The Financial Accelerator and International Business Cycles under Alternative Monetary Regimes.

Simon Gilchrist
Boston University

Jean-Olivier Hairault
EUREQua, Université Paris-1 Panthéon-Sorbonne.

Hubert Kempf
EUREQua, Université Paris-1 Panthéon-Sorbonne.

Preliminary Version

October 19, 2001

Abstract

In this paper, we study the consequence of the introduction of a financial accelerator in a model of monetary union. We do so by developing a dynamic stochastic general equilibrium macro model of a two country economy, studied under four variants: with or without monetary union, with or without financial accelerator. This enables us to compare the impact of supply shocks, be they global or country-specific, in these four variants. We conclude from this exercise that both the presence of financial frictions and the use of a single currency have significant impacts of the international propagation of exogenous shocks. The introduction of asymmetries in the financial contract widens the differences in cyclical behavior of national economies even though the monetary regime seems not to make a marked difference.

1 Introduction

The impact and desirability of the European Monetary Union is currently the object of much debate both among economists and policy makers. On the theoretical side, the issue is whether the abandonment of exchange rates along with monetary policy autonomy will hamper the possibility to stabilize the economy, given the likeliness of idiosyncratic shocks and the existence of a unique monetary policy authority. On the empirical side, what is disputed are the channels of transmission of real and monetary impulsions throughout the euro zone. How does the existence of a common currency modify these channels? Is it likely to amplify the destabilizing influences of these shocks or to the contrary dampen them, given the modification of the vector of prices (exchange rates disappear) and consequently of the individual optimal decisions? Economists are aware of the differences in transmission channels for exogenous disturbances at least from the days of Keynes. The distinction between impulsions and propagation mechanisms is well honored. The difficulty of course is in devising unambiguous techniques for the assessment of these channels. Indeed, economists use a variety of methods for this purpose, which can deliver different, if not contradictory, results. Eijffinger and de Haan (2000, p.147), summarizing the ongoing debate, conclude that qualitatively, these channels differ widely among countries. The heterogeneity of the euro zone is emphasized. National structures differ within Europe, both because of differences in consumption patterns and of production specialization. Moreover, financial structures are widely divergent in Europe. It is then likely that exogenous shocks will have different impacts in the various member states composing the euro zone.

In this paper, we intend to explore these questions by means of a fully micro-based macromodel emphasizing the role of banks in the international transmission of exogenous disturbances. This is done by means of financial frictions with respect to the external financing of investment. The crucial elements are first the fact that some agents have no other financial opportunities except borrowing from banks, and second the asymmetry existing between lenders and borrowers. Borrowers have more precise information about the true profitability of investment projects and their net worth than possible lenders. That is why banks are useful: they are equipped and able to monitor their potential customers: they then meet borrowing needs with superior information. Their lending behavior reflects this superiority. In so doing they partially overcome the asymmetry in information. However, this comes at the cost of monitoring. When risk-free interest rates, plausibly controlled by the monetary authority, increase a bank faces the prospect of increases in monitoring costs (because of more investment made by risky firms) and therefore have to increase the spread between their lending interest rate and the risk-free interest rate. Of course the variation of the spread depends on the characteristics of the productive firms and their profitability. This represents a transmission channel linked to credit and banks.

Altogether, this leads to two conclusions: economies where the share of investment financed through bank loans is important and economies where the health of the banking system is low are likely to experience more potent effects of monetary policy through these channels.

Evidence concerning the existence of financially based transmission channels is now clear and undisputed, even though the magnitude of these channels is still discussed.[1] Therefore an assessment of the macroeconomic signification of these channels is needed. Several studies have been published on this point. In particular, Bernanke, Gertler and Gilchrist (1999) were the first to embed the informational financial asymmetries in a dynamic general equilibrium macro model so as to answer the question of the importance of financial frictions stemming from informational asymmetries. Calibrating their model on US data, they prove that the financial accelerator (propagating shocks on investment decisions through the lending behavior of financial intermediaries) has a significant impact on the business cycle.

Recent unpublished studies have recently attempted to incorporate the financial accelerator in an international environment. Gertler, Gilchrist and Natalucci (2000) develop a model of the financial accelerator for a small open economy under alternative exchange rate regimes. Faia (2001) sets up a model of a two country world economy with financial frictions and focuses on the positive and normative properties of different exchange rate regimes. Our own focus, in addition to alternative specification choices for our model, is rather on the impact of monetary unification, that is the consequences of having two large economies using the same currency and forming a currency area.

In a world economy with differentiated goods and exchange markets regulating the flows of capital and trade, the international transmission of shocks goes through the exchange rate adjustment. A fully flexible exchange rate is supposed to have insulation properties, and prohibits or at least dampens the external effect of an idiosyncratic shock affecting one country. It may overcome by means of its flexibility the international consequences of national nominal and real rigidities. Introducing financial frictions and wealth considerations implies additional effects of the exchange rate adjustment. In-

[1] For a summary of the empirical investigations on these channels, see Kashyap and Stein (1997).

ternational flows of savings and the exchange rate adjustment lead to the modification of interest rates and real capital valuations, in any financial connected country. Hence this modifies the wealth of investors. Since in a financially imperfect economy, wealth is used as collateral for loans, this generates an adjustment in the conditions of loans (internationally) available to any investor. In other words, the financial accelerator is likely to modify the international propagation mechanisms of disturbances at work in a world economy. The choice of the monetary regime is then crucial for this additional propagation mechanism. In particular, the adoption of a common currency severs the link through the exchange rate. However this does not mean that the financial accelerator is not influencing the international propagation of shocks between countries forming a monetary union. These countries remain financially interdependent, but the adjustment of relative prices becomes more important with the abandonment of the exchange rate mechanism. Hence, this again influences the relative valuation of investors' wealth. It is then important to attempt to assess the relative importance of the financial accelerator in the international propagation of disturbances under alternative monetary regimes, implying a common or several currencies. This is the main objective of the present paper.

The paper is organized as follows. Section 2 presents some stylized facts on financial integration in the euro zone. This leads us to conclude that Europe banks will continue playing a major role in the financing of investment and that financial frictions will be present and seriously alter the impact of decisions made by monetary policy-makers within the European System of Central Banks.

Section 3 presents a model of a two country world economy. This model is consistent with the New Keynesian dynamic aggregate model, built on money holdings and nominal rigidities. It is studied under two different international monetary arrangements. The first one is a system of multiple currencies, autonomous national monetary policies, and flexible exchange rates so as to balance the external flows of currencies. The second one is a monetary union, encompassing both countries, with a common monetary policy and trade flows adjusted through relative prices of goods expressed in the same currency. It is also such that it can be studied with or without financial frictions. These frictions are formally introduced, following the approach pionered by Bernanke, Gertler and Gilchrist (1999). Banks act as financial intermediaries, offering external financing to entrepreneurs. However, information asymmetries induce them to introduce an interest rate spread so as to cover their monitoring costs. Here, the productive sectors are not integrated. Countries are specialized in an extreme way, since each country produces one good only and may be affected by idiosyncratic supply shocks.

We then dispose of four variants of the same world economy: with or without financial frictions, with or without monetary union. These four variants are calibrated and used to explore the impact of various external shocks in the economy. The comparison of these impacts is the core subject of this paper and is developed in Section 4. We investigate the dynamic behaviour of the world economy when financial frictions are present and likely to alter the transmission channels of exogenous disturbances. We are then able to assess the incidence of financial frictions and the monetary regime on the cyclical behaviors of these two interdependent economies by means of comparing the results obtained in the four variants.

We then proceed to a first investigation of the financial fragmentation between countries in a monetary union. This fragmentation leads to different credit arrangements between firms and banks in the two countries and as such, to different transmission channels of the monetary impulsions and/or different responses to supply shocks. Hence we simulate our economy under monetary union with different financial accelerators in the two countries and discuss the results.

Throughout the paper, we assume a neutral (inactive) monetary policy. But clearly, the whole exercise is intended to give us a better understanding of monetary policy in a monetary union: before intervening, it is necessary to have a better view on the propagation mechanisms at work in a common currency area.

Section 5 concludes the paper, summarizing our results and offering new perspectives for future research.

2 Financial integration and banks in the euro zone

The advent of the euro has already had a major impact on Europe's financial markets and this influence is likely to be reinforced in the years to come as non-financial agents will do all their transactions in euro. This last feature will without doubt foster competition among financial intermediaries throughout Europe.

This event came on top of previous decisions which had already shaken upthe financial markets and institutions in Europe. Following the discussion of the Single Market Act, a number of European directives have been issued by the European commission. In particular, the Second Banking Directive set the principles of the "single passport" (a bank recognized in any country of the European Union is able to do business in the whole union) and the "home country control" (the control of any given bank is left to the public authority of its home country). Moreover, the logic of universal banking is recognized as the model for Europe. This perfectly illustrates the principles of European integration: recognizing the initial fragmentation and dissimilarities across Europe, they are used as the building steps for further integration. The tension between fragmentation and integration is at the core of any European venture and financial matters are no exception to this rule.

Looking at broad similarities between the euro zone and the US, based on size, wealth and external trade, many thought that the euro would rapidly become a world currency, on par with the dollar. However, this view did not (yet?) materialize and the euro is not seen as a competitor to the dollar. This is probably due to the differences in the depth and liquidity of financial markets. Several studies have attempted to compare the financial characteristics of the euro zone and the US. The main findings of these studies are summarized as follows:

1. The euro zone relies much more on bank credits than the US or the UK. Banking credit accounts for more than 50% of financial intermediation in the euro zone, much more than in the US (20%) and the UK (32%).[2] A further decomposition shows large dissymmetries among European countries: while banking credits represent 80% of financial intermediation in Ireland, they represent 25% in Denmark, and 39% in Finland.[3]

2. The banking sectors in European countries diverge sharply in many dimensions. Three simple indicators suffice to give a view on this diversity.

    - Concentration in the banking industry varies widely among European countries. Kashyap and Stein (1999) have computed various concentration ratios, standard in concentration studies[4]. While these individual ratios differ and give different information, Kashyap and Stein conclude that :

    "*In Belgium, Netherlands and the UK, the large banks appear to hold a dominant position. Conversely, Italy, Germany, and Luxembourg*

[2]See Hurst, Perée and Fischbach (1999), Table 1, p.86.
[3]See Cecchetti (1999), Table 4, p.16.
[4]See Kashyap and Stein (1999), Table 2, p.10.

stand out as countries in which the smaller banks control a significant fraction of the assets. The limitation of the data preclude drawing any sharp distinctions among the remaining countries." (Kashyap and Stein, 1999, p.10).

On the whole, the dissimilarities as captured by concentration ratios between national banking sectors in Europe cannot be denied.

