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Regional Financial Spillovers Across Europe: A Global VAR Analysis

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Regional Financial Spillovers Across Europe: A Global VAR Analysis[1]

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Abstract

The recent financial crisis raises important issues about the transmission of financial shocks across borders. In this paper, a global vector autoregressive (GVAR) model is constructed to assess the relevance of international spillovers following a historical slowdown in U.S. equity prices. The GVAR model contains 27 country-specific models, including the United States, 17 European advanced economies, and 9 European emerging economies. Each country model is linked to the others by a set of country-specific foreign variables, computed using bilateral bank lending exposures. Results reveal considerable comovements of equity prices across mature financial markets. However, the effects on credit growth are found to be country-specific. Evidence indicates that asset prices are the main channel through which—in the short run—financial shocks are transmitted internationally, while the contribution of other variables—like the cost and quantity of credit—becomes more important over longer horizons.

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I. Introduction

Financial systems in advanced and emerging economies of Europe have undergone remarkable changes over the past decade. Cross-border ownership of assets has increased, revealing important benefits and new risks associated with financial integration. Greater financial integration has clearly shown its ability to disperse claims to a broader range of portfolios, so that risks are better spread. In particular, financial integration holds great potential to smooth incomes through cross-border asset diversification, and thus stabilize income in the face of asymmetric shocks.[2] Adjusting well to shocks means having a system that is not only resilient but also reallocates resources more efficiently across sectors and across firms, thereby fostering growth.[3] At the same time, though, financial integration poses new challenges to market investors and policymakers. Cross-border ownership of assets exposes financial institutions such as banks to macroeconomic, financial, and asset price fluctuations in the countries where they hold positions. Increasingly complex linkages across market segments and borders make the transmission of shocks in the international economy and the pattern of risk dispersion more opaque, creating uncertainty for agents and policymakers about where the ultimate risks lie.

With the pace of private sector credit growth having remained brisk in emerging Europe until end-2007, reliance on foreign funding channeled primarily through the banking sector has correspondingly increased in many countries, given the relatively underdeveloped domestic capital markets and the easy access to cheap financing from the parent institutions of the mostly foreign-owned banks. Loan-to-deposit ratios have been rising through end-2007 in most countries in the region, particularly in the Baltic countries, where they have roughly doubled since the early 2000s, and in Ukraine, Hungary, and Russia, where they ranged from 120 to 150 percent in 2007. Except in a few cases (Moldova; Serbia; Macedonia, FYR; and Bosnia and Herzegovina), the changes in the ratio of bank credit to GDP significantly exceeded those in the ratio of bank deposits to GDP, suggesting that credit growth has significantly outpaced deposit growth in recent years (Figure 1).

The sizable cross-border financial linkages across Europe highlight the vulnerabilities arising from reliance on concentrated foreign funding. International banking statistics from the Bank for International Settlements (BIS) provide consolidated foreign claims of reporting banks on individual countries (through both direct lending and local banking systems) and give a sense of the magnitude and distribution of exposures of emerging European countries to western European banking systems. Similarly, they provide exposures of western European countries to emerging European economies by the nationality of the reporting banks.[4] Data suggest that

[2]Empirical analysis shows that, since 1999, risk sharing has begun to emerge across European economies, although the extent to which financial integration is able to insure incomes against country-specific shocks is still limited and uneven across regions (IMF, 2008).

[3]Empirical studies find that advances in financial integration are indeed associated with better growth opportunities and that Europe is one of the world regions that has integrated the fastest, reaping the largest real gains in the process (De Nicolo' and Ivaschenko, 2008).

[4]The BIS consolidated banking statistics report banking groups' on-balance sheet financial claims on the rest of the world and thereby provide a measure of the risk exposures of lenders' national banking systems. The quarterly data cover contractual lending by the head office and all its branches and subsidiaries on a worldwide consolidated basis, e.g. net of inter-office accounts. Reporting on this contractual lending on an immediate borrower basis allows the allocation of claims to the bank entity that would bear the losses as a result of default by borrowers. Total claims are broken down by maturity, sector (banks, non-bank private sector and public sector) as well as vis-à-vis country. Currently, central banks in 30 countries report their aggregate national consolidated data to the BIS, which uses them as the basis for calculating and publishing global data. The data are published as part of the BIS Quarterly Review. For detailed information about the structure of the BIS consolidated

most emerging European economies are heavily exposed to—and dependent on—western European banks (either directly or through the local banking systems). Most countries in the region have concentrated exposures to banks in Austria, Italy, and Germany, and the Baltic countries have large exposures to Sweden. Among those most dependent on foreign funding, some are more diversified (e.g., the Czech Republic and Poland), while several depend on funding from a very few countries (Figure 2). The concentration of funding exposure is contributing to the vulnerabilities associated with heavy reliance on foreign funding, particularly when it concerns the funding of banks. Banking systems that are heavily dependent on foreign borrowing to support credit growth could face a sudden shortfall of funding or a sharp increase in its cost if there were a sudden reassessment of parent bank exposure to a host country.

In order to shed light on potential international spillovers and the feedback between the real and the financial sectors, it is crucial to look into the time profile of the cross-country transmission of financial shocks, while explicitly accounting for regional interdependencies. In this perspective, country-specific vector error-correction models are estimated, where the domestic macroeconomic variables are related to the corresponding foreign variables constructed to match the international financial flows of the country under consideration. The individual country models are then combined consistently and cohesively to generate predictions for all the variables in the world economy simultaneously. The resulting global VAR (GVAR) model is estimated for 26 European countries, grouped into 5 regions plus the United States, using monthly data on real GDP growth, real interest rates, and real growth in credit to the corporate sector and equity prices, from June 1999 to April 2008.

To anticipate our findings, dynamic analysis reveals considerable comovements of equity prices across those countries characterized by mature financial markets. However, the effects on credit growth are found to be generally country-specific. Empirical results also indicate that asset prices are the main channel through which, in the short run, financial shocks are transmitted internationally, whereas the role of other variables—including the cost and quantity of credit—becomes important over longer horizons.

The structure of the paper is as follows. Section 2 describes the structure of the Global VAR framework and the properties of the dataset employed for the analysis. Section 3 illustrates in detail the estimation procedure and discusses the extent to which our sample satisfies the necessary conditions for the validity of the GVAR methodology. The results from the dynamic analysis are discussed in Section 4, while Section 5 draws some concluding remarks.

II. The GVAR Model (1999-2008)

A. Structure of the model

In order to assess the importance of financial spillovers among countries, we build a GVAR model, following Pesaran, Schuermann and Weiner (2004*a*, henceforth PSW) and Dées, di Mauro, Pesaran and Smith (2007, henceforth DdPS). The GVAR model is a multicountry framework which allows the investigation of interdependencies among countries. It is generally composed by several country economies modeled by corresponding vector autoregressive (VAR) models. Each country model is linked with the others by including

banking statistics, see McGuire and Wooldridge (2005).

foreign-specific variables. In this way, each country is potentially affected by developments in other countries, thus an ideal usage of this new global macroeconometric modeling approach consists in the analysis of the regional propagation of shocks.

In our paper, foreign-specific variables are constructed using financial weights, mirroring the relative importance of each country's financial partner. Financial weights represent an original contribution to the GVAR modeling technique. In fact, PSW (2004a) and DdPS (2007) employ weights which are based on cross-country trade flows, Vansteenkiste (2007) uses weights which are based on the geographical distances among regions, whereas Hiebert and Vansteenkiste (2007) adopt weights based on sectorial input-output tables across industries.

Our GVAR model covers 27 developed and emerging economies. Since all countries are modeled individually, the GVAR is composed by 27 country-VARX* models, namely VAR models augmented by weakly exogenous I(1) variables. Countries and regions included in the analysis are listed in Table 11. In each country-VARX* model, country-specific variables are related to deterministic variables—such as a time trend (t)—and a set of country-specific foreign variables, calculated as weighted averages of the corresponding country-specific variables for the remaining countries.

Specifically, we consider N countries, indexed by $i = 1, \ldots, N$. Each country i is modeled as a VARX*(1,1):

$$\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1} + \mathbf{\Phi}_i \mathbf{x}_{i,t-1} + \mathbf{\Lambda}_{i0} \mathbf{x}^*_{it} + \mathbf{\Lambda}_{i1} \mathbf{x}^*_{i,t-1} + \mathbf{u}_{it}, \tag{1}$$

for $t = 1, 2, \ldots, T$ and $i = 1, \ldots, N$. $\mathbf{x}_{it} = (gequ'_{it}, gcc'_{it}, ggdp'_{it}, ibk'_{it})'$ is a $k_i \times 1$ vector of country-specific (domestic) variables listed below, and $\mathbf{x}^*_{it} = (gequ^{*'}_{it}, gcc^{*'}_{it}, ggdp^{*'}_{it}, ibk^{*'}_{it})'$ is the $k^*_i \times 1$ vector of foreign variables specific to the country i. $\mathbf{\Phi}_i$ is a $k_i \times k_i$ matrix of coefficients associated to lagged domestic variables, while $\mathbf{\Lambda}_{i0}$ and $\mathbf{\Lambda}_{i1}$ are $k_i \times k^*_i$ matrices of coefficients related to, respectively, contemporaneous and lagged foreign variables. $\mathbf{a}_{i0}$ is a $k_i \times 1$ vector of fixed intercepts, $\mathbf{a}_{i1}$ is a $k_i \times 1$ vector of coefficients of the deterministic time trend, and $\mathbf{u}_{it}$ is a $k_i \times 1$ vector of country-specific shocks assumed to be serially uncorrelated with a zero mean and a non-singular covariance matrix $\mathbf{\Sigma}_{ii} = (\sigma_{ii,ls})$, where $\sigma_{ii,ls} = cov(u_{ilt}, u_{ist})$. Specifically,

$$\mathbf{u}_{it} \sim i.i.d.(\mathbf{0}, \mathbf{\Sigma}_{ii}). \tag{2}$$

Moreover, a cross-country correlation among the idiosyncratic shocks is allowed. In particular, it is assumed that

$$E(\mathbf{u}_{it}\mathbf{u}'_{jt'}) = \begin{cases} \mathbf{\Sigma}_{ij} & \text{for } t = t' \\ \mathbf{0} & \text{for } t \neq t \end{cases} \tag{3}$$

Therefore, by construction, the GVAR model allows for interactions among the different economies through two channels: (i) the contemporaneous interrelation of domestic variables, $\mathbf{x}_{it}$, with foreign-specific variables, $\mathbf{x}^*_{it}$, and with their lagged values; (ii) the contemporaneous dependence of shocks in country i on the shocks in country j, as described by the cross-country covariances, $\mathbf{\Sigma}_{ij}$, where $\mathbf{\Sigma}_{ij} = Cov(\mathbf{u}_{it}, \mathbf{u}_{jt}) = E(\mathbf{u}_{it}\mathbf{u}'_{jt})$, for $i \neq j$.

The domestic variables included in the country-specific models are the following: the real interbank rate (ibk) and the rates of growth of, respectively, real credit to corporates (gcc), real equity prices ($gequ$), and real gross domestic product ($ggdp$).

The foreign variables, $gequ^*_{it}$, gcc^*_{it}, $ggdp^*_{it}$, ibk^*_{it}, are specific to each country, and represent the influence of the financial partners for a given economy. These are calculated as weighted averages of the corresponding variables for that country. Specifically, the set of foreign-specific variables for country i, $\mathbf{x}^*_{it}$, is given by:

$$\mathbf{x}^*_{it} = \sum_{j=1}^{N} w_{ij}\mathbf{x}_{jt}, \tag{4}$$

where

$$\begin{aligned} w_{ii} &= 0, \quad \forall i = 1, \ldots, N, & (5)\\ \sum_{j=1}^{N} w_{ij} &= 1, \quad \forall i, j = 1, \ldots, N. & (6) \end{aligned}$$

The weights, w_{ij} for $j = 1, \ldots, N$, capture the importance of country j for country i. They are based on cross-country financial flows. In particular, weights are fixed and computed using the average annual bank lending exposures over the period 1999-2007.

All country models contain the 4 domestic variables and their corresponding foreign-specific counterparts. Thus, k_i and k^*_i are both equal to 4, for each country i, with $i = 1, \ldots, N$. Due to data limitations, we set the lag orders of both domestic and foreign variables equal to one. Hence, our GVAR model includes in total 108 (27×4) endogenous variables.

Each country-VARX* model is estimated individually, treating $\mathbf{x}^*_{it}$ as weakly exogenous $I(1)$, in order to ensure consistency of parameter estimates. Assuming the weak exogeneity of the foreign variables implies that each (non US) country is considered as a small open economy: in other words, its domestic macroeconomic developments cannot affect the whole set of the 'rest of the world' countries, at least in the long-run, though allowing for short-run feedbacks between these two sets of variables.

