CHAPTER 1

Trade Invoicing in a Bipolar International Monetary System and Financial Stability

1.1 Introduction

A recent literature in financial crises has underlined the importance of cross-border transmission of financial turmoils in emerging economies while the links between currency crises and banking runs are also commented in some papers.[1]

From this literature (Miller, 1998b), we learn that currency crises abroad could imply banking crises in developing countries. This could happen through a devaluation of a foreign currency that could damage the debt repayment ability of firms exporting to the devaluating country. Another possible channel of transmission could be the fact that most of the assets in banks' portfolios be denominated in the devaluated currency while the liabilities are mostly denominated in other currencies. Moreover, a banking crisis originated abroad can occurs when firms' revenues are mostly denominated in a devaluated foreign currency.

Thus, the stability of the financial system in an open developing country appears to be closely linked to the behavior of international currencies that dominate the global monetary system. It appears to us useful to deal with the issue of trade invoicing in a bipolar international monetary system. We are interested in its subsequent implications for a small developing country concerned with its financial stability as the euro-dollar

[1] Miller (See for example 1996, 1998a,b).

exchange rate is determined through the European Monetary Union (EMU) and the United States (US) interdependent monetary policies. In other words, we want to undertake a positive analysis of the EMU-US monetary game externalities for a small country policymaker who plans to insulate the domestic financial sector from external disturbances related to the euro-dollar exchange rate. The small country policymaker is expected to pay accurate attention to the fluctuations of the domestic currency exchange rate. An interesting feature of this study is that we will combine the financial crisis transmission literature and the one devoted to the advent of euro and its implications[2].

Inasmuch as the advent of the euro is the final step of a monetary integration process, some consequences of the euro behavior on developing countries, if they are real, could have been observed on the basis of the data related to the integration process period. Empirical investigation related to the subject will be the content of another research project. This study will focus on a theoretical discussion of possible external effects of the European monetary integration through the behavior of the euro-dollar exchange rate.

The second section will be devoted to a selective survey of the two kinds of literature on the issue. On the one hand, the financial crisis transmission will be discussed; on the other hand we will review the literature on the external effect of the euro, especially focusing on asymmetric multi-country model analysis. In the third section, we will highlight the basic channel through which the euro behavior could have an impact on a developing country's financial stability. Actually, we focus on the international trade invoicing pattern as the euro is poised to compete with the dollar. Changes of the euro-dollar exchange rate are assumed to induce variations of our typical small country's trade balance. For this purpose, we are going to draw a formal current account definition that allows us to isolate the nominal disturbing effect that could take place as euro competes with the US dollar in the invoicing of international trade.

In the fourth section, the two country model of Canzoneri and Henderson (1991) will be expanded in order to study the external effects of a two big players' game that has an impact on a third small player. We will investigate the implications of taking into account alternative exchange rate regimes for the small open country welfare as it faces the external effects discussed here. The final section concludes.

[2]In this chapter, we focus on the analysis of a bipolar international monetary system environment that is a consequence the advent of the euro. We will not deal with the process of European monetary integration process.

1.2 Financial Stability, Currency Crises and Monetary Interdependence: A Selective Literature Review

Two kinds of literature are going to be reviewed in a selective way in order to set up the basis of our model. It will allow us to tackle the issue of externalities of European Monetary Union and United States monetary interdependence on small developing countries. On the one hand, we review the literature on financial crises that stem from currency crises abroad. On the other, we discuss the monetary interdependence literature, especially the one that is focused on a three country economy.

Because of the occurrence of past and recent financial crises in developing countries in the eighties and nineties, a growing amount of literature began to investigate the links between currency and banking crises. In this literature, bank crises are thought to be likely to cause currencies crises to occur. Velasco (1987), Obstfeld (1994), Calvo (1998) and Kaminsky and Reinhart (1999) treat this direction of causation. For example, Calvo (1998) shows that when a Central bank acts as a lender of last resort, a subsequent permissiveness of banks could lead to a central bank bailout that will imply a loss of external reserves. This is likely to provoke a currency crisis. Therefore, a bank run could precipitate a currency crisis. Mishkin (1999) also invokes the case of a deterioration of banks' balance sheets which can promote currency crisis. Indeed, when investors know that the central banker will be unwilling to raise interest rates to defend the exchange rate parity — as he avoids to exacerbate the banking sector weakness —, they will be motivated to actually launch speculative attacks that could lead to a currency crisis. On empirical grounds, Kaminsky and Reinhart (1999) found that banking crises could help to predict currency crises to some degree.

A noticeable feature of the link between currency crises and bank runs is that the relation could work in the opposite way. Indeed, Miller (1996) indicates that an "internal drain" could be the consequence of an "external drain". It means that when a speculative attack on a currency occurs, speculators are likely to use deposit money to purchase foreign exchange; then, a banking crisis may ensue. Obstfeld (1994) and Rojas-Suarez and Weisborg (1995) argue that a vulnerable banking sector could face turmoil episodes if the government tries to tackle a depreciating pressure on its currency and raises interest rates. But Kaminsky and Reinhart (1999) merely conclude that a currency crisis could deepen a banking crisis, implying a vicious spiral. Therefore, it can be stressed that turmoils in monetary sphere could lead to a destabilization of the banking sector (see also Mishkin, 1998a,b, 1999).

An interesting complement of this literature is the introduction of the cross-border

effects leading to an international transmission of financial crises. The seminal work of Miller (1998a; 1998b) gives many examples of currency and banking crises interaction in an international context. Miller (1998b) provides two examples in which currency crises abroad cause banking crises. When domestic banks lend to domestic companies that export to a foreign country, a devaluation of the foreign currency could negatively affect the firms' ability to repay loans. The same problem can arise when firms operating abroad face a currency crisis abroad that interrupts economic activity.

Furthermore, currency mismatches are destabilizing factors. When more assets than liabilities are denominated in terms of a devaluing currency, bank portfolios are likely to be "currency-mismatched". In addition, if firms revenues are pegged to foreign currency while loans are denominated in terms of domestic currency, a devaluation of foreign currency could lead to bank turmoil. A clear causation effect is then established from a crisis in the monetary sphere abroad to a domestic banking sector destabilization. This currency mismatch issue is also consistent with the financial crisis propagation mechanisms extensively described by Mishkin (1998a). He stresses that in the case of a banks' balance sheet deterioration, the foreign exchange crisis invoked above could lead to a full-fledged financial crisis. Considering that a foreign currency devaluation (depreciation) — in which bank assets are denominated — could be the cause of banks' balance sheet deterioration, we retain this mechanism as an additional example of foreign currency crisis transmission to the domestic financial sector of a developing country.

We are going beyond this literature, arguing that, in a bipolar international monetary system, monetary interdependence between leading economies will have some impact on the financial flows of developing countries. According to the insights of the reviewed literature, this is likely to increase the risk of a banking crisis. In this way, we suggest the link between the literature on imported financial crises and the literature on monetary interdependence.

A great amount of studies dealing with monetary interdependence between world economies already exists. We are interested in those using a three country framework and one shot games. Canzoneri and Henderson (1991), Benassy-Quéré et al. (1997) and Ghironi and Giavazzi (1997, 1998) are some relevant authors who illustrate the evolution of the use of this kind of model. Dealing with various types of strategic monetary policies, the three country models help to draw interesting insights. Canzoneri and Henderson (1991) use a symmetric model to conclude that the cooperation between two of the three policymakers may be counterproductive. Benassy-Quéré et al. (1997) explore the possible behavior of the euro as two of the three countries choose to form a

monetary union, especially the EMU. In order to be able to get analytical solutions of the model, perfectly symmetric framework is assumed. On the one hand, the symmetry is assumed for two small countries that get in cooperative game or monetary union; on the other hand, the size of two countries taken together is identical to the size of the big country. In addition, all the behavioral equations of the these models are identical.

Ghironi and Giavazzi (1997; 1998) introduce a very interesting feature in their model. They introduce an asymmetry in the sizes of the countries which are represented by specific parameters. The combination of the two parameters allows to build a model in which the asymmetry in the size helps to generalize results of symmetric models. Of course, analytical solutions of these models are hard to interpret; that is why numerical solutions are used.

Despite the interesting feature of the asymmetric model in terms of size, some weakness persists, especially due to the assumption of identical behavioral equations in all countries. The fact is that a developing country economy works differently when compared with a developed one. We plan to extend the monetary interdependence discussion, including the situation of a very small developing country that does not have any impact on the big partners. Hamada (1998) retains the similar framework to study the implications of different exchange rate regimes in a bipolar international system where two currencies both dominate. Our model departs from his in that it explicitly introduces features specific to developing countries like the lack of wage bargaining and the commodity-biased composition of exports.

