EUROPEAN CENTRAL BANK

WORKING PAPER SERIES

ECB EZB EKT BCE EKP

WORKING PAPER NO. 286

COUNTRY AND SECTOR-SPECIFIC SPILLOVER EFFECTS IN THE EURO AREA, THE UNITED STATES AND JAPAN

BY BERND KALTENHAEUSER

November 2003

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES

WORKING PAPER NO. 286

COUNTRY AND SECTOR-SPECIFIC SPILLOVER EFFECTS IN THE EURO AREA, THE UNITED STATES AND JAPAN

BY BERND KALTENHAEUSER

November 2003

1 A substantial part of the paper was written while I was visiting the Research Department of the European Central Bank as part of the Graduate Research Programme 2002. I am grateful to an anonymous referee and seminar participants at the European Central Bank for helpful comments and thank the European Central Bank for its hospitality. The opinions expressed in this paper are my own and do not necessarily reflect the views of the Deutsche Bundesbank or the European Central Bank. This paper can be downloaded without charge from http://www.ecb.int or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=487449.

2 Deutsche Bundesbank, Wilhelm-Epstein-Str. 14, D-60431 Frankfurt/Main, Germany, Email: bernd.kaltenhaeuser@bundesbank.de

Address	**Kaiserstrasse 29**
	D-60311 Frankfurt am Main
	Germany
Postal address	**Postfach 16 03 19**
	D-60066 Frankfurt am Main
	Germany
Telephone	**+49 69 1344 0**
Internet	**http://www.ecb.int**
Fax	**+49 69 1344 6000**
Telex	**411 144 ecb d**

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

Contents

Abstract

Within a two-step GARCH framework we explore the linkages between equity returns of ten sectors in the euro area, the United States and Japan, respectively. Our estimation framework allows a distinction to be made between spillover effects originating from one of the three currency areas and intra-sectoral spillover effects. We use daily data from the period between January 1986 and October 2002.

We find that, during the late 1990s, the worldwide importance of European equity markets has increased considerably. More precisely, price innovations in European equities (both aggregate returns and sector returns) have doubled or tripled their impact on other stock markets. At the same time, there is evidence that sectors have become more heterogeneous in each of the three currency areas, ie the response to aggregate shocks has increasingly varied across sectors. Spillover effects of aggregate market innovations have generally outweighed intra-sectoral spillover effects. Overall, the process towards higher integration has been primarily a phenomenon of equity markets in the euro area and the United States.

Keywords: equity returns, spillover effects, country-specific, sector-specific, financial integration

JEL classification: F36, G15

Non-technical summary

The introduction of the euro at the beginning of 1999 constituted a major step towards an integrated European equity market. A higher degree of integration may be reflected in a greater influence of the European market on other major world stock markets. Furthermore, stock prices are one indicator that central banks use to assess economic conditions. In order to promote the understanding of stock price movements, the present paper investigates how price innovations in equity markets are propagated between the major global stock markets and whether the propagation mechanism has changed over time.

To investigate the linkages among equity markets, a distinction can be made between three types of spillover effects: first, cross-country linkages, second, cross-sector linkages *within* a given country or currency area and, third, linkages among equivalent sectors *across* countries, ie intra-sectoral linkages. This paper focuses on the latter two types of spillover effects.

We estimate an empirical model of daily return spillover effects, which enables us to make statements about the degree of equity market integration at the industry level by investigating the exposure of different sectors in different currency areas to country-specific and sector-specific shocks. Cross-sector linkages within a given country or currency area are measured as the exposure of a given sector to innovations in the domestic aggregate market. Intra-sectoral linkages are investigated by estimating the spillover effects between equivalent industries in different currency areas. The more heavily an industry return is dependent on domestic market shocks, the more integrated the return becomes domestically (cross-sector dimension). The more heavily an industry return is dependent on foreign sector-specific shocks, the more integrated it becomes at the cross-country industry level. We identify country-specific and sector-specific shocks in a multivariate GARCH framework.

We find that the importance of European equity markets in the world has increased considerably over time. More precisely, price innovations in European equities, stemming from both aggregate returns and sector returns, have doubled or tripled their impact on other stock markets. At the same time, there is evidence that sectors have become more heterogeneous in each of the three currency areas, ie the response to aggregate shocks has increasingly varied across sectors. Furthermore, country-specific spillover effects have generally outweighed sector-specific spillover effects. For example, a European sector responded more strongly to US market innovations than to innovations in its US counterpart. Overall, we find that the process towards greater integration has been primarily a phenomenon of equity markets in the euro area and the United States. There is no sign of a comparable process taking place with respect to the Japanese equity market.

1 Introduction

The introduction of the euro at the beginning of 1999 is likely to have had an impact on the allocation of capital on international financial markets. With the introduction of the euro, the exchange rate risk between European Monetary Union (EMU) member states was eliminated. Since then, stocks in the participating countries have been quoted in one currency – the euro – rather than in different domestic currencies. Undoubtedly, EMU constituted a major step towards an integrated European equity market, which may be reflected in a larger influence of the European market on other major world stock markets.

While the euro area financial system is still dominated by bank intermediation, stock prices may influence the economy through cost of capital, wealth, confidence and balance sheet effects. Further, as stock prices reflect the discounted stream of expected dividends, they are inherently forward-looking and, thus, a useful indicator of market participant's expectations regarding future economic developments. Therefore, stock prices are one indicator that central banks use to assess economic conditions[1] and it appears useful to explore the mechanisms of the determination of stock prices further.

To investigate the linkages among equity markets, a distinction can be made between three types of spillover effects: On the one hand, cross-country linkages at the aggregated country level and, on the other hand, cross-sector and intra-sectoral linkages at the more disaggregated industry level. Cross-country linkages between aggregated market indices have been used by Fratzscher (2001) to address the issue of financial integration in Europe. Spillover mechanisms at the industry level are the subject of the present paper. Therefore, cross-sector linkages *within* a given country or currency area, measured as the exposure of a given sector to innovations in the domestic aggregate market, and linkages among equivalent sectors *across* countries, ie intra-sectoral linkages, are investigated.

Recently, there has been evidence of a closer co-movement of national stock markets. The source of the increase in co-movements can be attributed to the declining importance of country-specific factors in the determination of stock prices, as is argued by Brooks and DelNegro (2002b). In addition, Campbell et al (2001) provide evidence that returns at the firm level show increasingly idiosyncratic risk, which points to a strengthened influence of firm-specific factors. Fratzscher (2001) investigated the spillover effects of European and US returns to several national equity returns. He found evidence of an increased impact of

[1] For a more thorough discussion of the relationship between the stock market and monetary policy see European Central Bank (2002).

aggregate European shocks on most European stock markets over time. This was, however, more a cyclical process than a smooth, linear one.

But to what extent has the increase in cross country co-movement led to an increase in co-movement among sectors across currency areas? This paper explores the evolution of sector-specific spillover effects between different currency areas, while accounting for country-specific market innovations. Against this background, we revisit the relative importance of sector and country-specific effects in industry returns. In addition, identifying the direction of the shock transmission allows us to assess, whether and how the global importance of European equity markets has changed over time.

Our sample consists of the euro area, the United States and Japan. We employ a generalised autoregressive conditional heteroskedasticity (GARCH) framework to take account of the time variation and persistence of volatility and perform rolling estimations to explore the time-varying nature of the spillover effects. “Euro area” and “European” are used synonymously throughout the paper.

We find that, during the late 1990s, the global importance of European equity markets in the world has increased considerably. More precisely, price innovations in European equities, both aggregate returns and sector returns, have doubled or tripled their impact on other stock markets. At the same time, there is evidence that sectors have become more heterogeneous in each of the three currency areas, ie the response to aggregate shocks has increasingly varied across sectors. Although decreasing in 1999/2000, spillover effects of aggregate market innovations have outweighed intra-sectoral spillover effects over most of the sample period.

The remainder of the paper is organised as follows: section two provides an overview of the literature; section three outlines the econometric framework we use; section four presents the data; section five discusses the results and section six presents conclusions.

2 Relevant literature

There is a long tradition of investigating co-movements in international stock markets. Several approaches have been pursued. First, starting from a solid theoretical foundation, various versions of the capital asset pricing model (CAPM), developed by Sharpe (1964), Lintner (1965), and Mossin (1966), have been applied. In the CAPM, asset returns in excess of the risk-free interest rate are proportional to the non-diversifiable market risk. Therefore, a single factor drives asset returns. In fully integrated markets, stocks and portfolios depend only on the market risk factor. In countries with different currencies, exchange rate risk is another risk factor of individual returns. In completely segmented markets, however, excess returns depend only on the local price of risk. Hardouvelis et al (1999), for example, estimated several versions of the CAPM allowing for a time-varying degree of financial integration, modelled as the weight of the EU-wide risk factor as opposed to country-specific risk factors. They found that during the period from 1991 to 1995 local risk factors accounted for an average of 77% of total expected returns across the 11 starting members of EMU and the United Kingdom. From 1996 to 1998 the average impact of local risk factors dropped to 34%, suggesting a considerable increase in stock market integration over time.

Second, Brooks and DelNegro (2002a, 2002b), Heston and Rouwenhorst (1994, 1995), Rouwenhorst (1999), and Campbell et al (2001) adopted a more micro-based approach. Heston and Rouwenhorst (1994, 1995) and Rouwenhorst (1999) collected individual stock returns and ran cross-sectional regressions on country and industry dummies in order to quantify the sector-specific and the country-specific components of stock returns. Up to the late 1990s, country effects far outstripped sector-specific effects.

Recently, Brooks and DelNegro (2002a) have updated the Heston and Rouwenhorst estimations using an enlarged sample. They find that, at the global level, industry effects have increased since the mid-1990s and have been outgrowing country effects since 1999. However, once the telecommunications, media, biotechnology and information technology (TMBT) sectors are excluded, there is no evidence in mature markets – except Europe – that industry effects have become more important than country effects. In Europe, however, there has been a broad-based increase in the relative and absolute importance of industry effects with or without TMBT firms. This is a relatively recent phenomenon, which was not obvious until August 1998 when Rouwenhorst’s (1999) sample period ends.

Brooks and DelNegro (2002b) estimated a factor model, which distinguishes firm level equity returns in terms of a global factor, a country-specific component, an industry-specific component and a firm-specific component. In contrast to the Heston and Rouwenhorst approach, the factor model relaxes the assumption that all firms have the same exposure to their given country or industry factor. They found evidence over the 1990s of an increased importance of the global factor, an unchanged impact of industry factors and, most importantly, a waning impact of country-specific factors in stock markets. Their results suggest that the increased co-movement of national stock markets is mainly due to the decline of the importance of country-specific factors.

Campbell et al (2001) investigated the long-run behaviour of the volatility of stocks and its sources at the market, industry and firm levels. As outlined above, the CAPM predicts a proportional relation between industry returns and the market return as well as between individual stock returns and the respective industry return or market return. The degree of proportionality is measured by the respective beta. In order to circumvent the problem of time-varying betas, Campbell et al computed weighted averages of firm-level volatility across firms in one industry, weighted averages of industry volatility across industries and market volatility. That allowed for a beta-free variance decomposition, since the weighted betas aggregate out. They found that firm volatility is clearly the largest component of volatility of US stocks explaining about 72% of the unconditional mean of total volatility of an average firm. The shares of market volatility and industry volatility are 16% and 12%, respectively. While market and industry volatilities in levels are stable in the sample period (despite some spikes during recessions and crashes), the average firm volatility measure increased steadily over the sample period (including in addition to some spikes during recessions and crashes). This points to a declining correlation among individual stock returns, which is actually the case as Campbell et al show.

Third, some authors used more aggregate measures such as country and sector returns to investigate the relation between country and sector-specific factors or to estimate their interdependence with European or international returns. Along those lines, Fratzscher (2001) investigated the size of spillovers from European and US stock markets to individual countries using a trivariate GARCH model. He found evidence of a higher degree of integration between equity markets of several European countries since 1996, which, he argues, is mainly attributable to a decrease in exchange rate volatility.

Berben and Jansen (2002) developed a novel bivariate GARCH model with smoothly time-varying correlation to test for an increase in co-movements between equity returns at the market and the industry levels. They found that conditional correlations between Germany, the United Kingdom and the United States doubled in the period between 1980 and 2000 and that no specific sectors played a dominant role in this process of integration. Conditional correlations with Japan remained at the low level of the 1980s.

Adjaoute and Danthine (2000, 2001) used country returns and returns of the same sector in different countries and calculated sub-period correlations as well as dispersions of weekly sector and country returns. They found upward trending correlations (and decreasing dispersion) for the pre-euro or convergence period. However, after the introduction of the euro, correlations between sectors and countries are significantly lower (higher dispersions) than before. One possible conclusion is that dispersions fluctuate cyclically and are unrelated to the degree of integration.

Baele (2002) investigated the magnitude and the time-varying nature of volatility spillovers from aggregate European and US equity market indices to 13 local European equity markets. Baele proceeded in two steps. First, he estimated several bivariate models to isolate pure European and pure US innovations. Second, these innovations were used as additional explanatory variables for several local county returns. The novelty of the paper was to allow for Markovian regime switches in the shock spillover intensity. Baele found strong evidence of regime switches in spillover intensity. On average, the dominant market for EMU member countries is the aggregate European market, while for most non-EMU countries that role is still played by the US market.

The present paper estimates the level of co-movement in equity returns at a disaggregated level. Our identification method separates the country-specific impact from the sector-specific impact in a – to the authors best knowledge – unprecedented manner. We identify sector-specific spillover effects between different currency areas, while accounting for country-specific shocks. We ask how a given sector is affected by domestic and foreign market innovations and innovations to its foreign counterparts and infer the degree of integration from the size of these spillover effects. Section 3 describes the estimation technique in greater detail.

3 Framework of analysis

Ultimately, we are interested in the degree of integration at the industry level and how it has changed over time. As already mentioned, we distinguish two types of integration at the industry level.[2] These are: first, cross-sector linkages *within* a given country or currency area, measured as the exposure of a given sector to innovations to the domestic aggregate market, and, second, linkages among equivalent sectors *across* countries, ie intra-sectoral linkages. The degree of integration is defined in terms of spillover effects. An industry return is more integrated with respect to the domestic cross-sector dimension the stronger the return depends on domestic market shocks. It is more integrated at the cross-country industry level the stronger the return depends on foreign sector-specific shocks.[3]

In order to quantify the spillover effect, we need to identify country-specific and sector-specific effects in industry returns. We proceed in two steps. First, we estimate a trivariate GARCH model of European, US and Japanese market returns in order to identify the respective country-specific shocks. Second, another trivariate GARCH model of European, US and Japanese equity returns of a given sector is estimated to identify the sector-specific shocks and the

[2] In addition to cross-country integration at the country level.

[3] For an identical interpretation of the coefficient on spillover effects as a measure of the degree of integration of equity markets see Fratzscher (2001), p 11.

spillover mechanism. The model allows for spillover effects between sector returns and volatilities over and above the prior identified country-specific shocks. In order to focus only on shocks that are external to each sector, the country returns used as input in step one exclude the sector under consideration in step two. Thus, the respective country returns $r_{EMU,t}$, $r_{US,t}$, $r_{JA,t}$ for each individual sector *i* were calculated as

$$r_{country,t} = \sum_{k \neq i} w_{k,t} r_{k,t} \Big/ \sum_{k \neq i} w_{k,t} \qquad (1)$$

with *k* including all domestic sectors, except for sector *i*, and $w_{k,t}$ as the weight of sector *k* at time *t* in the total domestic market. The rationale for the two-step procedure is to limit the number of coefficients during the estimation process.

