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Were there warning signals from banking sectors for the 2008/2009 global financial crisis?

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This article takes the position that there have been significant costs attached to global banking financial integration and these costs were identified in a period prior to the 2008 Global Financial Crisis revealed by the analysis of daily country banking index data from December 1999 to September 2008. Regression, correlation, cointegration, causality and variance decomposition analysis of daily bank price index data indicate that banking systems had achieved a high level of global integration, exemplified in the global involvement in the US sub-prime mortgage market. Integration implies interdependence, which in turn implies the existence of systemic risk or the threat of contagion. Re-focusing by banks on a culture of portfolio diversification of investments and borrowings is necessary. Greater involvement by a global banking regulatory authority such as the Bank for International Settlements (BIS) to monitor undiversified systemic interdependence may be inevitable (e.g. the administration of insurance schemes for interbank lines of credit).

I. Introduction

This article deals primarily with integration, linkages and interdependence in banking systems. Several important studies have examined changes in the correlations of banking asset returns between 'crisis' and 'noncrisis' periods.[1] However, whilst there have been other financial crises (e.g. the Latin American debt crisis and the South East Asian currency crisis), major and widespread global financial instability did not occur until late 2008 partly because of the inception and general implementation of the Basel Accord guidelines for bank capital adequacy commencing in the late 1980s. This article posits that real financial contagion exists when bank burials (rather than failures) are so widespread that severe international financial instability results. Whilst this has not occurred in the aftermath of the 2008 Global Financial Crisis, the need for substantial recapitalization of banking systems has been identified and acted on by governments and central banks.

The problem may be investigated using banking price index data with analysis involving serial correlation, regression, cointegration and causality. It is important to demonstrate the effect on exogeneity of hypothetical market shocks to banking systems using impulse response and variance decomposition analysis. By demonstrating the warning signals in the period prior to the current crisis, bankers, regulators, economists and government policy makers may then

[1] See Baig and Goldfajn (1998), Forbes and Rigobon (1999), Ellis and Lewis (2000), Dungey and Zhumabekova (2001), Caporale *et al*. (2005) and Rigobon (2003).

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be in a position to continue to try to pre-empt future crises with appropriate theory, practice and policies.

Economic integration is the process of reducing and eventually removing barriers to free trade in goods and services and the free movement of factors of production between countries and regions. Financial integration relates to the free flow of financial services and factors of production, mainly capital, across borders. In the last decade or so leading up to the current crisis, international inter-bank lines of credit, cross shareholdings, payment systems and lending had been increasing in both dollar values and frequency. Accounting practices had become more standardized and more international banks had become compliant with regulatory capital adequacy guidelines. This was not sufficient to stave off the crisis. In the process of globalization, theory has it that international regulatory barriers will gradually be broken down. Bank customers should experience lower costs of services as trade barriers are removed. More funds should be made available for trade and investment to fuel economic growth. Political benefits of integration relate ultimately to global peace and harmony.[2] With standardization, economists, policy makers and banking authorities should be able to compare like bank data with like. International financial and economic analysis should become a less daunting task.

The literature on economic and financial integration is mixed in what, where and how it has been studied. Much of the literature prior to 2008 has focused on Europe[3] and the USA.[4] The countries within the EU and the European Monetary Union (EMU) aim ultimately for full economic and financial integration. It was around 22 years ago that the White Paper on the Completion of a Single Market announced the financial integration of the European banking systems. This immediately raised the issues as to home country and host country control of international banks, whether or not deposit insurance was the best way to the control international banks and which authority would administer the scheme. Finally issues arose with regard to uniform taxation treatment. The regional integration of European banking systems is occurring in a formalized way with free trade agreements and regulations. The EU's evolution into the EMU is a unique example of integration.

Whilst economic and political benefits are quite clear at a theoretical level, the potential costs of financial integration require discussion and relate to the phenomena of bank runs and bank failures. These phenomena are the manifestations of systemic risk arising out of interdependence of either domestic or international banking systems. The early studies of bank runs and failures used nonparametric techniques to provide explanations for runs on individual banks in the USA.[5] Later studies used least squared regression analysis[6] and then autoregressive models to overcome some of the misspecification and other problems in unlagged times series data.

Other studies in the US have focused on the concentration of the banking industry into mega banks. Integration within US banking has proceeded strongly but with the absorption of investment banking and insurance activities into bank holding companies, questions have also been asked as to what exactly constitutes a bank. The pre-2008 US studies are particularly relevant, dealing with contagion and systemic risk as a result of bank interdependence and the role of regulatory authorities.[7] In the late 1980s larger US banks (as well as other Western banks) had engaged in significant international and interbank borrowing and lending to fund the oil import generated current account deficits of Latin American countries in the form of floating rate US dollar loans. These types of loans were interest rate and exchange rate sensitive and inflation was problematic in the wake of the Organization of Petroleum Exporting Countries (OPEC) cartel agreements to restrict oil supply in the late 1970s and early 1980s.

The resultant inability by the Latin American countries to service their floating rate debt following interest rate increases and devaluations of exchange rates (undertaken to maintain purchasing power) saw the decline of Western bank balance sheet values. This deterioration of Western bank balance sheets stimulated research into international systemic risk

[2] Hill (2003) provides a definition of economic integration and Hughes and MacDonald (2002) the broad economic and political benefits.
[3] See Gual (2003), Kleimeier and Sander (2003) and Simpson (2005).
[4] See Harchaoui (2004) and Yeager (2004).
[5] See Diamond and Dybvig (1983) and Chari and Jagannathan (1988).
[6] See Grossman (1993).
[7] See Aharony and Swary (1983), Swary (1986), Goodhart (1987), Kaufman (1994) and Goodhart and Schoenmaker (1995).

and the threat of global financial instability.[8] It is probable that the threat of international financial contagion arising from ill-considered and undiversified loans to developing countries through the interbank market alone, led to the original Basel Accord in the late 1980s.