The issue discussed in the model is the one of a world in which two big economies interact each other in a such a way that their monetary game induces externalities on a small economy, while the monetary policy actions of the latter have no effect on the big economies. The small country monetary policymaker is concerned himself with the stability of his financial sector in the sense that he pays particular attention to destabilizing effects of either the exchange rate change of the foreign currencies or that of the domestic currency. Thus, we illustrate the concern on a probable domestic financial crisis that could stem from monetary game abroad. In fact, we complete the "twin crises" analysis by showing that interdependent monetary policies of big economies are likely to affect variables whose movements can lead to financial crises. We will use a Canzoneri and Henderson (1991) two country model of monetary interdependence game as the basic framework on which an asymmetric three country model will be built. One main question is going to be answered: Will cooperation between the European Monetary Union and the United States, set in order to avoid the euro-dollar exchange rate movements, be beneficial for a typical small African country?

1.3 Euro-dollar competition and trade invoicing

What seems to us the principal channel of the euro behavior transmission on developing countries is concerned with trade partnership and invoicing. Changes in the value of the invoicing currencies of exports and imports can have some implications on the current and, finally, capital accounts of a country. We consider here nominal changes in price and exchange rate in countries issuing the dominant currency as the factor that could imply variability of flows and current account balance in developing countries.

In order to illustrate our argument, we will use a basic current account model. In this model, a developing country can be characterized as an exporter with receipts denominated in dollar and an importer with expenses denominated in euro. Although this specification appears very strong, it follows the trade pattern of some countries and the competition process of euro versus dollar in the area of trade invoicing.

Table 1.1: Importance of EMU goods in global imports of selected countries.

Imports from EMU in percentage of total imports				
Country	1990	1993	1996	1999
Angola	64	58.4	47.3	39.9
Benin	50.1	43.5	40	38.6
Cameroon	65.2	66.3	58.4	61.9
Cape Verde	73.1	61.7	62.1	82.5
Chad	62.8	66.2	64.1	47.3
Comoros	79.7	65.3	69.4	48.1
Côte d'Ivoire	58.9	51	51	50.6
Gabon	68.7	64	62.6	79.7
Madagascar	61.8	52	51	55.3
Sao T & P	55.6	61.1	73.4	72.3
Senegal	62.6	56.7	61.1	59.5

Source: IMF, International Financial Statistics, June 2001

Indeed, most imports of many African countries come from European economies. Table 1.1 shows the share of EMU goods in global imports of some Sub-Saharian Africa's countries — EMU being their main provider of imports. The case of CFA zone countries is a very interesting one because if we consider the intra-CFA zone trade flows and imports from Central and Eastern Europe which, roughly speaking, use euro as an anchor (Benassy-Quéré, 1996), it turns out that the most imports of CFA zone countries are likely to be invoiced in euro. It has also to be noticed that for countries in Table 1.1, EMU is the main trading partner in the sense that she is the most important

destination of African exports[3].

Furthermore, economic literature on the international role of the euro states that the dollar will again continue to rule over other currencies quite a while until some inertia in trade and financial markets be removed (See for example Benassy-Quéré, 1996). More precisely, the invoicing pattern of commodities and raw materials on international places will last during an undetermined period. The fact is that many of these products are currently invoiced in dollar. Inasmuch as almost African exports exclusively consist of such products, we can consider these countries as invoicing their exports in dollar[4]. Thus, let the current account of a developing country i be defined as:

$$CA_i = \frac{P_x X}{P_m M} \tag{1.1}$$

where CA_i is an index of current account expressed as a ratio of exports on imports[5], X represents exports and M means imports. P_x and P_m are respectively prices of exports and imports in domestic currency. It has to be underlined that CA_i and all other variables are expressed in deviation from an equilibrium level. Each variable can then be seen as a change from equilibrium level. P_x can be explicitly described like this

$$P_x = E_{i/\$}.P_\$ \tag{1.2}$$

where $P_\$$ is the export price index in dollar, and $E_{i/\$}$ the unit price of dollar in home currency.

The import price P_m can be defined as follows:

$$P_m = E_{i/€}.P_€ \tag{1.3}$$

where $P_€$ is the import price index in euro and $E_{i/€}$ is the unit price of euro in home currency. For now, we assume that $P_\$$ and $P_€$ are exogenous. The assumption that $P_€$ is exogenous will be relaxed latter.

In order to see the impact of an euro-dollar exchange rate ($E_{i/€}/E_{i/\$}$) variation, we transform equation 1.1 and concentrate on the amplitude of its impact. Substituting

[3]Detailed and updated stylized facts on the trade links between African countries and the European economic area and the United States, respectively, are provided in Nyembwe (2004).

[4]See Nyembwe (2004) for a more extensive treatment of trade invoicing literature.

[5]We use a Trade Balance definition in place of a classical current account. $CA_i > 1$ and $CA_i < 1$ mean respectively that the current account balance is positive and negative.

(1.2) and (1.3) in (1.1), transforming the current account equation in log form and rearranging yields:

$$ca_i = (p_\$ - p_\in + x - im) + (e_{i/\$} - e_{i/\in}) \tag{1.4}$$

where lowercase letters are logarithms of the variables explained above. It is easy to see that a decrease of the euro-dollar exchange rate $(e_{i/\$} - e_{i/\in})$, i.e, a dollar depreciation vis-à-vis the euro leads to a one–to–one change in the current account, before a volume effect works because x and im are functions of $e_{i/\$}$ and $e_{i/\in}$ respectively. Our point is to show that the "quasi-*bipolarization*" of the international monetary system caused by the euro advent entails a systemic risk as the euro-dollar exchange variability is likely to affect a nominal developing country's current account in a dramatic way.

Henceforth, the developing country currency exchange rates against dollar $(e_{i/\$})$ and the euro $(e_{i/\in})$ will be respectively noted e^{us} and e^e. Thus, the above current account equation becomes:

$$ca_i = (p_\$ - p_\in + x - im) + (e^{us} - e^e) \tag{1.5}$$

1.4 Transatlantic monetary interdependence and Developing Countries

1.4.1 The model

The model we present is a three country world economy in which there are two big economies named US and EMU. US stands for the US economy while EMU stands for the European Monetary Union. Thus, we will refer to the two big countries by subscripts us and $\in$ attached to variables. The third economy is the one of a small developing country that we will call "$Home$". The variables related to it will not have any subscript, except for e, the euro-dollar exchange rate, that will neither have any subscript nor be related to $Home$. All variables, except interest rates, are expressed in terms of logarithms and represent deviation from an equilibrium level. We assume in the model that productivity and positive demand disturbances, respectively u' and ι' affect only the two big economies. The only disturbances that affect $Home$ economy are the externalities of the monetary policy game between EMU and US.

Although the introduction of more than one type of asymmetry at once in a model is not usual in economic literature, it seems to us that in our model it will be necessary to do so. This is because we need to tackle the real issue of euro behavior externality

through the use of a model that is as realistic as possible. Therefore, the following asymmetries are assumed:

- The size of $Home$ is such that it has no economic impact on the two big partners.
- There is no wage bargaining in the small country while labor corporations have some bargaining power in US and EMU, but nominal rigidities (of wages) are assumed in all the economies.
- The financial sector of *Home* is tightly regulated in a such away that interest rates are not flexible.
- Finally, we assume that the $Home$ monetary policymaker concerns himself with the stability of the domestic financial sector given the external equilibrium while domestic preferences prevail in *EMU* and *US*, i.e, we assume, for the two latter, the traditional loss functions whose variables are full employment and price stability.

The production of each country y increases with employment n but only that of big countries decreases with a zero mean identically and independently distributed productivity shock u':

$$y = (1-\alpha)n \tag{1.6}$$
$$y_{€} = (1-\alpha)n_{€} - u' \tag{1.7}$$
$$y_{us} = (1-\alpha)n_{us} - u' \tag{1.8}$$

with $0 < \alpha < 1$, where the coefficient of production function, α, is the same in all countries.

Firms set their production programs in such a way that real wage is equal to marginal cost of labor in order to maximize their profits:

$$w - p = -\alpha n \tag{1.9}$$
$$w_{€} - p_{€} = -\alpha n_{€} - u' \tag{1.10}$$
$$w_{us} - p_{us} = -\alpha n_{us} - u' \tag{1.11}$$

w and p are respectively nominal wage and domestic product price while $w - p$ is real wage. Marginal products increase with employment drops in the whole economy

and when u' is positive in the big economies. The nominal wage setting processes are discussed below. For the moment let us note that US and EMU workers and firms enter in wage contracts before markets meet each period. Nominal wages are set in such a way that employments are at their full-employment levels if all disturbances are zero, that is $n_{€} = n_{us} = 0$. Moreover, in the small country, there is no wage bargain process because of the weakness of labor corporations and the fact that wages are just set when governments decide. This is the first asymmetric feature we introduce in the model in order to distinguish the small country from the two others.