After having estimated each country VARX* model, the construction of the GVAR model is straightforward.[5] First, we group both the domestic and foreign variables as $\mathbf{z}_{it} = (\mathbf{x}'_{it}, \mathbf{x}^{*\prime}_{it})'$, in order to write each country model as

$$\mathbf{A}_i\mathbf{z}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \mathbf{B}_i\mathbf{z}_{i,t-1} + \mathbf{u}_{it}, \tag{7}$$

where

$$\mathbf{A}_i = (\mathbf{I}_{k_i}, -\mathbf{\Lambda}_{i0}), \quad \mathbf{B}_i = (\mathbf{\Phi}_i, \mathbf{\Lambda}_{i1}). \tag{8}$$

Second, by collecting all the domestic variables of all the countries, we create the *global* vector,

$$\mathbf{x}_t = \begin{pmatrix} \mathbf{x}_{1t} \\ \mathbf{x}_{2t} \\ \vdots \\ \mathbf{x}_{Nt} \end{pmatrix}, \tag{9}$$

[5]Our GVAR model is a simpler version of the original model presented in PSW (2004a): in particular, our model does not include *global* variables, that is, common variables to each country model. See PSW (2004a) for the complete presentation of the GVAR methodology.

which is a $k \times 1$ vector containing all endogenous variables, where $k = \sum_{i=1}^{N} k_i$. Following these two steps, we obtain the identity:

$$\mathbf{z}_{it} = \mathbf{W}_i \mathbf{x}_t, \tag{10}$$

for $i = 1, \ldots, N$, where $\mathbf{W}_i$ is a country-specific *link* matrix of dimensions $(k_i + k_i^*) \times k$, constructed on the basis of financial weights. This identity allows to write each country model in terms of the *global* vector in (9). In fact, by substituting (10) in (7), we obtain

$$\mathbf{A}_i \mathbf{W}_i \mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1} t + \mathbf{B}_i \mathbf{W}_i \mathbf{x}_{i,t-1} + \mathbf{u}_{it}, \tag{11}$$

with $i = 1, \ldots, N$, and $\mathbf{A}_i \mathbf{W}_i$ being a matrix of dimension $k_i \times k$. The GVAR(1) model is thus built by simply stacking up each country model, so that:

$$\mathbf{G}\mathbf{x}_t = \mathbf{a}_0 + \mathbf{a}_1 t + \mathbf{H}\mathbf{x}_{t-1} + \mathbf{u}_t, \tag{12}$$

where

$$\mathbf{G} = \begin{pmatrix} \mathbf{A}_1\mathbf{W}_1 \\ \mathbf{A}_2\mathbf{W}_2 \\ \vdots \\ \mathbf{A}_N\mathbf{W}_N \end{pmatrix}, \quad \mathbf{H} = \begin{pmatrix} \mathbf{B}_1\mathbf{W}_1 \\ \mathbf{B}_2\mathbf{W}_2 \\ \vdots \\ \mathbf{B}_N\mathbf{W}_N \end{pmatrix},$$

$$\mathbf{a}_0 = \begin{pmatrix} \mathbf{a}_{10} \\ \mathbf{a}_{20} \\ \vdots \\ \mathbf{a}_{N0} \end{pmatrix}, \quad \mathbf{a}_1 = \begin{pmatrix} \mathbf{a}_{11} \\ \mathbf{a}_{21} \\ \vdots \\ \mathbf{a}_{N1} \end{pmatrix}, \quad \mathbf{u}_t = \begin{pmatrix} \mathbf{u}_{1t} \\ \mathbf{u}_{2t} \\ \vdots \\ \mathbf{u}_{Nt} \end{pmatrix}.$$

If the $\mathbf{G}$ matrix in (12) is nonsingular, we can then invert it and obtain the GVAR model in its reduced form,

$$\mathbf{x}_t = \mathbf{b}_0 + \mathbf{b}_1 t + \mathbf{F}\mathbf{x}_{t-1} + \mathbf{v}_t. \tag{13}$$

where

$$\mathbf{F} = \mathbf{G}^{-1}\mathbf{H}, \quad \mathbf{b}_0 = \mathbf{G}^{-1}\mathbf{a}_0, \quad \mathbf{b}_1 = \mathbf{G}^{-1}\mathbf{a}_1, \quad \mathbf{v}_t = \mathbf{G}^{-1}\mathbf{u}_t. \tag{14}$$

The dynamic properties of the GVAR model in (13) are analyzed below by using Generalized Impulse Response Functions (GIRFs) and Generalized Forecast Error Variance Decomposition (GFEVD).

B. The Data and Properties of the Series

Our dataset includes 27 countries from different regions of the world. The sample period spans, on a monthly basis, from June 1999 to April 2008. For each country, we consider the following variables: the real interbank rate (ibk), the rates of growth of real equity prices ($gequ$), real credit to corporations (gcc) and real GDP ($ggdp$). Specifically, these variables are constructed as follows:

$$\begin{aligned}
gequ_{it} &= \ln(EQU_{it}/EQU_{i,t-12}) \times 100 - \ln(CPI_{it}/CPI_{i,t-12}) \times 100, \\
gcc_{it} &= \ln(CC_{it}/CC_{i,t-12}) \times 100 - \ln(CPI_{it}/CPI_{i,t-12}) \times 100, \\
ggdp_{it} &= \ln(GDP_{it}/GDP_{i,t-12}) \times 100 - \ln(CPI_{it}/CPI_{i,t-12}) \times 100, \\
ibk_{it} &= IBK_{it} - \ln(CPI_{it}/CPI_{i,t-12}) \times 100,
\end{aligned}$$

where EQU_{it} is the nominal equity prices index, CC_{it} the nominal credit to corporations, CPI_{it} the consumer price index, GDP_{it} the nominal Gross Domestic Product, and IBK_{it} is the nominal interbank rate, for country i over the period t.[6]

The country-specific foreign variables are built using financial weights. In particular, weights are computed using cross-country bank lending exposures data for the period 1999-2007. Moreover, regional impulse responses and forecast error variances are obtained as weighted averages of the counterparts at country level. Aggregation weights are based on averages of Purchasing Power Parity GDPs of all countries under study, for the period 1999-2008.[7]

We investigate the order of integration of each variable under study by means of formal unit root tests. In particular, we first undertake the traditional Augmented Dickey-Fuller (ADF) tests on levels, first and second differences for all the domestic and foreign variables series. The lag order of the ADF test statistics is determined by the minimization of the Akaike Information Criterion (AIC), for which the maximum lag allowed is set to 6. The ADF tests' outcomes, reported in Table 5, indicate that the hypothesis of a unit root cannot be rejected for most variables in most countries. Moreover, given the small sample power of the traditional ADF tests, we also conduct the Weighted Symmetric DF tests following Park and Fuller (1995), based on the related regressions with the same lag order, accordingly with the AIC. Also WS tests' outcomes, reported in Table 6, indicate that the vast majority of the series under study is I(1).

III. Estimation

A. Conditions for the GVAR estimation

Given the considerable dimension of the GVAR model with respect to a traditional VAR model, it would not be possible to estimate the global model using the traditional procedure. In fact, it would involve the estimation of a number of parameters greater than the number of available observations. However, this shortcoming is solved by the original estimation procedure of the GVAR model. Specifically, such an estimation procedure is based on a country-by-country estimation, rather than a full system estimation, given the weak exogeneity of the foreign-specific variables. The weights used for the construction of the foreign variables are computed rather than estimated. In doing so, this estimation procedure reduces considerably the number of unrestricted parameters to be estimated.

The weak exogeneity of foreign variables is the key assumption for the whole GVAR modeling approach. This fundamental assumption is further tested after the individual estimation of each country model. In addition, PSW (2004a) indicate three further requirements as sufficient conditions for the validity of the GVAR methodology:

1. The global model must be dynamically stable. Specifically, the eigenvalues of the $\mathbf{F}$ matrix in (13) must be either on or inside the unit circle.

[6] Monthly data for credit growth in the corporate sector have been provided by national central banks; equity prices are taken from Bloomberg, while 3-month interbank interest rates and consumer price indices have been collected from the IMF International Financial Statistics. Quarterly data on GDP growth have been exponentially interpolated to derive corresponding series with monthly frequency. When not previously performed, the series are seasonally adjusted using the Census X12 procedure.

[7] As noted in DdPS (2007), weights based on PPP GDP tend to be more reliable than weights based on US $ GDP.

2. The weights must be relatively small, such that

$$\sum_{j=1}^{N} w_{ij}^2 \to 0 \text{ as } N \to \infty, \quad \text{for } i = 1, 2, \ldots, N.^8 \tag{15}$$

3. The cross-dependence of the idiosyncratic shocks must be sufficiently small, so that

$$\frac{\sum_{j=1}^{N} \sigma_{ij,ls}}{N} \to 0, \text{ as } N \to \infty, \quad \text{for all } i, l, s, \tag{16}$$

   where $\sigma_{ij,ls} = cov(u_{ilt}, u_{jst})$ is the covariance of the variable l in country i with the variable s in country j.

All the three requirements are met in our GVAR model. First, the model is dynamically stable: the moduli of the 108 eigenvalues of the $\mathbf{F}$ matrix in (13) are all on or within the unit circle. Specifically, the number of eigenvalues lying on the unit circle (e.g. the number of unitary roots) is 78. Second, the financial weights are relatively small. They are reported in the 27×27 matrix in Table 7. The vast majority of the weights are 'granular' for each country; in other words, they are not too close to one. The largest weights are observed for Sweden, with its greatest values equal to 0.76 towards Estonia, 0.691 towards Latvia, and 0.672 towards Lithuania. Third, the idiosyncratic shocks are weakly correlated. In order to check this last property, we calculate 4 sets of pair-wise cross-section correlations: two sets relate to variables in levels and in differences, respectively, while the remaining two sets relate to the residuals obtained from each country-VECM estimation and from each country-VECMX* estimation, respectively. The idea behind this procedure is simple: the foreign variables can be considered as common factors for each country model, so the estimation of each country model including the foreign variables aims at reducing the common correlation among all the variables in the system. Our purpose is thus to obtain simultaneously weakly correlated residuals in the system, such that, in the context of the dynamical analysis of the model, our simulated shocks would be potentially idiosyncratic.

In Table 8 the average pair-wise cross-section correlations are reported. Among the variables in levels, the rate of growth of real equity prices appears to be the most correlated, with a maximum of 0.70 for UK and Spain. The rate of growth of real GDP and the real interbank rate show a lower degree of correlation. Surprisingly, the correlation of real credit growth is extremely low. Moreover, with respect to the variables in differences, we observe a generalized fall in the degree of correlation for all the variables under study. The VAR residuals are obtained from the estimation of country-VECM models, containing solely domestic variables. They are moderately correlated for the rate of growth of real equity prices and for the real interbank rate, while they are weakly correlated for the rates of growth of both real credit and real GDP. The VARX residuals are obtained from the estimation of each country-VECMX* model, now containing both the domestic and the foreign variables. The comparison between the correlations among VAR and VARX residuals is striking: the VARX residuals are generally weakly correlated and, in some cases, completely uncorrelated for all the variables under study. The inclusion of the foreign variables in the country model estimation cleans the common factor among the variables, thereby yielding weakly correlated residuals. In this way, this condition allows us to simulate shocks which are mainly country-specific.

[8] One might think that a possible way to satisfy this requirement is to choose N, the number of countries, sufficiently high. However, as explained in PSW(2004*b*), it is not the number of countries that determines the 'smallness' condition, but the size of country i with respect to the rest of the world.

B. ESTIMATION OF THE COUNTRY-SPECIFIC MODELS

Given that most of the variables under study have a unit root, we individually estimate each country-VARX* model in its vector error-correcting form.[9] Specifically, we undertake the Johansen's (1992, 1995) reduced-rank procedure. First, we perform a cointegration analysis in which each country-VECMX* model is subject to the reduced-rank restriction. Then, the cointegration rank is derived by employing both the *trace* and the *maximum eigenvalue* statistics.[10] The asymptotic distribution of the *trace* statistics depends on whether the intercept and/or the coefficients on the deterministic trend are restricted or not. We perform the reduced rank regressions by restricting the trend coefficients into the cointegrating space, while letting the intercept coefficients to be unrestricted in levels, in order to eschew the possibility of introducing quadratic trends when the cointegrating matrix is rank deficient.[11] Thus, we use the critical values obtained in MacKinnon *et al.* (1999). Rank tests results are reported in Table 9, while the ranks obtained for each country VARX* model are reported in Table 2.

In Table 2 the cointegrating ranks for each country model are reported. In cases where cointegration is found, each country-VARX* model is estimated under its vector error-correcting (VECMX*) form. In contrast, country models characterized by a zero rank of the cointegrating matrix are estimated in differences, given that no error-correcting terms are included among the regressors.[12] All hypothesis testing has been performed using White's heteroskedasticity-corrected standard errors.

C. TESTING FOR WEAK EXOGENEITY

After having individually estimated each country-VARX* model, we test the assumption of weak exogeneity of the foreign variables of each country. In doing so, we undertake the weak exogeneity tests proposed by Johansen (1992) and Harbo *et al.* (1998). Specifically, for each country model we test the joint significance of the estimated error-correcting terms in the marginal models for the foreign variables. This amounts to conducting the following regression for each element l of $\mathbf{x}_{it}^*$ in each country i model:

$$\Delta x_{it,l}^* = \mu_{il} + \sum_{j=1}^{r_i} \gamma_{ij,l} ECM_{i,t-1}^j + \phi_{i,l} \Delta \mathbf{x}_{i,t-1} + \theta_{i,l} \Delta \mathbf{x}_{i,t-1}^* + \varepsilon_{it,l}, \tag{17}$$

where $ECM_{i,t-1}^j$ are the estimated error-correcting terms associated with the r_i cointegrating relations for the country i, with $j = 1, \ldots, r_i$. Then, by means of an F-test, we verify the joint hypothesis that $\gamma_{ij,l} = 0$ for each $j = 1, \ldots, r_i$.

The weak exogeneity test outcomes are reported in Table 3. The weak exogeneity assumption is not rejected for most of the foreign variables, despite some exceptions. In particular, the assumption is rejected at the 5% significance level for the following variables: the foreign rate of change of real equity prices in Switzerland; the foreign rate of change of real credit to corporations in Belgium and France; the foreign rate of real gross domestic product in

[9]The presence of nonstationary variables makes the traditional OLS regressions in levels no longer valid.

[10]The *trace* is preferred to the *maximum eigenvalue*, because it is more robust to departures from the assumption of normality of the residuals.

[11]This is the case IV in Pesaran, Shin and Smith (2000) and in Garratt *et al.* (2006).

[12]The zero rank does not particularly concern us, since our aim is not to identify any long-run relationship, but to analyze short-run dynamics.

Belgium, France, Hungary and Sweden; and the foreign real interbank rate in Estonia. It is important to note that for those countries in which no cointegrating relations (and thus no error-correcting terms) were found—namely Austria, Croatia, Ireland, Netherland and Poland—the weak exogeneity of foreign variables is automatically assured.

Concluding, given that only 8 out of 108 foreign variables fail to satisfy the weak exogeneity assumption, we consider these outcomes as acceptable, thereby justifying the estimation procedure of each country model in the GVAR.

D. Impact Elasticities

From the estimation of each country-VECMX* model we obtain the coefficient estimates of the contemporaneous foreign variables in differences. These estimates, also called *impact elasticities*, measure the contemporaneous variation of a domestic variable due to a one percent change in its corresponding foreign-specific counterpart. These are particularly useful in the GVAR framework in order to identify co-movements among variables across different countries. In Table 4, the estimated impact elasticities are reported, along with the corresponding t-ratios, calculated using the White's heteroscedasticity-consistent variance estimator.

The impact elasticities related to the growth rate of real equity prices ($gequ$) are statistically significant for most of the countries. All the values are positive, either greater or lower than one: for a given country, impact elasticities greater than one indicate that the domestic variable overreacts to a variation in real equity prices of its financial partners, while the opposite holds when impact elasticities are lower than one. Therefore, these results suggest strong co-movements in equity prices' dynamics across countries. Moreover, these findings give us already some insights with respect to the dynamics of the GIRFs: we will indeed observe a strong synchronization of the GIRFs associated with changes in real equity prices across regions. As for the rate of growth of real credit, gcc, almost all the coefficient estimates are not statistically significant. Thus, there is no evidence of strong international linkages across countries concerning the national dynamics of real credit to corporations. Concerning the rate of growth of real GDP, $ggdp$, and the real interbank rate, ibk, we do not find striking evidence of linkages across countries. In fact, the estimated impact elasticities are seldom statistically significant for both variables.

IV. Dynamic Analysis

We undertake the dynamic analysis of the GVAR model by means of the Generalized Impulse Response Functions (GIRFs), as proposed by Koop, Pesaran and Potter (1996) for non-linear models and further developed in Pesaran and Shin (1998) for vector error-correcting models.

