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The macroeconomic determinants of banks' nonperforming loans in Europe: a GVAR approach

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Abstract

The Global Vector Autoregressive method is used to model the real and financial determinants of banks' nonperforming loans in Europe. The macroeconomic determinants of nonperforming loans have been examined previously (see for example Klein (2013), Beck and Jakubik (2013) and Nkusu (2011)). However, these studies have only considered domestic macroeconomic variables, whilst the crisis has shown that banks' nonperforming loans are globally interlinked. Using a superior and unique data set of banks' nonperforming loans from Q1 2000 to Q3 2013, the thesis aims to show that the vulnerability of European banks' nonperforming loans extends across borders. In particular that the macroeconomic conditions of the US, UK, Japan and Germany, have a strong effect on banks' nonperforming loans in Europe. It is found that European banks' nonperforming loans are sensitive to shocks in real activity coming from the US, especially those countries with a dominant financial sector. Nonperforming loans in Europe also show synchronised dynamics with the US, German and Japanese long term interest rate. Finally, the response of European banks' nonperforming loans is considerably larger when transmitted via the financial channel rather than the trade channel, illustrating the importance of the financial channel in the global transmission of real and financial shocks on banks' nonperforming loans.

Key Words: Global VAR, Macro-Prudential Policy, Nonperforming Loans, Spill-Overs, Macro-Stresstesting, Transmission Channels.
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1. Introduction

Macro stress-testing models have become increasingly scrutinised as the macro-prudential aspect of financial supervision calls for better tools to anticipate how financial imbalances are affected by adverse macroeconomic shocks in the real economy. Recent years' trends in nonperforming loans (NPL) data show that European banks' balance sheets are suffering from deteriorating asset quality due to macroeconomic conditions in Europe (Figure 1, Appendix II). Reducing these deteriorating trends in banks' NPLs have become a major focus of the European Central Bank who is conducting a substantial Asset Quality Review in an attempt to harmonise the standards for NPL definitions across Europe and facilitate the work of existing macro stress-testing models.

Currently, empirical methods used to assess how banks' nonperforming loans respond to macroeconomic conditions are subject to substantial shortcomings. For example a recent International Monetary Fund (IMF) working paper (see Klein 2013 and Nkusu 2011) uses a Panel Vector Autoregression Method (PVAR)[2]. However, the PVAR method is limited to examining domestic macroeconomic variables whilst the crisis has shown that banks are globally interlinked. Therefore, the primary research question of this thesis is: do macroeconomic conditions of large advanced economies, such as the US, Japan, UK and Germany impact banks' NPLs in Europe? In addition, the secondary research question include: how do real and financial macroeconomic shocks of large advanced countries impact banks' NPLs in Europe? And, what is the main channel for which these real and financial macroeconomic shocks are transmitted to European banks' NPLs? A suitable method for examining the across-border macroeconomic determinants of banks' NPLs in Europe would be to apply the Global Vector Autoregressive (GVAR) method. The GVAR allows for the across-border interaction between NPLs in European countries and macroeconomic conditions in US, Japan, UK and Germany to be modelled simultaneously and can assess systemic risk, defined as the risk of collapse of an entire financial system or market due to the spread of financial instability (Duca & Peltonen 2011). In this study the endogenous variables are the NPL ratio as a measure of banks' asset quality, real gross domestic product (GDP) and inflation

[2] The Vector Autoregressive (VAR) method can be defined as a model where K variables are specified as linear functions of the p of their own lags, p lags of the other K − 1 variables, and other exogenous variables.

(CPI) growth, long term interest rates and the unemployment rate spanning from Q1 2000 to Q3 2013.

The objective of this thesis is not just to uncover macroeconomic determinants of NPLs which has already been done extensively in the literature. Rather, the thesis aims to show that the vulnerability of European banks' NPLs extends across borders. In particular, that macroeconomic conditions of large advanced countries, such as the US, UK, Japan and Germany, have a strong effect on NPLs in Europe. The contribution to the literature will be to (i) provide a novel insight on the macroeconomic effects of large economies on European banks' NPLs. By using the GVAR as a method one would be enable to examine the interlinkages between NPLs in Europe and macroeconomic conditions in the US, UK, Germany and Japan and endogenously account for cross-border transmissions of macroeconomic shocks. To my knowledge, this paper will be the first to model the propagation of macroeconomic shocks to NPLs using a multi-country GVAR approach. In addition, this paper will (ii) compile a unique and superior data sample on banks' nonperforming loans from national supervisory authorities (NCB) and combine it with the nonperforming loans data from the IMF and the World Bank for 25 EU countries and five large advanced economies spanning over the financial crisis. (iii) Analyse the importance of financial and trade channel in transmitting shocks from large advanced countries to NPLs in Europe. The use of financial sector weights (Bank of International Settlements (BIS) data used from Sgherri & Galesi (2009)) will be contrasted to the use of conventional IMF export based weights similar to Pesaran et al. (2002) to illustrate the importance of the financial channel in the global transmission of real and financial shocks on European banks' nonperforming loans.

The findings show that European countries' NPLs are affected by macroeconomic conditions in the US, Japan and Germany and highlight the interlinkages that exists between the asset quality of banks in Europe and macroeconomic conditions in large advanced countries. These findings can be used for macroprudential policy and to assess systemic macrofinancial risks more broadly. The policy implication of the analysis will be that the making of economic policy in the US has a central role in influencing the asset quality of banks in Europe.

2. Literature

2.1. *Real to Financial Transmission of Shocks*

There are several papers in the theoretical literature examining the macroeconomic determinants of nonperforming loans. Carey for example argues that the single most important systemic factor influencing diversified debt portfolio loss rates is the state of the economy (Carey 1998). This strand of literature argues that during a recession NPLs start to rise as both consumers and firms have less income and revenues to service their debt. Specifically, subdued macroeconomic conditions reduce the revenues and profits for banks and household incomes which increases default probabilities. This in turn weakens the position of bank and borrower's balance sheets; the primary transmission channels that account for shocks that run from the financial to the real sector (Basel Committee on Banking Supervision 2011)[3]. The financial accelerator theory has an important role in shaping the understanding of the interaction between NPLs and macroeconomic variables. Bernanke and Gertler (1990) showed that borrowers face an external finance premium (EFP), defined as a positive wedge between external (e.g. equity and debt) and internal (e.g. retained earnings) funding costs which are assumed to be inversely related to the borrower's net worth and the level of collateral. In other words, borrowers tend to take on a greater amount of risks than that which is in the lender's interest. This can be difficult to monitor due to information asymmetries between the borrower and lender. However, by allowing the borrower to include his own net worth as collateral in the financing of a project one may be able to align the risk taking of the borrower with the lender's willingness to finance the project. Thus, the greater the level of collateral, the lower is the funding cost to the borrower and the premium demanded by the lender. This implies that any shock to aggregate demand or interest rates is spread via endogenous changes in the EFP which discourages investment and consumption. This cycle may be amplified further as even those with succesful projects may find it difficult to obtain financing when economic conditions are deterioating and collateral values are low (Bernanke & Blinder 1988). Overall, the consequences of weakening in economic activity may in turn reduce the revenues and profits of banks and household incomes which increases default probabilities.

[3] The theoretic literature studying real and financial transmission channels primarily focuses on the linkage that runs from the financial to the real economy via (i) the borrower balance sheet channel; (ii) the bank balance sheet channel; (iii) the liquidity channel. Although (i) and (ii) mostly apply for financial to real sector transmission channels, they have re-transmitting effects from the real economy to the financial sector.

The theoretical literature of life-cycle consumption models examined by Lawrence (1995) provides a more explicit illustration of the primary macroeconomic determinants of NPLs. By incorporating the probability of default to the model, Lawrence shows that borrowers with low incomes have higher rates of default because their incomes are more unstable and because they face a higher risk of unemployment and inability to service their debt. Furthermore, risky borrowers are charged higher interest rates because of insufficient incomes which in turn influence the default rate (Lawrence 1995). Rinaldi and Sanchis-arellano (2006) extend the theoretical model by Lawrence and allow agents to borrow in order to invest in real and financial assets. It follows that default rates depend on current income and the amount of loan taken. In the long run it also depends on the bank lending rate, inflation rate and the uncertainty of future income as well as wealth changes associated with the employment prospects and asset prices. They empirically show that in the long run debt to income is associated with higher levels of household NPLs which are more than offset by a simultaneous rise in real disposable income. Moreover, they show that in the long run changes to inflation and lending rates matter whilst in the short-run the role of financial wealth and housing wealth (proxied by the house price index) is negatively associated with rising NPLs (Rinaldi & Sanchis-arellano 2006).

2.2. The International Dimension of Real to Financial Transmission Channels

There is also an international dimension to the way shocks are transmitted from the real to the financial sector as outlined in section 2.1. In particular, an important fact of today's financial markets is that banks are increasingly globalised and as such have shared exposures (for example European banks holding the same assets as US banks through subsidiaries in the US). This implies that the increase in the cross-border linkages of banks' assets combined with the transmission of shocks via the trade, bank and balance sheet channels, provide an additional dimension for which macroeconomic shocks are transmitted to the financial sector. For example, an adverse macroeconomic shock abroad is no longer limited to impact the default probabilities of banks in the shock-originating country but also impact the balance sheet of firms and households abroad in the same way as if the shock was originated at home. The international dimension of real to financial linkages was tested by Forbes and Chinn (2004). Although focusing on stock and bond markets in advanced economies, they show that markets around the world are driven by cross-country rather than country specific factors and that international trade and financial linkages have become an important driver of international movements of financial markets. In particular, they show that trade (as measured by a country's reliance on exports to the largest economies) appears to be one of the most important determinants of cross-country linkages between the largest economies and markets around the world. Thus, the trade channel may also function as an indirect route for which shocks run from the real to the financial sector due to weakened export activity which discourages investment and consumption and hence market activity.

Moreover, recent research by Eickmeier and Ng (2011) and Backé and Feldkircher (2013) apply the GVAR method to explore the relative importance of the financial versus the trade channel in transmitting real and financial shocks across borders. Eickmeier and Ng (2011) focus on the international transmission of credit supply shocks using both trade and financial weights; distinguishing between portfolio investments, direct investment and banking claims, via both asset- and liability side channels. They conclude that a weighting scheme that uses both trade and financial weights for macroeconomic and financial variables respectively tend to give a better model fit than a weighting scheme based on trade based weights alone. Backé and Feldkircher (2013) use the GVAR method to model spillovers from the Euroarea to the Central, Eastern and South Eastern Europe region with different weighting schemes to reflect the relative importance of the financial versus trade channel. The results show that advanced countries, such as the US react more strongly if the shocks are spread via the trade channel except for the UK (with its traditionally strong financial sector) where the financial channel dominates. Meanwhile, in the Euroarea the impact of a one percent shock to GDP is almost equally spread between the two channels.

Motivated by Backé and Feldkircher (2013) and Eickmeier and Ng (2011), this study will attempt to explore the relative importance of the financial and trade channel in transmitting real and financial shocks from large advanced countries on European banks' NPLs. The particular use of banks' balance sheet exposure data from the BIS will serve to reflect the importance of the bank balance sheet channel in transmitting these shocks across countries. While Backé and Feldkircher (2013) focus on the transmission of shocks on output activity and Eickmeier and Ng (2011) on financial to real activity via endogenous changes to credit supply, this thesis will mainly contrast the financial versus trade channels' effect on the real to financial transmission of shocks on European banks NPLs.

Meanwhile, the importance of large advanced countries (in particular that of the US) in transmitting financial to real shocks across borders has been well documented in the literature. For example, by Dees et al. (2007) and Chudik and Fratzscher (2011), by applying a GVAR framework, conclude that financial shocks are transmitted rapidly and strongly to the Euroarea when originating from the US. While Chudik and Fratzscher (2011) focus on the transmission of liquidity shocks (measured by TED spread) and risk shocks (VIX index), Dees et al. (2007) focus on shocks to both real and financial variables showing that the Euroarea real activity react both directly via financial variables and indirectly via the trade channel. Interestingly, Chudik and Fratzscher (2011) note that the equity markets of European economies were more affected by shocks to US risk appetite than the US economy itself.

Overall, a key point from this strand of literature is that the global transmission of financial and real shocks is complex and cannot be diminished to one single country but extends across borders. In addition, the relative importance of the financial or trade channels in transmitting these shocks remain a relatively unexplored topic whilst it is an established fact that the US in particular is an important driving source for transmitting shocks across borders.

2.3. The Empirical Literature on Macro-Nonperforming Loans Linkages

A number of empirical papers have contributed to the literature on the interaction between NPLs and macroeconomic performance. Hoggarth et al. (2005) uses a VAR approach to account for the dynamics between the fragility of the banking system in the UK and adverse macroeconomic shocks. In contrast to this study, they measure bank fragility using bank write-offs to loan ratio. They also account for the sector specific dynamics and find that both bank and corporate loan write-offs are specifically related to deviations in the output gap. They also show that unexpected changes in the nominal interest rate result in increased aggregate write-off ratios after one to three years.

Other empirical papers, (such as those by Espinoza and Prasad (2010); Nkusu (2011)) use a PVAR to show that macroeconomic variables, in particular GDP growth are linked with falling NPLs. While Espinoza and Prasad (2010) (using a sample of 80 banks in the Gulf Cooperation Council) show that rising interest rates have a negative impact on the NPL ratios, Nkusu (2011) (using a sample of 26 advanced countries and single equation panel regression) confirm that higher unemployment and falling asset prices are associated with rising NPLs. Beck and

Jakubik (2013) and Jakubík and Reininger (2013) use a dynamic and fixed effect panel regression approach to study the macroeconomic determinants of NPLS across 75 countries and similarly find that real GDP growth, share prices as well as the exchange rate and lending interest rate have an impact on the NPL ratio. In the case of share prices, the impact is found to be larger in countries which have a large stock market relative to GDP. In addition, Jakubík and Reininger (2013) (focusing on the Central, Eastern and South-Eastern European region) find that domestic and foreign economic activity plays a key role for NPLs. Similar to Nkusu (2011) and Beck and Jakubik (2013), Rinaldi and Sanchis-arellano (2006) show that stock prices can directly influence the NPL ratio but that the depreciation of a local currency also has a sizeable negative impact on the quality of banks' assets as well as private credit to GDP. Finally, Klein (2013) uses five endogenous variables (NPLs, real GDP growth, unemployment rate, the credit to GDP ratio and inflation rate) in a PVAR to show that a positive shock to GDP growth and a negative shock to the inflation rate leads to a higher NPL ratio in the Central and Eastern and South Eastern Europe region.

A major disadvantage of the PVAR and standard VAR method used in the current literature is that it is limited to studying the interaction of domestic macroeconomic variables whilst the crisis has shown that banks are highly interlinked. As such, a policy relevant method for determining NPLs would be to apply the GVAR (see section 3.1 regarding literature contribution). Based on the aforementioned literature this paper will focus on GDP growth, inflation growth, unemployment rate and long term interest rates as the primary macroeconomic determinants of NPLs.

2.4. Macro-Prudential Policy Applications

Macro-prudential policy has become a topical issue for many central banks in the aftermath of the 2008 financial crisis. The primary goal has been set to identify and contain systemic risk arising in the financial system. Borio and Drehmann (2009) define financial instability as "a set of conditions that is sufficient to result in the emergence of financial distress/crises in response to normalised shocks. These shocks could originate either in the real economy or from the financial system itself" (Borio & Drehmann 2009, pp. 4). A major challenge, however, is that the existing methods and tools available to monitor and measure systemic risks are limited in terms of endogenously accounting for cross-border transmission channels, including cross-border contagion between financial institutions (Foglia 2009). Thus, most current analysis is limited to domestic macroeconomic variables, neglecting the effect of foreign output on the financial sector which can be difficult when the financial sector and the transmission of financial shocks extend across borders (Borio & Drehmann 2009). Overall, there are limitations to the available analysis measuring financial instability which require further analytical and empirical work to capture any macro-financial feedback effects.

Al-Haschimi and Dées (2013) discuss how the GVAR can be used for macroprudential policy as a counterfactual assessment of financial instability. They focus on two existing applications of the GVAR model that link the probability of default risk with macroeconomic variables. The first application comes from Castrén et al. (2009) who connect a GVAR model by constructing a satellite model linking the probability of default in the Euroarea corporate sector to a set of macroeconomic and financial variables. The results show that the median expected default frequency (EDF)[4] of Euroarea firms are particularly responsive to macroeconomic and financial shocks (such as GDP, equity prices, and exchange rates) and that the magnitude of these responses are diverse across sectors. The second application comes from Chen et al. (2010) who when applying the GVAR find that bank distress, industrial production, stock prices and real short term interest rates impact the EDF ratio. Regarding the interlinkages, the results show that cross-country spill-overs are stronger when the shocks originate in large, advanced economies, such as the US and that advanced economies appear more vulnerable to shocks to banks than shocks to non-financial corporations.

Motivated by Chen et al. (2010), this study will hypothetically confirm that shocks when originating in systemically important economies, such as the US, Japan and Germany will impact NPL ratios in Europe. In contrast to Chen (2010), the focus will mainly be limited to looking at shocks from the real economy to the financial sector and show that real country specific macroeconomic shocks can have adverse implications on banks asset quality abroad. In addition, the measure of linking credit risk to the real economy will be nonperforming loans rather than EDF as it more explicitly reflects banks' asset quality. Thus, nonperforming loans would better capture the underlying measure of banks' asset quality whilst the EDF includes a

[4] Moody's developed the EDF measure based on 35000 financial institutions and corporations in 55 countries. A firm is considered to be in default if the market value of the assets is lower than its debt obligations which is based on (among other things) the value and the volatility of firms' assets relative to the agreed debt repayments.

broader source of data that would contribute to a bank's potential to default, such as investor's market risk appetite and the structure of a firm's balance sheet (Chen et al. 2010).

3. Contribution to Existing Literature

3.1. *The Global Macroeconomic Effect on European Banks' Nonperforming Loans*

The primary research question of this thesis is: do macroeconomic conditions of large advanced economies, such as the US, Japan, UK and Germany impact banks' NPLs in Europe? This question is particularly relevant since it is a crucial feature of financial markets today that they are globally interlinked. Specifically, banks have become increasingly globalised and as such have shared exposures (for example European banks holding the same assets as US banks through subsidiaries in the US). Since banks are increasingly globalised and have shared exposures, European banks also indirectly via balance-sheet interlinkages, face similar vulnerabilities to for example US macroeconomic conditions as banks in the US. As such, the impact of a US slowdown would not only affect US banks' NPLs, but also banks' NPLs in other European countries.

Furthermore, current empirical studies examining the macroeconomic determinants of NPLs are limited to domestic macroeconomic variables and are often limited to one or a few countries. For example, a common methodology used by Hoggarth et al. (2005); Espinoza and Prasad (2010) and Nkusu (2011) is the use of a VAR or a PVAR when modelling the dynamics of macroeconomic shocks on NPLs. However, a suitable method for answering the primary research question would instead be to use the GVAR since it would be able to model many countries simultaneously and endogenously account for the transmission of macroeconomic shocks across borders.

The GVAR approach is particularly suitable as opposed to the PVAR and VAR when studying the across-border interactions between NPLs and macroeconomic conditions. Firstly, a GVAR approach allows for the interaction between a large numbers of countries to be modelled simultaneously. In a PVAR this would result in too many countries relative to the short time series making the dimensionality unmanageable (Canova & Ciccarelli 2013)[5]. As such, a major

[5] An issue in the literature that is referred to as the 'curse of dimensionality' in that PVARs follow the same set up as standard VARs but adds a cross sectional dimension to it so that when time series are short examining the input and output links between regions or areas become an issue.

disadvantage of the PVAR approach used in the current literature is that it is limited to studying the interaction of domestic macroeconomic variables whilst the crisis has shown that banks are highly interlinked. The PVARs differ from GVARs in that: (i) the coefficients on the foreign variables are restricted to zero; (ii) only one set of coefficients are estimated and not one for each country as in the GVAR (see section 4.1). The GVAR enables the analysis to include a large number of countries and answer questions such as what is the impact of a US slowdown not only on US NPLs but also on NPLs in other European countries. Such results represent an important input to the research on macrostress testing models as well as the current financial stability work conducted at many central banks.

Secondly, a common procedure when using a standard VAR or PVAR would be to apply the Cholesky decomposition, which is equivalent to applying a particular prior ordering of the variables for the impulse response functions. However, according to Hoggarth et al. (2005) setting a particular prior ordering of variables could be a major disadvantage when conducting stress tests because the impulse responses are also sensitive to the ordering of these variables (Hoggarth et al. 2005). Furthermore, even if an argument could be made for a specific ordering of the variables in each country *variable* in the GVAR, there is no economic intuition that would justify such ordering of *countries* in a GVAR (Pesaran & Smith 2005; Dees et al. 2007). In other words, the generalised impulse response functions in a GVAR benefit from not being sensitive to the ordering of variables in the country models. This is an advantage compared to the standard VAR analysis since the focus of this analysis in a GVAR is on the *transmission* of various macroeconomic shocks and their impact on the nonperforming loan ratios rather than the structural *identification* of the causes of these shocks as in a VAR analysis.

Overall, the current empirical studies examining the macroeconomic determinants of NPLs are subject to a number of shortcomings and limited to domestic macroeconomic variables. Meanwhile, the crisis has shown that banks' nonperforming loans are globally interlinked. As such, examining the impact of a slowdown in the real activity of large advanced economies on banks' NPLs in Europe is particularly relevant. A suitable method to capture the across-border transmission of macroeconomic shocks on European banks' NPLs would be to use the GVAR.

3.2. The Nonperforming Loans Data

This paper contributes to the literature by compiling a unique and superior data sample of nonperforming loans to total gross loans from national central banks and supervisory authorities[6]. The data is combined with NPL data from the IMF and the World Bank[7] spanning over the financial crisis (see Appendix I for further details regarding the definition of NPLs used). Previous studies in the literature (such as that from De Bock and Demyanets, 2012; Klein, 2013; Nkusu, 2011) have used bank level data from Bankscope. However, a major caveat of these studies is that the analysis of bank level data could potentially be skewed by differences in NPL definitions across banking groups since banks use different qualitative and quantitative elements in their loan quality assessments. For example, a majority of Société Générale's nonperforming loans are less than 30 days past due whilst a majority of KBCs and INGs nonperforming loans are more than 90 days past due. In addition, the term 'nonperforming' and 'impaired' are often used interchangeably among banks even though the terms are not identical. For example, in the case of Unicredit, the impaired loans reported by banks are broadly defined and include four categories: non-performing, doubtful, restructured, and past due whilst ING's definitions of impaired and nonperforming loans are identical and measured by the risk rating 20 to 22. Furthermore, according to DZ Bank's definition past due loans are distinct from impaired loans, whilst according to Unicredit's definition past due loans are a type of impaired loan. Finally, the methods used by banks to identify nonperforming loans can also differ substantially. In particular, the existence of write-offs, collateral or restructured loans could influence the classification of the loan quality (ING Group 2012; KBC Group 2012; Société Générale 2013; DZ Bank Group 2012; Unicredit Bank AG 2012).

As such, focusing on country level NPL data from NCBs and the IMF rather than bank level data from Bankscope may bring more precision to the analysis. Firstly, the World Bank, the IMF and the NCBs are mostly following the 90+ days overdue criteria in line with the Financial Soundness Indicators (FSI) Compilation Guide (IMF 2007). Although, a major caveat may still be that the additional qualitative criteria applies at national level (Barisitz 2013). However,

[6] A unique data set of NPLs have been collected from Bank of Estonia, Bank of Czech Republic, Finansinspektionen, Bank of Spain, Bank of Lithuania, Bank of Latvia, Bank of Greece, Bank of Finland, Finanstilsynet, Bank of Portugal and Bank of Croatia.