- Another crucial variable illustrating the dissymmetries among European bank is profitability. In the same study, Kashyap and Stein provide us with various measures of profitability[5]. Again, they conclude that European countries:

"*tend to fall into three fairly distinct groups. The evidence for the first group, Netherlands, Luxembourg, and the UK, suggests that the banks are in good shape ... In the case of the second group, France and Italy, the numbers consistently show that the banking sectors are relatively weak, with high levels of bad loans and low profit rate.... The third group, comprising all remaining countries, falls somewhere in between."* (Kashyap and Stein, 1999, p. 11)

- This difference in profitability is probably to be related to differences in efficiency. It is true that banks' operating costs appear to be lower in the Euro zone than in the US or UK, but the relative costs are higher than for their American and British counterparts? Worse, they escalated since 1993, while the reverse is true for the US and the UK. Staff costs are also relatively higher in the euro zone[6].
- This fragmentation along national lines is reinforced by the supervisory system existing in the euro zone. Basically, national regulatory authorities, which may or may not be the national Central Bank retain their control over national financial agents. It is based on the separation between monetary and regulatory authority. The lender-of-last-resort capacity too is left at the national level, with the possibility for the European central bank to intervene actively so as to preclude the failure of a bank. The assessment of such a system is beyond the scope of the present paper.[7] But it is clear that it reinforces the "centrifugal" aspect of the banking and financial sector in Europe.

[5]See Kashyap and Stein (1999), Table 3, p.12.

[6]See Hurst, Perée and Fischbach (1999), Figure 6, p.91.

[7]see Favero et al., (2000) for a thorough discussion of this system.

3. Capital markets are still fragmented (Gros et Lannoo, 1999). However, the risk-free financial markets seem to have converge to the point where it is now possible to talk about a unique risk-free market. A proper index of this is the yields curves on public bonds at various maturity. Galati and Tsatsaronis (2001) refer to the bond market as "the success story" of the euro. Indeed the yield curves appear to have converged, with yield spreads below 30 basis points. This implies that banks throughout Europe face almost identical conditions for refinancing[8].

Two broad conclusions emerge from these stylized facts. The euro zone is structurally characterized by two important features with respect to the financing of investment:

1. the predominance of bank credits, relative to securities;
2. the importance of asymmetries between countries' banking and finance industries and markets. This is widely seen as a major cause of asymmetries in transmission mechanisms of monetary policy. Cecchetti perfectly expresses this concern when he writes:

   > *In this paper, I have suggested that differences in financial structures are a proximate cause for these national asymmetries in the monetary policy transmission mechanism... The countries of the EU differ quite dramatically, in all of the dimensions that would seem to matter, leading to the prediction that the impact of interest rates on output and prices will not be consistent across countries. While the estimates of the impact of interest rate changes on output and inflation tend to be quite imprecise, they do differ, and in the way that is predicted by the state of the countries' financial systems.* (Cecchetti, 1999, p.22).

In this perspective, the creation of the European Monetary Union creates a major problem. Before the advent of the euro, the differences in monetary policy impulses and transmission channels were mitigated by the adjustment through exchange rates. Hence national monetary policies could be independent (more or less so given the exchange rates regimes put in place). After the euro, there is a unique monetary policy, in terms of a unique impulsion

[8]See Galati and Tsatsaronis (2001), Graph 3.2, p.7.

controlled by the European (System of) Central Bank(s). But this unique impulsion will logically have different consequences in the various member countries, since their transmission channels will differ given the differences in their financing structure. This may create unexpected results, maybe perverse effects, jeopardizing the benefits of de facto coordination coming from the existence of a unique monetary authority.

Therefore we think that it is worthwhile to pursue a theoretical analysis of the role of monetary policy in a monetary union by means of a model based on the following assumptions, which broadly correspond to the stylized facts we have just summarized.

- perfect mobility of savings,
- banks acting as the financial intermediaries for the external financing of investment,
- with informational asymmetries between lenders and borrowers, generating a spread between the risk-free and the lending interest rates.

3 A New International Macroeconomics Model with a Financial Accelerator

We set up a general model of a world economy and supplement it with various and incompatible assumptions regarding the nature of the world's monetary "order" and the role of financial intermediaries. The model is a dynamic stochastic general equilibrium model characteristic of the New Neoclassical Synthesis. As such, it generates business cycle features when the economy responds to exogenous shocks.

Regarding the international monetary order, we oppose two polar cases:

1. There may be multiple currencies, and the exchange of currencies is made on an exchange market, cleared by means of a perfectly flexible exchange rate. Then each country retains its full monetary sovereignty. Since we are for the present time only interested in the comparison of the responses to an exogenous shock, due to various structural differences, we shall not discuss the role of monetary policy.
2. There may exist a unique currency circulating in the world economy and making it a monetary union. Again we do not discuss the role and the impact of the common monetary policy being put in place by the policymaker.

Regarding the financing of investment, we study two opposite cases:

1. There is no asymmetric information about the lender's position. Therefore there is no need for a financial intermediary able to screen the various investment projects and monitor the borrowers when needed. Hence, it is as if investing firms are able to directly tap the world savings pool and the expected rate of return on risky investment is equal to the risk-free interest rate.

2. There is asymmetric information about the risks assumed by any lender and financial intermediaries are needed and assume the risk that private savers are unwilling to bear. Since financial intermediaries or "banks" need to cover their agency costs, this introduces a wedge, or an external finance premium between the risk-free interest rate and the interest rate charged to investors. This premium varies inversely with the borrowers' net worth. Hence any external shock which diminishes this worth increases the premium. This depresses investment and increases the downturn of the economy.

Altogether, we are able to study four variants of the world economy: with or without monetary union, with or without financial accelerator.

3.1 The Core Model

The core model corresponds to a two-country monetary economy under a flexible exchange rate regime. Importantly given the plurality of currencies, it is necessary to convert all the prices in the same currency unit. We choose to use the domestic currency, which implies to introduce the nominal exchange rate, e, in the foreign representative household program. The real value of any price will then be expressed in the domestic composite good using the real exchange rate Γ for the foreign country real aggregates. Both countries are similar in size and structure. There is a continuum of agents of equal measure in each country. Labor is immobile. Each country is specialized in the production of one good but consumers in any country want to consume both goods. As a consequence, there is trade across countries. Households have access to a complete set of contingent assets. As a consequence, there is perfect risk sharing as far as consumers are concerned and saving flows are perfectly mobile between the two countries. There is imperfect competition on the good markets, allowing to introduce nominal rigidities due to price contracts *à la Calvo*.

Then we first present the model when the financial accelerator problem is absent and with flexible exchange rates. Later we shall develop on the various modifications entailed by the introduction of the financial accelerator and the existence of a common currency.

3.1.1 Households:

The representative infinitely-lived household in each country participates to the trade on the labor market: L is the quantity of time devoted to leisure; then $1 - L = H$ is equal to the working period remunerated at a rate of w which will expressed in terms of the good produced locally. She consumes a composite good C including the two goods indexed by 1 for the good produced in the domestic country and by 2 for the good produced in the foreign country[9].

$$C = \frac{C_1^{\gamma} C_2^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{\gamma}} \tag{1}$$

Similarly the composite good for the foreign consumers is defined as:

$$C^* = \frac{C_1^{*1-\gamma} C_2^{*\gamma}}{\gamma^{\gamma}(1-\gamma)^{\gamma}}$$

with $\gamma \in [0, 1]$. We can define a price index in each country:

$$P = P_1^{\gamma} P_2^{1-\gamma}$$

and for the foreign country

$$P^* = P_1^{*1-\gamma} P_2^{*\gamma}$$

with P_i (P_i^*) the price of the good i expressed in the home (foreign) currency. We assume throughout the paper that the law of one price holds. Heterogeneity can arise among households according their international location due to the existence of asymmetrical shocks. $\mathcal{A}$ is a multivariate stochastic variable, denoting the state of nature, with a density function $f(\mathcal{A})$. We assume that households have access to contingent international claims $\mathcal{B}$ at prices v, implying perfect international risk sharing. In order to price the real interest rate R and the nominal one R^n in each country we assume the

[9]The foreign country variables will be denoted by a $\star$.

existence of non-contingent real B and nominal B^n claims traded in local financial markets[10]. The instantaneous utility U depends on three arguments: consumption, real balances and leisure. The utility function is assumed to be of the form:

$$U(C_t, \frac{M_{t-1}}{P_t}, L_t) = \frac{C_t^{\xi}\left(\frac{M_{t-1}}{P_t}\right)^{1-\xi}}{\xi^{\xi}(1-\xi)^{1-\xi}} + v(L) \quad \text{with} \quad v(L) = \theta_H \frac{L^{1-\sigma}}{1-\sigma} \quad \text{and} \quad \xi, \sigma > 0, \theta_H > 0.$$

$\frac{M_{t-1}}{P_t}$ is the present real value of the money stock transferred from the previous period. The domestic country representative household is assumed to maximize the expected discounted sum of its utility flows:

$$W^H(\mathcal{B}_{t-1}, B_{t-1}, B_{t-1}^n, M_{t-1}) = \max\left\{U\left(C_t, \frac{M_{t-1}}{P_t}, 1-H_t\right) + \beta\int W^H(\mathcal{B}_t, B_t, B_t^n, M_t) f(\mathcal{A}) d\mathcal{A}\right\}$$

subject to the following constraint:

$$P_t C_t + P_t \int v_t \mathcal{B}_t d\mathcal{A} + P_t B_t + B_t^n + M_t \leq P_t \mathcal{B}_{t-1} + P_t R_{t-1} B_{t-1} + R_{t-1}^n B_{t-1}^n + M_{t-1} + P_t w_t H_t + \tau_t$$

that we may write in terms of domestic composite good units:

$$C_t + \int v_t \mathcal{B}_t d\mathcal{A} + B_t + \frac{B_t^n}{P_t} + \frac{M_t}{P_t} \leq \mathcal{B}_{t-1} + R_{t-1} B_{t-1} + \frac{R_{t-1}^n}{P_t} B_{t-1}^n + \frac{M_{t-1}}{P_t} + w_t N_t + \frac{\tau_t}{P_t} \qquad (\lambda_t)$$

with τ the total lump-sum transfers received by the domestic households from the monopolistic firms and from the central bank. The first-order conditions for the domestic households are (respectively the leisure, consumption, money, real bond, nominal bond and contingent bonds demands):

$$\theta v'(1-H_t) = \lambda_t W_t$$

$$u'_{C_t} = \lambda_t$$

$$\beta E_t\left(u'_{m_t} + \frac{\lambda_{t+1}}{\pi_{t+1}}\right) = \lambda_t$$

with $m_t = \frac{M_t}{P_t}$ the domestic money stock in terms of domestic composite good and π the CPI inflation rate.

$$\beta E_t\left(\frac{\lambda_{t+1} R_t}{\lambda_t}\right) = 1 \qquad (2)$$

[10] We are conscious that these claims are redundant given the existence of contingent claims. At the equilibrium, the different interest rates are related each other by some non-arbitrage conditions, namely non-covered interest parity and Fisher formula.