This relatively new approach differs in a number of ways from the traditional Orthogonalized Impulse Responses (OIRs) in Sims (1980). First, it does not orthogonalize the residuals of the system, as it takes into account the historical correlations among the variables, summarized by the estimated variance-covariance matrix. For this reason, it does not require any *a priori* economic-based restrictions and its outcome is invariant to the ordering of the variables in the model. Second, since shocks are not identified, the GIRFs cannot provide information about the causal relationships among the variables. This shortcoming limits the potential applications of the GIRFs, especially for purposes of policy simulation. Nonetheless, GIRFs have a comparative advantage with respect to the traditional OIRs in the context of multi-country frameworks such as the GVAR model. In fact, they can provide interesting insights on how shocks internationally propagate, by unveiling potential linkages among different national economies. In addition, it is actually a difficult task to employ traditional OIRs in a GVAR, since there is no reasonable way to order the countries in the model.

In our application, we analyze the dynamic properties of our GVAR model by simulating a negative standard error shock to the US growth rate of real equity prices.[13] The scope of this simulation is to determine the degree of interregional financial spillovers: in other words, we seek to analyze how each region responds to the shock. Since each economy is potentially linked to the others, each country/region will be affected from the disturbance.

Then, by means of the GFEVD we investigate the international financial linkages among the regions. In doing so, we allocate the forecast error variance of the simulated historical shock into its respective variables and regions. The relative contributions measure the importance of the innovation to a given region's variable to the rest of the regions' variables. The sum of these contributions does not add up to unity, due the existence of contemporaneous correlations among innovations. Although the contributions of each region to the forecast error variance of the historical shock cannot be considered as proportions, GFEVD remain an useful device to study the transmission channels through which region-specific shocks are geographically propagated.

A. Generalized Impulse Response Functions

The GIRFs associated to a one standard error negative shock to the US growth rate of real equity prices are plotted in Figures 3-6, and in Figure 7. For each region, the charts show the dynamic response of each variable over a time horizon of 2 years, which is a reasonable period for inference on short-run macroeconomic dynamics. The graphs in 7 include the confidence intervals at the 68 percent significance level, calculated using the sieve bootstrap technique with 1000 replications.[14] We are aware that, with very few exceptions, the responses appear to be statistically not significant using custom confidence intervals. This lack of efficiency of the parameters estimator is not surprising, given that the model is estimated using only 95 monthly observations. However, there is anyway an economic interest in analyzing whether the dynamic behavior of the variables are synchronized or not across regions, following a region-specific shock. Focussing our attention on the dynamic properties of the responses (rather than on the significance of their signs) is instrumental to the evaluation of potential cross-border financial spillovers.

Figure 3 plots the regional GIRFs associated with the growth rates of real equity prices. The response for the US shows an instantaneous fall of 2.86 percent, increasing over time until it reaches a peak after four months (equal to a 2.37 percent decrease), and then reaching 3.17 percent below the baseline after two years. The other regions' GIRFs generally display synchronized dynamics with the US: the considerable extent to which regional GIRFs follow

[13] Setting the shock equal to one standard error is common practice in the empirical literature. Given that the GVAR is a linear model, resizing the shock is straightforward.

[14] See Kreiss (1992), Buhlmann (1997) and Bickel and Buhlmann (1999) for a complete presentation of the sieve bootstrap technique.

the US dynamic response suggests that these countries' equity markets are strongly interrelated. This is particularly true for those countries characterized by mature financial systems. As expected, the dynamic behavior of the GIRF associated with Southeastern European countries is mainly self-driven, implying a low degree of financial integration for these countries with respect to the rest of the world.

The GIRFs in Figure 4 imply a lack of synchronization among the growth rates of real credit to corporations of the regions under analysis. The response for the US shows, on impact, a 0.15 percent decline, further reaching a minimum of 0.32 percent below the pre-shock level after four months. After two years, the effect averages a 0.27 percent decrease with respect to the baseline. The GIRF for the other developed European countries share a common behavior with the US: it starts on impact from the zero line, rapidly falling 0.2 percent below it, and stabilizing over time around that level. The behaviors of the GIRFs related to the Baltic countries and the Central-eastern European countries are similar: they decrease in the short run, while returning over time to their initial levels. Surprisingly, the Euro Area's credit growth rate hardly increases above its pre-shock level. Finally, the GIRF associated with the Southeastern European countries fluctuates considerably: it increases during the initial months, reaching its peak after four months (0.14 percent increase), and implying a complete reabsorption of the shock after two years. Interestingly, the fact that the responses of credit growth are mainly region-specific denotes that the national credit developments do not follow common international dynamics.

Figure 5 displays regional GIRFs associated with the real GDP growth rates. We observe a general decrease in GIRFs across all the regions, and their dynamic behaviors appear to be moderately correlated. The strongest response is observed for the US: the associated GIRF monotonically decreases over time and stabilizes after two years to 0.13 percent below the pre-shock level. Similar behaviors are found for the GIRFs associated with the Euro area and the other developed European countries: their GIRFs mildly decreases over time, both reaching levels which average 0.05 percent below the zero line. The responses associated with the other regions behave differently during the first months after the shock, although they stabilize below baseline after two years. These findings suggest that there exists considerable international co-movement of real growth among regions.

Finally, Figure 6 shows the responses associated with the real interbank rates. Also in this case, the majority of the GIRFs decreases over time. The US real interbank rate decreases on impact by 8 basis points; it then falls steadily, averaging 14 basis points below baseline after two years. The real interbank rate associated with the other developed European countries overreacts: it reaches its minimum after four months (28 basis points decrease), further stabilizing over time around a 27 basis points loss. Consistently with previous results, the GIRF of the Southeastern European countries diverges from the dynamics of the other regions: it increases, reaching a 7 basis points increase after three months, to return to the zero line after 15 months.

B. Generalized Forecast Error Variance Decompositions

Results of the Generalized Forecast Error Variance Decompositions are reported in Table 10. Following the historical shock to the US growth rate of real equity prices, we observe that, among the US variables, the real equity prices explain most of the forecast error variance in the short run: on impact, they contribute for 42.43 percent of the variance of the historical shock, while the other variables—real credit to corporations, real interbank rate, and real GDP—contribute respectively for 7.24, 6.11, and 0.05 percent respectively. However, the relative contribution of real equity prices decreases over time, while the opposite holds true for the other US variables: after one year, the real equity prices contribute to the explanation of the forecast error variance for 9.66 percent, the real credit for 15.82 percent, the real GDP for 12.67 percent, and the real interbank rate for 7.38 percent. After two years, the relative contributions of the US variables are, in decreasing order, 17.38 percent for the real GDP growth, 15.21 percent for the real credit growth, 7.17 percent for the real interbank rate, and 7.12 percent for the real equity prices growth. Hence, as a first result, we observe that among the US variables, the variable which explains most of the variance of the shock in the short-term is the real equity prices growth. On the contrary, in the longer term, the other domestic variables gain increasing relevance.

From a global perspective, we generally observe the same dynamic behavior just highlighted in the US: for all other regions, real equity price growth explains most of the forecast error variance of the historical shock over the short run; its relative importance decreases over time, while the opposite is observed for the rest of the variables. After two years, real credit growth, real GDP growth, and real interbank rate explain most of the variance of the shock, and the order of importance of these three variables is generally specific to each region. Moreover, by focusing on the relative contribution of each region to the explanation of the forecast error variance, we observe the degree to which interregional linkages matter in the geographical transmission of the US financial shock. On impact, the foreign regions that contribute mostly to the variance of the shock are, in decreasing order, the other developed European countries (11.26 percent) and the Baltic countries (10.23 percent). Regional contributions change over time and, after two years, the other developed European countries explain most of the shock (15.72 percent), followed by the Euro area (13.62 percent). Finally, we disentangle the contributions due to both domestic (US variables) and foreign (non-US variables) innovations. On impact, the US explains most of the variance of the shock in the short run (55.83 percent), but its importance decreases over time. Interestingly, in the longer term, the forecast error variance of the historical shock is mainly explained by foreign variables (53.12 percent).

V. Concluding Remarks

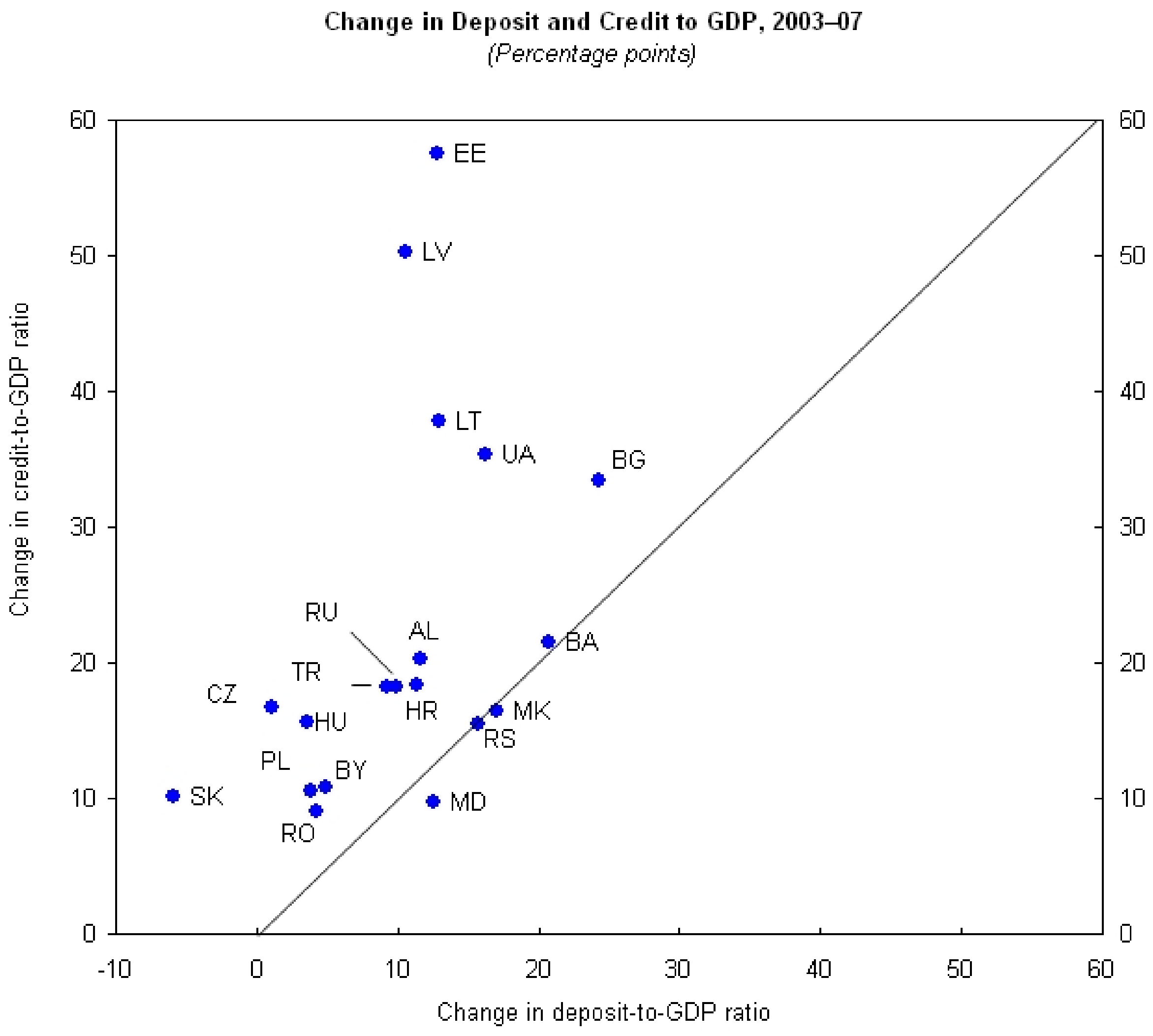
Greater financial integration and the increasing prevalence of cross-border ownership of assets are found to be associated with better growth opportunities, with the link stronger in countries where integration is faster. At the same time, though, these developments in international financial markets have the potential to further amplify business cycle fluctuations and the impact of asset price movements on real activity by increasing the strength of cross-border financial spillovers. In particular, the sizable cross-border financial linkages across Europe highlight the vulnerabilities arising from reliance on concentrated foreign funding. International banking statistics suggest hat most emerging European economies are heavily exposed to—and dependent on—western banks (either directly or through the local borrowing systems).

In order to bridge the gap between purely statistical analysis and the traditional modelling approaches, the present paper studies the transmission of a historical negative shock to the U.S. equity prices to advanced and emerging European countries using a GVAR model. Such a global modelling framework is able of generating forecasts for a core set of macroeconomic and financial factors for a set of regions and countries, while explicitly allowing for the interdependencies that exist between national and international factors in a consistent manner. The key to the GVAR modelling is the systematic inclusion of country-specific foreign variables in individual country models in order to deal with the common factor dependencies that exist in the world economy. Unlike any previous study using GVAR models, this paper originally links each country to the rest of the world economy by employing cross-country financial flows from international banking statistics, e.g., annual bank lending exposures over the period 1999-2007.

From a policy analysis perspective, a number of interesting results emerge. The simulations clearly show that financial shocks are transmitted relatively quickly and often get amplified as they travel from the US to the euro area. Equity markets seem to be far more synchronous as compared to the banking systems. In addition, dynamic analysis indicates that asset prices are the main channel through which, in the short run, financial shocks are transmitted internationally, whereas other variables—including the cost and quantity of credit—start playing a significant role in the transmission of shocks over longer horizons.