It is evident that the Western banks have again failed to conceptualize country and political risk. They have again failed to employ prudent lending criteria (such as ability to repay debt for example, in the sub-prime mortgage market) and importantly, they have again failed to utilize portfolio diversification in their international loan assets.[9]

The foregoing literature dealt mainly with sources of fragility of individual banks and moves to examine aggregate shocks and financial crises. However, it is of more relevance for the purposes of this article to investigate some of the literature dealing with the specific channels of systemic risk or contagion. Contagion can also be described as the transfer by a single financial institution (bank) facing insolvency to a group of banks.[10] Broadly speaking, the channels of contagion can arise out of wealth effects, international externalities and the interbank market and payment systems. This article takes the view that each of these channels has much to do with banking interdependence through the fundamental activities of developed banks in interbank borrowing and lending.[11] Interdependence through the international interbank market in developed systems can be demonstrated through analysis of interbank offered rates in the major global currencies.[12]

There is a body of evidence that supports the use of international stock market price indices to study the issue of contagion.[13] The evidence pointing towards regional integration and contagion as either an economic or a financial phenomenon is mixed. As an economic phenomenon the regional interdependence exists directly through trade ties between countries within regions. Other evidence suggests that geographic location and economic factors may be incidental and that contagion can exist between countries that do not have such ties and maybe in different corners of the world. In the latter case the common factors were that the countries concerned had high levels of external debt to fund current account deficits and that the debt was in interest rate and exchange rate sensitive floating rate US dollar commitments.[14] At an international level integration is central to the objectives of the World Trade Organization (WTO) in financial services liberalization,[15] and it is probably true that the process will not be halted or reversed despite what has occurred in financial markets in 2008/2009.

This article is not suggesting that liberalization is undesirable. It merely suggests that there may be economic, financial and social costs unless it is properly managed. The various authors, in predominantly US banking system studies, have alluded to the growth of integration and concentration of banking systems but beg the question as to whether or not there are financial and economic costs and if so what can be done by banks and regulatory authorities to minimize systemic risk.

Therefore, the objectives of this article are to demonstrate through correlation, regression, cointegration and causality analysis of daily country, regional and world banking stock price indices data (as proxies for the various banking systems) that the integration process in international banking systems continued in a robust manner in developed countries and regions in the period up to the 2008 Global Financial Crisis and began to gather pace in developing and transitional economies. The policy implications are that banks should, if not only for their own purposes of sound financial management, take the responsibility for risk diversification in their investment and borrowing activities. In addition, regulators may need to act at a global level to contain the risk of contagion in providing guidelines on regulatory capital requirements that include bringing undiversified interdependence to account (e.g. a bank systemic regulatory model was suggested by Simpson and Evans (2005)). It may also involve authorities looking more closely into international interbank deposit insurance schemes administered and monitored by a global banking authority such as the Bank for International Settlement (BIS).

[8] The literature is in general agreement that this is a reasonable synopsis of the circumstances surrounding the Latin American debt crisis. Oort (1990) noted that whilst systemic risk existed there had been few bank burials probably due to the adequacy of prudential supervision.
[9] See Bourke and Shanmugam (1990).
[10] For example, Rochet (2004).
[11] For example, Bhattacharya and Gale (1987), Allen and Gale (2000), Calomiris (1999) and Richot and Tirole (1996).
[12] Simpson *et al*. (2005).
[13] For example, Ratanapakorn and Sharma (2002).
[14] For example, Sell (2001).
[15] See Hill (2003) and Hughes and MacDonald (2002).

The article firstly discusses literature and evidence on contagion and financial integration in banking in a period before the current crisis. The model, methodology and data are then proposed, the findings reported and discussed and a conclusion containing policy implications is put forward. The following issues are addressed: What was the degree of financial integration and interdependence in global banking systems in the period leading up to the 2008 crisis and did the threat of financial contagion exist? Which banking countries/regions have been the major players in the global integration process? What are the policy implications of financial integration for banks and for regulators?

Financial contagion and regulation

The issues of contagion and regulation have been addressed by researchers such as Aharony and Swary (1983) and Swary (1986) who studied contagion effects when the central bank acted in a preventative role as lender of last resort. Kaufman (1994) felt that systemic risks have been overstated. The lack of evidence does not preclude the possibility of such bank contagion. If a larger bank fails it will this lead to a domino effect failure of other banks? Goodhart (1987) felt that central bank intervention into individual banks may be appropriate at times to prevent spillovers. Ultimately, governments and, therefore, taxpayers are providing the liquidity for this intervention and this in itself is an argument for banking supervision and regulation. Goodhart and Schoenmaker (1995) argue that the adverse selection and moral hazards involved in central bank support, need to be contained through supervision and regulation.

Early models of bank runs (Diamond and Dybvig, 1983) assumed consumption risk to be reflected in a stochastic deposit withdrawal and riskless but illiquid investments with the actual bank run triggered by a shift in expectations. The next set of models was developed by researchers such as Chari and Jagannathan (1988) who more realistically brought investment risk into the analysis. The early models helped to explain the reasons for runs on individual banks whether they are due to fears of insolvency in the case of the latter or self-fulfilling beliefs in the case of the former. However, the first models failed to address the problem of systemic risk or the chain reaction runs on or failures of other banks. The need for a central bank to take on the role of custodian of systemic safety became important in addition to its monetary policy role.

The literature on the channels of contagion that have particular relevance for the purposes of this article is that which deals with interbank borrowing and lending. The foregoing evidence and additional studies discussed by Rochet (2004) suggest that interdependence is a major source of systemic risk in developed banking systems such as those in Europe and the USA. For example, Bhattacharya and Gale (1987) examined the role of interbank markets in a fractional reserve system. Their argument was that in such a system interbank markets could trade reserves and insure against unsystematic liquidity shocks. This introduces fragility into the banking system, just as fractional reserves make individual banks more fragile. Allen and Gale (2000) constructed banking industry models that showed contrasting effects of interbank markets where the probability of individual bank failure decreased on the one hand and on the other hand the chance of collapse of an entire system increased.

Allen and Gale (2000) suggested that banking systemic risk would vanish if interbank deposits were insured but Rochet (2004) feels that this may result in more moral hazard problems with the loss of disciplining power over short-term interbank loans. Calomiris (1999) felt that the International Monetary Fund (IMF) had been in error in this regard when they implicitly guaranteed the loans of international banks. The IMF in turn provided loans to troubled banks in the recent Asian currency crisis of 1997/1998. He suggested the participation in such IMF borrowing by sufficiently many commercial banks so that there was an incentive for each bank in the group to monitor the lending activities of the other. Calomiris also suggested that subordinated debt should be part of a bank's capital adequacy requirement. Rochet and Tirole (1996) studied the properties of a peer monitoring system. Banks should be provided with the incentive by the central bank to monitor both their own borrowers and the lending activities of other banks and it would generate economies of scope between commercial and interbank lending. Rochet and Tirole indicate that a necessary condition for the provision of peer monitoring can only be practical if a central bank would be willing in the circumstances of contagion to close a large number of banks and this was not likely.