$$\beta E_t\left(\frac{\lambda_{t+1}R_t^n}{\pi_{t+1}\lambda_t}\right) = 1 \tag{3}$$

$$\beta\frac{\lambda_{t+1}}{\lambda_t}f(\mathcal{A}) = v_t \tag{4}$$

The country 2 representative households is assumed to maximize the expected discounted sum of its utility flows:

$$W^{H*}(\mathcal{B}^*_{t-1}, B^*_{t-1}, B^{n*}_{t-1}, M^*_{t-1}) = \max\left\{U\left(C^*_t, \frac{M^*_{t-1}}{P^*_t}, 1-H_t\right) + \beta\int W^{H*}(\mathcal{B}^*{}_t, B^*_t, B^{n*}_t, M^*_t)f(\mathcal{A})\lceil\mathcal{A}\right\}$$

subject to the following constraint (with e the nominal exchange rate):

$$e_tP^*_tC^*_t + P_t\int v_t\mathcal{B}^*{}_t d\mathcal{A} + e_tP^*_tB^*_t + e_tB^{n\prime*} + e_tM^*_t$$
$$\leq P_t\mathcal{B}^*{}_{t-1} + e_tP^*_tR^*_{t-1}B^*_{t-1} + e_tR^{n*}_{t-1}B^{n*}_{t-1} + e_tM^*_{t-1} + e_tP^*_tw^*_tH^*_t + e_t\tau^*$$

that we may write in terms of domestic composite good units:

$$\Gamma_tC^*_t + \int v_t\mathcal{B}^*{}_t d\mathcal{A} + \Gamma_tB^*_t + \frac{e_t}{P_t}B^{n*}_t + \frac{e_t}{P_t}M^*_t$$
$$\leq \mathcal{B}^*{}_{t-1} + \Gamma_tR^*_{t-1}B^*_{t-1} + \frac{R^{n*}_{t-1}e_t}{P_t}B^{n*}_{t-1} + \frac{e_t}{P_t}M^*_{t-1} + \Gamma_tw^*_tH^*_t + \frac{e_t}{P_t}\tau^* \quad (\lambda^*_t)$$

with Γ the real exchange rate: $\Gamma = \frac{eP^*}{P}$. Then, the foreign households first-order conditions are:

$$\theta v'(1-H^*_t) = \lambda^*_tW^*_t\Gamma_t$$

$$u'_{C^*_t} = \lambda^*_t\Gamma_t$$

$$\beta E_t\left(u'_{m^*_t} + \frac{\lambda_{t+1}}{\pi_{t+1}}\Delta e_{t+1}\right) = \lambda_t$$

with $m^*_t = \frac{M^*_te_t}{P_t}$ the foreign money stock in terms of domestic composite good.

$$\beta E_t\left(R^*_t\frac{\Gamma_{t+1}\lambda^*_{t+1}}{\Gamma_t\lambda^*_t}\right) = 1 \tag{5}$$

$$\beta E_t\left(R^{n*}_t\frac{\Gamma_{t+1}\lambda^*_{t+1}}{\Gamma_t\lambda^*_t\pi^*_{t+1}}\right) = 1 \tag{6}$$

$$\beta \frac{\lambda^*_{t+1}}{\lambda^*_t} f(\mathcal{A}) = v_t \tag{7}$$

From the equations (2), (3), (5) and (6) derived from the real and nominal bonds demands we can deduce the Fisher formula:

$$R^n_t = R_t E_t \pi_{t+1} \tag{8}$$

$$R^{n*}_t = R^*_t E_t \pi^*_{t+1} \tag{9}$$

From the equations (4) and (7) derived from the contingent claims demand, we can deduce the risk sharing condition:

$$\frac{\lambda_{t+1}}{\lambda_t} = \frac{\lambda^*_{t+1}}{\lambda^*_t}$$

Considering this last equation and the equations (2) and (5), we get implicitly the non-covered interest rate parity which expresses in a more traditional way the fact that international arbitrage is allowed through access to contingent claims.

3.1.2 Production

The entrepreneurs in both countries produce imperfectly substitutable goods with capital and labor. In both countries, fluctuations arise from persistent shocks to aggregate productivity. Each country specializes in the production of a single good. More particularly, national entrepreneurs produce wholesale goods in competitive markets and then sell their output to national retailers who are monopolistic competitors. The latter only differentiate the wholesale goods at no ressource cost and sell them to households. Given that the retailers are price-setters, this allows us to introduce nominal rigidities. To assume that the entrepreneurs are monopolistically competitive would complicate the analysis of the financial contract when we will later take into account financial imperfections. For comparison motivations, we introduce this structure in the model without financial accelerator.

Retail sectors: The retail goods form the national composite aggregate that are converted into consumption and investment goods, and whose price index defines the aggregate price level P_1 and P^*_2. Profits from retail activity are rebated lump-sum to households. We model nominal rigidities by means of the Calvo assumption: a given retailer is free to change his price in a given period only with probability $1-\zeta$ (Calvo (1983)). The retailer price decisions lead to the "new Phillips curve" expression.

$$\pi_{1t} = -\kappa\mu_t + \beta E_t\{\pi_{1,t+1}\} \tag{10}$$

where

$$\pi_{1t} = \log(P_{1t}/P_{1,t-1})$$

knowing that

$$P_{1,t} = \mu_t P_{1,t}^w$$

with μ the mark-up and $P_{1,t}^w$ the price of the wholesale good produced in the domestic country. We get, as it is usual in Calvo type price contract, that $\kappa = \frac{(1-\zeta)(1-\zeta\beta)}{\zeta}$.

The foreign condition is analogous:

$$\pi_{2t} = -\kappa\mu_t^* + \beta E_t\{\pi_{2,t+1}\} \tag{11}$$

where

$$\pi_{2t} = \log(P_{2t}/P_{2,t-1})$$

and

$$P_{2,t} = \mu_t^* P_{2,t}^w$$

with $P_{2,t}^w$ the price of the wholesale good produced in the foreign country.

Entrepreneurs: The wholesale goods are produced by the entrepreneurs by combining physical capital and labor with a constant return to scale technology.

$$Y_t = a_t K_{t-1}^{\alpha} H_t^{1-\alpha} \tag{12}$$

a_t is a stochastic variable following a first auto-regressive process. This is the only source of aggregate disturbances in the model. We assume that investment in each country is an index of the two goods 1 and 2 with the same structure than the consumption one (equations (1) and 2). Capital evolves according to the following dynamic equation:

$$K_t = (1-\delta)K_{t-1} + I_t \tag{13}$$

We assume there are capital adjustment costs Φ_t, given by the following equation:

$$\Phi_t = \frac{\phi}{2}\frac{(K_t - K_{t-1})^2}{K_{t-1}} \tag{14}$$

The representative firm maximizes its expected discounted sum of profit flows:

$$W^F(K_{t-1}) = \max\left(\frac{P^w_{1,t}}{P_t}Y_{1,t} - \Phi_t - I_t - w_t H_t + \int v_t W^F(K_t) d\mathcal{A}\right)$$

subject to the following constraint:

$$K_{t+1} = (1-\delta)K_t + I_t \qquad (q_t)$$

The labor and investment domestic demands derive from the following first-order conditions:

$$\mu_t W_t = (1-\alpha)Z_t^{1-\gamma}\frac{Y_t}{H_t}$$

with $Z = \frac{P_1}{P_2}$ the terms of trade.

$$q_t = 1 + \Phi'_I \tag{15}$$

$$1 = \beta E_t\left(\frac{\lambda_{t+1}}{\lambda_t}R^K_{t+1}\right) \tag{16}$$

with R^K_t the return of capital expressed in term of domestic composite good:

$$R^K_t = \frac{\left(\frac{\alpha Z_t^{1-\gamma}}{\mu_t}\frac{Y_t}{K_{t-1}} - \delta + q_t\right)}{q_{t-1}} \tag{17}$$

The program of each firm in country 2 is analogous and it maximizes its expected discounted sum of profit flows:

$$W^{F*}(K^*_{t-1}) = \max\left(\frac{P^w_{2,t}}{P^*_t}\Gamma_t Y_{2,t} - \Gamma_t(\Phi^*_t + w^*_t H^*_t + I^*_t) + \int v_t W^{F*}(K^*_t) d\mathcal{A}\right)$$

subject to the following constraint:

$$K_t = (1-\delta)K_{t-1} + I_t \qquad (q_t)$$

The first-order conditions are:

$$\begin{aligned}
\mu_t^* W_t^* &= (1-\alpha) Z_t^{\gamma-1} \frac{Y_t^*}{H_t^*} \\
q_t^* &= (1+\Phi'_{I^*})\Gamma_t \\
1 &= \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t} R_{t+1}^{K*} \right) && (18)
\end{aligned}$$

with R_t^{K*} the return of foreign physical capital expressed in the domestic composite good:

$$R_t^{K*} = \frac{\left(\frac{\alpha Z_t^{\gamma-1}}{\mu_t^*} \frac{Y_t^*}{K_{t-1}^*} \Gamma_t + q_t^* - \delta \Gamma_t \right)}{q_{t-1}^*} \tag{19}$$

Considering the equations (4), (7), (16) and (18), it must be underlined that the expected return of physical capital are equalized both to the pricing kernel. They are then equal to the risk-free interest rates.

3.1.3 The money supply

Since we do not tackle in this paper with the monetary policy debate, we consider that the money supply (expressed in real terms) follows an exogenous process:

$$m_t = g \frac{m_{t-1}}{\pi_t}$$

and

$$m_t^* = g \frac{m_{t-1}^* \Delta e_t}{\pi_t}$$

We assume that the monetary authorities inject money at the same steady rate g. They are concerned by the stability of inflation in the long run without being involved in business cycles stabilization.

3.2 Introducting a financial accelerator

In the core model, the Modigliani-Miller theorem holds: financial structure is both indeterminate and irrelevant to real economic outcomes. However, when credit markets are characterized by asymmetric information and agency problems, the Modigliani-Miller irrelevance theorem no longer applies. A convenient way to formalize these frictions is by introducing a financial accelerator as in Bernanke, Gertler and Gilchrist (1999). The key mechanism involves the negative link between external finance premium s (the difference between the cost of funds raised externally and the opportunity cost of funds internal to the firm) and the net worth of borrowers N (defined as the liquid assets plus collateral value of illiquid assets less outstanding obligations). This inverse relationship arises because, when borrowers have little wealth to contribute to project financing, the potential divergence of interests between the borrowers and the lenders is greater, implying increased agency costs; in equilibrium, lenders must be compensated for higher agency costs by a large premium. To the extent that borrowers' net worth is procyclical through the behavior of profits and asset prices, enhancing the swings in borrowing and thus in investment, spending and production. The existence of this external finance premium is due to a costly state verification problem first analysed by Townsend (1979) and incorporated in a macro style model by Bernanke, Gertler and Gilchrist (1999).

The role of entrepreneurs is reinforced in the model. The return of capital (equations (17) and (19)) is sensitive to both aggregate and idiosyncratic risk. There is now an idiosyncratic disturbance ω which is i.i.d. across time and across firms[11]. Lenders must pay a fixed auditing cost if they want to observe an individual entrepreneur' realized return. As it can be shown (Townsend (1979)), in this environment, uncollateralized external finance is more expansive than internal finance. Entrepreneurs are assumed to be risk-neutral, so that they bear all the aggregate risk, and have finite horizons. Each one has a constant probability η of surviving to the next period. This assumption has the merit to preclude the possibility that they accumulate enough wealth to be fully self-financing: the entrepreneurs who die consume a fraction $1-\nu$ of their accumulated resources and depart from the scene. Since we assume a worldwide pool of savings from non financial agents, we de facto are making a very important assumption. All banks have the same access to the same supply of financial resources. This corresponds to a full financial integration of the world economy.