[7] Annual data of NPLs to total gross loans from the World Bank have been interpolated to quarterly data using a cubic spline in Matlab. The study therefore benefits from covering data expanding prior to the 2007 financial crisis.

there is still an economic interest for analysing the determinants of NPLs given the recent rise in trends in nonperforming loans across Europe and the heightened agenda among EU policy makers to deal with the systemic risks it imposes on the financial system. Secondly, expanding the dataset from the IMF with NPL data from NCBs is consistent with the fact that national authorities are the ultimate sources of the FSI indicators. The result is then that we get a sufficiently long time-series to be able to apply the GVAR to the analysis (the estimation of the GVAR model as an individual partial system is justified if the number of available observations are sufficiently large (Pesaran et al. 2002) which otherwise would be an imprecise and unfeasible aggregation exercise using limited information from banks' balance sheets. In addition, for the purpose of macroeconomic stress-testing it is important to have data on banks' asset quality covering at least one full economic cycle (Foglia 2009). Finally, the potential for loan write-offs having an impact on nonperforming loan data has been mitigated by working with NPL ratios rather than levels. The reason being, working with ratios rather than levels would mitigate the impact of write-offs on NPLs over time as the year on year change is higher for levels than ratios.

3.3. The Weights: the Trade versus Financial Transmission Channels.

To evaluate the sensitivity of a change in weighting scheme, financial weights (using lending data from the BIS) is compared to trade weights (based on export data from the IMF's Direction of Trade). All weights in this study are fixed over time. The baseline model uses financial lending based weights as they best reflect the relative importance of each country's economic partner and are particularly relevant as a transmission channel for nonperforming loans. The comparison of the baseline model (which contains financial weights) to the model using a trade-weighting scheme is an important feature of the paper as it illustrates the significance of the financial channel in transmitting shocks from large advanced countries on European banks' NPLs. This is in contrast to previous studies that have shown that the trade and financial channels have broadly similar effects for impulse responses on Euroarea credit supply and output activity (Eickmeier & Ng 2011; Backé et al. 2013).

Table 3 compares the cross-country pairs of the two different weighting schemes. The reason for comparing the two weighting schemes is that there are significant differences in the trade weights and financial weights. For example, the US and the UK have a proportionally higher share in terms of financial weights than the smaller European countries while Sweden has a proportionally higher financial share of the Baltic region. As a result, these countries' exposures are higher than when applying the trade weighting scheme. The economic interpretation for these differences could be that the UK for example has more exposure to the financial sector than that of Germany which has a relative stronger manufacturing base and therefore carries a relatively larger exposure in terms of trade weights.

The differing dynamic results due to the weighting schemes also represent an important input to the literature on international transmission of shocks. In particular, it illustrates how US macroeconomic shocks to European NPLs when transmitted via the financial channel may have a stronger impact than when transmitted via the trade channel in terms of impulse responses. As illustrated in Appendix IV, the fact that the variable dynamics are quite different when using trade weights compared to financial weights (in particular the sign and the magnitude of the effects differ) is not surprising given that the foreign specific variables are computed using different sets of data which impact the global solution of the model. Specifically, the weighting scheme influences the residuals and hence the covariance structure which forms a basis of the generalised impulse response function. Furthermore, the weighting scheme determines the dynamic transmission of country specific variable shocks in the global solution of the GVAR model.

4. The Global VAR Model

4.1. Model Structure: the Country Specific VARX Models*

The GVAR was originally developed by Pesaran et al. (2002) and is based on VAR models of individual countries. Each country specific VARX* model include a set of domestic and foreign specific variables. One can see that if the foreign specific variables (i.e. the terms x_{it}^* and $x_{i,t-1}^*$) are set to zero then the model becomes a standard vector autoregressive process of order 1 (VAR(1)). However, in the presence of foreign specific variables it becomes an augmented first order VAR model which is denoted as VARX*(1,1). Each VARX* model has country specific variables related to deterministic variables (such as a time trend) and a set of foreign specific variables that are assumed to be weakly exogenous (Sgherri & Galesi 2009; Pesaran & Smith 2005; Pesaran et al. 2002). The country specific VARX*(1,1) model that includes a time trend and an intercept is written as:

$$x_{it} = a_{i0} + a_{i1}t + \Phi_{i1}x_{i,t-1} + \Lambda_{i0}x_{it}^* + \Lambda_{i1}x_{i,t-1}^* + u_{it}, \tag{1}$$

where a_{i0} is a vector of intercepts, $a_{i1}t$ a is the vector of coefficient of the time trend, both x_{it} and x_{it}^* both are $k_i * 1$ and $k_i^* * 1$ vectors of domestic and foreign variables respectively. The foreign variables denoted as x_{it}^* are constructed using weights w_i where each column must sum to one for each country and were each foreign variable is computed as a weighted average of the corresponding domestic variables for all countries. That is,

$$x_{it}^* = \sum_{j=0}^{N} w_{ij} x_{jt}, \tag{2}$$

where $w_{ij} = 0$, $j = 0,1,,,,,N,$ are a set of weights such that $w_{ij} = 0$ and $\sum_{j=0}^{N} w_{ij} = 1$. For example, GDP is one of the variables that is included in the VAR (1) specification. This implies that the foreign GDP variable (denoted as GDP*) will be constructed as a weighted average of the GDP of the rest of the countries. The weights are designed to capture the importance of country j to the ith economy (Pesaran & Smith, 2005, di Mauro & Smith, 2013). This analysis will focus on using financial weights as the baseline model and compare the baseline model with a model that applies a trade weighting scheme so as to illustrate the robustness of the results and the importance of financial linkages.

The error-correction form, VECMX* of equation (2) can be written as:

$$\Delta x_{it} = a_{i0} + a_{i1}t - (I_{ki} - \Phi_i)x_{i,t-1} + (\Lambda_{i0} + \Lambda_{i1})x_{i,t-1}^* + \Lambda_{i0}x_{i,t}^* + u_{it}, \tag{3}$$

with the coefficients and variables being the same as in the VARX* representation.

The VECM* is estimated separately for each country conditional on x_{it}^* being I(I) weakly exogenous (which will be tested in section 5.4).

4.2. Model Structure: Global Solution

In the final step, all the individual country's VAR models are selected and estimated in a single global VAR model[8]. This is done by first re-writing the foreign and domestic variables into a vector $z_{it} = (x_{it}', x_{it}^{*\prime})'$ to re-write the model in reduced form as

[8] The global VAR model used in this analysis does not include a global variable, i.e. a common variable for each country, and is a more simplified version of that used by Pesaran et al. (2002).

$$A_i Z_{it} = a_{i0} + a_{i1} t + B_i\, z_{i,t-1} + u_{it}, \qquad (4)$$

where

$$A_i = \left(I_{ki,} - \Lambda_{i0}\right), B_i = (\Phi_{i,} \Lambda_{i1}).$$

Given the fact that

$$z_i = W_i x_t, \qquad (5)$$

we get by solving the model as a whole via link matrices that

$$A_i W_i x_t = a_{i0} + a_{i1} t + B_i\, W_i x_{i,t-1} + u_{it}, \qquad (6)$$

where W_i is country specific link matrices based on the financial weights used in the baseline model and where $x_t = (x'_{1t}, x'_{2t} x'_{1t}, \ldots, x'_{Nt})'$ which is a k*1 vector containing endogenous variables for all countries $i, k = \sum_{i=1}^{N} k_i$. For example in a two country (i, j) model with three variables, the matrix for country i becomes $(k_i + k_i^*) * k$ where k is the sum of all k_i variables. This would mean that $W_i = 6 * 6$ so that $W_i = \begin{bmatrix} I_3 & 0 \\ 0 & w_j I_3 \end{bmatrix}$ (Smith & Galesi 2011). Using the link matrix one can then derive the global solution

$$G x_t = a_0 + a_{1t} + H x_{t-1} + u_t, \qquad (7)$$

where

$$G_0 = \begin{bmatrix} A_1\, W_1 \\ A_2\, W_2 \\ \cdot \\ \cdot \\ \cdot \\ A_N\, W_N \end{bmatrix}, H_1 = \begin{bmatrix} B_1\, W_1 \\ B_2\, W_2 \\ \cdot \\ \cdot \\ \cdot \\ B_N\, W_N \end{bmatrix}, a_0 = \begin{bmatrix} a_{10} \\ a_{20} \\ \cdot \\ \cdot \\ \cdot \\ a_{N0} \end{bmatrix}, a_1 = \begin{bmatrix} a_{11} \\ a_{21} \\ \cdot \\ \cdot \\ \cdot \\ a_{N1} \end{bmatrix}, u_t = \begin{bmatrix} u_{1t} \\ u_{2t} \\ \cdot \\ \cdot \\ \cdot \\ u_{Nt} \end{bmatrix}.$$

Since G_0 is known and non-singular we can premulitply the above equations by G_0^{-1} to obtain

$$x_t = b_0 + b_1 t + F_1 x_{t-1} + F_2 x_{t-2} + \varepsilon_t \varepsilon_t, \qquad (8)$$

where $F_1 = G_0^{-1}G_1, F_2 = G_0^{-1}G_2, b_0 = G_0^{-1}a_0, b_1 = G_0^{-1}a_1$ and $\varepsilon_t = G_0^{-1}u_t$ (Smith & Galesi 2011). The GVAR in its reduced form can be used for when analysing the dynamic properties of the GVAR and the Generalised Impulse Response Functions (GIRFs). This is also one of the major advantageous of using the GVAR since it enables a full analysis of the interactions between countries to be captured directly via the construction of foreign specific variables for each country. Furthermore, since the individual VARX* country models are estimated globally, it makes it possible to investigate how shocks specific to one country impact other countries simultaneously.

4.3. The Model Rank

The rank of the error correction model provided in section 4.1 can be derived from part 4.2. Again, using $z_{it} = (x_{it}', x_{it}^{*\prime})'$, $A_i = \left(I_{ki,} - \Lambda_{i0}\right)$ and $B_i = \left(\Phi_{i,}\Lambda_{i1}\right)$ we get the error correction model in reduced form as:

$$\Delta x_{it} = a_{i0} + a_{i1}t + (A_i - B_i)z_{i,t-1} + \Lambda_{i0}\Delta x_{it}^* + \varepsilon_{it}. \tag{9}$$

From which we may determine the model rank and the number of cointegrating relations $A_i - B_i = \Pi_i$, which is also the same as $A_i - B_i = \alpha_i\beta'_i$, and is the model rank which specifies the number of long run relationships that exist among the domestic and foreign specific variables specific to the countries in the $(k_i + k_i^*) * k$ matrix (Pesaran et al. 2002)[9]. These properties will be used later in the cointegration analysis.

5. <u>Estimation of the GVAR Model</u>

5.1. Conditions for the GVAR Estimation

As outlined previously, in an unrestricted VAR model covering N countries the number of unknown parameters would rise with N since there will be $p(kN - 1)$ parameters estimated per equation where p is the order of the VAR and k the number of endogenous variables per country. This implies that if $p = 1, k = 5$ and $N = 30$, there will be 149 parameters to be estimated per equation. This is not feasible as the number of parameters would be greater than the number of available observations (observations is equal to 51) (Pesaran & Smith 2005). However, this shortcoming is solved in a GVAR by assuming that the foreign specific variables

[9] α_i is the $k_i * r_i$ matrix with full column rank and β_i is the $(k_i + k_i^*) * r_i$ matrix of cointegrating vectors.

are weakly exogenous for most countries when N is large enough. The foreign specific variables can therefore be computed using the weight matrix rather than estimated which reduces the number of restricted parameters to be estimated. Three further criteria are needed for the GVAR methodology to be valid (Sgherri & Galesi 2009).

1.) The global model must be dynamically stable. This implies that the eigenvalues of the global solution to the GVAR in reduced form lie within or on the unit circle.
2.) The weights must be relatively small.
3.) The cross-dependence of idiosyncratic shocks must be sufficiently small.

All three requirements are met in the baseline GVAR model used for this application. The model is dynamically stable and the global system has 77 eigenvalues that fall on the unit circle (i.e. the number of endogenous variables (150) minus the number of cointegrating relationships for the individual VARX* models (73)) (Dees et al. 2007)[10]. Secondly, the average financial weight exposure towards each country is relatively small with Germany being the country that on average carries the most exposure to the remaining countries equal to 0.21. The third condition is also met as illustrated in Table 4. It presents the average pair-wise cross-section correlations which serves as a diagnostic check with a low correlation in the residuals indicating that the GVAR has successfully captured the common macroeconomic determinants of NPLs. Among the variables in levels, the NPL ratio appears to be the most correlated, with a maximum of 0.65 for Belgium and Slovenia whilst the rate of growth in the NPL ratio and the unemployment rate show a lower degree of correlation. The correlations in the residuals are very small (between 5 and 2 percent on average for the variables). As such, the GVAR approach should be sufficiently effective in explaining the cross-country macroeconomic determinants of NPLs in Europe (Sgherri & Galesi 2009).

[10] After the unit roots, the three largest eigenvalues are 0.939, 0.930 and 0.930 which also implies a satisfactory rate of convergence of the model.

5.2. The Data Set and the Properties of the Series (2000 to 2013)

Data is collected for 25 European and 5 large non-European advanced economies[11]. The models are estimated from Q1 2000 to Q3 2013 (51 observations). The dependent variable is nonperforming loans of banks to total gross loans. The unique and superior sample of NPL ratio has been compiled from national central banks and supervisory authorities as well as the IMF and the World Bank (see section 3.2 for a discussion of the benefits of compiling such series and Appendix I for the definitions used). The explanatory variables are real GDP growth, CPI growth, unemployment rate and the long term interest rate which have been seasonally adjusted using X-12 ARIMA method in Matlab[12]. The specific use of GDP and CPI in log differences is motivated from studies by Nkusu (2011) and Beck et al. (2013) where the inflation and GDP levels are transformed into growth rates while NPLs, unemployment and the long term interest rate are measured in percentages.

Appropriate weights are built using export data and lending data and it is important that these weights reflect as close as possible the underlying linkages between the countries. This is because the construction of weights will impact the construction of foreign specific variables which is a critical factor determining the global solution to the model (Dees et al. 2007). The financial trade data is built based on lending data from the BIS while the trade weights are built using export data from the Direction of Trade database from the IMF (Appendix I, Tables 1 and 2 in Appendix II). As can be seen when comparing country pairs, there are significant differences in the trade and financial weights used. For example, Spain has a very high share of financial weights with the UK whilst the Baltics and the Nordic region have a high financial share with Sweden. Both these shares are higher than trade shares. Germany has strong trade exposures to most European countries compared to its financial shares with the rest of Europe. The trade weight matrix reveals interesting information about cross country linkages. For example, with the exception of Slovenia, Portugal, Norway, Latvia, Ireland and Belgium, Germany is consistently the most important trading partner for European countries whilst the

[11] Countries include: Australia, Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom and United States.

[12] The method applied was the S_{n*m} seasonal filter to de-seasonalise the quarterly time series that were available on a non-seasonally adjusted basis to complement the data from Eurostat.

most important financial partners for European countries appear to be a mixture between the US, Sweden and UK.

5.2.1. Unit Root Tests

To estimate the model the procedures included in the GVAR toolbox provided by Vanessa Smith and Alessandro Galesi have been used[13]. The first step in the analysis is to understand the integration properties of the variables examined. This is important even though the GVAR methodology can be applied to both stationary and non-stationary variables because it allows us to distinguish between long term and short term relationships. If the variables included in the analysis are integrated of order I(1) it would be possible to interpret those long run relationships as co-integrating (Pesaran & Smith 2005; Dees et al. 2007). As such, the analysis begins by examining the integration properties of the variables displayed in results from the unit root tests. The Augmented Dickey-Fuller (ADF) tests on levels and first differences for the domestic and foreign variables are displayed in Table 5 and Table 6 in Appendix II. The lag order of the ADF test is determined by the minimization of the Akaike Information Criteria (AIC) with the maximum lag order set to 4. The results show that the majority of the variables are unable to reject the null hypothesis of non-stationarity[14]. The analysis continues on the basis that the majority of the variables are I(1).

5.2.2. Lag Orders of the Individual VARX Models

The second step is to select the lag orders of the individual country VARX* models i.e. p_i and q_i based on the AIC criteria. Where p_i and q_i are the lag order of the domestic and foreign variables respectively. However, for the purpose of this analysis, the order of the underlying VAR models were given as one due to the small number of time-series observations available and the large number of endogenous variables and unknown parameters involved to ensure stability of the GVAR (Pesaran et al. 2000; Nkusu 2011). Thus, all country models will contain five endogenous variables and their corresponding foreign specific counterparts. Hence, the GVAR model includes in total 150 (30 * 5) endogenous variables.

[13] The toolbox is available to download from http://www-cfap.jbs.cam.ac.uk/research/gvartoolbox/index.html.

[14] Between 92 % to 100 % of the domestic and foreign NPL ratios, ten year bond yields and unemployment rate are I(1). The majority of the real GDP growth and inflation growth variables are stationary since real GDP and inflation are measured in first differences to reflect the quarterly growth rate in line with the literature.

5.3. Estimation of the Country Specific Model in Error Correction Form

Given that most of the variables are I(1), the vector error correction model is used when estimating each country VARX* model. Thus, following Dees et al. (2007) the modelling begins with assuming that (i) all country specific variables are I(1), (ii) the country-specific foreign variables are weakly exogenous and (iii) the parameters of the individual models are stable over time. Assumption (ii) will be tested later on in the analysis whilst assumption (i) and (iii) were successfully met as outlined in section 5.2.1 and 5.1.

5.3.1. *Deterministics of the VECMX Models*

For the majority of the countries the variables contain a deterministic trend as can be seen from the first differences of the variables (provided in the unit root tests) and by initial inference. As such, the appropriate vector error correction model that has been used for most countries is given by Case IV (unrestricted intercepts and restricted trend coefficients) (Pesaran et al. 2000). This choice of deterministics in the estimation is based on visual inspection of the data from which one can infer that there is an intercept in the data and therefore exclude Case 1 (no intercept, no trend) and Case 2 (restricted intercept, no trend). Case 5 (unrestricted intercept, unrestricted trend) is also not included since if the first-differences of the variables display a trend it can be captured in Case IV. Furthermore, if there is no trend in the first differenced series but when estimating the VECMX* model with Case IV the coefficients attached to the trend is close to zero, the results will resemble that of a VECMX* estimation with Case III. However, to more formally distinguish between Case IV and Case III and whether the cointegrating relations are trended a test for co-trending restrictions was performed. The results showed that for the baseline model, the trend coefficients (a_i) in the VECMX* specifications in section 4.3 were mostly restricted to lie in the cointegrating space (Pesaran et al. 2000; Pesaran et al. 2002; Smith & Galesi 2011) with the exception of Belgium, Croatia, Czech Republic, Lithuania, Luxembourg, UK and the US where Case III is used.

5.3.2. Cointegration Tests

Second, the number of cointegrating relationships for the individual VARX* models are computed using the Johansen trace statistics as outlined in Pesaran, Shin, & Smith (2000). Detailed cointegration results for the maximum eigenvalue and trace statistics at the 5 percent significance level are presented in Appendix II. The Johansen's trace and maximum eigenvalue test support the existence of cointegrating relationships and the number of cointegrating vectors varies from 1 to 4.

The number of cointegrating relations for a few of the sampled countries has been reduced by one to two units. This was required in order for the persistency profiles of the cointegrating relations to converge to zero after 40 periods and for the eigenvalues to lie on or inside the unit circle (Smith & Galesi 2011). Thus, the final choice of the baseline estimation was determined by satisfactory performance of the stability of the model related to the eigenvalues and persistency profiles of the model[15].

5.4. Weak Exogeneity Test

The main assumption underlying the GVAR methodology is that the foreign specific variables are weakly exogenous and stable over time (di Mauro & Smith, 2013). In line with Dees et al. (2007) the weak exogeneity test is performed by testing the joint significance of the estimated error correction term for the country specific foreign variables.

The results are summarised in Table 12 in Appendix II. The assumption is not rejected for most of the foreign variables with the exception of 7 of the endogenous variables out of 150. Given that so few foreign variables fail to satisfy the weak exogenity assumption the outcome appears satisfactory and as such the estimation procedure for each country model in the GVAR appears justified.

5.5. Serial Correlation Test

Due to the fact that we are considering a VARX(1,1)* specification (due to the data limitations and the relatively large number of endogenous variables involved) it is important to check that the model adequately deals with the dynamics of the interrelationships that exists in the world economy (Pesaran et al. 2002). As such a test for serial correlation of order 4 in the residuals of the error correction regression for all the 150 endogenous is conducted. The results show that 65 percent of the endogenous variables pass the residual correlation test at 95 percent significance level.

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[15] It was often the case that for a few countries the number of cointegrating relations was too high for a single country, causing the persistency profiles to behave badly. The final specification was therefore derived provided that the conditions for stability and convergence was met

Overall, the results from the tests suggest that we can proceed with the examination of the interaction between variables using the Generalised impulse response functions.

5.6. Impact Elasticities

The contemporaneous effects of NPLs of foreign variables on the domestic variables are provided in Table 9. This thesis is partly interested in whether there is evidence of NPL linkages across European and other large advanced countries. The contemporaneous effects of Table 9 provide information regarding the linkages between the domestic and foreign variables of NPLs which are shown to be mostly significant and have a positive sign (70 percent of the NPL variables). This implies strong co-movement between the domestic and foreign variables of NPLs in Europe and other large advanced countries. In Spain for example, a one percent change in the foreign NPL ratio in a given quarter leads to a 1.5 percent increase in the domestic NPL ratio within the same quarter. In other words Spain as well as other countries such as Denmark, Netherlands and the UK appear to overreact to a variation in the nonperforming loans of its financial partners (as the impact coefficients are higher than one) whilst Italy and France show signs of underreacting to the same changes. These results are interesting and suggest that contemporaneous effects of nonperforming loans are present for European countries through the financial channel. As such, these results already provide an indication of what the dynamics (discussed in the next section) will display; strong synchronisation in changes to NPL ratios and striking evidence of NPL linkages across European countries and other large advanced economies.

6. <u>The Dynamic Effects</u>

The baseline model is the model that uses financial weights and lending data from the BIS when constructing the foreign specific variables in the VARX* specification. The country specific shocks that will be analysed are organised into *real shocks*, i.e. shocks to GDP growth, inflation growth and the unemployment rate, and *financial shocks*, i.e. shocks to the long term interest rate and banks' NPL ratio[16].

[16] The shocks have been chosen based on an ECB lunch seminar (February 2014) on 'Enhanced Stress Testing and Financial Stability' with Matthew Pritsker from the Federal Reserve Bank of Boston. The stress-testing process of the Comprehensive Capital Analysis and Review 2014/3 (a stress-testing program known as CCAR) used scenarios such as, a decline in US real GDP of between 4-3/4 %, a US yield curve flattening or steepening, a Japanese weakening in 2013,

In this analysis the focus is to understand the dynamic interactions between macro variables and NPLs rather than understanding which shock comes from which feedback loop. With generalised impulse response functions the ordering does not matter and as outlined previously this is an important fact since even though we can derive a suitable ordering of the variables using economic theory or a priori reasoning it is not clear how to order the countries when applying the GVAR (Dees et al. 2007). The analysis of the impulse responses will focus on a two to three year period which is consistent with the literature and economic theory.

