Are Banking Shocks Contagious? Evidence from the Eurozone

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Abstract

We test for contagion between banking stocks – global and domestic – and the domestic non-financial sector for eleven Eurozone countries. Using a Markov-switching Factor augmented VAR (MS-FAVAR) model, we assess changes to the transmission mechanism of shocks as we move from 'normal' market conditions to a high-volatility, 'crisis' regime. Results confirm the role of contagion in propagating shocks between the global and domestic banking sectors but show that the non-financial sector suffered little contagion. In general, the non-financial sectors appear to 'de-couple' from the global and domestic banking sectors.

Keywords: Contagion; Shock transmission; Financial market crises.

JEL Classification: G01,G21,C32

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1. Introduction

Financial turbulence within the Eurozone member states has been prevalent since the onset of the global financial crisis (GFC) of 2007-09 and has persisted through the Eurozone sovereign debt crisis. Throughout this period, the financial health of the banking industry has been a persistent difficulty for the common currency zone. The banking problems contributed to the financial and economic downturns in many countries, with domestic governments forced to provide rescue and resolution programmes for their indigenous banking sectors. A central principle of the recovery programmes was that a healthy and well-functioning banking system was crucial to the general economic well-being and necessary to provide the platform for growth in the non-financial sector. Most recapitalisation programmes across the Eurozone were justified by governments as a need to get credit flowing in the domestic economies. Table 1, compiled from data in Laeven and Valencia (2013a), shows the estimated financial and output costs of the banking crisis over the period 2008-2011 for a sample of Eurozone economies. We observe high costs and much heterogeneity across the selected countries. Overall, it's a story of exorbitant costs borne by a number of economies and their taxpayers.

[Insert Table 1 about here]

The goal of our study is to investigate the relationships between banking and non-financial corporations (NFCs) across Eurozone countries before and during the crisis. We analyze the stability of the linkages between the global and domestic banking stocks and the domestic non-financial sectors. Specifically, we are interested if the transmission of shocks is stable between 'normal' and 'crisis' market conditions. The stability of linkages between banks and the non-financial sector of economies is an important issue for investors and policy makers. If banking shocks are contagious, investors in country portfolios will have reduced diversification benefits during the crisis period. Policy makers, who aim to curb the spread of the turmoil, will be concerned about the effects of banking distress on the broader non-financial sector and its ability to withstand a period of financial turbulence.

Our study is motivated by two strands of literature; namely the effects of banking crises on the real economy, and contagion in financial markets following a shock to the banking sector. The seminal work of Bernanke (1983) shows that banking crashes may accentuate downturns in the real economy and lead to or prolong economic recessions.[1] If banking crises exert an influence on the path of economic growth, it would seem a natural extension to investigate their effects on domestic NFCs which will also react to the expected growth with the reaction observed through its share price. Indeed Tong and Wei (2009) identify two channels – finance and demand – through which a crisis can spread to NFCs; the finance channel refers to external funding problems, while the demand channel arises due to lower consumption in a recession. The former is predominantly associated with credit flow disturbances during a banking crisis. These have been shown to have important real economic effects (e.g. Bernanke and Gertler, 1985) with credit restrictions adversely affecting non-financial firms that are unable to substitute bank loans for other forms of external financing (Peek et al., 2003 and Laeven and Valencia, 2013b, among others). Kiyotaki and Moore (1997) show how credit-constrained firms may be forced to sell assets (which also act as factors of production in their model) to unconstrained firms, resulting in falling asset prices. Asset price declines further impinge on their ability to access credit markets, creating a strong link between credit restrictions and asset prices. This transmission mechanism has the potential to generate negative consequences for the non-financial sector, especially firms that are dependent on external financing. However, Adrian et al. (2012) find that during the recent crisis, U.S. firms were able to source direct debt funding on the bond market to compensate for the curtailment

[1] A voluminous literature exists on the relationship between banking crises and economic growth. We do not attempt to review this literature here but the reader is referred to Reinhart and Rogoff (2009) and Dwyer et al. (2013) for reviews and alternative views.

in intermediated bank loans. It is shown that the adverse effects of the crisis were driven by a general jump in risk premiums rather than bank loan restrictions.

The second strand of literature to which our study relates is that of financial market contagion or shock transmission in the immediate aftermath of a banking crisis. Again, this topic has attracted much attention and tends to focus on the international transmission of banking shocks. Due to the highly integrated nature of the international banking industry, (see Bekaert et al., 2009), it is important to distinguish between 'normal' levels of asset comovements (interdependence) and those that are excessive or unpredictable during a crisis period (see Forbes and Rigobon, 2002). A rigorous study, covering 54 countries, by Dungey and Gajurel (2015) finds widespread evidence of contagion following the U.S. banking crisis. Gropp et al. (2009) use micro-level bank data for European countries and similarly finds evidence of contagion within the Eurozone. Fry-McKibben and Hsiao (2015) apply new tests of contagion to a sample of eight countries and conclude that contagion among international banking sectors was prevalent after the U.S. crisis.

Despite the evidence of contagion between international banks, relatively little attention has been afforded to the propagation of banking shocks to other sectors of the stock market. Exceptions are Bekaert et al. (2014) and Dungey and Renault (2015). The former tests for contagion from a U.S. factor, a global financial factor and a domestic factor to a wide range of country and industry portfolios. They find widespread evidence of contagion, with the domestic factor outweighing the other factors as the main source of contagion for many regions and industries. The latter analyze the transmission of banking shocks to a number of selected sectoral indices within the U.S. and find mixed evidence of contagion.[2] This issue is again the focus of this paper. We address the issue over a longer time period and

[2] Grammatikos and Vermeulen (2012) look at the crisis transmission from U.S. to European financials and U.S. to European non-financials, providing evidence of the latter but not the former. However, they do not look at the cross-sectoral effects.

concentrate on a group of Eurozone countries. We apply a different econometric approach, with the crisis regime selected endogenously.

We employ a Markov-switching factor-augmented vector autoregression (MS-FAVAR) model to analyze the stability of the relationships between the global and domestic banking stocks and the domestic non-financial sectors for eleven Eurozone countries. The factor is extracted from a broad range of shocks to international banking stock indices and is thus a proxy for global conditions. This model is well suited to addressing our question as it allows us to parsimoniously distinguish between external and internal banking conditions and to better identify potential sources of instability. We incorporate the factor augmented VAR within a Markov-switching framework, and generate regime-dependent impulse response functions (IRFs) to assess the stability of responses between regimes. Thus we are able to jointly assess the stability of relationships between global and domestic banks; global banks and domestic NFCs; and domestic banks and domestic NFCs.

Our results suggest that the shock transmission is often not constant across regimes but interestingly, patterns of contagion, interdependence and 'de-coupling' vary by the pair of markets analysed. Our regime-specific IRFs suggest that for many countries, there is a more intensive shock transmission (contagion) between the global banking factor and the domestic banking sector. Secondly, there is evidence of instability in the responses of the non-financial sectors to shocks to the global banking factor and the domestic banking sector. However, this change is more consistent with a de-coupling (lower comovement) of the sectors than with contagion.

The remainder of the paper is structured as follows. Section 2 presents the econometric methodology and describes how contagion or 'de-coupling' is identified. Section 3 describes the data and presents summary statistics. Our empirical results are discussed in section 4. Section 5 presents a robustness check, while section 5 concludes.

2. Econometric Methodology

We adopt a Markov-switching factor-augmented vector autoregression (MS-FAVAR) model to conduct our analysis. The FAVAR model was first introduced by Bernanke et al. (2005) to overcome problems of dimensionality encountered in empirical models of monetary policy and has more recently been applied to issues of spillover and contagion in financial markets by de Bandt and Malik (2010) and Claeys and Vasicek (2014). Our motivation for using this approach stems from the need to parsimoniously represent the non-domestic banking sector. The factor is a proxy for external banking conditions.

We incorporate the FAVAR within a Markov-switching approach. A number of studies of contagion have employed Markov-switching models, e.g. Gravelle et al. (2006); Flavin and Panopoulou (2009); and Mandilaras and Bird (2010) among others. Furthermore, the recent theoretical contribution of Acemoglu et al. (2015) shows how instability may arise due to different market conditions. They show that a highly-integrated network like the global banking system can exhibit different behavior beyond some threshold level of either the number or magnitude of shocks. They demonstrate how properties of the network that act as shock absorbers in ‘normal’ times, can actually make the system vulnerable to contagion and systemic risk in ‘crisis’ periods. Thus, the class of Markov-switching models appears ideally suited to empirically capture such instability.