The equations (16) and (18) no longer hold since the return on risk-free bonds are no longer equalized to the capital return. There is now a risk premium s due to the existence of monitoring costs which depends on the

[11] See Bernanke, Gertler and Gilchrist (1999) for a precise presentation of the properties of this stochastic variable and for the derivation of the optimal financial contract.

leverage ratio:

$$E_t R^K_{t+1} = s_t R_t$$

$$E_t R^{K*}_{t+1} = s^*_t R^*_t \frac{\Gamma_{t+1}}{\Gamma_t}$$

The external finance premium is negatively related to the share of the capital investment that is financed by entrepreneur's own net worth:

$$s_t = S\left(\frac{q_t K_t}{N_t}\right)$$

$$s^*_t = S\left(\frac{q^*_t K^*_t}{N^*_t}\right)$$

It can be shown that the function S is strictly increasing (Bernanke, Gertler and Gilchrist (1999)). The entrepreneurial net worth reflects the equity stake that entrepreneurs have in their firm, V, and a transfer D from the dead entrepreneurs.

$$N_t = \eta V_t + (1-\eta) D_t$$

$$N^*_t = \eta V^*_t + (1-\eta) D^*_t$$

with

$$V_t = R^K_t q_{t-1} K_{t-1} - E_{t-1} R^K_t \left(q_{t-1} K_{t-1} - N_{t-1}\right)$$

$$V^*_t = R^{K*}_t q^*_{t-1} K^*_{t-1} - E_{t-1}\left(R^{K*}_t \frac{\Gamma_t}{\Gamma_{t-1}}\right)\left(q^*_{t-1} K^*_{t-1} - N^*_{t-1}\right)$$

The entrepreneurial equity equals gross earnings on holdings of equity from $t-1$ to t less repayment of borrowing. As the entrepreneurs are risk neutral, they bear all the aggregate risk.

3.3 Moving to a monetary union

Until now the whole model has been developed under the assumption of flexible exchange rate regime. As the monetary union case will be considered too, we present here the main discrepancies to the flexible exchange rate case. Only the household behaviors are modified as there is now only one currency and one central bank which exogenously inject money M^u at a steady rate g^u. The prices of the goods i, P_i, are denominated in the common currency.

The domestic country representative household program is identical to the one developed for the flexible exchange rate economy, while the foreign country representative household budgetary constraint is different, since it is no longer necessary to convert foreign nominal variables by the use of the nominal exchange rate:

$$P_t^* C_t^* + P_t \int v_t \mathcal{B}_t^* d\mathcal{A} + P_t^* B_t^* + B^{n_t *} + M_t^* \leq P_t \mathcal{B}_{t-1}^* + P_t^* R_{t-1}^* B_{t-1}^* + R_{t-1}^{n*} B_{t-1}^{n*} + M_{t-1}^* + P_t^* w_t^* H_t^* + \tau^*$$

that we may write in terms of domestic composite good units:

$$\Gamma_t C_t^* + \int v_t \mathcal{B}_t^* d\mathcal{A} + \Gamma_t B_t^* + \frac{1}{P_t} B_t^{n*} + \frac{1}{P_t} M_t^* \leq \mathcal{B}_{t-1}^* + \Gamma_t R_{t-1}^* B_{t-1}^* + \frac{R_{t-1}^n}{P_t} B_{t-1}^{n*} + \frac{1}{P_t} M_{t-1}^* + \Gamma_t w_t^* H_t^* + \frac{1}{P_t} \tau^*$$

with Γ is always what we can call the real exchange rate: $\Gamma = \frac{P^*}{P}$. The equation (5) is modified in the following way:

$$\beta E_t \left(u'_{m_t^*} + \frac{\lambda_{t+1}}{\pi_{t+1}} \right) = \lambda_t$$

with $m^* = \frac{M^*}{P}$. The pricing of the nominal interest rate becomes:

$$\beta E_t \left(R_t^{n*} \frac{\lambda_{t+1}^*}{\lambda_t^* \pi_{t+1}} \right) = 1$$

We can then deduce the equality of the nominal interest rates: $R_t^{n*} = R_t^n$. We still have both the fisherian equations.

4 The Role of the Financial Accelerator in the International Propagation of Shocks

In this section, we report the results obtained by simulating and then comparing the dynamics generated by the four variants of our general model. We denote "NMK" the curves relative to the new macro-keynesian model without financial accelerator, while the version incorporating this last dimension corresponds to the curve "AF". We shall concentrate on the impact of an exogenous real disturbance occuring in the domestic country, that is a shock on a_t. This is the most obvious case as this disturbance is obviously independent from the monetary regime.[12]

We first assume perfect structural symmetry between the two economies and asymmetric disturbances. Secondly we revert this and study the impact of structural asymmetry (in financial frictions) when disturbances are symmetric between the two countries. But previously we must calibrate the model.

4.1 Calibration

The procedure for calibrating is traditional: we choose share parameters for preferences and production such that means of ratios of aggregate times series are equal to analogous ratios for the theoretical economy's steady state. For numerous parameters, we use the same calibration than in Bernanke, Gertler and Gilchrist (1999). We adopt a symmetrical calibration between the two countries.

First we choose standard values for the taste and technology parameters. The depreciation rate δ is set at 0.025. α which corresponds to the labor share of output is calibrated in order to replicate a labor share of 64%. ϕ, the adjustment cost parameter, is calibrated in order to get an elasticity of the price of capital with respect to the investment capital ratio equal to 0.25. The discount factor is fixed at 0.99 and the auto-regressive coefficient ρ_A of the supply shock will be equal to 0.95. The value of γ allows to replicate the 15% stationary ratio of imports to GDP. σ is set such that the individual labor supply elasticity is in the range of the values reported by MaCurdy (1981). We choose a value of 0.95 for ξ in order to get a money velocity value of 3.

The non-standard parameters concern the financial dimension of the model and the nominal rigidities. Following Bernanke, Gertler and Gilchrist (1999), we choose parameters (death rate of entrepreneurs, variance of the idiosyncratic productivity shock and the scale of monitoring costs) in order to get

[12] We could also study demand shocks, by means of introducing public expenditures, or by assuming that the taste parameter is stochastic. This is for the present time, outside the scope of the paper, even though these extensions are natural and easily introduced in the model. On the contrary, a monetary shock on the supply side of the money market is affected by the monetary regime and cannot be the proper vehicle for comparisons.

the following stationary values: a value of 2 for the ratio of capital to net worth, an external finance premium of two hundred basis points and an annualized failure rate of three percent. Finally the probability ζ a retailer does not change its price is fixed at 0.75.

4.2 The financial accelerator with asymmetrical shocks

4.2.1 The case with flexible exchange rates

Let us first look at the impact of a positive disturbance on a_t in the flexible exchange rate regime. Two effects are at work.

1. Marginal productivity increases for both factors. As a consequence demands from firms for capital and labour increase and therefore their price in the domestic country. The use of labour and investment jump before slowly reverting to their long term level (fig. 2). The immediate increase in the marginal value of capital q_t (fig. 4) increases the entrepreneurs' wealth. Because of that, the financial accelerator is able to amplify this dynamics. The external finance premium decreases (fig. 5). The presence of the financial accelerator adds to the upsurge in investment (see fig. 2 where the star-line is well above the continuous line, corresponding to the model without the financial accelerator): investment increase is more than twice what it is without financial accelerator. Altogether output increase is larger with the presence of the financial accelerator (fig. 1).

2. The usual absorption channel contributes to the spreading of these effects to the foreign country. The demand for the foreign good is increased by the domestic expansion, which triggers an increase in foreign output (see fig. 1). Then the presence of the financial accelerator modifies the dynamics of the foreign country's variables. Since foreign investment is increased, the value of foreign capital is increased; this diminishes the external finance premium for the foreign firms and the financial accelerator acts in the foreign country as well. Interestingly, the presence of financial frictions clearly amplify this international transmission effect. Without financial accelerator, the lagged foreign output response is negligible, whereas the presence of this accelerator generates much persistence in foreign output. But a second effect is at work, through the exchange rate and of terms of trade. This effect is clearly international in nature and alters the respective dynamics of

both economies. The asymmetric increase in domestic marginal productivities induces a decrease in the terms of trade Z, which is beneficial to the domestic country and detrimental to the foreign country. But it feeds a future decrease in the real exchange rate Γ (fig. 3). This channel depresses domestic investment, or counter balance the first effect. It has the reverse effect on the foreign country. The presence of the financial accelerator dampens this channel, since the move in the terms of trade is smaller with financial accelerator making the expected depreciation in the real exchange rate less volatile. This comes from the fact that the price of the domestic good decreases more with the financial accelerator.

However, quantitatively, this second effect tends to be small, with or without financial accelerator: the initial variation in terms of trade is less than 1% without financial frictions. This is due to the adjustment of the nominal exchange rate e (see fig. 3). It immediately jumps down in any case, and (rather rapidly) appreciates and returns to its long run value. Hence this immediate depreciation (corresponding to an appreciation of the domestic currency) limits the downturn of the terms of trade, since it depresses the price of the foreign good expressed in domestic currency.

4.2.2 The case with a monetary union

What are the consequences of forming a monetary union between the two countries? In particular, how the influence of the financial accelerator is altered when both countries share the same currency?

The responses to the real disturbances with and without financial accelerator in a monetary union are given in figures 6 - 10. A clear asymmetry between the two countries is apparent in both cases: whereas the dynamics for the domestic aggregate variable are marginally modified only, when compared to the multiple currency case, the dynamics for the foreign country are strikingly different. In other words, the move to a common currency drastically alters the international transmission mechanisms at work in the world economy. In the domestic country, the various impulse response functions for real variables have basically the same shapes and magnitudes. However, the responses of the foreign real variables are reversed (fig. 6 and 7): foreign output, investment and labor are depressed and not increased following a positive domestic real shock. The presence of the financial accelerator is destabilizing on foreign output, in particular because the foreign investment drop is then larger. Globally, there is more international instability in a common currency area due to real disturbances and the presence of financial frictions is a worsening factor.

This point to a major role played by the nominal exchange rate, which disappears when a common currency is installed. In the multiple currency case, the depreciation of the nominal exchange rate had a counter effect to the decrease in the domestic price, leading to a milder response of the terms of trade. Without this adjustment, the terms of trade react more strongly in favor of the domestic country (compare fig. 3 and 8). This leads to an inverted response of the real interest rates (compare fig. 4 and 9). Now, both with and without financial accelerator, the domestic country experiences a decrease in the real interest rate, which amplifies the increase in domestic wealth and the decrease in the external finance premium. In the foreign country however, the detrimental effect of the larger response of the terms of trade lead to an increase in the real interest rate. This in turn leads both to a negative impact on the valuation of capital. This explains the drop in investment. Adding the financial accelerator, the increase in the real interest rate depresses aggregate wealth and consequently leads to an increase in the external finance premium paid by foreign investors (compare fig. 5 and 10). This further decreases foreign investment and feeds back into lower foreign output.