Now another fundamental feature of the model can be revealed; that is, $Home$ has trade relations only with EMU while the latter has trade relations with the two other partners. Relative to the weight of EMU, $Home$ exports are so small that they have no influential impact on EMU economy. Then, φ, the EMU average propensity to import from $Home$ could be assumed to be approximatively equal to zero so that $1 - \beta - \varphi \approx 1 - \beta$, β being the average propensity to import from US.

The real exchange rates (or Home import relative price) z are:

$$z = e^e + p_{€} - p \tag{1.12}$$

$$z_{€} = e + p_{us} - p_{€} \tag{1.13}$$

where z is the relative price of goods produced by EMU in terms of $Home$ domestic goods, while $z_{€}$ stands for relative price of US goods in terms of EMU goods.

In all the economies, consumer price indexes are weighted averages of prices of domestic and foreign goods. ψ and β are respectively the $Home$ resident average propensity to import, and the average propensity to import from each other in US and EMU economies while e is the exchange rate of dollar expressed in euro, i.e, amount of euro needed to get one dollar. Finally, e^e is the amount of $Home$ currency needed to get 1 unit of euro.

Thus, consumer price indexes q could be specified as follows:

$$q = (1 - \psi)p + \psi(e^e + p_{€}) = p + \psi z \tag{1.14}$$

$$q_{€} = p_{€} + \beta z_{€} \tag{1.15}$$

$$q_{us} = \beta(p_{€} - e) + (1 - \beta)p_{us} = p_{us} - \beta z_{€} \tag{1.16}$$

with[6] $\varphi \approx 0$, and $0 < \beta < 1$.

According to the asymmetry in bilateral trade patterns between $Home$ and EMU, on the one hand, and the perfect symmetry assumption in EMU and US relationships, on the other, the three demand equations of the world economy are[7]:

$$d = \delta z + (1-\psi)\varepsilon y + \varphi\varepsilon y_{€} \tag{1.17}$$

$$d_{€} = \delta z_{€} + (1-\beta)\varepsilon y_{€} + \beta\varepsilon y_{us} - (1-\beta)\nu r_{€} - \beta\nu r_{us} + \iota' \tag{1.18}$$

$$d_{us} = -\delta z_{€} + \beta\varepsilon y_{€} + (1-\beta)\varepsilon y_{us} - \beta\nu r_{€} - (1-\beta)\nu r_{us} - \iota' \tag{1.19}$$

with $0 < \beta < 1, 0 < \varepsilon < 1$ and $0 < \psi < 1$.

The demand $(d, d_{€}, d_{us})$ equations show that demands for both goods increase with outputs and change inversely with expected real interest rates $(r_{€}, r_{us})$. ψ is the $Home$ residents marginal propensity to import which is equal to the average propensity to import. ε is the fraction of increase in output by which residents of each country increase spending. φ is EMU marginal propensity to import from $Home$. β is the marginal propensity to import in EMU and US. To simplify we assume that the marginal propensities to import are equal to the average propensities to import.

Moves of real exchange rates shift demands from one partner goods to the ones of another partner. It means that positive changes of z shift demand from EMU to $Home$ goods, while positive changes of $z_{€}$ shift demand from US to EMU goods. Negative changes of the two relative prices involve inverse effects. ι' is an identically and independently distributed demand disturbance with zero mean. Moreover, in US and EMU residents decrease spending by the same amount ν for each percentage point increase in the expected real interest rate that is specified as follows:

$$r_{€} = i_{€} - q_{e+1|} + q_{€} \tag{1.20}$$

$$r_{us} = i_{us} - q_{us+1|} + q_{us} \tag{1.21}$$

[6]This approximation is meaningful only in the behavioral equations relative to EMU because the global average propensity to import of EMU residents $\beta + \varphi \approx \beta$ that is the average propensity to import from US. Thus, we derive the EMU consummer price index as follows:

$$\begin{aligned} q_{€} &= (1-\beta-\varphi)p_{€} + \beta(e + p_{us}) + \varphi(p - e^{e}) \\ &\approx (1-\beta)p_{€} + \beta(e + p_{us}) \\ &\approx p_{€} + \beta z_{€} \end{aligned}$$

[7]See appendix A.1 for details on the derivation of the demand of EMU.

where $i_{€}$, and i_{us} are respectively nominal interest rates on euro and dollar. The subscript $+1|$ indicates the expected value of a variable for the next period based on today information.

The goods market equilibrium conditions for the three economies are:

$$y = d \tag{1.22}$$
$$y_{€} = d_{€} \tag{1.23}$$
$$y_{us} = d_{us} \tag{1.24}$$

We assume that in each economy money demand does not depend on interest rates. The money market equilibrium conditions are then simple Cambridge equations:

$$m = p + y \tag{1.25}$$
$$m_{€} = p_{€} + y_{€} \tag{1.26}$$
$$m_{us} = p_{us} + y_{us} \tag{1.27}$$

The interaction in the financial sector is only important between the two big countries as we assume that the small country has imperfect access to international financial markets. Expected returns parity of currencies holds because agents regard bonds denominated in euro and dollar as perfect substitutes.

$$i_{us} = i_{€} + e_{+1|} - e \tag{1.28}$$

We can obtain useful product price expressions for the three economies. Considering money market clearing conditions (1.25 - 1.27), eliminating y, $y_{€}$, y_{us} with equations (1.6 - 1.8) and using (1.9 - 1.11) , we get the following price equations:

$$p = w + \alpha n \tag{1.29}$$
$$p_{€} = w_{€} + \alpha n_{€} + u' \tag{1.30}$$
$$p_{us} = w_{us} + \alpha n_{us} + u' \tag{1.31}$$

In addition, we can draw employment expressions:

$$n = m - w \tag{1.32}$$

$$n_{€} = m_{€} - w_{€} \tag{1.33}$$

$$n_{us} = m_{us} - w_{us} \tag{1.34}$$

The nominal rigidity assumed in the three economies is due to different reasons depending on the kind of country is considered. Here, we are introducing another feature of the model that brings to the fore the fact that labor corporations in US and EMU have some influential power during wage bargains while such corporations do not have any power in many developing countries. In EMU and US firms and workers agree to set nominal wages in such a way that wages are equal to expected money supplies $(m_{€|-1}, m_{us|-1})$. We also assume that wage setters expect money supplies to be zero, i.e, $m_{e|-1} = m_{us|-1} = 0$. The subscript $|-1$ indicates the expectation of a variable from today based on information available yesterday. Nominal wages become then:

$$w_{€} = 0, \tag{1.35}$$

$$w_{us} = 0. \tag{1.36}$$

In $Home$, there is no wage bargain at all. As in many developing countries, especially the least developed ones, wage changes are subject to the influence of the political environment. Moreover, in the presence of permanent macroeconomic stabilization constraints, wage increases are sporadic events which have a low likelihood to occur. Adding the fact that wage decreases are scarce in all economic regimes, we can reasonably assume a zero value wage (change) in $Home$, i.e., $w = 0$.

1.4.2 Reduced Forms Derivation

The behavioral equations specified above and the wage setting process assumed create a world economy in which there are two blocs, working differently. On the one hand, EMU and US interact with each other, forming together the first bloc. Thus, the derivation of reduced form equations and the solution of this bloc of the model work like a two country model because the functioning of $Home$ economy does not have any influential impact on both the two big economies. The interested reader can refer to Canzoneri and Henderson (1991) two country framework — from which we are building our three country version — to see how to derive reduced forms relative to EMU and

US. Here are the relevant reduced form equations:

$$
\begin{aligned}
n_{€} &= m_{€} && (1.37)\\
n_{us} &= m_{us} && (1.38)\\
\sqrt{\eta} q_{€} &= m_{€} - 2\theta m_{us} + u - \iota && (1.39)\\
\sqrt{\eta} q_{us} &= -2\theta m_{€} + m_{us} + u + \iota && (1.40)\\
z_{€} &= \xi\gamma(1-\alpha)(m_{€} - m_{us}) - \left(\frac{1}{\beta\sqrt{\eta}}\right)\iota && (1.41)\\
e &= [\alpha + \xi\gamma(1-\alpha)](m_{€} - m_{us}) - \left(\frac{1}{\beta\sqrt{\eta}}\right)\iota && (1.42)
\end{aligned}
$$

$$
\begin{aligned}
\sqrt{\eta} &= \frac{1}{\rho+\alpha}, & u &= \sqrt{\eta}u',\\
0 < \theta &= \frac{1}{2}\sqrt{\eta}\rho < \frac{1}{2}, & \iota &= 2\sqrt{\eta}\beta\gamma\iota',\\
\xi &= 1 - (1-2\beta)\varepsilon > 0, & \gamma &= \frac{1}{[2\delta + (1-2\beta)^2\nu]}.
\end{aligned}
$$

On the other hand, $Home$ economy is the second block of world economy. It is affected by the policies of US because of the invoicing of its exports in dollar and by those of EMU because of trade partnerships and the invoicing of $Home$ imports in euro. We are focusing on the derivation of reduced forms equation relative to the latter.