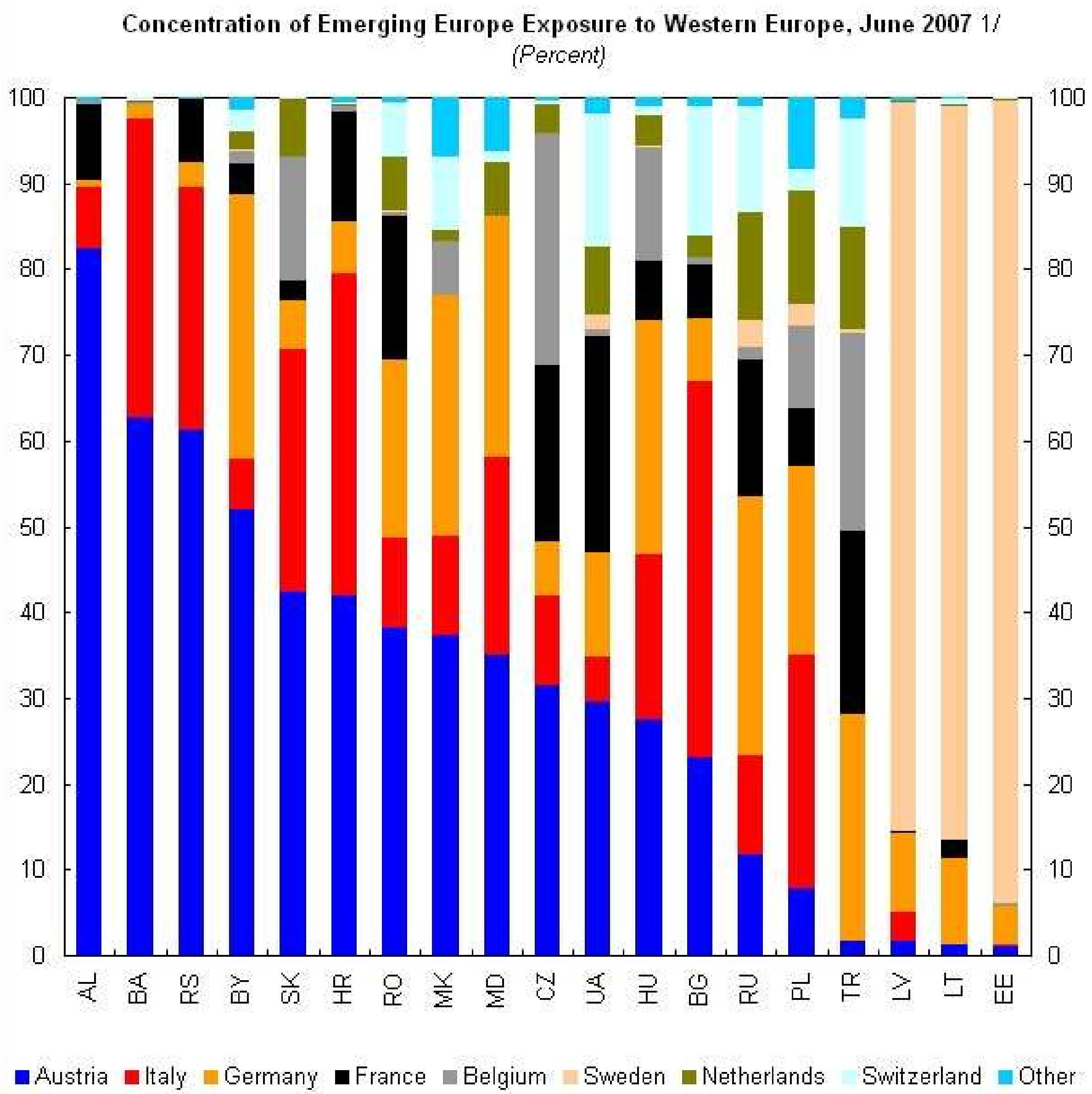
All in all, the GVAR modelling framework employed in this paper presents a reasonable and manageable spatio-temporal structure for the analysis of the international transmission of financial shocks and second-round effects, which can be easily modified and extended further according to policy interests.

Figure 1: Increasing Reliance of Emerging Europe on Foreign Bank Funding



Note: Country names are abbreviated according to the ISO standard codes.
Source: IMF, *International Financial Statistics;* and IMF staff calculations.

Figure 2: Concentration of Emerging Europe Exposure to Western Europe



Source: Bank for International Settlements, *Quarterly Review*, December 2007.
Note: Country names are abbreviated according to the ISO standard codes.
1/ Emerging Europe exposure to western European banks is defined as the share of the reporting banks in each western European country in the total outstanding claims on a given emerging European country (both bank and nonbank sectors). For example, about 42 percent of Croatia's exposures to Western European reporting banks is owed to Austrian banks, 38 percent to Italian banks, 13 percent to French banks, etc. For the Baltic countries, 85 percent or more of exposures to the reporting banks is owed to Swedish banks.

Figure 3: Generalized Impulse Responses of a Negative (-1 σ) Shock to US Rates of Growth of Real Equity Prices on Rates of Growth of Real Equity Prices Across Regions

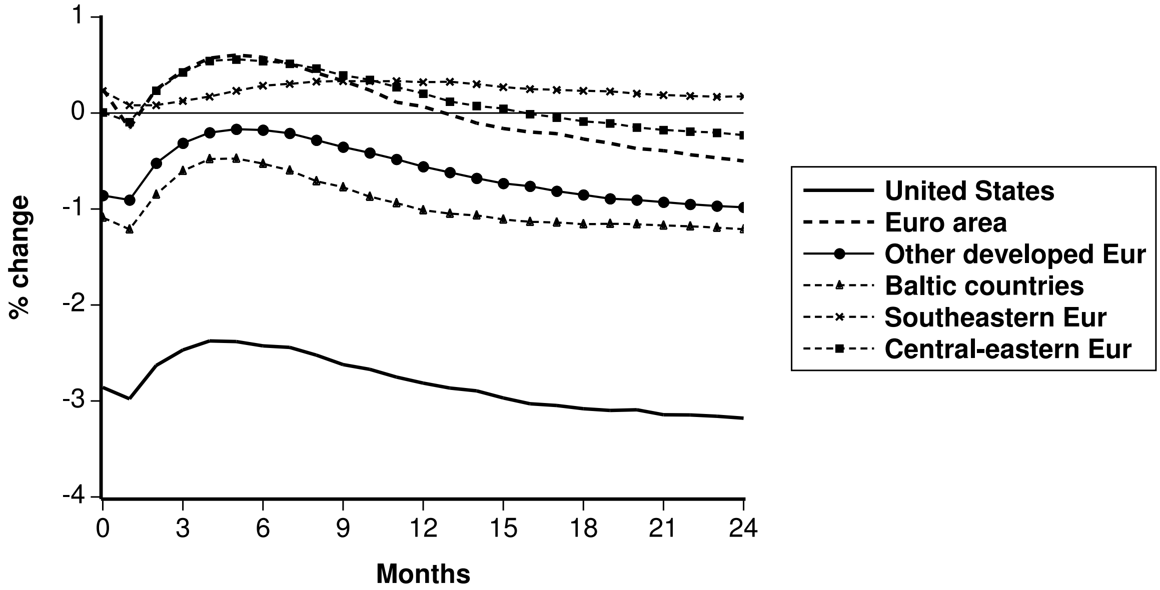


Figure 4: Generalized Impulse Responses of a Negative (-1 σ) Shock to US Rates of Growth of Real Equity Prices on Rates of Growth of Real Credit to Corporations Across Regions

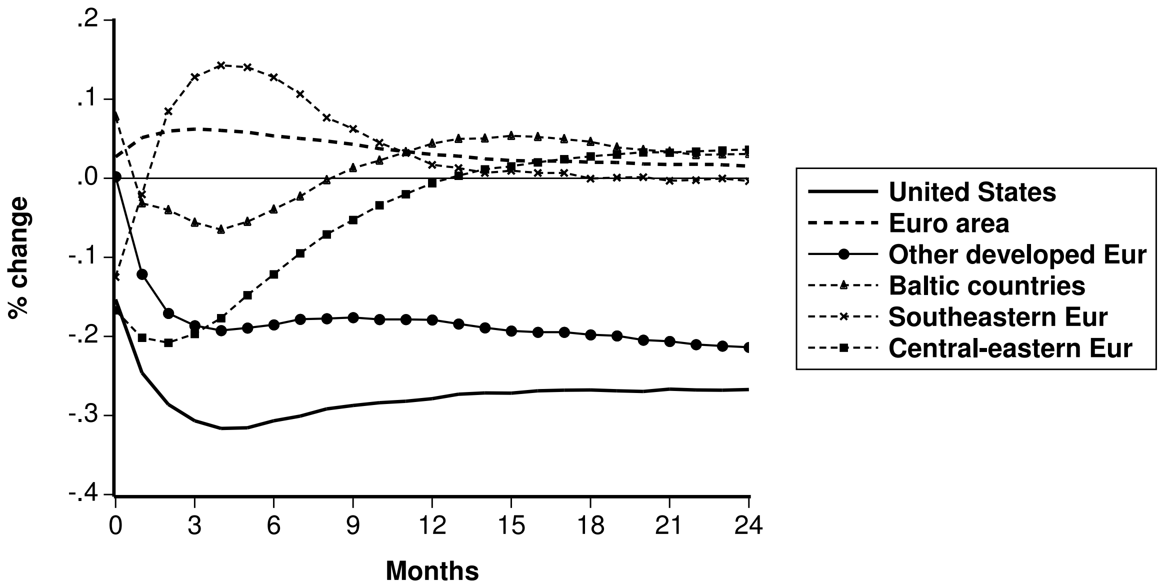


Figure 5: Generalized Impulse Responses of a Negative (-1 σ) Shock to US Rates of Growth of Real Equity Prices on Rates of Growth of Real Gross Domestic Product Across Regions

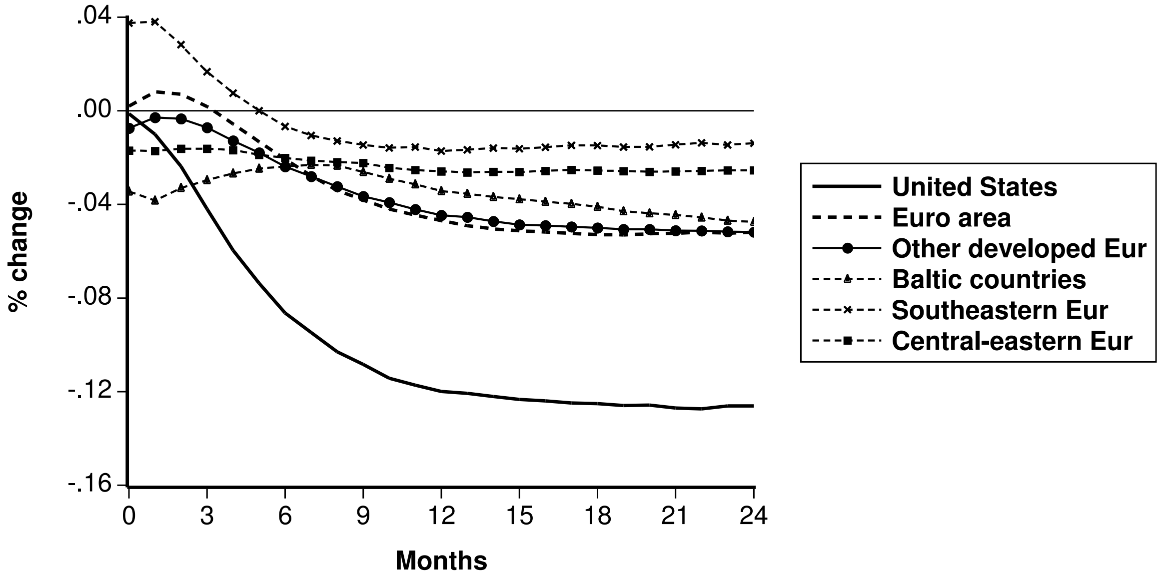


Figure 6: Generalized Impulse Responses of a Negative (-1 σ) Shock to US Rates of Growth of Real Equity Prices on Real Interbank Rates Across Regions

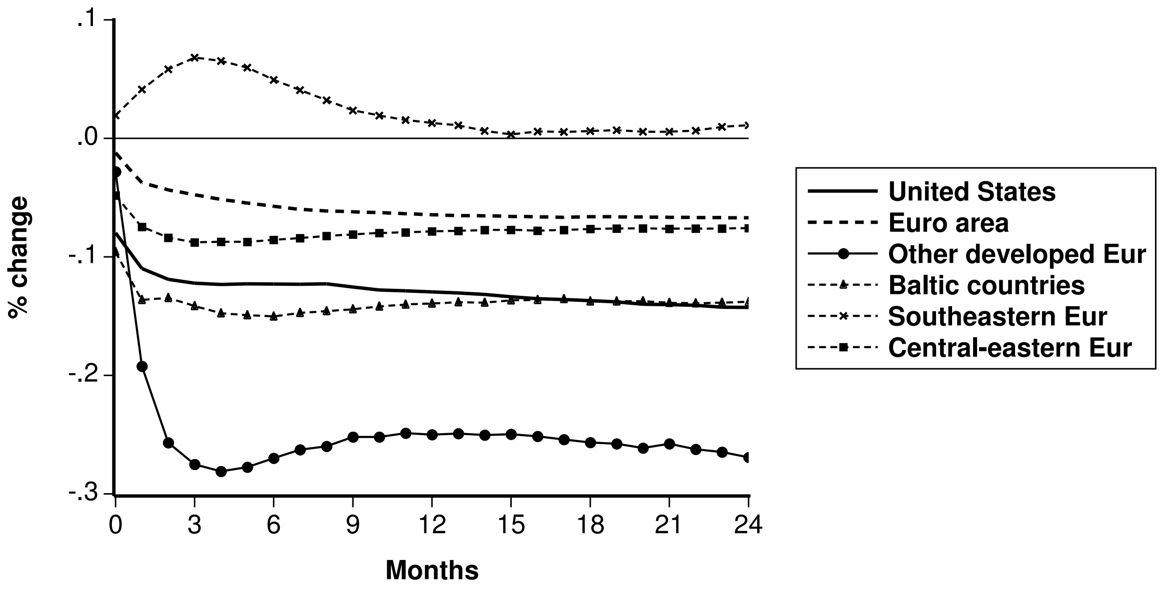


Figure 7: Generalized Impulse Responses of a Negative Unit (-1 σ) Shock to US Rate of Growth of Real Equity Prices (Bootstrap Mean Estimates with 68 percent Bootstrap Error Bounds)

