.

The other mechanism underlying (11) is the optimal price setting (5). It reflects the *consumption-effort trade off*, and operates only in the long run:

$$-\sigma^{-1}(\bar{c} - \bar{c}^*) + (\bar{p}^h - \bar{p}^f) = \varpi(\bar{y} - \bar{y}^*)$$

This relation negatively relates output and consumption through two complementary links. First, an increase in output results in a higher marginal cost of effort due to the convexity of the effort cost in (1).[22] Holding the terms of trade constant, consumption must fall in order to maintain the ratio between the marginal cost of effort and the marginal utility of consumption. Second, a rise in output requires a worsening of the terms of trade through the consumption switching effect. (5) shows that this worsening must be matched by a higher ratio between the marginal

[22]Note that this link does not operate if the cost of effort is a linear ($\varpi = 0$). The second link through the terms of trade remains however valid.

utility of consumption and the marginal cost of effort, resulting in a fall in consumption.

(11) is completed by a second relation between overall consumption and overall output:

$$y_{npv} - y^{*}_{npv} = \rho(\rho - 1)^{-1}(c_{npv} - c^{*}_{npv}) \tag{12}$$

(12) captures the relation between consumption and real sales revenue. It shows that home residents can consume more than foreign residents overall only if their real revenue increases relative to foreign residents. We refer to this mechanism to as the *real revenue* effect. The relation is positive if the Marshall–Lerner–Robinson condition holds, as in the MLR case.

As the purchasing power parity holds, the real revenue of home residents, relative to the real revenue of foreign residents, is given by the sum of relative output and the terms of trade ($y - y^{*} + p^{h} - p^{f}$ in the short run and $\bar{y} - \bar{y}^{*} + p^{\bar{h}} - \bar{p}^{f}$ in the long run). Output and the terms of trade are negatively linked through the consumption switching effect, the more so when home and foreign goods are close substitutes. In the MLR case, an output expansion increases the real revenue, whereas it reduces it in the NON-MLR case.

Fig. 1 illustrates (11) and (12), with consumption ($c_{npv} - c^{*}_{npv}$) on the horizontal axis and output ($y_{npv} - y^{*}_{npv}$) on the vertical axis. It depicts the situation in the absence of any shock. (11), which reflects the consumption-effort trade off and real balances effects, is represented by the EB locus. The real revenue effect (12)

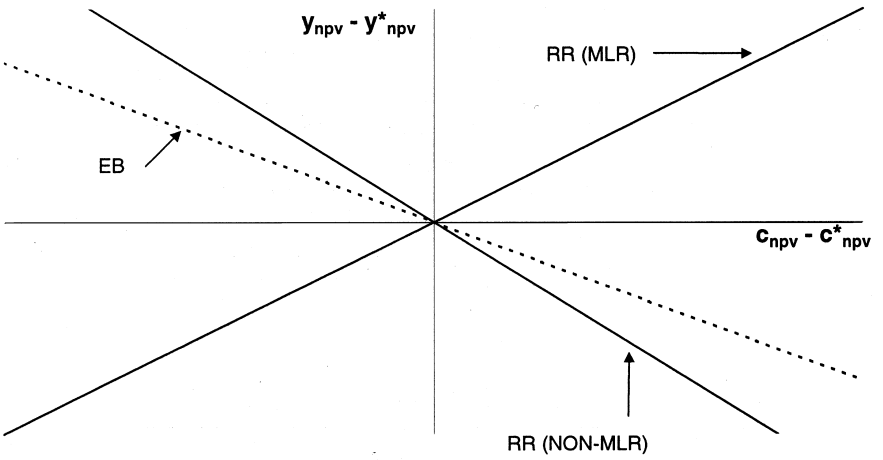

Fig. 1. Overall output–consumption relations.

is given by the RR locus. Given the central role of the cross-country substitutability in the real revenue channel, RR is drawn for the MLR, NON-MLR cases.[23]