In particular, we follow Ehrmann et al. (2003) who show how to generate regime-dependent IRFs in a Markov-switching VAR. This allows us to study the stability of the dynamics of shocks between regimes. The implementation of the model is done in two stages; firstly we extract a common shock from a set of banking stock returns; and secondly, this is included in a Markov-switching VAR from which we generate the IRFs. We discuss each stage in greater detail below.

2.1 Extracting the common factor

To detect contagion between the banking and the domestic non-financial sectors, we must first properly disentangle external and domestic banking shocks. Given the turmoil across the international banking sector during the period, this is crucial so as not to overestimate the spillover to the non-financial sector from the domestic banking sector.

In our analysis of market *j*, we extract a common shock from the banking returns of the other ten Eurozone countries plus the UK and the US. The US and the UK are included as they both suffered major shocks to their banking industries and are likely to have generated much of the negative returns and volatility experienced by the sector. Since we are interested in the shock component of the returns we first run a standard model of the returns and retrieve the vector of residuals. We then perform a principal components based factor analysis of the correlation matrix of residuals and use the first principal component as our common external shock.

2.2 Estimating the MS-FAVAR

We estimate a three-variable VAR model in a Markov-switching framework for each country. For country *j*, we include the external banking shock (described above) and the shocks to the returns of the domestic banking and non-financial sectors. As in all VAR models, we must make a choice regarding the ordering of the variables since this determines which variables will be subject to contemporaneous shocks from other variables in the system. Given our focus on the transmission of banking shocks, we specify the dependent vector of variables for country *i* as

$$y_{i,t} = \{\text{global factor, bank shock}_i\text{, NFC shock}_i\}_t.$$

Hence, shocks to the global factor affect all variables contemporaneously with the domestic banking shock similarly affecting the domestic NFC sector.

The shocks to the domestic returns are proxied by the residuals from a first order VAR model with exogenous variables included to capture global stock market and liquidity conditions. For country i, the model can be written as:

$$r_{j,t} = \alpha_j + \rho r_{j,t-1} + \sum_{k=0}^{1} \beta_i r_{w,t-k} + \sum_{k=0}^{1} \gamma_j \Delta TED_{t-k} + \xi_{j,t} \quad (1)$$

where r_j (j =banks, non-financials), r_w and ΔTED represent the sectoral returns, the market portfolio returns and the change in liquidity respectively.[3]

We then proceed to estimate the following MS-FAVAR model:

$$y_{i,t} = \lambda(s_t) + \sum_{1}^{p} \theta_p(s_t) y_{i,t-p} + \varepsilon_{i,t}^{st} \quad (2)$$

$$S_t \in \{1,2\}$$

$$\varepsilon_{i,t}^{st} \sim i.i.d.(0, \sigma_s^2)$$

where $y_{i,t}$ is a 3x1 vector as defined above. The regression constant (λ), the matrix of autoregressive coefficients (θ) and the covariance matrix of residuals (σ) are all regime-dependent. S_t is the unobservable latent variable governing the regime path, which takes a value of unity in 'normal' market conditions (low asset volatility) and a value of 2 in 'crisis' (high-volatility) episodes. Following the regime-switching literature, the regime paths are Markov switching and are endogenously determined. The conditional probabilities of remaining in the same state are defined as follows:

$$\begin{aligned} \Pr[S_t = 1 \mid S_{t-1} = 1] &= p_{11} \\ \Pr[S_t = 2 \mid S_{t-1} = 2] &= p_{22} \end{aligned} . \quad (3)$$

The model is estimated using a Bayesian Markov-chain Monte Carlo (MCMC approach). We first specify the prior distributions for the parameters. For the variances, we employ a Wishart distribution, the VAR coefficients have a flat prior and we use a weak Dirichlet prior for the transitions, with a preference towards remaining in the same state.

[3] The TED spread is the difference between the interest rate on interbank loans and short-term U.S. Treasury bills. It is an often used proxy for market liquidity.

Using Gibbs sampling, we estimate the parameters and regimes in the following sequence;

Step 1: We draw the sigmas, given the mean coefficients and regimes.

Step 2: We draw the mean coefficients ($\boldsymbol{\lambda}$ and $\boldsymbol{\theta}$) given sigmas and regimes.

Step 3: We draw the regimes, given the sigmas and mean coefficients.

Step 4: We draw the transition parameters.

This sequence of steps is repeated 10,000 times after discarding an initial 'burn-in' set of 2000 replications. Once we have obtained our estimated parameters, we generate the regime-dependent IRFs and their associated confidence bands. The IRFs are the Choleski factors standardized to unit variances. This facilitates a comparison of the differences in dynamics rather than the differences in variances, since what we are interested in is the stability of the shock transmission between regimes. We interpret a statistically significant increase in the response of variable j to a shock to variable i in the crisis regime as contagion from i to j. On the other hand, a statistically significant decrease constitutes 'de-coupling'. If the IRF is unchanged between regimes, this is interdependence.

3. Data

Our data consists of daily stock returns for the banking and non-financial sectors of eleven Eurozone countries plus the UK and the US. The UK and the US are included to give broad coverage of external (or non-Eurozone) events that potentially exerted common shocks throughout the global banking system. All data are sourced from Datastream and we use Datastream-constructed indices to represent the sectors under investigation. The indices have the form BANKS+CC (for the banking sector) and TOTLI+CC (for the non-financial sector) where CC represents the country-specific suffix. The full set of countries analyzed are Austria (AUT), Belgium (BLG), Finland (FIN), France (FRA), Germany (GER), Greece (GRC), Ireland (IRE), Italy (ITA), the Netherlands (NLD), Portugal (PTG), Spain (ESP), the

UK (UK) and the US (US). Furthermore, we proxy for developments in global stock markets and funding / liquidity markets by including a Datastream-constructed world market portfolio (TOTMKWD) and the TED spread (the difference between rates on interbank loans and short-term US government Treasury bills) respectively. The latter is obtained from the database of the Federal Reserve Board. Our sample begins on January 1, 2004 and runs until March 31, 2015. The starting point is chosen to avoid contamination with earlier crises such as the bursting of the Dot.com bubble or the collapse of the LTCM hedge fund. Table 2 presents summary statistics for the variables employed in the analysis.

[Insert Table 2 about here]

Panels A and B of Table 2 refer to banking sector and non-financial stock returns respectively. There are striking differences between the bank returns and those on the non-financial sectors. The mean return on non-financials is positive in every country, while returns to banking stocks are, on average, negative for nine of the thirteen countries in our sample. Finland records the highest average daily return while Irish and Greek banks have the largest negative returns. In fact, Finland is the only country whose banking stocks record a higher mean return than their non-financial counterparts over the period. Banking stocks are also more risky, with a higher standard deviation for this sector compared to the non-financials in every country. Among the Eurozone countries, particularly high levels of risk are observed in states where banks had to be bailed out by domestic governments such as Ireland, Belgium, the Netherlands and Greece. Spain is an exception since it was predominantly a large number of small banks that required state support while the larger banks performed relatively well. Non-financial firms in Belgium performed particularly well over the sample, recording the highest average return and the lowest standard deviation of return. Also in this sector, Greek firms have the smallest mean and largest risk measure. Furthermore, all returns (for both sectors) exhibit skewness and strong evidence of kurtosis.

The prevalence of fat tails suggests that modeling these returns in a Markov-switching framework may be a better approach than in a single state setting.

4. Discussion of results

4.1 Results of the MS-FAVAR model

A three-variable MS-FAVAR model is estimated for each Eurozone country. Table 3 presents an overview of the model specification and some statistics for the identified regimes.

[Insert Table 3 about here]

Firstly, the global or common banking factor extracted in the principal components analysis represents about 50% of the total variation in banking stocks across the sector. It varies from a low of 48% in the model for France to a high of 53% in the specifications for the Netherlands and Greece. In general, the factor loadings on this first principal component are roughly equal, suggesting that common factors influenced banking stocks across our sampled countries. The number of lags included in the country-specific MS-FAVAR varies between one and two and is selected using the Hannan-Quinn information criterion.

We report 'Frequency' and 'Duration' statistics for the high-volatility regime. 'Frequency' measures the proportion of the time that the system spends in the 'crisis' regime. It varies substantially across countries, with Greece being in this high-volatility state for over half the sample (53%). Portugal also suffers a prolonged crisis with the turbulent regime prevailing for almost 45% of the sample. Next, there is a club of countries who spend roughly one-third (30%-36%) of the time in a crisis state, and this includes Belgium, Ireland, Italy, the Netherlands and Spain. At the other extreme, the country for which the crisis is least common is Germany, with less than 20% of the time spent in the high-volatility regime. 'Duration' captures the persistence of the high-volatility shock. On average, across countries, a high-volatility shock persists for nearly 9 days but ranges from 5 days in the case of Finland to almost 14 days in the model for Greece.