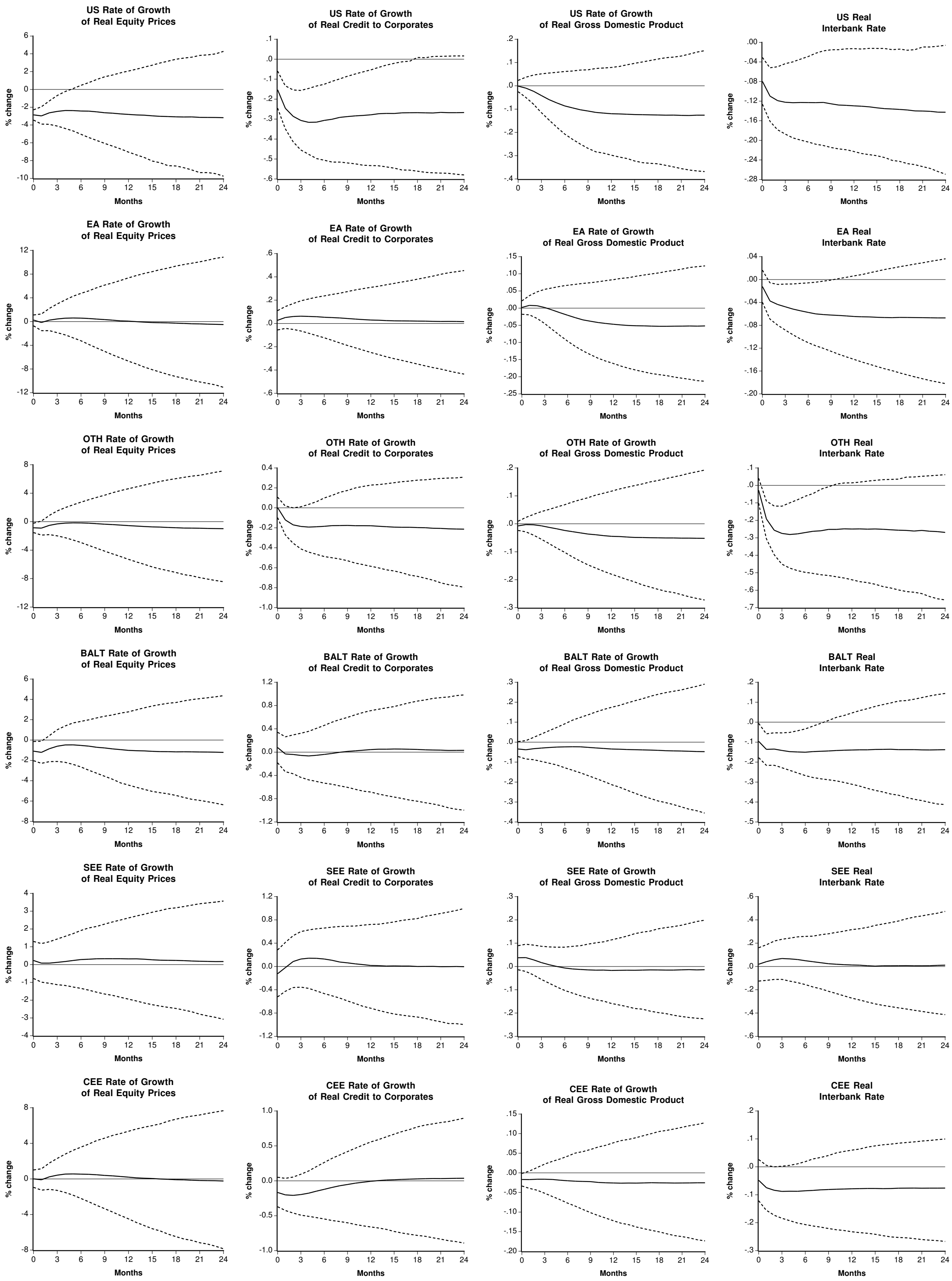


Table 1: Countries and Regions in the GVAR model

United States	**Euro Area**	**Other Developed Countries**
	Austria	Denmark
	Belgium	Norway
	Finland	Sweden
	France	Switzerland
	Germany	United Kingdom
	Greece	
	Ireland	
	Italy	
	Netherlands	
	Portugal	
	Slovenia	
	Spain	
South-Eastern European Countries	**Central-Eastern European Countries**	**Baltic Countries**
Bulgaria	Czech Republic	Estonia
Croatia	Hungary	Latvia
	Poland	Lithuania
	Slovak Republic	

Table 2: Number of Cointegrating Relationships in the Country-Specific Models

Country	# Coint Relations	Country	# Coint Relations	Country	# Coint Relations
Austria	0	Germany	1	Poland	0
Belgium	1	Greece	2	Portugal	1
Bulgaria	1	Hungary	1	Slovak Republic	1
Croatia	0	Ireland	0	Slovenia	1
Czech Republic	1	Italy	2	Spain	2
Denmark	1	Latvia	2	Sweden	2
Estonia	1	Lithuania	1	Switzerland	1
Finland	3	Netherlands	0	United Kingdom	2
France	1	Norway	1	United States	1

Note: Rank orders are derived using Johansen's trace statistics at the 95% critical value level.

Table 3: F-statistics for Testing the Weak Exogeneity of the Country-Specific Foreign Variables

Country		95% C.V.	$gequ^*$	gcc^*	$ggdp^*$	ibk^*	Country		95% C.V.	$gequ^*$	gcc^*	$ggdp^*$	ibk^*
AT	F(0,84)	—	—	—	—	—	LV	F(2,82)	3.11	2.04	0.79	0.10	0.62
BE	F(1,83)	3.96	0.82	4.32*	4.55*	1.07	LT	F(1,83)	3.96	0.72	0.89	2.79	2.22
BG	F(1,83)	3.96	0.13	0.02	2.56	0.28	NL	F(0,84)	—	—	—	—	—
HR	F(0,84)	—	—	—	—	—	NO	F(1,83)	3.96	1.07	3.25	0.00	0.00
CZ	F(1,83)	3.96	0.43	0.01	0.06	0.03	PL	F(0,84)	—	—	—	—	—
DK	F(1,83)	3.96	3.64	3.14	0.24	2.93	PT	F(1,83)	3.96	0.04	0.71	0.13	0.50
EE	F(1,83)	3.96	0.02	2.54	0.23	5.74*	SK	F(1,83)	3.96	0.31	0.03	1.53	0.01
FI	F(3,81)	2.72	0.96	0.25	1.75	1.61	SI	F(1,83)	3.96	0.02	0.03	0.35	0.09
FR	F(1,83)	3.96	0.96	5.19*	9.50*	1.59	ES	F(2,82)	3.11	0.37	0.45	0.81	2.38
DE	F(1,83)	3.96	1.75	2.16	0.10	0.48	SE	F(2,82)	3.11	1.41	0.14	4.23*	0.89
GR	F(2,82)	3.11	0.69	0.31	0.42	1.05	CH	F(1,83)	3.96	10.55*	0.05	0.75	1.20
HU	F(1,83)	3.96	0.00	1.71	8.34*	0.78	GB	F(2,82)	3.11	0.32	0.11	1.77	1.03
IE	F(0,84)	—	—	—	—	—	US	F(1,83)	3.96	0.00	1.02	1.66	0.32
IT	F(2,82)	3.11	0.96	1.72	2.36	0.01							

Note: * denotes statistical significance at the 5%.

Table 4: Contemporaneous Effects of Foreign Variables on their Country-Specific Counterparts

Country	Domestic Variables				Country	Domestic Variables				Country	Domestic Variables			
	$gequ$	gcc	$ggdp$	ibk		$gequ$	gcc	$ggdp$	ibk		$gequ$	gcc	$ggdp$	ibk
AT	0.64	-0.06	0.39	0.58	DE	1.68	0.05	1.16	0.35	PL	0.79	-1.11	0.68	0.75
	[5.791]	[-0.247]	[3.387]	[4.149]		[13.634]	[0.303]	[5.064]	[2.795]		[4.456]	[-1.644]	[2.814]	[1.401]
BE	0.68	0.14	0.95	0.96	GR	0.24	0.83	-0.30	0.61	PT	0.12	-0.16	-0.02	0.39
	[10.999]	[0.358]	[2.131]	[5.200]		[1.647]	[2.186]	[-0.500]	[2.775]		[1.261]	[-0.251]	[-0.044]	[2.239]
BG	0.35	0.11	1.03	0.71	HU	0.83	0.06	0.13	0.57	SK	0.28	-0.47	-0.43	1.02
	[1.258]	[0.192]	[3.046]	[0.764]		[5.123]	[0.104]	[0.810]	[1.100]		[1.593]	[-0.614]	[-1.782]	[2.618]
HR	0.17	-1.29	0.67	0.60	IE	0.34	-1.14	1.21	-0.05	SI	0.30	-0.11	0.65	1.36
	[0.855]	[-1.305]	[1.283]	[0.529]		[1.884]	[-0.793]	[1.006]	[-0.268]		[2.461]	[-0.233]	[1.609]	[3.430]
CZ	0.65	-0.18	-0.38	1.01	IT	0.67	-0.15	0.84	0.37	ES	1.15	0.17	-0.13	0.18
	[5.396]	[-0.262]	[-7.355]	[3.358]		[6.505]	[-0.513]	[6.283]	[3.821]		[12.674]	[0.815]	[-1.096]	[1.331]
DK	0.69	0.76	1.14	0.46	LV	0.18	0.06	0.09	1.10	SE	1.49	-0.01	0.58	0.68
	[7.847]	[2.155]	[2.089]	[4.115]		[1.572]	[0.376]	[0.373]	[1.948]		[12.244]	[-0.020]	[3.619]	[5.155]
EE	0.71	-0.38	0.29	0.83	LT	0.39	-0.31	0.38	0.31	CH	0.97	-0.35	0.63	0.25
	[5.032]	[-1.298]	[1.786]	[3.364]		[3.439]	[-0.589]	[1.073]	[0.888]		[10.308]	[-1.135]	[3.270]	[1.504]
FI	0.80	0.12	0.35	0.62	NL	1.30	0.79	0.84	0.08	GB	0.62	-0.42	0.41	0.51
	[5.844]	[0.583]	[1.774]	[4.292]		[15.712]	[1.723]	[3.154]	[0.362]		[11.600]	[-1.583]	[5.371]	[0.826]
FR	1.23	-0.03	0.73	0.51	NO	0.61	-0.16	0.60	1.08	US	0.70	0.06	0.96	0.39
	[16.863]	[-0.096]	[4.496]	[3.007]		[6.535]	[-0.720]	[1.396]	[3.447]		[9.362]	[0.203]	[4.188]	[2.151]

Note: White's heteroscedastic-robust t-ratios are given in square brackets.

Table 5: Augmented Dickey-Fuller (ADF) Unit Root Test Statistics for Domestic and Foreign Variables (Based on AIC Order Selection)

Variables	AT	BE	BG	HR	CZ	DK	EE	FI	FR	DE	GR	HU	IE	IT
$gequ$	-1.08	-1.63	-0.95	-2.37	-0.72	-2.59	-1.67	-4.53	-2.63	-2.78	-1.81	-1.71	-1.29	-1.95
$\Delta gequ$	-6.20	-4.48	-6.35	-4.92	-7.14	-6.25	-5.44	-6.04	-3.42	-4.76	-3.60	-7.34	-3.88	-3.18
$\Delta^2 gequ$	-6.52	-6.35	-7.97	-6.75	-5.22	-7.90	-7.09	-6.55	-6.76	-6.04	-7.99	-7.23	-7.43	-6.86
gcc	-3.12	-2.67	-1.68	-2.98	-1.47	-1.98	-0.67	-2.18	-2.31	-2.40	-1.96	-4.10	-1.88	-2.41
Δgcc	-2.92	-7.09	-6.74	-3.45	-4.44	-7.06	-6.87	-6.77	-3.03	-6.56	-4.19	-3.63	-4.39	-7.43
$\Delta^2 gcc$	-7.85	-6.91	-7.44	-5.44	-6.80	-8.30	-7.57	-7.26	-5.66	-6.78	-7.73	-10.28	-7.97	-8.14
$ggdp$	-3.07	-4.34	-3.50	-2.55	-3.58	-0.61	-1.51	-3.36	-3.62	-2.93	-3.12	-1.88	-4.71	-3.64
$\Delta ggdp$	-2.80	-3.42	-3.19	-3.36	-2.36	-2.77	-1.94	-2.23	-2.36	-2.42	-17.36	-2.36	-4.16	-3.55
$\Delta^2 ggdp$	-6.94	-6.38	-6.39	-6.34	-5.66	-10.98	-6.31	-5.85	-7.62	-6.28	-8.55	-11.02	-4.74	-7.00
ibk	-1.51	-1.84	-2.82	-2.12	-2.56	-2.80	-1.74	-4.43	-1.81	-1.51	-1.91	-1.96	-2.98	-1.72
Δibk	-7.39	-6.48	-6.13	-4.63	-5.78	-3.49	-8.55	-8.69	-3.94	-6.41	-8.58	-7.15	-4.05	-5.05
$\Delta^2 ibk$	-7.16	-8.39	-6.88	-7.78	-7.31	-7.71	-7.13	-7.35	-6.58	-6.96	-6.92	-9.80	-6.12	-5.72
$gequ^*$	-2.22	-2.24	-1.65	-1.82	-1.97	-2.37	-3.14	-2.31	-2.20	-2.05	-2.10	-2.11	-2.19	-2.17
$\Delta gequ^*$	-4.87	-5.37	-3.17	-5.39	-5.36	-5.40	-3.71	-3.57	-5.39	-5.46	-5.22	-5.31	-5.42	-5.31
$\Delta^2 gequ^*$	-6.13	-6.19	-7.95	-6.75	-5.94	-6.17	-6.13	-5.95	-5.90	-6.00	-6.00	-5.87	-5.97	-6.15
gcc^*	-2.21	-2.00	-1.88	-2.05	-2.27	-2.75	-1.98	-1.92	-2.70	-2.33	-2.77	-2.58	-2.83	-3.13
Δgcc^*	-7.49	-6.93	-3.77	-3.19	-7.46	-7.84	-7.91	-7.60	-3.41	-3.49	-7.08	-8.08	-2.81	-8.18
$\Delta^2 gcc^*$	-7.07	-5.03	-7.58	-7.72	-6.92	-8.11	-8.18	-8.33	-4.72	-4.60	-5.58	-7.63	-11.53	-7.40
$ggdp^*$	-3.82	-3.56	-2.55	-3.40	-4.11	-4.16	-3.55	-3.24	-3.64	-3.80	-4.63	-3.08	-3.46	-3.59
$\Delta ggdp^*$	-3.38	-3.13	-6.33	-3.04	-2.68	-3.06	-2.94	-3.09	-3.01	-2.93	-3.01	-3.02	-2.81	-3.12
$\Delta^2 ggdp^*$	-4.21	-7.06	-4.49	-6.84	-6.71	-6.15	-9.48	-9.55	-6.68	-6.72	-3.73	-6.88	-7.26	-6.71
ibk^*	-2.01	-2.64	-1.63	-1.38	-1.65	-2.58	-3.99	-2.71	-2.95	-2.44	-2.14	-1.60	-3.28	-2.19
Δibk^*	-6.47	-2.57	-6.68	-5.86	-6.55	-3.23	-7.16	-6.55	-2.39	-2.34	-3.31	-6.01	-2.42	-3.39
$\Delta^2 ibk^*$	-6.56	-10.83	-6.62	-6.53	-9.17	-10.84	-6.25	-10.44	-3.69	-3.60	-10.95	-6.53	-3.86	-10.58