Equity returns are assumed to consist of a predictable, μ_t, and an unpredictable part, e_t.

$$\begin{bmatrix} r_{EMU,t} \\ r_{US,t} \\ r_{JA,t} \end{bmatrix} = \begin{bmatrix} \mu_{EMU,t} \\ \mu_{US,t} \\ \mu_{JA,t} \end{bmatrix} + \begin{bmatrix} e_{EMU,t} \\ e_{US,t} \\ e_{JA,t} \end{bmatrix} \qquad (2)$$

In step one, the predictable part is modelled as a constant and the lagged return. The unpredictable part is assumed to consist of the innovations to returns while allowing for spillover effects between the euro area, the Unites States and Japan. Note that, because of the difference in trading hours, European innovations are only allowed to affect Japanese returns with a lag of one day and US shocks are only allowed to affect European and Japanese returns on the following day. L denotes the lag operator.

$$\begin{bmatrix} \mu_{EMU,t} \\ \mu_{US,t} \\ \mu_{JA,t} \end{bmatrix} = \begin{bmatrix} c_{EMU} \\ c_{US} \\ c_{JA} \end{bmatrix} + \begin{bmatrix} \alpha_{EMU} r_{EMU,t-1} \\ \alpha_{US} r_{US,t-1} \\ \alpha_{JA} r_{JA,t-1} \end{bmatrix} \qquad (3)$$

$$\begin{aligned} \begin{bmatrix} e_{EMU,t} \\ e_{US,t} \\ e_{JA,t} \end{bmatrix} &= \begin{bmatrix} 1 & 0 & \gamma_{JA,EMU} \\ \gamma_{EMU,US} & 1 & \gamma_{JA,US} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{EMU,t} \\ \varepsilon_{US,t} \\ \varepsilon_{JA,t} \end{bmatrix} + \begin{bmatrix} 0 & \gamma_{US,EMU} & 0 \\ 0 & 0 & 0 \\ \gamma_{EMU,JA} & \gamma_{US,JA} & 0 \end{bmatrix} \begin{bmatrix} \varepsilon_{EMU,t-1} \\ \varepsilon_{US,t-1} \\ \varepsilon_{JA,t-1} \end{bmatrix} \\ &= \begin{bmatrix} 1 & \gamma_{US,EMU} \cdot L & \gamma_{JA,EMU} \\ \gamma_{EMU,US} & 1 & \gamma_{JA,US} \\ \gamma_{EMU,JA} \cdot L & \gamma_{US,JA} \cdot L & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{EMU,t} \\ \varepsilon_{US,t} \\ \varepsilon_{JA,t} \end{bmatrix} \end{aligned} \qquad (4)$$

The vector of innovations, ε_t, is assumed to be normal distributed conditional on the past information set, Ω_{t-1}, that is $\varepsilon_t | \Omega_{t-1} \sim N(0, H_t)$. H_t denotes the time-varying variance covariance matrix. The assumption of conditionally normal distributed innovations does not *per se* contradict the empirical evidence of excess kurtosis in the unconditional returns.

Conditional normal distributed innovations are able to produce excess kurtosis in the unconditional returns when volatility exhibits some persistence.

The time-varying variances for euro area, US and Japanese returns are assumed to depend only on own lagged values and own lagged squared innovations. However, we allow for volatility spillovers between the euro area, the United States and Japan applying the same lag structure as in the return equation. Covariances are not modelled to limit the number of coefficients to be estimated.

$$\begin{bmatrix} s^2_{EMU,t} \\ s^2_{US,t} \\ s^2_{JA,t} \end{bmatrix} = \begin{bmatrix} w_{EMU} \\ w_{US} \\ w_{JA} \end{bmatrix} + \begin{bmatrix} a_{11} e^2_{EMU,t-1} \\ a_{22} e^2_{US,t-1} \\ a_{33} e^2_{JA,t-1} \end{bmatrix} + \begin{bmatrix} b_{11} s^2_{EMU,t-1} \\ b_{22} s^2_{US,t-1} \\ b_{33} s^2_{JA,t-1} \end{bmatrix} + \begin{bmatrix} 0 & d_{US,EMU} \cdot L & d_{JA,EMU} \\ d_{EMU,US} & 0 & d_{JA,US} \\ d_{EMU,JA} \cdot L & d_{US,JA} \cdot L & 0 \end{bmatrix} \begin{bmatrix} e^2_{EMU,t} \\ e^2_{US,t} \\ e^2_{JA,t} \end{bmatrix} \qquad (5)$$

After having obtained estimates for the innovations to euro area, US and Japanese returns, we proceed with step two by estimating the trivariate GARCH model for the returns of the *i*th sector in each of the three currency areas allowing for spillover effects in returns and volatilities between sectors as well as for country-specific shocks. Recall that sector *i* was excluded from aggregate market returns when country-specific shocks were identified.

As in step one, returns are assumed to consist of a predictable part and an unpredictable part. The predictable part is modelled as a constant, the own lagged return and the three country-specific shocks identified in step one. The unpredictable part, $e_{i,t}$, is assumed to consist of three sector-specific return innovations while allowing for intra-sectoral spillover effects between the euro area, the US and Japan. European and US return innovations are only allowed to affect Japanese returns with a lag of one day because of the difference in trading hours. The same logic applies to US returns with respect to European returns. The time-varying variances for industry returns were modelled as those for country returns in step one.

$$\begin{bmatrix} r_{i,EMU,t} \\ r_{i,US,t} \\ r_{i,JA,t} \end{bmatrix} = \begin{bmatrix} c_{i,EMU} \\ c_{i,US} \\ c_{i,JA} \end{bmatrix} + \begin{bmatrix} a_{i,EMU} r_{i,EMU,t-1} \\ a_{i,US} r_{i,US,t-1} \\ a_{i,JA} r_{i,JA,t-1} \end{bmatrix} + \begin{bmatrix} h_{i,EMU} & h_{i,US,EMU} \cdot L & h_{i,JA,EMU} \\ h_{i,EMU,US} & h_{i,US} & h_{i,JA,US} \\ h_{i,EMU,JA} \cdot L & h_{i,US,JA} \cdot L & h_{i,JA} \end{bmatrix} \begin{bmatrix} e_{EMU,t} \\ e_{US,t} \\ e_{JA,t} \end{bmatrix} + \begin{bmatrix} e_{i,EMU,t} \\ e_{i,US,t} \\ e_{i,JA,t} \end{bmatrix}$$

(6), where

$$
\begin{bmatrix} e_{i,EMU,t} \\ e_{i,US,t} \\ e_{i,JA,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & \phi_{i,JA,EMU} \\ \phi_{i,EMU,US} & 1 & \phi_{i,JA,US} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{i,EMU,t} \\ \varepsilon_{i,US,t} \\ \varepsilon_{i,JA,t} \end{bmatrix} + \begin{bmatrix} 0 & \phi_{i,US,EMU} & 0 \\ 0 & 0 & 0 \\ \phi_{i,EMU,JA} & \phi_{i,US,JA} & 0 \end{bmatrix} \begin{bmatrix} \varepsilon_{i,EMU,t-1} \\ \varepsilon_{i,US,t-1} \\ \varepsilon_{i,JA,t-1} \end{bmatrix}
$$

$$
= \begin{bmatrix} 1 & \phi_{i,US,EMU} \cdot L & \phi_{i,JA,EMU} \\ \phi_{i,EMU,US} & 1 & \phi_{i,JA,US} \\ \phi_{i,EMU,JA} \cdot L & \phi_{i,US,JA} \cdot L & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{i,EMU,t} \\ \varepsilon_{i,US,t} \\ \varepsilon_{i,JA,t} \end{bmatrix} \qquad (7)
$$

Our main focus is twofold. First, it is on the spillover coefficients of aggregate European, US and Japanese innovations to the return of sector *i*, that is $\eta_{i,...}$. Here, the relative importance of European, US and Japanese equity markets for individual sectors can be identified. Furthermore, $\eta_{i,EMU}$, $\eta_{i,US}$ and $\eta_{i,JA}$ measure the degree of co-movement with the domestic market return. A coefficient close to one on the corresponding aggregated home market implies minor sector-specific effects and therefore little diversification gains relative to the aggregate market.

Second, we look at intra-sectoral spillover effects, denoted with ϕ. $\phi_{i,X,Y}$ describes the spillover effect from sector *i* in country *X* to sector *i* in country *Y*. This allows us to make statements about the degree of international financial integration at the industry level.

The parameters of the system are estimated by maximising a multivariate log likelihood function. Since the conditional distribution of the innovations are assumed to be Gaussian, the conditional distribution of the returns is also Gaussian and the likelihood function for one observation is given by

$$
f\left(y_t \mid \mu_t, y_{t-1}, y_{t-2}, \ldots, y_0\right) = \frac{1}{\sqrt{2\pi\sigma_t^2}} \exp\left(\frac{-\left(y_t - \mu_t\right)^2}{2\sigma_t^2} \right) \qquad (8).
$$

The likelihood function of the entire sample is the product of the likelihood functions of all individual observations. Equivalently, the log likelihood function $L(\theta)$ of the entire sample is the sum of the log likelihood functions of all individual observations:

$$
L(\theta) = \sum_{t=1}^{T} \log f\left(y_t \mid \mu_t, y_{t-1}, y_{t-2}, \ldots, y_0; \theta\right) = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\log\left(\sigma_t^2\right) - \frac{1}{2}\sum_{t=1}^{T}\log\left(\frac{\left(y_t - \mu_t\right)^2}{\sigma_t^2} \right) \qquad (9).
$$

In the multivariate case the part of the log likelihood function that is to be maximised becomes $L(\theta) = -\frac{1}{2}\sum_{t=1}^{T}\left(\log\left|H_t\right| + \varepsilon'_t H_t^{-1} \varepsilon_t\right)$. Initial values are obtained using the Simplex algorithm, after which the numerical maximisation procedure of Berndt, Hall, Hall, and Hausmann (1974) is employed to estimate the coefficients.

4 Data

We use stock market indices and data on market values for the euro area, the United States and Japan from Datastream International at daily frequency. At the industry level, we follow the broad distinction of ten economic sectors according to the Financial Times Actuaries, which Datastream uses: basic industries, cyclical consumer goods, cyclical services, financials, general industrials, information technology, non-cyclical consumer goods, non-cyclical services, resources, and utilities (see table 1 for a more detailed description). Datastream indices target 80% coverage of market capitalisation of the relevant investable universe.

Our sample starts on 1 January 1986 and ends on 31 October 2002 for a total of 4391 observations. Returns are computed as the first difference of the logarithm of the index. All indices are total return indices and are expressed in US dollar. Tables 2 to 4 show some descriptive statistics. Almost all returns have a positive mean (except the Japanese financial sector) and most of them (but not all) are negatively skewed. All returns show the well-known properties of excess kurtosis (leptokurtic) and autocorrelations in squared returns. The hypothesis of normal distributed returns (Jarque-Bera) is always rejected at the 1% level of significance.

Table 5 shows the *intra-sectoral* correlation coefficients at different leads and lags in order to take account of the difference in trading hours. Table 6 displays the average correlation coefficient of aggregate market returns with foreign market indices. Table 7 shows the average correlation coefficient of the return of each industry (and the aggregate) with each of the remaining industries *in the same* currency area. It is obvious that, over the entire sample period, average intra-sectoral correlations were clearly lower than average correlations among the different sectors within one currency area, although the former has been increasing recently and the latter has been decreasing over the past decade. For example, the correlation among industries is relatively high in the euro area and Japan (0.69) and somewhat lower in the United States (0.61). Average intra-sectoral correlations, however, move between 0.07 and 0.28. Even the IT sector, which is generally the most highly correlated sector across countries, remains more strongly correlated with other sectors of its own currency area (min: 0.54 in the United States; max: 0.64 in Japan) than with foreign IT sectors (min: 0.1 between United States and Japan; max: 0.34 between EMU and US-lagged). This simple correlation analysis suggests that intra-sectoral spillover effects are still dominated by country-specific spillover effects (referring to the euro area as a country). However, over time, country-specific effects seem to have moderated, while sector-specific effects have gained in importance.

5 Results

We report the results of rolling estimations of one year windows moved month by month, which translate into 191 estimates for each coefficient. Given that we look at country-specifc and intra-sectoral spillover effects for a total of 30 sectors, we cannot show the results in all details. Therefore, we structure the presentation of our results as follows. After presenting some general results, we discuss the results for each currency area separately beginning with country-specific spillover effects followed by sector-specific spillover effects. The annex provides point estimates, standard errors and significance values for the entire sample period and four sub-periods (see table 8) and detailed figures for the euro area. Figures for the United States and Japan show only the average impact on sectors (mean across sectors) and its variance.

5.1 General results for the euro area, the United States and Japan

Throughout the sample period all industry returns have been strongly dominated by their respective domestic market return (measured as the value-weighted return of all other industries in that economy). However, the impact of the domestic market on most of the sectors has trended downwards over the sample period. During 1999/2000, the impact of the aggregate market on most sectors fell sharply but recovered thereafter. Thus, during the boom in technology stock prices, the diversity of industry returns increased considerably.[4]

Further, domestic market innovations no longer affect sectors in one currency area in a similar way. In other words, sectors in each of the three currency areas have become considerably more heterogeneous over the sample period. The observation of increased heterogeneity of industry returns is a worldwide phenomenon. European and Japanese sectors showed that feature only after 1998, whereas, in the United States, this trend started in the early 1990s. On the other hand, a given sector (eg basic industries) – regardless of whether it is located in the euro area, the Unites States or Japan – has been, in general, similarly affected by domestic aggregate shocks.

Country-specific spillover effects between the euro area and the United States have generally outweighed sector-specific spillover effects (see figures 1 and 2 for averages).[5] This means that a European sector responded more strongly to US market innovations than to innovations in its US counterpart. Only during 1999/2000, for a number of sectors (basic industries, cyclical

[4] Further estimations revealed that this effect does not disappear - though it weakens somewhat - once the IT sector is excluded from the measure of aggregate returns.

[5] Very small spillover effects (coefficients below 0.05) are often insignificant. As a rough indicator, coefficients above 0.1 are in general highly significant.

consumer goods, financials, IT, non-cyclical consumer goods, utilities in the euro area and United States) sector-specific innovations dominated market innovations. The results regarding Japan are more mixed, partly due to the relatively small size of both country and sector-specific spillover effects.

The size of sector-specific spillover effects has varied widely. Some industries, such as cyclical services, general industrials and utilities, were found to be little affected by their respective sector-specific shocks. Other industries, such as information technology, resources and non-cyclical consumer goods, were found to be more intensively linked with their foreign counterparts.

The Japanese equity market seemed to be less affected by price innovations, both sector and aggregate, in foreign equity markets and had also little impact on foreign equity markets. The European equity market has increased its impact on foreign equity markets since the late 1990s and has become simultaneously more exposed to US shocks. Consequently, equity markets in the US have become more affected by European price innovations, while having itself a sizeable impact on foreign markets. Thus, equity markets in the euro area and the United States have become more integrated with each other during the late 1990s. This increase in integration was especially pronounced for sectors although at a lower absolute level compared to the aggregate market. Overall, the results of the correlation analysis are confirmed.

5.2 Euro area industries

5.2.1 Impact of country-specific shocks

Figures 3 to 8 display the time-varying coefficient of the spillover effect from European, lagged US and Japanese market return innovations to European industry returns. Figures 9 and 10, respectively, show the mean and the variance of the above-mentioned spillover coefficients across European sectors.

Over the entire sample period, the dominant driving force for European sectors was the aggregate European market. During the peak of the so-called stock market bubble in 1999/2000, the impact of the European market decreased somewhat but has recovered recently to levels comparable to those prevailing in the 1990s. The impact of the US market was considerably smaller but highly significant; the coefficient fluctuates around 0.3, a level less than half of the impact of European market shocks. However, the coefficient also decreased during 1999/2000 but rebounded strongly in 2001/02. The impact of the Japanese market decreased during the early 1990s from a level comparable with the US market to almost negligible levels.