Setting that $w = 0$ in equation (1.32) and using (1.29) and (1.6) we obtain:

$$p = \alpha m, \tag{1.43}$$

and

$$y = (1-\alpha)m \tag{1.44}$$

where $0 < \alpha < 1$.

In order to derive the expression of the exchange rate in terms of money supply, we consider the $Home$ good market equilibrium as a part of the world economy while

neglecting the effect of EMU real interest rate change on $Home$ product[8]. We have:

$$y = (1-\psi)\varepsilon y + \delta z + \varphi\varepsilon y_{€} \tag{1.45}$$

From equations 1.7, 1.12 and 1.38, we obtain:

$$e^e = \Delta m - \otimes m_{€} + \mho u' \tag{1.46}$$

where
$$\begin{aligned} \Delta &= \frac{(1-\alpha)[1-(1-\psi)\varepsilon]}{\delta} + \alpha \\ \otimes &= \alpha + \frac{\varphi\varepsilon(1-\alpha)}{\delta} \\ \mho &= \frac{\varphi\varepsilon}{\delta} - 1. \end{aligned}$$

We obtain an expression for the real exchange rate which is:

$$\delta z = (1-\alpha)[1-(1-\psi)\varepsilon]m - \varphi\varepsilon(1-\alpha)m_{€} + \varphi\varepsilon u' \tag{1.47}$$

Our purpose in this section is to analyze the implication of the euro behavior on $Home$ financial system stability through external reserve changes as they affect the central bank ability to act as the lender of last resort. Thus, the most relevant reduced form equation we need is the one of current account. We consider a current account equation that is similar to the equation (2.3) in which all variables are logarithms and represent deviations from a zero value equilibrium state. After normalizing export price to one, i.e., $p_{\$} = 0$, and considering the fact that ψy and $-\delta z$ represent imports (im) while $\varphi\varepsilon y_{€}$ is the expression of exports (x), we obtain:

$$\begin{aligned} ca &= x - im - p_{€} + (e^{us} - e^e) \\ &= \delta z + \varphi\varepsilon y_{€} - \psi y - p_{€} + (e^{us} - e^e) \end{aligned} \tag{1.48}$$

Note that $(e^{us} - e^e)$ is equal to e. It means that the two are equivalent expressions of the euro-dollar exchange rate, i.e, the amount of euro needed to have one US dollar. $(e^e - e^{us})$ can then be replaced by equation (1.42). We use equation (1.42) and put equations (1.37) and (1.38) respectively in (1.7) and (1.8) to replace y and $y_{€}$. Using

[8]We ignore the impact of $r_{€}$ because of the fact that since debt crises episodes and their lasting effects in Sub Saharian African countries have occurred, European investors have drastically reduced their investment flows toward these countries.

the results of these manipulations, given the reduced form of EMU product price[9], we get:

$$ca = \Psi m + \Xi m_{€} - \Theta m_{us} + u' - \left(\frac{1}{\beta\sqrt{\eta}}\right)\iota \tag{1.49}$$

$$\begin{aligned} \Psi &= [1-(1-\psi)\varepsilon](1-\alpha)-\psi(1-\alpha), & \Theta &= \alpha+\xi\gamma(1-\alpha), \\ \Xi &= \xi\gamma(1-\alpha), \end{aligned}$$

where $\Psi \gtreqless 0$, and $\Theta > \Xi > 0$.

1.4.3 Monetary Policymaker Preferences

Now, we can tackle the monetary policymakers preferences issue in the three economies. As stated above, here is an additional area that allows to introduce a behavioral difference between the two big countries and the small one. The loss functions of the monetary policymakers are:

$$L = \frac{1}{2}[(e^e)^2 + ca^2] \tag{1.50}$$

$$L_{€} = \frac{1}{2}(\sigma n_{€}^2 + \eta q_{€}^2) \tag{1.51}$$

$$L_{us} = \frac{1}{2}(\sigma n_{us}^2 + \eta q_{us}^2) \tag{1.52}$$

The EMU and US policymakers loss functions are the classical specifications extensively discussed in the related literature. Then, there is no need of many comments. We simply notice that in EMU and US, the losses of the policymakers rise with squared deviations of employment (n) from their full-employment value. Recall that the equilibrium value of all variables — which are deviations from equilibrium levels — is zero. Moreover, their losses rise with squared changes in CPIs. The symmetry assumption between EMU and US allows us to have the same ratio of the loss from a CPI change to an equal employment change ($\frac{\sigma}{\eta}$) in the two countries.

Conversely, the $Home$ policymaker concerns himself with the stability of the finan-

[9] EMU price reduced form equation is an intermediary step of the derivation process of the most relevant reduced forms equations listed above. It is $p_{€} = me + (\alpha - 1)(m_{€} - m_{e|-1)} + u'$. Considering the assumption that $m_{e|-1} = 0$, we have $p_{€} = \alpha m_{€} + u'$.

cial system through the target of external balance and the stability of exchange rate. As explained in Section 1.2, the financial system can be negatively affected if exchange rate moves endanger the safety of exporting and importing firms assets as these firms are banks debtor. Exchange rate appreciation could imply capital inflows that can trigger a loan expansion and then provoke a financial crisis (Kaminsky and Reinhart, 1999). Moreover, exchange rate variation creates inflation or deflation because the CPI (q) depends on the exchange rate by equations (1.15-1.16). That is why the monetary policymaker would like to minimize exchange rate variation. Besides the exchange rate movements, squared current account (ca) is the other factor that rises or decreases with the policymaker loss. As argued by Hamada and Kawai (1997), the introduction of a certain current account level in the preference function is a valid alternative, even if they prefer to use a explicit level of international reserve. We choose, as Oudiz and Sachs (1984), to use the current account in our model. Changes in ca affect external reserve whose movements are likely to affect the Central bank ability to correctly act as the lender of last resort. For apparent same reasons, an exchange rate appreciation can lead to a banking system crisis. A capital account surplus could rise the liquidity in the domestic monetary space and ,then, increase risks of a loaning boom.

We assume that $Home$ monetary authorities cannot easily borrow from abroad in order to finance their current account deficit. This is a consequence of an imperfectly integration to international financial markets. The investors and the money depositors are aware of this fact. Thus, the risk of banking crises is real as a current account deficit is expected.

Substituting the reduced form of e^e, ca, $n_{€}$, $q_{€}$, n_{us}, and q_{us} into the loss functions, we obtain:

$$\begin{aligned} L \quad &= \frac{1}{2}\Big\{(\Delta m - \otimes m_{€} + \mho u')^2 + \Big[\Psi m + \Xi m_{€} - \Theta m_{us} + u' \\ &\quad -\Big(\tfrac{1}{\beta\sqrt{\eta}}\Big)\iota\Big]^2\Big\}, \end{aligned} \tag{1.53}$$

$$L_{€} = \frac{1}{2}[\sigma m_{€}^2 + (m_{€} - 2\theta m_{us} + u - \iota)^2], \tag{1.54}$$

$$L_{us} = \frac{1}{2}[\sigma m_{us}^2 + (-2\theta m_{€} + m_{us} + u + \iota)^2]. \tag{1.55}$$

Now, we can tackle the monetary policy game between EMU and US. For each type of disturbance, i.e., asymmetric and symmetric shocks, we discuss two kinds of game: Nash non-cooperative equilibrium and Pareto cooperative equilibrium. We sim-

ply present the outcomes of different games with a brief comment. Actually, we are mostly interested in the small country loss. The graphics and the expressions featuring the various equilibria are useful to analyze the small country policymaker welfare. Furthermore, the same results are classical and extensively commented in the economic cooperation literature[10].

1.4.4 Big Country Interdependent Monetary Policy Game.

Outcomes of a Symmetric Shock: a Productivity Disturbance in large economies.