On an international level, Simpson *et al*. (2005) felt that it was firstly necessary to demonstrate that systemic risk in interbank lines of credit existed in the major developed banking systems centred in London, New York and Tokyo. This interdependence was demonstrated using cointegration, causality, impulse response and variance decomposition analysis of the interbank offered rates applying in each market for the major global currencies of US dollars, sterling and yen. The results showed that the New York

interbank market drove firstly the UK system and then the Japanese system. That is, exogeneity lay with New York in both London and Tokyo. In the London and Tokyo system exogeneity lay with London.

The models used for the analysis of bank runs and systemic risk have evolved from simple nonparametric tests of banking system generated data to least squares regression analysis of time series data such as that used by Grossman (1993). Problems of mis-specification have led to the use of autoregressive, cointegration, and causality techniques such as those used in this article. Initially it is necessary to differentiate between systemic, systematic and unsystematic risks arising out of integration and interdependence. Drawing on portfolio theory from Markowitz (1952), systematic risk is market risk and is unavoidable and undiversifiable. Systematic risk is measurable from an analysis of historical price or returns data and is represented by a regression coefficient (the Beta). Unsystematic risk is idiosyncratic risk (in the model specified in this article unsystematic risk is country and regional banking system specific). Unsystematic risk cannot be measured effectively; its assessment is subjective,[16] but it is avoidable through diversification.

Contagion or the threat of contagion?

Equity market literature and evidence in Baig and Goldfajn (1998), Forbes and Rigobon (1999), Dungey and Zhumabekova (2001), Caporale *et al.* (2005), Rigobon (2003) and also currency market literature in Ellis and Lewis (2000) have focused on the manifestation of financial contagion. Investigations of the differences in correlations of asset returns between 'crisis' and 'noncrisis' periods were undertaken where a statistically significant change in the correlations was interpreted as evidence of contagion. Dungey and Zhumabekova (2001) warn that the power of correlation tests may be hampered by the relatively few observations in the 'crisis' period. Included in their testing was a heteroscedasticity correction developed by Forbes and Rigobon (1999). Forbes and Rigobon (1999) found that when investigating a linear relationship between returns in different systems that the move between a 'noncrisis' and 'crisis' period produced volatility in the error term that violated the assumption of homoscedasticity. There were changes in the variance structure of the data between periods and more particularly the variance of the series increased with the advent of the crisis. They introduced a correction to allow for heteroscedasticity.

Dungey and Zhumabekova (2001) feel that a stronger test is to estimate 'crisis' and 'noncrisis' Vector Autoregressive (VAR) models separately and to then test whether or not the unadjusted correlation coefficients are significantly different across the two samples. Caporale *et al.* (2005) used a parameter stability test when testing for contagion in the East Asian region and following Rigobon (2003) controlled for bias resulting from heteroscedasticity, endogeneity and omitted variables. Their approach was based on full-sample estimation and hence avoided the problems arising from comparatively small 'crisis' samples. Moreover, they selected endogenously, the breakpoints that corresponded to the beginning of the contagion period. Their findings provide evidence of the existence of contagion in the East Asian region, which was consistent with various theories of asset market linkages.

The position in this article is that real financial contagion exists when there is a 'domino' or 'chain reaction' effect of bank burials (not merely bank failures) and subsequent severe widespread global financial instability rather than when there is differentiation between changes in correlations of bank systemic returns over 'crisis' and 'noncrisis' periods. The article posits that whilst real financial contagion has not occurred, largely due to the impact of Basel Accord guidelines and capital adequacy adoption, the threat remains real and has only been averted in 2008/2009 by governments and central bank intervention with large volumes of funds to recapitalize banking systems. Continued vigilance is needed to avert the threat of widespread contagion. The central issue is whether or not the threat of contagion existed in a period prior to the current crisis and if so what steps were taken to continue to insure against its manifestation. The approach in this article is to investigate the degree of financial integration, banking system interrelationships and linkages and therefore the degree of interdependence between country and regional banking systems in equity prices. Firstly, unlagged data are tested in correlation and regression analysis. Then, for optimally lagged data, VAR models are specified and testing undertaken for cointegration and exogeneity to demonstrate the major driving forces of

[16] Unsystematic risk includes political and cultural factors that are based on opinion and as such are not easily measurable or predictable.

financial integration and therefore possible sources of the threat of contagion. Impulse response and variance decomposition analysis reinforces any causal influences when hypothetical market shocks are delivered to the endogenous variables to reinforce evident of causality. The literature now turns to other studies that specifically investigate financial integration.

Financial integration

With regard to European studies, questions arose as to whether or not greater concentration of the banking industry would ensue and how this would affect competition in the market place. Some studies examined commercial and retail banking only and applied cointegration methodology to investigate integration in the presence of country specific credit rates. For example, Kleimeier and Sander (2003) found a growing pace of integration with the introduction of a single currency and provided one of the first pictures of an emerging uniform banking market in the Eurozone. The difference was more pronounced in the corporate lending market and all evidence suggested that the integration process would be enhanced with a single monetary authority.

Kleimeier and Sander also examined the financial part of the monetary transmission process in the pass through of monetary policy induced interest rate changes in the Eurozone between 1993 and 2002. Findings were that there were increases in the size and speed of monetary policy shocks. Such measures also provided an indication of integration in the Eurozone banking market but they found that the market was still fragmented. However, their view was that nominal, real and structural convergence can lead to a more homogenous transmission process in the Eurozone but full convergence may be precluded by legal and cultural differences.

Others such as Gual (2003) have found that in market opening there exists a difficult trade-off between respect for domestic preferences and the elimination of regulations that protect local competitors. The study by Gual also examined various indicators of financial integration in EU banking but also analysed the impact of integration policies on the conduct, structure and performance of the banking industry. Overall Gual found that the EU single banking market policies were starting to achieve their objectives. Simpson (2005) found that the financial integration of European banking systems into the EMU was robust and that cointegration exists in segmented European systems with the EMU. Moreover, causality and influence ran from the EMU banking system to the segmented systems and that the influence of the EMU on segmented European systems was greater than that of the important UK banking system.

In the USA, one of the recent issues prior to the current crisis has been finding the most successful methodology in identifying and grouping banks as producing units into homogenous economic activities to assist with empirical research relying on micro data to draw inferences on the structure, conduct and performance of the banking sector as a whole (Harchaoui, 2004). The Harchaoui study has implications as to the measurement or assessment of the degree of integration in the US banking system. Banking and financial services generally are also in the process of concentration into mega-bank holding companies and the issue is becoming a question of what constitutes a banking industry.