4.2 Conditional correlations.

Next, we analyze the regime-specific correlations, generated by the MS-VAR model, for each pair of variables. Though not a statistical test for the stability of relationships, they provide an overview of the comovement changes between regimes. Table 4 presents the correlations.

[Insert Table 4 about here]

Firstly, we focus on the relationship between the global banking factor and returns on the domestic banking sector. We observe great heterogeneity across countries, with six (five) countries exhibiting increased (decreased) comovement. Interestingly, countries whose domestic banks suffered large declines, like Ireland, Spain, and the Netherlands, appear to become more idiosyncratic during the crisis. The largest change is recorded for the Netherlands and appears to be driven by a large downward jump in the banking index, coinciding with the Dutch government bailout of ING in October 2008. While Greece exhibits an increase in correlation in the crisis regime, it is noteworthy that it is much less correlated with the global factor than any of its Eurozone partners in both states.

The change in correlation between the global banking factor and domestic NFCs shows similar dispersion and heterogeneity. No clear pattern emerges, but results suggest that for the majority of countries domestic NFCs become more de-coupled from the global banking industry.

Finally, we turn to the regime-specific comovements of the domestic banking and NFC sectors. Here a much clearer pattern emerges, with the vast bulk of countries showing a decline in correlation as we move from ‘normal’ market conditions to the ‘crisis’ regime. The relatively lower levels of comovement during the crisis are especially evident for Germany and the Netherlands. This preliminary investigation offers comfort to investors in country portfolios in that it suggests that adverse shocks to a country's banking sector can be diversified away to some degree by holding the stocks of NFCs from that same country.

4.3 Impulse Response Functions – effects of banking shocks

To test for contagion, and to better understand the contemporaneous impact of shocks and their persistence, we generate regime-dependent IRFs for each of the estimated models. This allows us to analyze the stability of market linkages between the two regimes. Firstly we focus on the effects of a shock to the global banking factor. Figure 1 presents the IRFs, with 95% confidence bands, for the domestic banking sectors to a unit shock in the global factor.

[Insert Table 5 and Figure 1 about here]

During 'normal' market conditions, the domestic banking sectors of all countries react positively, i.e. in the same direction, to a shock to the global banking factor. However, the response is relatively muted and ranges from 0.04 to 0.08. As we move to a 'crisis' episode, there is evidence of contagion from the global factor to the domestic banking sectors in Belgium, Finland, Ireland, Greece and Portugal. All exhibit an increased contemporaneous response to a shock in the global banking sector. This is particularly strong in Ireland, with the Irish banking sector being more sensitive to world banking conditions than the other countries. However, interdependence is a better characterization of the relationship between the global factor and the domestic banking sectors in France, Germany and Italy as there is no statistical difference in the contemporaneous response. Finally, the banking sectors of Austria, the Netherlands and Spain have a tendency to 'de-couple' from global events and all appear less sensitive to global events during the crisis. Our results confirm the existence of the international transmission of banking contagion as reported in Dungey and Gajurel

(2015).[4] Our results are similar in many respects with more evidence of contagion in the smaller markets. In both studies, France and Italy exhibit interdependence to common shocks, while both Spain and the Netherlands become less responsive during a crisis period.

Blatt et al. (2015) show that changes to market linkages may not always be immediate following a shock in one market and show that changes to the dynamics of relationships can often occur without a contemporaneous effect. Our methodology allows us to detect these types of changes. The dynamics of the relationship change between 'normal' and 'crisis' conditions for many counties. Contagion effects are compounded by increased shock persistence in Belgium, Greece and Portugal. Though, showing no immediate change between regimes, France and Italy also exhibit increased persistence during the crisis, while for Austria, the benefits of 'de-coupling' are partially offset by increased persistence of the shock. In summary, only Germany (interdependence), Spain and the Netherlands (de-coupling) avoid any negative repercussions from the global factor during a crisis.

[Insert Figure 2 about here]

Figure 2 shows the response of the domestic non-financial sector to a shock in the global banking factor. In the 'normal' regime, all domestic NFC indices respond to a global bank shock by moving in the same direction, though the magnitude of the reaction is dampened relative to the domestic banking sector. When we analyze the stability of linkages between regimes, a more consistent pattern emerges. There is a clear 'de-coupling' of domestic NFCs from the global banking factor in the vast majority of countries during the crisis regime. The NFCs appear to be less sensitive to global banking conditions in the turbulent state. This result is most pronounced for the larger economies of Germany, France and Spain. Only Portuguese NFCs appear to suffer contagion from international banking shocks, while Austria and Greece exhibit interdependence.

[4] In their study, they do not differentiate between contagion and de-coupling as we do. So any statistically significant changes to coefficients during the crisis period are interpreted as contagion.

There is also evidence of a change in dynamics with a slower reversal (greater persistence) of shocks recorded for Belgium, France, Greece, Italy and Portugal during the crisis. The benefits of the reduced contemporaneous effect in Germany are further enhanced by a quicker reversal of the shock in the turbulent regime. Overall, domestic NFCs are less sensitive to external banking shocks than their domestic banking counterparts.

We now turn to the effects of a domestic banking shock on the domestic NFCs. Figure 3 presents the IRFs.

[Insert Figure 3 about here]

First, it is worth noting that the NFC sector in every country is more sensitive to domestic banking shocks than common external banking disturbances. This suggests that non-financial firms largely rely on domestic banks for intermediated loans. This reaction is most strongly observed in Greece and Spain but, consistent with the evidence for the global bank shock, a positive contemporaneous correlation is observed during normal regimes across all countries. Focusing on the differences between regimes, the evidence is strongly against the presence of contagion. Normal levels of interdependence prevail in Austria and Italy, while there is clear evidence of de-coupling in each of the other nine countries. The contemporaneous response of the domestic NFC sector is dampened in a crisis relative to 'normal' market conditions. The difference in the response is often quite large, e.g. the Netherlands and Germany, implying that NFCs are able to avoid much of the impact of adverse domestic banking shocks.

Compared to the propagation of the global bank shock, there is less evidence that the dynamics of the relationship change. We find less persistence in Finland, Italy and Portugal to reinforce the contemporaneous 'de-coupling' result, while only for Belgium is there evidence of the weaker linkage being offset by greater persistence. The relationship dynamics are unchanged in all other countries.

Combining the evidence from Figures 1-3 (Table 5 provides a summary), we conclude that, while banking shocks are contagious between international banking sectors, there is little evidence to suggest that contagion spread to the non-financial sectors of Eurozone countries during this deep and prolonged financial crisis. On the contrary, there is strong evidence of reduced sensitivity to banking shocks among Eurozone NFCs. This finding is consistent with Laeven and Valencia (2013b), Bekaert et al. (2014) and Dungey and Renault (2015) who attribute this partly to the success of government interventions in 'disconnecting' banks from the real economy during the crisis. Though we don't have any direct evidence of changes in debt composition, our results suggest that Eurozone NFCs were able to overcome credit flow restrictions during the banking crisis. This is consistent with U.S. studies which show that NFCs were able to replace bank loans by sourcing direct financing on bond markets (e.g. Adrian et al., 2012 and Becker and Ivashina, 2014).

Our results are remarkably robust across countries given the large differences in industrial composition of the non-financial sectors across Eurozone member states. Therefore diversifying a country portfolio between these two sectors will help offset some of the banking risk, with the diversification strategy yielding the greatest benefits when most needed through the observed de-coupling of sectors.

4.4 Impulse Response Functions – restricted (non-contemporaneous) shocks

Due to the ordering of our variables in the VAR model, a number of shocks have to be restricted to have a zero contemporaneous effect. We analyze their dynamic responses. Results for all the remaining cross-sectoral shocks are summarized in Panel A of Table 6. Firstly, Figure 4 shows the response of the global banking factor to a shock in the domestic banking sector.

[Insert Table 6 and Figure 4 about here]

In the non-crisis regime, a shock to the domestic sector elicits a negative lagged reaction in all countries, though this response is often not statistically significant. In most cases, there is no statistically significant difference in the response between regimes. However, some countries do buck the trend and these tend to be the countries which suffered significant banking problems. Shocks to the domestic banking sectors in Belgium and Ireland have a negative effect on the global banking factor during 'normal' market conditions but this becomes statistically significantly positive during the 'crisis' regime. Spain exhibits a similar pattern but the crisis-regime reaction is not statistically different from zero. This feedback effect is important in analyzing the effect of domestic bank shocks as it shows that even small economies with severe banking shocks can contribute to the global banking turmoil.

