**Kiel Institute of World Economics**
**Duesternbrooker Weg 120**
**24105 Kiel (Germany)**

**Kiel Working Paper No. 1115**

# Financial Market Integration and Business Cycle Volatility in a Monetary Union

**by**

**Christian Pierdzioch**

July 2002

# Financial Market Integration and Business Cycle Volatility in a Monetary Union[1]

**Abstract**

This paper uses a dynamic general equilibrium two-country optimizing sticky-price model to analyze the consequences of international financial market integration for the propagation of asymmetric productivity shocks in a monetary union. The model implies that business cycle volatility is higher the more integrated the capital markets of the member countries of the monetary union are.

*Keywords*: Open Economy Macroeconomics; Monetary union; Business cycles Financial markets

*JEL classification*: F33, F36, F41

Dr. Christian Pierdzioch
Kiel Institute of World Economics
24100 Kiel, Germany
Telephone: +49-431-8814-269
Fax: +49-431-8814-525
E-mail: c.pierdzioch@ifw.uni-kiel.de

---

[1] I would like to thank Claudia Buch for most helpful discussions and comments on an earlier draft. Remaining errors and inaccuracies are solely in my own responsibility.

## 1. Introduction

An assumption often made in theoretical analyses of the incidence of shocks in a monetary union is that the financial markets of the member countries of the monetary union are perfectly integrated.[2] Though this assumption alleviates the theoretical analysis of the propagation of shocks in a monetary union, it clearly is at variance with the empirical evidence available for the European Monetary Union. The evidence reported in the empirical literature suggests that, although a number of steps have been taken during the past decade to speed up cross-border financial transactions, financial markets in Europe are not yet perfectly integrated.[3] Nevertheless, it can be expected that, with the introduction of the euro, the process of financial market integration in Europe will gain further momentum (see, e.g., Danthine et al. 2000). It is therefore an interesting and important question how this process could alter the propagation of shocks in the European Monetary Union.

In this paper, I use a stochastic dynamic general equilibrium two-region model of a monetary union with sticky-prices and monopolistic competition to address this question. Specifically, I explore the implications of the ongoing integration of regional financial markets for the propagation of asymmetric productivity shocks in an otherwise symmetric monetary union. The basic structure of my model is similar to the structure of the monetary union models recently developed by Benigno (2001) and Lombardo (2002). The structure of their models closely resembles that of the canonical new open economy macro (NOEM) model pioneered by Obstfeld and Rogoff (1995, 1996). Because NOEM models have become a standard tool for analyzing international macro issue, they are a natural

---

2 Monetary union models featuring imperfect substitutability between internationally traded financial assets can be found, e.g., in Allen and Kenen (1980) and in Marston (1985).

3 The extent of cross-border capital mobility in Europe has been the subject of a number of recent empirical studies. In general, the empirical evidence indicates that the degree of financial market integration in Europe has increased. Yet, the empirical evidence also suggests that the degree of financial market integration differs across financial market segments. For a further discussion, see, e.g., Lemmen (1998), Bayoumi et al. (1999), Berger et al. (2000), Centeno and Mello (1999), and the references cited therein.

candidate for analyzing the impact of financial market integration on the propagation of shocks in a monetary union.

The core feature of the NOEM model I use in this paper is that it departs from the assumption made by Benigno (2001) and Lombardo (2002) that the financial markets of the member countries of the monetary union are fully integrated. To build into their NOEM model the assumption that the financial markets of the member countries of the monetary union are imperfectly integrated, I use the approach recently advanced by Sutherland (1996) and Senay (1998). They have shown how a relatively simple transaction cost technology for cross-border financial transactions can be used to extend NOEM models to incorporate the assumption of imperfect international financial market integration.

My NOEM model shows that the integration of regional financial markets amplifies the output effects of asymmetric productivity shocks, that is, business cycle volatility is higher the more integrated the capital markets of the member countries of a monetary union are. However, the results of numerical simulations indicate that this effect might be quantitatively small if productivity shocks are persistent. Moreover, for a given degree of financial market integration, business cycle volatility tends to be larger the higher is the substitutability between goods produced in different member countries of the monetary union. In contrast, business cycle volatility tends to be lower the more sluggish goods prices adjust to productivity shocks. Further, as would have been expected, financial market integration in the monetary union leads to a reduction of consumption volatility because households can hold better diversified portfolios of financial assets when financial markets are highly integrated.

The remainder of the paper is organized as follows. In Section 2, I lay out the NOEM model I use to derive the results reported in this paper. In Section 3, I use impulse response functions and numerical simulations to analyze the implications of financial market integration for the propagation of asymmetric productivity shocks in a monetary union. Section 4 offers some concluding remarks.

## 2. The Model

The monetary union is made up of two regions, Home, $H$, and Foreign, $F$. Each region is populated by a continuum of infinitely-lived households. In addition, each region is populated by a continuum of firms. Each firm produces a differentiated product and sells it in a monopolistically competitive goods market. All goods produced by Home and Foreign firms are traded between the regions. The only production factor needed to produce a differentiated product is labor. Firms hire labor in a perfectly competitive labor market. There is no possibility of migration across regions.