Let us consider a negative world productivity disturbance that affects EMU and US in a symmetric way, i.e, $u' > 0$ and $\iota' = 0$. In a Nash like equilibrium, each policymaker plays independently without taking account of the cross-border effects of his policy actions. From equations 1.54 and 1.55, we see that a change in monetary supply of each player ($m_{€}$ or m_{us}) has a negative externality on the other. As shown in Figure 1.1, the two reaction functions ($R_{€}, R_{us}$) – obtained by using the first order conditions (F.O.C.) – intersect each other at N that is the locus of Nash equilibrium. $L^N_{€}$ and L^N_{us} are the ellipses representing the two loss functions. $B_{€}$ and B_{us} are the bliss points that each of the two policymakers would choose if he could control both money supplies. Because of the symmetry hypothesis, the two policymakers issue the same amount of money. They both contract and have:

$$m^N_{€} = m^N_{us} = -\frac{u}{1 - 2\theta + \sigma}, \tag{1.56}$$

which gives when replaced in (1.54) and (1.55):

$$L^N_{€} \quad = \quad L^N_{us} = u^2 l^N = \frac{u^2(\frac{1}{2})\sigma(1+\sigma)}{(1-2\theta+\sigma)^2} \tag{1.57}$$

In the Pareto like cooperative equilibrium the two policymakers commit themselves to act as a single policymaker in order to avoid losses as they internalize their externalities. In Figure 1.1, the *contract curve* ($B_{€}PB_{us}$) gives the pairs of money supply for which neither policymaker can be better off when there is a change without making the other worse off. Because of the perfect symmetry hypothesis between the two policymakers, the equilibrium will be at the middle point P. The ellipses ($L^P_{€}, L^P_{us}$) passing through are nearer to bliss points than the ones related to Nash equilibrium.

[10]The solution of the non cooperative game as like as of the other types of equilibria are both detailed in Canzoneri and Henderson (1991).

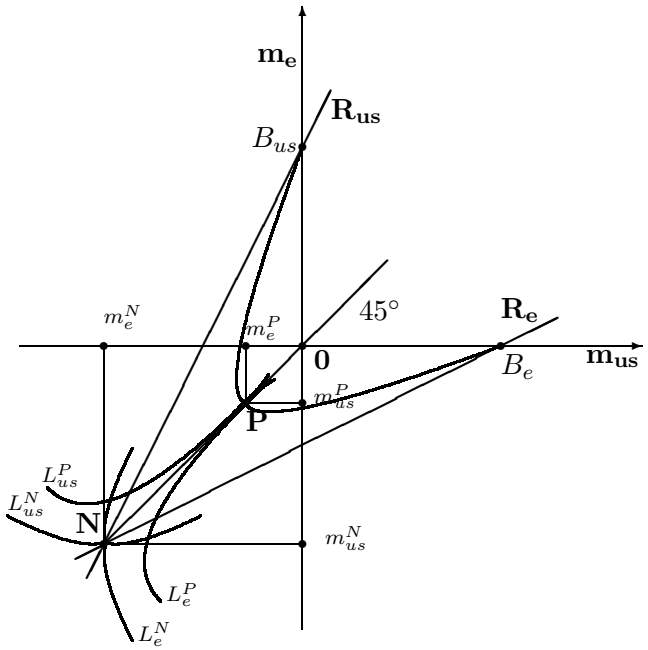

Figure 1.1: Nash and Pareto-Cooperative equilibria after a productivity disturbance

The resolution of the F.O.C. leads to Pareto equilibrium money supplies which are used to derive the losses :

$$m_{€}^P = m_{us}^P = -\frac{uw}{1-2\theta+\sigma}, \tag{1.58}$$

$w = \frac{(1-2\theta)(1-2\theta+\sigma)}{(1-2\theta)^2+\sigma} < 1.$

$$L_{€}^P = L_{US}^P = \frac{u^2(\frac{1}{2})\sigma(1+\sigma)}{1-2\theta+\sigma} \tag{1.59}$$

The following expressions hold:

$$L_{€}^P = L_{US}^P < L_{€}^N = L_{US}^N, \tag{1.60}$$

and

$$m_{€}^P = m_{us}^P < m_{€}^N = m_{us}^N. \tag{1.61}$$

The classical result obtained when a symmetric disturbance occurs is that cooperation in interdependent world could be a better choice for two policymakers. We next

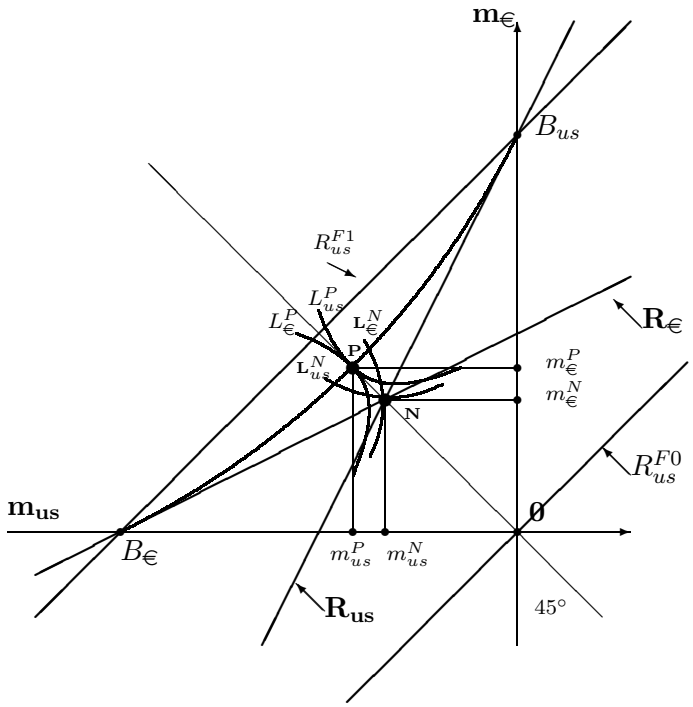

Figure 1.2: Nash and Pareto cooperative equilibria with a shift in demand.

discuss the asymmetric shock alternative.

Outcomes of an asymmetric shock: a shift in demand.

When the disturbance is a shift in demand from EMU product to US product ($u' = 0, \iota' > 0$) the bliss points of the two policymakers are respectively $B_{€}$ and B_{us} in Figure 1.2. In contrast to the case of a symmetric productivity disturbance, the actions of the policymaker imply positive externalities. The non-cooperative Nash equilibrium lies at N where EMU policymaker reaction function ($R_{€}$) intersects the US policymaker one (R_{us}). The welfare improvement zone for the EMU policymaker lies to the southwest of N, whereas the improvement zone of US policymaker is to northeast of N. We obtain the equilibrium money supplies:

$$m_{€}^{N} = -m_{us}^{N} = \frac{\iota}{1+2\theta+\sigma} > 0 \tag{1.62}$$

which can be put in (1.54) and (1.55) to get:

$$L_{€}^{N} = L_{us}^{N} = \iota^2 \left(\frac{1}{2}\right) \sigma \left(\frac{1+\sigma}{1+2\theta+\sigma}\right) \tag{1.63}$$

In Figure 1.2, we represent the Pareto like equilibrium as the policymakers act as

a single one. The equilibrium point P is on the line with slope -1 because the effects of a demand disturbance on the policymakers are of equal magnitude but opposite sign. They are both better off than in Nash equilibrium. The mathematical solution of equilibrium conditions gives

$$m_{€}^{P} = -m_{us}^{P} = \frac{\iota q_1}{1+2\theta+\sigma} > 0 \tag{1.64}$$

where $q_1 = \frac{(1+2\theta)(1+2\theta+\sigma)}{(1+2\theta)^2+\sigma} > 1$, and:

$$L_{€}^{P} = L_{us}^{P} = \iota^2 q_2 \left(\frac{1}{2}\right)\sigma\left(\frac{1+\sigma}{1+2\theta+\sigma}\right) \tag{1.65}$$

where $q_2 = \frac{(1+2\theta+\sigma)^2}{(1+2\theta+\sigma)^2+4\theta^2\sigma} < 1$. Then, $L_{€}^{N} = L_{us}^{N} > L_{€}^{P} = L_{us}^{P}$.

R_{us}^{F0} and R_{us}^{F1} in Figure 1.2 are the schedules along which nominal and real exchange rates are kept fixed in the so called fixed-exchange rate leadership equilibrium.[11] R_{us}^{F0} is the ante-disturbance schedule which passes through the origin and has slope +1, while R_{us}^{F1} is the post-disturbance schedule with slope +1 which passes through $B_{€}$ and B_{us}.

1.4.5 Externalities of the two big Policymakers Game on the small economy.

As explained above, the analytical solution of the whole model can become intractable inasmuch as we have assumed different behavioral frameworks for big and small economies. In order to bypass the problem, we will combine the analytical solution of the symmetric block of *EMU-US* game and a calibration of the entire model after drawing analytical equilibria expressions for *Home*. We will then obtain some figures and simulated values through which insights will be drawn for the small country policymaker, called Home policymaker (HP).

Small Home Loss and big Countries Monetary Policies.