Fig. 2 illustrates the impact of a monetary expansion in the home country ($\bar{m} - \bar{m}^* > 0$). The shock does not affect RR, but shifts EB upwards from the origin. Holding consumption constant, an increase in nominal balances must be offset by an increase in the price level through a depreciation in the home currency. The resulting worsening of the terms of trade boosts output through the consumption switching effect. Fig. 2 indicates the new equilibrium, both for the MLR and the NON-MLR cases. Overall output unambiguously increases, whereas the consumption effect depends of the degree of cross-country substitutability.[24]

4.2. Home welfare versus foreign welfare: a generalized Marshall–Lerner–Robinson condition

By combining (10) and its foreign equivalent, we derive the indifference curve along which residents in both countries are equally well off ($u = u^*$):

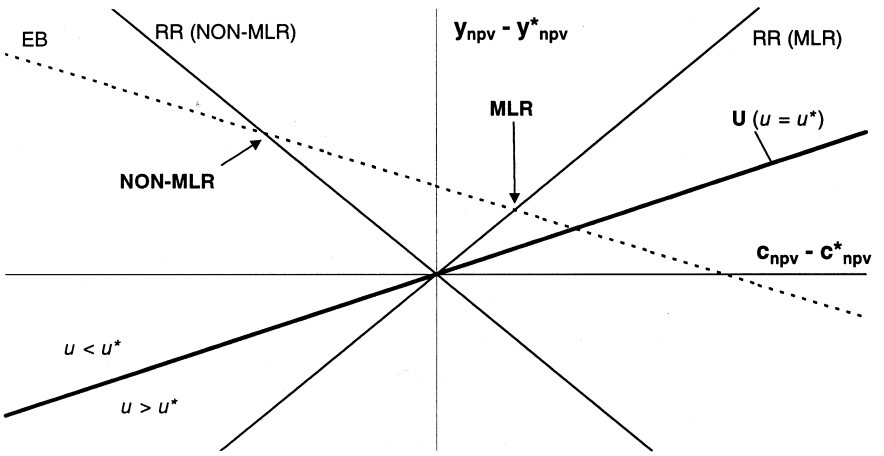

Fig. 2. Monetary shock.

[23]Note that ρ also affects the slope of EB, without however changing its sign. For clarity, we do not draw a different curve EB for each case. The reader may also worry whether RR and EB become indistinguishable in the NON-MLR case. We however assume that $\rho > 1 - \sigma$. Under such an assumption, RR is unambiguously steeper than EB in the NON-MLR case.

[24]Our model therefore allows for the possibility of a devaluation to expand employment while reducing consumption. For a discussion of the contractionary effects of a devaluation, see Hanson (1983), Krugman and Taylor (1978), and Lizondo and Montiel (1989).

$$y_{npv} - y^*_{npv} = \theta(\theta - 1)^{-1}(c_{npv} - c^*_{npv}) \tag{13}$$

implies a positive relation between output and consumption, along which the benefit from an increase in consumption is exactly offset by the disutility from an increase in output, hence effort.

Fig. 2 illustrates the indifference curve (13), denoted by U, for the case where there cross-country substitutability is smaller than the within-country substitutability ($\rho < \theta$). In such a case, RR(MLR) is steeper than U. At any point located above U home residents are worse off than foreign residents ($u < u^*$). A home monetary expansion clearly reduces home welfare, relative to foreign welfare, when $\rho < \theta$. If $\rho = \theta$, U and RR are identical and the welfare effect is the same in both countries, as in Obstfeld and Rogoff (1995, 1996). If $\rho > \theta$, U is steeper than RR and home residents are better off relative to foreign residents.