### *2.1 Households' Preferences and Goods Market Structure*

The member countries of the monetary union are inhabited by a continuum of infinitely-lived households on the interval $[0,1]$. The households on the segment $j \in [0,n)$ reside in region $H$, while the households on the segment $j \in [n,1]$ belong to region $F$. Home and Foreign households have identical preferences. They form rational expectations and seek to maximize the present value of their expected lifetime utility defined as:

$$U_{t,i}(j) = E_t \sum\nolimits_{s=t}^{\infty} \beta^{s-t} [\log(C_{s,i}(j)) + \chi \log(M_s(j)/P_{s,i}) - \kappa_{s,i} N(j)_{s,i}^2 / 2], \qquad (1)$$

where $i = H$ if $j \in [0,n)$ and $i = F$ if $j \in [n,1]$, $\chi > 0$, $0 < \beta < 1$, and $E_t$ denotes the conditional expectations operator. In Eq. (1), $C_{t,i}(j)$ denotes a real consumption index, $N_{t,i}(j)$ is the households' labor supply, $\kappa_{t,i}$ is a region specific stochastic productivity index, and $M_t(j)/P_{t,i}$ denotes the end-of-period real money demand, where $P_{t,i}$ is the aggregate price index in region $i$ defined below.

The aggregate consumption index, $C_{t,i}(j)$, is a CES aggregate of an index of Home consumption goods, $C_{t,i}^{H}$, and of an index of Foreign consumption goods, $C_{t,i}^{F}$:

$$C_{t,i}(j) = \left[ n^{1/\rho} (C_{t,i}^{H}(j))^{(\rho-1)/\rho} + (1-n)^{1/\rho} (C_{t,i}^{F}(j))^{(\rho-1)/\rho} \right]^{\rho/(\rho-1)}, \tag{2}$$

where $\rho > 0$ denotes the elasticity of substitution between the Home and Foreign consumption index. As in Tille (2001), the index $C_{t,i}^{H}(j)$ ($C_{t,i}^{F}(j)$) is defined as a CES aggregate over a continuum of differentiated, perishable Home (Foreign) consumption goods consumed by Households of country $i$. These goods are sold by Home and Foreign firms in a monopolistically competitive goods market. The indices $C_{t,i}^{H}(j)$ and $C_{t,i}^{F}(j)$ can be expressed as:

$$C_{t,i}^{H}(j) = \left[ n^{-1/\theta} \int_{0}^{n} \{c_{t,i}^{j}(h)\}^{(\theta-1)/\theta} dh \right]^{\theta/(\theta-1)}, \tag{3}$$

$$C_{t,i}^{F}(j) = \left[ (1-n)^{-1/\theta} \int_{n}^{1} \{c_{t,i}^{j}(f)\}^{(\theta-1)/\theta} df \right]^{\theta/(\theta-1)}, \tag{4}$$

where $h \in [0, n)$ denotes Home and $f \in (n,1]$ denotes Foreign goods, $c_{t,i}^{j}(z)$ denotes consumption of good $z$ by household $j$ residing in country $i$, and $\theta > 1$ denotes the elasticity of substitution between consumption goods produced within the same country. The optimal consumption allocation is given by (neglecting the household index from now on):

$$c_{t,i}(h) = \left[ p_{t,i}(h) / P_{t,i,h} \right]^{-\theta} \left[ P_{t,i,h} / P_{t,i} \right]^{-\rho} C_{t,i}, \tag{5}$$

$$c_{t,i}(f) = \left[p_{t,i}(f) / P_{t,i,f}\right]^{-\theta} \left[P_{t,i,f} / P_{t,i}\right]^{-\rho} C_{t,i}\,. \tag{6}$$

Analogous expressions can be derived for the consumption allocation of Foreign households. In Eqs. (5) and (6), $p_{t,i}(h)$ denotes the price of the Home good in region $i$ and $p_{t,i}(f)$ denotes the price of the Foreign good in region $i$. The price index $P_{t,i,h}$ ($P_{t,i,f}$) is defined as the minimum expenditure required to buy one unit of the index of Home (Foreign) consumption goods, $C^H_{t,i}$ ($C^F_{t,i}$), in region $i$. These price indices are given by:

$$P_{t,i,h} = \left[ n^{-1} \int_0^n \{p_{t,i}(h)\}^{1-\theta} dh \right]^{1/(1-\theta)}, \tag{7}$$

$$P_{t,i,f} = \left[ (1-n)^{-1} \int_0^n \{p_{t,i}(f)\}^{1-\theta} df \right]^{1/(1-\theta)}. \tag{8}$$

The aggregate price index for region $i$ is then of the form:

$$P_{t,i} = \left[ n(P_{t,i,h})^{1-\rho} + (1-n)(P_{t,i,f})^{1-\rho} \right]^{1/(1-\rho)} \tag{9}$$

I assume that there are no transaction costs for transporting goods across regions and that firms consider the whole monetary union as a common market when setting prices. With households' preferences being the same in the member countries of the monetary union, these assumptions imply that $p_{t,H}(h) = p_{t,F}(h)$

and $p_{t,H}(f) = p_{t,F}(f)$. It immediately follows that we also have $P_{t,H} = P_{t,F} \equiv P_t$, i.e., purchasing power parity holds.[4]