Yeager (2004) accepted that there is a growing concentration of US banking assets into mega banks but that most research finds that economies of scale and scope are small. By applying the survivor principal to the US banking industry between 1984 and 2002, Yeager finds that the economies of integration are significant, even after accounting for off balance sheet activities and after replicating the analysis at the holding company level. Yeager used regression analysis to show that deregulation of branching restrictions played a significant role and permitted banks to exploit economies of integration. Yeager's explanation for the paradox where there were significant integration economies (but not cost economies) was that the size benefit of a bank emanates from sources other than cost efficiencies.

The evidence is mixed but tends to indicate that the process of country and regional integration occurred in a robust way in the larger developed banking systems prior to the current crisis and in those systems such as in Latin America, which are now (since the debt crisis of the late 1980s and early 1990s) highly dependent on the major developed banking systems. The evidence also indicates that the process may have been driven by the economies associated with integration, if not economies of scale and scope, but that the process may have been hindered across state and international borders by legal and cultural differences.

Various studies have used stock price index data to examine international and regional interdependence and integration (Ratanapakorn and Sharma, 2002) whilst others (Sell, 2001) have examined the issues (again analysing stock market price data) as to whether or not contagion is an economic function (dependent on regional trade ties) or whether contagion was a financial or banking phenomenon and not intra-regional (e.g. Russia and Brazil experienced

contagion but did not have strong trade ties nor are they in the same region but they are both countries dependent on large external US dollar denominated floating rate debt).

II. The Model, Data and Preliminary Analysis

This study commences with the specification of a basic linear market model[17] to initially analyse unlagged stock price index data. The first part of the analysis of this article replicates the model, data and findings in Simpson and Westaway (2009) as follows:

$$B_{i_t} = \alpha_t + \beta_t B_{w_t} + e_t \quad (1)$$

where B_{i_t} is the banking price index return for country i at time t, B_{w_t} is the world banking price index return at time t and α_t, β_t and e_t are the regression intercept, coefficient and error terms at time t, respectively.

Based on Granger (1988) findings that financial and economic time series may contain unit roots and in the development of the theory of nonstationary time series analysis, the unlagged regression model is re-specified into a model to implement VAR-based tests for both cointegration and causality in optimally lagged data.

The respecified model is as follows:

$$B_{i_t} = a_1 B_{i_{t-1}} + \cdots + a_n B_{i_{t-n}} + bB_{w_t} + e_t \quad (2)$$

where B_i is the vector of endogenous variables being bank price index price index values for country i (at times t to $t-n$), B_{w_t} is the vector of exogenous world banking price index values at time t, $a_1, \ldots, a_n$ and b are matrices of coefficients to be estimated and e_t is the error term and specifically it represents a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

Note: In the model specified in Equation 2 both variables for the banking system in a country and the global banking system are lagged.

Daily time series banking price index data were collected for each country/region as well as a world banking price index from Datastream covering the period 31 December 1999 to 20 September 2004. Level and first difference data were analysed using the EViews 4 (2001)[18] statistical package. Preliminary analysis of the various time series was undertaken. Jarque–Bera test statistics indicated that there were problems with skewness and kurtosis[19] with each of the level and first differenced series for each country/region. An initial drawback of the analysis is that none of the series is normally distributed, which in the absence of any problem with sample size, provided an initial indication that the series were serially correlated.

With the country/regional banking price indices as the dependent variables and the world series as the independent variable, pairwise Ordinary Least Squares (OLS) regression analysis was firstly undertaken to see how the unlagged level data behaved. The Durbin–Watson (DW) test statistic detected significant serial correlation (i.e. the level series regressions were found to be spurious. White tests with no cross terms (as pairwise regressions were analysed) revealed significant error term heteroscedasticity. First difference series were initially analysed using pairwise OLS market models. First differencing removed the problem of serial correlation in the errors of the regressions. However, heteroscedasticity remained persistent. The OLS regression was respecified into a weighted least squares model to account for heteroscedasticity of an unknown form. Pairwise correlation analysis of the unlagged price index first differences also enabled an initial investigation of the degree of interdependence of the various country/regional-banking systems with the world system.

Augmented Dickey–Fuller (ADF) unit root tests were applied to the level series of prices, then to the first differences and then to the error terms of the regressions of these series to test for stationarity or nonstationarity. The level series were found to be nonstationary (except in the level series of the developing markets in Malaysia and Indonesia). First differencing converted all remaining series to stationarity, which was also evident in the errors of the price index first differences regressions. The level series were thus found to be integrated nonstationary processes.

This part of the analysis extends the unlagged model of Simpson and Westaway (2009) and specifies

[17] The market model used is a simplified version of Sharpe's Capital Assets Pricing Model (Sharpe, 1964) as discussed and reported in Reilly and Brown (2003) who also feel that the analysis of indexed data is feasible in the study of risk/return relationships in stock markets, assuming the indices studied are representative. The indices used in this article are taken from the commonly used Datastream database.

[18] All test statistics and regression models applied throughout the analysis are described in the EViews 4 (2001) package.

[19] The problem is skewness and kurtosis in the level series but primarily with kurtosis in price index first differences series.

a VAR to examine optimally lagged data so that VAR-based cointegration tests (Johansen tests)[20] can be implemented on the basis that stationary linear combinations may represent cointegrating equations and imply long-run equilibrium or stable relationships among the pairs of variables in each market model. If cointegration was to be found on optimally lagged data, the study would move to test causality (Granger, 1988) and thus to test the short-run dynamics of the model and the speed at which world banking market information was absorbed into each banking system and/or *vice versa*.

The final part of the analysis is to confirm the foregoing relationships by examining impulse response functions and, specifically, variance decomposition of a VAR that involved the major banking systems of the USA, the UK, the EMU and Japan interacting with the world banking system. Impulse response functions trace the effects of an impulse (shock) to one endogenous variable on the other variables in the VAR. Variance decomposition separates the variation in the endogenous variable into component shocks to the VAR and thus gives an indication of the relative importance of each random innovation as it affects the variables in the VAR. This analysis is useful as it indicates relative strength of exogenous forces and also shows how quickly each interacting banking system returns to equilibrium after the hypothetical market shock.

III. The Findings

Pairwise correlation analysis of unlagged price index first differences data is a basic indicator of interrelationship and integration of country/regional banking systems in relation to the world banking system. The ranking of the correlation coefficients provides an initial indication of the degree of systemic risk (i.e. the degree of interdependence of each country/regional system with the world system). These relationships are confirmed when regressions are run and when the adjusted R square values and t statistics are considered. The ranking of the regression coefficients (Betas) indicates the level of systematic (market) risk in each country/regional banking system considered pairwise with the world system.[21] The initial indication of the strength and direction of the relationship is indicated in the correlation coefficients in Table 1, the adjusted R square values in Table 2 and the ranking of the regression Betas in Table 3.