Secondly, we concentrate on the shocks to the domestic NFC sector. Figure 5 presents the IRFs for the global banking factor.

[Insert Figure 5 about here]

In general, and in both regimes, we find that the feedback between the variables tends to generate a negative response one period ahead and then die out. In many cases, the magnitude of the negative effect is greater during the crisis and is statistically significantly larger in the cases of Austria, Finland, Ireland, Italy, the Netherlands and Spain. Again this is consistent with the 'de-coupling' of the two variables and offers diversification benefits to investors. Furthermore, it suggests that the non-financial sector performance in most countries was not an exacerbating factor during this particular banking crisis.

Finally, in this subsection we analyze the responses of the domestic banking sector to a shock in the domestic non-financial sector (Figure 6).

[Insert Figure 6 about here]

A clear pattern emerges here. For most countries, the feedback effect is positive in 'normal' conditions and negative during the 'crisis', with both effects being statistically significant.

The exceptions are in Finland and France, where the response is negative in both regimes and not statistically different from each other; and in the Netherlands where there is a positive effect in both regimes, though the response in the 'crisis' period is not statistically different from zero. All the evidence is consistent with lower (or unchanged) levels of comovement following a shock to the domestic non-financial sector and implies that during this crisis, bank problems were more likely to be offset, rather than exacerbated, by the performance of domestic NFCs. The potential negative spiral outlined in Kiyotaki and Moore (1997) doesn't appear to have occurred during this turbulent period. Overall, results indicate that country portfolios diversified between banking and non-financial stocks enjoy risk reduction benefits during episodes of high-volatility.

4.5 Impulse Response Functions – own shocks

For completeness, we present the regime-dependent IRFs for the own shocks. Panel B of Table 6 summarizes these results. Differences to the transmission of these shocks between regimes tend to be small and not statistically significant. Figure 7 presents the evidence for global bank factor. There is no change recorded for any country. Figure 8 contains the IRFs for the domestic banking sectors. In general, there is no change between regimes but Ireland, the Netherlands and Spain are exceptions with evidence of increased persistence during the market turbulence. All of these countries had significant problems in their banking sectors and required substantial interventions from their domestic governments. Finally, Figure 9 shows the IRFs for the domestic NFC sector. In contrast to the banking sectors, there is evidence of a change between regimes for a number of countries, with lower persistence (i.e. quicker reversion) of shocks (i.e. quicker reversion) in the crisis regime. Admittedly, the economic significance of these changes is small.

[Insert Figures 7-9 about here]

5. Conclusions

Banking collapses are often associated with adverse consequences in the wider economic and financial environments. We assess the impact of banking shocks, both external and domestic, on the non-financial sectors of a number of Eurozone countries over the period 2004-2015. In particular, we test for the stability of financial linkages between international and domestic banks and both of their relationships with the domestic non-financial sector. We concentrate on the Eurozone countries, where many suffered large negative shocks to their banking systems. From our results, we can distill a number of noteworthy findings.

Firstly, external banking shocks generated contagious effects for the domestic banking sectors of many Eurozone countries, especially the smaller markets where feedback effects from the worst affected member states tended to reinforce the global factor and contribute to the persistence of the international banking turmoil. Secondly, NFCs are more sensitive to domestic banking shocks, but both external and domestic banking turmoil tends to lead to a 'de-coupling' with the non-financial sector. Non-financial sectors across the Eurozone show a more muted reaction to banking shocks in the crisis regime relative to 'normal' market conditions. Thirdly, feedback effects from NFC shocks to the banking variables also decrease lagged comovements between the sectors. This is particularly evident with relation to domestic banks with the sign of the response changing from positive to negative as we transit from a normal to a crisis regime. Hence, the domestic NFC sector provides a useful hedge against banking shocks, both global and domestic. Finally, our results are consistent with domestic NFCs being able to access other forms of capital or at least not being reliant on intermediated bank loans. A caveat is that our non-financial corporations are all exchange-listed firms and are relatively large in their domestic economies, so it's still possible that smaller, bank-dependent enterprises may have suffered due to credit flow disruptions. However, it is reassuring for portfolio managers who manage 'country portfolios' that large banking shocks (as experienced in the Eurozone) can be partially diversified away by holding the stocks of non-financial firms.

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Table 1: Estimated Costs of Banking Crises for selected Eurozone countries

	Output Loss	**Fiscal Cost**
Austria	13.8	4.9
Belgium	19.1	6.0
France	23.6	1.0
Germany	12.1	1.8
Greece	43.1	27.3
Ireland	105.3	40.7
Italy	33.2	0.3
Netherlands	23.0	12.7
Portugal	36.8	0.0
Spain	38.7	3.8

Notes: This table is compiled from figures in the appendix (Table A1) of Laeven and Valencia (2013). From our sample, only Finland does not appear in this Table as it is deemed to have not suffered a banking crisis starting in 2008. Both output and fiscal losses are expressed as a percentage of GDP. The output loss is the cumulative loss from trend real GDP between T and T+3. Fiscal costs cover gross fiscal outlays related to restructuring the financial sector. Full details are provided in Laeven and Valencia (2013), pp 259.

Table 2: Summary Statistics

Panel A: Banking Stock Returns				
	Mean	**Std. Dev**	**Skewness**	**Kurtosis**
Austria	0.0041	2.2638	-0.185	5.2985
Belgium	-0.0035	2.6652	-0.4309	9.7803
Finland	0.0566	2.136	0.1575	10.4334
France	0.0114	2.2865	0.3087	7.6767
Germany	-0.0113	2.0258	-0.0379	11.2752
Greece	-0.1378	3.3755	0.0060	7.6254
Ireland	-0.0842	4.3709	-1.45	37.572
Italy	-0.002	2.1109	-0.1161	4.7339
Netherlands	-0.0393	2.2532	-4.7409	99.1813
Portugal	-0.0535	2.1532	0.0944	6.1827
Spain	0.0178	1.9542	0.4462	9.8685
UK	-0.0094	1.9341	-0.1112	15.3589
US	-0.0019	2.3739	0.1347	17.3561
Panel B: Non-Financial Stock Returns				
Austria	0.0337	1.2316	-0.4276	6.6764
Belgium	0.0594	1.0535	-0.3320	4.4304
Finland	0.0227	1.4779	-0.1834	4.8460
France	0.033	1.1673	0.0347	8.2581
Germany	0.0402	1.2022	1.0284	28.9875
Greece	0.0053	1.5269	-0.2143	5.0090
Ireland	0.0402	1.2869	-0.7909	6.8867
Italy	0.0239	1.2408	-0.1187	7.1506
Netherlands	0.0346	1.1815	-0.4429	8.5255
Portugal	0.0237	1.133	-0.21681	10.0376
Spain	0.0378	1.1831	-0.1031	5.8661

Notes: This Table presents summary statistics for all the sectoral returns used in the study.

Table 3. Details of Model and Regimes

	Percentage of variance explained by 1st PC	No of lags in MS-VAR	Duration of Crisis Regime	Frequency of Crisis
Austria	50.42	1	8.0	23.3
Belgium	49.02	1	9.8	36.4
Finland	51.89	1	5.3	27.4
France	47.99	2	11.2	22.6
Germany	48.97	2	6.6	19.3
Greece	53.20	1	13.7	52.9
Ireland	52.33	2	7.0	31.9
Italy	48.64	1	8.6	35.2
Netherlands	53.27	1	7.8	34.8
Portugal	51.50	1	8.2	44.5
Spain	48.80	1	10	29.6

Notes: We present information on our model specification and the frequency and persistence of regimes. Column 2 reports the proportion of the variance of banking stocks in the UK and the US plus the other *'n-1'* Eurozone countries that is explained by our global factor. Column 3 tells us the number of lags included in the MS-FAVAR model. Columns 4 and 5 present statistics about the regimes. Frequency measures the proportion of time that each country spends in the 'crisis' regime, while Duration measures the length of time (in days) for which the shock persists. Frequency and Duration are calculated as $(1-p_{11})/(2-p_{11}-p_{22})$ and 1/(1-p22) respectively with p_{11} and p_{22} as defined in Eq. 3.

Table 4. Regime-specific correlations

	Global Bank factor & Domestic Banks		Global Bank factor & Domestic NFCs		Domestic Banks & Domestic NFCs	
	Normal	**Crisis**	**Normal**	**Crisis**	**Normal**	**Crisis**
Austria	0.506	0.505	0.359	0.399	0.451	0.546
Belgium	0.482	0.559	0.354	0.313	0.402	0.293
Finland	0.356	0.450	0.364	0.299	0.391	0.383
France	0.659	0.610	0.494	0.380	0.631	0.524
Germany	0.519	0.536	0.442	0.202	0.558	0.247
Greece	0.199	0.228	0.172	0.240	0.653	0.616
Ireland	0.392	0.342	0.335	0.332	0.402	0.242
Italy	0.548	0.568	0.463	0.446	0.630	0.658
Netherlands	0.348	0.142	0.394	0.428	0.428	0.171
Portugal	0.319	0.415	0.217	0.411	0.474	0.467
Spain	0.602	0.523	0.524	0.451	0.764	0.722

Notes: This presents the regime-dependent pairwise correlations generated by our MS-FAVAR model.