## 2.2 The Structure of Financial Markets

Households can trade in Home and Foreign nominal bonds. When trading in these bonds, households have to take into consideration that the national financial markets of the member countries of the monetary union are not perfectly integrated. Whereas Home households have free access to the Home financial market, they incur intermediation costs when undertaking positions in the Foreign financial market. Similarly, Foreign households can trade in the Foreign financial market without incurring transaction costs but incur intermediation costs when trading in the Home financial market. The real intermediation costs, $Z_{t,i}$, of undertaking positions in the international financial market are given by:

$$Z_{t,i} = 0.5\psi_1 I_{t,i}^2 + 0.5\psi_2[(F_{t,i} - \overline{F})/P_t]^2, \tag{10}$$

where $\psi_1 > 0$ and $\psi_2 > 0$ are positive constants, $F_{t,i}$ denotes the stock of foreign currency denominated assets held by the households of region $i$, $\overline{F}$ is the steady state level of the foreign asset holdings of households (assumed to be identical across regions), and $I_{t,i}$ denotes the level of real funds households residing in region $j$ transfer abroad and, thus, corresponds to the trade balance of region $i$. Both $Z_{t,i}$ and $I_{t,i}$ are denominated in terms of the consumption aggregator, $C_{t,i}$.

---

4 As purchasing power parity holds, the model renders it possible to abstract from effects due to the segmentation of national goods markets when analyzing the effects of financial market integration for macroeconomic dynamics in the monetary union. Using a standard NOEM model with flexible exchange rates, Senay (1998) has shown that the effects of financial market integration on macroeconomic dynamics are largely independent of the degree of goods market integration.

The first term on the right-hand side of Eq. (10) reflects convex adjustment costs and is identical to the transaction cost technology used by Sutherland (1996). The second term on the right-hand side of Eq. (10) is introduced to ensure that the foreign asset positions of the member countries of the monetary union and, thus, the steady state around which the model is log-linearized is stationary (Schmitt-Grohe and Uribe 2001). The stationarity of the steady state will serve useful in the stochastic simulations of the model presented in Section 3.

Total income received by households consists of the yield on their holdings of Home and Foreign bonds, the profit income for the ownership of firms (i.e., dividend income), and the labor income. Given total income, households determine their optimal consumption, decide on their preferred Home and Foreign bond holdings, and determine their preferred money holdings. In addition, they receive transfers from the government of the region in which they reside and incur transaction costs for undertaking cross-border asset transactions. The dynamics of households' domestic bond holdings, therefore, obey the following flow budget constraint:

$$D_{t,i} = (1+R_{t-1,i})D_{t-1,i} + M_{t-1} - M_t + w_{t,i}N_{t,i} - P_tC_{t,i} - P_tI_{t,i} - P_tZ_{t,i} + \Pi_{t,i} + P_tT_{t,i}, \quad (11)$$

where $D_{t,i}$ stands for the quantity of domestic nominal bonds held by agents in region $i$, $R_{t,i}$ denotes the nominal interest rate earned upon holding the bonds issued by region $i$ between period $t$ and $t+1$, $T_{t,i}$ stands for real lump-sum transfers (denominated in terms of the consumption aggregate, $C_{t,i}$), $w_{t,i}$ is the nominal wage rate earned by the households of region $i$ in a perfectly competitive labor market, and $\Pi_{t,i}$ denotes the nominal profit income the household in region $i$ receive from the firms of that region.

The dynamics of households' Foreign bond holdings are given by:

$$F_{t,i} = (1+R_{t-1,k})F_{t-1,i} + P_tI_{t,i}, \quad (12)$$

where $k \in (H, F)$ and $k \neq i$, i.e., $R_{t,k}$ denotes the nominal interest rate earned by the households residing in region $i$ for holding between period $t$ and $t+1$ a nominal bond issued by the Foreign region $k$.

## *2.3 Individual Maximization*

The first-order conditions for the households' intertemporal optimization problem are:

$$1/C_{t,i} = \lambda_{t,i} P_t, \tag{13}$$

$$\chi / M_t + \beta E_t(\lambda_{t+1,i}) = \lambda_{t,i}, \tag{14}$$

$$\kappa_{t,i} N_{t,i} = \lambda_{t,i} w_{t,i}, \tag{15}$$

$$(1 + R_{t,i}) \beta E_t(\lambda_{t+1,i}) = \lambda_{,it}, \tag{16}$$

$$\lambda_{t,i} - \beta(1 + R_{t,k}) E_t(\lambda_{t+1,i}) + \psi_1 \lambda_{t,i} + \psi_2 \lambda_{t,i} (F_{t,i} - \overline{F}) / P_t = \beta(1 + R_{t,i}) E_t(\lambda_{t+1,i} I_{t+1,i}), \tag{17}$$

where $\lambda_{t,i}$ denotes the region-specific Lagrange multiplier. Eq. (17) shows that the intermediation costs for undertaking cross-border financial transactions ($\psi_1 > 0$, $\psi_2 > 0$) imply that the interest parity condition linking the interest rates on Home and Foreign bonds includes terms accounting for the costs incurred when transferring funds between the Home and the Foreign bond market.