In order to highlight the intuition behind the welfare results, we use (12) to write the relative welfare effect as:

$$u - u^* = (\rho - \theta)(\rho\theta)^{-1}(y_{npv} - y^*_{npv}) \tag{14}$$

(14) is a central result of this paper, as it clearly illustrates how various adverse welfare effects can occur. (14) reflects the combination of two links between consumption and output. First, (12) shows that output is transformed into consumption through the real revenue effect at a rate equal to $(\rho - 1)\rho^{-1}$, which captures the negative linkage between output and the terms of trade:

$$c_{npv} - c^*_{npv} = (\rho - 1)\rho^{-1}(y_{npv} - y^*_{npv})$$

Second, as producers charge a markup over marginal cost, exerting an additional unit of effort is equivalent to sacrificing $(\theta - 1)\theta^{-1} < 1$ units of consumption. In consumption units, the cost of effort is therefore given by $(\theta - 1)\theta^{-1}$ times effort (output), and residents are better off if they receive more than this amount in additional consumption:

$$u - u^* = (c_{npv} - c^*_{npv}) - (\theta - 1)\theta^{-1}(y_{npv} - y^*_{npv})$$

Intuitively, the cost of effort in consumption units reflects the markup due to monopolistic competition. This markup is in turn a function of the price elasticity that firms face, which is equal to θ. If $\rho = \theta$, as in Obstfeld and Rogoff (1995, 1996), the benefit from consumption exactly offsets the cost of effort, and there is no welfare difference across countries.

The relative welfare effect can therefore be interpreted as reflecting a *generalized Marshall–Lerner–Robinson* condition. As shown by (12), a given output expansion raises consumption, relative to the foreign country, if $\rho > 1$, which is the

usual condition. The expansion however raises welfare, relative to the foreign country, only if $\rho > \theta > 1$. The relevant threshold for the cross-country elasticity is therefore different depending on whether we analyze the effect on consumption (the usual condition) or welfare (the generalized condition).

When $y_{npv} - y^*_{npv}$ is positive, the residents of the home country are worse off, *relative* to their foreign counterparts, if $\rho < \theta$. The worsening of the terms of trade required to absorb the rise in output through the consumption switching effect is such that home residents cannot afford enough consumption to offset the extra cost of effort. The additional effort therefore costs more in consumption units than it generates through the real revenue effect.

As pointed out by Obstfeld and Rogoff (1998), the difference between the cross-country and the within-country elasticities of substitution generates an externality. Focusing on the home country, (4) shows that the relevant price elasticity for an individual firm is θ, as it can only change its own price, $P^{\mathrm{h}}(k)$, and its impact on the price indexes P^{h}, P, $P^{*\mathrm{h}}$ and P^* is negligible. The firm then chooses a markup $\theta(\theta-1)^{-1}$ over its marginal cost. The problem faced by a planner who coordinates the firms' price setting in the country is however different. By analogy to an individual firm's choice, we consider that the planner ignores the effect of her choices on the aggregate price indexes P and P^*.[25] As the planner coordinate the firms' choices, the ratio between $P^{\mathrm{h}}(k)$ and P^{h} remains constant to unity, and the relevant demand elasticity is ρ. The planner then chooses a markup equal to $\rho(\rho-1)^{-1}$.

As $\rho < \theta$, the planner chooses a larger markup than firms. From the planner's point of view, firms should contract output from their uncoordinated choice, as this significantly improves the terms of trade. Real revenue then rises, or falls by an extent so small that it is dominated by the reduction in effort. An output expansion is therefore adverse in relative terms, as it pushes output beyond a level that is already suboptimally large from the point of view of the planner. Note that the goal of the planner is not to reach the competitive equilibrium, which requires an output expansion, but to exploit the country's monopoly power in the most efficient way.

In this setup, the equilibrium where firms do not coordinate their choices is therefore characterized by two inefficiencies. The first is given by the existence of a markup over marginal cost, and reflects the monopolistic competition. The second reflects a coordination failure among home firms to exploit their monopoly

[25] This can easily be rationalized in the case of a small country. In the case of a large country however the reader may object to the assumption of holding P and P^* constant. The justification for doing so is that the mentioning of a planner is done simply for expositional purposes. The choice of a myopic planner, who ignores the effects on P and P^*, is conceptually identical to the choice of an individual firm, and the central mechanism of the model can then be highlighted in a simple way.

power more efficiently, and is similar to the optimal tariff concept in the trade literature.