The analysis of the impulse responses includes confidence intervals of 80 percent significance level (70 percent for unemployment rate). Although some of the responses appear not significant using the standardised confidence bands, this is not surprising given the model is estimated using only 51 observations. Nonetheless, there is still an economic interest in analysing the macroeconomic determinants of NPLs given the recent rise in trends in nonperforming loans across Europe and the heightened agenda among EU policy makers to deal with the systemic risks it imposes on the financial system. As such, focusing the analysis on the dynamic properties of the responses rather than the significance of the signs provides an important input to the research on macroprudential policy and understanding systemic risk[17].

6.1. A negative shock in US GDP growth confirms the hypothesis that European nonperforming loans are particular sensitive to shocks stemming from the US.

Figure 1 in Appendix III plots the results associated with a one standard error negative shock to the US real GDP growth rate. The negative shock of US GDP growth results in a positive rise in the NPL ratio across a majority of the European countries. The response for the US itself shows an instantaneous rise followed by a steady increase over time until it reaches its peak after 5 quarters (equal to 17 percent). The European countries generally display a rising pattern although the rise in NPLs only starts after the first year. The average rise in NPL ratio for Spain in the second year is ten percent, UK 14 percent and Italy 17 percent whilst for Germany and

a rise in US unemployment rate to 13 % in 2013, a fall in equity prices by 50 % in 2014 or a lowering of the US interest and inflation rate (Pritsker 2014).

[17] Sometimes there were oscillating signs in the impulse responses. The bootstrap simulation also had some rapidly widening confidence bands for the GIRF. As such, the main results presented are only an indicative of impulse response of European banks' nonperforming loans.

France the response is slightly lower (around five and eight percent respectively). It appears as if European banks' NPL ratios rise in response to a negative shock to US GDP growth, and whilst the impact is an immediate rise to US NPL ratios, the shock takes a while longer to transmit (after one year) to the European economies. The economic explanation is that when there is a slowdown in the US economy, borrowers will have greater difficulty in repaying their debt in the US. However, since banks are increasingly globalised and have shared exposures, European banks also indirectly via balance-sheet interlinkages, face similar vulnerabilities as in the US. As such, we can see that the impact of a US slowdown, not only affects US banks' NPLs, but also banks' NPLs in other European countries.

The results are compared to shocks associated with a negative shock in the GDP growth in other large advanced countries. Austria, Belgium, France, Germany and Sweden are countries which show small but rising NPL trends in response to a negative shock to the German GDP growth whilst for the remainder of the countries the results are to a large extent insignificant. With the exception of Portugal and Estonia, rising bank NPL ratios are generally associated with a negative shock in the Japanese GDP growth rate (although for a large number of countries the results are insignificant), with the impact being small and immediate over the first year. Generally, the response of rising NPL ratios is much weaker when the shock to GDP growth rate originates in Germany and Japan compared to when the shock originates in the US. The impact on German NPL ratios is even higher when the GDP growth shock originates in the US than when originating in Germany itself (around five versus two percent respectively), bearing in mind that the shock from the US takes a year to impact German NPL ratios.

Overall, the results show an increase in the NPL ratio for many of the countries involved but the effect is particularly strong when the shock originates in the US. This is consistent with economic theory which suggests that rising incomes and reduced financial distress associated with a rise in real GDP is negatively associated with NPLs. Furthermore, the results are consistent with the hypothesis and literature on the international transmission of US shocks on European countries which show that European economies are in particular sensitive to shocks stemming from the US, and perhaps more so than from shocks occurring at home.

6.2. A rise in the US unemployment rate shows that the impact is strong on most European economies after the second year.

A positive shock to US unemployment rate has on average a strong immediate impact on most of the European banks' NPL ratios after the second year. Thus, not only does the rise in unemployment rate in the US have a strong impact on NPLs in the US (ten percent), it also impacts NPL ratios in other European countries and in particular those for the UK, Spain, France and Germany who on average see a rise in NPL ratios of between five to 18 percent. Again, the same economic reasoning can be applied: when there is a slowdown in the US economy the rise in unemployment implies that borrowers face greater difficulties in repaying their debt in the US. However, because banks' NPLs are globally interlinked, vulnerabilities to the US unemployment rate extend across borders. As such, European banks also indirectly via balance-sheet interlinkages face similar vulnerabilities as in the US.

6.3. A rise in US inflation growth rate has a strong impact on European nonperforming loan ratios (especially countries with a dominant financial sector), whilst shocks to German and Japanese inflation growth takes longer to transmit.

Figure 5 shows a positive one standard error shock to US inflation growth which has a strong positive impact on the NPL ratios of European countries in the second year and their dynamic behaviour appears to be interlinked with the US. Thus, the impact on US NPLs are immediate and large (one percent rise on impact) and reaching its peak in the second year (on average 16 percent rise in NPL ratios). The European banks' NPL ratios follow a similar albeit lagged response as that of the US. In other words, the European NPL ratios start to impact after the first year and stabilises over time at around that level. The strongest impacts are seen in the European countries with relatively larger financial sectors, such as Sweden, UK, Spain and Ireland (twelve, 17, 13 and eleven percent respectively after the first year). Meanwhile, the impact of a positive one standard error shock to German and Japanese inflation growth takes longer to transmit but nevertheless has a strong impact on the NPL ratios of other European economies, in particular the UK, Spain, Sweden, the Netherlands and Ireland. The results are consistent with economic theory which suggests that borrower's ability to service their debt falls as inflation reduces real income if nominal wages are sticky. Furthermore, inflation is also likely to reduce borrowers' debt service capacity as lenders adjust their lending rates to maintain their real returns or pass on increases in policy rates associated with monetary policy actions to minimise the negative effects resulting from the rising inflation.

6.4. European nonperforming loans display synchronised dynamics with large advanced countries' interest rates. Countries with a large financial sector are particularly sensitive.

The magnitude of the rise in banks' NPLs following a positive standard error shock to the US ten year bond yield curve has a strong impact on most of the 25 European member states' NPL ratios between the second to sixth quarter (with the exception of Luxembourg, Poland, Slovakia and Estonia). The response for the US follows an immediate rise and reaches its peak in the fourth quarter (around 16 percent). The other European countries display similar dynamics as the US albeit with a two quarter lag: the bank NPL ratios in Europe starts to impact after the first year especially for the UK, the Netherlands, Spain, Sweden and Ireland (where the impact varies between 9 and 18 percent over the first year). Meanwhile, the effects following a rise in German long term interest rates also have a strong and significant effect between the first and second year (between 16 and ten percent rise for the UK, Spain and the Netherlands). Moreover, the response for German NPL ratios follows a similar response as from a shock to the US long run interest rate: on average between a two to ten percent increase between second and sixth quarter.

Finally, the impact from a rise in Japan's long term interest rate takes slightly longer to transmit. The response for Japan shows on average a seven percent rise in the first year and increases over time. The GIRF for the other European countries show a common behaviour as Japan: the impact starts after the first year and reaches its peak between the eighth and twelfth quarter. This is consistent with economic theory as a rise in interest rates are expected to weaken borrower's debt service capacity. Interest rates have also been used in the literature extensively in explaining payment difficulties via the debt service ratio (Brookes et al. 1994; Espinoza & Prasad 2010). Furthermore, the yield curve also has a large influence on bank profits and thereby bank's asset quality position which in turn via channels outlined in section 2.1 influences the future asset quality of banks (in particular if interest rate risk is not fully hedged by banks) (Basel Committee on Banking Supervision 2011).

Overall, the European countries NPL ratios display synchronised dynamics with large advanced countries. This is particularly true for countries with large financial markets such as Spain, UK, Netherlands and Sweden. The fact that the European GIRFs follow the US, Germany and Japan's dynamic responses suggest that the bank NPL responses to long run interest rates are strongly interrelated and in particular stemming from large advanced countries across borders.

6.5. The dynamics confirm evidence of strong nonperforming loan interlinkages across European countries and other large advanced economies.

Figure 11 shows the GIRFs associated with a positive standard error shock in US bank NPL ratios. The European bank NPL ratios display the same dynamics as already identified in the impact elasticities (Section 5.6). That is, strong synchronisation in changes to NPL ratios and striking evidence of NPL linkages across European countries and other large advanced economies. Similar to the responses associated with shocks to the long run interest rates, the NPL ratios of Spain, UK, Ireland, Sweden and the Netherlands are particularly responsive with an average response in the second year of around a ten percent increase. The GIRFs following a positive standard error shock to German NPL ratios have a common behaviour to that of US NPL shocks: they start to rise after the first year (around ten percent on average) for Spain, UK, Ireland, Sweden and the Netherlands. The rise in NPL ratios follow a similar pattern to that of shocks in the long run interest rate in that the response is rather immediate and occurs between the second and eighth quarter. Meanwhile, Figure 13 displays the GIRFs associated with a positive standard error shock to Japan's bank NPL ratio. For a few of the European countries the dynamic behaviour of European NPL ratios appears to be moderately correlated to that of Japan's NPL ratio, albeit at a lesser extent than that of the US. The strongest response is for the UK: the associated GIRF increases over time and stabalises at 15 percent in the third year. Thus, the dynamic responses associated with a shock to the UK bank NPL ratio suggest that European NPL ratios are strongly interrelated with that of the UK. In particular this is true for countries with developed financial systems, such as Spain, Ireland, Sweden and the Netherlands with average responses of 17, 20, twelve and 16 percent respectively between the second and eighth quarter.

7. <u>Sensitivity Analysis – The Trade versus Financial Transmission Channels</u>

7.1. Real shocks from the US on European nonperforming loan ratios are primarily spread via the financial channel.

To account for possible differences in the dynamics due to the differences in weighting schemes, the baseline model is re-run using a weighting scheme that is based on export data from the IMF Direction of Trade statistics rather than financial data of the locational banking statistics from the BIS. The dynamic impulse responses from a negative standard error shock to US GDP are displayed in Appendix III (Figure 15). Figure 15 illustrates how the magnitude of the dynamic response from a negative US GDP growth shock on banks' NPLs differs when transmitted via the trade channel compared to when transmitted via the financial channel. On average the response on US banks' NPLs in the first five quarters is three percent when the shock is transmitted via the trade channel compared to seven percent when the shock is transmitted via the financial channel. Similarly, the average response to a negative US GDP growth shock on German banks' NPLs in the second year is five percent (via the financial channel) and two percent (via the trade channel). Depending on the country the effect may vary considerably, however in general when shocks to US GDP growth are transmitted via the trade channel the responses of European banks' NPLs are not even half as responsive as when transmitted via the financial channel. Thus, it appears as if European banks react more strongly if shocks to real GDP growth in the US are spread via the financial channel. This is consistent with the fact that the BIS data will serve to reflect the importance of the bank balance sheet channel in transmitting shocks across countries. Furthermore, when the foreign specific variables are computed using different weighting schemes it will impact the global solution of the model. As illustrated in Table 3 in Appendix II, the US and the UK for example, have a proportionally higher exposure to the smaller European countries in terms of financial weights while Germany has a proportionally higher exposure to the same countries when applying the trade weighting scheme. As such, the variable dynamics will be quite different when using trade weights compared to financial weights.

Figure 16 shows the dynamic responses from a negative shock to German GDP growth on European banks' NPLs when trade weights are applied. Again, the impact is smaller for trade based weights than financial based weights. In for example Austria, banks' NPL ratios rise by one percent in the first four quarters when using trade weights compared a two percent rise when financial weights are being used. Furthermore, the sign of the shock responses also differs considerably. On average European banks' NPL ratios fall by four percent in the first year when using trade weights whilst the average European NPL response is marginally positive (0.5 percent) in the first year when financial weights are applied. The fact that the sign of the dynamics for Germany is mostly negative under the trade based weighting scheme could have an important economic interpretation in that European banks' exposure to Germany is relatively higher when using export based weights (Table 3). As such, a strong export led German recovery in recent years (at the same time as NPL ratios in Europe have been rising) may lead to negative dynamic impulse responses.

Finally, Figure 17 display a one standard error shock to US inflation growth associated with the trade weighting scheme. It shows a positive impact on the NPL ratios of European countries in the second year and their dynamic behaviour appear to follow that of the US. However, the impacts are significantly smaller in magnitude compared to when the financial weighting scheme is being used. For example, Swedish banks' NPL ratios rise by a mere one percent in the second year compared to twelve percent when financial weights are applied. Similarly, responses for the UK, Spain and Ireland rise on average by seven percent (compared to 17 percent for financial weights), eight percent (13 percent for financial weights) and one percent (eleven percent) respectively in the second year.

Overall, it appears as if the dynamics of the responses vary considerably but that the response of European banks' NPLs to shocks in real activity stemming from the US are considerably larger in magnitude when transmitted via the financial channel (except for shocks to US unemployment rate when the trade channel dominates). The fact that the variable dynamics are quite different when using trade weights compared to financial weights is not surprising given that the global solution of the model change. The policy implication is that the financial transmission channel of real shocks from the US matters for European banks' NPLs and increasingly so given that European banks NPLs are globally interlinked. As such, the financial channel carries an even more important role in transmitting shocks across borders.

7.2. The financial channel appears to be the main channel for which the US long term interest rate is transmitted to European bank nonperforming loans.

Figure 18 displays the response of European NPLs associated with a shock to the US long run interest rate. Also in this case, the majority of the GIRFs associated with for example a positive shock to US long run interest rates appear to increase the NPL ratio of European economies, such as Spain, Sweden, Germany, France, the Netherlands and Ireland. However, although the differences are not too large in NPL responses for countries such as Germany and France when transmitted via the trade channel (one and three percent) versus financial channel (four and five percent), the effects vary considerably more for countries such as the UK (four versus nine percent) and Spain (eighth versus twelve percent) when transmitted via the trade versus financial channel respectively. As such, the financial channel appears to be the main channel for which financial shocks are transmitted to European bank NPL ratios. Although for countries such as Germany and France, the effects of the trade versus financial channel are broadly similar in size whilst for the UK the financial channel outplays the trade channel, which is not surprising given its traditionally strong financial sector.

As a further robustness check the model was re-run using NPLs in log differences rather than NPLs in levels (ratios). The reason being, log differences may better account for possible qualitative and measurement differences in the dependant variable which may impact the results (Klein 2013; Beck & Jakubik 2013). The results mostly become insignificant to these changes although the variable dynamics are broadly similar to the baseline specification.

8. Conclusion

The primary aim of the thesis was to demonstrate that NPLs of European countries are affected by the macroeconomic conditions of the US, Japan, Germany and the UK. The results have shown that European countries' NPLs are affected by macroeconomic conditions in the US, Japan and Germany and highlight the interlinkages that exists between the asset quality of banks in Europe and macroeconomic conditions in large advanced countries. In particular, European banks' NPLs are vulnerable to shocks in real economic activity coming from the US. That is, European banks' NPLs are sensitive to US GDP growth shocks. A positive shock to the US unemployment rate shows that the impact is strong on most European economies after the second year. Furthermore, shocks to US inflation growth have a strong impact and in particular on those European countries with a dominant financial sector. Whilst the German and Japanese inflation growth rate have significant and positive effects on European banks' NPL ratios, these take longer to transmit to Europe. NPLs of banks in Europe also display synchronised dynamics with the US, German and Japanese long term interest rates. Again, countries with a relatively large financial sector are particularly sensitive.

The response of European banks' NPLs to real activity shocks stemming from the US is considerably larger in magnitude when transmitted via the financial channel than the trade channel. That the sign and the magnitude of the effects change when using trade weights is not surprising given that the cross-pair country exposures for some of the countries change. The estimates reflected in the impulse responses represent an important input to the research on macro-stresstesting models as well as the current financial stability work conducted at many central banks. The policy implication of the analysis is that the making of US economic policy in particular has a central role in influencing the development of banks' nonperforming loan ratios in Europe.

The model could be extended to add endogenous variables such as the short term interest rate, exchange rate (global variable), house price index and the stock price volatility index since interest rates and asset prices have been suggested by the literature to affect bank asset quality. The analysis could also benefit from using trade weights for the foreign variables related to the real economy (i.e. real GDP growth, CPI growth and the unemployment rate) and financial weights for foreign variables related to the financial sector (i.e. the long term interest rate and nonperforming loan ratio).

Appendix I

Table 1: Explanatory Variables

Description	*Data Source*
Unemployment rate (ratio)	Eurostat
10 year government bond yield (ratio)	Eurostat/datastream
Logarithmic difference of real GDP	Eurostat
Logarithmic difference of CPI	IMF (Index 2005=100)

Table 2: Dependent Variables

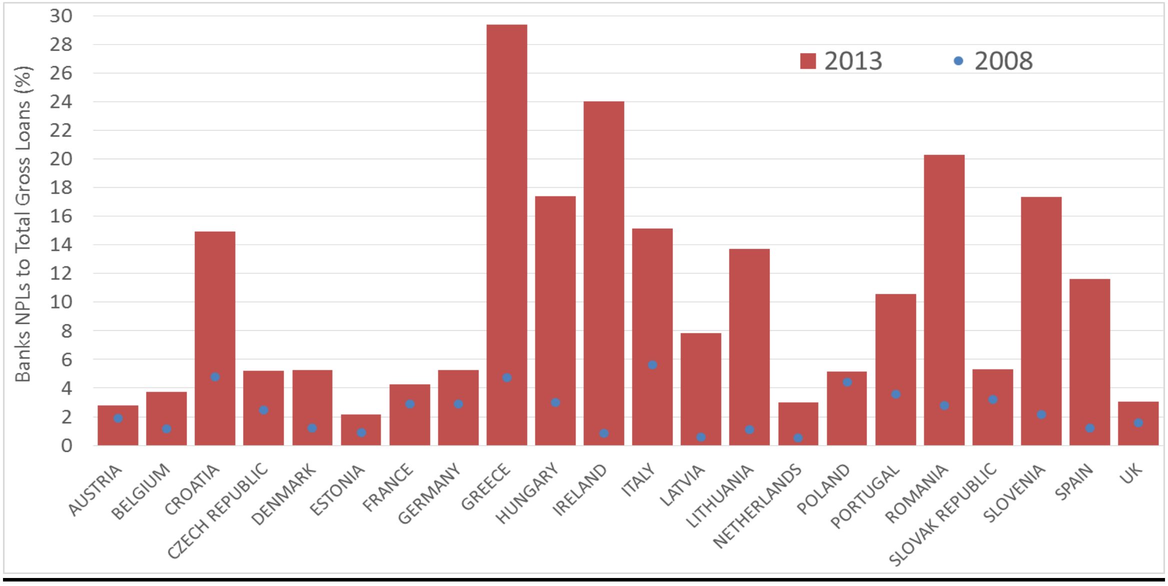
Description	*Data Source*
Bank nonperforming loans to total gross loans (across-country consolidated). IMF FSI definition of NPL recommends that loans (and other assets) should be classified as NPL when (1) payments of principal and interest are past due by three months (90 days) or more, or (2) interest payments equal to three months (90 days) interest or more have been capitalised (re-invested into the principal amount), refinanced, or rolled over (i.e. payment has been delayed by arrangement). The 90-day criterion is the time period that is most widely used by countries to determine whether a loan is nonperforming. Incorporates all credit institutions.	IMF Financial Soundness Indicators
Bank nonperforming loans to total gross loans are value of NPLs / total value of loan portfolio (including NPL before deduction of specific loan-loss provisions). The loan amount recorded as NPL should be the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue. Incorporates all credit institutions.	World Bank
Loans that are overdue are more than 60 days non-performing. Not net of provisions.	Bank of Estonia
The reporting entities are banks and foreign bank branches operating in Czech Republic and excludes non-bank credit institutions.	Bank of Czech Republic
Includes all banks and credit institution. Defines nonperforming/impaired as a specific debt where payments are unlikely to be completed according to the contract terms.	Finansinspektionen (Swedish Financial Service Authority)
Distinguishes between "standard," "substandard," "doubtful due to customer arrears," "doubtful for reasons other than customer arrears," and "write-off" loans. The last three categories comprise NPLs. Since the category "doubtful due to customer arrears" refers to arrears of more than three months and the category "doubtful for reasons other than customer arrears" relates to reasonable doubts about full repayment on contractual terms (of principal and interest).	Bank of Spain
Bank of Lithuania use non-cross country consolidated NPL data and excludes nonperforming loans of AB Ukio bankas in their ratio for 2013.	Bank of Lithuania
Categories of nonperforming loans include substandard, doubtful and lost loans.	Bank of Latvia
Greek commercial banks NPL ratios (business, mortgage and consumer loans)	Bank of Greece
Includes nonperforming assets (due>90days) over outstanding loans. Include bank guarantees.	Bank of Finland
Cross country unconsolidated nonperforming loan data.	Finanstilsynet (Norwegian Financial Service Authority)
Banks nonperforming loans (non cross-country consolidated).	Bank of Croatia
Overdue loans summed by type of economic activity.	Bank of Portugal

Table 3: Weighting Schemes

Description	*Data Source*
The financial weights are Bank of International Settlement consolidated banking statistics reporting banking group's on balance sheet claims on the rest of the world. The quarterly data covers lending data by head office and all its branches and subsidiaries worldwide on a consolidated basis. The data series have been rescaled for Australia, Canada, Japan, Romania and Luxembourgs using export data from the IMF.	Bank of International Settlements
Trade weights to reflect the value of exporting goods in US dollars on world wide basis.	IMF Direction of Trade Statistics
Data for construction of the aggregation weights was the average 2010-2012 GDP converted into international dollars using purchasing power parity rate.	World Bank

Appendix II

Figure 1: Bank Nonperforming Loans to Total Gross Lending (%) in European Economies



Source: National Central Banks, National Financial Service Authorities, IMF Financial Service Indicators. Note that an additional eight countries are included in this study but not illustrated in the chart.