Furthermore, the variance of the average country effect across European sectors increased tremendously in the case of European market innovations and still considerably in case of US market innovations (see figure 10). This points to a substantial increase in the diversity of shock responses of sectors within the euro area. Sectors with large exposure to aggregate shocks are IT and non-cyclical consumer services (including telecommunication services). Sectors with little exposure to aggregate shocks are non-cyclical consumer goods, resources, and utilities.[6]

5.2.2 Impact of sector-specific shocks

The impact of intra-sectoral spillover effects was clearly smaller than the impact of market shocks. However, starting from a low level, the average spillover effect from a US sector to a European sector tripled between 1997 and 2002 (see figure 19).[7] In other words, on average, European industry returns have become more exposed to international sector-specific shocks. Larger spillover effects have been present in the resources sector (probably due to the homogeneity of commodities) and, since 1995, in the IT sector. While the Japanese country component lowered their impact on global stock markets over time, Japanese sectors increased their impact, although it remained very moderate and often insignificant. The degree of heterogeneity (variance of average impact, see figure 20) remained broadly unchanged over the sample period.

5.3 US industries

5.3.1 Impact of country-specific shocks

As for European industries, the domestic stock market played the dominant role for US industries. The average impact, however, was somewhat smaller than in Europe. Again, during 1999/2000, aggregate market innovations played, on average, a smaller role, but rebounded thereafter to 1997 levels. The European market enlarged its impact during the second half of the 1990s. The impact of the Japanese market remained negligible (see figure 11). The diversity of US industries with respect to US market innovations increased, while all US industries were, by and large, similarly affected by European market innovations. (see figure 12).

[6] The size of the spillover effect is independent of the weight of the sector in the country index, because a new value-weighted measure of country returns was calculated that excludes the respective sector.
[7] Simultaneously, many coefficients were shifted from insignificant to highly significant levels.

5.3.2 Impact of sector-specific shocks

Since 1997, European sectors have steadily increased their impact on US industries to unprecedented levels (see figure 21). Although this has been a widespread phenomenon, the pace of the increase has varied across sectors. Resources, non-cyclical consumer goods, IT, basic industries and financials have become earlier more integrated with their European counterparts than cyclical services and general industrials. Japanese industries did not affect their US counterparts significantly.

5.4 Japanese industries

5.4.1 Impact of country-specific shocks

Japanese sectors also remained dominated by domestic market innovations (which also dropped during 1999/2000 and recovered thereafter, see figure 13). European market innovations increased their impact slightly during the late 1990s, while, despite some fluctuations, the impact of US market innovations remained unchanged over the sample period. Japanese sectors also started to exhibit more heterogeneous responses to market innovations in 1998.

5.4.2 Impact of sector-specific shocks

Japanese industries were also less affected by foreign industry shocks than foreign market shocks. Furthermore, the impact of foreign sectors was often insignificant. Since 1999, the impact of European industries on their Japanese counterparts increased considerably (figure 23). Japanese industries were only little influenced by US industry innovations. Only the IT sector has become more exposed to US IT shocks.

6 Conclusion

Our empirical model of daily return spillover effects enables us to make statements about the degree of equity market integration at the industry level by investigating the exposure of different sectors in different currency areas to country and sector-specific shocks. Cross-sector linkages *within* a given country or currency area, measured as the exposure of a given sector to innovations to the domestic aggregate market, and linkages among equivalent sectors *across* countries, ie intra-sectoral linkages, are investigated. An industry return is more integrated domestically (cross-sector dimension) the stronger the return depends on domestic market shocks. It is more integrated at the cross-country industry level the stronger the return depends on foreign sector-specific shocks. We identify country and sector-specific shocks in a multivariate GARCH framework.

We find that, during the late 1990s, the importance of European equity markets in the world has increased considerably. More precisely, price innovations to European equities, both aggregate returns and sector returns, have doubled or tripled their impact on other stock markets. At the same time, there is evidence that sectors have become more heterogeneous in each of the three currency areas, ie the response to aggregate shocks has increasingly varied across sectors.

Country-specific spillover effects between the euro area and the United States have generally outweighed sector-specific spillover effects. For example, a European sector responded more strongly to US market innovations than to innovations in its US counterpart. Only, during 1999/2000, for a number of sectors in the euro area and United States (basic industries, cyclical consumer goods, financials, IT, non-cyclical consumer goods, utilities) sector-specific innovations dominated market innovations.

The Japanese equity market seemed to be less affected by price innovations, both sector and aggregate, in foreign equity markets and had also little impact on foreign equity markets. Equity markets in the US have become more affected by European price innovations. The aggregate US market has maintained its influence on foreign markets, while US sectors have increased their impact, especially on European industries. Thus, the process towards higher integration has been primarily a phenomenon of equity markets in the euro area and the United States.

References

Adjaoute, K. and J.-P. Danthine (2000), EMU and Portfolio Diversification Opportunities, FAME Research Paper No. 31.

Adjaoute, K. and J.-P. Danthine (2001), Portfolio Diversification: Alive and Well in Euroland!, CEPR Discussion Paper No. 3086.

Baele, L. (2002), Volatility Spillover Effects in European Equity Markets: Evidence from a Regime Switching Model, mimeo, University of Ghent.

Berben, R.P. and W.J. Jansen (2002), Comovement in International Equity Markets: A Sectoral View, mimeo, DeNederlandsche Bank.

Berndt, E.K., B.H. Hall, R.E. Hall, and J.A. Hausman (1974), Estimation and Inference in Nonlinear Structural Models, Annals of Economic and Social Measurement 3,4, pp. 653-665.

Billio, M., L. Pelizzon, and D. Satore, (2002), The European Single Currency and the Volatility of European Stock Markets, mimeo, University of Padua.

Brooks, R. and L. Catao (2000), The New Economy and Global Stock Returns, IMF Working Paper 00/216.

Brooks, R. and M. DelNegro (2002a), The Rise in Comovement Across National Stock Markets: Market Integration or Bubble?, IMF Working Paper 02/147.

Brooks, R. and M. DelNegro (2002b), Firm-Level Evidence on Globalization, mimeo.

Campbell, J.Y., M. Lettau, B.G. Malkiel, and Y. Xu (2001), Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk, Journal of Finance, Vol. 56, No. 1, pp. 1-43.

Ehling, P. and S.B. Ramos (2002), The EMU and Strategies of Asset Allocation, mimeo.

European Central Bank (2002), The Stock Market and Monetary Policy, Monthly Bulletin, February.

Fratzscher, M. (2001), Financial Market Integration in Europe: On the Effects of EMU on Stock Markets, ECB Working Paper 48.

Fatas, A. (1997), EMU: Countries or Regions?, European Economic Review, Vol. 41, pp. 743-751.

French and Poterba (1991), Investor Diversification and the Equity Markets, American Economic Review, Vol. 81, pp. 222-226.

Hardouvelis, G., D. Malliaropulos, and R. Priestley (1999), EMU and European Stock Market Integration, CEPR Discussion Paper No. 2124.

Heston, S. and G. Rouwenhorst (1994), Does Industrial Structure Explain the Benefits of International Diversification?, Journal of Financial Economics, Vol. 36, pp. 3-27.

Heston, S. and G. Rouwenhorst (1995), Industry and Country Effects in International Stock Returns, Journal of Portfolio Management, Vol. 21, pp. 53-58.

Licht, A. (1997), Regional Stock Market Integration in Europe, CAER II Discussion Paper No. 15, Harvard Institute for International Development, Cambridge, MA.

Lintner, J. (1965), The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets, Review of Economics and Statistics, Vol. 47, pp. 13-37.

Longin, F. and B. Solnik (1995), Is the Correlation in International Equity Returns Constant: 1960-1990?, Journal of International Money and Finance, Vol. 41, pp. 3-26.

Mossin, J. (1966), Equilibrium in a Capital Asset Market, Econometrica, Vol. 34, pp. 768-783.

Rouwenhorst, G. (1999), European Equity Markets and EMU: Are the Difference Between Countries Slowly Disappearing?, Journal of Portfolio Management.

Sharpe, W. (1964), Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk, Journal of Finance, Vol. 19, pp. 425-442.

Table 1: FTSE Actuaries

BASIC INDUSTRIES	Chemicals
	Construction & Building Materials
	Forestry & Paper
	Steel & Other Metals
CYCLICAL CONSUMER GOODS	Automobiles & Parts
	Household Goods & Textiles
CYCLICAL SERVICES	General Retailers
	Leisure Entertainment & Hotels
	Media & Photography
	Support Services
	Transport
FINANCIALS	Banks
	Insurance
	Life Assurance
	Investment Companies
	Real Estate
	Speciality & Other Finance
GENERAL INDUSTRIALS	Aerospace & Defence
	Electronic & Electrical Equipment
	Engineering & Machinery
INFORMATION TECHNOLOGY	Information Tech Hardware
	Software & Computer Services
NON-CYCLICAL CONSUMER GOODS	Beverages
	Food Producers & Processors
	Health
	Personal Care & Household Products
	Pharmaceuticals & Biotechnology
	Tobacco
NON-CYCLICAL SERVICES	Food & Drug Retailers
	Telecommunication Services
RESOURCES	Mining
	Oil & Gas
UTILITIES	Electricity
	Gas Distribution
	Water

Table 2: Descriptive statistics of euro area equity returns

Tables 2-5: Jarque-Bera and Ljung-Box statistics are all significant at the 1% level, except where indicated (* = significant at 5% level, ** = significant at 10% level, and *** = not significant)

Euro Area 03.01.1986 - 31.10.2002	Mean	Standard Error	Skewness	Kurtosis	Jarque-Bera	Ljung-Box (5) of returns	Ljung-Box (5) of squared returns
Aggregate	0.00035	0.01028	-0.48	8.74	6175.4	43.12	626.83
Basic Industries	0.00033	0.01035	-0.47	9.37	7565.9	36.67	419.80
Cyc. Consumer Goods	0.00024	0.01217	-0.39	9.06	6831.3	63.07	473.32
Cyc. Services	0.00032	0.01041	-0.53	8.83	6409.2	62.76	827.25
Financials	0.00027	0.01086	-0.43	9.43	7675.0	78.71	776.19
General Industrials	0.00028	0.01163	-0.49	8.97	6696.6	33.80	442.87
Information Technology	0.00062	0.01848	-0.30	7.52	3790.7	44.90	913.79
Non-cyc. Cons. Goods	0.00051	0.00996	-0.51	9.47	7832.0	19.71	918.99
Non-cyc. Services	0.00046	0.01381	-0.14	7.82	4259.0	53.84	739.87
Resources	0.00058	0.01178	-0.32	7.34	3506.6	19.76	1144.50
Utilities	0.00045	0.00937	-0.18	8.40	5356.4	18.06	219.25

Table 3: Descriptive statistics of US equity returns

US 03.01.1986 - 31.10.2002	Mean	Standard Error	Skewness	Kurtosis	Jarque- Bera	Ljung-Box (5) of returns	Ljung-Box (5) of squared returns
Aggregate	0.00044	0.01085	-1.83	38.06	227072.5	23.90	329.26
Basic Industries	0.00037	0.01255	-1.37	30.84	143033.5	57.82	364.69
Cyc. Cons. Goods	0.00033	0.01274	-1.53	29.89	133808.6	12.21*	214.10
Cyc. Services	0.00041	0.01250	-1.69	34.51	183528.6	64.93	358.41
Financials	0.00052	0.01193	-0.81	19.97	53082.7	59.76	507.26
General Industrials	0.00045	0.01233	-1.47	29.03	125385.6	28.93	400.58
Information Technology	0.00039	0.01865	-0.44	13.96	22100.1	11.86*	390.59
Non-cyc. Cons. Goods	0.00058	0.01132	-1.36	27.02	106788.5	59.71	422.45
Non-cyc. Services	0.00033	0.01222	-1.04	22.57	70769.1	19.17	618.02
Resources	0.00041	0.01312	-1.04	25.29	91588.1	51.05	390.14
Utilities	0.00030	0.00928	-1.10	23.52	77859.7	44.21	722.40

Table 4: Descriptive statistics of Japanese equity returns

Japan 03.01.1986 - 31.10.2002	Mean	Standard Error	Skewness	Kurtosis	Jarque-Bera	Ljung-Box (5) of returns	Ljung-Box (5) of squared returns
Aggregate	0.00012	0.01457	-0.09	11.29	12556.6	22.43	193.40
Basic Industries	0.00008	0.01576	0.00	11.50	13199.1	34.01	246.72
Cyc. Cons. Goods	0.00027	0.01539	-0.11	11.52	13275.4	28.64	327.10
Cyc. Services	0.00016	0.01394	-0.15	12.16	15339.0	27.15	207.35
Financials	-0.00001	0.01756	0.24	9.61	8017.6	96.45	247.07
General Industrials	0.00014	0.01527	-0.14	11.85	14323.7	15.94	297.60
Information Technology	0.00013	0.01921	0.13	6.70	2509.3	42.73	448.03
Non-cyc. Cons. Goods	0.00021	0.01337	-0.38	16.20	31963.9	7.22***	225.21
Non-cyc. Services	0.00008	0.02158	0.99	15.10	27485.6	12.55*	221.67
Resources	0.00005	0.01884	0.07	8.36	5249.9	15.20	325.81
Utilities	0.00018	0.01674	0.35	11.09	12055.5	30.05	543.26

Table 5: Correlation coefficients of industry *i* or aggregate index returns with their foreign counterparts for the euro area, the US, and Japan at different lag structures

Sample period / Index	Euro Area – US (lagged)					Euro Area – US					Euro Area (lagged) – Japan				
	01/86 - 10/02	01/86 – 12/89	01/90 – 12/93	01/94 – 12/97	01/98 – 10/02	01/86 - 10/02	01/86 – 12/89	01/90 - 12/93	01/94 – 12/97	01/98 – 10/02	01/86 - 10/02	01/86 – 12/89	01/90 - 12/93	01/94 – 12/97	01/98 – 10/02
Aggregate	0.34	0.38	0.25	0.43	0.34	0.33	0.25	0.29	0.21	0.42	0.17	0.11	0.12	0.10	0.26
Basic Industries	0.30	0.33	0.20	0.37	0.33	0.30	0.28	0.31	0.17	0.35	0.14	0.13	0.14	0.06	0.17
Cyc. Cons. Goods	0.27	0.30	0.22	0.28	0.28	0.28	0.16	0.22	0.15	0.41	0.13	0.04	0.10	0.08	0.23
Cyc. Services	0.30	0.35	0.22	0.29	0.32	0.29	0.29	0.28	0.14	0.33	0.14	0.14	0.13	0.05	0.19
Financials	0.30	0.29	0.24	0.35	0.31	0.31	0.22	0.27	0.22	0.39	0.13	0.11	0.09	0.07	0.18
General Industrials	0.29	0.34	0.19	0.36	0.29	0.32	0.25	0.29	0.18	0.40	0.17	0.07	0.12	0.09	0.28
Inf. Technology	0.34	0.15	0.20	0.47	0.38	0.33	0.20	0.18	0.15	0.42	0.22	0.00	0.11	0.13	0.35
Non-cyc. Cons. G.	0.31	0.34	0.22	0.33	0.33	0.29	0.33	0.26	0.15	0.31	0.15	0.18	0.11	0.10	0.18
Non-cyc. Services	0.23	0.32	0.15	0.21	0.23	0.24	0.07	0.24	0.13	0.34	0.14	0.02	0.05	0.09	0.26
Resources	0.36	0.40	0.29	0.39	0.34	0.34	0.34	0.20	0.26	0.40	0.13	0.15	0.10	0.12	0.15
Utilities	0.12	0.22	0.14	0.12	0.07	0.11	0.06	0.21	0.13	0.11	0.04	0.02	0.08	0.09	0.02
Average over all industries	0.28	0.30	0.21	0.32	0.29	0.28	0.22	0.24	0.17	0.35	0.14	0.09	0.10	0.09	0.20