In the case where $\rho = \theta$, there is no incentive for a planner to alter the uncoordinated equilibrium, as firms perceive the right demand elasticity. If $\rho > \theta$, the situation is reversed: the elasticity for the planner is larger than for the firms, which set their markup at an inefficiently high level. Because of the high sensitivity of output with respect to the terms of trade, the planner sets the markup below $\theta(\theta - 1)^{-1}$, which rises the real revenue by enough to offset the additional cost of effort.

5. Can an expansionary shock be detrimental?

Our welfare analysis so far has focused on the difference between the home and the foreign countries, and shown that home and foreign residents can be adversely affected in *relative* terms ($u \gtrless u^*$). In order to assess whether they can be adversely affected in *absolute* terms ($u < 0$, $u^* < 0$), we need to combine the cross-country differences with the worldwide effects, recalling that $u = u^w + (1 - n)(u - u^*)$, $u^* = u^w - n(u - u^*)$.

Without loss of generality, we focus on an expansionary shock in the home country ($\bar{m} > 0$, $\bar{m}^* = 0$), a shock that would be beneficial in a closed economy. Appendix A shows that it can have an adverse effect either on the home or the foreign country. The home country experiences an beggar-thyself effect ($u < 0$) if the following condition is met:

$$n < \bar{n} \equiv \frac{\theta - \rho}{\theta - \rho + \sigma + (\rho - 1)\left(1 - \beta \dfrac{\varpi\rho}{1\varpi\rho}\right)} \tag{15}$$

(15) clearly cannot be satisfied if there is more substitutability across countries than within countries ($\rho > \theta$), as the home residents are then better off than the foreign residents. If $\theta > \rho$ however, the threshold $\bar{n}$ is between 0 and 1,[26] and the possibility of a beggar-thyself problem cannot be excluded. Such a problem is more likely if the home country is small (low value of n), there is little cross-country substitutability (low value of ρ) or the economy is already close to the competitive outcome (high value of θ).

If the home country is small, the worldwide impact of its monetary expansion is negligible and only time adverse terms of trade effect remains. Note that a small

[26] Assuming that $\rho - 1 > -\sigma$ ensures this result.

country can be adversely affected even if ρ and θ are relatively close. Intuitively, the role of the cross-country substitutability in generating a beggar-thyself effect can be understood as follows: the worsening of the home terms of trade does not result in any sizable shift of world consumption towards home goods. The home country residents therefore do not benefit from significantly higher revenue, but face a higher cost if imports, away from which they cannot substitute. Foreign residents on the other hand benefit as the cost of their imports is reduced. In the extreme case of non-substitutability ($\rho \to 0$), there is a beggar-thyself problem if $n < \theta(\theta + \sigma - 1)^{-1}$, which is close to 1: even a very large country is adversely affected by its monetary expansion when there is little cross-country substitutability. If the economy is already operating close to the competitive outcome ($\theta \to \infty$), the initial distortion due to monopolistic competition is negligible, and the worldwide welfare gain from a monetary expansion is close to zero.

Turning to the foreign country, a monetary expansion in the home country results in a beggar-thy-neighbor problem ($u^* < 0$) if:

$$\rho - \theta > \sigma + (\rho - 1)\left(1 - \beta \frac{\varpi\rho}{1 + \varpi\rho}\right) \tag{16}$$

clearly cannot hold if there is less substitutability across countries than within countries ($\rho < \theta$), as the welfare effect is then larger in the foreign country. If $\rho \to \infty$ however, (16) holds. Intuitively, there is a beggar-thy-neighbor problem when the cross-country substitutability is high because the worsening of the home terms of trade results in a massive shift of world consumption towards home goods. This generates a fall in revenue for foreign residents, which dominates the beneficial effect through imported deflation.