Variables	LV	LT	NL	NO	PL	PT	SK	SI	ES	SE	CH	GB	US
$gequ$	-2.70	-1.63	-2.37	-2.26	-1.08	-2.19	-3.49	-4.17	-2.20	-2.42	-2.41	-1.48	-2.73
$\Delta gequ$	-8.00	-4.76	-5.62	-5.88	-6.51	-6.49	-5.39	-3.29	-7.02	-3.59	-3.32	-6.13	-3.35
$\Delta^2 gequ$	-8.42	-5.92	-6.82	-6.56	-5.95	-7.83	-8.20	-7.64	-6.50	-5.98	-7.98	-7.14	-9.05
gcc	1.20	-1.98	-1.64	-1.91	-2.01	-2.83	-1.93	-2.83	-0.76	-2.00	-2.47	-2.13	-2.68
Δgcc	-2.38	-6.30	-6.54	-5.91	-6.44	-1.83	-5.69	-4.02	-5.20	-8.15	-6.32	-3.81	-4.97
$\Delta^2 gcc$	-7.92	-6.29	-5.45	-7.23	-7.53	-9.61	-12.13	-8.42	-8.55	-8.62	-8.31	-9.30	-9.45
$ggdp$	-1.54	-1.87	-2.87	-3.80	-3.29	-2.55	-1.91	-2.17	-2.24	-3.64	-3.88	-4.00	-2.60
$\Delta ggdp$	-2.63	-2.34	-3.03	-3.56	-2.12	-3.36	-2.22	-2.47	-1.71	-3.03	-2.42	-2.70	-3.49
$\Delta^2 ggdp$	-9.89	-7.18	-8.42	-6.43	-6.74	-4.39	-7.35	-7.27	-10.69	-9.58	-4.81	-6.49	-6.53
ibk	-2.06	-2.17	-4.39	-2.37	-1.26	-2.31	-1.82	-0.30	-1.89	-4.60	-2.29	-2.85	-1.95
Δibk	-2.67	-3.37	-4.41	-6.24	-4.58	-4.21	-6.29	-4.68	-6.59	-7.32	-2.95	-3.49	-4.81
$\Delta^2 ibk$	-7.52	-6.56	-7.85	-8.30	-7.90	-7.02	-8.06	-7.71	-7.13	-6.19	-6.58	-4.51	-7.67
$gequ^*$	-3.19	-3.18	-2.19	-2.39	-2.27	-2.16	-1.80	-1.92	-2.25	-2.57	-2.26	-2.24	-2.11
$\Delta gequ^*$	-3.72	-3.70	-5.38	-3.57	-4.85	-5.57	-5.40	-5.42	-5.26	-5.39	-5.74	-5.29	-5.30
$\Delta^2 gequ^*$	-6.22	-6.21	-8.01	-6.02	-6.01	-6.11	-6.42	-6.03	-5.95	-5.96	-8.29	-6.12	-5.83
gcc^*	-2.01	-2.01	-2.60	-2.27	-3.01	-0.85	-2.55	-2.75	-2.75	-2.90	-3.07	-3.51	-1.11
Δgcc^*	-7.89	-7.86	-3.97	-7.29	-7.26	-8.01	-8.75	-7.59	-3.60	-6.40	-4.14	-7.45	-5.02
$\Delta^2 gcc^*$	-8.12	-8.15	-7.07	-6.35	-8.34	-7.87	-7.82	-7.33	-4.97	-7.39	-8.56	-7.05	-5.43
$ggdp^*$	-3.56	-3.52	-3.76	-3.27	-3.36	-3.58	-3.55	-3.46	-3.58	-3.02	-3.46	-4.70	-4.15
$\Delta ggdp^*$	-2.95	-2.98	-3.01	-3.01	-2.68	-2.96	-2.63	-2.86	-2.97	-2.58	-3.25	-3.34	-2.64
$\Delta^2 ggdp^*$	-9.61	-9.59	-6.70	-8.52	-7.44	-6.98	-6.64	-7.09	-6.68	-6.73	-6.27	-3.77	-3.94
ibk^*	-3.76	-3.66	-2.29	-2.56	-1.99	-2.28	-1.55	-1.47	-3.07	-2.40	-2.75	-1.95	-3.29
Δibk^*	-5.15	-5.16	-2.63	-3.49	-4.38	-3.21	-6.08	-6.38	-2.54	-6.07	-2.36	-7.25	-2.59
$\Delta^2 ibk^*$	-6.29	-6.31	-4.01	-11.04	-6.68	-10.67	-6.14	-6.24	-3.93	-10.09	-3.71	-6.52	-4.02

Note: The ADF statistics for all level variables are based on regressions including a linear trend, while regressions including only intercept are related to all first and second differences variables. The 95% critical value of the ADF statistics for regressions with trend is -3.17, and for regressions without trend -2.59.

Table 6: Weighted Symmetric ADF Unit Root Test Statistics for Domestic and Foreign Variables (Based on AIC Order Selection)

Variables	AT	BE	BG	HR	CZ	DK	EE	FI	FR	DE	GR	HU	IE	IT
$gequ$	-1.44	-2.07	-1.20	-2.65	-1.13	-2.60	-2.00	-1.85	-1.45	-2.01	-2.06	-1.95	-1.65	-1.70
$\Delta gequ$	-6.41	-4.55	-6.53	-4.86	-7.30	-6.32	-5.55	-6.11	-3.17	-4.89	-2.53	-7.40	-3.91	-3.26
$\Delta^2 gequ$	-6.70	-6.79	-8.28	-6.72	-5.25	-7.72	-7.06	-6.54	-7.02	-6.34	-8.45	-7.40	-7.84	-6.78
gcc	-1.13	-1.45	-1.95	-3.18	-1.78	-1.13	-1.04	-1.17	-1.56	-0.91	-2.24	-4.35	-1.61	-1.79
Δgcc	-2.51	-7.21	-6.89	-2.82	-4.64	-6.55	-6.68	-7.00	-3.12	-6.73	-3.56	-3.81	-4.60	-7.31
$\Delta^2 gcc$	-8.10	-7.26	-7.83	-5.65	-7.16	-7.87	-7.89	-7.61	-5.83	-7.12	-6.26	-10.49	-8.26	-7.62
$ggdp$	-0.96	-3.64	-3.54	-2.10	-2.12	-0.56	-1.89	-1.92	-1.89	-1.08	-1.78	-2.24	-4.04	-2.45
$\Delta ggdp$	-1.82	-3.36	-3.14	-3.23	-2.44	-2.59	-2.08	-2.12	-2.18	-2.22	-0.93	-2.58	-3.99	-3.74
$\Delta^2 ggdp$	-6.89	-6.45	-6.13	-6.43	-5.61	-11.53	-6.23	-6.14	-7.98	-6.40	-4.15	-11.38	-4.75	-7.25
ibk	-1.75	-2.09	-3.00	-2.33	-2.83	-2.61	-2.02	-4.40	-1.39	-1.56	-1.06	-1.90	-3.36	-1.37
Δibk	-7.52	-6.64	-6.41	-4.54	-5.96	-3.79	-8.72	-8.77	-4.03	-6.55	-8.78	-7.38	-4.05	-5.08
$\Delta^2 ibk$	-7.52	-8.68	-7.09	-8.00	-7.60	-7.39	-7.50	-7.32	-6.87	-7.34	-7.11	-9.99	-6.02	-5.69
$gequ^*$	-1.62	-1.70	-2.16	-1.53	-1.77	-1.56	-2.13	-2.22	-1.87	-1.86	-1.61	-1.66	-1.76	-1.61
$\Delta gequ^*$	-5.05	-5.54	-3.01	-5.55	-5.48	-5.57	-3.26	-3.43	-5.54	-5.61	-5.37	-5.45	-5.56	-5.47
$\Delta^2 gequ^*$	-6.38	-6.47	-8.18	-7.18	-6.36	-6.38	-6.17	-6.12	-6.22	-6.29	-6.35	-6.24	-6.33	-6.47
gcc^*	-2.31	-1.94	-2.19	-1.98	-1.91	-2.97	-1.25	-1.11	-2.48	-1.74	-3.02	-1.94	-2.93	-3.38
Δgcc^*	-7.65	-7.04	-3.19	-2.83	-7.64	-8.03	-8.10	-7.65	-3.45	-3.65	-7.38	-8.18	-2.78	-8.39
$\Delta^2 gcc^*$	-7.46	-5.34	-7.07	-7.50	-7.29	-8.37	-8.43	-8.44	-4.82	-4.77	-5.83	-7.99	-11.62	-7.84
$ggdp^*$	-1.46	-1.48	-1.69	-1.92	-2.39	-2.37	-2.84	-2.23	-1.82	-2.31	-1.42	-1.50	-2.07	-1.62
$\Delta ggdp^*$	-3.29	-3.08	-1.10	-3.16	-2.79	-2.19	-2.21	-2.48	-2.75	-2.89	-2.95	-2.89	-2.34	-3.13
$\Delta^2 ggdp^*$	-4.44	-7.37	-4.55	-7.08	-6.82	-6.29	-9.60	-9.80	-6.83	-6.83	-3.85	-7.16	-7.58	-7.10
ibk^*	-2.25	-2.92	-1.36	-1.38	-1.76	-2.88	-2.96	-2.75	-3.17	-2.75	-2.42	-1.65	-3.14	-2.49
Δibk^*	-6.60	-2.78	-6.82	-5.90	-6.68	-3.42	-7.34	-6.68	-2.60	-2.53	-3.53	-6.10	-2.51	-3.61
$\Delta^2 ibk^*$	-6.89	-11.08	-6.95	-6.62	-9.37	-11.11	-6.53	-10.72	-3.89	-3.70	-11.20	-6.85	-3.70	-10.85

Variables	LV	LT	NL	NO	PL	PT	SK	SI	ES	SE	CH	GB	US
$gequ$	-2.49	-1.84	-1.68	-2.28	-1.35	-1.48	-3.65	-4.24	-1.82	-2.32	-2.41	-1.74	-2.86
$\Delta gequ$	-7.88	-4.94	-5.80	-6.02	-6.62	-6.65	-5.36	-3.40	-7.23	-3.06	-3.50	-6.25	-3.65
$\Delta^2 gequ$	-8.06	-6.25	-7.10	-6.84	-6.00	-8.05	-8.39	-7.64	-6.55	-6.07	-8.21	-7.09	-9.04
gcc	0.97	-2.22	-1.61	-1.50	-1.17	-1.47	-1.96	-3.11	-0.74	-1.21	-2.28	-2.08	-2.74
Δgcc	-2.20	-6.50	-6.69	-6.10	-6.59	-2.10	-5.73	-4.05	-5.39	-8.35	-6.73	-3.82	-5.16
$\Delta^2 gcc$	-8.28	-6.69	-5.80	-7.54	-7.91	-9.50	-12.34	-8.54	-8.84	-8.91	-8.35	-9.46	-9.64
$ggdp$	-2.03	-1.78	-1.51	-3.56	-3.32	-2.12	-2.27	-1.86	-1.33	-3.18	-1.76	-3.75	-2.56
$\Delta ggdp$	-2.66	-2.17	-3.07	-3.00	-1.84	-2.80	-2.51	-2.18	-1.08	-2.31	-2.54	-2.36	-2.68
$\Delta^2 ggdp$	-10.25	-7.18	-8.67	-6.51	-6.77	-4.46	-7.52	-6.99	-11.19	-9.73	-5.08	-6.59	-6.64
ibk	-2.45	-2.59	-1.43	-2.57	-1.63	-0.39	-2.16	-1.19	-2.10	-3.31	-2.41	-2.25	-1.46
Δibk	-2.90	-3.70	-4.12	-6.42	-2.50	-4.16	-5.51	-4.96	-6.74	-7.51	-3.00	-3.51	-5.00
$\Delta^2 ibk$	-7.52	-6.53	-7.77	-8.66	-7.88	-7.11	-8.00	-7.65	-7.50	-6.49	-6.67	-4.38	-7.91
$gequ^*$	-2.16	-2.18	-1.84	-1.47	-1.61	-1.62	-1.71	-1.65	-1.72	-2.03	-2.06	-1.74	-1.58
$\Delta gequ^*$	-3.29	-3.28	-5.52	-3.43	-5.04	-5.73	-5.54	-5.58	-5.41	-5.57	-5.89	-5.44	-5.45
$\Delta^2 gequ^*$	-6.27	-6.28	-8.08	-6.22	-6.29	-6.33	-6.81	-6.41	-6.28	-6.14	-8.29	-6.43	-6.19
gcc^*	-1.27	-1.22	-2.86	-0.99	-2.36	-1.25	-2.78	-2.99	-1.67	-3.13	-3.02	-3.71	-1.85
Δgcc^*	-8.08	-8.05	-4.00	-7.39	-7.38	-8.15	-8.80	-7.68	-3.72	-6.49	-4.32	-7.63	-5.11
$\Delta^2 gcc^*$	-8.39	-8.42	-7.39	-6.50	-8.44	-8.26	-8.04	-7.76	-5.19	-7.31	-8.71	-7.47	-5.43
$ggdp^*$	-2.73	-2.68	-2.05	-2.13	-1.68	-1.61	-2.30	-1.80	-1.75	-1.72	-2.48	-1.74	-1.52
$\Delta ggdp^*$	-2.15	-2.14	-2.80	-2.28	-2.40	-3.08	-2.73	-2.79	-2.86	-2.06	-2.43	-3.19	-2.63
$\Delta^2 ggdp^*$	-9.71	-9.70	-6.83	-8.71	-7.69	-7.15	-6.82	-7.33	-6.83	-7.10	-6.41	-3.90	-4.21
ibk^*	-3.49	-3.39	-2.58	-2.79	-1.51	-2.57	-1.54	-1.58	-3.12	-2.70	-3.17	-1.55	-3.25
Δibk^*	-5.39	-5.41	-2.85	-3.70	-4.55	-3.44	-6.15	-6.48	-2.67	-6.12	-2.60	-7.37	-2.74
$\Delta^2 ibk^*$	-6.59	-6.62	-4.20	-11.30	-6.90	-10.90	-6.43	-6.55	-4.00	-10.33	-3.90	-6.81	-3.95

Note: The WS statistics for all level variables are based on regressions including a linear trend, while regressions including only intercept are related to all first and second differences variables. The 95% critical value of the WS statistics for regressions with trend is -3.24, and for regressions without trend -2.55.