From Tables 1 and 2 it can be seen that the developed banking systems in Europe, the USA, the UK and Canada had strong interrelationships with the world banking system in the period prior to the current crisis. The systems in the Pacific Basin, Latin America (which is strongly influenced by US and Canadian systems) Asia, Hong Kong, the Far East, Japan, Singapore, Australasia (which includes New Zealand) and South East Asia (including Singapore and Hong Kong) had a medium degree of integration and interdependence, while the smaller developed systems of Australia and Korea had a smaller degree of interaction with the world system along with the less developed banking systems in Thailand, Taiwan, Malaysia, Indonesia, the Philippines and China.

In Table 2 it can be seen that each system showed explanatory power (as seen in adjusted R square values) on unlagged data and therefore the comparative strength of the regression coefficients in explaining banking price index variation. The relationships are positive.

Table 3 illustrates that when country and regional systems interacted with the Americas system, higher levels of interdependence and therefore integration were seen with the larger and more developed banking systems such as Europe and the UK. It is noted that the Americas system must by definition be highly related to the US, Canadian and Latin American systems and the US dominates that regional banking system. Additional evidence is provided that developed banking systems dominated the process of global interrelationships over the period studied and that this is probably due to increased trends towards concentration in those banking systems, particularly in US, Canada, UK and Western Europe through takeovers and mergers, cross shareholdings and increased interbank borrowing and lending.

Table 4 illustrates that in respect to the period before the 2008 crisis the developed systems of Hong Kong, the Americas and Europe have higher levels of systematic risk than developing and smaller developed systems in relation to the world system. It is logical that they therefore have lower levels of unsystematic risk because of comparative political stability and advanced economic reform, but this should not preclude the developed systems from

[20] See EViews 4 (2001).

[21] Care needs to be taken with the results, as the ranking of correlation coefficients, adjusted R square values and Betas is also a reflection of the size and level of development of individual markets.

Table 1. Correlation analysis

Ranking according to correlation	Banking system	Correlation coefficient (correlation with the world banking index)
1	Europe (excluding emerging systems)	0.8295
2	The Americas (including Canada and USA)	0.8108
3	Europe (excluding the UK)	0.7987
4	USA	0.7963
5	The EMU	0.7843
6	Europe (excluding the economic union)	0.6841
7	UK	0.6742
8	Canada	0.5301
9	The Pacific Basin	0.4346
10	The Pacific Basin (excluding Japan)	0.4335
11	Latin America	0.4281
12	Asia	0.4153
13	Asia (excluding Japan)	0.4064
14	The Far East	0.3975
15	Hong Kong	0.3627
16	Japan	0.3076
17	Singapore	0.2980
18	Australasia	0.2832
19	South East Asia	0.2822
20	South Korea	0.2363
21	Australia	0.1896
22	Taiwan	0.1699
23	Thailand	0.1542
24	Malaysia	0.0795
25	Indonesia	0.0571
26	Philippines	0.0579
27	China	−0.0062

Note: Replicated from Simpson and Westaway (2009).

pursuing policies of diversification of the idiosyncratic risk component in the interests of systemic safety.

The study then turned to the analysis of optimally lagged data and the application of Equation 2. Pairwise VAR models were specified and in each case, and VAR stability tests on one through 20 daily lags were undertaken. The pairwise VARs were all stable.[22] Maximum likelihood ratios [23] and minimum information criteria (FPE, AIC, SC and HQ) [24] were used to test the optimal lags. Johansen tests were applied for cointegration analysis. Maximum eigenvalues and minimum trace statistics indicated the number of cointegrating equations in each case. Table 5 illustrates these results as well as the results of Granger causality analysis.

Table 5 indicates the existence of cointegration in most of the pairwise variables, thus providing further evidence of country/regional banking system interdependence with the world system, through the long-term equilibrium relationships established. No cointegrating relationship was found with the Chinese, Thailand and Australian systems. All remaining interrelationships were confirmed in causality analysis. It would be expected that the world banking system would be the driver in all cases of the various country and regional systems (or the major influences on those systems) and the evidence shows that in most cases the world was the exogenous system.

In the cases where there was dual causality, the stronger causality was decided by the higher values of the F statistics and the lower probability values in significance levels. Exceptions to the findings of world system exogeneity are the major country and regional systems of the USA, Canada and the Americas, which

[22] The tests indicate that no root lay outside the unit circle when tested from one through to 20 lags.
[23] The maximum LR is the maximum sequential modified likelihood ratio test statistic.
[24] FPE is the Final Prediction Error, AIC is the Akaike Information Criterion, HQ is the Hannan–Quinn information criterion and SC is the Schwartz Criterion for optimal lag determination. Minimum values are sought with these information criteria (EViews 4, 2001).

Table 2. Regression analysis

Country and regional banking price index first differences regressed on the world banking price index first differences	Rank (Adjusted *R* square value and *t*-statistic value)	Regression adjusted *R* square value	Regression coefficient (Beta)	*t*-statistics
Europe without emerging European systems	1	0.6881	0.8284	52.0867
Americas	2	0.6572	1.0544	48.577
Europe without UK	3	0.6378	0.7559	46.5411
USA	4	0.6340	1.4740	46.1639
EMU	5	0.6150	0.7003	44.3240
Europe without countries in the EMU	6	0.6103	1.2249	43.8934
Europe without the EU	7	0.4689	1.1482	32.8939
UK	8	0.4546	7.3415	32.0174
Canada	9	0.2796	0.7140	21.9207
Pacific Basin countries without Japan	10	0.1879	0.2701	16.8739
Latin American countries	11	0.1833	0.0339	16.6136
Asian countries including Japan	12	0.1720	0.4024	15.9998
Asia excluding Japan	13	0.1652	0.2821	15.6026
East Asia	14	0.1576	0.4279	15.1825
Hong Kong	15	0.1314	1.7724	13.6528
Japan	16	0.0938	0.1423	11.3225
Singapore	17	0.0887	0.1874	10.9430
Australasia	18	0.0796	0.1949	10.3611
South East Asia	19	0.0789	0.1110	10.3035
South Korea	20	0.0557	0.0305	8.5310
Australia	21	0.0354	0.2116	6.7778
Taiwan	22	0.0289	0.0370	6.0462
Thailand	23	0.0235	0.0617	5.4680
Malaysia	24	0.0061	0.0926	2.8017**
Philippines	25	0.0014	0.0248	2.0180**
Indonesia	26	0.0017	0.0059	1.900**

Notes: All *t*-statistics are significant at the 1% level except those marked.
** indicates significance at the 5% level. The ranking is according to explanatory power in the adjusted *R* square value and the *t*-statistic value. These are unlagged data. The results for China are not significant and not reported. This data and analysis is replicated from Simpson and Westaway (2009).

were exogenous systems with significant causality running from those systems to the world system. The fact that most systems adjusted with world systems after a 2–5 day lag is another indication of the extent of integration and interdependence.