Table 1: Financial Weight Matrix (Average 1999-2008)

	AUL	AUT	BEL	CAN	CRO	CZR	DEN	EST	FIN	FRA	GER	GRE	HUG	IRE	ITA	JAP	LAT	LIT	LUX	NET	NOR	POL	POR	ROM	SLR	SLV	SPN	SWE	UK	US
AUL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
AUT	0.01	0.00	0.01	0.00	0.31	0.19	0.01	0.01	0.01	0.01	0.04	0.03	0.17	0.02	0.03	0.01	0.02	0.02	0.01	0.01	0.01	0.07	0.01	0.05	0.31	0.34	0.01	0.00	0.01	0.01
BEL	0.02	0.03	0.00	0.01	0.01	0.30	0.03	0.00	0.02	0.07	0.03	0.07	0.13	0.05	0.07	0.02	0.00	0.00	0.31	0.13	0.03	0.09	0.04	0.03	0.13	0.08	0.04	0.01	0.05	0.03
CAN	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.06	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.26
CRO	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
CZR	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.01
DEN	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.11	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.02	0.00	0.01	0.08	0.02	0.00	0.01	0.00	0.01	0.00	0.17	0.01	0.01
EST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01
FIN	0.01	0.00	0.00	0.00	0.00	0.00	0.07	0.10	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.11	0.09	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.01	0.01
FRA	0.06	0.04	0.12	0.01	0.06	0.19	0.02	0.00	0.04	0.00	0.09	0.15	0.05	0.07	0.18	0.05	0.00	0.01	0.10	0.08	0.05	0.04	0.11	0.08	0.03	0.13	0.12	0.03	0.10	0.08
GER	0.10	0.38	0.11	0.02	0.15	0.14	0.16	0.05	0.12	0.16	0.00	0.21	0.34	0.20	0.22	0.08	0.13	0.16	0.31	0.16	0.18	0.27	0.17	0.23	0.11	0.31	0.19	0.19	0.19	0.12
GRE	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.01
HUG	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.01
IRE	0.01	0.06	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.05	0.07	0.00	0.00	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00	0.05	0.01	0.00	0.00	0.05	0.02	0.08	0.02
ITA	0.05	0.09	0.07	0.01	0.43	0.04	0.01	0.00	0.01	0.10	0.08	0.05	0.13	0.07	0.00	0.03	0.01	0.00	0.03	0.06	0.01	0.20	0.06	0.16	0.27	0.08	0.05	0.01	0.04	0.02
JAP	0.21	0.01	0.02	0.03	0.00	0.01	0.01	0.01	0.02	0.01	0.03	0.01	0.02	0.01	0.02	0.00	0.00	0.00	0.01	0.04	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.03	0.10
LAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
LIT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01
LUX	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NET	0.03	0.05	0.21	0.01	0.01	0.04	0.05	0.00	0.03	0.07	0.08	0.08	0.05	0.04	0.09	0.02	0.00	0.00	0.08	0.00	0.03	0.13	0.05	0.05	0.07	0.02	0.08	0.04	0.07	0.07
NOR	0.00	0.00	0.01	0.01	0.00	0.00	0.05	0.00	0.06	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.01	0.01
POL	0.00	0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.01
POR	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.00	0.01	0.00	0.00	0.06	0.00	0.01	0.01
ROM	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.05	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00
SLR	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.01
SLV	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
SPN	0.02	0.01	0.03	0.00	0.00	0.00	0.01	0.00	0.01	0.06	0.05	0.02	0.01	0.04	0.04	0.01	0.00	0.00	0.01	0.04	0.02	0.01	0.28	0.04	0.00	0.00	0.00	0.01	0.06	0.02
SWE	0.02	0.01	0.01	0.00	0.00	0.00	0.31	0.74	0.40	0.01	0.03	0.01	0.00	0.01	0.00	0.01	0.69	0.67	0.01	0.01	0.27	0.02	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.01
UK	0.06	0.07	0.16	0.02	0.01	0.01	0.14	0.00	0.06	0.18	0.21	0.10	0.01	0.34	0.11	0.03	0.00	0.00	0.02	0.16	0.09	0.01	0.11	0.03	0.00	0.01	0.24	0.11	0.00	0.16
US	0.33	0.06	0.11	0.85	0.01	0.04	0.08	0.00	0.06	0.21	0.20	0.09	0.04	0.08	0.07	0.35	0.00	0.01	0.06	0.21	0.06	0.08	0.05	0.02	0.04	0.01	0.09	0.09	0.24	0.00

Source: Sgherri & Galesi (2009), Bank of International Settlements consolidated foreign claims of reporting banks immediate and ultimate basis on individual countries. The financial weights are displayed in columns by country where each column adds to one. Weights for Canada, Australia, Japan, Romania and Luxembourg have been rescaled using export data from the IMF. The rescaling has negligible effects on the original weights.

Table 2: Trade Weight Matrix (Average 2010-2012)

	AUL	AUT	BEL	CAN	CRO	CZR	DEN	EST	FIN	FRA	GER	GRE	HUG	IRE	ITA	JAP	LAT	LIT	LUX	NET	NOR	POL	POR	ROM	SLR	SLV	SPN	SWE	UK	US
AUL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01
AUT	0.01	0.00	0.01	0.00	0.10	0.06	0.01	0.01	0.01	0.01	0.06	0.02	0.08	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.05	0.08	0.13	0.01	0.01	0.01	0.01
BEL	0.02	0.03	0.00	0.01	0.02	0.03	0.04	0.03	0.05	0.14	0.10	0.06	0.03	0.04	0.06	0.02	0.02	0.06	0.31	0.15	0.04	0.05	0.04	0.03	0.02	0.03	0.05	0.05	0.07	0.03
CAN	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.06	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.42
CRO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
CZR	0.00	0.05	0.01	0.00	0.03	0.00	0.02	0.02	0.02	0.02	0.06	0.01	0.05	0.01	0.02	0.00	0.02	0.02	0.01	0.02	0.01	0.06	0.01	0.03	0.24	0.03	0.02	0.02	0.01	0.00
DEN	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.02	0.04	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.02	0.03	0.00	0.01	0.09	0.02	0.01	0.01	0.01	0.00	0.01	0.10	0.02	0.01
EST	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
FIN	0.01	0.00	0.01	0.00	0.01	0.00	0.02	0.13	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.05	0.03	0.00	0.01	0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.07	0.01	0.00
FRA	0.06	0.03	0.13	0.01	0.04	0.04	0.05	0.02	0.04	0.00	0.11	0.11	0.06	0.05	0.15	0.05	0.03	0.04	0.10	0.07	0.03	0.06	0.09	0.08	0.05	0.06	0.19	0.06	0.08	0.04
GER	0.10	0.52	0.19	0.02	0.20	0.36	0.26	0.15	0.20	0.25	0.00	0.20	0.30	0.10	0.26	0.08	0.15	0.17	0.31	0.25	0.15	0.36	0.16	0.23	0.24	0.22	0.21	0.22	0.19	0.10
GRE	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00
HUG	0.00	0.04	0.00	0.00	0.08	0.04	0.01	0.01	0.00	0.01	0.03	0.01	0.00	0.00	0.02	0.00	0.01	0.01	0.00	0.01	0.00	0.03	0.01	0.13	0.11	0.05	0.01	0.01	0.01	0.00
IRE	0.01	0.00	0.05	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01	0.04	0.03
ITA	0.05	0.08	0.04	0.01	0.17	0.05	0.04	0.04	0.04	0.11	0.08	0.19	0.07	0.02	0.00	0.03	0.04	0.06	0.03	0.03	0.03	0.08	0.07	0.16	0.05	0.23	0.12	0.04	0.05	0.04
JAP	0.21	0.01	0.02	0.03	0.00	0.02	0.01	0.01	0.02	0.01	0.03	0.01	0.02	0.01	0.02	0.00	0.00	0.00	0.01	0.05	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.03	0.16
LAT	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
LIT	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
LUX	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NET	0.03	0.06	0.27	0.01	0.04	0.08	0.11	0.04	0.11	0.11	0.19	0.10	0.06	0.07	0.09	0.02	0.05	0.06	0.08	0.00	0.08	0.08	0.07	0.05	0.03	0.05	0.09	0.09	0.10	0.03
NOR	0.00	0.01	0.01	0.01	0.00	0.01	0.08	0.02	0.04	0.02	0.02	0.01	0.00	0.03	0.01	0.01	0.01	0.02	0.00	0.05	0.00	0.02	0.01	0.00	0.00	0.00	0.01	0.08	0.09	0.01
POL	0.00	0.02	0.01	0.00	0.03	0.10	0.04	0.07	0.02	0.02	0.05	0.02	0.07	0.01	0.03	0.00	0.09	0.15	0.01	0.02	0.02	0.00	0.01	0.05	0.08	0.03	0.02	0.04	0.02	0.00
POR	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.01	0.00
ROM	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.05	0.00	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00
SLR	0.00	0.04	0.00	0.00	0.02	0.10	0.01	0.00	0.00	0.01	0.02	0.01	0.08	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.04	0.00	0.03	0.00	0.02	0.01	0.01	0.01	0.00
SLV	0.00	0.02	0.00	0.00	0.14	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00
SPN	0.02	0.02	0.03	0.00	0.02	0.02	0.02	0.01	0.02	0.10	0.04	0.06	0.03	0.02	0.08	0.01	0.01	0.02	0.01	0.02	0.02	0.03	0.40	0.04	0.01	0.03	0.00	0.02	0.04	0.01
SWE	0.02	0.01	0.02	0.00	0.01	0.01	0.15	0.12	0.19	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.01	0.02	0.25	0.03	0.01	0.01	0.01	0.01	0.01	0.00	0.03	0.01
UK	0.06	0.02	0.07	0.02	0.01	0.03	0.06	0.03	0.04	0.06	0.06	0.05	0.03	0.46	0.05	0.03	0.03	0.02	0.02	0.10	0.07	0.04	0.04	0.03	0.01	0.02	0.07	0.07	0.00	0.06
US	0.33	0.02	0.09	0.85	0.03	0.01	0.03	0.02	0.05	0.05	0.05	0.03	0.02	0.12	0.05	0.35	0.05	0.06	0.06	0.11	0.05	0.02	0.02	0.02	0.00	0.02	0.05	0.04	0.11	0.00

Source: IMF Direction of Trade. Goods value of exports on individual countries. The trade weights are displayed in column by country and add up to 1.

Table 3: Changes to the Weight Matrix

	AUL	AUT	BEL	CAN	CRO	CZR	DEN	EST	FIN	FRA	GER	GRE	HUG	IRE	ITA	JAP	LAT	LIT	LUX	NET	NOR	POL	POR	ROM	SLR	SLV	SPN	SWE	UK	US
AUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AUT	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
BEL	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	-0.1	-0.1	0.0	0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
CAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
CRO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0
DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
EST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
FRA	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	0.0
GER	0.0	-0.1	-0.1	0.0	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0
GRE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HUG	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
IRE	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ITA	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.2	-0.1	-0.1	0.0	0.0	0.0
JAP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
LAT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NET	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
NOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0
POL	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
POR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLR	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLV	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SPN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWE	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.1
US	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0

The changes are the differences between the financial and trade weights.

Table 4: Average Pairwise Cross-Section Correlations: Variables and Residuals

	Nonperforming Loans			Real GDP Growth			Long Term Interest Rate			Unemployment rate			Inflation Rate		
	Levels	First Differences	VECMX Residuals	Levels	First Differences	VECMX Residuals	Levels	First Differences	VECMX Residuals	Levels	First Differences	VECMX Residuals	Levels	First Differences	VECMX Residuals
AUL	0.36	0.18	0.00	0.15	0.10	0.07	0.46	0.39	-0.01	0.27	0.40	-0.01	0.38	0.31	0.03
AUT	0.32	0.19	-0.02	0.45	0.14	-0.04	0.60	0.56	0.08	0.40	0.39	0.02	0.52	0.52	-0.02
BEL	0.66	0.46	0.02	0.48	0.27	0.10	0.61	0.53	0.13	0.22	0.28	-0.01	0.52	0.48	0.04
CAN	0.44	0.38	0.04	0.17	0.13	-0.02	0.50	0.39	-0.02	0.45	0.43	-0.01	0.42	0.42	-0.05
CRO	0.33	0.18	0.01	0.44	0.30	0.05	0.20	-0.02	0.04	0.31	0.21	0.02	0.45	0.39	-0.02
CZR	0.40	0.25	0.08	0.38	0.18	0.06	0.61	0.49	0.07	0.41	0.48	0.03	0.46	0.40	0.02
DEN	0.49	0.25	-0.04	0.38	0.18	0.07	0.54	0.45	-0.03	0.51	0.45	0.06	0.51	0.48	0.01
EST	0.59	0.32	0.00	0.47	0.18	0.03	0.54	0.21	0.04	0.43	0.37	0.04	0.49	0.39	0.01
FIN	0.59	0.48	0.01	0.49	0.22	-0.01	0.57	0.54	0.08	0.24	0.32	-0.01	0.42	0.42	-0.01
FRA	0.57	0.39	0.00	0.51	0.23	-0.01	0.60	0.55	0.10	0.45	0.45	0.00	0.54	0.52	0.02
GER	0.24	0.23	0.00	0.40	0.25	0.03	0.54	0.49	-0.12	-0.12	0.24	-0.04	0.52	0.50	-0.04
GRE	0.48	0.17	0.02	0.22	0.13	-0.01	-0.31	0.14	0.10	0.40	0.27	0.03	0.37	0.33	-0.01
HUG	0.51	0.41	0.01	0.39	0.28	0.06	0.30	0.21	0.09	0.24	0.32	0.04	0.30	0.25	0.04
IRE	0.53	0.49	-0.01	0.29	0.10	-0.04	0.08	0.36	0.09	0.33	0.36	0.03	0.43	0.47	0.04
ITA	0.55	0.31	0.00	0.43	0.11	0.05	0.20	0.37	0.09	0.42	0.26	-0.04	0.52	0.46	0.02
JAP	0.34	0.36	-0.04	-0.11	0.00	-0.02	0.37	0.35	0.02	0.29	0.39	-0.05	0.21	0.19	-0.05
LAT	0.62	0.43	0.06	0.41	0.16	0.01	0.31	0.06	0.03	0.47	0.37	0.01	0.32	0.23	0.03
LIT	0.63	0.42	0.01	0.46	0.25	0.01	0.35	0.06	0.02	0.41	0.34	0.01	0.30	0.23	0.02
LUX	0.14	0.08	-0.04	0.30	0.10	-0.03	0.57	0.50	-0.02	0.22	0.37	0.03	0.51	0.54	-0.01
NET	0.63	0.37	-0.06	0.43	0.07	0.01	0.57	0.54	0.02	0.29	0.26	-0.01	0.33	0.33	-0.03
NOR	0.56	0.35	0.04	0.38	0.26	0.00	0.55	0.46	0.02	0.30	0.34	-0.03	0.29	0.37	0.00
POL	-0.03	0.04	0.00	0.41	0.29	0.06	0.57	0.41	0.06	0.08	0.35	0.02	0.26	0.29	0.08
POR	0.45	0.20	-0.02	0.40	0.23	0.07	-0.18	0.33	0.07	0.23	0.25	0.01	0.46	0.38	0.04
ROM	0.60	0.33	-0.03	0.46	0.31	-0.03	0.38	0.06	0.04	0.20	0.40	0.01	0.17	0.02	0.03
SLR	0.43	0.18	0.04	0.39	0.23	0.07	0.54	0.36	0.00	0.35	0.45	0.04	0.26	0.17	0.03
SLV	0.65	0.42	0.07	0.49	0.29	0.09	0.30	0.14	0.04	0.48	0.48	0.03	0.44	0.44	0.04
SPN	0.54	0.47	0.06	0.42	0.14	0.06	0.07	0.34	0.07	0.38	0.26	0.02	0.51	0.47	0.05
SWE	0.54	0.32	-0.04	0.37	0.34	0.01	0.51	0.43	-0.12	0.17	0.26	-0.01	0.43	0.45	-0.06
UK	0.65	0.43	0.00	0.37	0.31	0.03	0.47	0.41	-0.18	0.30	0.32	0.00	0.35	0.49	-0.08
US	0.51	0.40	-0.09	0.00	0.11	-0.05	0.46	0.42	-0.14	0.38	0.37	-0.06	0.49	0.52	-0.02

Table 5: Unit Root Tests for the Domestic Variables at 5 percent Significance Level

Domestic Variabl	Critical Value	AUL	AUT	BEL	CAN	CRO	CZR	DEN	EST	FIN	FRA	GER	GRE	HUG	IRE	ITA	JAP	LAT	LIT	LUX	NET	NOR	POL	POR	ROM	SLR	SLV	SPN	SWE	UK	US
Npl (with trend)	-3.45	-2.31	-2.67	-1.49	-2.81	-1.08	-3.48	-2.21	-3.12	-2.04	-1.38	-2.06	-0.92	-1.45	-1.73	-1.67	-2.71	-2.87	-1.80	-1.67	-2.31	-1.93	-0.99	-2.62	-2.38	-2.04	-1.78	-2.26	-2.21	-2.33	-2.37
Npl (no trend)	-2.89	-0.74	-2.69	-2.50	-2.75	-2.05	-3.81	-0.09	-2.71	-2.21	-1.60	-2.25	-0.94	0.80	-0.13	-0.23	-3.33	-2.24	-1.05	-1.67	-2.19	-1.96	-0.93	-1.28	-1.78	-3.42	-1.44	-1.01	-2.24	-1.94	-1.38
DNpl	-2.89	-1.96	-3.87	-1.86	-2.60	-2.20	-2.50	-2.17	-1.91	-2.54	-2.35	-4.56	-4.06	-2.39	-3.26	-3.38	-2.80	-2.82	-2.47	-2.98	-2.62	-2.65	-2.16	-3.10	-4.33	-4.08	-2.67	-2.22	-2.18	-2.26	-3.05
y (with trend)	-3.45	-4.70	-3.03	-4.23	-3.85	-5.26	-6.28	-4.57	-3.13	-3.16	-2.74	-4.20	-6.28	-6.49	-2.52	-3.37	-5.69	-2.61	-3.16	-4.60	-3.29	-4.76	-4.79	-3.61	-4.40	-4.08	-3.11	-3.36	-4.43	-4.33	-5.48
y (no trend)	-2.89	-4.77	-3.05	-4.10	-3.91	-1.85	-5.70	-4.51	-2.95	-3.12	-2.53	-4.20	-2.03	-5.56	-2.30	-2.68	-5.64	-2.68	-3.19	-4.58	-2.88	-4.81	-4.81	-2.80	-4.21	-3.69	-2.47	-1.68	-4.44	-4.37	-5.57
Dy	-2.89	-5.60	-2.95	-5.53	-6.16	-7.98	-12.10	-8.09	-3.22	-6.13	-5.56	-8.01	-7.16	-7.45	-7.57	-6.40	-5.69	-3.74	-5.29	-8.91	-6.80	-5.65	-7.71	-6.69	-6.42	-6.57	-6.68	-4.01	-5.16	-9.05	-7.46
Lrr (with trend)	-3.45	-2.59	-2.74	-2.95	-3.48	-4.74	-2.49	-2.51	-2.83	-2.84	-2.59	-2.33	-2.35	-3.58	-2.65	-2.32	-2.26	-2.65	-1.98	-1.85	-2.62	-2.31	-3.24	-2.54	-2.28	-2.38	-1.53	-2.22	-3.02	-2.40	-2.80
Lrr (no trend)	-2.89	-1.77	-1.37	-1.96	-1.37	-4.20	-1.64	-1.32	-2.60	-1.51	-1.15	-0.95	-1.48	-3.61	-2.49	-2.41	-1.88	-2.67	-2.09	-1.55	-0.85	-1.21	-2.15	-1.83	-2.01	-1.79	-2.22	-2.16	-1.44	-0.55	-1.84
DLrr	-2.89	-4.29	-3.96	-4.26	-4.53	-4.61	-4.73	-4.49	-3.05	-3.65	-5.93	-5.45	-2.06	-4.76	-3.77	-3.96	-6.00	-3.12	-5.01	-4.06	-5.15	-4.69	-3.77	-3.93	-3.86	-4.65	-2.13	-5.02	-5.24	-5.91	-2.66
Un (with trend)	-3.45	-1.84	-3.66	-3.55	-2.22	-1.39	-2.58	-2.41	-2.83	-3.48	-2.34	-2.90	-1.13	-3.24	-1.52	-0.86	-2.27	-1.94	-2.96	-3.01	-2.60	-2.95	-2.77	-2.44	-2.34	-1.65	-2.12	-1.98	-2.78	-2.72	-3.04
Un (no trend)	-2.89	-1.81	-3.60	-3.63	-2.26	-1.79	-2.44	-2.40	-2.86	-3.50	-1.33	-1.54	-1.68	-1.04	-0.48	-0.87	-1.93	-1.52	-2.82	-0.65	-2.26	-2.54	-1.83	-0.99	-2.11	-1.96	-2.19	-0.71	-1.90	-0.45	-2.35
DUn	-2.89	-3.84	-3.54	-3.87	-3.41	-2.31	-3.36	-3.70	-2.46	-4.24	-4.64	-3.42	-1.93	-3.33	-2.24	-3.73	-3.41	-2.61	-1.50	-3.75	-2.92	-2.66	-2.33	-3.88	-3.93	-3.22	-3.06	-3.13	-3.39	-3.89	-2.67
Inf (with trend)	-3.45	-4.35	-4.19	-3.84	-5.54	-4.20	-3.28	-4.18	-3.84	-4.01	-5.03	-4.05	-3.59	-3.24	-3.02	-2.96	-3.02	-2.32	-2.16	-5.04	-3.62	-3.23	-3.95	-3.69	-4.25	-2.81	-2.89	-4.76	-4.89	-4.77	-3.71
Inf (no trend)	-2.89	-4.28	-4.27	-3.88	-3.88	-4.15	-3.30	-4.19	-3.89	-3.97	-4.94	-4.13	-2.87	-3.06	-2.29	-2.91	-2.93	-2.26	-2.26	-5.09	-3.28	-3.30	-4.01	-3.20	-4.95	-2.44	-2.72	-4.07	-4.65	-2.33	-3.75
DInf	-2.89	-5.19	-5.95	-6.29	-7.56	-5.00	-5.30	-5.45	-4.38	-6.02	-5.87	-8.39	-5.17	-4.74	-7.02	-5.27	-5.81	-5.23	-5.91	-6.51	-4.68	-6.31	-4.90	-5.55	-3.68	-4.06	-4.57	-6.63	-7.94	-7.24	-7.38

Note: Green highlights stationary properties in levels. Unit root tests on first differences are done including an intercept.