4.3 Financial asymmetries with symmetrical shocks

We now turn to the case of financial heterogeneity between countries. We would like to know first how important is this heterogeneity for the propagation of a real shock and second whether the existence of one or multiple currencies modifies this propagation. Focusing on financial heterogeneity, we now consider economies with informational asymmetries leading to the presence of a financial accelerator in both countries.

Financial asymmetries were already studied by Bernanke, Gertler and Gilchrist (1999), when they considered two sectors facing different financial conditions. However, since there was a common pool of workers, their sectors cannot be compared to our countries sharing a common currency.

We formalize financial asymmetries in the following way: financial contracts are more costly to enact for various reasons (higher administrative or auditing costs, lower quality of the financial reports and data on customers, etc...), making the external finance premium higher, ceteris paribus, in the foreign country than in the domestic one. In other words, the function $S(\cdot)$ is steeper in the foreign country than in the domestic country. Since we want to focus on the consequences of financial asymmetries, we consider a symmetric real shock, hitting both countries in exactly the same way. Without financial asymmetries, then with neutral monetary policy(ies), the behavior of the two countries would be the same, independently from the monetary regime: in the multiple currency case, the nominal exchange rate would remain equal to one forever, and the terms of trade would not be altered in any way. With financial asymmetries, the responses to the common disturbance will differ in the two countries. On the one hand, the differences in external finance premia will generate different investment behavior, but on the other hand, there are adjustment mechanisms at work between the two economies which may counterbalance these centrifugal forces.

The impulse response functions are given in fig. 11-13 in the case of multiple currencies and in fig. 14-16 in the case of a common currency.

As far as the influence of the monetary regime is concerned, the striking result coming from the various impulse response functions is that it seems that the monetary regime has no major impact on the transmission mechanisms at work in the world economy. The major reason comes from the fact that the nominal exchange rate is almost unmoved by the occurence of the common shock (fig. 12) and immediately returns back to its long run value. Hence no international transmission effect is channeled by the exchange rate. The monetary regime does not make much of a difference in these conditions. But remind that this comes from the very peculiar experience we consider. Probably in the case of asymmetrical shocks, the nominal exchange rate channel would be play a role and its interplay with financial asymmetries could then have a major impact.

As expected, countries experience differing dynamic paths. The positive real shock corresponds to an increase in the factors' productivity in both countries, raising the value of and the demand for capital. Even though the real interest rate increases, the wealth of entrepreneurs increases in both countries. This is particularly welcome in the foreign country which experiences the worst financial conditions. This increase leads to a larger drop in the external finance premium (since the $S(\cdot)$ is steeper) than in the domestic country. Consequently, the investment upsurge is larger in the foreign country than in the domestic one (fig. 11). This in turn amplifies the increase in the valuation of capital and in the wealth of entrepreneurs. The same effects are at work in the domestic country of course, but to a lower degree, since the positive productivity shock triggers a less robust financial accelerator effect in a "sounder" financial system. In the limit, if there is no informational asymmetry in the domestic country, making the real return to capital equal to the real interest rate, there would be almost no lasting effect of this temporary supply shock through investment channels.

5 Conclusion

The present paper developed a fully consistent model of a world economy with two countries. This model, with sound micro foundations, allows us to study alternative assumptions regarding the international monetary regime, and the presence of financial frictions. Given that the core structure of the economy remains the same, we may compare the various impulse response functions generated in alternative variants of the model by exogenous disturbances, and relate the differences in dynamic trajectories to the introduction of a particular feature.

Here, taking into consideration the case of real disturbances only, we asked three related questions:

1. whether the presence of financial frictions significantly alters the aggregate dynamics of both countries, in other words plays a major role in the international transmission mechanisms between the two countries,

2. whether the existence of a common currency instead of two, is also generating differences in the dynamics of the world economy.

3. whether asymmetries in financial frictions have a significant impact and generates discrepancies between the two economy, depending on the monetary regime.

To each question, we are able to answer positively. More specifically, the financial accelerator has an amplifying role in the dynamics of aggregate real variables and contributes to the business cycle in a significant way. The existence of a common currency in lieu of two happens to have a major impact on the dynamics too, in particular for the foreign country which now reacts in the opposite way, compared to the flexible exchange rate case. As the financial accelerator still amplifies these responses, we conclude that the financial accelerator is likely to augment international (interregional) cyclical differences in a monetary union. Lastly, the heterogeneity in financial structures within a monetary union leads, as was expected, to differences in responses to a common shock in the two countries.

These results are clearly preliminary and need to be confirmed by means of other empirical investigations. Moreover they open several issues in particular related to the role of stabilization policy, be it monetary or fiscal. When we take into consideration the possible use of policy instruments, we would like to know whether the presence of financial frictions makes their usage more difficult and less efficient, given the monetary regime. More explicitly, the challenge is to be able to study both from a positive and a normative point of view, various policy rules for intervention, both on the fiscal and the monetary side, when both financial frictions and the monetary regime are taken into consideration. This is left to further research.

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Figure 1: Responses to a domestic supply shock under a flexible exchange rate