When impulse responses and variance decomposition are considered in the major banking systems of the US, UK, EMU and Japan interacting with the world system (i.e. nonpairwise) the following results are evident (Appendix). Firstly, each system adjusted to equilibrium within 6–8 days. When the world system was shocked, it is apparent that after 2 days it explained 97.5618% of its own variance. Equilibrium was achieved within 7 days at which time it explained 97.3160% of its own variance. The US was the main exogenous influence increasing its exogeneity slightly from 2.0839% after 2 days to equilibrium after 7 days when it explained 2.2850% of the world system. When a shock was delivered to the US system, after 1 day the world explained 68.0435% of US variance, the US explained 31.9565% of its own variance with negligible influence from the UK, the EMU and Japan. Equilibrium was achieved after 7 days when world exogeneity reduced to 67.7804% and the US explained 31.7759% of its own system, with small increases in exogeneity from Japan, the UK and the EMU in that order. When a shock was delivered to the UK system, after 1 day the world explained 42.5257% of its variance and 48.4455% was self-explained; the US explained 9.0288% with zero contributions from the EMU and Japan. Equilibrium was achieved after 6 days when world exogeneity reduced to 41.3349%, US exogeneity increased to 13.5816%, the UKs explanation of its own system (endogeneity) reduced to 44.7146% and the exogeneity of the EMU and Japan increased slightly but both remained negligible influences. The results of shocks to the EMU and the Japanese systems are similarly analysed and the overall results are summarized as follows.

When the world system was considered as the endogenous variable and shocked, the only significant exogenous influence on it was the US system. When the US system was shocked as the endogenous

Table 3. Correlation analysis: banking systems with the Americas banking system

Ranking according to correlation	Banking system	Correlation coefficient
1	USA	0.9974
2	Canada	0.5955
3	Europe (excluding emerging economies)	0.4300
4	EMU	0.4148
5	Europe (excluding the UK)	0.4124
6	UK	0.3707
7	Latin America	0.3604
8	Europe (excluding the EU)	0.3323
9	Singapore	0.1213
10	Asia (excluding Japan)	0.0979
11	Pacific Basin (excluding Japan)	0.0975
12	Pacific Basin	0.0964
13	Asia	0.0961
14	Japan	0.0939
15	Far East	0.0911
16	Taiwan	0.0834
17	Hong Kong	0.0829
18	South East Asia	0.0695
19	Korea	0.0585
20	Australasia	0.0442
21	Australia	0.0284
22	Thailand	0.0225
23	Philippines	0.0212

Table 4. Market risk in country and regional banking systems

Country and regional banking price index first differences regressed on the world banking price index first differences	Rank (By value of Beta)	Regression coefficient (Beta)	*t*-statistics
Hong Kong	1	1.7724	13.6528
USA	2	1.4740	46.1639
UK	3	1.3415	32.0174
Europe without countries in the EMU	4	1.2249	43.8934
Europe without the EU	5	1.1482	32.8939
Americas	6	1.0544	48.577
Europe without emerging European systems	7	0.8284	52.0867
Europe without UK	8	0.7559	46.5411
Canada	9	0.7140	21.9207
EMU	10	0.7003	44.3240
East Asia	11	0.4279	15.1825
Asian countries including Japan	12	0.4024	15.9998
Pacific Basin countries without Japan	13	0.2701	16.8739
Asia excluding Japan	14	0.2821	15.6026
Australia	15	0.2116	6.7778
Australasia	16	0.1949	10.3611
Singapore	17	0.1874	10.9430
Japan	18	0.1423	11.3225
South East Asia	19	0.1110	10.3035
Malaysia	20	0.0926	2.8017**
Thailand	21	0.0617	5.4680
Taiwan	22	0.0370	6.0462
Latin American countries	23	0.0339	16.6136
South Korea	24	0.0305	8.5310
Philippines	25	0.0248	2.0180**
Indonesia	26	0.0059	1.900**

Notes: Results are significant at the 1% level except those marked.
** indicates significance at the 5% level. The higher the ranking, the higher the level of market risk when system first differences are regressed against world first differences.

Table 5. Pairwise optimal lags, cointegration and causality test results

Country/regional banking system	Optimal lag (see footnote 7 for likelihood ratios and information criteria)	Cointegrating equations (VAR assumption)	Granger causality
America	3 (According to FPE, AIC and HQ)	2 (Assuming no deterministic trend)	America causes World on lag of 3*. No significant dual causality.
Asia including Japan	2 (FPE, AIC, HQ and SC)	2 (Linear deterministic trend)	World causes Asia on a lag of 2*. No significant dual causality.
East Asia	2 (FPA, AIC, HQ, SC)	2 (Linear deterministic trend)	Dual causality on a lag of 2. World causality* is slightly more than East Asia** significance in terms of probability value.
Asia without Japan	5 (LR, FPE, AIC)	1 (Linear deterministic trend)	Dual causality on a lag of 5. World Granger causes Asia without Japan.* Japan causes World**.
Australasia	5 (LPE, AIC)	1 (Linear deterministic trend)	World causes Australasia. lag of 2*. No significant dual causality
Australia	4 (FPE, AIC)	**No cointegration found**	World causes Australia on 2 lags*. No significant dual causality.
Canada	3 (FPE, AIC)	2 (No deterministic trend)	Canada causes the world on 2 lags**. No significant dual causality.
China	2 (FPE, AIC, HQ, SC)	**No cointegration found**	World causes China on 2 lags***. No significant dual causality.
EMU	2 (FPE, AIC, HQ, SC)	1 (Linear deterministic trend)	World causes EMU on 2 lags*. EMU causes World on 2 lags**.
Europe without emerging systems	9 (LR, FPE, AIC)	2 (Linear deterministic trend)	Dual causality exists on 9 lags*. Causality from World slightly higher than vice versa (lower probability)
Europe without the EMU	11 (LR, FPE, AIC)	2 (Linear deterministic trend)	World causes Europe without the EMU and vice versa on a lag of 11*. Causality is slightly stronger from World (lower probability value).
Europe without the EU	2 (FPE, AIC, HQ, SC)	2 (Quadratic deterministic trend)	World causes and Europe without EU Granger causes on a lag of 2*. World causation is slightly more significant (lower probability value).