Table 6: Unit Root Tests for the Foreign Variables at 5 percent Significance Level

Domestic Variables	Critical Value	AUL	AUT	BEL	CAN	CRO	CZR	DEN	EST	FIN	FRA	GER	GRE	HUG	IRE	ITA	JAP	LAT	LIT	LUX	NET	NOR	POL	POR	ROM	SLR	SLV	SPN	SWE	UK	US
Npls (with trend)	-3.45	-4.20	-2.77	-2.83	-2.35	-1.18	-1.81	-2.50	-2.19	-2.53	-2.33	-2.58	-2.25	-1.85	-2.28	-2.21	-3.50	-2.17	-2.18	-2.20	-1.90	-2.75	-2.81	-2.32	-2.26	-1.64	-2.19	-1.92	-2.45	-2.45	-1.67
Npls (no trend)	-2.89	-3.80	-2.66	-2.36	-1.34	-1.48	-1.67	-2.41	-2.20	-2.22	-1.79	-1.75	-1.79	-1.85	-1.83	-1.90	-0.87	-2.20	-2.21	-2.22	-1.26	-2.42	-2.63	-1.45	-2.07	-1.38	-2.23	-1.98	-1.31	-1.72	-1.66
DNpls	-2.89	-2.73	-2.00	-2.29	-3.18	-3.14	-2.81	-1.95	-2.07	-1.89	-1.90	-1.77	-2.25	-2.46	-1.42	-2.20	-2.79	-2.07	-2.06	-2.19	-1.68	-1.83	-2.12	-2.09	-1.98	-2.85	-2.75	-2.63	-1.98	-2.67	-2.29
ys (with trend)	-3.45	-5.65	-4.61	-3.48	-5.51	-3.04	-3.31	-4.55	-4.48	-4.81	-4.04	-4.56	-3.94	-3.47	-4.14	-3.94	-4.60	-4.44	-4.45	-3.99	-4.72	-4.68	-3.78	-3.46	-4.58	-3.18	-3.42	-4.09	-3.65	-4.91	-3.95
ys (no trend)	-2.89	-5.40	-4.51	-3.39	-5.24	-2.87	-3.30	-4.60	-4.51	-4.86	-4.09	-4.60	-3.94	-3.48	-4.17	-3.91	-4.63	-4.47	-4.48	-4.01	-4.80	-4.73	-3.80	-2.80	-4.20	-3.09	-3.41	-4.13	-3.68	-4.97	-3.98
Dys	-2.89	-7.81	-6.52	-5.06	-7.66	-5.34	-4.75	-5.48	-5.22	-5.73	-6.53	-6.60	-5.00	-6.95	-8.73	-8.51	-7.56	-5.19	-5.21	-7.58	-7.25	-5.74	-4.95	-4.62	-5.76	-5.85	-5.88	-5.14	-5.58	-7.51	-5.99
Lrrs (with trend)	-3.45	-2.45	-2.84	-2.75	-2.76	-2.83	-2.98	-2.92	-2.89	-2.72	-2.87	-2.93	-2.90	-2.76	-2.66	-2.87	-2.95	-2.86	-2.84	-2.95	-2.85	-2.86	-2.82	-2.95	-2.78	-2.80	-2.75	-3.00	-2.69	-2.95	-2.76
Lrrs (no trend)	-2.89	-0.94	-1.32	-0.86	-1.75	-1.79	-1.36	-0.89	-1.37	-1.31	-0.98	-1.00	-0.91	-0.79	-0.68	-0.81	-1.61	-1.34	-1.32	-1.29	-0.88	-1.28	-1.48	-1.42	-1.58	-1.61	-1.29	-1.44	-1.23	-1.09	-0.75
DLrrs	-2.89	-6.14	-5.50	-5.84	-5.76	-5.25	-5.33	-5.54	-5.25	-5.33	-5.94	-6.04	-5.59	-5.50	-6.00	-5.70	-5.63	-5.28	-5.28	-5.29	-5.98	-5.44	-5.52	-5.82	-5.15	-5.24	-5.58	-5.85	-5.23	-5.79	-5.65
Uns (with trend)	-3.45	-2.98	-2.62	-2.95	-3.12	-1.96	-2.80	-3.79	-3.28	-3.40	-2.96	-2.66	-3.16	-2.64	-3.15	-3.07	-2.58	-3.21	-3.16	-3.58	-3.06	-3.47	-2.72	-2.27	-2.59	-2.23	-2.62	-3.33	-2.82	-2.95	-3.02
Uns (no trend)	-2.89	-2.62	-2.49	-1.91	-2.41	-2.01	-2.80	-1.88	-2.14	-1.85	-2.09	-1.65	-2.39	-2.65	-2.00	-2.35	-2.41	-2.34	-2.40	-3.31	-2.33	-2.09	-2.58	-1.19	-2.26	-2.11	-2.66	-2.08	-2.78	-2.24	-2.61
DUns	-2.89	-2.96	-2.95	-3.51	-2.73	-2.74	-3.10	-3.57	-3.71	-3.02	-3.16	-3.37	-3.62	-3.21	-4.09	-3.69	-2.72	-3.70	-3.67	-2.69	-3.60	-3.72	-3.06	-2.86	-3.20	-3.89	-3.54	-3.93	-3.82	-3.30	-3.39
Infs (with trend)	-3.45	-5.05	-4.07	-4.55	-3.71	-3.54	-4.57	-5.09	-4.86	-4.98	-3.45	-3.47	-4.15	-3.76	-4.52	-4.18	-3.99	-4.91	-4.95	-4.41	-3.57	-4.78	-4.02	-4.35	-3.93	-3.71	-3.80	-4.42	-4.46	-3.49	-4.55
Infs (no trend)	-2.89	-5.12	-3.88	-4.48	-3.76	-3.55	-3.60	-5.11	-4.72	-4.91	-3.47	-3.44	-3.90	-3.49	-4.53	-3.92	-3.99	-4.81	-4.84	-4.46	-3.61	-4.79	-3.94	-4.13	-3.66	-3.68	-3.85	-4.46	-4.53	-3.36	-4.41
DInfs	-2.89	-6.66	-5.62	-5.89	-7.31	-5.50	-5.78	-6.35	-7.42	-6.46	-6.36	-6.48	-5.69	-7.03	-6.07	-5.60	-6.85	-7.32	-7.27	-5.61	-6.45	-6.10	-5.68	-5.48	-5.90	-5.61	-5.47	-6.06	-5.85	-6.27	-5.97

Note: Green highlights stationary properties in levels. Unit root tests on first differences are done including an intercept.

Table 7: Detailed Cointegration Results for the Trace Statistic at the 5 percent Significance Level

Country	AUL	AUT	BEL	CAN	CRO	CZR	DEN	EST	FIN	FRA	GER	GRE	HUG	IRE	ITA	JAP	LAT	LIT	LUX	NET	NOR	POL	POR	ROM	SLR	SLV	SPN	SWE	UK	US
r=0	247.2	159.8	172.3	204.6	175.6	211.6	314.7	195.7	243.4	235.0	220.5	270.8	247.3	246.5	228.3	244.1	193.9	238.5	231.6	249.1	190.8	307.9	263.3	223.4	208.5	234.4	180.6	177.6	163.7	252.2
r=1	164.6	103.9	108.4	126.1	113.7	128.5	223.5	136.8	143.4	143.1	144.8	172.6	160.2	145.2	140.4	139.7	116.1	141.2	149.7	167.1	135.7	184.5	172.9	134.2	126.1	147.7	116.2	102.8	107.4	154.6
r=2	102.3	63.4	64.5	62.1	58.1	68.9	151.8	81.5	85.5	75.0	83.9	105.1	95.6	84.6	82.6	73.8	64.7	84.8	85.0	113.7	88.1	96.2	90.9	72.1	77.8	92.8	69.9	58.8	60.2	86.7
r=3	54.2	38.3	28.5	34.4	23.4	33.9	92.7	44.5	37.6	36.2	34.2	51.6	47.4	36.6	38.2	40.9	38.4	42.8	46.4	64.9	48.5	49.5	35.1	28.3	40.2	50.7	38.4	31.7	24.9	41.2
r=4	19.0	15.4	11.8	11.8	11.3	11.9	37.1	15.1	16.3	11.7	12.2	17.1	9.6	14.2	9.7	15.6	13.3	16.8	14.1	23.3	19.7	18.5	17.0	10.5	18.1	17.2	11.6	14.0	10.7	16.9

Table 8: Critical Values for Trace Statistic at the 5 percent Significance Level

Country	AUL	AUT	BEL	CAN	CRO	CZR	DEN	EST	FIN	FRA	GER	GRE	HUG	IRE	ITA	JAP	LAT	LIT	LUX	NET	NOR	POL	POR	ROM	SLR	SLV	SPN	SWE	UK	US
r=0	145.3	145.3	129.0	145.3	129.0	129.0	145.3	145.3	145.3	145.3	145.3	145.3	145.3	145.3	145.3	145.3	145.3	129.0	129.0	145.3	145.3	145.3	145.3	145.3	145.3	145.3	145.3	145.3	129.0	129.0
r=1	110.0	110.0	96.8	110.0	96.8	96.8	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	96.8	96.8	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	96.8	96.8
r=2	78.5	78.5	68.5	78.5	68.5	68.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	68.5	68.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	68.5	68.5
r=3	50.7	50.7	43.9	50.7	43.9	43.9	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	43.9	43.9	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	43.9	43.9
r=4	26.2	26.2	22.6	26.2	22.6	22.6	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	22.6	22.6	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	22.6	22.6

Table 9: Contemporaneous Effects of Foreign Nonperforming Loan Variables on Domestic Counterparts

		Npl			Npl			Npl			Npl			Npl			Npl
AUT	Coefficient	1.3	**CZH**	Coefficient	0.3	**GER**	Coefficient	0.1	**JAP**	Coefficient	0.6	**NOR**	Coefficient	0.3	**SLV**	Coefficient	2.1
	Standard error	0.4		Standard error	0.4		Standard error	0.1		Standard error	0.1		Standard error	0.1		Standard error	0.3
	t-Ratio	3.5		t-Ratio	0.9		t-Ratio	0.6		t-Ratio	6.5		t-Ratio	2.1		t-Ratio	6.5
AUS	Coefficient	0.2	**DEN**	Coefficient	1.8	**GRE**	Coefficient	-0.2	**LAT**	Coefficient	0.5	**POL**	Coefficient	0.7	**SPA**	Coefficient	1.5
	Standard error	0.1		Standard error	0.3		Standard error	0.2		Standard error	0.2		Standard error	0.3		Standard error	0.2
	t-Ratio	1.5		t-Ratio	6.1		t-Ratio	-0.9		t-Ratio	2.6		t-Ratio	2.6		t-Ratio	7.5
BEL	Coefficient	0.1	**EST**	Coefficient	0.4	**HUN**	Coefficient	1.3	**LIT**	Coefficient	0.8	**POR**	Coefficient	0.2	**SWE**	Coefficient	0.8
	Standard error	0.1		Standard error	0.2		Standard error	0.2		Standard error	0.2		Standard error	0.2		Standard error	0.3
	t-Ratio	0.7		t-Ratio	2.3		t-Ratio	7.0		t-Ratio	3.3		t-Ratio	0.7		t-Ratio	2.6
CAN	Coefficient	0.7	**FIN**	Coefficient	0.3	**IRE**	Coefficient	0.6	**LUX**	Coefficient	1.1	**ROM**	Coefficient	2.8	**UK**	Coefficient	1.4
	Standard error	0.1		Standard error	0.1		Standard error	0.2		Standard error	0.6		Standard error	0.5		Standard error	0.1
	t-Ratio	4.7		t-Ratio	4.6		t-Ratio	3.2		t-Ratio	1.8		t-Ratio	5.9		t-Ratio	9.7
CRO	Coefficient	0.4	**FRA**	Coefficient	0.7	**ITA**	Coefficient	0.3	**NET**	Coefficient	1.1	**SLK**	Coefficient	0.2	**US**	Coefficient	0.7
	Standard error	0.4		Standard error	0.1		Standard error	0.1		Standard error	0.5		Standard error	0.7		Standard error	0.2
	t-Ratio	1.0		t-Ratio	5.6		t-Ratio	2.8		t-Ratio	2.1		t-Ratio	0.3		t-Ratio	4.4

Table 10: Number of Cointegrating Relationships for the Individual VARX Models

AUL	4
AUT	1
BEL	2
CAN	2
CRO	2
CZR	3
DEN	4
EST	3
FIN	3
FRA	3
GER	2
GRE	2
HUG	1
IRE	3
ITA	3
JAP	2
LAT	2
LIT	3
LUX	4
NET	4
NOR	3
POL	3
POR	3
ROM	2
SLR	2
SLV	1
SPN	1
SWE	1
UK	1
US	3

Table 11: F Statistics for the Serial Correlation Test of the VECMX Residuals

		Critical Value	Nonperforming Loans	Real GDP Growth	L-R Interest Rate	Unemployment Rate	Inflation Growth
AUL	F(4.39)	2.61	10.65	1.67	0.22	1.79	1.89
AUT	F(4.42)	2.59	4.13	5.97	1.62	2.83	3.36
BEL	F(4.41)	2.60	2.51	3.70	2.00	1.31	2.64
CAN	F(4.41)	2.60	4.15	1.19	0.89	0.64	0.59
CRO	F(4.41)	2.60	3.48	2.43	10.84	0.73	2.95
CZR	F(4.40)	2.61	1.16	0.90	0.14	1.61	2.71
DEN	F(4.39)	2.61	3.81	0.93	1.92	2.01	1.24
EST	F(4.40)	2.61	7.85	4.99	1.41	1.19	2.62
FIN	F(4.40)	2.61	0.44	1.36	0.72	0.52	1.13
FRA	F(4.40)	2.61	12.75	2.29	0.73	3.15	3.13
GER	F(4.41)	2.60	2.67	1.15	0.71	1.32	2.17
GRE	F(4.41)	2.60	0.99	3.11	5.69	1.91	2.13
HUG	F(4.42)	2.59	4.93	0.72	0.80	6.03	3.73
IRE	F(4.40)	2.61	3.40	1.55	1.92	2.54	0.15
ITA	F(4.40)	2.61	8.01	2.24	0.71	2.50	0.80
JAP	F(4.41)	2.60	0.20	1.95	0.20	3.47	6.16
LAT	F(4.41)	2.60	1.35	0.16	0.98	2.05	1.99
LIT	F(4.40)	2.61	3.89	2.29	2.74	0.97	0.58
LUX	F(4.39)	2.61	6.49	4.74	1.20	2.89	2.43
NET	F(4.39)	2.61	0.85	0.95	3.27	4.09	2.06
NOR	F(4.40)	2.61	3.65	0.70	0.92	0.71	8.03
POL	F(4.40)	2.61	2.27	0.91	1.01	1.58	1.60
POR	F(4.40)	2.61	12.00	0.16	0.82	2.00	0.88
ROM	F(4.41)	2.60	9.80	1.01	0.44	2.22	1.78
SLR	F(4.41)	2.60	52.69	1.57	0.45	1.06	2.13
SLV	F(4.42)	2.59	9.59	3.03	2.81	0.94	5.68
SPN	F(4.42)	2.59	5.81	6.48	1.43	4.04	2.60
SWE	F(4.42)	2.59	0.98	1.16	1.67	0.50	2.59
UK	F(4.42)	2.59	6.32	1.27	0.73	0.65	5.49
US	F(4.40)	2.61	5.33	0.73	0.74	1.37	0.42

Table 12: Test for Weak Exogeneity at the 5 Percent Significance Level

	F test	Critical Value	Nonperforming Loans	Real GDP Growth	L-R Interest Rate	Unemployment Rate	Inflation Growth
AUL	F(4.37)	2.63	0.54	2.95	0.25	1.70	0.81
AUT	F(1.40)	4.08	0.11	0.42	0.12	1.57	1.23
BEL	F(2.39)	3.24	0.60	0.15	0.73	0.76	2.53
CAN	F(2.39)	3.24	0.23	1.95	0.59	0.31	1.50
CRO	F(2.39)	3.24	0.23	3.66	0.26	0.96	0.15
CZR	F(3.38)	2.85	2.61	0.48	0.37	1.25	0.93
DEN	F(4.37)	2.63	1.64	0.78	0.43	0.34	0.78
EST	F(3.38)	2.85	0.68	1.11	0.69	0.33	0.44
FIN	F(3.38)	2.85	0.25	0.91	1.52	0.17	0.23
FRA	F(3.38)	2.85	0.37	0.20	0.62	0.36	0.32
GER	F(2.39)	3.24	0.16	0.35	4.25	0.01	0.09
GRE	F(2.39)	3.24	1.31	1.25	0.97	1.41	0.11
HUG	F(1.40)	4.08	0.18	0.47	0.71	0.62	0.23
IRE	F(3.38)	2.85	3.67	0.76	0.56	0.74	4.30
ITA	F(3.38)	2.85	1.59	0.49	0.28	0.13	0.71
JAP	F(2.39)	3.24	1.00	2.41	0.30	3.56	0.47
LAT	F(2.39)	3.24	0.89	2.28	1.28	1.10	1.67
LIT	F(3.38)	2.85	5.67	2.42	1.19	2.62	0.51
LUX	F(4.37)	2.63	1.13	0.51	0.57	0.62	0.65
NET	F(4.37)	2.63	1.13	0.59	0.92	0.23	0.73
NOR	F(3.38)	2.85	0.10	1.10	0.07	1.06	0.48
POL	F(3.38)	2.85	0.73	0.23	0.65	0.20	0.34
POR	F(3.38)	2.85	0.28	1.26	2.75	2.57	1.82
ROM	F(2.39)	3.24	0.03	0.72	0.19	0.96	0.02
SLR	F(2.39)	3.24	0.03	0.05	0.47	0.99	0.79
SLV	F(1.40)	4.08	0.24	0.64	0.06	3.08	0.05
SPN	F(1.40)	4.08	0.80	0.44	0.66	0.64	1.51
SWE	F(1.40)	4.08	0.07	1.13	0.97	0.03	0.09
UK	F(1.40)	4.08	0.22	0.00	0.20	1.17	0.45
US	F(3.38)	2.85	0.77	0.82	0.20	0.30	0.92

Appendix III

Figure 1: Generalised Impulse Response Function of Nonperforming Loans to a negative $(-\sigma)$ Shock in US Real GDP Growth Rate (confidence intervals of 80 percent significance level)

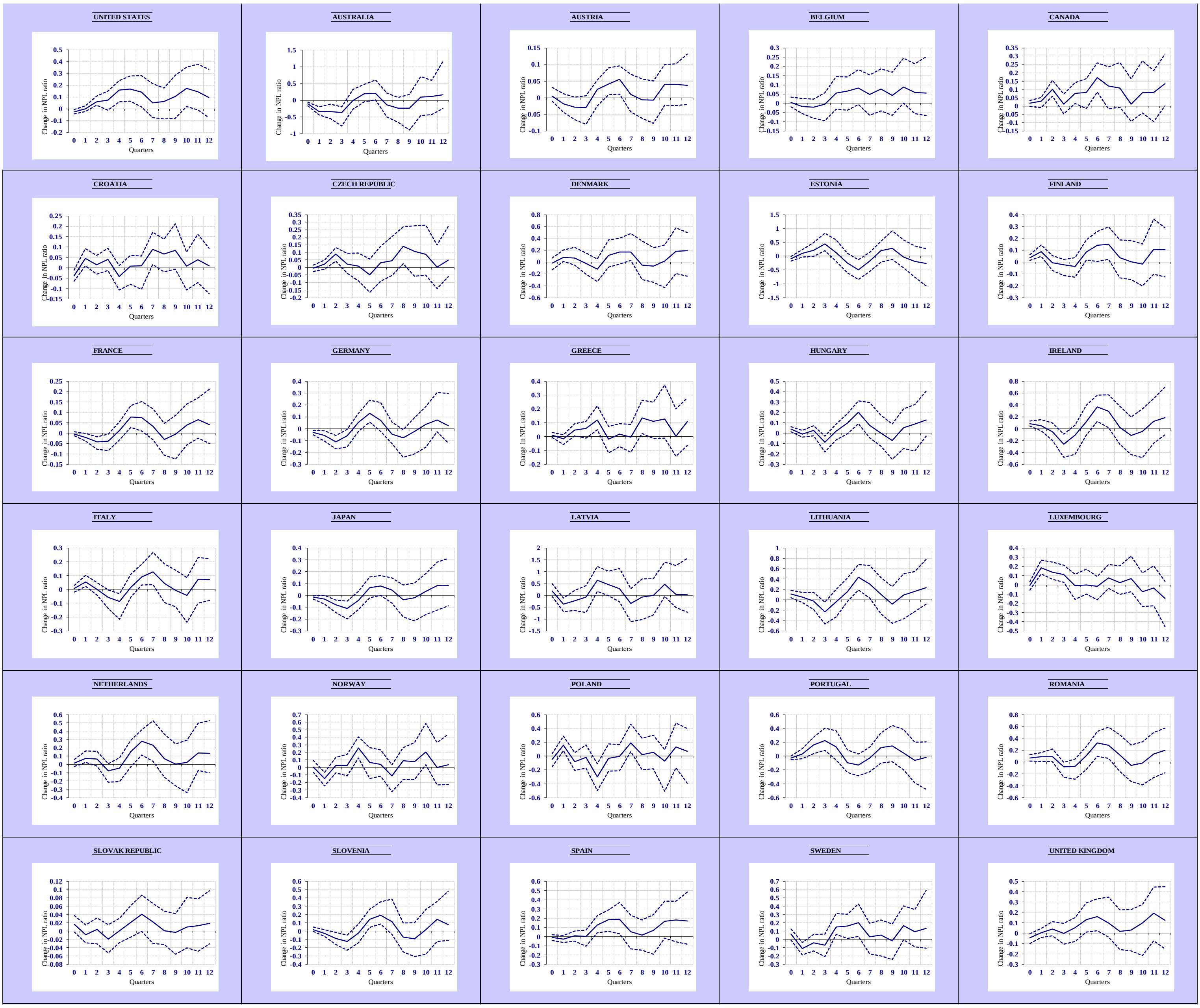


Figure 2: Generalised Impulse Response Function of Nonperforming Loans to a negative $(-\sigma)$ Shock in Japanese Real GDP Growth Rate (confidence intervals of 80 percent significance level)

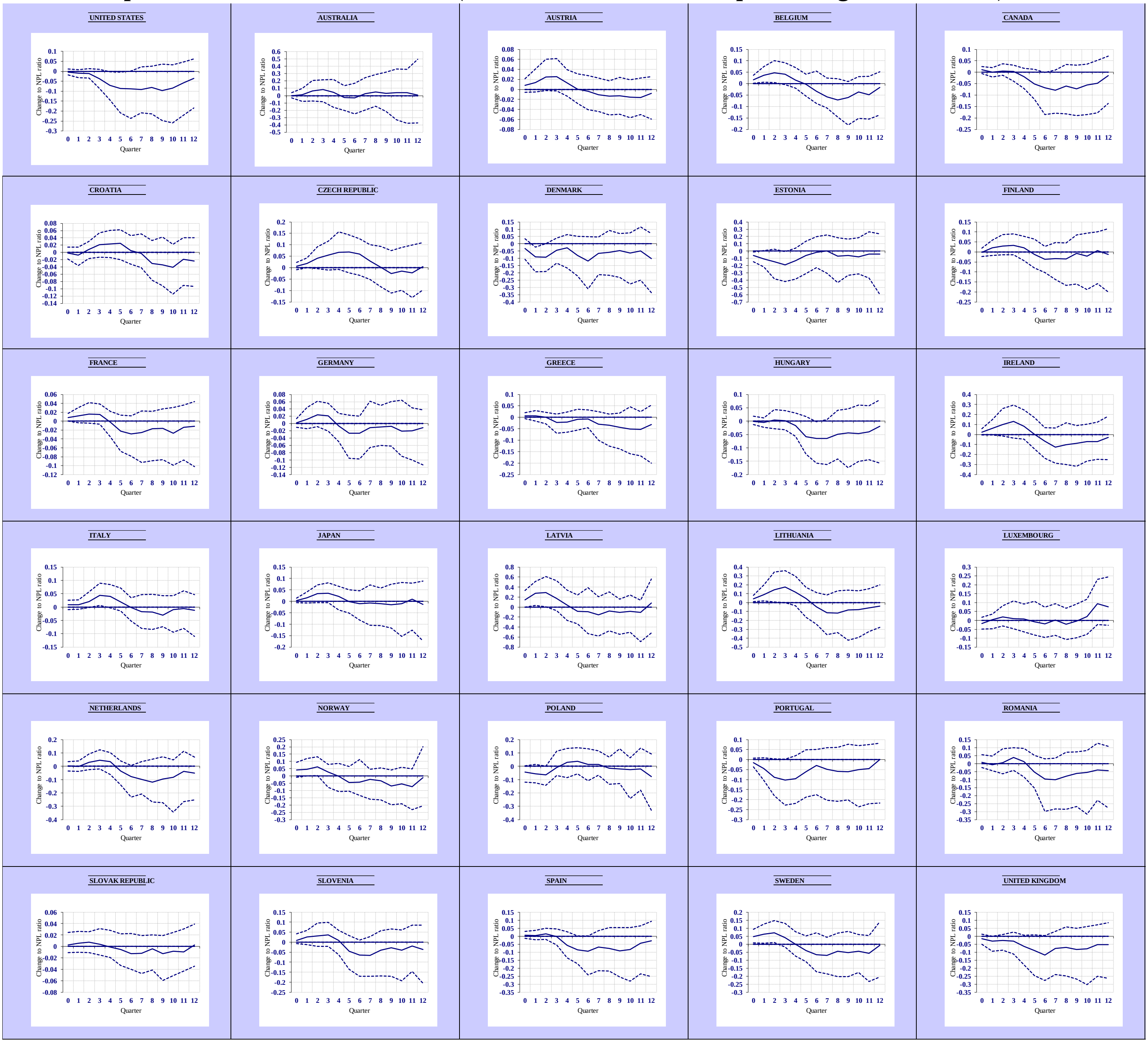


Figure 3: Generalised Impulse Response Function of Nonperforming Loans to a negative $(-\sigma)$ Shock in German Real GDP Growth Rate (confidence intervals of 80 percent significance level)