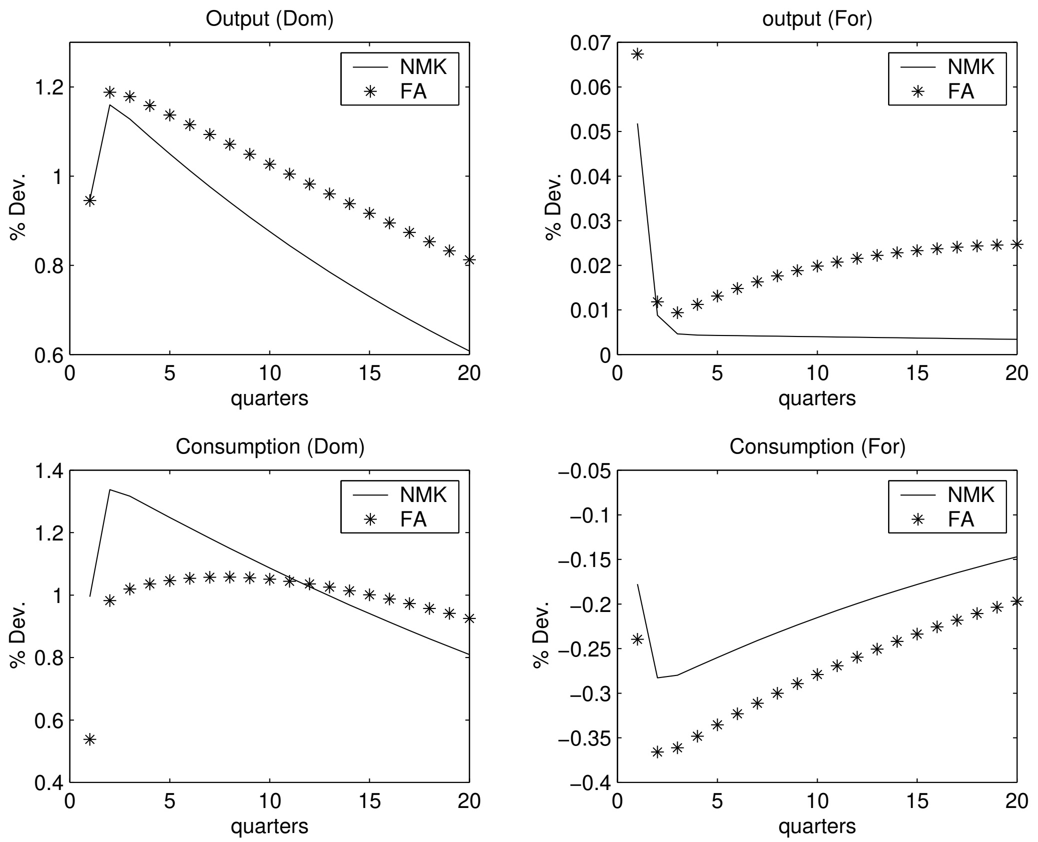

Figure 2: Responses to a domestic supply shock under a flexible exchange rate

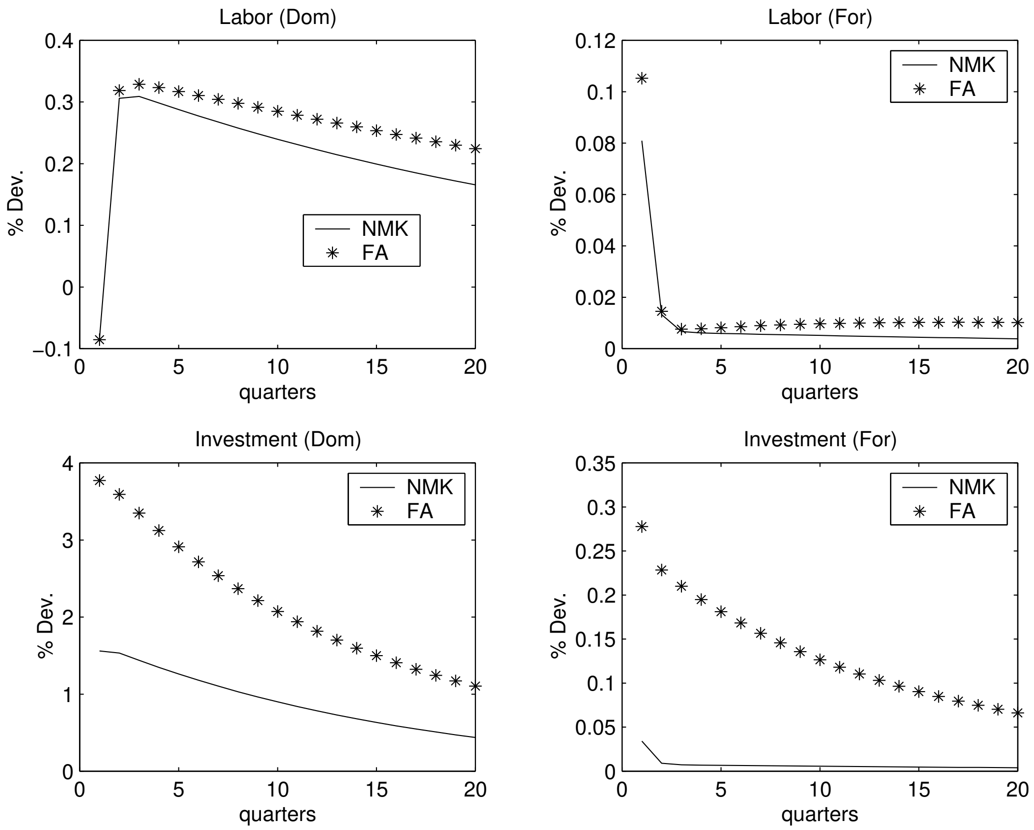

Figure 3: Responses to a domestic supply shock under a flexible exchange rate

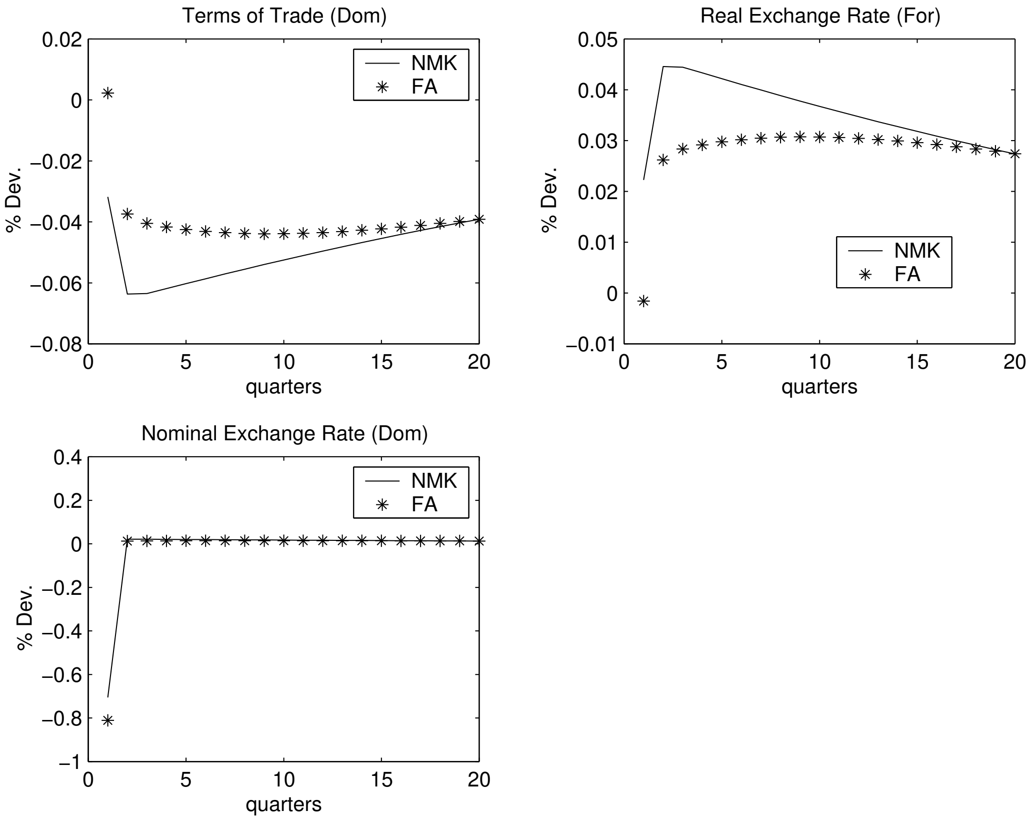

Figure 4: Responses to a domestic supply shock under a flexible exchange rate

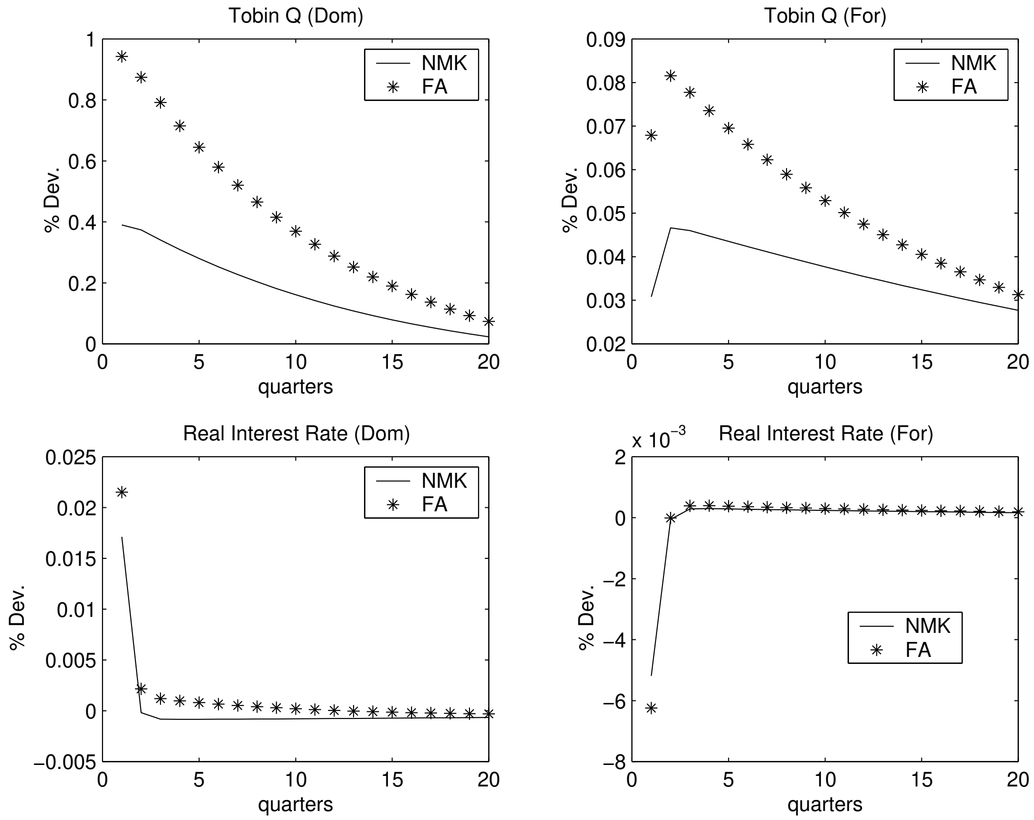

Figure 5: Responses to a domestic supply shock under a flexible exchange rate

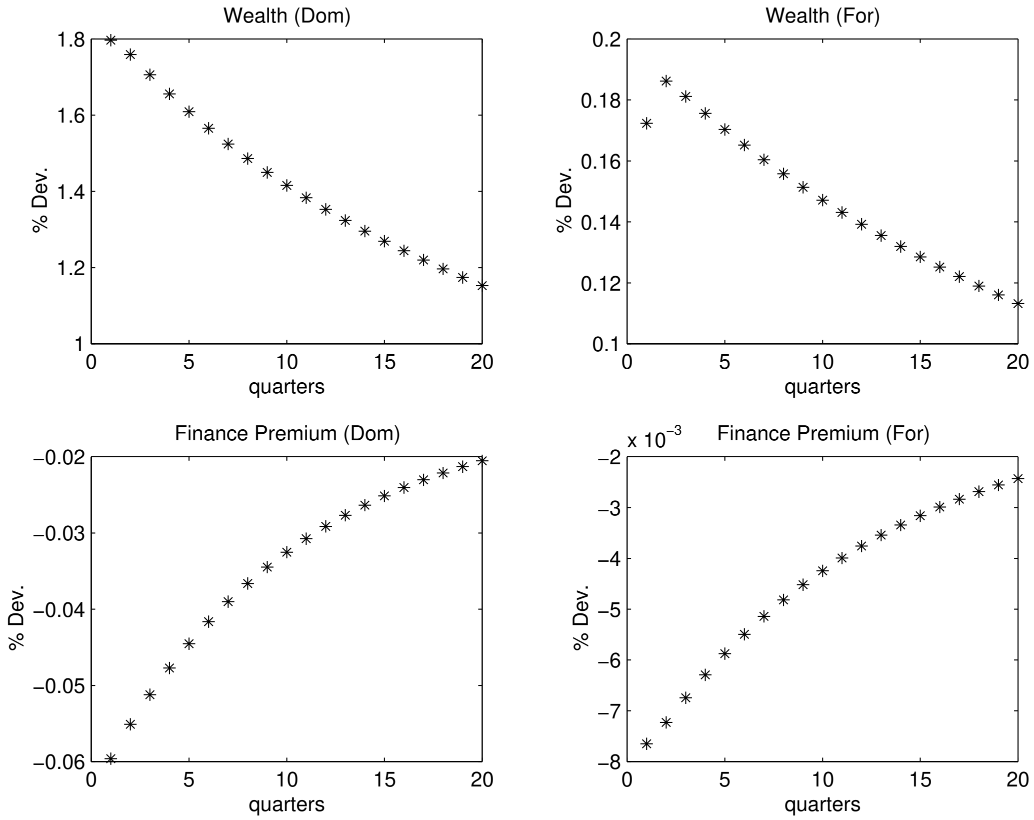

Figure 6: Responses to a domestic supply shock under a monetary union