We begin the analysis of the $EMU-US$ game external effects on $Home$ when the latter chooses the floating exchange rate regime as the big countries face a productivity disturbance ($u' > 0, \iota = 0$). After assuming some realistic values for simple parameters of the model, we have computed the complex ones. Moreover, we have derived the

[11] See either Canzoneri and Gray (1985) or Canzoneri and Henderson (1991) for a comprehensive treatment of this concept.

optimal $Home$ money supply as the policymaker minimizes his loss. The following F.O.C

$$\frac{\partial L}{\partial m} = 0$$

implies the optimal money supply

$$m = \frac{1}{\Delta^2 + \Psi^2}\left[\Psi\Theta m_{us} - (\Delta\otimes - \Psi\Xi)m_{€} - (\Psi - \Delta\mho)u' - \left(\frac{\Psi}{\beta\sqrt{\eta}}\right)\iota\right] \tag{1.66}$$

Putting equation 1.66 in equation 1.53 and assuming realistic values for the model parameters and for the productivity disturbance set in Appendix A.3, we obtain the three dimensional mesh figure 1.4 presented in Appendix B. This figure is the representation of $Home$ policymaker loss. The loss is shown as the height while m_{us} and $m_{€}$ are represented respectively on the x and y axes. The transformation of that mesh figure into a countourgraphics turns out to be very helpful. In Figure 1.5 the darker is a zone the less is the related.loss. Moreover in the darkest region, the locus of the least HP loss is the middle. The minimal loss zone lies then in the region that is in the left of the $+1$ value slope straight line.

Unfortunately, it can't be expected that EMU and US policymakers set their money supplies in order to minimize $Home$ loss. We can combine Figure 1.1 and the contourgraphics of the $Home$ policymaker loss (Figure 1.5) to imagine an integrated figure in which the various equilibria of EMU-US game are both represented with the $Home$ policymaker loss. Understanding this figure will be easier if we have in mind the equilibrium values of EMU and US money supplies, i.e., $m_{€}$ and m_{us} presented in Appendix A.3.

When a symmetric shock on the big countries productivity occurs, we see that all equilibria lie on the $+1$ slope straight line while the region of the least loss for $Home$, i.e., the darkest surface can be viewed as a set of straight lines with slope greater than $+1$. Thus, the nearer to the darkest region a point, the least the $Home$ loss at this point. Nash equilibrium (N) is the best outcome for HP because N is nearer to the least loss zone than P. Moreover, the computed losses of $Home$ policymaker in appendix C show that he is better off when EMU and US policymakers choose to be Nash players. The optimal values of $m_{€}$ and m_{us} are computed from equations 1.56 and 1.58.

Conversely, in the asymmetric shock case ($u' = 0$, $\iota' > 0$), the fact is that the cooperative equilibrium allows HP to be better off than when the Nash equilibrium of EMU-US game prevails. To see this, we combine Figure 1.2 with the countourgraphics

version of Figure 1.6, that is, Figure 1.7. Once again, the darker is a zone the less is the loss. The various levels of HP loss are shown as straight lines with a slope value greater than +1. Then, the least loss for HP is northwest located. P is nearer to the darkest zone than N. In this way, HP is better off at P than at N.

Let us turn to the case of fixed exchange rate in *Home*. According to the exchange rate equation 1.46, the fixed exchange rate regime, i.e., $e^e = 0$, implies that:

$$m = \frac{1}{\Delta}(\otimes m_{€} - \mho u'). \tag{1.67}$$

This means, of course, that the HP looses his ability to have a discretionary monetary policy. With the same values of parameters set in the floating case, we get similar graphics of th HP loss, two of which being reported in Appendix C, and numerical solutions. Even in the fixing case, the cooperative (Pareto) game is shown to outperform the Nash equilibrium of the big country game when an asymmetric shock occurs. Conversely, non-cooperative game is better for the small country HP when EMU and US face a symmetric shock. Indeed, combining on the one hand, Figures 1.1 and 1.8 and, on the other, Figures 1.2 and 1.9, lead to the same conclusions than that of the floating case. The computed optimal values of HP loss displayed in Appendix C confirm of the following statement:

Proposition 1 *From a small developing country policymaker point of view, cooperation between EMU and US monetary policymakers could be more beneficial than a non cooperative game only when the big countries face an asymmetric demand shock affecting their bilateral exchange rate. Otherwise, the non cooperative game between the two big economies is better than cooperation.*

The intuition that lies behind these results can be highlighted through equations 1.41 and 1.42. Actually, the cooperative policies conducted by the two big country policymaker aim to internalize externalities of their actions. Equations 1.41 and 1.42 show that both the real and the nominal euro-dollar exchange rates can be affected only by asymmetric shocks. When such a shock occurs, EMU and US have the possibility to internalize the externalities of their monetary policies through a cooperative game choice that induces a lesser variability of euro-dollar exchange rate that enters in small country policymaker wealth through equation 1.48.

Then, whatever exchange rate regime the small country adopts, cooperation between big countries turns out to be more beneficial than non-cooperative game. In fact, euro-dollar stabilization' matter prevails on the impact of other destabilizing ef-

fect of the big country policy impact.

The reduced forms of the model allow to understand why cooperation implies smaller changes of exchange rates. In equation 1.42, one can easily check that, for plausible values of parameters and a significantly important shock value (ι), $\left(\frac{1}{\beta\sqrt{\eta}}\right) > 1 > [\alpha + \xi\gamma(1-\alpha)]$. By equations 1.62 and 1.64, we see that given the asymmetric shock and the initial zero value of money supplies, the greater absolute values of $m_{€}$ and m_{us}, the more euro-dollar exchange rate change is small. This relation holds till the coordinates $(m_{€}, m_{us})$ which indicate the point where the schedule R_{us}^{F1} intersects the -1 slope straight line in Figure 1.2. Remember that R_{us}^{F1} is the post-disturbance representation of loci where exchange rate is kept unchanged. The cooperation equilibrium of the $EMU - US$ game displays greater absolute values of money supplies than the non-cooperative equilibrium. This implies that as the small developing country policymaker is concerned himself with the domestic financial sector stability, greater variability of euro-dollar exchange rate could increase the likelihood of crises occurrence.

1.4.6 Asymmetric Productivity Shocks and Symmetric Demand shocks in the big Economies

For the sake of checking the results obtained above, we first consider the alternative case of asymmetric productivity shock in EMU and US while the demand shock is symmetric in the two countries.

After having solved the two big country game, we have derived a set of reduced form equations shown in Appendix A.2. It has to be noticed that only the asymmetric productivity shock has an impact on most of the equations of interest, i.e, equations A.75 - A.83.

In the case of an asymmetric productivity shock ($u' > 0$ and $\iota' = 0$), we get two possible couples of optimal money supplies. On the one hand, if the parameters are such that $u < 0$, the money supply of EMU policymaker is positive while that of US is negative. The non-cooperative (N) and the cooperative (P) equilibria are therefore located in the Zone 1 of Figure 1.3. On the other hand, if $u > 0$, the money supply of EMU policymaker is positive while that of US is negative, the two equilibria points being located in Zone 2 — see also the equations A.84 and A.85. But, in the two cases, the absolute value of non-cooperative (Nash equilibrium) money supplies are smaller than those of cooperative equilibrium. This implies that P is located either to the northwest (Zone 1) or to the southeast (Zone 2) of N. The realistic values of parameters we set impose the solution located in Zone 2.

Contrary to the preceding case, the occurrence of a symmetric demand shock in the

big countries does not imply any money supply. In fact, when observing the equations A.79 and A.80, we see that money supply will be equal to zero in the two economies because setting $m_{€} = 0$ and $m_{us} = 0$ yields full employment($n_{€} = n_{us} = 0$) and zero CPI inflation ($q_{€} = q_{us} = 0$). This, of course, will lead to zero loss for both big country policymakers. It turns out that the symmetric demand shock works like the absence of shock, implying a zero money supply equilibrium at the point 0 in Figure 1.3, i.e., the origin of the axes.

The solution of the small country model allows to obtain interesting results given the realistic parameters retained and presented in Appendix A.3. When considering the asymmetric productivity shock in the big countries, we obtain that, from the HP point of view, the non-cooperative monetary policy of large economies is better than the cooperative one. Indeed, combining the figure 1.3 on the one hand, and, on the other hand, the figures 1.10 and 1.11 allows to see that the northwest or the southeast a point in Figure 1.3 the greater the loss of the small country policymaker at this point. This means that cooperative monetary game of EMU and US is no more better for small country policymaker. This departs from the results obtained above. The numerical solutions (see Appendix A.3) also confirm this outcome which holds for both the floating exchange rate and the fixed exchange rate regimes in the small economy.