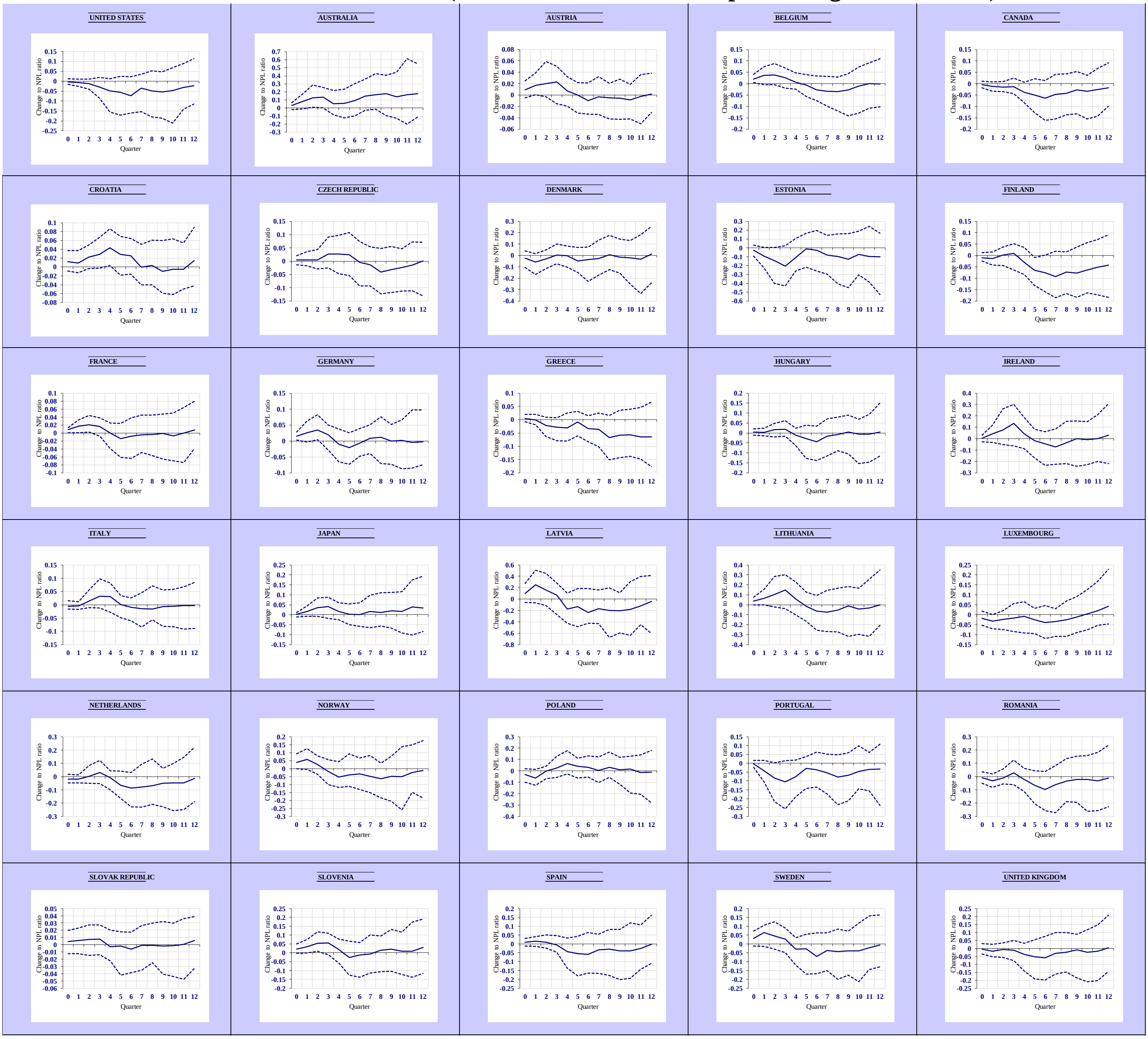


Figure 4: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in US Unemployment Rate (confidence intervals of 70 percent significance level)

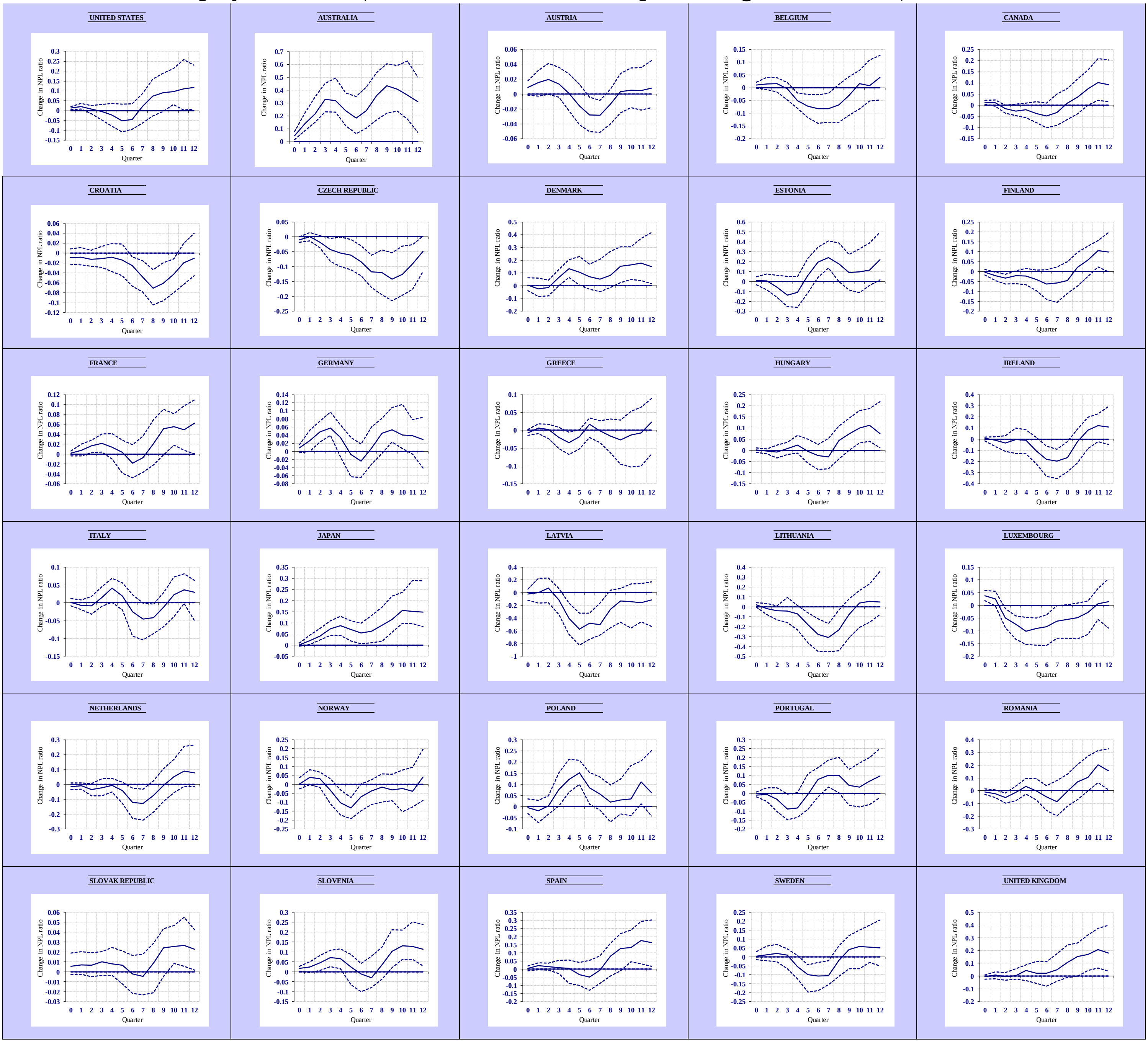


Figure 5: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in US Inflation Growth Rate (confidence intervals of 80 percent significance level)

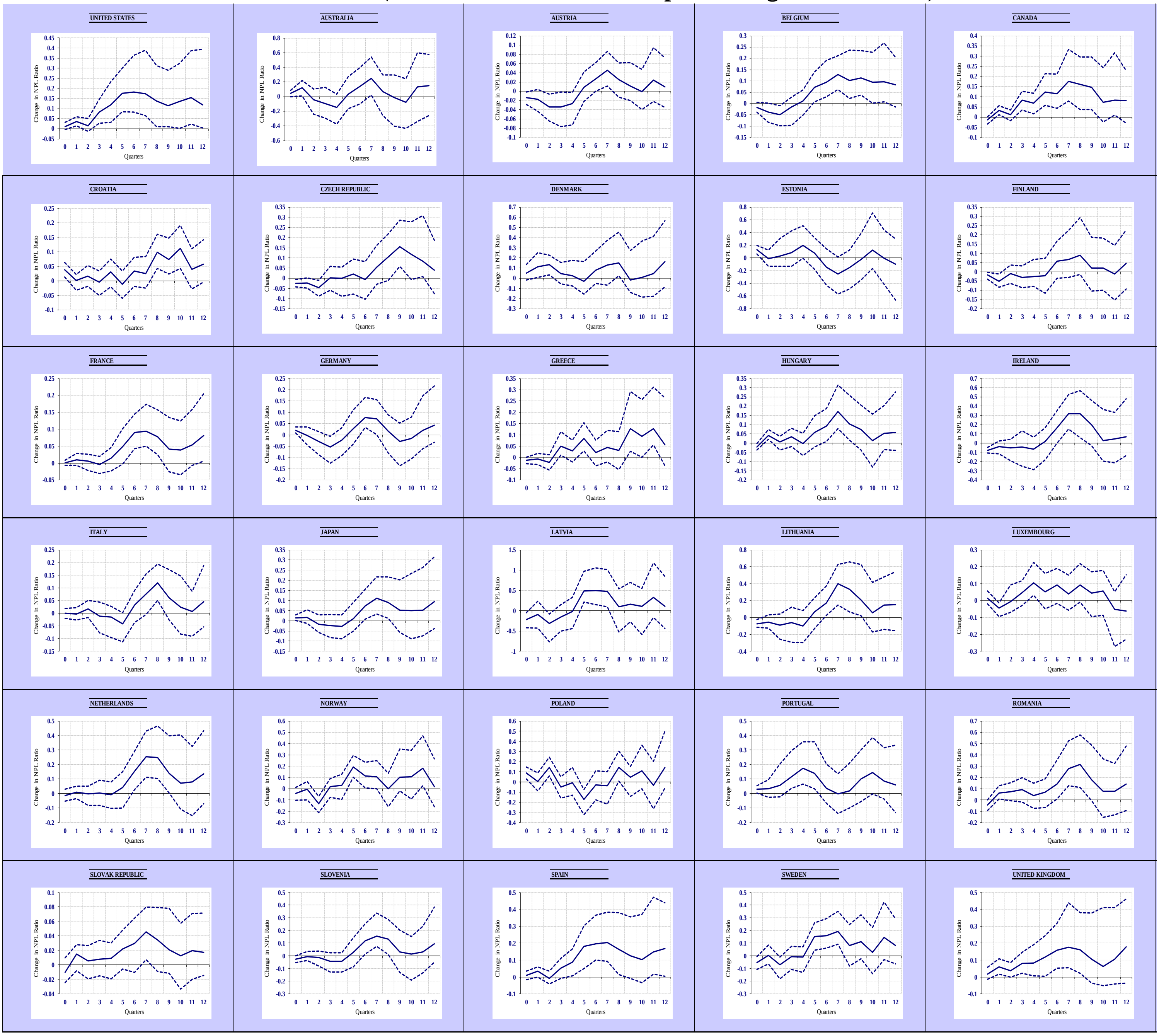


Figure 6: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in German Inflation Growth Rate (confidence intervals of 80 percent significance level)

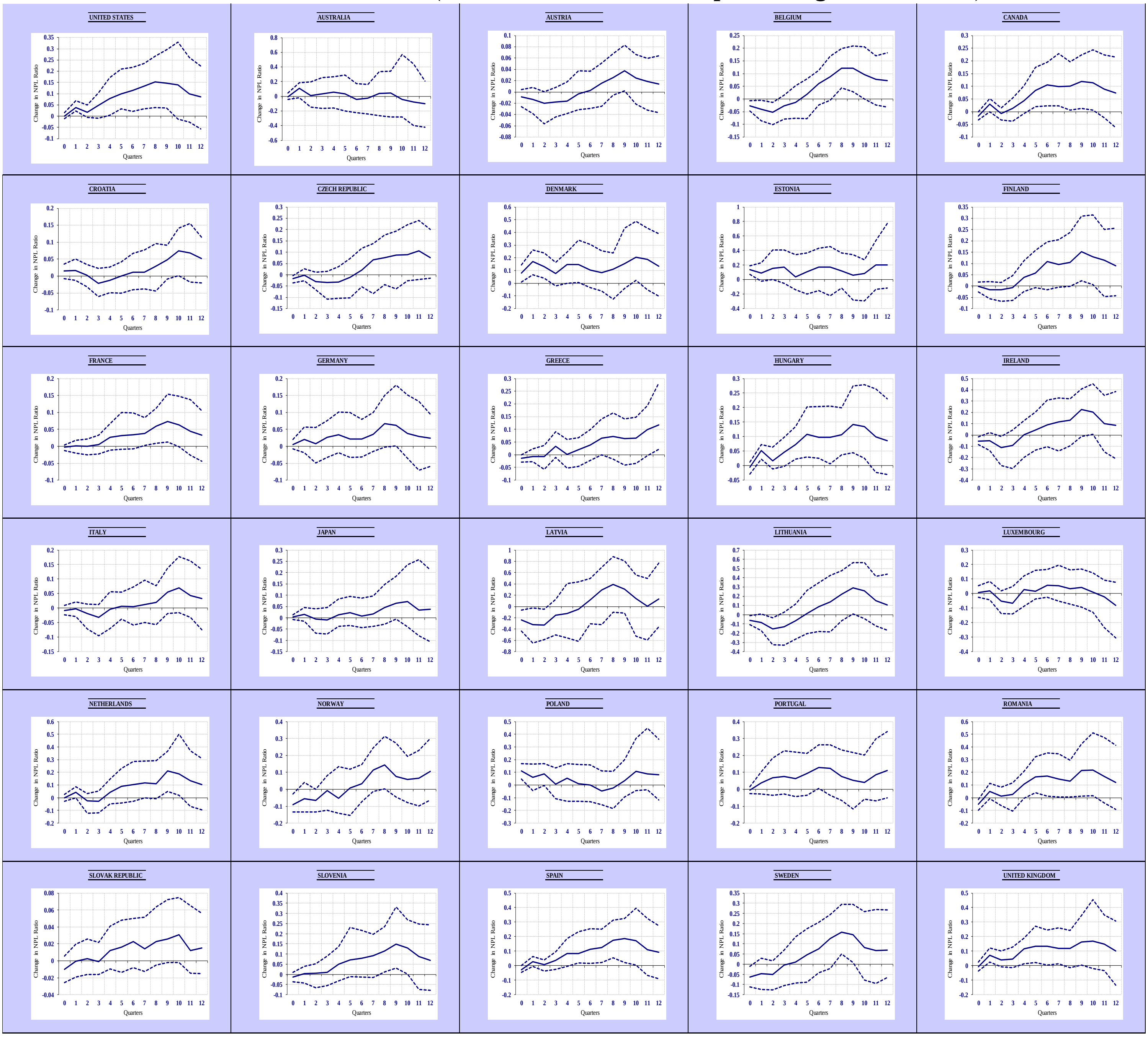


Figure 7: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in Japanese Inflation Growth Rate (confidence intervals of 80 percent significance level)

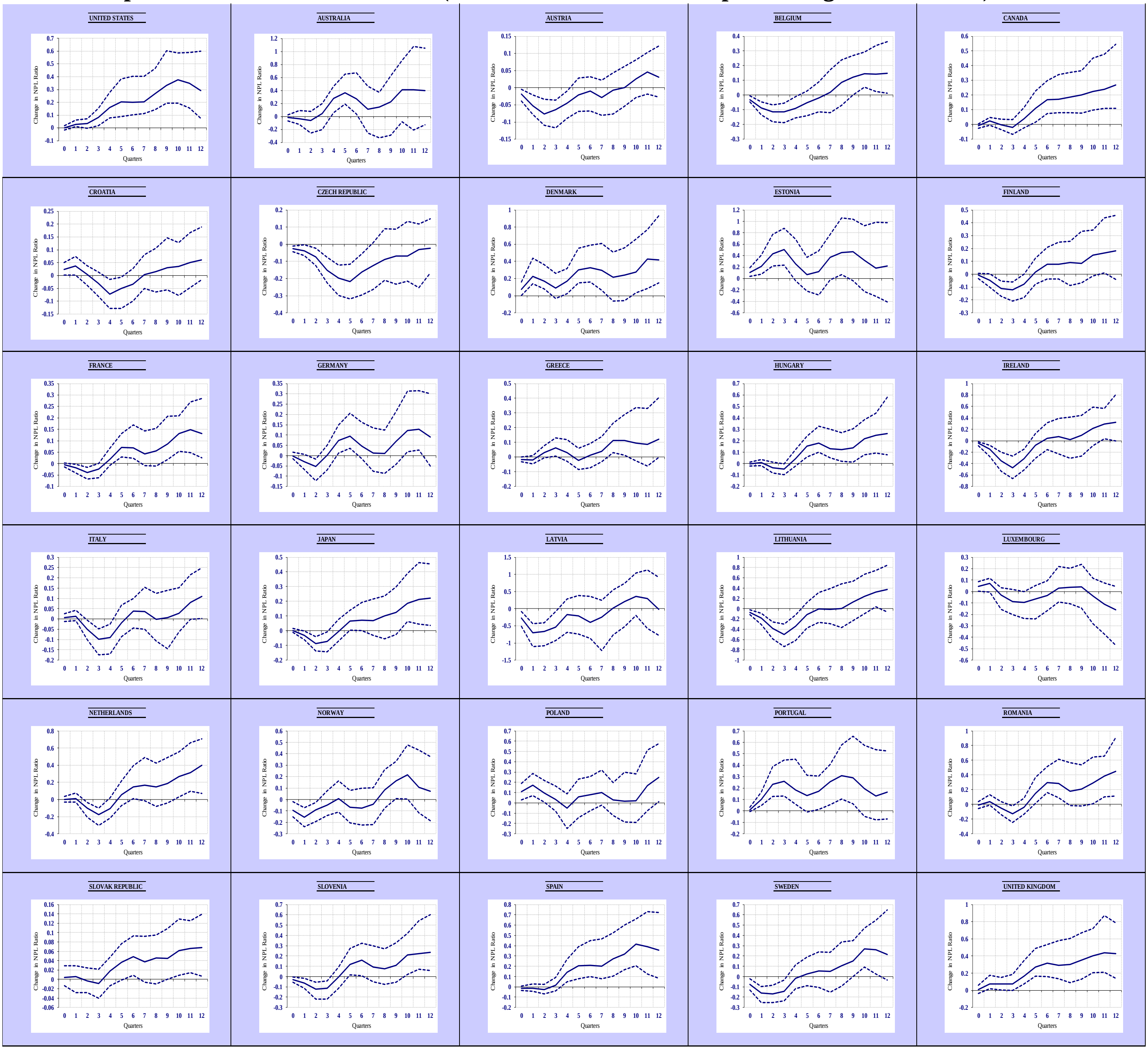


Figure 8: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in US L-R Interest Rate (confidence intervals of 80 percent significance level)

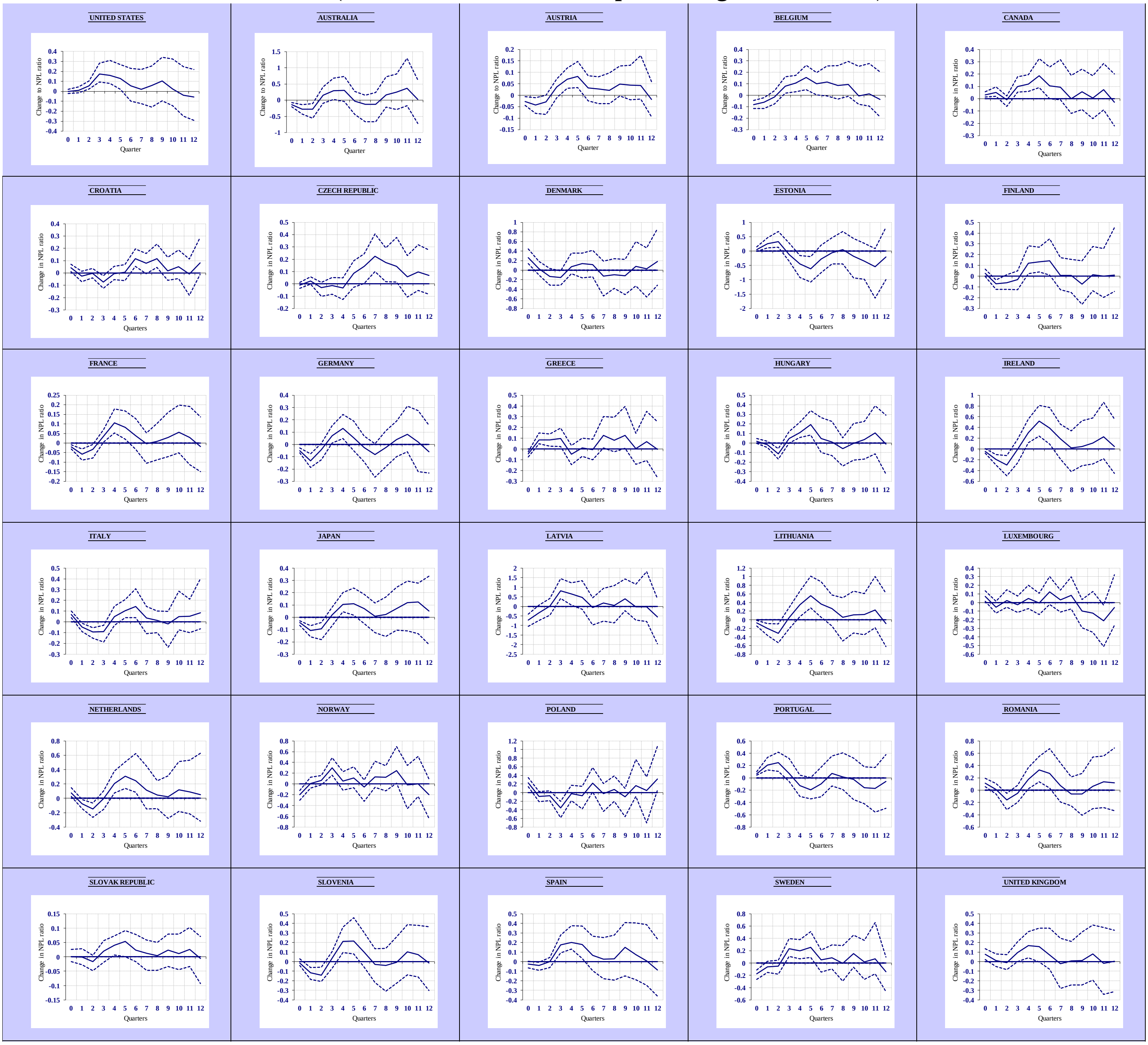


Figure 9: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in German L-R Interest Rate (confidence intervals of 80 percent significance level)