Eliminating the Lagrange multiplier from Eq. (17), this interest rate parity condition can be shown to be:

$$(1+R_{t,i})(1+\psi_1 I_{t,i}) = (1+R_{t,k})(1+\psi_1 E_t I_{t+1,i}) - \psi_2(1+R_{t,i})(F_{t,i} - \overline{F})/P_t \tag{18}$$

## 2.4 *Price Setting*

Each profit-maximizing firm hires labor to produce a differentiated good indexed by $z$ according to the production function $y_{t,i}(z) = N_{t,i}(z)$. The firm's nominal profits are, therefore, given by $\Pi_{t,i}(z) = p_{t,i}(z)y_{t,i}(z) - w_{t,i}y_{t,i}(z)$. Because each firm has monopoly power on the market for the differentiated good it produces, it treats the price, $p_{t,i}(z)$, it charges for its product as a choice variable and seeks to set the price of its product to maximize profits. When setting the price of its product, the firm faces the following demand curve for its good in the monopolistically competitive goods market:

$$y_{t,i}(z) = (p_{t,i}(z)/P_t)^{-\theta} Q_t, \tag{19}$$

where $Q_t = (nC_t(H) + (1-n)C_t(F))$ is the aggregate goods demand in the monetary union.

When setting prices, firms have to take into account that they are subject to sluggish price adjustment of the form described in Calvo (1983). According to this price adjustment mechanism each firm has to take into account when setting its profit-maximizing price that there is a positive probability $0 < \gamma < 1$ that it cannot revise its price setting decision made in period $s < t$ in period $t$. Firms, therefore, set the current price of their product, $p_{t,i}(z)$, so as to maximize the expected present value, $V_{t,i}(z)$, of current and future real profits, where period $s$,

$s > t$, profits are weighted by the probability that the current period price, $p_{t,i}(z)$, will still be in force in period $s$. As in Sutherland (1996), firms maximize:

$$\max_{p_{t,i}(z)} V_{t,i}(z) = E_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s,i} \Pi_{s,i}(z) / P_s \,, \tag{20}$$

where $R_{t,s,i} \equiv \Pi_{x=s}^{t} d_{x,i}$ with $d_{t,i} = 1/(1 + R_{t,i})$ is the discount factor for period $s > t$ expected real profits. Eq. (20) shows that the sluggish price adjustment makes each firms' price setting problem dynamic; rather than maximizing its profits period-by-period, each firm acts to maximize its total market value. Using Eq. (19) in Eq. (20), the profit-maximizing price can expressed as:

$$p_{t,i}(z) = \left( \frac{\theta}{\theta - 1} \right) \frac{E_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s,i} (Q_s / P_s)(1/P_s)^{-\theta} w_{s,i}}{E_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s,i} (Q_s / P_s)(1/P_s)^{-\theta}} \tag{21}$$

With prices being perfectly flexible, Eq. (21) implies that firms set the profit-maximizing price of their product according to the rule $p_{t,i}(z) = [\theta / (\theta - 1)] w_{t,i}$, i.e., the difference between the price and the marginal costs of production is given by the constant mark up $\theta / (\theta - 1)$.

### 2.5 *The Government Sector*

Assuming that seignorage revenues are returned to the households of the regions according to its source, the budget constraint in period $t$ of the government of region $i$ is given by:

$$P_t \int_{j \in i} T_t(j) + \int_{j \in i} M_t(j) - \int_{j \in i} M_{t-1}(j) = 0 \tag{22}$$

The supply of outside money in the monetary union, $M_t^u$, is given by:

$$M_t^u = \int_0^1 M_t(j)dj \tag{23}$$

*2.6 Definition of Equilibrium and Model Solution*

In a symmetric monopolistic competition equilibrium in the monetary union, output, consumption, prices, interest rates, wage rates, and bond holdings follow stochastic processes such that (i) the labor markets in each country clear, (ii) the optimality conditions for consumption and asset holding are satisfied, (iii) the intertemporal budget constraint for each country is satisfied, (iv) the union-wide demand for outside money is equal to the aggregate supply of outside money, and (v) the bond markets are in equilibrium.

— Insert Table 1 about here.—

To solve the model, I follow Obstfeld and Rogoff (1995) and Sutherland (1996) and log-linearize the model around a symmetric flexible-price steady state in which the bond holdings of the member countries of the monetary union are zero. I then use numerical simulations to analyze the properties of the calibrated log-linearized model. The calibration of the model is fairly standard and is given in Table 1. Most of the parameters are as given in Sutherland (1996).

## 3. Financial Market Integration and Macroeconomic Volatility in a Monetary Union

In this section, I use impulse response functions and stochastic simulations to analyze how the integration of the financial market of the member countries of the monetary union affects the propagation of asymmetric productivity shocks. I assume that the productivity shocks, measured in deviations from the steady state, evolve according to the following first-order autoregressive processes:

$$\hat{\kappa}_{t,i} = \phi\hat{\kappa}_{t,i-1} + \varepsilon_{t,i}, \tag{24}$$

where $\phi \in [0,1]$ and a hat denotes that a variable is measured in terms of deviations from the steady state. I follow Sutherland (1996) in assuming that Home (Foreign) is hit by a positive (negative) unit productivity shock, i.e., $\varepsilon_{t,H}$ and $\varepsilon_{t,F}$ are perfectly negatively correlated.