Table 5: Summary of Results of Banking Shocks

	Panel A: Contemporaneous Effects		
	Global to Domestic Banks	**Global to Domestic NFCs**	**Domestic Banks to Domestic NFCs**
Austria	D	I	I
Belgium	C	D	D
Finland	C	D	D
France	I	D	D
Germany	I	D	D
Greece	C	I	D
Ireland	C	D	D
Italy	I	D	I
Netherlands	D	D	D
Portugal	C	C	D
Spain	D	D	D
	Panel B: Change to Persistence of Shock		
Austria	+	0	0
Belgium	+	+	+
Finland	0	0	-
France	+	+	0
Germany	0	-	0
Greece	+	+	0
Ireland	0	0	0
Italy	+	+	-
Netherlands	0	0	0
Portugal	+	+	-
Spain	0	0	0

Notes: This Table summarises the information from the regime-dependent IRFs for the shocks allowed to have contemporaneous effects (Figures 1-3). In panel A, ‘C’, ‘I’ and ‘D’ represent ‘contagion’, ‘interdependence’ and ‘de-coupling’ respectively. In panel B, we show changes to the persistence of a shock in the ‘crisis’ regime relative to the ‘normal’ regime. An increase in persistence is marked with ‘+’; a decrease with ‘-’, while 0 implies no change.

Table 6: Summary of Results for 'Non-contemporaneous' and 'Own' Shocks

	Panel A: Non Contemporaneous Shocks		
	Domestic Banks to Global Factor	**Domestic NFCs to Global Factor**	**Domestic NFCs to Domestic Banks**
Austria	0	-	-
Belgium	+	0	-
Finland	0	-	0
France	-	0	0
Germany	0	+	0
Greece	0	0	-
Ireland	+	-	-
Italy	0	-	-
Netherlands	0	-	0
Portugal	0	0	-
Spain	+	-	-
	Panel B: Own Shocks		
Austria	0	0	-
Belgium	0	0	-
Finland	0	0	-
France	0	0	0
Germany	0	0	-
Greece	0	0	0
Ireland	0	+	0
Italy	0	0	-
Netherlands	0	+	-
Portugal	0	0	-
Spain	0	+	0

Notes: This Table summarises the information from the regime-dependent IRFs for the shocks restricted to have zero contemporaneous effects (Figures 4-6) and 'own' shocks (Figures 7-9). We show changes to the persistence of a shock in the 'crisis' regime relative to the 'normal' regime. An increase in persistence is marked with '+'; a decrease with '-', while 0 implies no change.