Sample period / Index	Euro Area – Japan					US – Japan					US (lagged) – Japan				
	01/86 - 10/02	01/86 – 12/89	01/90 – 12/93	01/94 – 12/97	01/98 – 10/02	01/86 - 10/02	01/86 – 12/89	01/90 - 12/93	01/94 – 12/97	01/98 – 10/02	01/86 - 10/02	01/86 – 12/89	01/90 - 12/93	01/94 – 12/97	01/98 – 10/02
Aggregate	0.30	0.42	0.38	0.25	0.22	0.07	0.04	0.19	-0.01	0.06	0.28	0.37	0.22	0.26	0.29
Basic Industries	0.29	0.35	0.36	0.24	0.22	0.11	0.11	0.17	0.01	0.12	0.20	0.35	0.16	0.16	0.17
Cyc. Cons. Goods	0.29	0.34	0.38	0.22	0.23	0.09	0.04	0.18	0.03	0.10	0.24	0.36	0.17	0.15	0.24
Cyc. Services	0.28	0.37	0.36	0.22	0.21	0.07	0.02	0.19	-0.02	0.09	0.24	0.37	0.22	0.19	0.19
Financials	0.24	0.31	0.32	0.23	0.17	0.08	0.07	0.19	0.04	0.05	0.21	0.28	0.19	0.21	0.18
General Industrials	0.32	0.41	0.37	0.24	0.26	0.10	0.10	0.20	-0.04	0.13	0.30	0.38	0.22	0.24	0.32
Inf. Technology	0.25	0.17	0.32	0.21	0.28	0.10	0.10	0.12	-0.01	0.13	0.32	0.27	0.17	0.27	0.41
Non-cyc. Cons. G.	0.26	0.32	0.34	0.21	0.16	0.03	0.01	0.13	-0.05	0.01	0.22	0.36	0.19	0.21	0.14
Non-cyc. Services	0.16	0.14	0.26	0.16	0.14	0.01	-0.04	0.16	-0.04	0.01	0.16	0.13	0.11	0.14	0.22
Resources	0.18	0.29	0.28	0.18	0.08	0.03	-0.03	0.09	0.00	0.04	0.14	0.25	0.08	0.15	0.10
Utilities	0.19	0.22	0.29	0.16	0.08	0.04	0.04	0.17	-0.05	0.01	0.11	0.23	0.17	0.07	0.03
Average over all industries	0.25	0.29	0.33	0.21	0.18	0.07	0.04	0.16	-0.01	0.07	0.21	0.30	0.17	0.18	0.20

Table 6: Average correlation coefficients of index *i* with foreign market indices j ($i \neq j$).

	Euro Area	US	Japan	Average over all currency areas
Full sample	0.31	0.20	0.19	0.23
01/86-12/89	0.33	0.14	0.23	0.23
01/90-12/93	0.34	0.24	0.29	0.29
01/94-12/97	0.23	0.10	0.12	0.15
01/98-10/02	0.32	0.24	0.14	0.23

Table 7: Average correlation coefficients of industry i or aggregate index returns with each of the remaining domestic industry returns ($i \neq j$) in the euro area, the US, and Japan

Sample period / Index	Euro Area					US					Japan				
	01/86 - 10/02	01/86 – 12/89	01/90 - 12/93	01/94 – 12/97	01/98 – 10/02	01/86 - 10/02	01/86 – 12/89	01/90 – 12/93	01/94 – 12/97	01/98 – 10/02	01/86 - 10/02	01/86 – 12/89	01/90 - 12/93	01/94 – 12/97	01/98 – 10/02
Aggregate	0.84	0.84	0.92	0.85	0.81	0.78	0.93	0.80	0.78	0.70	0.83	0.75	0.91	0.90	0.80
Basic Industries	0.74	0.76	0.87	0.74	0.68	0.63	0.86	0.66	0.60	0.50	0.77	0.67	0.88	0.85	0.71
Cyc. Cons. Goods	0.71	0.71	0.84	0.71	0.68	0.64	0.85	0.62	0.56	0.55	0.72	0.59	0.86	0.82	0.67
Cyc. Services	0.75	0.76	0.88	0.74	0.70	0.70	0.89	0.71	0.67	0.60	0.79	0.68	0.88	0.87	0.75
Financials	0.76	0.74	0.88	0.76	0.73	0.67	0.86	0.68	0.65	0.58	0.70	0.57	0.80	0.78	0.68
General Industrials	0.76	0.75	0.87	0.76	0.72	0.70	0.89	0.70	0.68	0.61	0.77	0.65	0.88	0.86	0.72
Inf. Technology	0.59	0.57	0.80	0.56	0.56	0.54	0.81	0.59	0.48	0.46	0.64	0.49	0.79	0.78	0.59
Non-cyc. Cons. G.	0.71	0.73	0.87	0.75	0.62	0.63	0.88	0.63	0.62	0.47	0.73	0.63	0.86	0.85	0.67
Non-cyc. Services	0.68	0.67	0.83	0.72	0.63	0.61	0.85	0.64	0.56	0.49	0.56	0.31	0.69	0.73	0.59
Resources	0.55	0.57	0.71	0.63	0.47	0.47	0.77	0.35	0.47	0.33	0.61	0.45	0.79	0.76	0.52
Utilities	0.62	0.59	0.80	0.61	0.57	0.50	0.81	0.57	0.52	0.34	0.59	0.51	0.79	0.72	0.47
Average over all industries	0.69	0.68	0.83	0.70	0.64	0.61	0.85	0.61	0.58	0.49	0.69	0.55	0.82	0.80	0.64

Table 8: Estimation results

Key: C = country-specific spillover effects, S = sector-specific spillover effects; BA = basic industries, CC = cyclical consumer goods, CS = cyclical services, GE = general industrials, IT = information technology, NCC = non-cyclical consumer goods, NCS = non-cyclical services, RE = resources, TO = financials, and UT = utilities; *** (**, *) denotes significance at the 1% (5%,10%) level

Sample period	01/1986 - 10/2002			01/1986 - 12/1990			01/1991 - 12/1994			01/1995 - 12/1998			01/1999 - 10/2002		
Coefficient	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.
Impact of EMU country-specific shocks on EMU industries, $h_{i,EMU}$															
EMU C BA	0.955	0.006	***	1.049	0.012	***	1.032	0.011	***	0.850	0.018	***	0.648	0.016	***
EMU C CC	1.025	0.008	***	1.046	0.015	***	1.072	0.016	***	1.069	0.025	***	0.842	0.017	***
EMU C CS	0.902	0.006	***	0.949	0.011	***	0.950	0.012	***	0.798	0.013	***	0.855	0.013	***
EMU C GE	1.060	0.005	***	1.132	0.012	***	1.104	0.008	***	0.974	0.014	***	1.001	0.016	***
EMU C IT	1.079	0.012	***	0.982	0.027	***	1.043	0.021	***	1.109	0.035	***	1.534	0.044	***
EMU C NCC	0.860	0.007	***	0.881	0.016	***	0.924	0.011	***	0.861	0.014	***	0.562	0.017	***
EMU C NCS	1.039	0.008	***	0.976	0.015	***	1.038	0.014	***	1.041	0.022	***	1.253	0.033	***
EMU C RE	0.697	0.010	***	0.570	0.021	***	0.742	0.014	***	0.834	0.032	***	0.595	0.026	***
EMU C TO	0.956	0.005	***	0.929	0.011	***	0.964	0.012	***	0.965	0.013	***	0.842	0.014	***
EMU C UT	0.746	0.007	***	0.696	0.017	***	0.878	0.013	***	0.739	0.024	***	0.519	0.019	***
... US country-specific shocks on US industries, $h_{i,US}$															
US C BA	0.928	0.007	***	1.011	0.009	***	0.998	0.024	***	0.758	0.023	***	0.672	0.028	***
US C CC	0.946	0.008	***	1.028	0.012	***	1.155	0.033	***	0.798	0.026	***	0.731	0.024	***
US C CS	1.040	0.007	***	1.122	0.010	***	1.148	0.020	***	0.902	0.015	***	0.928	0.020	***
US C GE	1.002	0.007	***	1.032	0.010	***	0.896	0.020	***	0.972	0.014	***	0.979	0.019	***
US C IT	1.155	0.015	***	1.085	0.013	***	1.304	0.046	***	1.270	0.045	***	1.315	0.054	***
US C NCC	0.942	0.008	***	1.070	0.009	***	0.899	0.021	***	0.878	0.017	***	0.407	0.016	***
US C NCS	0.884	0.009	***	1.018	0.011	***	0.784	0.022	***	0.763	0.023	***	0.806	0.026	***
US C RE	0.636	0.012	***	0.870	0.018	***	0.507	0.033	***	0.618	0.031	***	0.389	0.034	***
US C TO	0.869	0.007	***	0.837	0.009	***	0.921	0.021	***	0.931	0.017	***	0.806	0.023	***
US C UT	0.519	0.006	***	0.569	0.006	***	0.488	0.016	***	0.449	0.019	***	0.309	0.027	***
... Japanese country-specific shocks on Japanese industries, $h_{i,JA}$															
JA C BA	0.988	0.005	***	1.002	0.012	***	1.005	0.007	***	1.083	0.011	***	0.893	0.015	***
JA C CC	0.899	0.005	***	0.907	0.012	***	0.890	0.008	***	0.927	0.012	***	0.858	0.021	***
JA C CS	0.902	0.004	***	0.966	0.009	***	0.909	0.007	***	0.891	0.008	***	0.804	0.012	***
JA C GE	0.950	0.004	***	0.949	0.013	***	0.972	0.008	***	0.927	0.008	***	0.948	0.015	***
JA C IT	0.967	0.009	***	0.932	0.021	***	0.983	0.013	***	0.893	0.014	***	1.192	0.030	***
JA C NCC	0.819	0.005	***	0.846	0.012	***	0.856	0.007	***	0.813	0.009	***	0.599	0.013	***
JA C NCS	0.985	0.011	***	0.792	0.029	***	1.000	0.019	***	0.913	0.019	***	1.238	0.035	***
JA C RE	0.953	0.010	***	0.867	0.022	***	0.989	0.014	***	1.034	0.020	***	0.681	0.035	***
JA C TO	0.989	0.008	***	0.865	0.015	***	1.060	0.014	***	1.146	0.015	***	0.979	0.022	***
JA C UT	0.794	0.008	***	1.138	0.028	***	0.939	0.014	***	0.673	0.014	***	0.440	0.021	***

Sample period	01/1986 - 10/2002			01/1986 - 12/1990			01/1991 - 12/1994			01/1995 - 12/1998			01/1999 - 10/2002		
Coefficient	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.
... EMU country-specific shocks on US industries, $h_{i,EMU,US}$															
EMUUS C BA	0.233	0.010	***	0.156	0.014	***	0.149	0.020	***	0.273	0.028	***	0.501	0.034	***
EMUUS C CC	0.228	0.012	***	0.150	0.018	***	0.167	0.029	***	0.313	0.029	***	0.425	0.027	***
EMUUS C CS	0.246	0.008	***	0.177	0.010	***	0.129	0.018	***	0.369	0.020	***	0.512	0.024	***
EMUUS C GE	0.268	0.008	***	0.198	0.012	***	0.112	0.019	***	0.362	0.018	***	0.590	0.024	***
EMUUS C IT	0.269	0.017	***	0.209	0.023	***	0.131	0.031	***	0.302	0.049	***	0.711	0.052	***
EMUUS C NCC	0.213	0.009	***	0.153	0.013	***	0.172	0.019	***	0.269	0.025	***	0.125	0.021	***
EMUUS C NCS	0.224	0.010	***	0.157	0.015	***	0.115	0.018	***	0.286	0.031	***	0.560	0.031	***
EMUUS C RE	0.150	0.014	***	0.063	0.023	***	0.095	0.025	***	0.256	0.037	***	0.293	0.037	***
EMUUS C TO	0.254	0.008	***	0.157	0.013	***	0.208	0.018	***	0.393	0.021	***	0.420	0.024	***
EMUUS C UT	0.124	0.008	***	0.077	0.011	***	0.078	0.015	***	0.120	0.019	***	0.187	0.033	***
... US country-specific shocks on EMU industries, $h_{i,US,EMU}$															
USEMU C BA	0.333	0.005	***	0.352	0.010	***	0.337	0.015	***	0.319	0.017	***	0.201	0.014	***
USEMU C CC	0.349	0.008	***	0.351	0.013	***	0.361	0.024	***	0.404	0.017	***	0.285	0.019	***
USEMU C CS	0.302	0.006	***	0.302	0.008	***	0.304	0.017	***	0.231	0.014	***	0.342	0.012	***
USEMU C GE	0.351	0.005	***	0.350	0.010	***	0.344	0.015	***	0.382	0.014	***	0.322	0.013	***
USEMU C IT	0.389	0.011	***	0.244	0.018	***	0.372	0.032	***	0.687	0.043	***	0.749	0.050	***
USEMU C NCC	0.267	0.007	***	0.332	0.013	***	0.292	0.016	***	0.297	0.011	***	0.047	0.016	***
USEMU C NCS	0.326	0.009	***	0.376	0.014	***	0.283	0.021	***	0.278	0.020	***	0.387	0.026	***
USEMU C RE	0.306	0.009	***	0.340	0.019	***	0.317	0.022	***	0.311	0.025	***	0.196	0.026	***
USEMU C TO	0.312	0.006	***	0.306	0.010	***	0.262	0.017	***	0.343	0.015	***	0.256	0.017	***
USEMU C UT	0.166	0.008	***	0.222	0.012	***	0.194	0.021	***	0.174	0.029	***	0.056	0.017	***
... EMU country-specific shocks on Japanese industries, $h_{i,EMU,JA}$															
EMUJA C BA	0.158	0.008	***	0.097	0.021	***	0.079	0.014	***	0.149	0.019	***	0.303	0.019	***
EMUJA C CC	0.154	0.011	***	0.030	0.025		0.069	0.017	***	0.176	0.024	***	0.327	0.028	***
EMUJA C CS	0.142	0.008	***	0.076	0.019	***	0.039	0.012	***	0.142	0.016	***	0.277	0.015	***
EMUJA C GE	0.186	0.009	***	0.049	0.024	**	0.091	0.017	***	0.188	0.016	***	0.417	0.018	***
EMUJA C IT	0.179	0.014	***	0.047	0.043		0.081	0.024	***	0.238	0.029	***	0.510	0.034	***
EMUJA C NCC	0.034	0.008	***	0.006	0.024		0.051	0.014	***	0.159	0.016	***	0.082	0.019	***
EMUJA C NCS	0.196	0.022	***	0.009	0.066		0.064	0.036	*	0.237	0.037	***	0.554	0.043	***
EMUJA C RE	0.162	0.017	***	0.128	0.040	***	0.041	0.026		0.189	0.038	***	0.109	0.043	**
EMUJA C TO	0.173	0.013	***	0.028	0.025		0.130	0.027	***	0.220	0.027	***	0.290	0.030	***
EMUJA C UT	0.081	0.015	***	0.002	0.042		0.124	0.029	***	0.070	0.031	**	-0.004	0.028	
... Japanese country-specific shocks on EMU industries, $h_{i,JA,EMU}$															
JAEMU C BA	0.147	0.004	***	0.213	0.007	***	0.154	0.007	***	0.098	0.011	***	0.064	0.013	***
JAEMU C CC	0.157	0.005	***	0.214	0.010	***	0.182	0.013	***	0.133	0.012	***	0.115	0.017	***
JAEMU C CS	0.144	0.005	***	0.214	0.008	***	0.144	0.008	***	0.143	0.009	***	0.083	0.009	***
JAEMU C GE	0.159	0.004	***	0.197	0.010	***	0.143	0.006	***	0.169	0.007	***	0.093	0.014	***
JAEMU C IT	0.150	0.009	***	0.192	0.016	***	0.149	0.015	***	0.154	0.021	***	0.195	0.045	***
JAEMU C NCC	0.125	0.005	***	0.209	0.009	***	0.126	0.008	***	0.112	0.008	***	0.004	0.015	
JAEMU C NCS	0.145	0.006	***	0.219	0.010	***	0.163	0.011	***	0.125	0.012	***	0.124	0.026	***
JAEMU C RE	0.115	0.008	***	0.163	0.014	***	0.117	0.011	***	0.120	0.016	***	0.045	0.028	
JAEMU C TO	0.163	0.004	***	0.232	0.008	***	0.177	0.009	***	0.118	0.008	***	0.051	0.014	***
JAEMU C UT	0.120	0.005	***	0.219	0.012	***	0.116	0.010	***	0.091	0.013	***	0.022	0.016	
... US country-specific shocks on Japanese industries, $h_{i,US,JA}$															
USJA C BA	0.299	0.007	***	0.294	0.017	***	0.315	0.016	***	0.237	0.021	***	0.244	0.017	***
USJA C CC	0.346	0.010	***	0.299	0.017	***	0.366	0.021	***	0.329	0.026	***	0.357	0.025	***
USJA C CS	0.285	0.007	***	0.298	0.015	***	0.338	0.015	***	0.238	0.016	***	0.240	0.015	***
USJA C GE	0.367	0.007	***	0.322	0.015	***	0.343	0.020	***	0.290	0.016	***	0.424	0.018	***
USJA C IT	0.369	0.015	***	0.354	0.035	***	0.342	0.030	***	0.409	0.028	***	0.470	0.039	***
USJA C NCC	0.234	0.008	***	0.267	0.018	***	0.329	0.018	***	0.218	0.017	***	0.089	0.016	***
USJA C NCS	0.318	0.020	***	0.147	0.055	***	0.204	0.045	***	0.332	0.039	***	0.524	0.040	***
USJA C RE	0.230	0.016	***	0.160	0.032	***	0.393	0.035	***	0.171	0.028	***	0.088	0.044	**
USJA C TO	0.299	0.012	***	0.237	0.025	***	0.418	0.035	***	0.349	0.027	***	0.202	0.026	***
USJA C UT	0.139	0.014	***	0.204	0.037	***	0.302	0.033	***	0.120	0.032	***	-0.024	0.027	
... Japanese country-specific shocks on US industries, $h_{i,JA,US}$															
JAUS C BA	0.037	0.006	***	0.006	0.009		0.048	0.012	***	-0.040	0.018	**	0.092	0.025	***
JAUS C CC	0.051	0.008	***	0.006	0.011		0.062	0.017	***	0.083	0.016	***	0.097	0.020	***
JAUS C CS	0.044	0.005	***	0.009	0.008		0.045	0.010	***	0.017	0.010	*	0.113	0.017	***
JAUS C GE	0.001	0.004		-0.001	0.007		0.032	0.011	***	0.019	0.009	**	0.103	0.020	***
JAUS C IT	0.028	0.010	***	-0.011	0.015		0.012	0.018		0.070	0.024	***	0.172	0.047	***
JAUS C NCC	0.019	0.005	***	-0.001	0.008		0.024	0.011	**	-0.004	0.015		-0.015	0.018	
JAUS C NCS	0.021	0.006	***	0.009	0.009		0.048	0.012	***	0.005	0.018		0.057	0.024	**
JAUS C RE	0.020	0.008	**	-0.013	0.015		0.037	0.016	**	0.032	0.019	*	0.021	0.033	
JAUS C TO	0.038	0.005	***	0.027	0.007	***	0.077	0.011	***	-0.013	0.012		0.031	0.021	
JAUS C UT	0.021	0.005	***	-0.003	0.007		0.040	0.009	***	-0.012	0.011		0.036	0.023	