Europe without UK	3	(FPE, AIC)	1 (Linear deterministic trend)	Dual causality on 2 lags*. World causation is slightly more significant.
Hong Kong	2	(FPE, AIC, HQ, SC)	1 (No deterministic trend)	Dual causality on a lag of 2*. World causality is slightly more significant.
Indonesia	14	(FPE, AIC)	2 (Linear deterministic trend)	World causes Indonesia on a lag of 13*. No significant dual causality.
Japan	2	(FPE, AIC, HQ, SC)	2 (No deterministic trend)	Dual causality on a lag of 2*. World causality is slightly more significant.
Korea	4	(FPE, AIC)	1 (Linear deterministic trend)	World causes Korea on 2 lags*. No significant dual causality.
Latin America	7	(FPE, AIC)	2 (Linear deterministic trend)	World causes Latin America on a lag of 7*. No significant dual causality.
Malaysia	3	(FPE, AIC)	1 (Linear deterministic trend)	Dual causality on a lag of 2*. World Causality is slightly more significant.
Pacific Basin Countries without Japan	5	(FPE, AIC)	1 (Linear deterministic trend)	Dual causality on a lag of 2*. World causality is slightly more significant.
The Philippines	4	(FPE, AIC)	2 (Linear deterministic trend)	Dual causality on a lag of 2*. World causality is sightly more significant.
South East Asia	6	(FPE, AIC)	1 (Linear deterministic trend)	Dual causality on a lag of 2*. World causality is slightly more significant.
Singapore	5	(FPE, AIC)	1 (Linear deterministic trend)	Dual causality on a lag of 2*. World causality is slightly more significant.
Taiwan	2	(FPE, AIC, HQ, SC)	2 (No deterministic trend)	World causes Taiwan on a lag of 2*. No significant dual causality.
Thailand	6	(FPE, AIC)	**No cointegrating equations**	Dual causality on a lag of 2*. World causality is slightly more significant.
UK	4	(FPE, AIC)	1 (No deterministic trend)	Dual causality on a lag of 2*. World causality is slightly more significant.
USA	3	(FPE, AIC, HQ)	2 (No deterministic trends)	US causes World on a lag of 1*. No significant dual causality.

Notes: Optimal lags and number of cointegrating equations are significant at the 5% level.
In Granger causality, *, ** and *** denote significance at the 1, 5 and 10% levels, respectively.

variable, the only significant exogenous force was the world system. When the UK was shocked, the significant exogenous influence was the world system followed by the US system. When the EMU was shocked, the significant exogenous forces were the world and then the US systems. When Japan was shocked the significant exogenous forces were the EMU, the UK, the world and the US systems in that order. When the systems of the US, UK, EMU and Japan were each shocked the world system was the most significant exogenous force in each system with the strength of exogeneity running to the US, the EMU, Japan and to the UK in that order. Overall, when lagged data were considered together in a VAR, the world banking system was the leading exogenous force, followed by the US, the EMU, Japan and the UK in that order. The systems when considered together all achieved equilibrium within 6–8 days.

IV. Discussion

In this article it is put forward that integration and systemic risk can be studied by the use of banking stock market price indices. The study thus is in concurrence with researchers such as Ratanapakorn and Sharma (2002) and Sell (2001). Moreover, it is felt that the issue of systemic risk is primarily a financial issue (as suggested by Sell (2001)) because large international banks, as key economic agents with their substantial interbank borrowing and lending (predominantly in floating US dollar commitments) and investment activities have been at the heart of the globalization process.

Important studies of financial contagion arising from integration and interdependence of banking systems and foreign exchange systems have examined the change in correlations between returns in different systems between periods of 'crisis' and periods of 'noncrisis'. Studies such as those by Baig and Goldfajn (1998), Forbes and Rigobon (1999), Ellis and Lewis (2000), Dungey and Zhumabekova (2001), Caporale *et al.* (2005) and Rigobon (2003) have encountered problems relating to 'crisis' sample size, heteroscedasticity and issues relating to endogeneity. In this article it is also put that the literature generally suffers from problems relating to the definition of contagion and whether or not the central issue should be the study of contagion or the study of the threat of contagion.

A more accurate definition of contagion may well be a severe global and financial melt-down. That is, a chain reaction of bank burials (rather than bank failures) that leads to severe international financial instability. This scenario has not yet been observed in the global system up to 2008/2009 largely due to bank capital adequacy adherence and recent substantial capital injection into banking systems by governments and central banks in the cases of the more influential developed banking systems.

The evidence reported in this article supports other evidence that the integration of country and regional banking systems continued in the period prior to the current Global Financial Crisis, particularly in developed country banking systems such as the Americas and Europe (e.g. studies of Europe by Gual (2003), Kleimeier and Sander (2003) and Simpson (2005)). This process continued despite the fact that most non-EMU regions do not have a single currency as in the EMU and that there were no stringently applied and uniform integration policies and regulations. The US banking system is a large, developed and sophisticated financial system and US banks are among the largest in terms of market capitalization and global influence in the major banking systems. It is logical that the processes of integration and concentration of the US banking system has also been a research focus (Harchaoui, 2004; Yeager, 2004).

Because of the growing integration of the US banking industry since the 1980s researchers have also examined the associated issues of increasing systemic risk and prudential supervision (Aharony and Swary 1983; Swary, 1986; Goodhart, 1987; Kaufman, 1994; Goodhart and Schoenmaker, 1995). However, it is probably not coincidental that many of the above studies were undertaken at the time of the Latin American debt crisis when issues of international systemic risk first became apparent. This cannot be said of most developing systems (e.g. in most Asian banking systems) and in some developed systems (e.g. Japan whose banks are still among the largest in the world, but have declined in importance since the mid-1990s).

The literature review has revealed that the channel of contagion arising out of interbank borrowing and lending is evident (Simpson *et al.*, 2005) and requires particular examination in future research as to how the risk may be mitigated with central bank involvement either thorough capital adequacy requirements or through interbank deposit insurance (Bhattacharya and Gale, 1987; Rochet and Tirole, 1996; Calomiris, 1999; Allen and Gale, 2000). This article provides further support for the existence of interdependence in the global banking system in the period prior to the current crisis that had the potential to cause severe widespread international financial instability. Interdependence exists for several reasons including cross shareholdings, but it is

suggested that undiversified lending against undiversified interbank lines of credit is a major source of systemic risk.