— Insert Figure 1 about here.—

Figure 1 shows the response of a number of key Home variables to a permanent asymmetric productivity shock ($\phi = 1$). The shock implies that the marginal productivity of Home labor increases. Home households react to this permanent change in the labor productivity by decreasing their labor supply. In consequence, Home output and consumption fall. Because Home households seek to smoothen consumption intertemporally, they react to the decline in current consumption by running a current account deficit. This implies that the Foreign asset position of the Home country declines. Because the Foreign asset position is stationary, the Home country realizes a trade balance surplus in the medium- and longer-run.

Furthermore, in the medium- and longer-run, as nominal contracts and therefore goods prices start to adjust, the real exchange rate, $\hat{e}_t$, appreciates. The real exchange rate is defined as:

$$\hat{e}_t \equiv \hat{q}_{t,F} - \hat{q}_{t,H}\,, \qquad \text{with} \quad \hat{q}_{t,i} \equiv (1-\gamma)\sum\nolimits_{j=t}^{\infty}\gamma^j \hat{p}_{t-j,i}(i) \quad , \quad i \in \{H,F\}, \tag{25}$$

where the aggregate price indices, $\hat{q}_{t,i}$, are constructed so as to summarize the period $t$ information on all the prices set by Home and Foreign firms, respectively. The dynamics of the real exchange rate in the aftermath of the asymmetric productivity shock reflect that the asymmetric productivity shock leads to a contraction (expansion) of Home (Foreign) output, requiring Home goods to become more expensive relative to Foreign goods.

Figure 1 further illustrates that the effect of the productivity shock on output is the larger the more integrated are the financial (bond) markets of the member countries of the monetary union. Hence, the integration of national financial markets in the monetary union tends to amplify business cycle volatility. Yet, Figure 1 suggests that this effect tends to be quantitatively small if productivity shocks are permanent, i.e., if the stochastic processes describing the dynamics of the Home and Foreign productivity shocks have a unit root. If, in contrast, productivity shocks are transitory ($0 < \phi < 1$), the integration of the financial markets of the member countries of the monetary union has a more significant impact on macroeconomic dynamics (Figure 2).

— Insert Figure 2 about here.—

To fully understand this result, it is worth analyzing in more detail the channel through which financial market integration affects macroeconomic dynamics in the monetary union. If financial market integration is low, the transaction costs for undertaking cross-border financial transactions are high. When transaction costs are high, it is more difficult for households to diversify their asset holdings. This, in turn, implies that the impact of the productivity shock on consumption is larger and that the Home (Foreign) current account deficit (surplus) observed in the aftermath of such a shock is smaller when the national financial (bond) markets of the member countries of the monetary union are only imperfectly integrated. A smaller current account deficit, in turn, directly implies that, in a general equilibrium, the impact of the productivity shock on the real exchange rate is smaller the less integrated national financial markets are. Because the real exchange rate and, hence, the relative price of Foreign goods in terms of Home goods is less responsive to productivity shocks when financial markets are integrated, it follows that the impact of such a shock on output is an inverse function of the degree of financial market integration. In consequence, output volatility tends to be higher the higher the degree of financial market integration in the monetary union is.

To obtain further insights into the properties of the model, I report in Table 2 the results of stochastic simulations of the model. Table 2 gives the volatilities (standard deviations) of Home output and consumption for different degrees of financial market integration in the monetary union. In addition, Table 2 illustrates the implications of varying the degree of elasticity of substitution between goods produced in the different member countries of the monetary union and of varying the degree of price stickyness for output and consumption volatility.

— Insert Table 2 about here.—

With respect to the impact of financial market integration on business cycle volatility, the results given in Table 2 confirm the findings summarized in Figures 1 and 2. Financial market integration tends to magnify the impact of productivity shocks on output. Hence, the more integrated the national financial markets of the member countries of the monetary union are the larger is business cycle volatility due to productivity shocks in the monetary union. Consumption volatility, in contrast, decreases if financial markets integrate because households can better diversify their asset holdings when financial markets are highly integrated.

Table 2 further suggests that business cycle volatility tends to be higher the larger the elasticity of substitution between Home and Foreign goods and the higher is the degree of price stickyness is. A high elasticity of substitution between Home and Foreign goods implies that a rise of the price of Home goods relative to the price of Foreign goods results in a strong shift of demand toward Foreign goods. Increasing the elasticity of substitution between Home and Foreign goods, therefore, implies that the appreciation of the real exchange rate triggered by an asymmetric productivity shock induces households to undertake a relatively large reallocation of consumption spending in favor of Foreign goods. In consequence, the output and consumption volatility caused by productivity shocks are increasing functions of the substitutability between Home and Foreign goods.

Another factor that affects business cycle volatility is the degree of price stickyness. As shown in Table 2, the higher the degree of price stickyness the lower is the volatility of output and consumption. Increasing the degree of price stickyness implies that it takes longer before productivity shocks unfold their full impact on the real exchange rate. Because the real exchange rate determines the price of Foreign goods in terms of Home goods, the slow response of the real exchange rate implies that the short-run output effect of a productivity shock tends to be an inverse function of the degree of price stickyness.