Sample period	01/1986 - 10/2002			01/1986 - 12/1990			01/1991 - 12/1994			01/1995 - 12/1998			01/1999 - 10/2002		
Coefficient	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.	Point Es-timate	Std. Error	Sign.
... EMU sector-specific shocks on US industries, $f_{i,EMU,US}$															
EMUUS S BA	0.106	0.020	***	-0.002	0.032		0.034	0.059		0.058	0.059		0.416	0.063	***
EMUUS S CC	0.109	0.019	***	0.044	0.026	*	0.002	0.051		0.099	0.045	**	0.322	0.043	***
EMUUS S CS	0.098	0.017	***	0.040	0.026		-0.021	0.044		0.019	0.045		0.078	0.045	*
EMUUS S GE	0.049	0.015	***	0.078	0.022	***	0.028	0.043		-0.020	0.036		0.063	0.047	
EMUUS S IT	0.089	0.015	***	-0.014	0.025		-0.067	0.037	*	0.068	0.038	*	0.361	0.032	***
EMUUS S NCC	0.120	0.018	***	0.013	0.026		-0.043	0.051		-0.065	0.052		0.450	0.035	***
EMUUS S NCS	0.007	0.015		-0.053	0.022	**	-0.044	0.033		0.030	0.043		0.125	0.031	***
EMUUS S RE	0.354	0.020	***	0.226	0.034	***	0.206	0.053	***	0.260	0.041	***	0.550	0.040	***
EMUUS S TO	0.019	0.018		-0.057	0.025	**	-0.099	0.046	**	0.109	0.047	**	0.304	0.046	***
EMUUS S UT	0.001	0.012		-0.035	0.017	**	0.016	0.027		0.011	0.031		-0.016	0.051	
... US sector-specific shocks on EMU industries, $f_{i,US,EMU}$															
USEMU S BA	0.100	0.009	***	0.034	0.021		0.055	0.018	***	0.063	0.025	**	0.152	0.018	***
USEMU S CC	0.046	0.011	***	0.006	0.024		0.005	0.022		0.045	0.022	**	0.143	0.026	***
USEMU S CS	0.056	0.012	***	0.018	0.027		0.063	0.026	**	0.023	0.028		0.006	0.017	
USEMU S GE	-0.025	0.013	*	-0.031	0.038		-0.038	0.019	**	0.002	0.025		0.000	0.030	
USEMU S IT	0.159	0.013	***	0.010	0.033		0.016	0.024		0.298	0.023	***	0.305	0.032	***
USEMU S NCC	0.085	0.011	***	0.045	0.029		0.015	0.022		0.066	0.019	***	0.237	0.023	***
USEMU S NCS	0.017	0.013		0.003	0.032		0.004	0.027		-0.019	0.024		0.114	0.029	***
USEMU S RE	0.280	0.011	***	0.348	0.026	***	0.227	0.019	***	0.268	0.025	***	0.319	0.030	***
USEMU S TO	0.077	0.010	***	0.065	0.024	***	0.078	0.025	***	0.079	0.020	***	0.097	0.020	***
USEMU S UT	0.013	0.014		-0.057	0.048		-0.016	0.031		-0.041	0.050		0.005	0.019	
... EMU sector-specific shocks on Japanese industries, $f_{i,EMU,JA}$															
EMUJA S BA	0.061	0.004	***	0.011	0.043		-0.029	0.033		-0.048	0.036		0.123	0.035	***
EMUJA S CC	0.058	0.018	***	-0.017	0.044		0.114	0.028	***	0.026	0.034		0.095	0.043	**
EMUJA S CS	-0.015	0.001	***	-0.061	0.038		0.007	0.029		0.021	0.030		-0.042	0.023	*
EMUJA S GE	0.013	0.016		0.118	0.035	***	-0.016	0.022		-0.006	0.020		0.081	0.023	***
EMUJA S IT	0.099	0.012	***	-0.069	0.041	*	0.063	0.023	***	0.048	0.024	**	0.177	0.015	***
EMUJA S NCC	0.069	0.014	***	-0.002	0.040		0.017	0.038		-0.001	0.035		0.185	0.028	***
EMUJA S NCS	0.095	0.028	***	0.080	0.063		-0.062	0.055		0.003	0.061		0.138	0.045	***
EMUJA S RE	0.095	0.012	***	-0.042	0.048		0.010	0.045		0.101	0.041	**	0.212	0.046	***
EMUJA S TO	0.011	0.028		0.013	0.054		-0.030	0.072		-0.050	0.052		0.116	0.056	**
EMUJA S UT	0.105	0.025	***	-0.007	0.063		0.031	0.051		0.039	0.047		0.084	0.046	*
... Japanese sector-specific shocks on EMU industries, $f_{i,JA,EMU}$															
JAEMU S BA	0.021	0.010	**	-0.010	0.014		-0.012	0.026		0.023	0.027		0.022	0.025	
JAEMU S CC	0.044	0.011	***	0.007	0.017		0.088	0.032	***	0.074	0.026	***	0.071	0.029	**
JAEMU S CS	0.034	0.013	***	0.022	0.019		0.040	0.033		0.028	0.032		-0.004	0.030	
JAEMU S GE	0.023	0.011	**	-0.010	0.016		0.037	0.020	*	-0.011	0.026		0.075	0.028	***
JAEMU S IT	0.001	0.013		-0.022	0.016		-0.008	0.032		0.029	0.039		0.216	0.047	***
JAEMU S NCC	0.022	0.012	*	-0.008	0.019		0.000	0.024		0.021	0.028		0.094	0.027	***
JAEMU S NCS	-0.001	0.006		0.001	0.008		0.009	0.013		-0.027	0.015	*	0.001	0.025	
JAEMU S RE	0.044	0.008	***	0.037	0.013	***	0.032	0.019	*	0.046	0.022	**	-0.002	0.023	
JAEMU S TO	-0.002	0.006		0.017	0.012		-0.024	0.017		-0.014	0.012		0.034	0.016	**
JAEMU S UT	0.021	0.007	***	-0.018	0.010	*	0.001	0.019		0.054	0.024	**	0.015	0.023	
... US sector-specific shocks on Japanese industries, $f_{i,US,JA}$															
USJA S BA	0.041	0.010	***	0.027	0.042		0.005	0.019		0.023	0.027		0.030	0.017	*
USJA S CC	0.032	0.011	***	0.043	0.038		0.032	0.018	*	0.000	0.027		0.056	0.030	*
USJA S CS	0.022	0.013	*	-0.041	0.038		0.002	0.026		-0.056	0.029	*	0.013	0.022	
USJA S GE	0.011	0.014		-0.006	0.053		0.029	0.031		-0.009	0.035		-0.020	0.025	
USJA S IT	0.133	0.011	***	0.128	0.050	***	0.021	0.021		0.100	0.020	***	0.218	0.022	***
USJA S NCC	0.065	0.012	***	0.050	0.049		-0.024	0.024		0.017	0.022		0.093	0.024	***
USJA S NCS	0.031	0.026		0.027	0.123		0.125	0.055	**	-0.079	0.049		0.045	0.047	
USJA S RE	0.068	0.017	***	0.168	0.048	***	0.027	0.033		0.031	0.029		0.111	0.042	***
USJA S TO	0.072	0.019	***	0.009	0.058		0.015	0.049		0.110	0.039	***	0.055	0.033	*
USJA S UT	0.087	0.020	***	0.316	0.105	***	-0.007	0.047		0.035	0.054		0.050	0.025	**
... Japanese sector-specific shocks on US industries, $f_{i,JA,US}$															
JAUS S BA	0.022	0.013	*	-0.009	0.016		-0.015	0.048		0.069	0.046		0.059	0.044	
JAUS S CC	0.011	0.014		0.012	0.018		-0.009	0.050		0.018	0.034		0.011	0.037	
JAUS S CS	0.023	0.015		-0.031	0.018	*	0.006	0.041		0.012	0.040		0.025	0.050	
JAUS S GE	0.021	0.011	*	0.019	0.013		-0.003	0.031		0.008	0.035		0.048	0.047	
JAUS S IT	0.008	0.011		0.004	0.015		0.018	0.039		0.021	0.047		0.187	0.045	***
JAUS S NCC	0.005	0.013		0.027	0.015	*	-0.058	0.032	*	-0.020	0.046		0.026	0.031	
JAUS S NCS	0.001	0.006		0.000	0.008		-0.007	0.016		-0.042	0.025	*	0.051	0.024	**
JAUS S RE	0.006	0.011		0.001	0.015		-0.041	0.031		0.001	0.030		-0.019	0.031	
JAUS S TO	-0.008	0.008		-0.022	0.012	*	0.008	0.023		0.019	0.020		0.009	0.027	
JAUS S UT	0.000	0.006		-0.004	0.007		0.008	0.019		0.017	0.023		0.008	0.033	

Figure 1: Average of country-specific and sector-specific spillover effects from euro area innovations to US industries
Key: C = country-specific spillover effect, S = sector-specific spillover effect

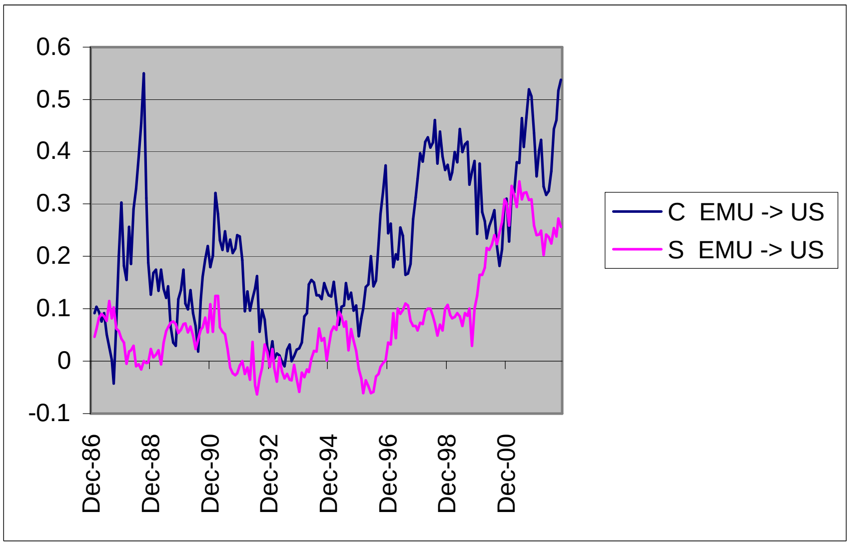


Figure 2: Average of country-specific and sector-specific spillover effects from US innovations to euro area industries

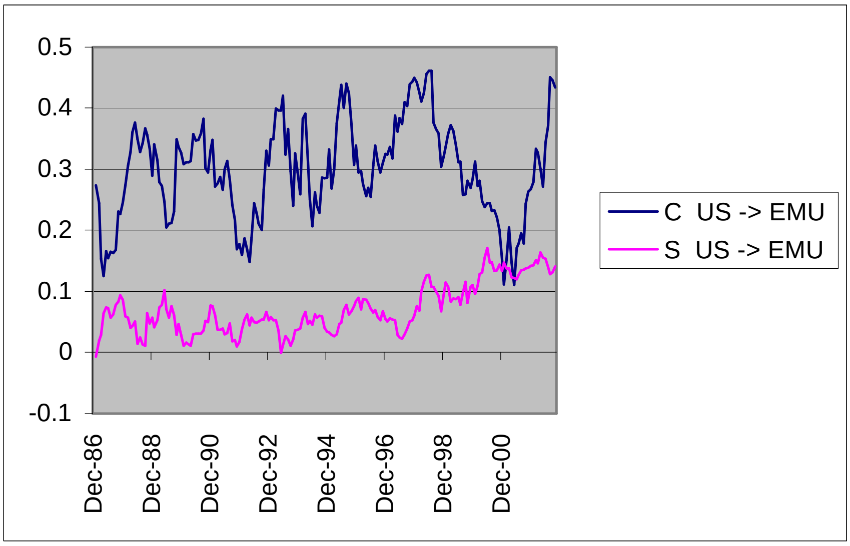


Figure 3: Country-specific return spillover effects from aggregate EMU return innovations to different EMU industries