Figure 1. Response of Domestic Banks to a Global Banking Shock

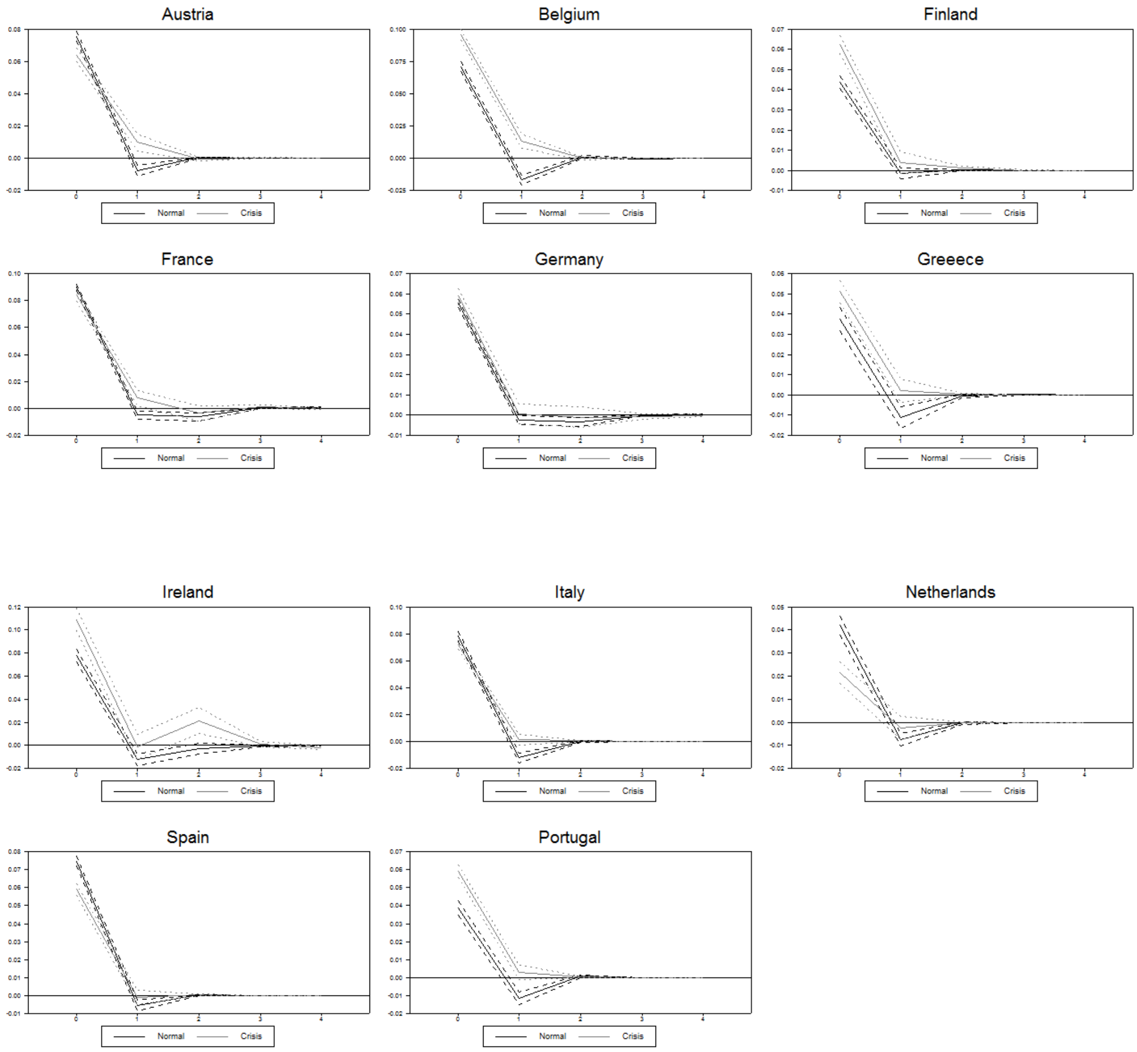

Figure 2. Response of Domestic NFCs to a Global Banking Shock

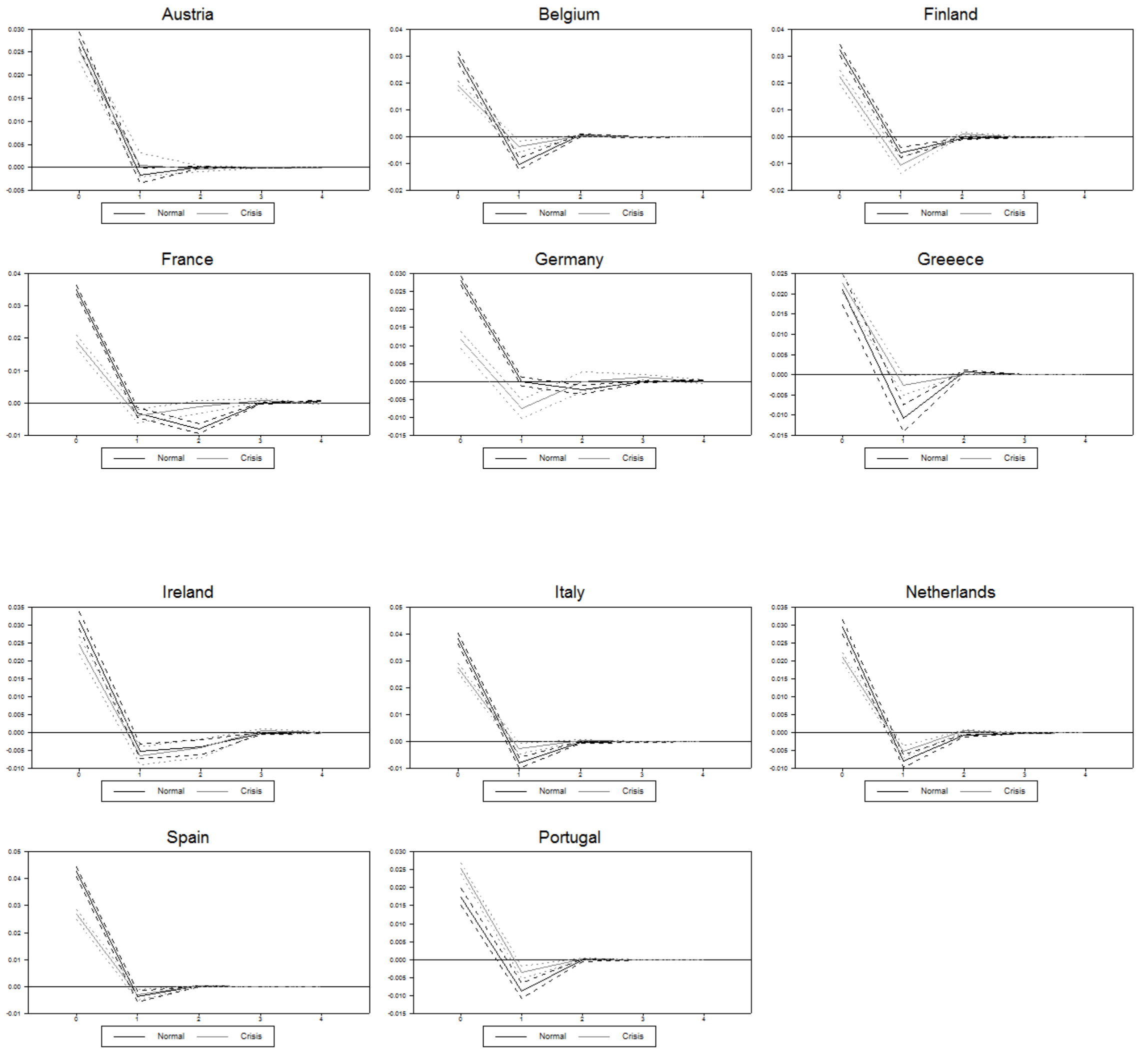

Figure 3. Response of Domestic NFCs to a Domestic Banking Shock