V. Conclusion

The issues addressed in this study were as follows: What were the degrees of financial integration, interdependence and the threat of contagion in global banking systems in the period leading up to the current Global Financial Crisis? Which banking countries/regions were the major players in the global integration process over that period? What are the policy implications of financial integration for banks and for regulators?

This study makes the assumption that country, regional and world banking systems can be proxied by database time series of banking price indices. The study also takes the view that real contagion refers to the 'domino' effect melt down of financial systems and this has not to this point in time occurred. If governments and central banks had not intervened during 2008/2009 it might have been a different story. It is the continuing threat of contagion in that sense that is important (i.e. the research issue that requires ongoing examination).

The article demonstrates that larger developed country and regional banking systems had achieved a high degree of global financial integration in the period of study. The evidence is demonstrated in pairwise correlation and regression analysis of unlagged data and in pairwise cointegration analysis of optimally lagged data. Pairwise Granger causality analysis initially indicates that the Americas region has been a significant driver of the world banking system. The world banking system has been the driver of other medium, large and smaller developed and less developed country and regional systems (e.g. the EMU, Japan and the UK). Smaller, less developed countries and regions have not been major players in global integration (e.g. Asia, Indonesia and Malaysia) but it is expected that their role will increase over time as macro and micro economic reforms are implemented and as political stability reduces the associated idiosyncratic risks.

When all major developed systems (US, UK, EMU and Japan) are considered together in a single VAR model interacting with the world system in the period prior to the current crisis (rather than pairwise with the world system), impulse response functions and variance decomposition analysis show that the major exogenous force has been the world banking system followed by the USA, the EMU, the UK and Japan systems in that order. When the systems are considered together, depending on which banking system is imparted a hypothetical market shock, they returned to equilibrium together within 6–8 days in the period studied.

Sub-prime mortgage market problems, overheated stock markets and high energy prices early in 2008 have conspired with Western banking sector interdependence to induce the late 2008/2009 Global Financial Crisis. The continuing need is for banks to re-focus on investment, borrowing and lending portfolio diversification and for banking regulators to be vigilant in regulation of banking systems as the process of global financial services liberalization again starts to gather pace. Regulators will need to closely monitor undiversified interdependence. A greater interaction between country central banks and a central global regulatory authority, such as the BIS may rapidly become desirable and necessary. As suggested in the literature review the notion of a global central banking function by the BIS in providing insurance for international interbank deposits is compelling.

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Appendix

Variance decomposition of major banking systems interacting with the world system

Period	S. E.	World	USA	UK	EMU	Japan
World						
1	10.52357	100.0000	0.000000	0.000000	0.000000	0.000000
2	10.88094	97.56188	2.083861	0.013187	0.100409	0.240660
3	10.89407	97.35658	2.254749	0.014847	0.132248	0.241579
4	10.90282	97.32021	2.282198	0.020772	0.135322	0.241502
5	10.90314	97.31624	2.284910	0.021025	0.136334	0.241488
6	10.90320	97.31600	2.284933	0.021201	0.136369	0.241500
7	10.90321	97.31596	2.284949	0.021211	0.136381	0.241500
8	10.90321	97.31596	2.284950	0.021212	0.136381	0.241500
USA						
1	20.03576	68.04352	31.95648	0.000000	0.000000	0.000000
2	20.07247	67.80525	31.88345	0.001485	0.042331	0.267483
3	20.14083	67.78204	31.77657	0.091894	0.070600	0.278901
4	20.14129	67.78049	31.77689	0.091985	0.070877	0.279758
5	20.14160	67.78038	31.77592	0.092881	0.071053	0.279770
6	20.14162	67.78041	31.77588	0.092882	0.071059	0.279771
7	20.14162	67.78040	31.77589	0.092883	0.071059	0.279771
UK						
1	113.6902	42.52570	9.028798	48.44550	0.000000	0.000000
2	118.2655	41.47864	13.34649	44.94167	0.083161	0.150048
3	118.5305	41.30602	13.51562	44.82485	0.180122	0.173381
4	118.6969	41.33547	13.58091	44.71625	0.190459	0.176908
5	118.6987	41.33427	13.58164	44.71545	0.191635	0.177003
6	118.7005	41.33488	13.58162	44.71459	0.191862	0.177051
7	118.7006	41.33488	13.58162	44.71458	0.191870	0.177053
8	118.7006	41.33489	13.58162	44.71458	0.191870	0.177053
9	118.7006	41.33489	13.58162	44.71458	0.191870	0.177053
EMU						
1	9.298883	59.37378	14.48279	0.287103	25.85633	0.000000
2	9.697657	58.88387	16.59258	0.384842	23.82814	0.310568
3	9.749052	58.30684	17.34514	0.394202	23.64484	0.308968
4	9.764854	58.34053	17.37013	0.405652	23.57331	0.310376
5	9.765867	58.33541	17.37474	0.407724	23.57180	0.310321
6	9.766018	58.33579	17.37446	0.408179	23.57118	0.310385
7	9.766031	58.33581	17.37444	0.408212	23.57115	0.310384
8	9.766031	58.33580	17.37444	0.408215	23.57115	0.310385
Japan						
1	4.957695	8.338651	5.915503	8.034805	31.26547	46.44557
2	5.050996	10.49922	5.770991	7.894329	30.13574	45.69972
3	5.058335	10.48137	5.975929	7.885217	30.06486	45.59262
4	5.059613	10.52458	5.973426	7.882194	30.04978	45.57002
5	5.059953	10.53100	5.976445	7.881737	30.04672	45.56410
6	5.059958	10.53102	5.976571	7.881724	30.04667	45.56401
7	5.059963	10.53115	5.976574	7.881730	30.04662	45.56392
8	5.059964	10.53115	5.976577	7.881730	30.04662	45.56392
9	5.059964	10.53115	5.976577	7.881730	30.04662	45.56392
Cholesky ordering						
	1. World	2. US	3. UK	4. EMU	5. Japan	

Notes: Cholesky ordering is described in EViews 4 (2001). When impulses or shocks are orthogonalized, an ordering of the variables in the VAR is imposed and therefore describes the influence of each variable (or the degree of exogeneity) in its contribution to the variance of the endogenous variable and how this changes over time.