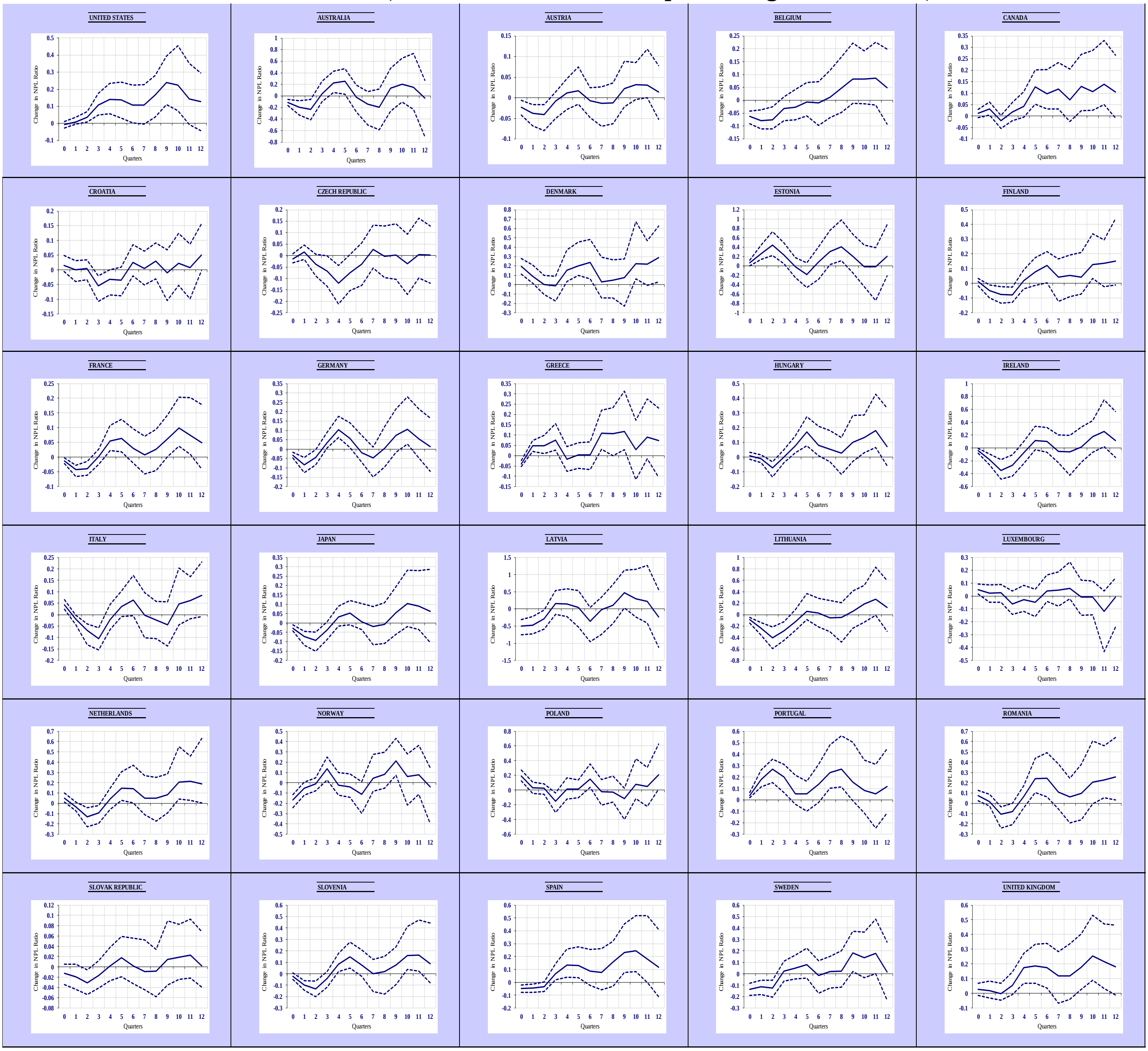


Figure 10: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in Japanese L-R Interest Rate (confidence intervals of 80 percent significance level)

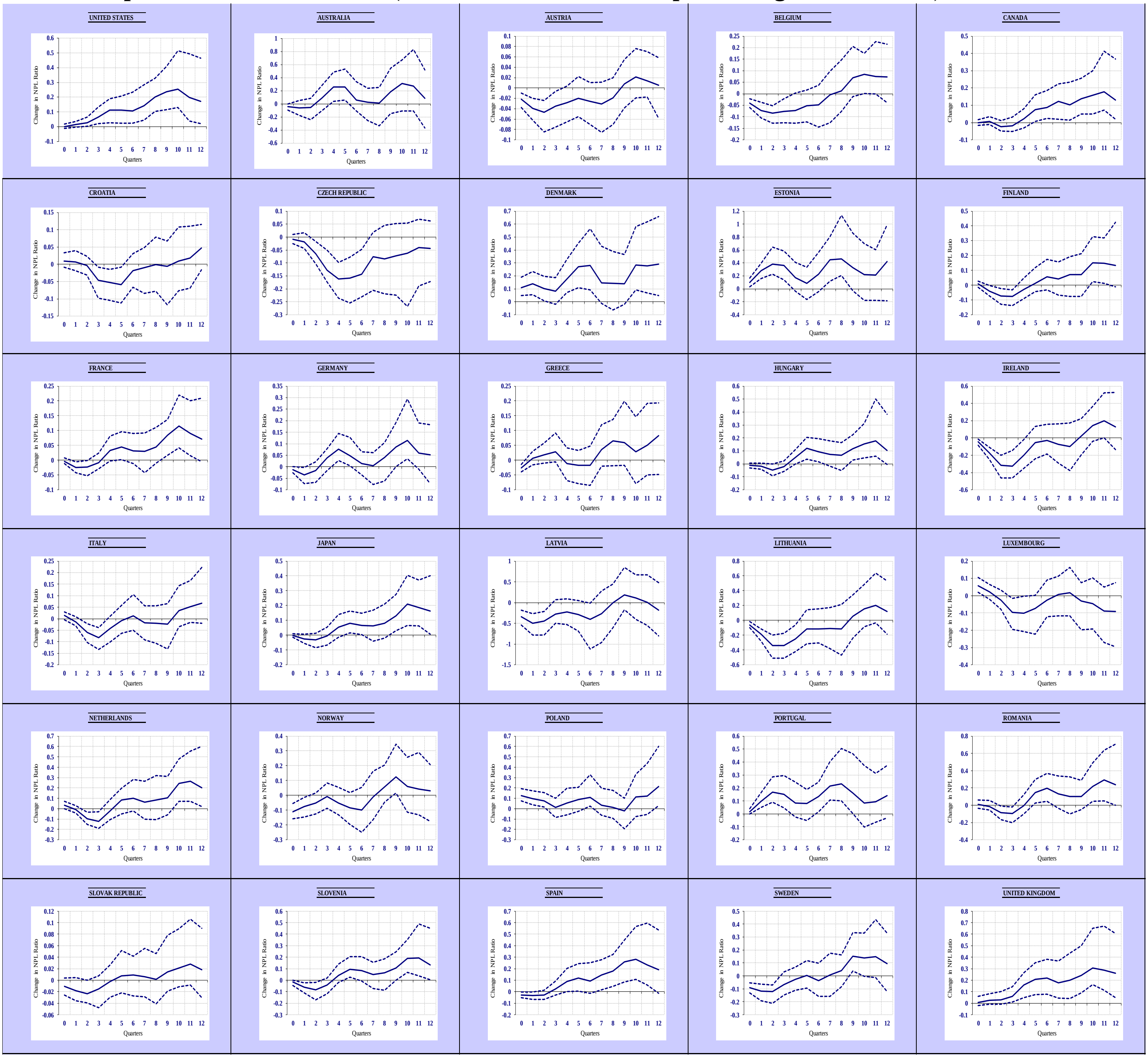


Figure 11: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in US NPL ratios (confidence intervals of 80 percent significance level)

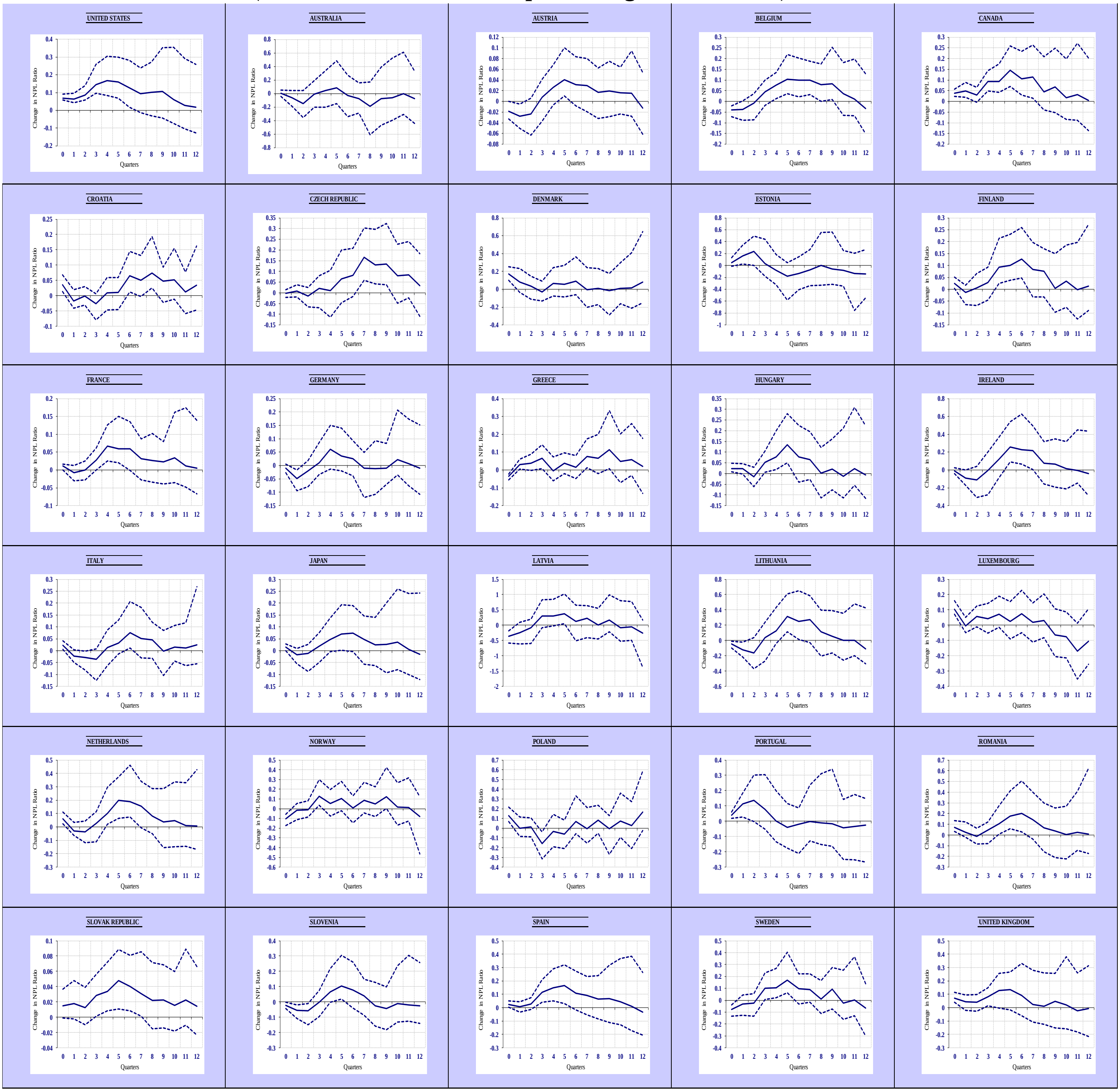


Figure 12: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in German NPL ratio (confidence intervals of 80 percent significance level)

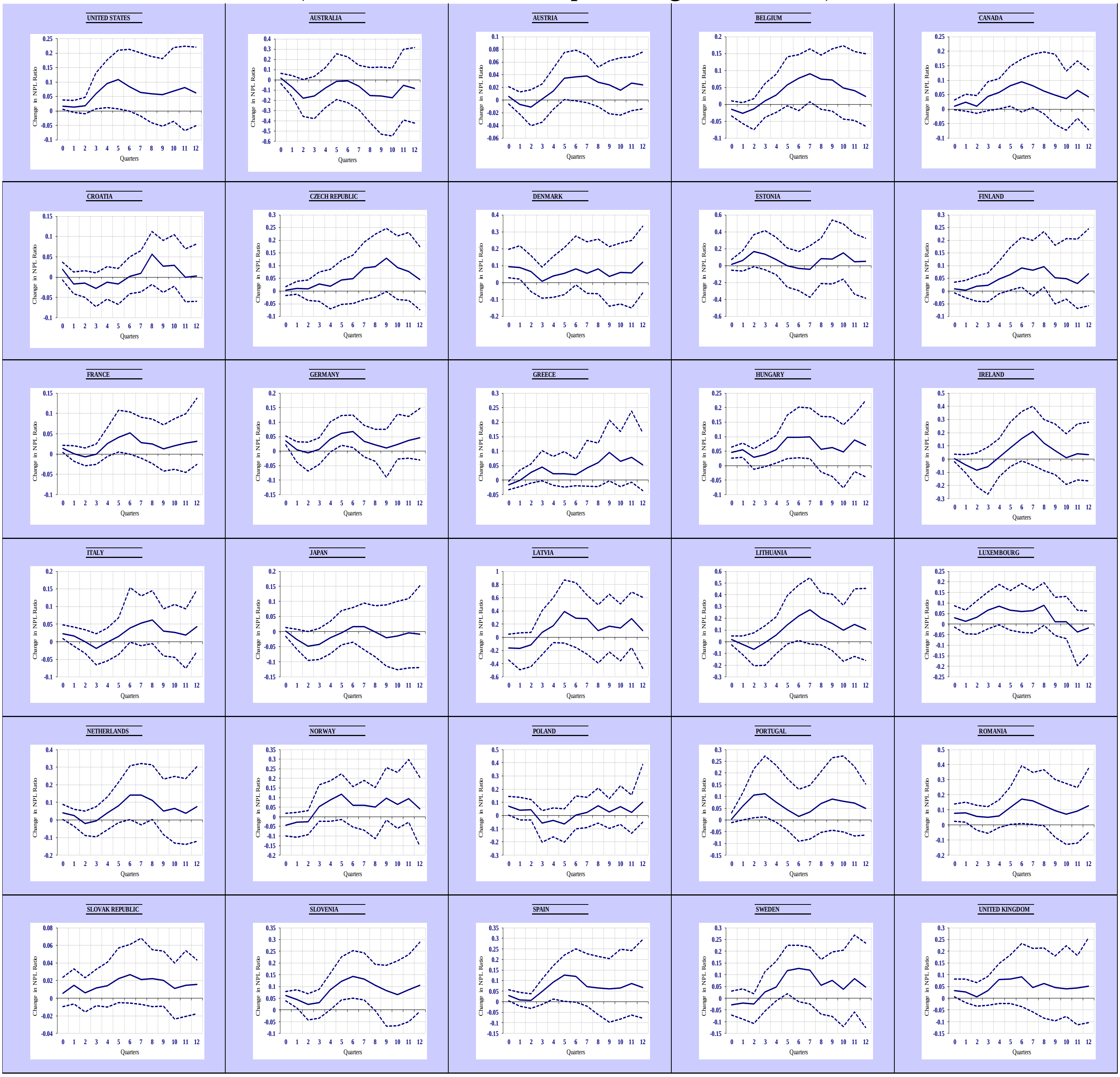


Figure 13: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in Japanese NPL ratio (confidence intervals of 80 percent significance level)

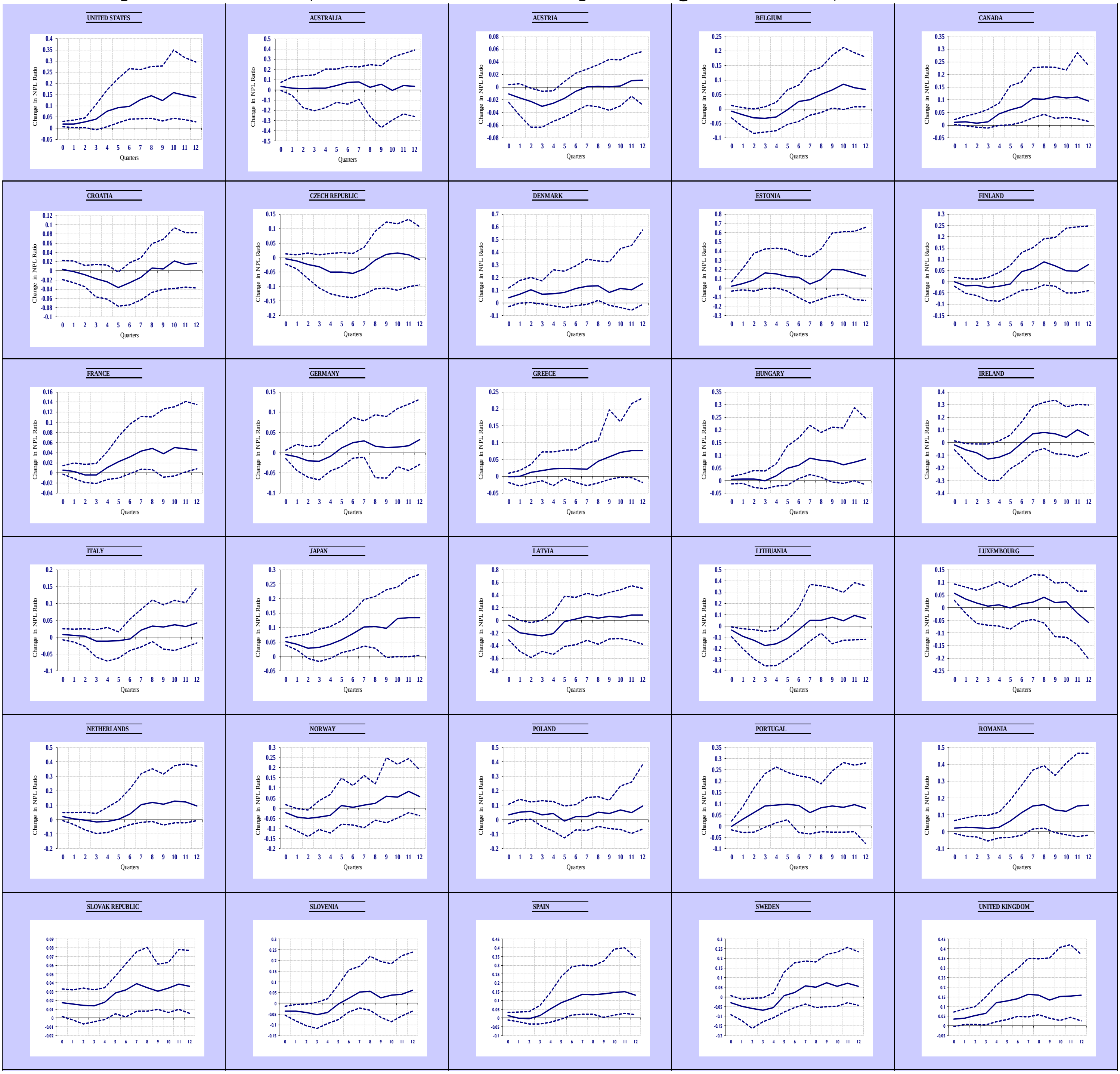


Figure 14: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in UK NPL ratio (confidence intervals of 80 percent significance level)

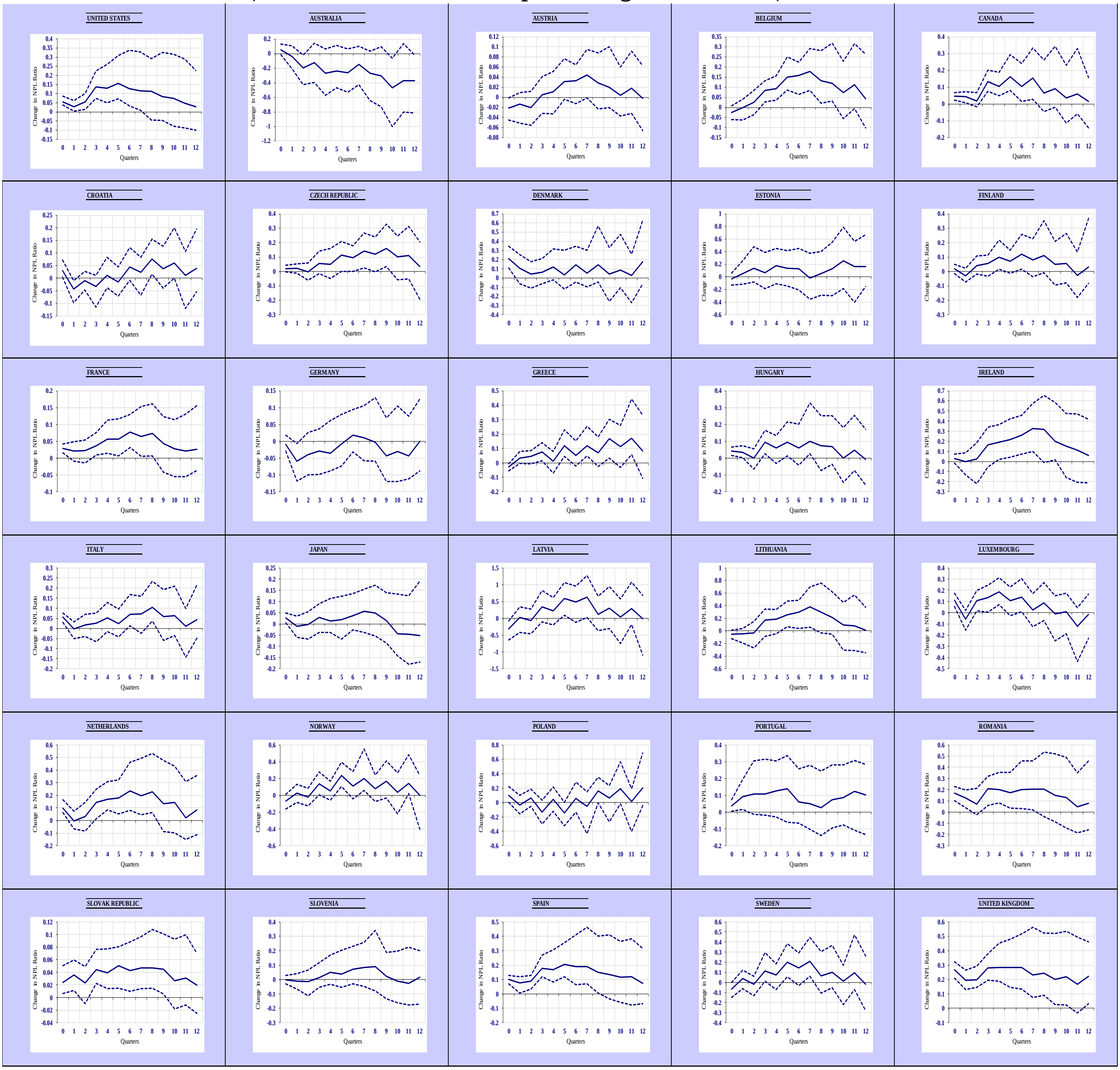


Figure 15: Generalised Impulse Response Function of Nonperforming Loans to a negative $(-\sigma)$ Shock in US Real GDP Growth Rate (confidence intervals of 80 percent significance level) – *Trade Weighting Scheme*