Key: EMUC = country-specific spillover effect from EMU aggregate returns to EMU industries; BA = basic industries, CC = cyclical consumer goods, CS = cyclical services, GE = general industrials, IT = information technology, NCC = non-cyclical consumer goods, NCS = non-cyclical services, RE = resources, TO = financials, and UT = utilities

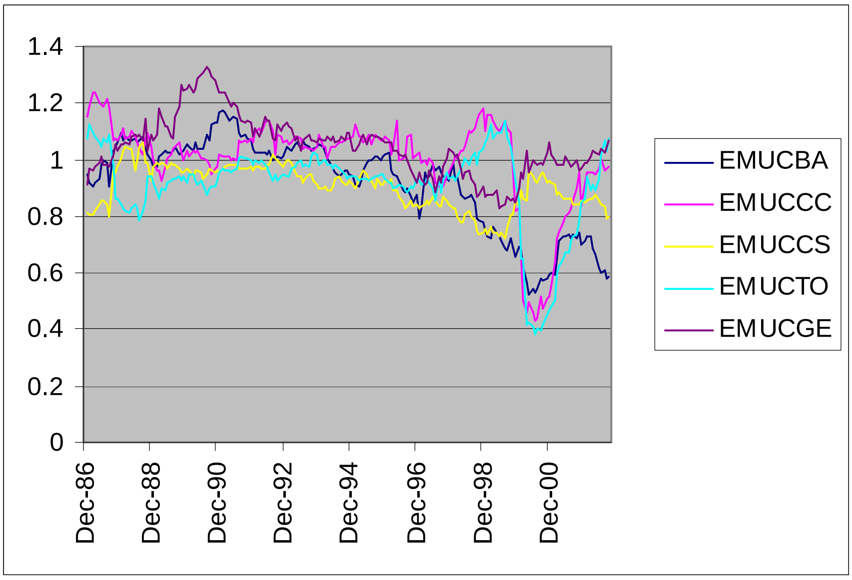


Figure 4: Country-specific return spillover effects from aggregate EMU return innovations to different EMU industries

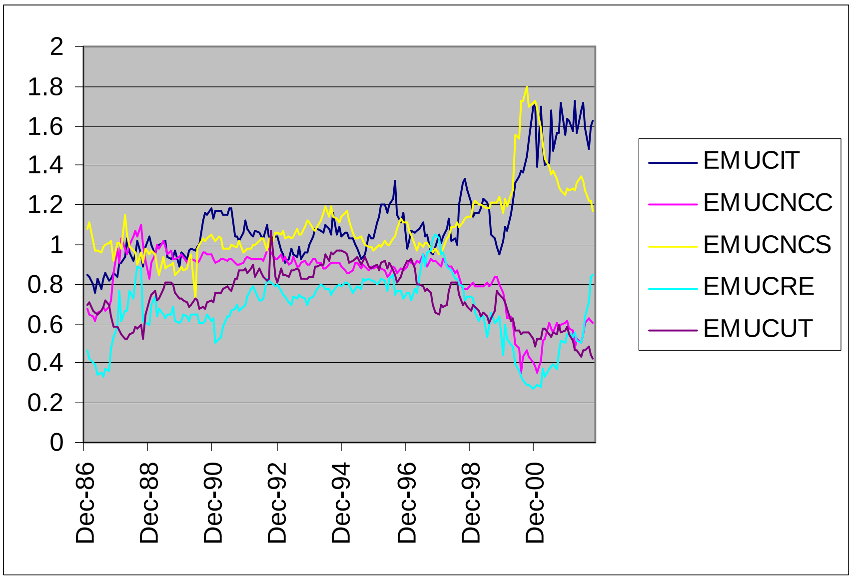


Figure 5: Country-specific return spillover effects from aggregate US return innovations to different EMU industries

Key: USEMUC = country-specific spillover effect from US aggregate returns to EMU industries

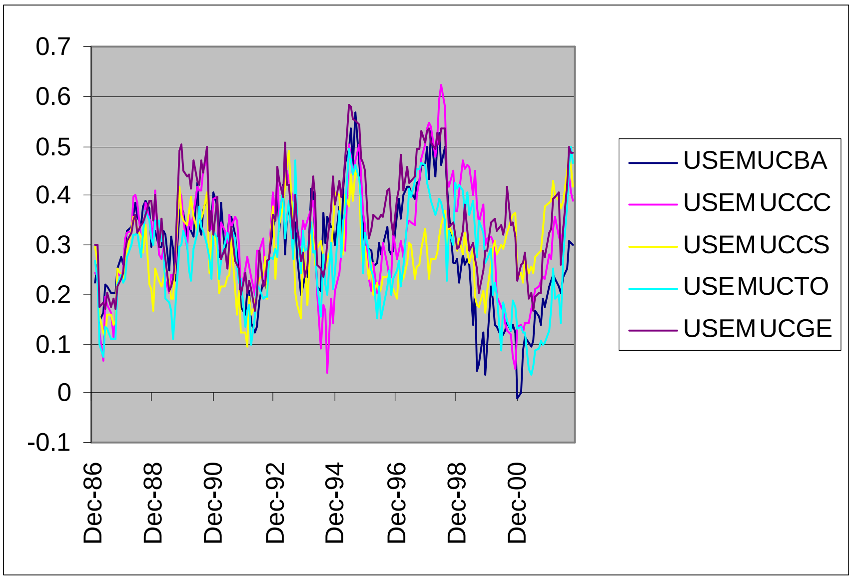


Figure 6: Country-specific return spillover effects from aggregate US return innovations to different EMU industries

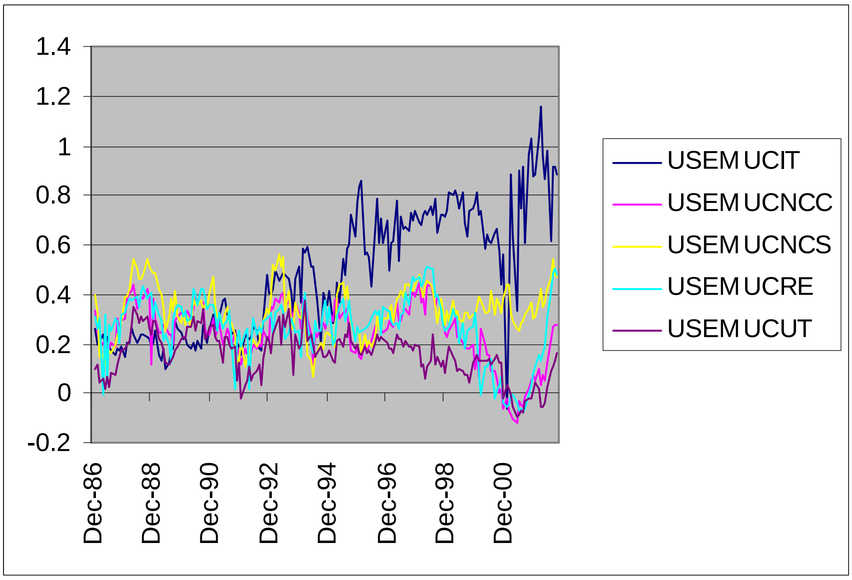


Figure 7: Country-specific return spillover effects from aggregate Japanese return innovations to different EMU industries

Key: JAEMUC = country-specific spillover effect from Japanese aggregate returns to EMU industries

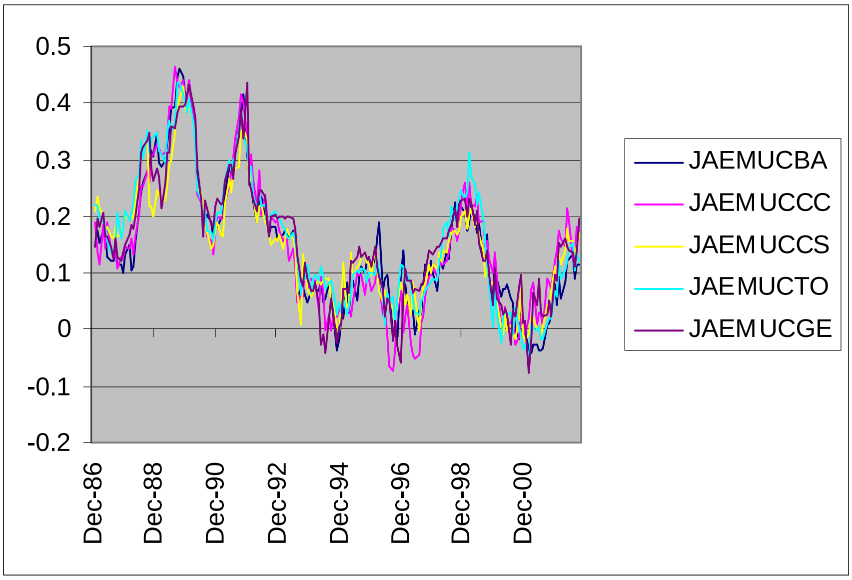


Figure 8: Country-specific return spillover effects from aggregate Japanese return innovations to different EMU industries

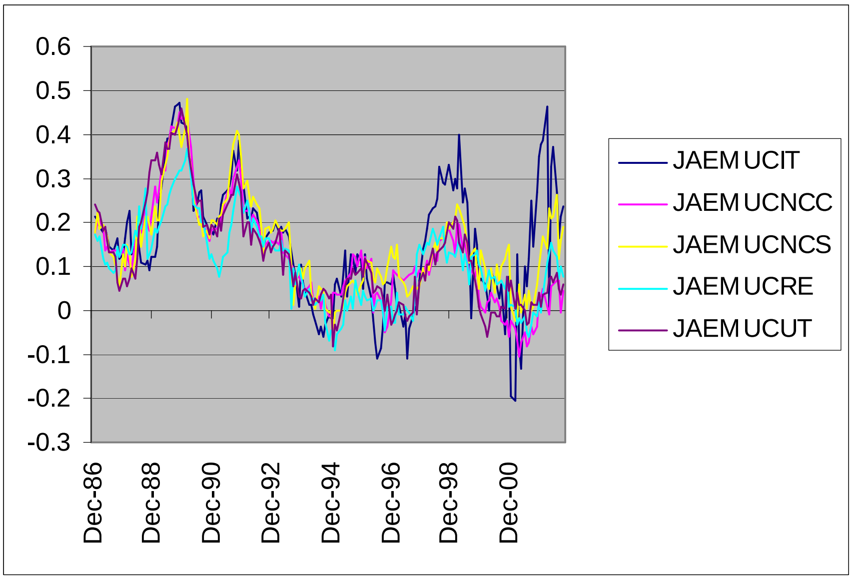


Figure 9: Average of country-specific return spillover effects from aggregate EMU, US, and Japanese return innovations to EMU industries

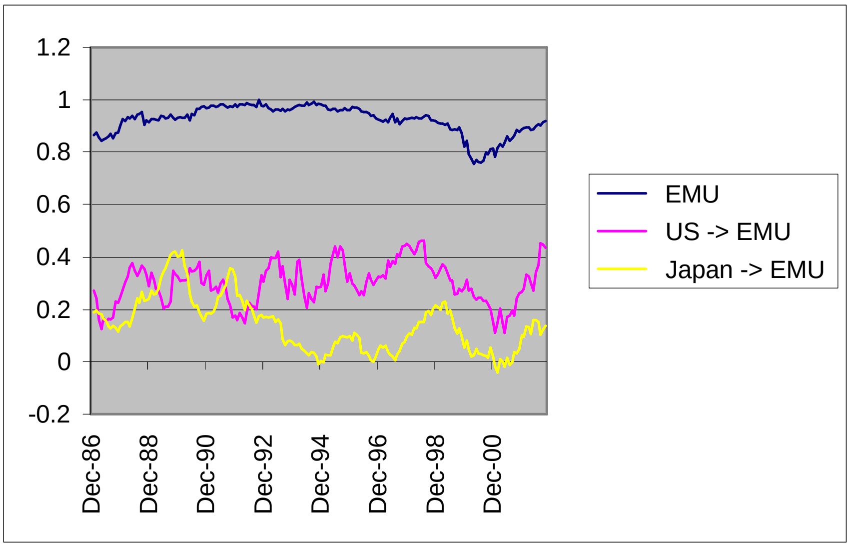


Figure 10: Variane of country-specific return spillover effects from aggregate EMU, US, and Japanese return innovations to EMU industries

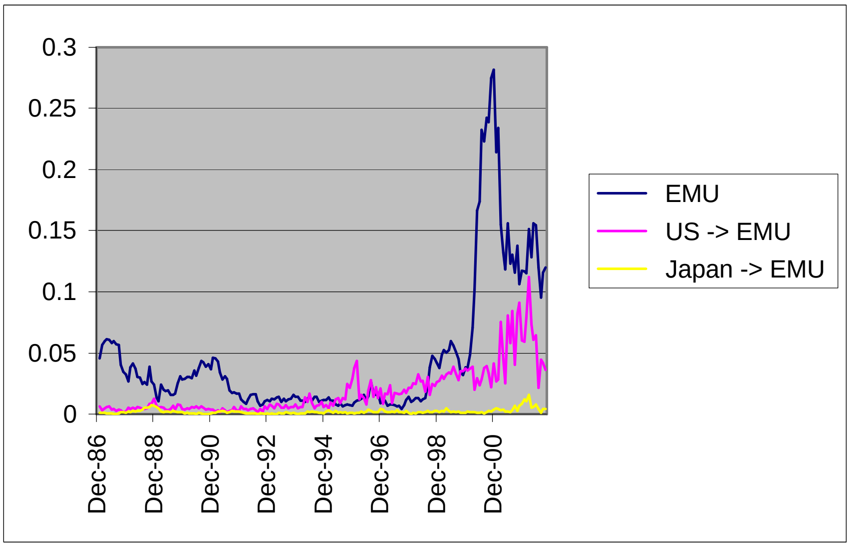


Figure 11: Average of country-specific return spillover effects from aggregate EMU, US, and Japanese return innovations to US industries

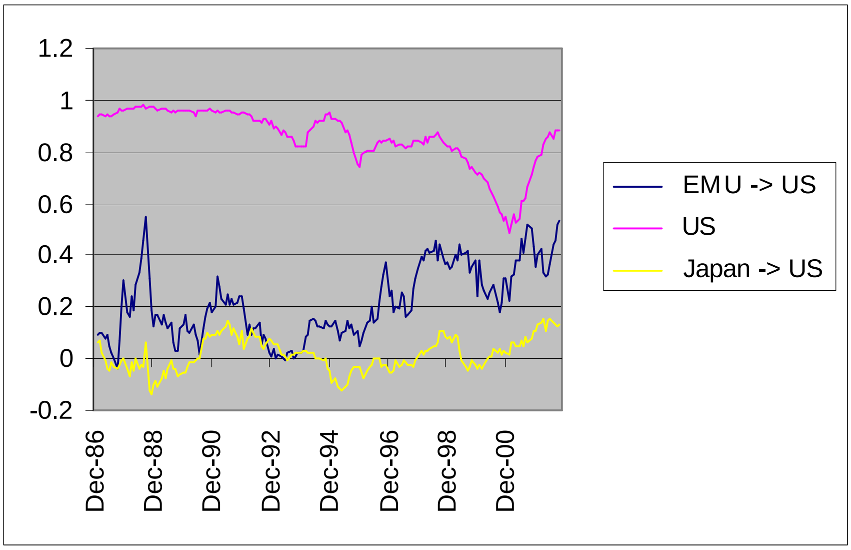


Figure 12: Variance of country-specific return spillover effects from aggregate EMU, US, and Japanese return innovations to US industries