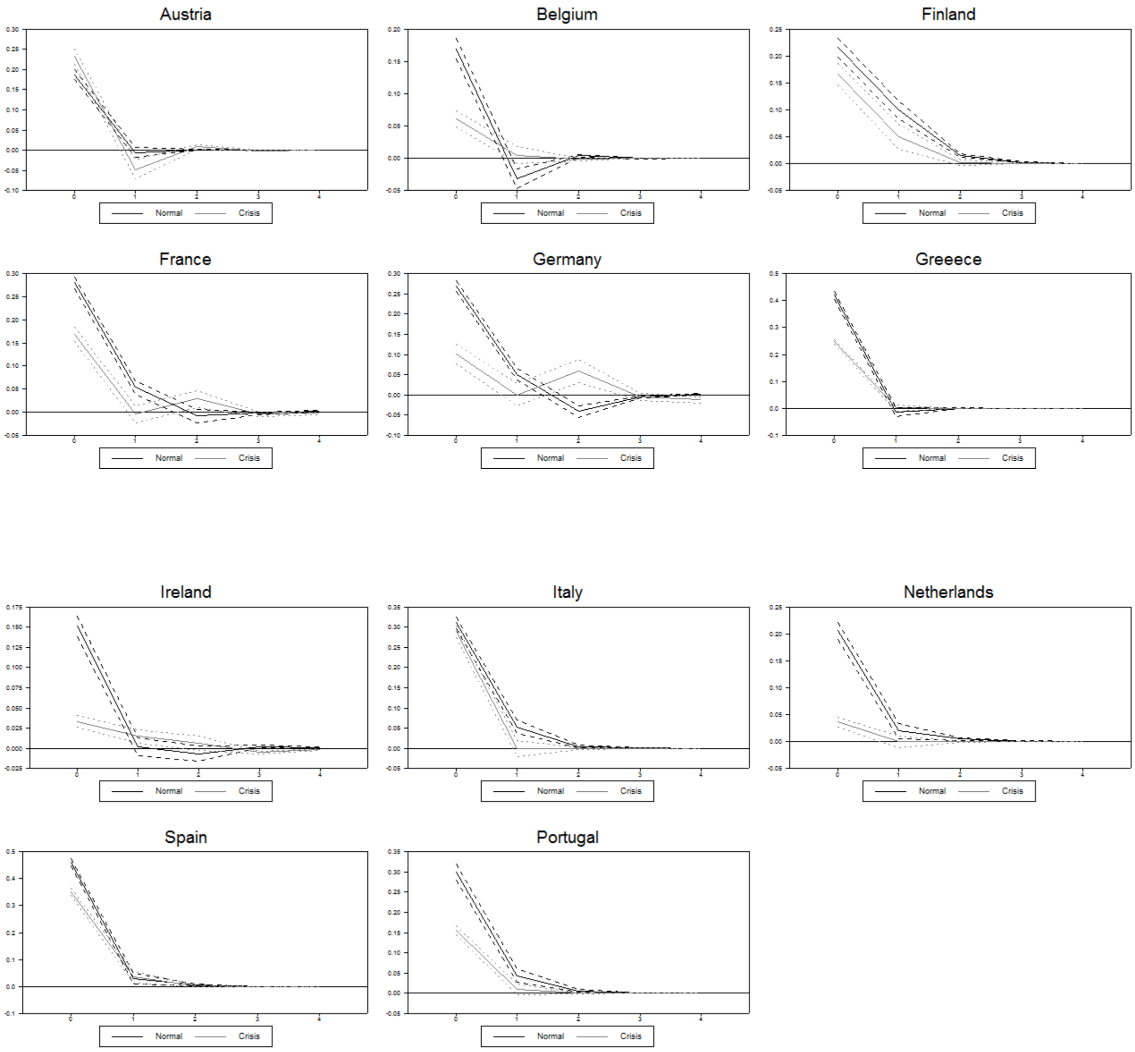

Figure 4. Response of Global Bank Factor to Domestic Bank Shock

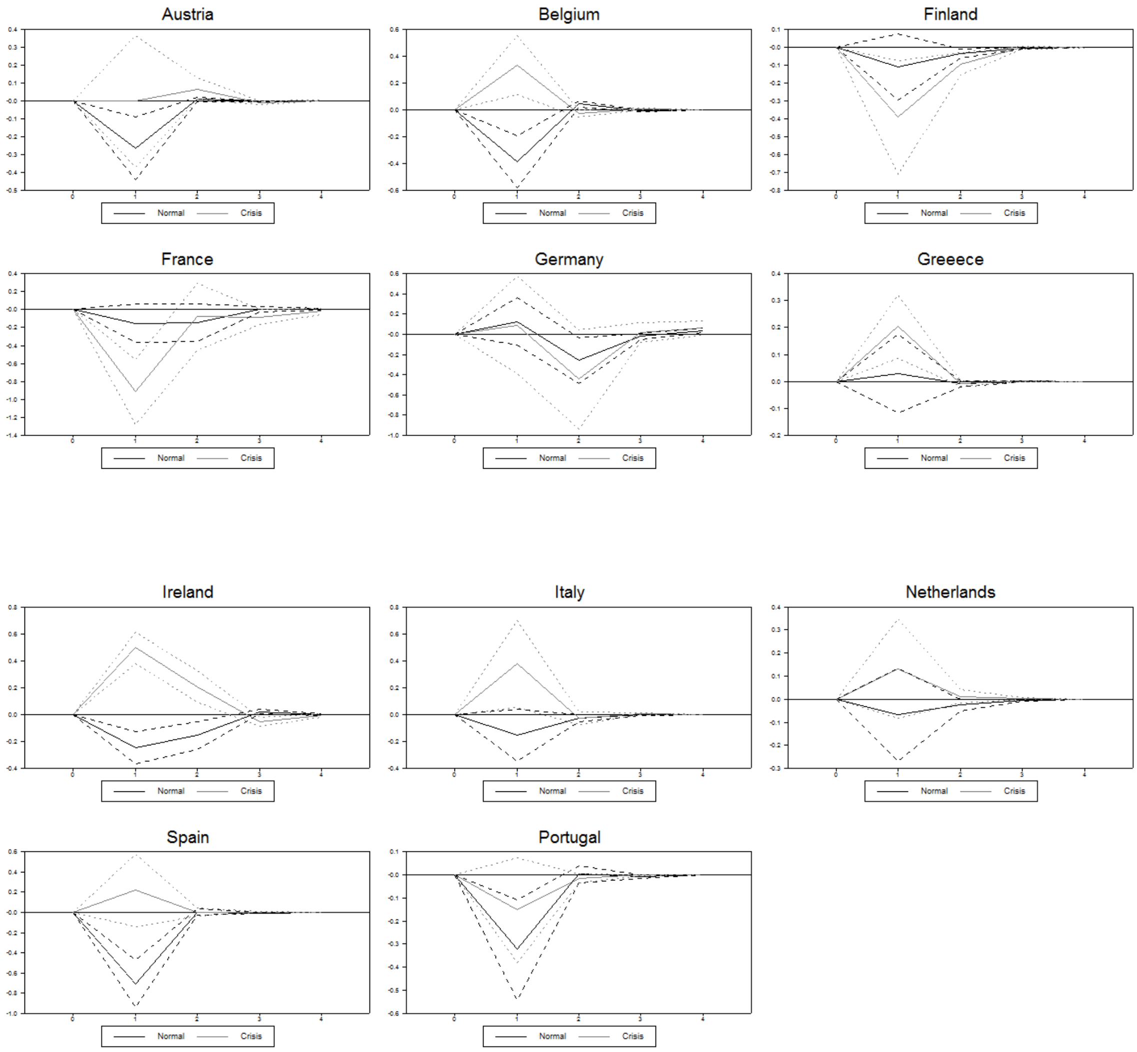

Figure 5. Response of Global Bank Factor to Domestic NFC Shock

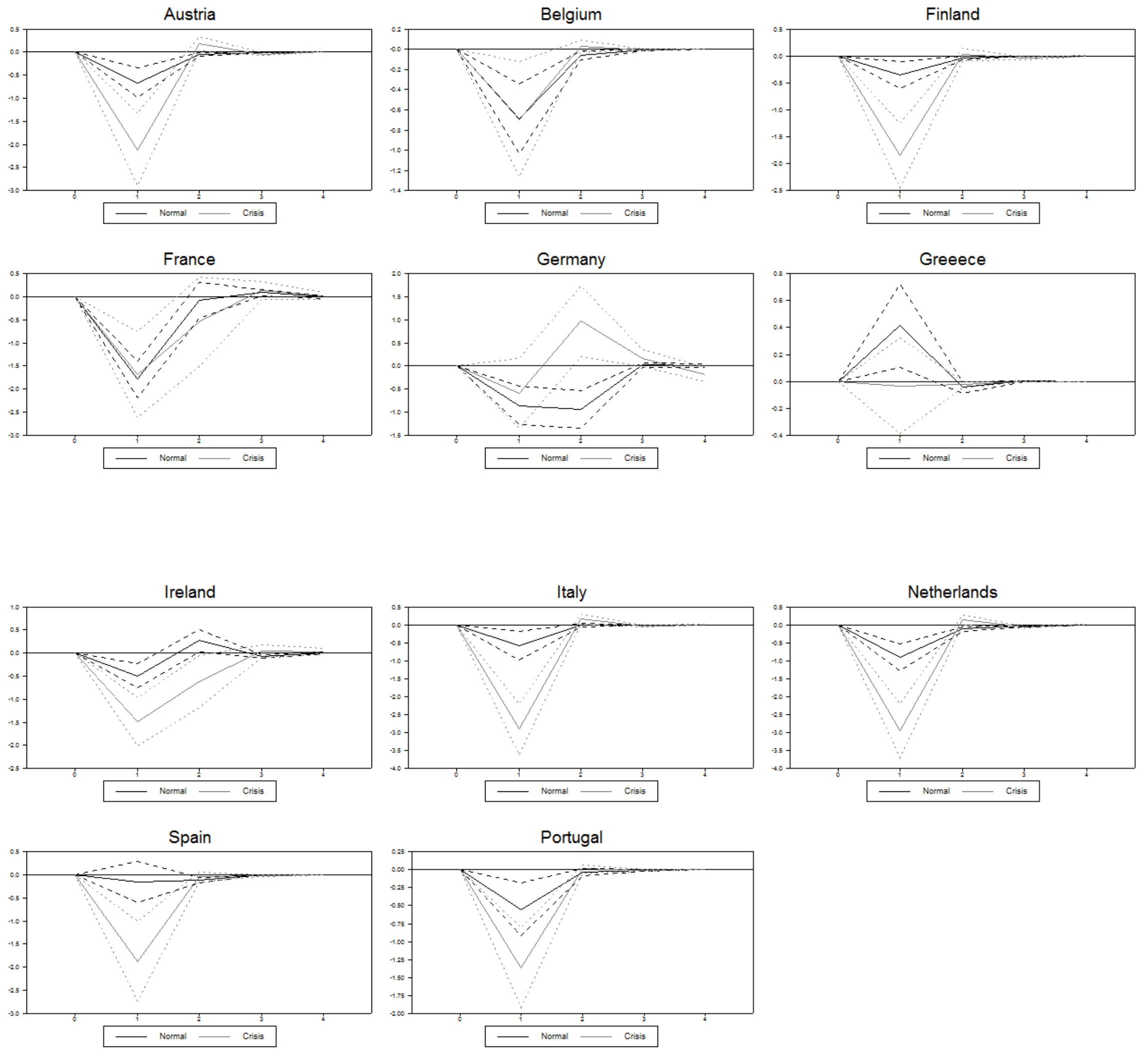