We can easily understand why cooperation ceases to be the best contingency. In fact, one plausible explanation lies in the less significant role of the nominal euro-dollar exchange rate in the variables of interest; inducing a weaker influence in the HP loss. When an asymmetric productivity shock occurs, its impact on the nominal euro-dollar exchange rate is no more totally transmitted in the small country policymaker like in the case of asymmetric shock in demand. Indeed, from the equations A.78 and A.83 we see that $(2\xi\gamma - 1) < 2(\xi\gamma - 1)$. The nominal euro-dollar exchange rate effect could be dampened by the opposite impact of the shock on the domestic nominal exchange rate if $\odot$ turns out to be of different sign from that of $2(\xi\gamma - 1)u'$ (Compare equation A.78 with equation A.81). In fact, as the shock affects many variables in various ways, inducing a complex impact on the small country economy, the cooperation that works through the euro-dollar nominal exchange rate stabilization no more ensures a benefit for the HP. We then suggest the following proposition:

Proposition 2 *From a small developing country policymaker point of view, cooperation between EMU and US monetary policymakers could be less beneficial if the euro-dollar is no more the only channel through which the shock in large economies will be transmitted to the small country economy.*

The symmetric demand shock does not imply any policy conflict between the two big economies. The cooperative game and non-cooperative game money supplies are both equal to zero, entailing that the small country loss is also equal zero. Therefore, the floating and the fixed exchange rate regime equilibria are similar as cooperation and non-cooperation between EMU and US lead to zero loss for *HP*.

1.5 Final Remarks

In this chapter we have dealt with the financial stability challenge that a small developing country policymaker faces in a bipolar international system. We used a three country framework in which two big countries are interacting each other in a monetary policy game. Their game has spillover effects on the small country which in turn has no impact on the two large ones. The situation is a quite realistic approximation of the current international monetary system in which the coming euro is expected to compete with the dollar. Moreover, the small country export earnings are in dollar while the whole import spendings are in euro.

We have drawn the classical result of interdependent macroeconomic literature, i.e, cooperation between two policymakers could be counterproductive for a third one. We have shown that this statement holds even if the third party is a small developing country whose the goal is to preserve the domestic financial sector from disturbances originating from abroad. This is one of our contributions to the existing literature.

Moreover, we have highlighted the fact that, from our typical small country point of view, the likelihood of financial crises could be increased when the big countries policy game induces greater variation of euro-dollar exchange rate. In this case, cooperation between large economies will be beneficial the small country if they are affected by an asymmetric shock only transmitted to the small economy through the euro-dollar exchange rate.

Therefore, developing country policymakers have to be aware of the potential destabilizing effect of euro-dollar exchange rate moves as the "bipolarization" of the international monetary system is expected to become more pronounced.

Appendix A

A.1 Derivation of the Demand of EMU: a Source of Asymmetry

The demand of the three goods is such that $Home$ exports and imports have no impact on EMU economy, while these are very influential in $Home$ economy. Before any simplification, the demand equation of EMU ($d_{€}$) is:

$$\begin{aligned} d_{€} &= \delta(1-\varsigma)z_{€} - \delta\varsigma z + (1-\beta-\varphi)\varepsilon y_{€} + \beta\varepsilon y_{us} + \psi\epsilon y \\ &\quad -(1-\beta-\varphi)\nu r_{€} - \beta\nu r_{us} - \varphi\nu r + \iota' \end{aligned} \tag{A.68}$$

where ς is the weight of $Home$ as trading partner of EMU. One refers to that weight to elaborate the effective real exchange rate of EMU. β and φ, are respectively EMU marginal propensities to import from US — by symmetry, it is also the US propensity to import from EMU — and $Home$. They are both equal to the corresponding average propensities to import.

In order to consider the fact that $Home$ does not have any impact on EMU economy, we assume that $\varsigma \approx 0$, $\varphi \approx 0$ and $\epsilon \approx 0$. It means that the fraction ϵ of output increase by which $Home$ residents increase their spending on EMU goods has no influential effect on EMU economy. It can be approximatively equal to zero like ς because the trade flows toward $Home$ are a very small part of EMU total exports. Finally, φ has the same specification like above. All these assumptions lead to the equation 1.18.

A.2 Model Solution With Asymmetric Productivity Shocks Versus Symmetric Demand Shocks in Large Economies

The robustness of the model results can be checked by considering , unlike the kind of shocks considered above, symmetric demand shocks and asymmetric productivity shocks in large economies. We show here only more relevant equations.

The product equations are now:

$$y_{€} = (1-\alpha)n_{€} + u' \tag{A.69}$$

$$y_{us} = (1-\alpha)n_{us} - u' \tag{A.70}$$

and the demand identities are given by:

$$d_{€} = \delta z_{€} + (1-\beta)\varepsilon y_{€} + \beta\varepsilon y_{us} - (1-\beta)\nu r_{€} - \beta\nu r_{us} - \iota' \quad (A.71)$$

$$d_{us} = -\delta z_{€} + \beta\varepsilon y_{€} + (1-\beta)\varepsilon y_{us} - \beta\nu r_{€} - (1-\beta)\nu r_{us} - \iota' \quad (A.72)$$

Solving the model allows to get reduced form equations of which the most important are:

$$n_{€} = m_{€} \quad (A.73)$$

$$n_{us} = m_{us} \quad (A.74)$$

$$\sqrt{\eta}q_{€} = m_{€} - 2\theta m_{us} + u \quad (A.75)$$

$$\sqrt{\eta}q_{us} = -2\theta m_{€} + m_{us} - u \quad (A.76)$$

$$z_{€} = \xi\gamma(1-\alpha)(m_{€} - m_{us}) - 2\xi\gamma u' \quad (A.77)$$

$$e = [\alpha + \xi\gamma(1-\alpha)](m_{€} - m_{us}) - 2(\xi\gamma - 1)u' \quad (A.78)$$

where $u = \sqrt{\eta}(2\beta\xi\gamma - 1)u' \lesseqgtr 0$ and all other parameters are defined like above. Therefore, the loss functions of the large country policymakers become:

$$L_{€} = \frac{1}{2}[\sigma m_{€}^2 + (m_{€} - 2\theta m_{us} + u)^2], \quad (A.79)$$

$$L_{us} = \frac{1}{2}[\sigma m_{us}^2 + (-2\theta m_{€} + m_{us} - u)^2]. \quad (A.80)$$

Among the small country reduced form equations of interest we have the nominal, the real exchange rate and the current:

$$e^e = \Delta m - \otimes m_{€} + \odot u' \quad (A.81)$$

$$\delta z = (1-\alpha)[1-(1-\psi)\varepsilon]m - \varphi\varepsilon(1-\alpha)m_{€} - \varphi\varepsilon u' \quad (A.82)$$

$$ca = \Psi m + \Xi m_{€} - \Theta m_{us} + (2\xi\gamma - 1)u' \quad (A.83)$$

where $\odot = 1 - \frac{\varphi\varepsilon}{\delta}$. All the other parameters are defined in the model.

When considering an asymmetric productivity shock and solving for the optimal money supplies in large economies, we obtain:

$$m_{€}^N = -m_{us}^N = -\frac{u}{1+2\theta+\sigma} \lesseqgtr 0 \quad (A.84)$$

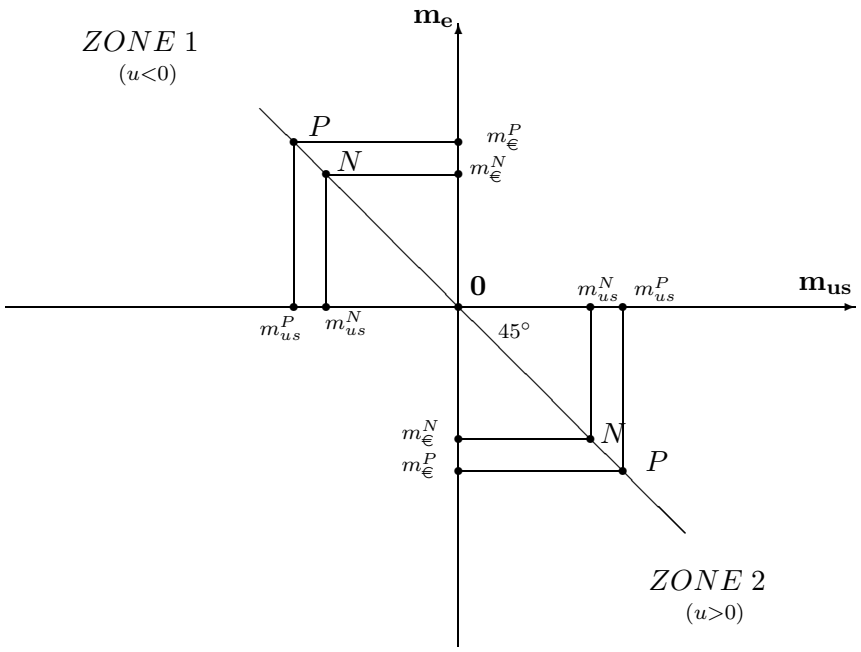

Figure 1.3: Nash and Pareto cooperative equilibria with an asymmetric productivity shock.

$$m_{€}^{P} \quad = \quad -m_{us}^{P} = -\frac{uq_1}{1+2\theta+\sigma} \lesseqgtr 0 \tag{A.85}$$

where $q_1 = \frac{(1+2\theta)(1+2\theta+\sigma)}{(1+2\theta)^2+\sigma} > 1$. $m_{€}^{N}$ ($m_{€}^{P}$) and m_{us}^{N} (m_{us}^{P}) are of respectively positive and negative sign if $u < 0$. Otherwise, $m_{€}^{N} < 0$ ($m_{€}^{P} < 0$) and $m_{us}^{N} > 0$ ($m_{us}^{P} > 0$).