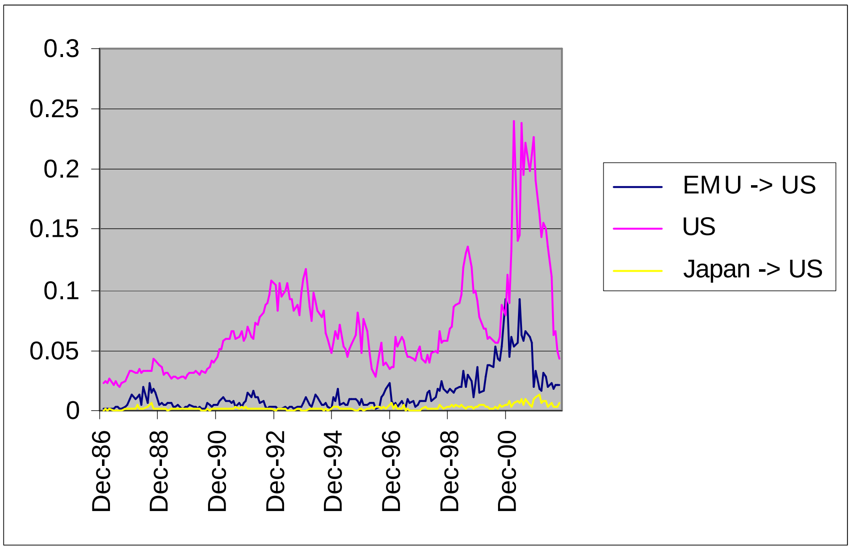


Figure 13: Average of country-specific return spillover effects from aggregate EMU, US, and Japanese return innovations to Japanese industries

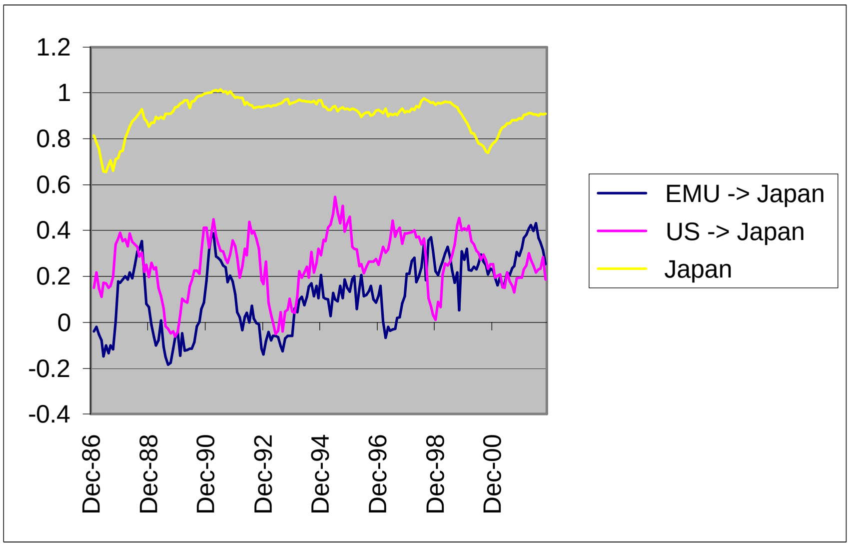


Figure 14: Variance of country-specific return spillover effects from aggregate EMU, US, and Japanese return innovations to Japanese industries

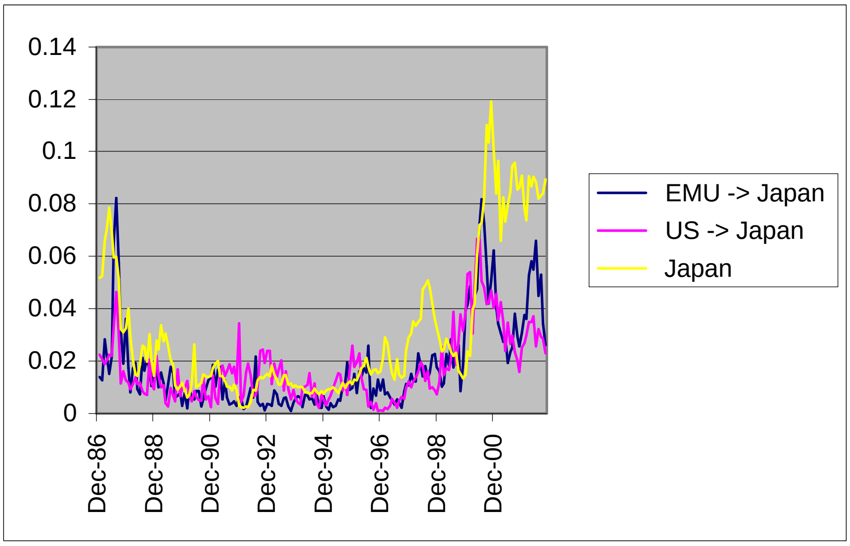


Figure 15: Sector-specific return spillover effects from innovations to US industries to returns of their EMU counterparts

Key: USEMUS = sector-specific spillover effect from US industry to EMU industry; sectors as above

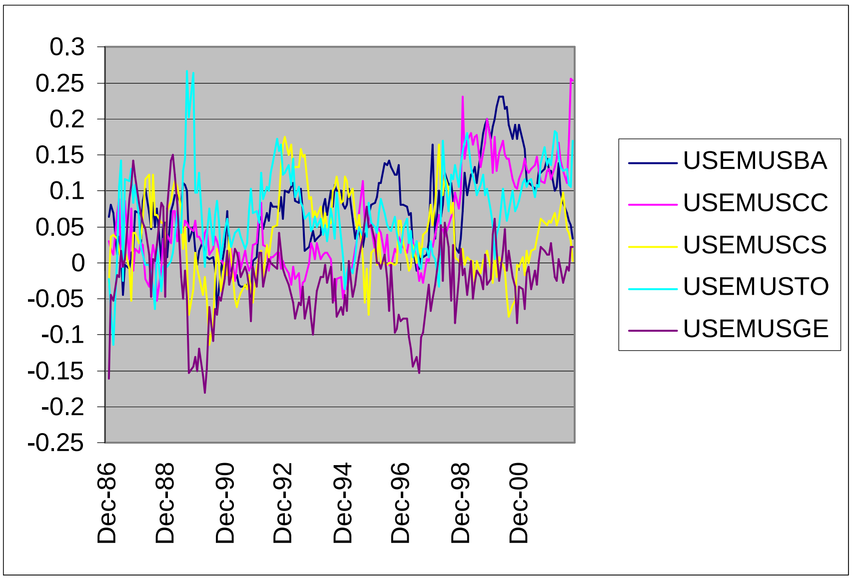


Figure 16: Sector-specific return spillover effects from innovations to US industries to returns of their EMU counterparts

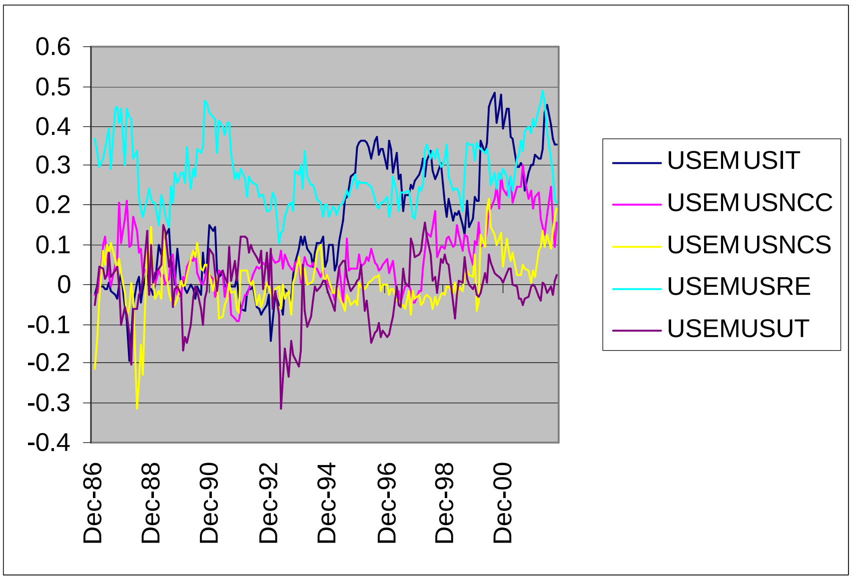


Figure 17: Sector-specific return spillover effects from innovations to Japanese industries to returns of their EMU counterparts
Key: JAEMUS = sector-specific spillover effect from Japanese industry to EMU industry; sectors as above

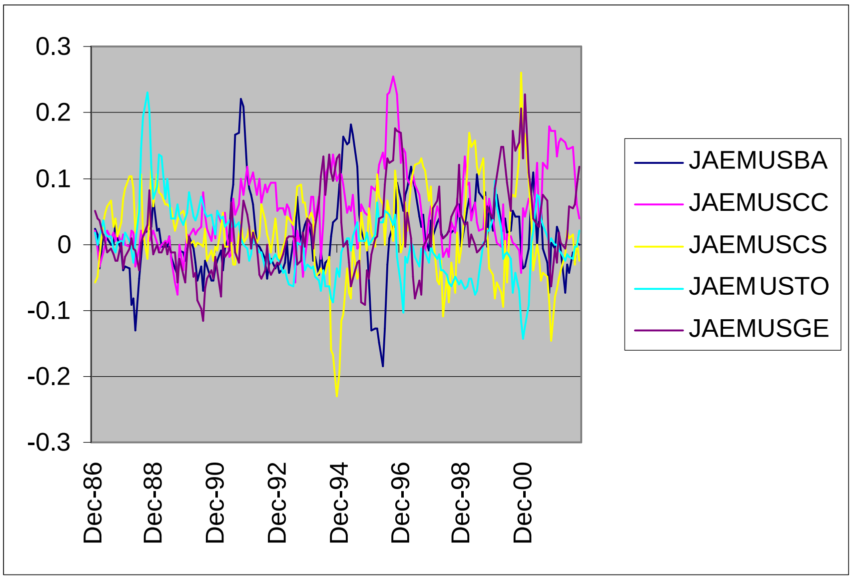


Figure 18: Sector-specific return spillover effects from innovations to Japanese industries to returns of their EMU counterparts

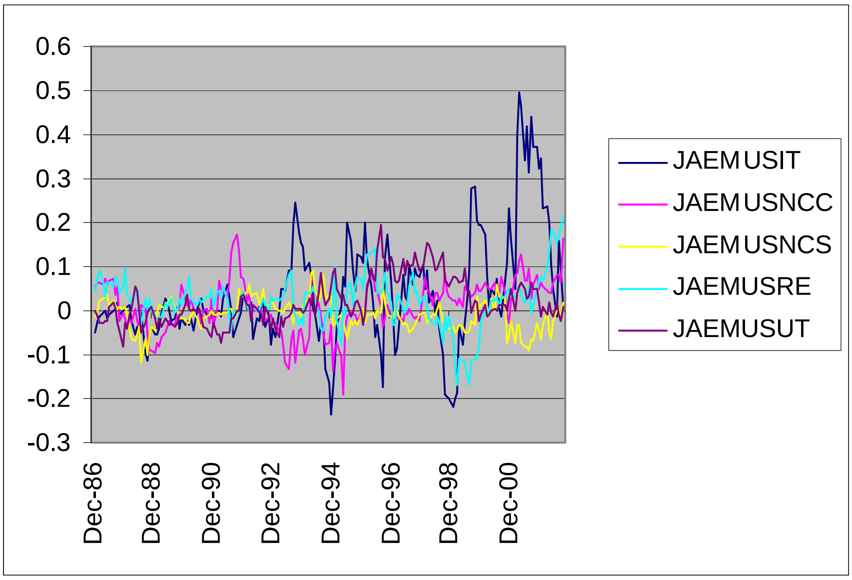


Figure 19: Average of sector-specific return spillover effects from innovations to US and Japanese industries to returns of their EMU counterparts

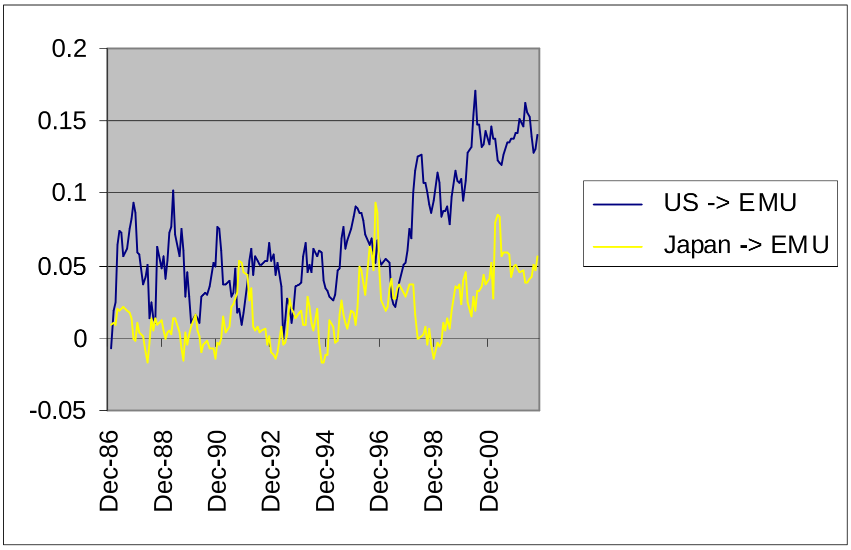


Figure 20: Variance of sector-specific return spillover effects from innovations to US and Japanese industries to returns of their EMU counterparts

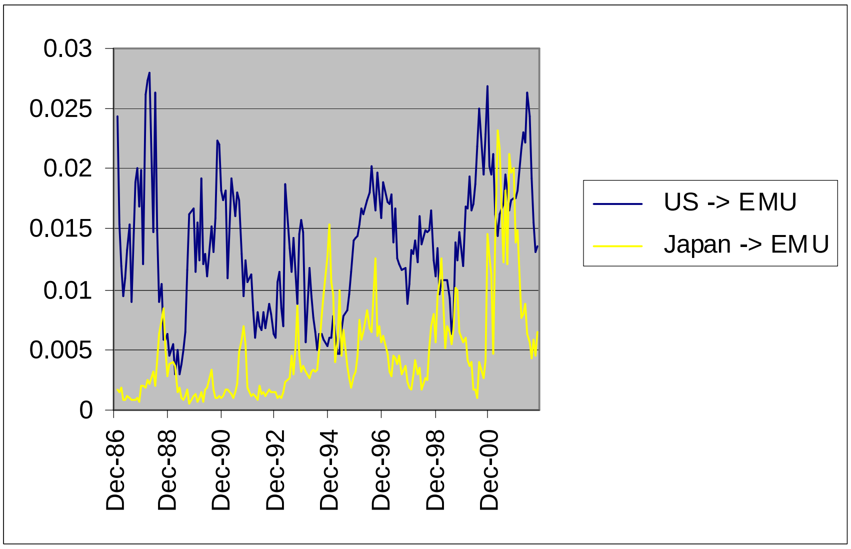


Figure 21: Average of sector-specific return spillover effects from innovations to EMU and Japanese industries to returns of their US counterparts