As a final exercise, I illustrate by means of Figure 3 the implications of asymmetric productivity shocks for selected important union-wide variables. Specifically, Figure 3 graphs the impact of an asymmetric productivity shock on the time paths of the union-wide output (i.e., the population-weighted some of Home and Foreign output), of the union-wide price level, of the international nominal short-term interest rate differential, and of the Home and Foreign money demand.

Because Home and Foreign productivity shocks are, by assumption, perfectly negatively correlated, the impact of such an asymmetric productivity shocks on union-wide output is equal to zero. Similarly, because the degree of price stickyness is, due of the assumption of perfect symmetry of the Home and Foreign economies, the same in both member countries of the monetary union the asymmetric productivity shock does not require a change in the aggregate price level. Were the degree of price stickyness in the Home country different from the degree of price stickyness in the Foreign country then the productivity shock would result in an adjustment of the union-wide price level.

— Insert Table 2 about here.—

Figure 3 further illustrates that an asymmetric productivity shock results in a change of the distribution of outside money between Home and Foreign households. Because in the Home country the nominal short-term interest rate increases and consumption decreases in the aftermath of an expansionary productivity shock, Home money demand declines. In contrast, money demand in the Foreign country increases by the same amount. The reason is that because of the asymmetry of the productivity shock the macroeconomic dynamics in the Foreign country are a mirror-image of those in the Home country. Because the union-wide supply of outside money does not change as long as the central bank does not react to productivity shocks, the population weighted sum of the Home and Foreign demand for outside money is exactly equal to zero.

## 4. Conclusions

In recent years, the so called NOEM models have become a popular way of analyzing macroeconomic dynamics in open economies. In this paper, I used a NOEM model to study how the integration of international financial markets affects the within-country and cross-country propagation of asymmetric productivity shocks in a monetary union consisting of two otherwise symmetric member countries. The results of numerical simulations of the model indicated that the integration of international financial markets could imply that the impact of permanent and transitory productivity shocks on output increases, thus leading to a more pronounced regional business cycles in a monetary union. However, simulations of the calibrated model showed that this effect might be quantitatively small if productivity shocks are permanent.

It goes without saying that the results reported in this paper should not be stretched too far. Before definitive policy conclusions can be reached from the kind of analysis undertaken in this paper, more research needs to be done. For instance, as it stands, the NOEM model developed in this paper described what happens when the financial markets of the member countries of a monetary union become more integrated. It would be interesting to extend this analysis in future research by studying how macroeconomic dynamics change when the (possibly integrated) financial markets of the member countries of a monetary union begin integrating into world financial markets. Such an analysis could yield important lessons for emerging market economies.

A further question not addressed in this paper is how monetary and fiscal policy in a monetary union should react to the integration of financial markets. In this respect it would be interesting to analyze how the integration of financial markets affects the transmission of monetary and fiscal policy shocks in a monetary union. When doing such research, not only the implications of financial market integration for business cycle volatility but also the welfare implications of both financial market integration and different monetary and fiscal policy strategies should be studied. The model laid out in this paper could provide a useful modeling platform for such research.

In this paper, I analyzed the implications of financial market integration for the propagation of asymmetric productivity shocks in an otherwise symmetric monetary union. In future research, the NOEM model outlined in this paper could be extended to analyze how the integration of international financial markets alters the effects of symmetric shocks in an asymmetric monetary union. For example, it would be interesting to analyze how the results documented in this paper are affected when a symmetric productivity shocks hits the member countries of a monetary union featuring different price adjustment parameters or different intratemporal and intertemporal consumption elasticities.

## References

Allen, P.R. and P.B. Kenen (1980), Asset Markets, Exchange Rates and Economic Integration. Cambridge: Cambridge University Press.

Bayoumi, T., L. Sarno, and M.P. Taylor (1999), European Capital Flows and Regional Risk. The Manchester School 67: 39 – 59.

Benigno, P. (2001), Optimal Monetary Policy in a Currency Area. Mimeo. Department of Economics. New York University.

Berger, A.N., R. DeYoung, and G.F. Udell (2000), Efficiency Barriers to the Consolidation of the European Financial Services Industry. European Financial Management (forthcoming).

Calvo, G., 1983. Staggered prices in a utility-maximizing framework, Journal of Monetary Economics 12, 383 – 398.

Centeno, M. and A.S. Mello (1999), How Integrated are the Money Market and the Bank Loan Market Within the European Union? Journal of International Money and Finance (18): 75 – 106.

Danthine, J.-P., F. Giavazzi, and E.-L. von Thadden (2000), European financial markets after EMU: a first assessment. Centre for Economic Policy Research (CEPR). Discussion paper 2413. London.

Lemmen, J. (1998), Integrating Financial Markets in the European Union. Cheltenham and Northampton: Edward Elgar.

Lombardo, G. (2002), Imperfect Competition, Monetary Policy, and Welfare in a Currency Area. Mimeo. Deutsche Bundesbank, Frankfurt a.M., Germany.

Marston, R.C. (1985), Financial Disturbances and the Effects of an Exchagne Rate Union. In J. Bhandari (ed.): Exchange Rate Management Under Uncertainty. Cambridge, Mass.: MIT Press: 272 – 291.