The possible outcomes of this game, when the asymmetric productivity shock occurs, are shown in Figure 1.3.

As explained above, the symmetric shock of demand ($\iota' > 0$) has no effect on the variables of interest and does not affect the policymaker losses. The optimal money supply value is zero in both the Nash and the cooperative games. This implies that the zero loss-equilibrium point be attained.

A.3 Model Calibration and Computation of Equilibria in the Small Country

Calibration values of the model

$$\alpha = 0.4 \quad \psi = 0.4 \quad \vartheta = 1.2$$
$$\beta = 0.2 \quad \delta = 0.1 \quad \nu = 0.2$$
$$\varepsilon = 0.8 \quad \varphi = 0 \quad \sigma = 0.3$$

Computed values in different equilibria

Big country money supplies	***Small country losses***	
	Floating	***Fixed ER regime***
Symmetric productivity shock in $EMU - US$ game		
$m^N_{€} = m^N_{us} = -0.16983$ $m^P_{€} = m^P_{us} = -0.143447$	$L^N = 0.000853524$ $L^P = 0.00129408$	$L^N = 0.00085381$ $L^P = 0.00129457$
Asymmetric shock of demand in $EMU - US$ game		
$m^N_{€} = -m^N_{us} = 0.140371$ $m^P_{€} = -m^P_{us} = 0.147471$	$L^N = 0.767163$ $L^P = 0.743589$	$L^N = 0.767285$ $L^P = 0.743702$
Asymmetric productivity shock in $EMU - US$ game		
$m^N_{€} = -m^N_{us} = -0.03996$ $m^P_{€} = -m^P_{us} = -0.04198$	$L^N = 0.0754929$ $L^P = 0.0776532$	$L^N = 0.0755245$ $L^P = 0.0776857$
Symmetric shock of demand in $EMU - US$ game		
$m^N_{€} = m^N_{us} = 0$ $m^P_{€} = m^P_{us} = 0$	$L^N = 0$ $L^P = 0$	$L^N = 0$ $L^P = 0$

L^j is the loss of small country policymaker when *EMU* and *US* policymakers play a j game, with $j = N, P$ while N and P mean respectively Nash and Pareto.

Appendix B Small Country Loss Figures

B.1 Floating Exchange Rate Regime in Small Country

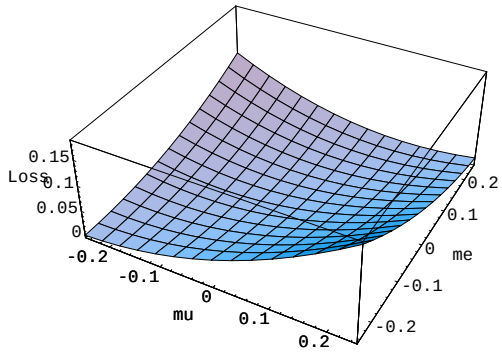

Figure 1.4: Externalities of EMU-US game on a small country loss when a symmetric productivity shock occurs (Meshgraphics).

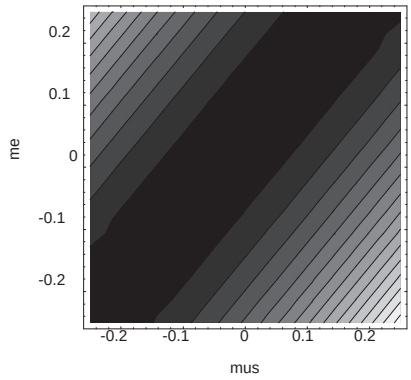

Figure 1.5: Externalities of EMU-US game on a small country loss when a symmetric productivity shock occurs (countourgraphics).

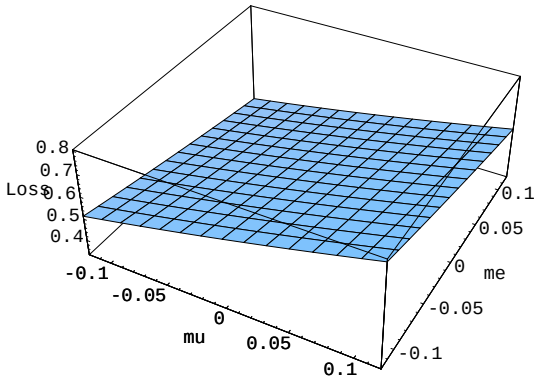

Figure 1.6: Externalities of EMU-US game on a small country loss when an asymmetric demand shock occurs (Mesh graphics)

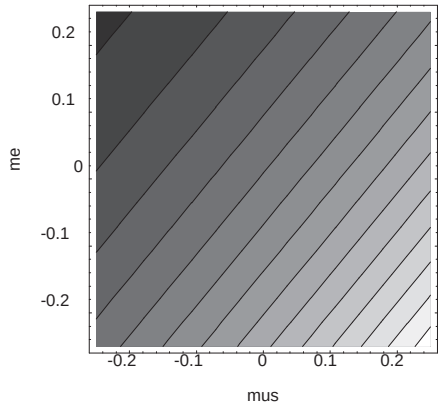

Figure 1.7: Externalities of EMU-US game on a small country loss when an asymmetric demand shock occurs(countourgraphics).

B.2 Fixed Exchange Rate Regime in Small Country

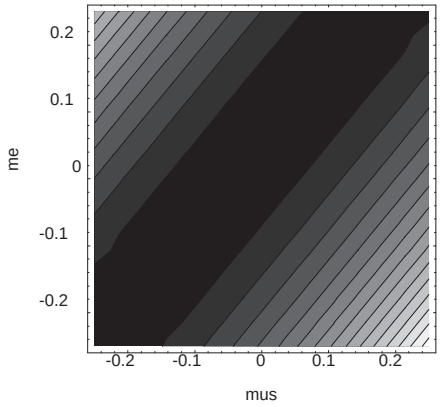

Figure 1.8: Externalities of EMU-US game on a small country loss when a symmetric productivity shock occurs (countourgraphics).

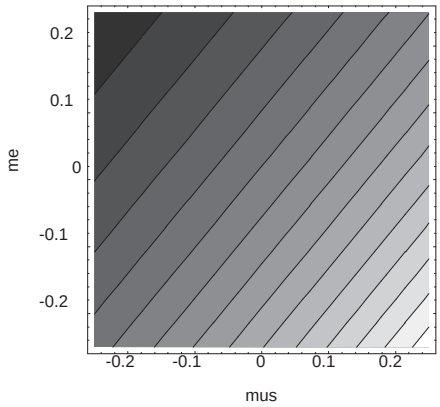

Figure 1.9: Externalities of EMU-US game on a small country loss when an asymmetric demand shock occurs (countourgraphics)

Appendix C Additional Small Country Loss Figures: Asymmetric productivity versus symmetric demand shocks in big economies

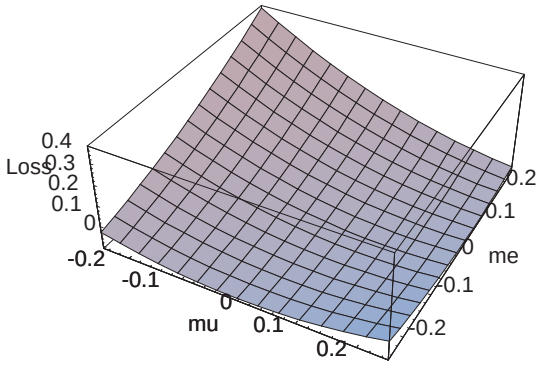

Figure 1.10: Externalities of EMU-US game on a small country loss when an asymmetric productivity shock occurs (Meshgraphics).

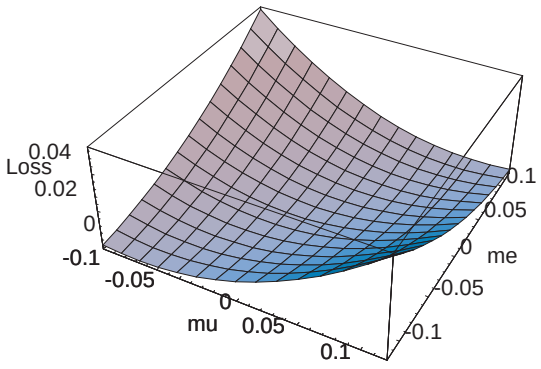

Figure 1.11: Externalities of EMU-US game on a small country loss when a symmetric demand shock occurs (Meshgraphics).