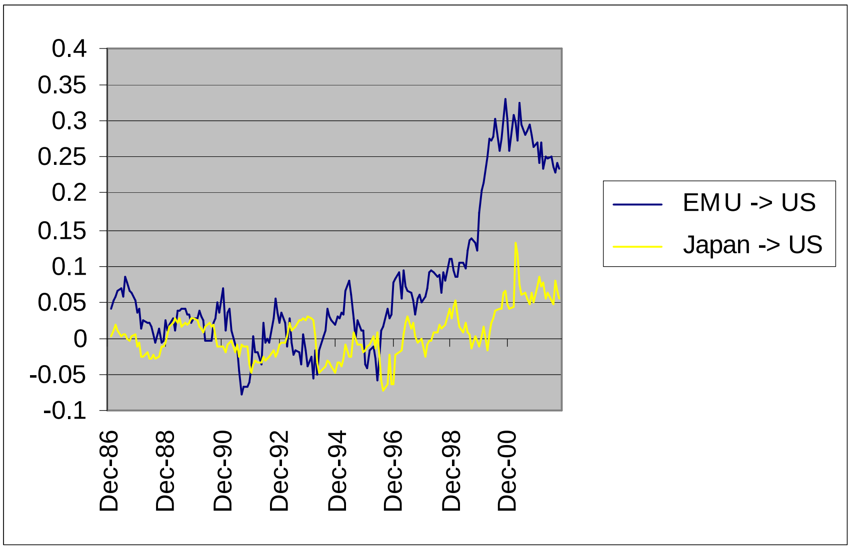


Figure 22: Variance of sector-specific return spillover effects from innovations to EMU and Japanese industries to returns of their US counterparts

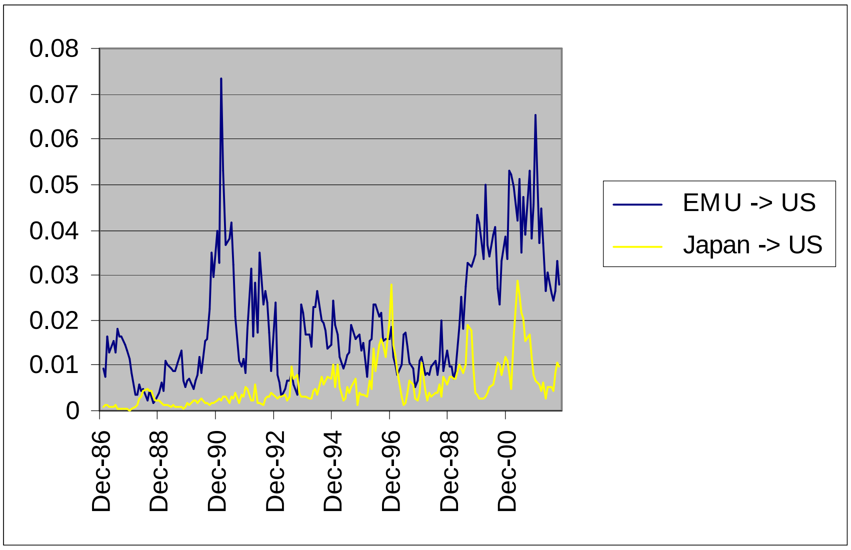


Figure 23: Average of sector-specific return spillover effects from innovations to EMU and US industries to returns of their Japanese counterparts

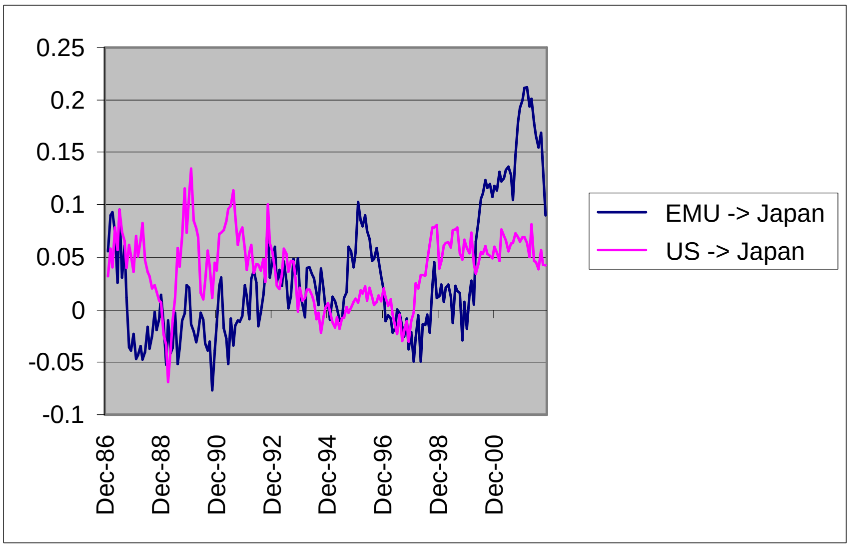
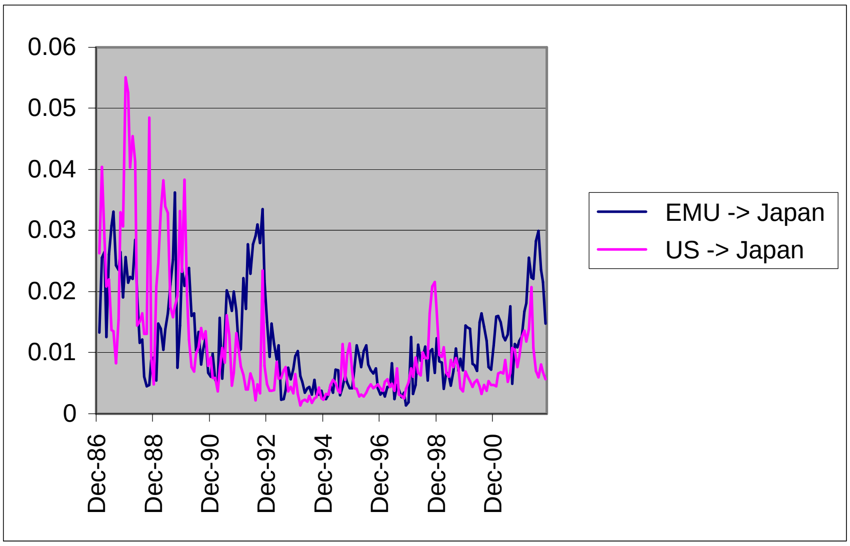


Figure 24: Variance of sector-specific return spillover effects from innovations to EMU and Japanese industries to returns of their US counterparts



European Central Bank working paper series

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.int).

202 "Aggregate loans to the euro area private sector" by A. Calza, M. Manrique and J. Sousa, January 2003.

203 "Myopic loss aversion, disappointment aversion and the equity premium puzzle" by D. Fielding and L. Stracca, January 2003.

204 "Asymmetric dynamics in the correlations of global equity and bond returns" by L. Cappiello, R.F. Engle and K. Sheppard, January 2003.

205 "Real exchange rate in an inter-temporal n-country-model with incomplete markets" by B. Mercereau, January 2003.

206 "Empirical estimates of reaction functions for the euro area" by D. Gerdesmeier and B. Roffia, January 2003.

207 "A comprehensive model on the euro overnight rate" by F. R. Würtz, January 2003.

208 "Do demographic changes affect risk premiums? Evidence from international data" by A. Ang and A. Maddaloni, January 2003.

209 "A framework for collateral risk control determination" by D. Cossin, Z. Huang, D. Aunon-Nerin and F. González, January 2003.

210 "Anticipated Ramsey reforms and the uniform taxation principle: the role of international financial markets" by S. Schmitt-Grohé and M. Uribe, January 2003.

211 "Self-control and savings" by P. Michel and J.P. Vidal, January 2003.

212 "Modelling the implied probability of stock market movements" by E. Glatzer and M. Scheicher, January 2003.

213 "Aggregation and euro area Phillips curves" by S. Fabiani and J. Morgan, February 2003.

214 "On the selection of forecasting models" by A. Inoue and L. Kilian, February 2003.

215 "Budget institutions and fiscal performance in Central and Eastern European countries" by H. Gleich, February 2003.

216 "The admission of accession countries to an enlarged monetary union: a tentative assessment" by M. Ca'Zorzi and R. A. De Santis, February 2003.

217 "The role of product market regulations in the process of structural change" by J. Messina, March 2003.

218 “The zero-interest-rate bound and the role of the exchange rate for monetary policy in Japan” by G. Coenen and V. Wieland, March 2003.

219 “Extra-euro area manufacturing import prices and exchange rate pass-through” by B. Anderton, March 2003.

220 “The allocation of competencies in an international union: a positive analysis” by M. Ruta, April 2003.

221 “Estimating risk premia in money market rates” by A. Durré, S. Evjen and R. Pilegaard, April 2003.

222 “Inflation dynamics and subjective expectations in the United States” by K. Adam and M. Padula, April 2003.

223 “Optimal monetary policy with imperfect common knowledge” by K. Adam, April 2003.

224 “The rise of the yen vis-à-vis the (“synthetic”) euro: is it supported by economic fundamentals?” by C. Osbat, R. Rüffer and B. Schnatz, April 2003.

225 “Productivity and the (“synthetic”) euro-dollar exchange rate” by C. Osbat, F. Vijselaar and B. Schnatz, April 2003.

226 “The central banker as a risk manager: quantifying and forecasting inflation risks” by L. Kilian and S. Manganelli, April 2003.

227 “Monetary policy in a low pass-through environment” by T. Monacelli, April 2003.

228 “Monetary policy shocks – a nonfundamental look at the data” by M. Klaeffing, May 2003.

229 “How does the ECB target inflation?” by P. Surico, May 2003.

230 “The euro area financial system: structure, integration and policy initiatives” by P. Hartmann, A. Maddaloni and S. Manganelli, May 2003.

231 “Price stability and monetary policy effectiveness when nominal interest rates are bounded at zero” by G. Coenen, A. Orphanides and V. Wieland, May 2003.

232 “Describing the Fed’s conduct with Taylor rules: is interest rate smoothing important?” by E. Castelnuovo, May 2003.

233 “The natural real rate of interest in the euro area” by N. Giammarioli and N. Valla, May 2003.

234 “Unemployment, hysteresis and transition” by M. León-Ledesma and P. McAdam, May 2003.

235 “Volatility of interest rates in the euro area: evidence from high frequency data” by N. Cassola and C. Morana, June 2003.

236 “Swiss monetary targeting 1974-1996: the role of internal policy analysis” by G. Rich, June 2003.

237 “Growth expectations, capital flows and international risk sharing” by O. Castrén, M. Miller and R. Stiegert, June 2003.

238 “The impact of monetary union on trade prices” by R. Anderton, R. E. Baldwin and D. Taglioni, June 2003.

239 “Temporary shocks and unavoidable transitions to a high-unemployment regime” by W. J. Denhaan, June 2003.

240 “Monetary policy transmission in the euro area: any changes after EMU?” by I. Angeloni and M. Ehrmann, July 2003.

241 Maintaining price stability under free-floating: a fearless way out of the corner?” by C. Detken and V. Gaspar, July 2003.

242 “Public sector efficiency: an international comparison” by A. Afonso, L. Schuknecht and V. Tanzi, July 2003.

243 “Pass-through of external shocks to euro area inflation” by E. Hahn, July 2003.

244 “How does the ECB allot liquidity in its weekly main refinancing operations? A look at the empirical evidence” by S. Ejerskov, C. Martin Moss and L. Stracca, July 2003.

245 “Money and payments: a modern perspective” by C. Holthausen and C. Monnet, July 2003.

246 “Public finances and long-term growth in Europe – evidence from a panel data analysis” by D. R. de Ávila Torrijos and R. Strauch, July 2003.

247 “Forecasting euro area inflation: does aggregating forecasts by HICP component improve forecast accuracy?” by K. Hubrich, August 2003.

248 “Exchange rates and fundamentals” by C. Engel and K. D. West, August 2003.

249 “Trade advantages and specialisation dynamics in acceding countries” by A. Zaghini, August 2003.

250 “Persistence, the transmission mechanism and robust monetary policy” by I. Angeloni, G. Coenen and F. Smets, August 2003.

251 “Consumption, habit persistence, imperfect information and the lifetime budget constraint” by A. Willman, August 2003.

252 “”Interpolation and backdating with a large information set” by E. Angelini, J. Henry and M. Marcellino, August 2003.

253 “Bond market inflation expectations and longer-term trends in broad monetary growth and inflation in industrial countries, 1880-2001” by W. G. Dewald, September 2003.

254 "Forecasting real GDP: what role for narrow money?" by C. Brand, H.-E. Reimers and F. Seitz, September 2003.

255 "Is the demand for euro area M3 stable?" by A. Bruggeman, P. Donati and A. Warne, September 2003.

256 "Information acquisition and decision making in committees: a survey" by K. Gerling, H. P. Grüner, A. Kiel and E. Schulte, September 2003.

257 "Macroeconomic modelling of monetary policy" by M. Klaeffling, September 2003.

258 "Interest rate reaction functions and the Taylor rule in the euro area" by P. Gerlach-Kristen, September 2003.

259 "Implicit tax co-ordination under repeated policy interactions" by M. Catenaro and J.-P. Vidal, September 2003.

260 "Aggregation-theoretic monetary aggregation over the euro area, when countries are heterogeneous" by W. A. Barnett, September 2003.

261 "Why has broad money demand been more stable in the euro area than in other economies? A literature review" by A. Calza and J. Sousa, September 2003.

262 "Indeterminacy of rational expectations equilibria in sequential financial markets" by P. Donati, September 2003.

263 "Measuring contagion with a Bayesian, time-varying coefficient model" by M. Ciccarelli and A. Rebucci, September 2003.

264 "A monthly monetary model with banking intermediation for the euro area" by A. Bruggeman and M. Donnay, September 2003.

265 "New Keynesian Phillips Curves: a reassessment using euro area data" by P. McAdam and A. Willman, September 2003.

266 "Finance and growth in the EU: new evidence from the liberalisation and harmonisation of the banking industry" by D. Romero de Ávila, September 2003.

267 "Comparing economic dynamics in the EU and CEE accession countries" by R. Süppel, September 2003.

268 "The output composition puzzle: a difference in the monetary transmission mechanism in the euro area and the US" by I. Angeloni, A. K. Kashyap, B. Mojon and D. Terlizzese, September 2003.

269 "Zero lower bound: is it a problem with the euro area?" by G. Coenen, September 2003.

270 "Downward nominal wage rigidity and the long-run Phillips curve: simulation-based evidence for the euro area" by G. Coenen, September 2003.

271 "Indeterminacy and search theory" by N. Giammarioli, September 2003.

272 “”Inflation targets and the liquidity trap” by M. Klaeffling and V. López Pérez, September 2003.

273 “Definition of price stability, range and point inflation targets: the anchoring of long-term inflation expectations” by E. Castelnuovo, S. Nicoletti-Altimari and D. Rodriguez-Palenzuela, September 2003.

274 “Interpreting implied risk neutral densities: the role of risk premia” by P. Hördahl and D. Vestin, September 2003.

275 “Identifying the monetary transmission mechanism using structural breaks” by A. Beyer and R. Farmer, September 2003.

276 “Short-term estimates of euro area real GDP by means of monthly data” by G. Rünstler, September 2003.

277 “On the indeterminacy of determinacy and indeterminacy" by A. Beyer and R. Farmer, September 2003.

278 “Relevant economic issues concerning the optimal rate of inflation” by D. R. Palenzuela, G. Camba-Méndez and J. Á. García, September 2003.

279 “Designing targeting rules for international monetary policy cooperation” by G. Benigno and P. Benigno, October 2003.

280 “Inflation, factor substitution and growth” by R. Klump, October 2003.

281 “Identifying fiscal shocks and policy regimes in OECD countries” by G. de Arcangelis and S. Lamartina, October 2003.

282 “Optimal dynamic risk sharing when enforcement is a decision variable” by T. V. Koeppl, October 2003.

283 “US, Japan and the euro area: comparing business-cycle features” by P. McAdam, November 2003.

284 “The credibility of the monetary policy ‘free lunch’” by J. Yetman, November 2003.

285 “Government deficits, wealth effects and the price level in an optimizing model” by B. Annicchiarico, November 2003.

286 “Country and sector-specific spillover effects in the euro area, the United States and Japan” by B. Kaltenhaeuser, November 2003.