Obstfeld, M. and K. Rogoff (1995), Exchange rate dynamics redux, Journal of Political Economy 103, 624 – 660.

Obstfeld, M. and K. Rogoff (1996), Foundations of International Macroeconomics. Cambridge, Mass.: MIT Press.

Schmitt-Grohe, S. and M. Uribe (2001), Closing small open economy models, manuscript, University of Pennsylvania, November 2001.

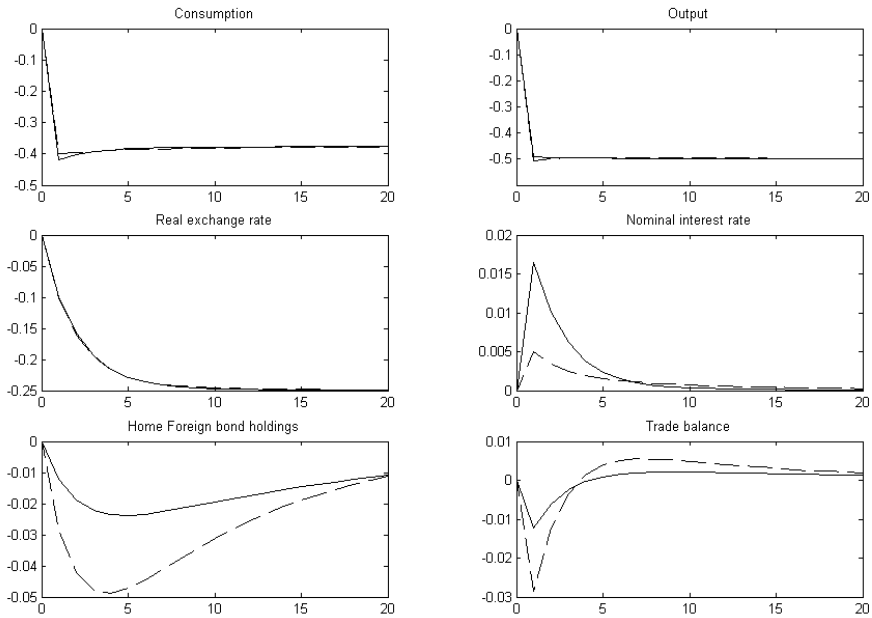
Senay, Ö. (1998), The Effects of Goods and Financial Market Integration on Macroeconomic Volatility. The Manchester School Supplement: 39 – 61.

Sutherland, A. (1996), Financial market integration and macroeconomic volatility, Scandinavian Journal of Economics 98, 521 – 539.

Tille, C. (2001), The role of consumption substitutability in the international transmission of monetary shocks, Journal of International Economics 53, 421 – 444.

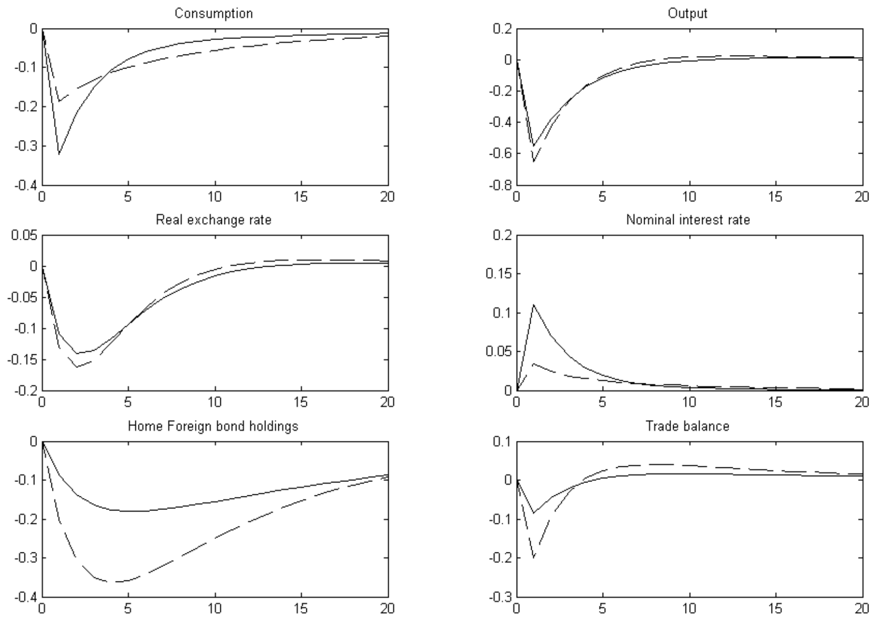
## Figures and Tables

Figure 1 — Financial market integration and the dynamic response of Home variables to a permanent Home technology shock