6. A numerical illustration

This section illustrate our welfare results through a numerical example. Following Betts and Devereux (2000), we consider prices to be set for a year and choose $\beta = 0.94$, leading to a steady state real interest rate of 6%. The value of the elasticity of substitution within a country, θ, is set at 6, which implies a markup of 20%, following Rotemberg and Woodford (1992). We choose a value of 1 for σ, which is consistent with Beaudry and van Wincoop (1996),[27] and consider the case of a quadratic cost of effort ($\varpi = 1$). We set the size of the home country, n, to 0.5, and focus on the impact of a unit monetary expansion in the home country ($\bar{m} = 1$, $\bar{m}^* = 0$) without loss of generality. We present the results for various values of the elasticity of substitution across countries ρ.

Table 3 presents the welfare effects in both countries. As can be seen from (10)

[27] This ensures that $\rho - 1 + \sigma \geq 0$ for any value of ρ.

Table 3
Welfare effects

ρ	1	2	3	4	5	6	7	8	9
u	−0.33	−0.16	−0.07	−0.01	0.04	0.08	0.12	0.16	0.20
u^*	0.50	0.33	0.24	0.18	0.13	0.08	0.04	0.01	−0.03

Closed economy: $u = 0.16$

the numbers can be interpreted as the percentage change in consumption that would generate the same welfare impact as the monetary shock considered. For comparison, the welfare effect in a closed economy is also presented. Both countries are better off to the same extent when the cross-country and within-country of substitutability are the same ($\rho = \theta$), as pointed out by Obstfeld and Rogoff (1995, 1996). If there is more substitutability across countries than within countries ($\rho > \theta$), foreign residents are worse off relative to home residents, and also in absolute terms if the degree of cross-country substitutability is large enough. If there is less substitutability across countries than within countries ($\rho < \theta$), a beggar-thyself phenomenon is possible. Overall, there is a wide range of values for the cross-country substitutability for which either the home or the foreign country is adversely affected, while the other country enjoys a beneficial effect larger than if it were a closed economy. This shows that cases where both countries benefit from a monetary shock appear to be more of an exception than the rule.

Table 3 does not show how the situation depends on the size of the home country. (15) however shows that the possibility of a beggar-thyself effect depends on n. Table 4 presents the value of $\bar{n}$ for various values of ρ. A beggar-thyself problem occurs when the home country is smaller than the threshold size given in Table 4 ($n < \bar{n}$). If the home country is very small, it is adversely affected even if there is not much difference between the degrees of substitutability across and within countries ($\bar{n}$ is small only when ρ is close to θ). This indicates that the finding of an equally beneficial welfare effect in both countries by Obstfeld and Rogoff (1995, 1996) is true only if ρ is *exactly* equal to θ: if ρ is close to θ, the welfare effects will be quantitatively close in both countries, but qualitatively different, as the effect is negative for the home country and positive for the foreign country. Furthermore, a beggar-thyself effect is not limited to a small country. If $\rho = 1$ or $\rho = 2$ for example, such an effect occurs if the home country represents less than 83% and 74% of the world, respectively. This suggests that taking the

Table 4
Threshold for the beggar-thyself effect

ρ	0	1	2	3	4	5	6
$\bar{n}$	1	0.83	0.74	0.65	0.53	0.35	0

case of a closed economy as an approximation of a large open economy can be misleading when domestic and imported goods are poor substitutes.

7. Extensions

Our analysis can be extended in several ways, and we now outline two of them. First, the setup can easily be modified to include fiscal shocks.[28] Following Corsetti and Pesenti (1997), government spending represents a source of demand with a complete home bias. A fiscal expansion in the home country increases the demand faced by home households at given prices. This leads to an increase in the price of home goods in the long run, which translates into a worsening of the terms of trade for the foreign country. In addition a fiscal expansion crowds out worldwide private consumption overall ($c^{w}_{npv} < 0$), which tends to reduce foreign output. In the NON-MLR case, the worsening of the terms of trade and the consumption crowding out reinforce each other to reduce the sales revenue of foreign households. In the MLR case, the worsening of the terms of trade only partially offsets the adverse impact of the crowding out of the sales revenue. A fiscal expansion in the home country unambiguously results in a beggar-thy-neighbor problem ($u^* < 0$), especially when home and foreign goods are poor substitutes.