Table 7: Financial Weights

	AT	BE	BG	HR	CZ	DK	EE	FI	FR	DE	GR	HU	IE	IT	LV	LT	NL	NO	PL	PT	SK	SI	ES	SE	CH	GB	US
AT	0.000	0.009	0.126	0.316	0.199	0.005	0.012	0.006	0.008	0.041	0.029	0.179	0.022	0.027	0.017	0.019	0.010	0.007	0.067	0.009	0.316	0.341	0.006	0.004	0.009	0.007	0.006
BE	0.025	0.000	0.007	0.006	0.307	0.024	0.005	0.019	0.066	0.034	0.065	0.138	0.050	0.067	0.001	0.003	0.136	0.035	0.087	0.043	0.134	0.083	0.040	0.012	0.017	0.047	0.032
BG	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HR	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CZ	0.039	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.003	0.000	0.000	0.000	0.003	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
DK	0.004	0.006	0.006	0.000	0.001	0.000	0.045	0.119	0.003	0.013	0.004	0.007	0.010	0.002	0.017	0.023	0.008	0.088	0.017	0.004	0.000	0.007	0.003	0.175	0.005	0.011	0.005
EE	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000
FI	0.003	0.003	0.000	0.000	0.000	0.067	0.107	0.000	0.003	0.006	0.002	0.000	0.001	0.001	0.111	0.093	0.003	0.056	0.001	0.001	0.000	0.000	0.002	0.133	0.001	0.002	0.003
FR	0.045	0.128	0.058	0.058	0.199	0.024	0.002	0.042	0.000	0.095	0.146	0.049	0.068	0.186	0.002	0.007	0.089	0.052	0.043	0.107	0.031	0.130	0.127	0.029	0.056	0.100	0.113
DE	0.379	0.111	0.127	0.154	0.147	0.156	0.055	0.121	0.160	0.000	0.211	0.365	0.207	0.234	0.135	0.159	0.166	0.185	0.279	0.168	0.113	0.312	0.197	0.195	0.078	0.202	0.181
GR	0.013	0.011	0.331	0.007	0.000	0.002	0.001	0.002	0.012	0.011	0.000	0.000	0.013	0.007	0.001	0.000	0.008	0.001	0.002	0.011	0.002	0.003	0.002	0.001	0.012	0.005	0.004
HU	0.029	0.008	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.006	0.000	0.000	0.000	0.007	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001
IE	0.053	0.043	0.000	0.000	0.000	0.034	0.000	0.003	0.031	0.056	0.067	0.000	0.000	0.061	0.000	0.000	0.022	0.012	0.000	0.053	0.000	0.000	0.048	0.021	0.011	0.084	0.018
IT	0.081	0.072	0.177	0.434	0.042	0.008	0.003	0.010	0.103	0.077	0.045	0.136	0.075	0.000	0.014	0.003	0.060	0.010	0.200	0.063	0.281	0.080	0.051	0.008	0.024	0.035	0.020
LV	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.000
LT	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.006	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.000	0.000	0.000
NL	0.044	0.214	0.037	0.006	0.045	0.047	0.002	0.029	0.073	0.081	0.079	0.049	0.041	0.089	0.001	0.004	0.000	0.031	0.128	0.055	0.072	0.018	0.086	0.039	0.025	0.074	0.097
NO	0.003	0.005	0.000	0.000	0.000	0.051	0.000	0.058	0.004	0.009	0.001	0.000	0.002	0.001	0.000	0.000	0.003	0.000	0.000	0.003	0.000	0.000	0.004	0.095	0.005	0.004	0.002
PL	0.017	0.008	0.000	0.000	0.000	0.006	0.000	0.001	0.002	0.008	0.001	0.000	0.000	0.017	0.000	0.000	0.007	0.000	0.000	0.016	0.000	0.000	0.001	0.004	0.001	0.000	0.002
PT	0.005	0.008	0.001	0.000	0.001	0.003	0.000	0.002	0.011	0.010	0.013	0.003	0.012	0.011	0.000	0.002	0.007	0.004	0.033	0.000	0.000	0.001	0.066	0.001	0.002	0.006	0.003
SK	0.023	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.007	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SI	0.011	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ES	0.014	0.033	0.002	0.000	0.004	0.010	0.001	0.013	0.055	0.050	0.011	0.006	0.045	0.039	0.000	0.000	0.045	0.019	0.012	0.283	0.001	0.003	0.000	0.010	0.010	0.057	0.022
SE	0.006	0.006	0.001	0.001	0.000	0.308	0.760	0.418	0.007	0.029	0.003	0.001	0.011	0.003	0.691	0.672	0.012	0.289	0.019	0.003	0.003	0.001	0.006	0.000	0.006	0.014	0.012
CH	0.042	0.027	0.088	0.004	0.004	0.029	0.001	0.014	0.047	0.040	0.117	0.012	0.021	0.037	0.003	0.006	0.026	0.057	0.014	0.018	0.006	0.005	0.020	0.021	0.000	0.096	0.234
GB	0.073	0.165	0.007	0.008	0.013	0.145	0.002	0.057	0.185	0.221	0.098	0.015	0.344	0.115	0.003	0.003	0.167	0.097	0.012	0.110	0.003	0.009	0.245	0.108	0.209	0.000	0.246
US	0.059	0.117	0.033	0.007	0.038	0.075	0.004	0.064	0.217	0.205	0.088	0.040	0.077	0.068	0.003	0.006	0.226	0.057	0.086	0.049	0.038	0.008	0.096	0.093	0.527	0.255	0.000

Note: Financial weights are displayed in column by country. Each column, but not row, sums to 1. Source: Bank of International Settlements; *Quarterly Review*, December 2007

Table 8: Average Pair-Wise Cross-Section Correlations of all Variables and associated Model's Residuals

Country	Real Equity Prices Change				Real Credit to Corporates Change			
	Levels	1st diff.	VAR Residuals	VARX* Residuals	Levels	1st diff.	VAR Residuals	VARX* Residuals
AT	0.61	0.38	0.39	0.03	-0.08	0.01	0.02	0.02
BE	0.64	0.40	0.40	0.02	0.03	0.04	0.03	-0.01
BG	0.25	0.21	0.21	0.03	0.02	-0.02	-0.01	0.00
HR	0.31	0.10	0.10	0.04	0.00	0.01	0.00	0.00
CZ	0.57	0.40	0.40	0.07	-0.10	0.01	0.02	0.01
DK	0.65	0.48	0.48	0.03	-0.04	0.02	0.03	0.02
EE	0.44	0.39	0.39	0.11	0.05	0.03	0.03	0.01
FI	0.56	0.37	0.34	0.00	0.04	0.00	0.01	0.00
FR	0.65	0.48	0.43	-0.09	-0.05	0.00	-0.01	0.00
DE	0.64	0.48	0.48	-0.12	-0.13	0.03	0.04	-0.01
GR	0.64	0.15	0.14	-0.01	-0.12	0.02	0.03	-0.02
HU	0.58	0.39	0.40	0.06	0.02	-0.06	-0.07	-0.04
IE	0.53	0.22	0.22	0.02	-0.06	-0.03	-0.02	0.00
IT	0.66	0.47	0.46	0.02	-0.04	0.00	0.00	0.02
LV	0.25	0.27	0.26	0.02	0.02	0.04	0.03	0.01
LT	0.48	0.31	0.31	0.07	0.05	0.05	0.05	0.02
NL	0.64	0.51	0.50	-0.05	-0.04	0.07	0.07	0.02
NO	0.69	0.48	0.48	0.01	0.01	0.00	0.01	-0.03
PL	0.62	0.36	0.36	0.04	-0.10	-0.02	-0.03	0.01
PT	0.63	0.27	0.26	0.02	-0.03	-0.01	0.00	0.03
SK	0.09	0.08	0.08	0.02	-0.05	-0.01	-0.01	-0.04
SI	0.01	0.15	0.16	-0.02	0.02	-0.02	-0.03	0.00
ES	0.70	0.43	0.44	-0.01	0.03	0.03	0.03	0.01
SE	0.69	0.47	0.47	-0.07	0.02	-0.01	-0.01	-0.04
CH	0.64	0.48	0.47	-0.04	0.04	0.02	0.03	0.02
GB	0.70	0.51	0.51	0.02	0.01	0.02	0.02	-0.03
US	0.67	0.49	0.49	-0.01	0.04	0.07	0.07	0.02

Country	Real GDP Change				Real Interbank Rate			
	Levels	1st diff.	VAR Residuals	VARX* Residuals	Levels	1st diff.	VAR Residuals	VARX* Residuals
AT	0.52	0.29	0.11	0.02	0.35	0.29	0.28	0.06
BE	0.51	0.20	0.10	-0.03	0.39	0.37	0.36	0.13
BG	0.29	0.05	0.03	-0.01	-0.04	0.07	0.08	-0.01
HR	-0.12	0.01	0.00	0.00	-0.01	0.07	0.07	-0.03
CZ	0.40	0.09	-0.08	0.02	0.19	0.21	0.20	0.05
DK	0.43	0.23	0.17	0.05	0.34	0.29	0.29	0.10
EE	0.30	0.23	0.12	0.04	0.18	0.29	0.28	0.11
FI	0.53	0.20	0.06	-0.02	0.17	0.31	0.27	0.07
FR	0.45	0.24	0.05	-0.03	0.35	0.38	0.37	0.16
DE	0.45	0.23	0.07	-0.06	0.38	0.27	0.27	0.06
GR	0.15	0.12	0.06	0.04	0.34	0.22	0.22	0.01
HU	-0.13	0.12	0.03	-0.04	-0.24	0.08	0.07	0.01
IE	0.19	0.06	0.00	-0.07	-0.12	0.24	0.25	0.15
IT	0.37	0.29	0.17	0.02	0.29	0.24	0.23	0.05
LV	0.36	0.12	0.11	0.08	0.23	0.16	0.13	0.01
LT	-0.09	0.02	0.04	0.00	0.17	0.15	0.15	0.02
NL	0.42	0.25	0.11	0.05	0.07	0.18	0.16	0.04
NO	0.27	0.13	0.13	0.07	0.31	0.15	0.15	0.01
PL	0.40	0.23	0.16	-0.02	0.21	0.10	0.09	0.05
PT	0.25	0.14	0.11	0.06	0.14	0.15	0.15	0.05
SK	0.17	-0.05	-0.03	-0.01	0.18	0.14	0.14	0.00
SI	0.45	0.10	0.04	-0.02	-0.16	0.25	0.25	0.08
ES	0.39	0.14	0.00	0.04	0.39	0.28	0.28	0.13
SE	0.45	0.27	0.17	-0.03	0.28	0.27	0.26	0.05
CH	0.51	0.23	0.08	-0.01	0.36	0.28	0.26	0.13
GB	0.32	0.27	0.17	0.01	0.04	0.06	0.05	-0.12
US	0.31	0.18	0.13	-0.09	0.31	0.33	0.31	0.14

Note: VAR residuals are based on cointegrating VAR models with domestic variables only. VARX* residuals refer to the country models with country-specific foreign variables.

Table 9: Cointegration Rank Statistics

Country	Eigenvalues	Trace				Maximum Eigenvalue			
		H0	H1	Statistics	95% Critical values	H0	H1	Statistics	95% Critical values
AT	0.3523	r=0	r>1	99.8	101.0	r=0	r=1	40.8	44.7
	0.2544	r<1	r≥2	59.0	71.6	r<1	r=2	27.6	38.2
	0.2009	r≤2	r≥3	31.4	45.9	r≤2	r=3	21.1	31.3
	0.1040	r≤3	r≥4	10.3	23.6	r≤3	r=4	10.3	23.6
BE	0.3870	r=0	r>1	106.8	101.0	r=0	r=1	46.0	44.7
	0.3218	r<1	r≥2	60.9	71.6	r<1	r=2	36.5	38.2
	0.1255	r≤2	r≥3	24.4	45.9	r≤2	r=3	12.6	31.3
	0.1175	r≤3	r≥4	11.8	23.6	r≤3	r=4	11.8	23.6
BG	0.3330	r=0	r>1	101.9	101.0	r=0	r=1	38.1	44.7
	0.3051	r<1	r≥2	63.8	71.6	r<1	r=2	34.2	38.2
	0.1733	r≤2	r≥3	29.6	45.9	r≤2	r=3	17.9	31.3
	0.1169	r≤3	r≥4	11.7	23.6	r≤3	r=4	11.7	23.6
HR	0.3453	r=0	r>1	98.1	101.0	r=0	r=1	39.8	44.7
	0.2953	r<1	r≥2	58.3	71.6	r<1	r=2	32.9	38.2
	0.1754	r≤2	r≥3	25.4	45.9	r≤2	r=3	18.1	31.3
	0.0741	r≤3	r≥4	7.2	23.6	r≤3	r=4	7.2	23.6
CZ	0.8442	r=0	r>1	229.2	101.0	r=0	r=1	174.7	44.7
	0.2883	r<1	r≥2	54.4	71.6	r<1	r=2	32.0	38.2
	0.1221	r≤2	r≥3	22.5	45.9	r≤2	r=3	12.2	31.3
	0.1031	r≤3	r≥4	10.2	23.6	r≤3	r=4	10.2	23.6
DK	0.4154	r=0	r>1	119.9	101.0	r=0	r=1	50.5	44.7
	0.2700	r<1	r≥2	69.5	71.6	r<1	r=2	29.6	38.2
	0.2169	r≤2	r≥3	39.9	45.9	r≤2	r=3	23.0	31.3
	0.1647	r≤3	r≥4	16.9	23.6	r≤3	r=4	16.9	23.6
EE	0.5971	r=0	r>1	143.9	101.0	r=0	r=1	85.5	44.7
	0.2837	r<1	r≥2	58.5	71.6	r<1	r=2	31.4	38.2
	0.1769	r≤2	r≥3	27.1	45.9	r≤2	r=3	18.3	31.3
	0.0896	r≤3	r≥4	8.8	23.6	r≤3	r=4	8.8	23.6
FI	0.5083	r=0	r>1	148.0	101.0	r=0	r=1	66.7	44.7
	0.3045	r<1	r≥2	81.3	71.6	r<1	r=2	34.1	38.2
	0.2741	r≤2	r≥3	47.1	45.9	r≤2	r=3	30.1	31.3
	0.1656	r≤3	r≥4	17.0	23.6	r≤3	r=4	17.0	23.6
FR	0.4414	r=0	r>1	120.7	101.0	r=0	r=1	54.7	44.7
	0.3429	r<1	r≥2	66.0	71.6	r<1	r=2	39.5	38.2
	0.1329	r≤2	r≥3	26.5	45.9	r≤2	r=3	13.4	31.3
	0.1302	r≤3	r≥4	13.1	23.6	r≤3	r=4	13.1	23.6
DE	0.3917	r=0	r>1	111.3	101.0	r=0	r=1	46.7	44.7
	0.3148	r<1	r≥2	64.6	71.6	r<1	r=2	35.5	38.2
	0.1762	r≤2	r≥3	29.0	45.9	r≤2	r=3	18.2	31.3
	0.1086	r≤3	r≥4	10.8	23.6	r≤3	r=4	10.8	23.6
GR	0.4900	r=0	r>1	135.0	101.0	r=0	r=1	63.3	44.7
	0.2916	r<1	r≥2	71.7	71.6	r<1	r=2	32.4	38.2
	0.2149	r≤2	r≥3	39.3	45.9	r≤2	r=3	22.7	31.3
	0.1611	r≤3	r≥4	16.5	23.6	r≤3	r=4	16.5	23.6
HU	0.5616	r=0	r>1	134.2	101.0	r=0	r=1	77.5	44.7
	0.2719	r<1	r≥2	56.7	71.6	r<1	r=2	29.8	38.2
	0.1882	r≤2	r≥3	26.9	45.9	r≤2	r=3	19.6	31.3
	0.0743	r≤3	r≥4	7.3	23.6	r≤3	r=4	7.3	23.6
IE	0.3506	r=0	r>1	93.0	101.0	r=0	r=1	40.6	44.7
	0.2549	r<1	r≥2	52.4	71.6	r<1	r=2	27.7	38.2
	0.1599	r≤2	r≥3	24.8	45.9	r≤2	r=3	16.4	31.3
	0.0854	r≤3	r≥4	8.4	23.6	r≤3	r=4	8.4	23.6
IT	0.5016	r=0	r>1	155.0	101.0	r=0	r=1	65.5	44.7
	0.4020	r<1	r≥2	89.6	71.6	r<1	r=2	48.3	38.2
	0.2203	r≤2	r≥3	41.3	45.9	r≤2	r=3	23.4	31.3
	0.1730	r≤3	r≥4	17.9	23.6	r≤3	r=4	17.9	23.6

Note: The null hypothesis (H0) indicates r cointegration vectors against the alternative hypothesis (H1) of (at most) $r+1$ cointegration vectors for the maximum eigenvalue (trace) test. r is choosen as the first non significant statistics, undertaking sequentially the test starting from $r=0$.