Figure 6. Response of Domestic Bank Factor to Domestic NFC Shock

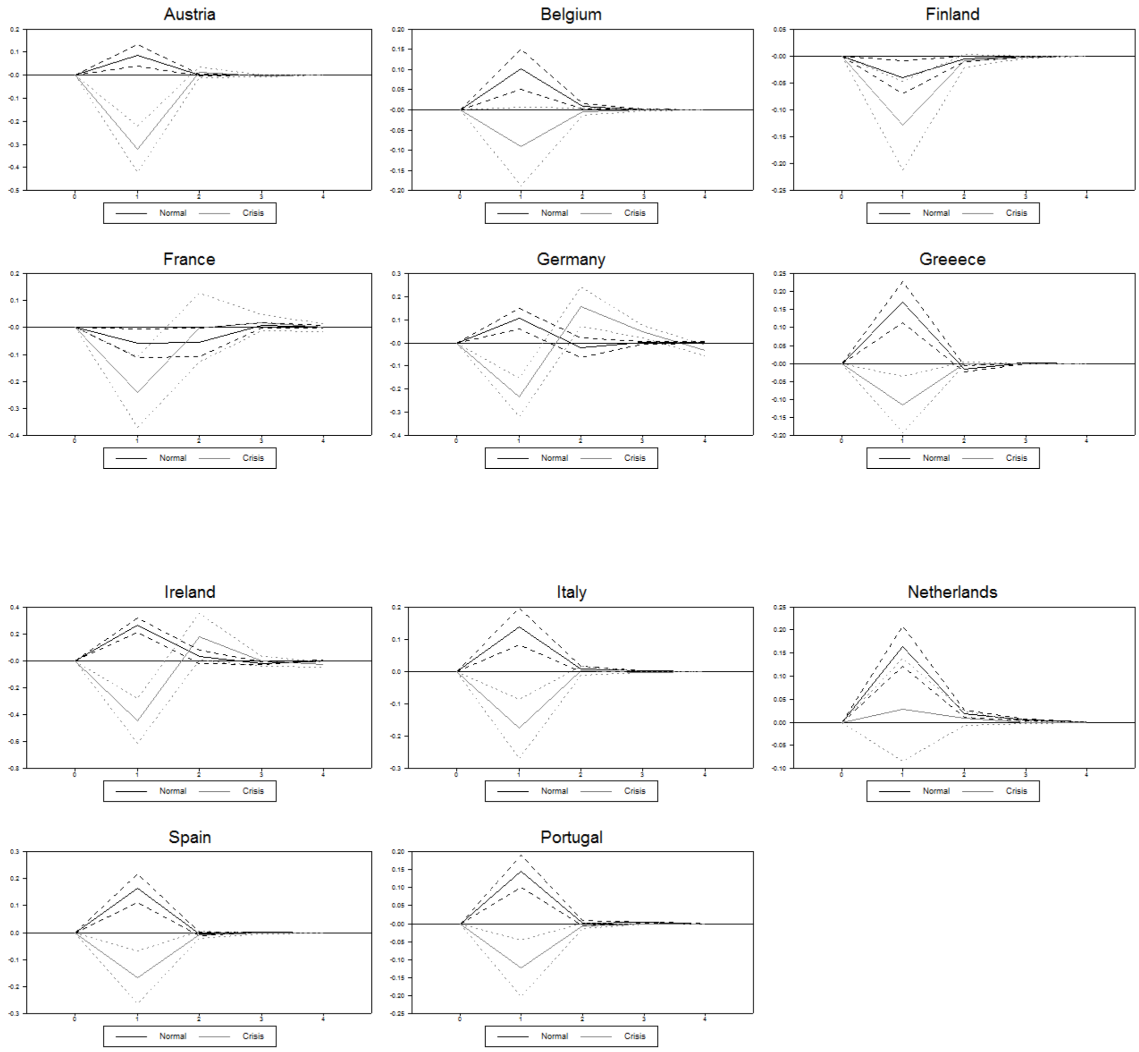

Figure 7. Own Shock to Global Bank Factor

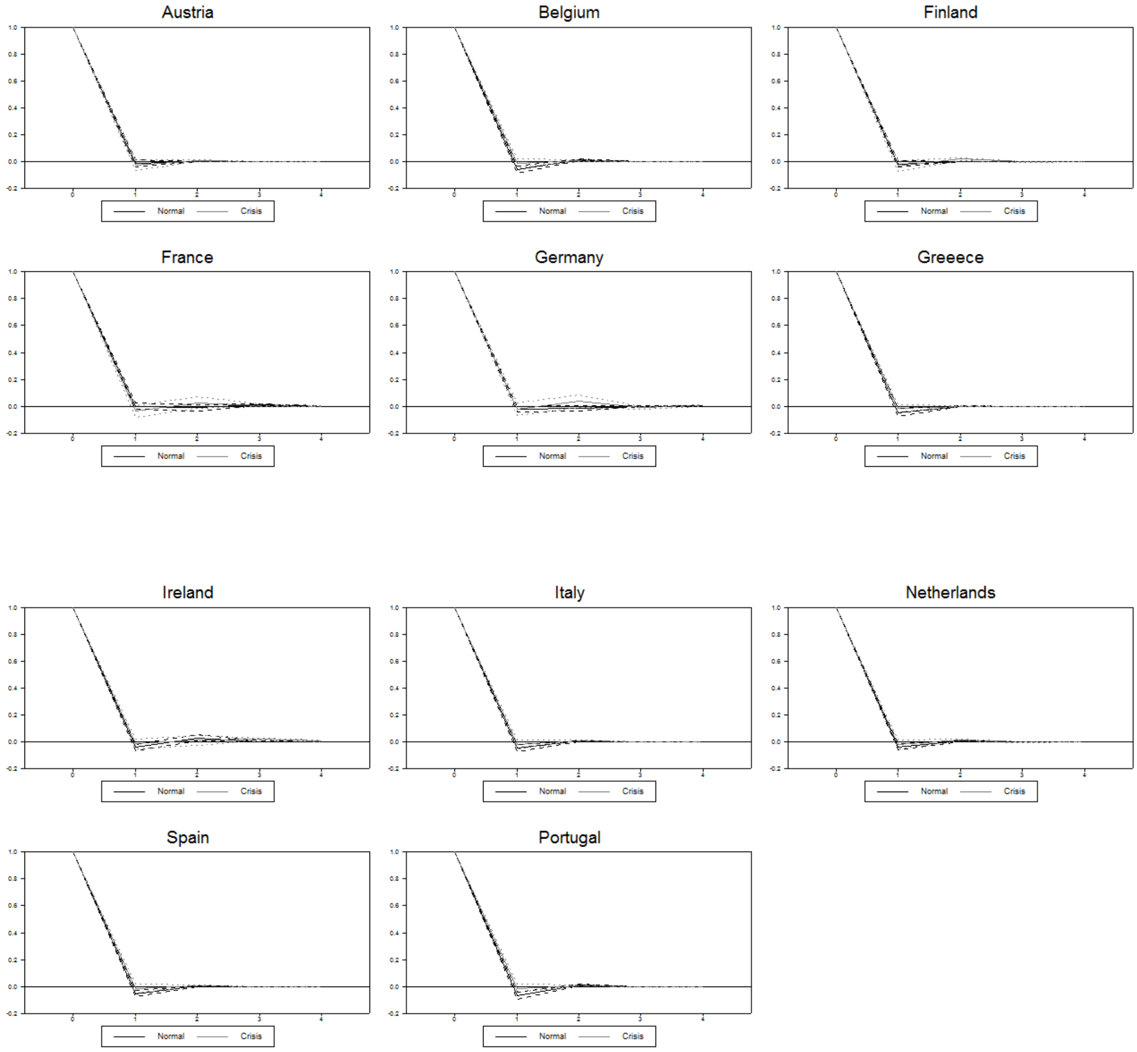

Figure 8. Own Shock to Domestic Banks

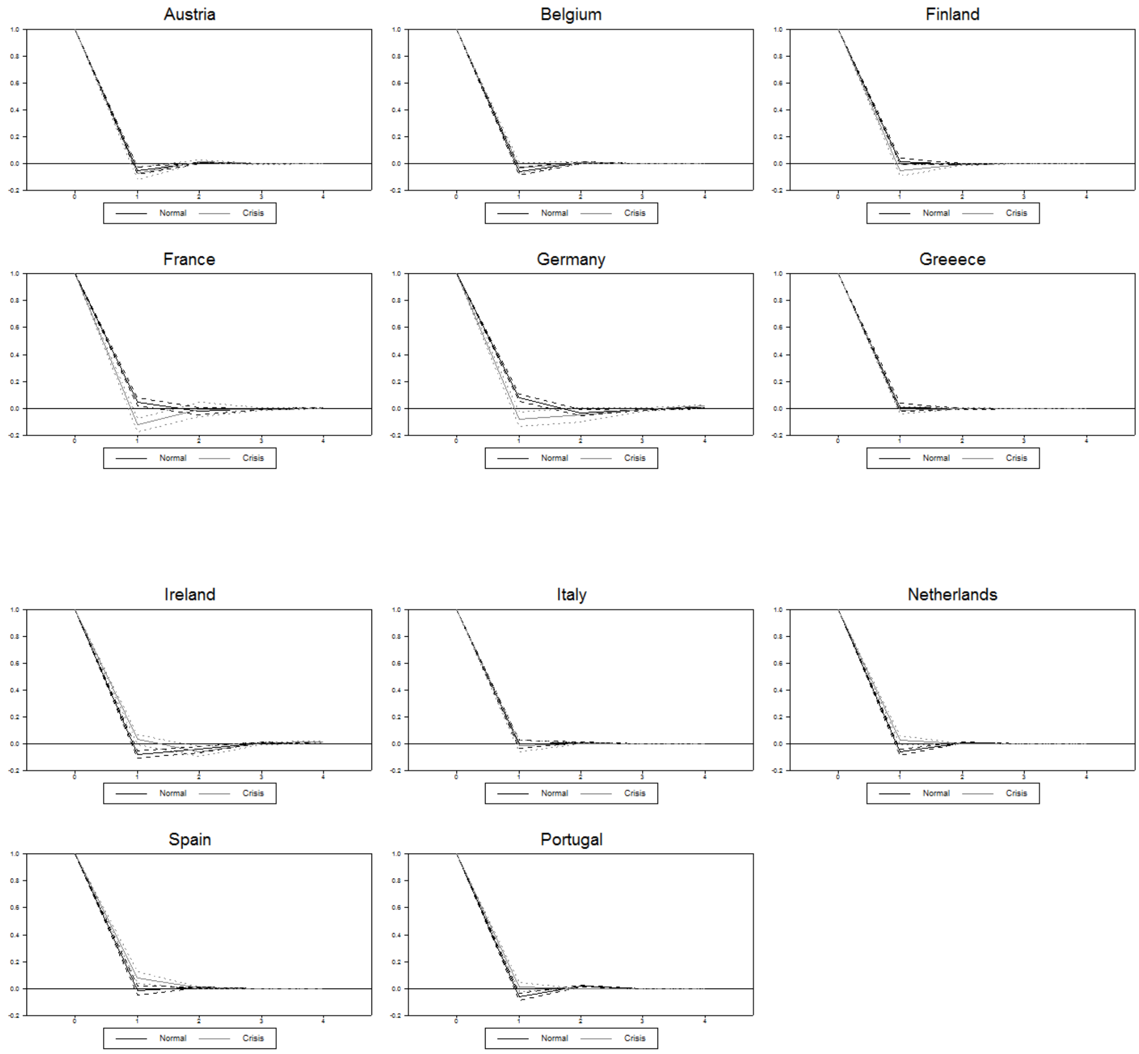

Figure 9. Own Shock to Domestic NFCs