Another extension is to relax the assumption of the law of one price, on which the empirical literature casts some doubt (Engel, 1997; Engel and Rogers, 1997; Betts and Devereux, 2000). Instead of assuming that export prices are set in the producer's currency, we can assume that at least some prices are set in the consumer's currency, implying that fluctuations in the exchange rate are not completely passed-through to consumers. The analysis, presented in a companion paper (Tille, 1998), shows that the home welfare is always increased under this alternative scenario, relative to our baseline analysis. Intuitively, a home monetary expansion generates a depreciation in both the nominal and the real exchange rates, the later being defined as the exchange rate times the ratio of consumer price indexes. This increases the purchasing power of a given revenue in the home country, relative to the foreign country. Furthermore, the reduced exchange rate pass-through lowers the consumption switching effect of the exchange rate, thereby reducing the gap between home amid foreign employment. In the extreme case where all export prices are set in the consumer's currency, we can show that the cross-country substitutability ρ becomes irrelevant, and home amid foreign employment are equal. In such a case, a monetary expansion unambiguously results in a beggar-thy-neighbor problem.

[28] The detailed analysis of fiscal shocks is presented in the working paper version.

8. Conclusion

This paper evaluates the role of the degree of substitutability between goods produced in different countries in the transmission of monetary shocks, building on previous work by Obstfeld and Rogoff (1995, 1996). We conclude that their finding that all countries benefit from a shock appears to be more of an exception than the rule. If home and foreign goods are poor substitutes, a country is adversely affected by its own monetary expansion because of the worsening of its terms of trade.

We extend the work by Corsetti and Pesenti (1997) and establish that the welfare effects differ across countries as long as time substitutability between home and foreign goods differs from the substitutability between various brands of a given type of good. A monetary expansion in a country makes its residents better off relative to the foreign residents if the cross-country substitutability is larger than the within-country substitutability. We refer to this condition as the 'generalized Marshall–Lerner–Robinson condition', by analogy with the usual condition under which a monetary expansion leads to an increase in consumption and a trade surplus when the cross-country substitutability exceeds unity.

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Appendix A

A.1. Solution of the model

This Appendix outlines the derivation of the solution. In terms of worldwide variables, the situation is identical to a closed economy: money affects output and employment in the short run, but is neutral in the long run ($c^w = y^w = \sigma \bar{m}^w$, $\bar{c}^w = \bar{y}^w = 0$). In terms of cross-country differences, we combine approximations of (4) and (5) in the long run to obtain a negative relation between output and consumption:

$$(\bar{y} - \bar{y^*})(1 + \varpi\rho) = -\rho\sigma^{-1}(\bar{c} - \bar{c^*}) \tag{A.1}$$

Linear approximations of the Euler equations (2) in both countries show that the cross-country consumption difference is the same at all horizons: $c - c^* = \bar{c} - \bar{c^*}$. Combining this result and linear approximations of the money demands (3), we show that there is no exchange rate overshooting:

$$s = \bar{s} = (\bar{m} - \bar{m^*}) - \sigma^{-1}(c - c^*) \tag{A.2}$$

Combining (A.2) with linear approximations of (4) in the short run, and recalling that $p^{\mathrm{h}} - p^{\mathrm{f}} = -s$, we derive a negative relation between output and consumption:

$$y - y^* = -\rho\sigma^{-1}(c - c^*) + \rho(\bar{m} - \bar{m^*}) \tag{A.3}$$

Combining (A.1) and (A.3) leads to Eq. (11) in the text. Eq. (12) in the text is obtained by combining linear approximations of (4) and (6)–(7) in the short and the long run.