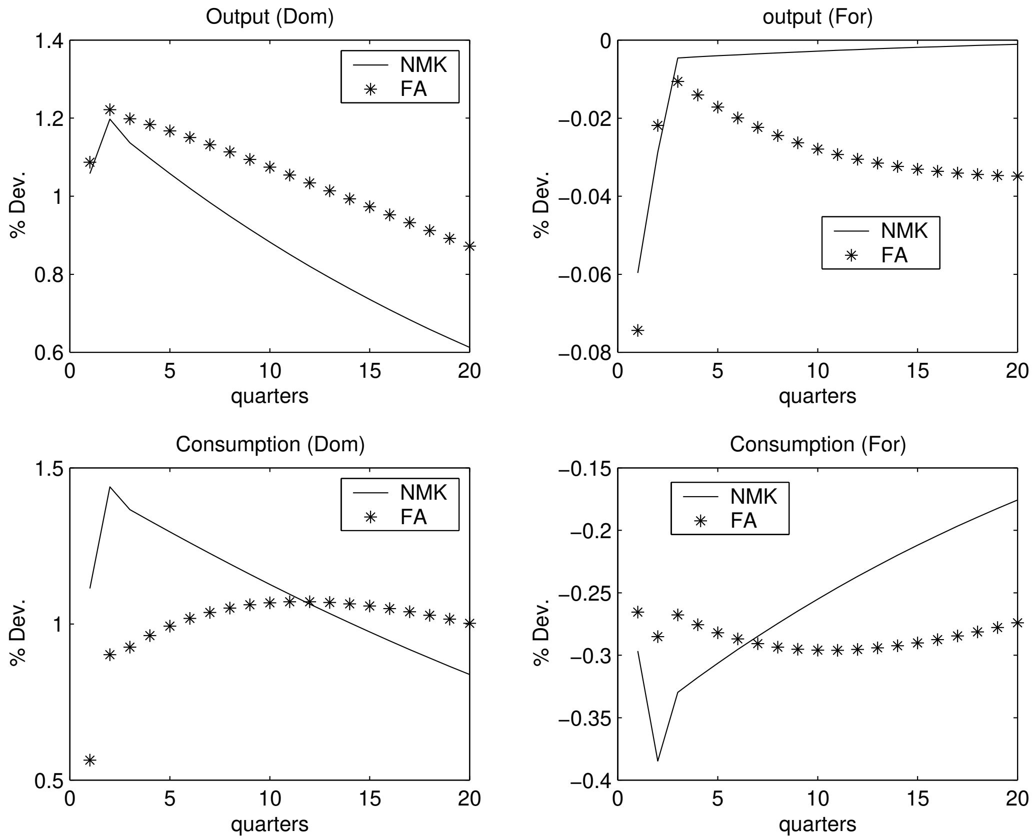

Figure 7: Responses to a domestic supply shock under a monetary union

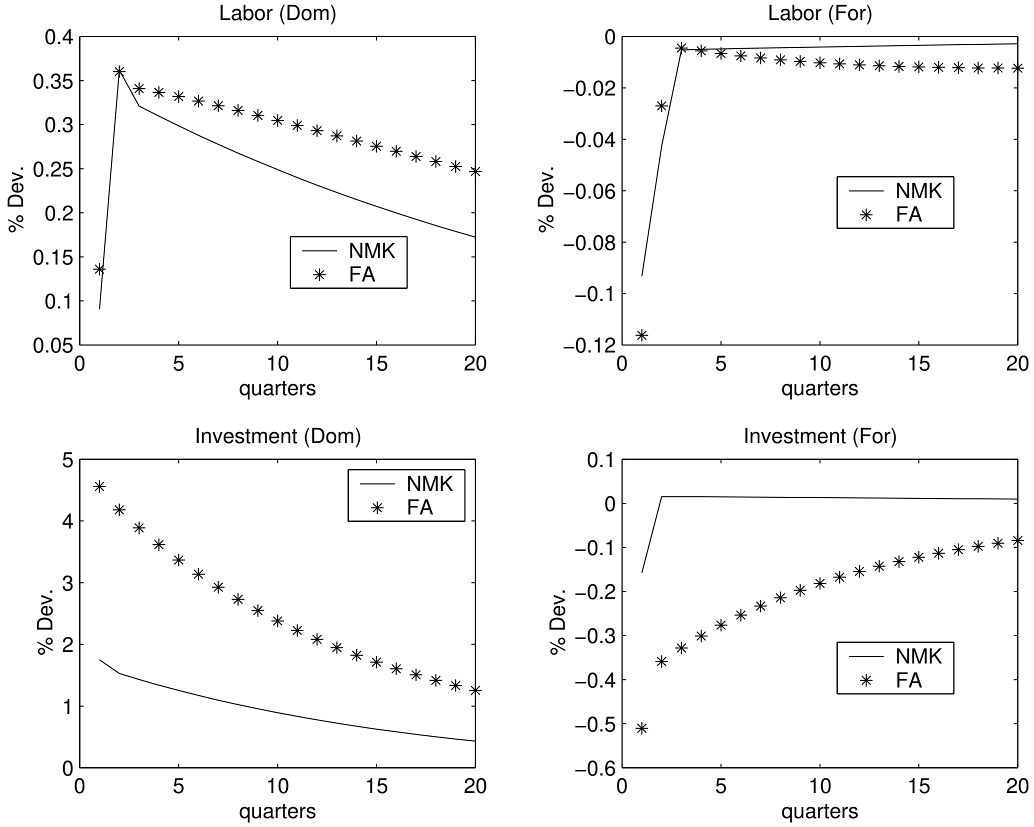

Figure 8: Responses to a domestic supply shock under a monetary union

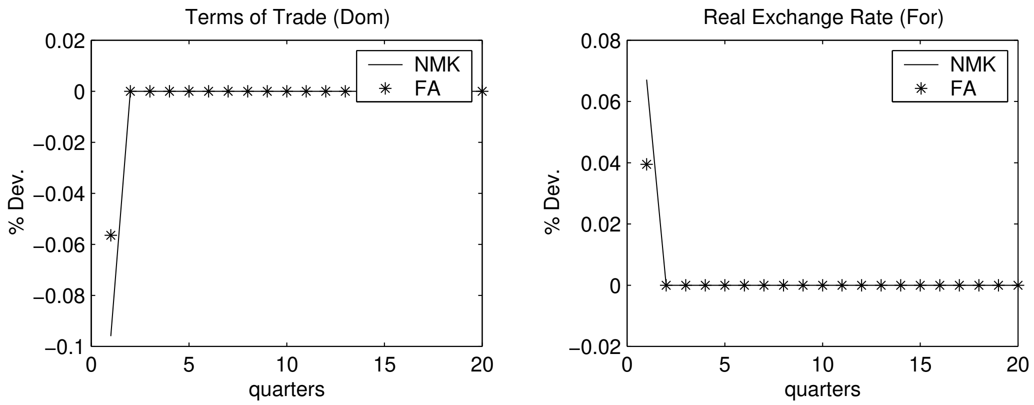

Figure 9: Responses to a domestic supply shock under a monetary union

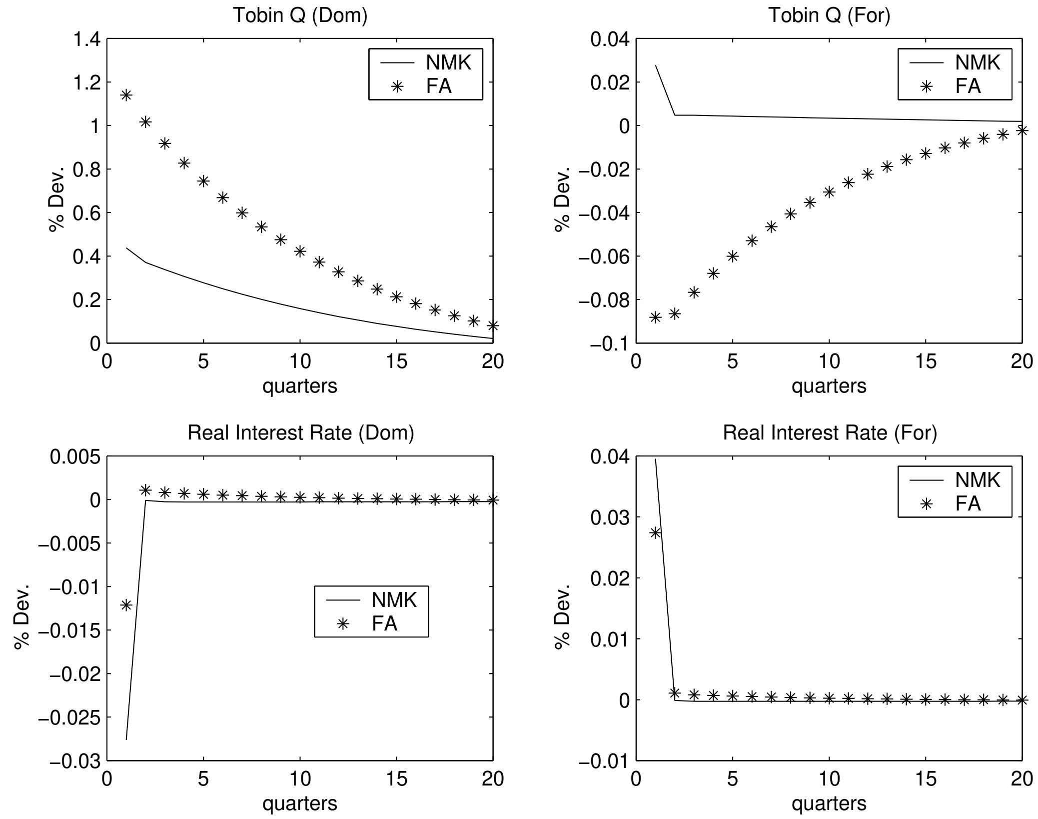

Figure 10: Responses to a domestic supply shock

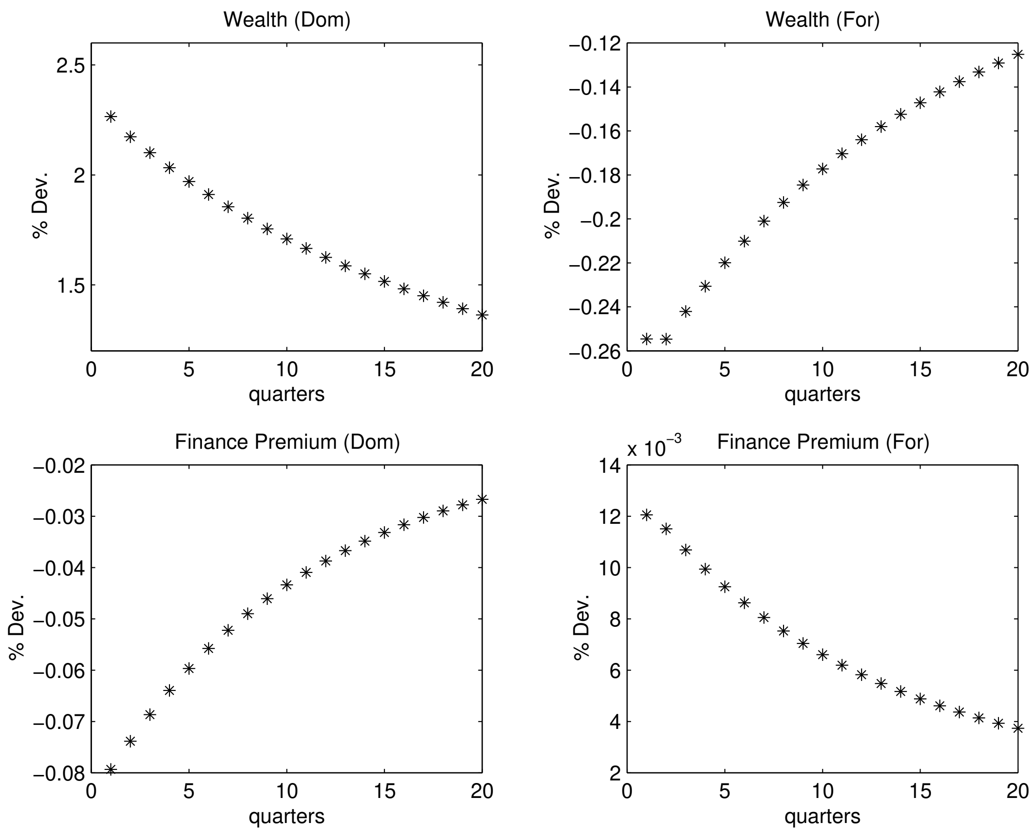

Figure 11: Responses to a common supply shock under a flexible exchange rate