Country	Eigenvalues	Trace				Maximum Eigenvalue			
		H0	H1	Statistics	95% Critical values	H0	H1	Statistics	95% Critical values
LV	0.6255	r=0	r>1	180.8	101.0	r=0	r=1	92.3	44.7
	0.3905	r<1	r≥2	88.5	71.6	r<1	r=2	46.5	38.2
	0.2771	r≤2	r≥3	42.0	45.9	r≤2	r=3	30.5	31.3
	0.1147	r≤3	r≥4	11.5	23.6	r≤3	r=4	11.5	23.6
LT	0.4257	r=0	r>1	116.6	101.0	r=0	r=1	52.1	44.7
	0.2473	r<1	r≥2	64.5	71.6	r<1	r=2	26.7	38.2
	0.2232	r≤2	r≥3	37.8	45.9	r≤2	r=3	23.7	31.3
	0.1385	r≤3	r≥4	14.0	23.6	r≤3	r=4	14.0	23.6
NL	0.3663	r=0	r>1	94.7	101.0	r=0	r=1	42.9	44.7
	0.2610	r<1	r≥2	51.9	71.6	r<1	r=2	28.4	38.2
	0.1620	r≤2	r≥3	23.4	45.9	r≤2	r=3	16.6	31.3
	0.0699	r≤3	r≥4	6.8	23.6	r≤3	r=4	6.8	23.6
NO	0.4578	r=0	r>1	117.1	101.0	r=0	r=1	57.5	44.7
	0.3054	r<1	r≥2	59.6	71.6	r<1	r=2	34.3	38.2
	0.1748	r≤2	r≥3	25.3	45.9	r≤2	r=3	18.1	31.3
	0.0745	r≤3	r≥4	7.3	23.6	r≤3	r=4	7.3	23.6
PL	0.3434	r=0	r>1	90.4	101.0	r=0	r=1	39.5	44.7
	0.2608	r<1	r≥2	50.9	71.6	r<1	r=2	28.4	38.2
	0.1311	r≤2	r≥3	22.5	45.9	r≤2	r=3	13.2	31.3
	0.0937	r≤3	r≥4	9.2	23.6	r≤3	r=4	9.2	23.6
PT	0.5374	r=0	r>1	135.2	101.0	r=0	r=1	72.5	44.7
	0.2591	r<1	r≥2	62.7	71.6	r<1	r=2	28.2	38.2
	0.2142	r≤2	r≥3	34.5	45.9	r≤2	r=3	22.7	31.3
	0.1185	r≤3	r≥4	11.9	23.6	r≤3	r=4	11.9	23.6
SK	0.3809	r=0	r>1	115.2	101.0	r=0	r=1	45.1	44.7
	0.3197	r<1	r≥2	70.1	71.6	r<1	r=2	36.2	38.2
	0.2240	r≤2	r≥3	33.9	45.9	r≤2	r=3	23.8	31.3
	0.1015	r≤3	r≥4	10.1	23.6	r≤3	r=4	10.1	23.6
SI	0.4946	r=0	r>1	116.9	101.0	r=0	r=1	64.2	44.7
	0.2417	r<1	r≥2	52.8	71.6	r<1	r=2	26.0	38.2
	0.1906	r≤2	r≥3	26.8	45.9	r≤2	r=3	19.9	31.3
	0.0708	r≤3	r≥4	6.9	23.6	r≤3	r=4	6.9	23.6
ES	0.5206	r=0	r>1	142.9	101.0	r=0	r=1	69.1	44.7
	0.3127	r<1	r≥2	73.8	71.6	r<1	r=2	35.3	38.2
	0.2399	r≤2	r≥3	38.6	45.9	r≤2	r=3	25.8	31.3
	0.1271	r≤3	r≥4	12.8	23.6	r≤3	r=4	12.8	23.6
SE	0.4547	r=0	r>1	131.1	101.0	r=0	r=1	57.0	44.7
	0.3687	r<1	r≥2	74.1	71.6	r<1	r=2	43.2	38.2
	0.2032	r≤2	r≥3	30.9	45.9	r≤2	r=3	21.4	31.3
	0.0964	r≤3	r≥4	9.5	23.6	r≤3	r=4	9.5	23.6
CH	0.5431	r=0	r>1	131.9	101.0	r=0	r=1	73.6	44.7
	0.2841	r<1	r≥2	58.3	71.6	r<1	r=2	31.4	38.2
	0.1847	r≤2	r≥3	26.8	45.9	r≤2	r=3	19.2	31.3
	0.0781	r≤3	r≥4	7.6	23.6	r≤3	r=4	7.6	23.6
GB	0.4395	r=0	r>1	151.5	101.0	r=0	r=1	54.4	44.7
	0.4310	r<1	r≥2	97.1	71.6	r<1	r=2	53.0	38.2
	0.3118	r≤2	r≥3	44.1	45.9	r≤2	r=3	35.1	31.3
	0.0909	r≤3	r≥4	9.0	23.6	r≤3	r=4	9.0	23.6
US	0.4943	r=0	r>1	114.7	101.0	r=0	r=1	64.1	44.7
	0.2550	r<1	r≥2	50.6	71.6	r<1	r=2	27.7	38.2
	0.1528	r≤2	r≥3	22.9	45.9	r≤2	r=3	15.6	31.3
	0.0751	r≤3	r≥4	7.3	23.6	r≤3	r=4	7.3	23.6

Note: The null hypothesis (H0) indicates r cointegration vectors against the alternative hypothesis (H1) of (at most) $r+1$ cointegration vectors for the maximum eigenvalue (trace) test. r is choosen as the first non significant statistics, undertaking sequentially the test starting from $r=0$.

Table 10: Generalized Forecast Error Variance Decompositions: a Negative Standard Error Unit Shock to US Rate of Growth of Real Equity Prices

Months		0	1	2	4	8	12	24
US Variables								
United States	gequ	42.43	35.64	29.65	20.98	12.74	9.66	7.12
	gcc	7.24	9.28	11.18	13.85	15.66	15.82	15.21
	ggdp	0.05	0.07	0.45	2.50	8.39	12.67	17.38
	ibk	6.11	6.67	7.20	7.73	7.65	7.38	7.17
	US Vars	**55.83**	**51.67**	**48.48**	**45.06**	**44.45**	**45.53**	**46.88**
Non-US Variables								
Euro Area	gequ	4.49	3.45	2.76	1.90	1.16	0.86	0.61
	gcc	2.08	2.54	3.17	3.77	3.40	2.96	2.42
	ggdp	1.24	1.16	1.04	0.86	1.32	2.19	3.86
	ibk	1.67	2.51	3.23	4.32	5.52	6.13	6.73
	EA Vars	9.47	9.66	10.21	10.84	11.40	12.13	13.62
Other Developed European countries	gequ	6.87	6.19	4.92	3.01	1.43	0.96	0.78
	gcc	0.29	1.74	3.01	4.58	5.19	4.90	4.24
	ggdp	0.99	0.75	0.74	1.03	1.90	2.54	3.30
	ibk	3.12	6.35	8.40	10.11	9.73	8.74	7.40
	OTH Vars	11.26	15.03	17.07	18.73	18.25	17.14	15.72
Baltic countries	gequ	2.87	2.74	2.47	2.08	1.76	1.59	1.54
	gcc	1.93	1.32	1.06	0.78	0.56	0.48	0.44
	ggdp	2.14	1.98	1.99	2.07	1.95	1.74	1.46
	ibk	3.29	4.89	5.91	7.35	8.20	7.58	5.80
	BALT Vars	10.23	10.93	11.43	12.28	12.47	11.38	9.23
South-Eastern Europe	gequ	1.29	0.96	0.83	0.73	0.75	0.87	1.04
	gcc	0.30	0.29	0.32	0.35	0.27	0.19	0.09
	ggdp	1.48	1.26	1.06	0.76	0.58	0.54	0.46
	ibk	0.26	0.37	0.45	0.49	0.36	0.25	0.15
	SEE Vars	3.34	2.89	2.66	2.34	1.96	1.84	1.75
Central-Eastern Europe	gequ	1.39	1.24	1.16	1.06	0.92	0.84	0.86
	gcc	2.79	2.95	3.22	3.69	4.27	4.63	5.10
	ggdp	2.22	2.33	2.35	2.33	2.59	2.98	3.68
	ibk	3.46	3.30	3.43	3.67	3.70	3.54	3.17
	CEE Vars	9.86	9.82	10.15	10.76	11.47	11.98	12.81
	Non-US Vars	**44.17**	**48.33**	**51.52**	**54.94**	**55.55**	**54.47**	**53.12**
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Note: Percentage of the k-step ahead forecast error variance of the historical shock to the United States rate of growth of real equity prices. Percentages do not sum to 100 due to non-zero covariance between the shocks, according to Pesaran and Shin (1998). However, for a better readability, we rescale variance decomposition as suggested by Wang (2002).

Table 11: Country Names and ISO Codes

Country Names	**ISO Codes**	**Country Names**	**ISO Codes**	**Country Names**	**ISO Codes**
Austria	AT	Germany	DE	Poland	PL
Belgium	BE	Greece	GR	Portugal	PT
Bulgaria	BG	Hungary	HU	Slovak Republic	SK
Croatia	HR	Ireland	IE	Slovenia	SI
Czech Republic	CZ	Italy	IT	Spain	ES
Denmark	DK	Latvia	LV	Sweden	SE
Estonia	EE	Lithuania	LT	Switzerland	CH
Finland	FI	Netherlands	NL	United Kingdom	GB
France	FR	Norway	NO	United States	US

REFERENCES

Bickel, P. J. & Buhlmann, P. (1999), 'A New Mixing Notion and Functional Central Limit Theorems for a Sieve Bootstrap in Time Series', *Bernoulli* **5**(3), 413–446.

Buhlmann, P. (1997), 'Sieve bootstrap for time series', *Bernoulli* **3**(2), 123–148.

De Nicolò, G. & Ivaschenko, I. (2008), Financial integration and risk-adjusted growth opportunities, IMF Working Paper 08/126, International Monetary Fund.

Dées, S., di Mauro, F., Pesaran, M. H. & Smith, L. V. (2007), 'Exploring the international linkages of the euro area: a global VAR analysis', *Journal of Applied Econometrics* **22**(1), 1–38.

Garratt, A., Lee, K., Pesaran, M. H. & Shin, Y. (2003), 'A Long run structural macroeconometric model of the UK', *Economic Journal* **113**(487), 412–455.

Harbo, I., Johansen, S., Nielsen, B. & Rahbek, A. (1998), 'Asymptotic Inference on Cointegrating Rank in Partial Systems', *Journal of Business & Economic Statistics* **16**(4), 388–399.

Hiebert, P. & Vansteenkiste, I. (2007), International trade, technological shocks and spillovers in the labour market; a GVAR analysis of the US manufacturing sector, Working Paper Series 731, European Central Bank.

IMF (2008), *Regional Economic Outlook: Europe*, International Monetary Fund, Washington.

Johansen, S. (1992), 'Cointegration in partial systems and the efficiency of single-equation analysis', *Journal of Econometrics* **52**(3), 389–402.

Johansen, S. (1995), *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, Oxford University Press, Oxford.

Koop, G., Pesaran, M. H. & Potter, S. M. (1996), 'Impulse response analysis in nonlinear multivariate models', *Journal of Econometrics* **74**(1), 119–147.

Kreiss, J. P. (1989), Bootstrap procedures for AR(∞)-processes., *in* K. H. Jockel, G. Rothe & W. E. Sendler, eds, 'Bootstrapping and Related Techniques. Lecture Notes in Economics and Mathematical Systems', Vol. 376, Springer-Verlag, Heidelberg, pp. 107–113.

MacKinnon, J. G., Haug, A. A. & Michelis, L. (1999), 'Numerical Distribution Fuctions of Likelihood Ratio Tests for Cointegration', *Journal of Applied Econometrics* **14**(5), 563–577.

McGuire, P. & Wooldridge, P. (2005), 'The bis consolidated banking statistics: Structure, uses and improvements', *BIS Quarterly Review* .

Park, H. J. & Fuller, W. A. (1995), 'Alternative Estimatiors and Unit Root Tests for the Autoregressive Process', *Journal of Time Series Analysis* **16**(4), 415–429.

Pesaran, M. H., Schuermann, T. & Weiner, S. M. (2004*a*), 'Modelling Regional Interdependencies using a Global Error-Correcting macro-econometric model', *Journal of Business and Economic Statistics* **22**(2), 129–162.

Pesaran, M. H., Schuermann, T. & Weiner, S. M. (2004*b*), 'Rejoinder to Comments on Modelling Regional Interdependencies using a Global Error-Correcting macro-econometric model', *Journal of Business and Economic Statistics* **22**(2), 175–181.

Pesaran, M. H. & Shin, Y. (1998), 'Generalized impulse response analysis in linear multivariate models', *Economics Letters* **58**(1), 17–29.

Pesaran, M. H., Shin, Y. & Smith, R. J. (2000), 'Structural analysis of vector error correction models with exogenous I(1) variables', *Journal of Econometrics* **97**(2), 293–343.

Sims, C. A. (1980), 'Macroeconomics and Reality', *Econometrica* **48**(1), 1–48.

Vansteenkiste, I. (2007), Regional housing market spillovers in the US - lessons from regional divergences in a common monetary policy setting, Working Paper Series 708, European Central Bank.

Wang, P. J. (2002), *Financial Econometrics: Methods and Models.*, Routledge, London.