The detailed solution for the various variables in the short and the long run can be computed as:

$c - c^* = \Pi_{CM}(\bar{m} - \bar{m^*})$	$p^{\bar{\mathrm{h}}} - p^{\bar{\mathrm{f}}} = \Pi_{TM}(\bar{m} - \bar{m^*})$
$s = \Pi_{SM}(\bar{m} - \bar{m^*})$	$y - y^* = \Pi_{YSM}(\bar{m} - \bar{m^*})$
$\dfrac{b}{1-n} = \Pi_{BM}(\bar{m} - \bar{m^*})$	$\bar{y} - \bar{y^*} = \Pi_{YLM}(\bar{m} - \bar{m^*})$

where the coefficients are:

$\Pi_{CM} = \dfrac{1}{D}(1-\beta)(\rho - 1)$	$\Pi_{TM} = \dfrac{1}{D}\dfrac{\rho - 1}{\sigma}\dfrac{1-\beta}{1+\varpi\rho}$
$\Pi_{SM} = \dfrac{1}{D}\left(1 + \dfrac{\rho - 1}{\sigma}\dfrac{\beta}{1+\varpi\rho}\right)$	$\Pi_{YSM} = \rho\Pi_{SM}$
$\Pi_{BM} = \dfrac{\beta(\rho-1)}{D}\left(1 + \dfrac{\rho - 1}{\sigma}\dfrac{1}{1+\varpi\rho}\right)$	$\Pi_{YLM} = -\rho\Pi_{TM}$
$D = 1 + \dfrac{\rho - 1}{\sigma}\left[1 - \beta\dfrac{\varpi\rho}{1+\varpi\rho}\right] > 0$	

Assuming $\rho > 1 - \sigma$ ensures that $D > 0$.

A.2. The Marshall–Lerner–Robinson condition

From Table 1, we can write the home country's exports and imports as:

$$IM = n(1-n)[P^{f}/P]^{-\rho}C\,, \qquad EX = n(1-n)[P^{h}/P]^{-\rho}C^{*}$$

In the initial symmetric steady state, both flows are equal to $n(1-n)C_0$. In terms of log linear approximations, we write:

$$im = \frac{dIM}{n(1-n)C_0} = \rho n(p^{h} - p^{f}) + c$$

$$ex = \frac{dEX}{n(1-n)C_0} = -\rho(1-n)(p^{h} - p^{f}) + c^{*}$$

Holding consumptions constant, the export and import elasticities with respect to the terms of trade, in absolute value, are given by:

$$\varepsilon_{EX} = -\frac{\partial ex}{\partial(p^{h} - p^{f})} = \rho(1-n)\,, \qquad \varepsilon_{IM} = \frac{\partial im}{\partial(p^{h} - p^{f})} = \rho n$$
$$\Rightarrow \varepsilon_{EX} + \varepsilon_{IM} = \rho$$

A.3. Absolute welfare effects

Focusing on an expansionary shock in the home country ($\bar{m} > 0$, $\bar{m^{*}} = 0$), the relative and worldwide welfare effects are:[29]

$$u - u^{*} = \Phi\Lambda\bar{m}\,, \qquad u^{w} = n\Phi\bar{m}$$

where $\Phi = \sigma c_0 \theta^{-1} > 0$, $\Lambda = (\rho - \theta)(\sigma D)^{-1}$. The home and foreign welfare effects are of the form:

$$u = (1-\Lambda)(n - \Lambda(1-\Lambda)^{-1})\Phi\bar{m}\,, \qquad u^{*} = n\Phi(1-\Lambda)\bar{m}$$

It is straightforward to see that a beggar-thy-neighbor problem ($u^{*} < 0$) occurs if $\Lambda > 1$, which is Eq. (16) in the text. The home welfare is a function of the ratio $-\Lambda(1-\Lambda)^{-1}$. We can show that $u > 0$ unless $n < -\Lambda(1-\Lambda)^{-1} < 1$, in which case there is a beggar-thyself problem. Eq. (15) in the text reflects this condition.

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[29] I am grateful to Michael Woodford for bringing the method to my attention.

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