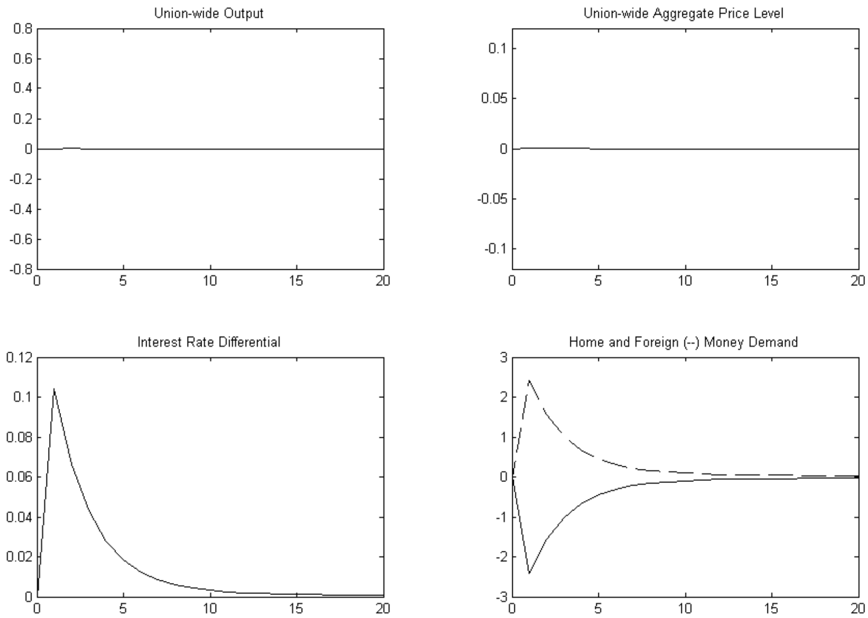

*Note*: Dashed lines obtain when setting $\psi_1 = 0.5$ and solid lines obtain when setting $\psi_1 = 5.0$. Consumption, output and the real exchange rate are measured as percentage deviations from the steady state. Bond holdings are measured as percentage deviations from the steady state consumption level. The interest rate is measured in terms of percentage point deviations from the steady state. The productivity shocks are assumed to evolve according to the first-order autoregressive process given in Eq. (24) with $\phi = 1.0$. The Home and Foreign productivity shocks are perfectly negatively correlated.

Figure 2 — Financial market integration and the dynamic response of Home variables to a transitory Home technology shock




*Note*: Dashed lines obtain when setting $\psi_1 = 0.5$ and solid lines obtain when setting $\psi_1 = 5.0$. Consumption, output and the real exchange rate are measured as percentage deviations from the steady state. Bond holdings are measured as percentage deviations from the steady state consumption level. The interest rate is measured in terms of percentage point deviations from the steady state. The productivity shocks are assumed to evolve according to the first-order autoregressive process given in Eq. (24) with $\phi = 0.7$. The Home and Foreign productivity shocks are perfectly negatively correlated.

Figure 3 — Financial market integration and the dynamic response of selected union-wide variables to a transitory asymmetric productivity shock




*Note*: The parameter describing the first component of the transaction cost for undertaking cross-border financial transactions is set equal to $\psi_1 = 5.0$. The Union-wide output is computed as the population weighted sum of the respective national output levels. Output, the aggregate price level and money demand are measured as percentage deviations from the steady state. The interest rate differential is measured in terms of percentage point deviations from the steady state. The productivity shocks are assumed to evolve according to the first-order autoregressive process given in Eq. (24) with $\phi = 0.7$. The Home and Foreign productivity shocks are perfectly negatively correlated.

Table 1 — The calibrated parameters

| *Parameter* | *Value* | *Description* |
|---|---|---|
| $\beta$ | 1/1.05 | Subjective discount factor |
| $\theta$ | 6.0 | Elasticity of substitution between goods produced in the same country |
| $\rho$ | 4.0 | Elasticity of substitution between Home and Foreign goods |
| $\psi_1$ | 5.0 (0.5) | First component of costs for undertaking positions in international financial market in the case of low (high) capital mobility |
| $\psi_2$ | 0.05 | Second component of costs for undertaking positions in international financial market |
| $n$ | 0.5 | Country size |
| $\phi$ | 1.0 (0.7) | Persistence of a permanent (temporary) productivity shocks |
| $\sigma$ | 0.01 | Standard deviation of productivity shocks |

Table 2 — Financial market integration and business cycle volatility

| *Parameter* | *Value* | $\sigma_{\hat{y}}$ | $\sigma_{\hat{C}}$ |
|---|---|---|---|
| Panel A: $\psi_1 = 5.0$ | | | |
| $\tilde{\rho}$ | 2<br>4 | 7.46<br>7.59 | 4.44<br>4.87 |
| $\gamma$ | 0.3<br>0.6 | 7.59<br>7.53 | 4.33<br>4.49 |
| Panel A: $\psi_1 = 0.5$ | | | |
| $\tilde{\rho}$ | 2<br>4 | 8.43<br>8.78 | 3.57<br>4.19 |
| $\gamma$ | 0.3<br>0.6 | 8.66<br>8.53 | 4.19<br>3.70 |

*Note*: The table reports standard deviations for Home output, $\sigma_{\hat{y}}$ and consumption, $\sigma_{\hat{C}}$, for alternative values of the cross-country elasticity of goods, $\tilde{\rho}$, and the parameter capturing the degree of price stickyness, $\gamma$. To compute the standard deviations, 100 time series of the endogenous variables of the model were generated, each time series consisting of 500 observations. In the simulations it was assumed that Home and Foreign productivity shocks are perfectly negatively correlated. The productivity shocks are assumed to evolve according to the first-order autoregressive process given in Eq. (24) with $\phi = 0.7$.