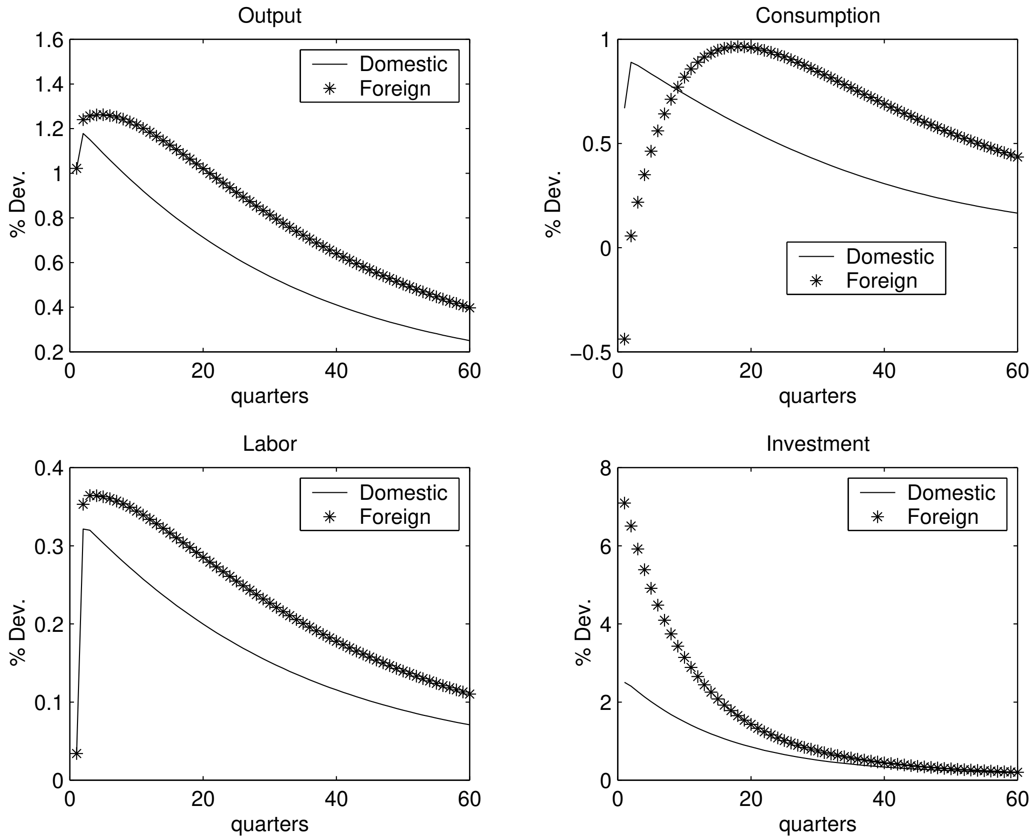

Figure 12: Responses to a common supply shock under a flexible exchange rate

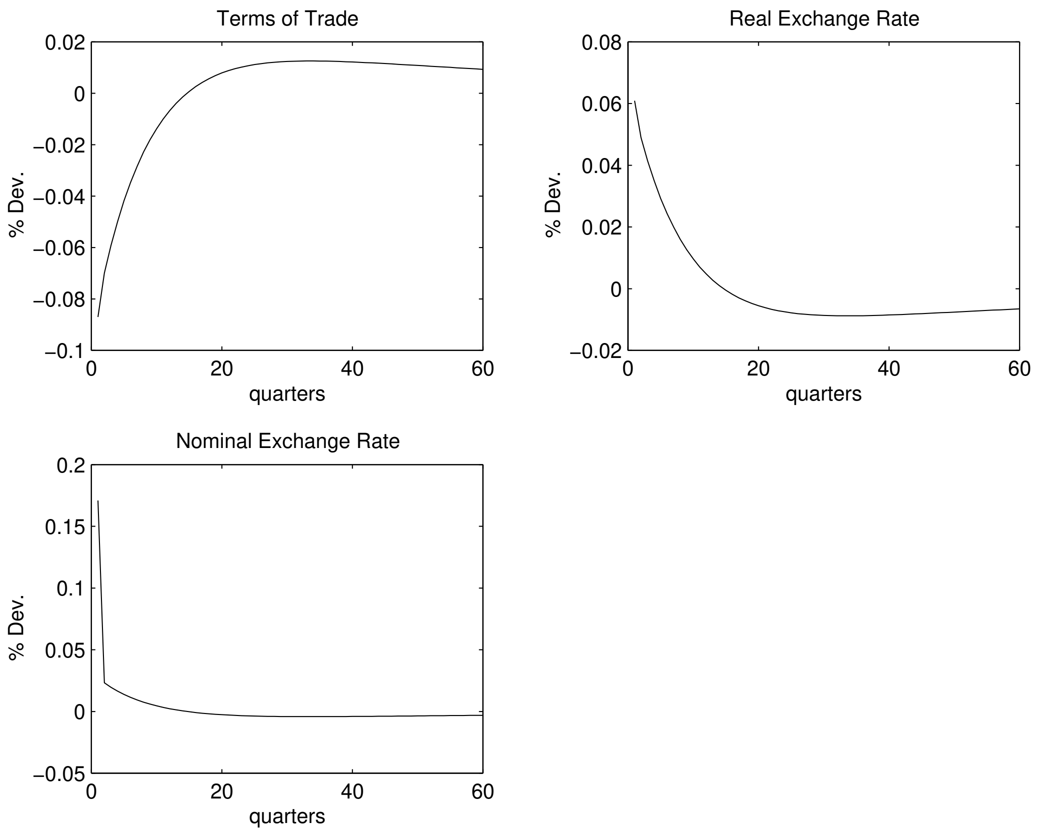

Figure 13: Responses to a common supply shock under a flexible exchange rate

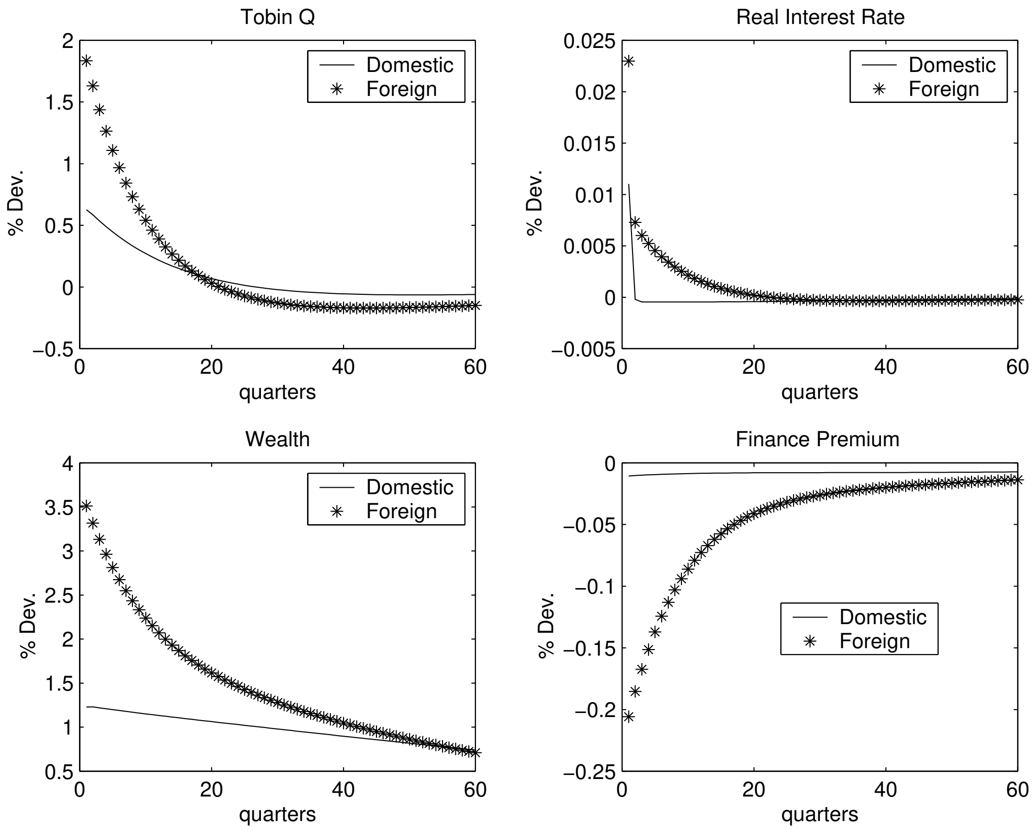

Figure 14: Responses to a common supply shock under a monetary union

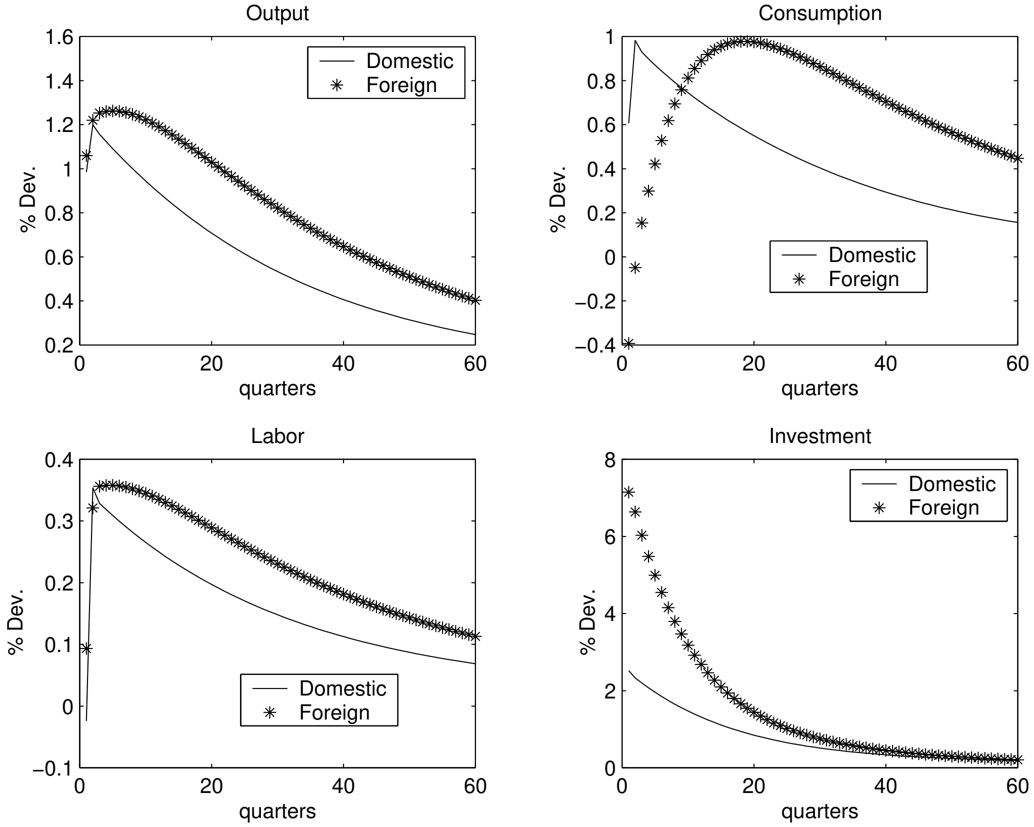

Figure 15: Responses to a common supply shock under a monetary union

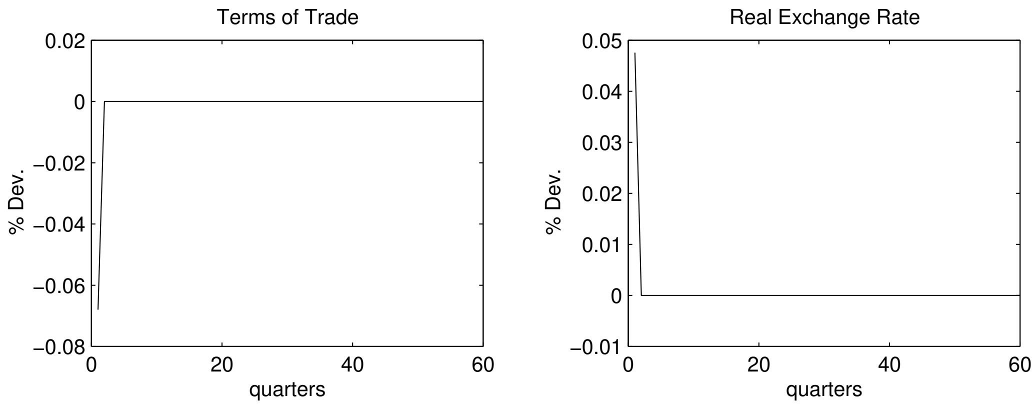

Figure 16: Responses to a common supply shock under a monetary union