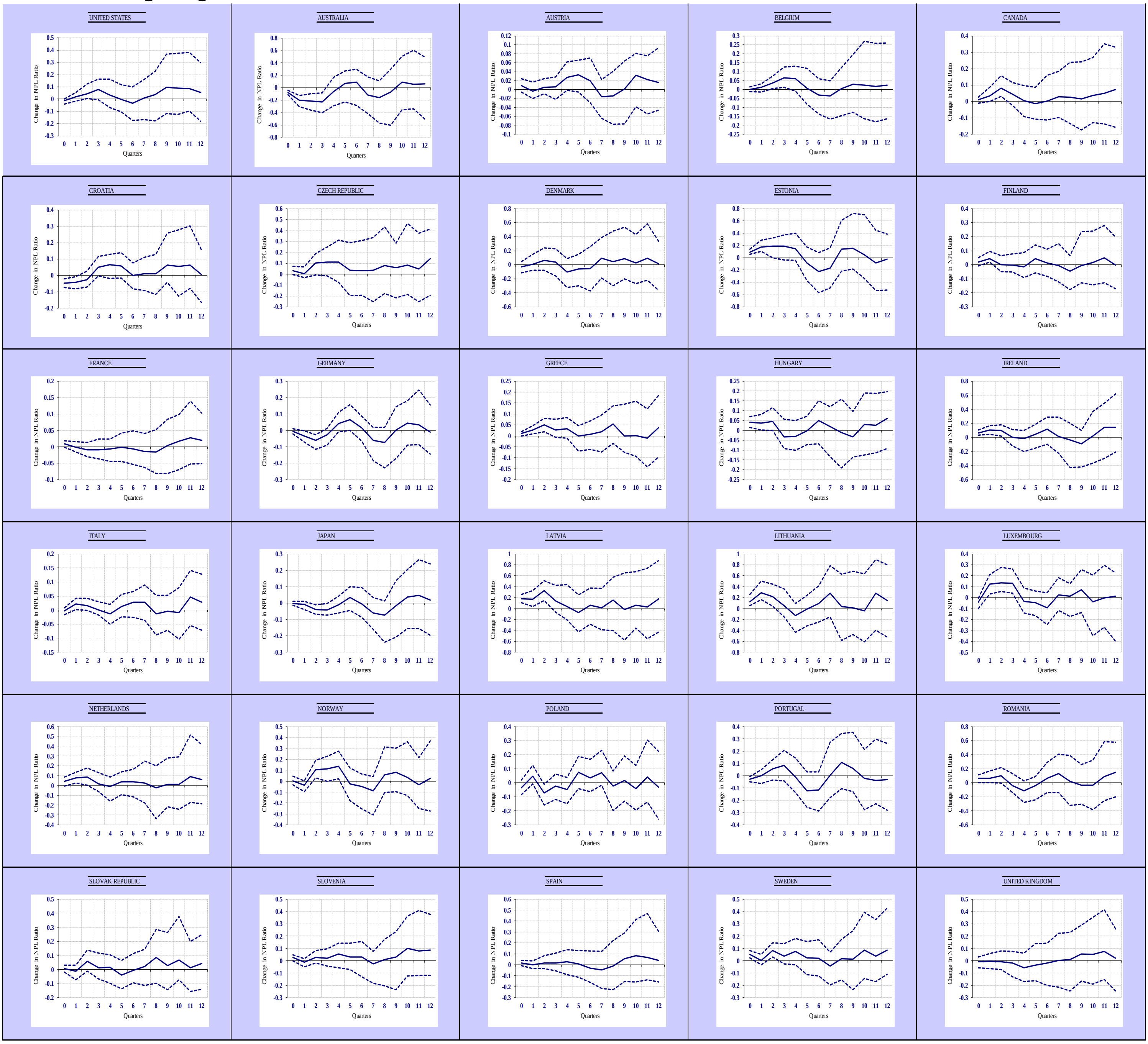


Figure 16: Generalised Impulse Response Function of Nonperforming Loans to a negative $(-\sigma)$ Shock in German Real GDP Growth Rate (confidence intervals of 80 percent significance level) – *Trade Weighting Scheme*

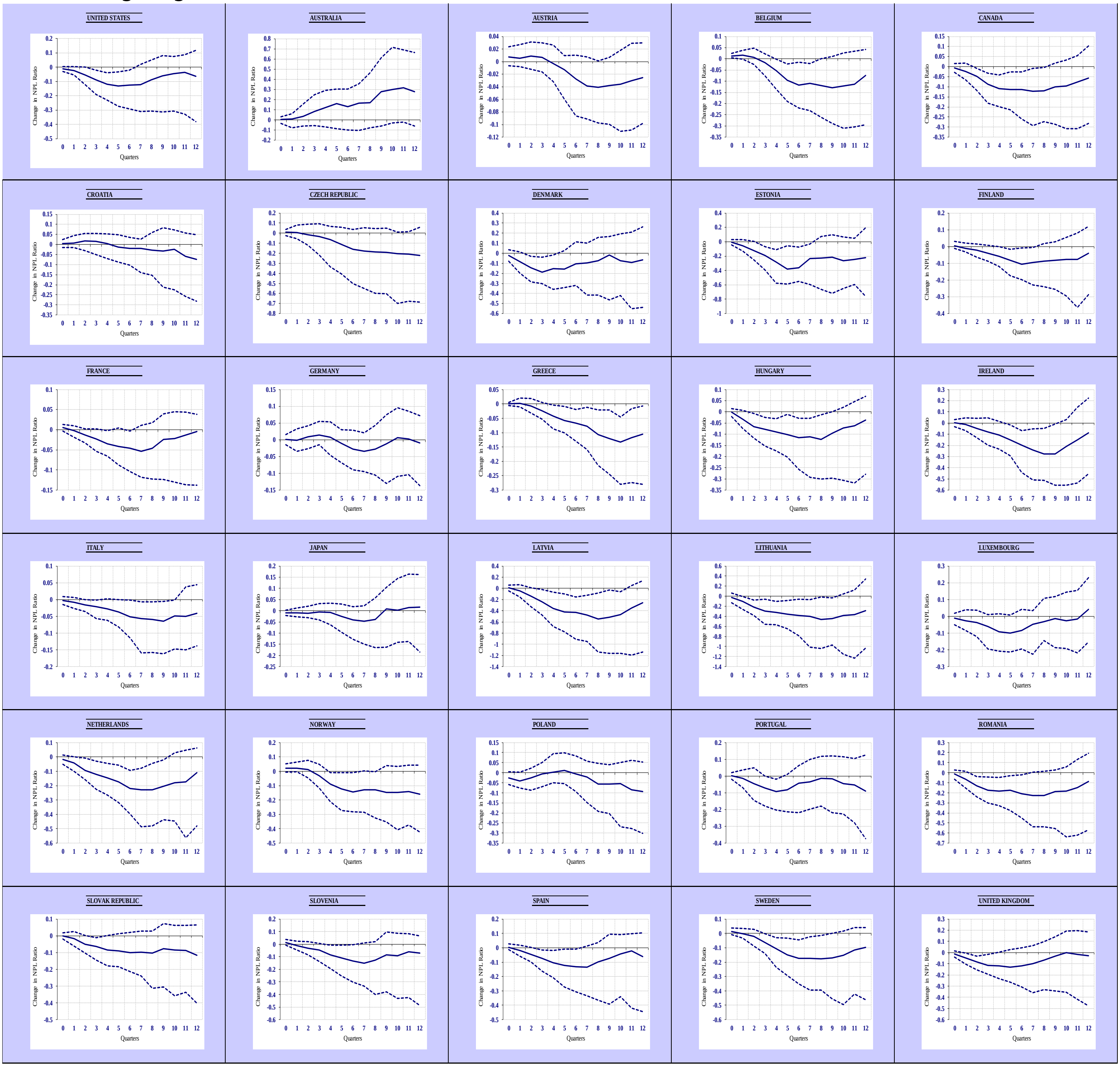


Figure 17: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in US Inflation Growth Rate (confidence intervals of 80 percent significance level)
– Trade Weighting Scheme

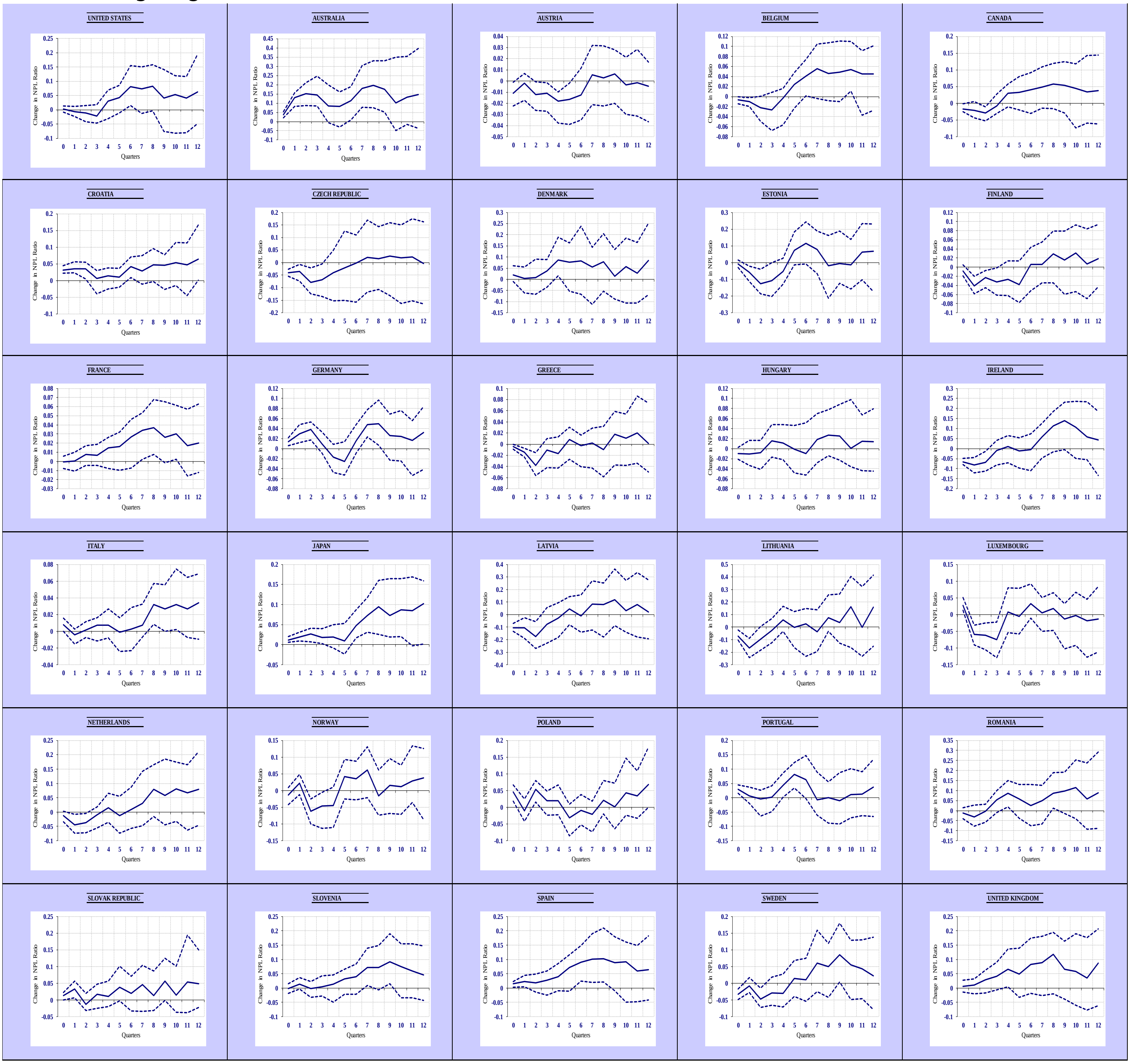
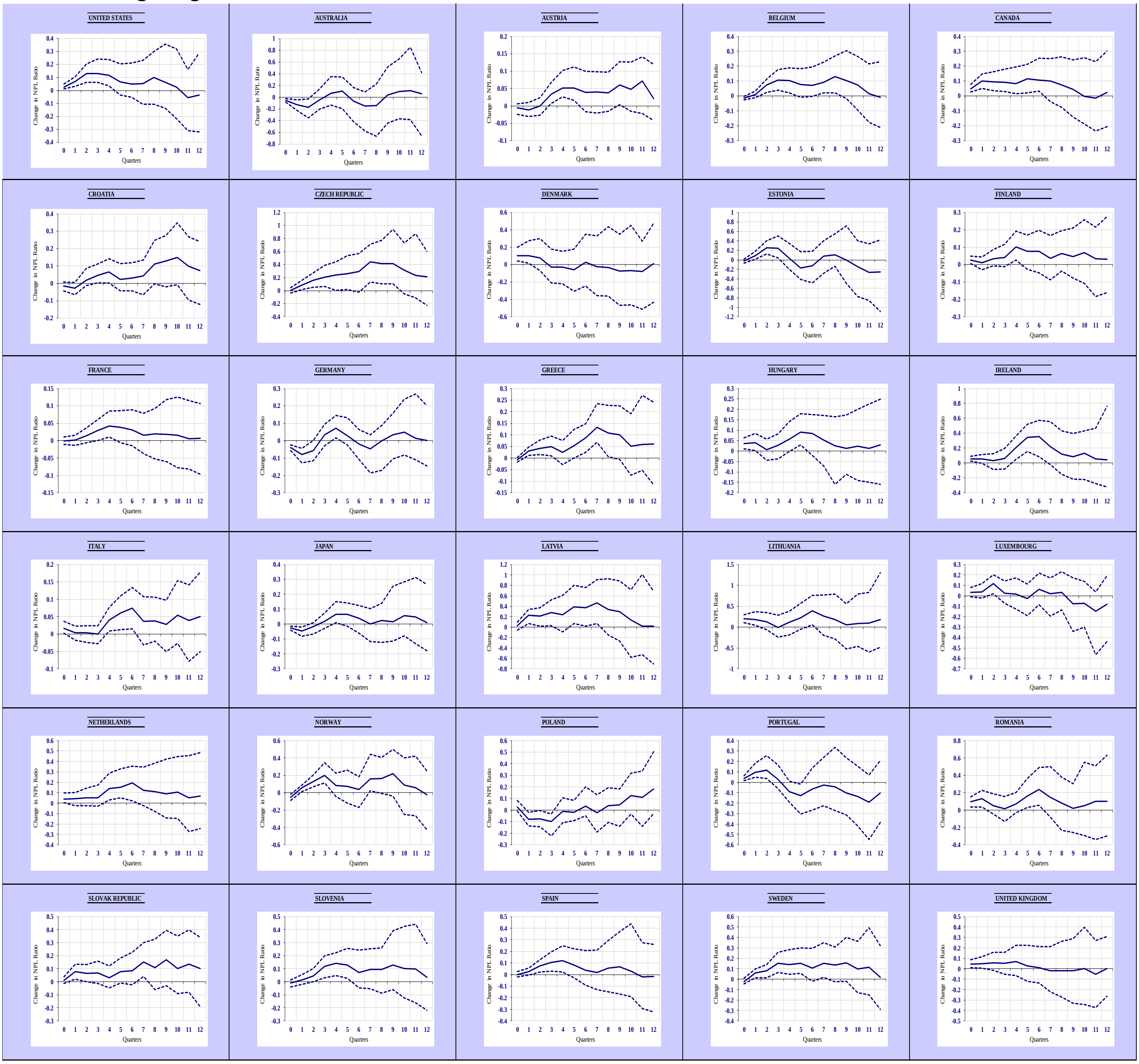


Figure 18: Generalised Impulse Response Function of Nonperforming Loans to a positive (σ) Shock in US L-R Interest Rate (confidence intervals of 80 percent significance level)
– *Trade Weighting Scheme*



Appendix IV

How a change in weighs impact the transmission of country specific shocks in the GVAR (Cesa-Bianchi; Pesaran; Rebucci & Tamayo 2009).

Consider equation (1) in section 4.1 but for simplicity it contains no constant, no trend and the lag order is 1. The example shows a three country model with three variables (e.g. GDP, CPI and unemployment). This means for country 0, 1 and 2 of the VARX*(1,1) becomes:

$$x_{0t} = \Phi_0 x_{0,t-1} + \Lambda_{00} x_{0t}^* + \Lambda_{01} x_{0,t-1}^* + u_{0t},$$

$$x_{1t} = \Phi_1 x_{1,t-1} + \Lambda_{10} x_{1t}^* + \Lambda_{11} x_{1,t-1}^* + u_{0t},$$

$$x_{2t} = \Phi_2 x_{2,t-1} + \Lambda_{20} x_{2t}^* + \Lambda_{21} x_{2,t-1}^* + u_{0t},$$

where $x_{0t} = \begin{bmatrix} y_{0t} \\ \pi_{0t} \end{bmatrix}$, $x_{0t}^* = \begin{bmatrix} y_{0t}^* \\ \pi_{0t}^* \\ u_{0t}^* \end{bmatrix}$, $x_{1t} = \begin{bmatrix} y_{1t} \\ \pi_{1t} \\ u_{1t} \end{bmatrix}$ and $x_{1t}^* = \begin{bmatrix} y_{1t}^* \\ \pi_{1t}^* \end{bmatrix}$, $x_{2t} = \begin{bmatrix} y_{2t} \\ \pi_{2t} \\ u_{2t} \end{bmatrix}$ $x_{2t}^* = \begin{bmatrix} y_{2t}^* \\ \pi_{2t}^* \end{bmatrix}$.

This implies that for country 0 the VARX*(1,1) is:

$$\begin{bmatrix} y_{0t} \\ \pi_{0t} \end{bmatrix} = \begin{bmatrix} \phi_{0,11} & \phi_{0,12} \\ \phi_{0,21} & \phi_{0,22} \end{bmatrix} + \begin{bmatrix} \lambda_{00,11} & \lambda_{00,12} & \lambda_{00,13} \\ \lambda_{00,21} & \lambda_{00,22} & \lambda_{00,23} \end{bmatrix} \begin{bmatrix} y_{0t}^* \\ \pi_{0t}^* \\ u_{0t}^* \end{bmatrix} + \begin{bmatrix} \lambda_{01,11} & \lambda_{01,12} & \lambda_{01,13} \\ \lambda_{01,21} & \lambda_{01,22} & \lambda_{01,23} \end{bmatrix} \begin{bmatrix} y_{0,t-1}^* \\ \pi_{0,t-1}^* \\ u_{0,t-1}^* \end{bmatrix} + \begin{bmatrix} u_{y0,t} \\ u_{\pi0,t} \end{bmatrix}.$$

Using the properties defined in equation (4) in section 4.2 that is $z_{it} = (x_{it}', x_{it}^{*\prime})'$ to re-write the country specific VARX* in terms of z_{it} in reduced form $A_i Z_{it} = B_i\, z_{i,t-1} + u_{it}$ becomes:

$$\begin{bmatrix} 1 & 0 & \lambda_{00,11} & \lambda_{00,12} & \lambda_{00,13} \\ 0 & 1 & \lambda_{00,21} & \lambda_{00,22} & \lambda_{00,23} \end{bmatrix} \begin{bmatrix} y_{0t} \\ \pi_{0t} \\ y_{0t}^* \\ \pi_{0t}^* \\ u_{0t}^* \end{bmatrix} = \begin{bmatrix} \phi_{0,11} & \phi_{0,12} & \lambda_{01,11} & \lambda_{01,12} & \lambda_{01,13} \\ \phi_{0,21} & \phi_{0,22} & \lambda_{01,21} & \lambda_{01,22} & \lambda_{01,23} \end{bmatrix} \begin{bmatrix} y_{0,t-1} \\ \pi_{0,t-1} \\ y_{0,t-1}^* \\ \pi_{0,t-1}^* \\ u_{0,t-1}^* \end{bmatrix} + \begin{bmatrix} u_{y0,t} \\ u_{\pi0,t} \end{bmatrix}.$$

We have that from equation (5) in section 4.2 that $z_i = W_i x_t$, so that for country 0, and $z_0 = W_0 x_t$, which becomes:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & w_{01} & 0 & 0 & w_{02} & 0 & 0 \\ 0 & 0 & 0 & w_{01} & 0 & 0 & w_{02} & 0 \\ 0 & 0 & 0 & 0 & w_{01} & 0 & 0 & w_{02} \end{bmatrix} \begin{bmatrix} y_{0t} \\ \pi_{0t} \\ y_{1t} \\ \pi_{1t} \\ u_{1t} \\ y_{2t} \\ \pi_{2t} \\ u_{2t} \end{bmatrix} = \begin{bmatrix} y_{0t} \\ \pi_{0t} \\ w_{01} y_{1t} \\ w_{01} \pi_{1t} \\ w_{01} u_{1t} \end{bmatrix} = \begin{bmatrix} y_{0t} \\ \pi_{0t} \\ y_{0t}^* \\ \pi_{0t}^* \\ u_{0t}^* \end{bmatrix}.$$

Re-writing the country specific VARX* of country $i = 0$, as the reduced form $A_i W_i x_t = W_i x_{i,t-1} + u_{it}$, we get:

$$\begin{bmatrix} 1 & 0 & -\lambda_{00,11} & -\lambda_{00,12} & -\lambda_{00,13} \\ 0 & 1 & -\lambda_{00,21} & -\lambda_{00,22} & -\lambda_{00,23} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & w_{01} & 0 & 0 & w_{02} & 0 & 0 \\ 0 & 0 & 0 & w_{01} & 0 & 0 & w_{02} & 0 \\ 0 & 0 & 0 & 0 & w_{01} & 0 & 0 & w_{02} \end{bmatrix} \begin{bmatrix} y_{0t} \\ \pi_{0t} \\ y_{1t} \\ \pi_{1t} \\ u_{1t} \\ y_{2t} \\ \pi_{2t} \\ u_{2t} \end{bmatrix} =$$

$$\begin{bmatrix} \phi_{0,11} & \phi_{0,12} & \lambda_{01,11} & \lambda_{01,12} & \lambda_{01,13} \\ \phi_{0,21} & \phi_{0,22} & \lambda_{01,21} & \lambda_{01,22} & \lambda_{01,23} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & w_{01} & 0 & 0 & w_{02} & 0 & 0 \\ 0 & 0 & 0 & w_{01} & 0 & 0 & w_{02} & 0 \\ 0 & 0 & 0 & 0 & w_{01} & 0 & 0 & w_{02} \end{bmatrix} \begin{bmatrix} y_{0,t-1} \\ \pi_{0,t-1} \\ y_{1,t-1} \\ \pi_{1,t-1} \\ u_{1,t-1} \\ y_{2,t-1} \\ \pi_{2,t-1} \\ u_{2,t-1} \end{bmatrix} + \begin{bmatrix} u_{y0,t} \\ u_{\pi 0,t} \end{bmatrix}.$$

The same procedure is applied for country 1 and 2 as for country 0. Stacking them together yields the global solution and equation (7) in section 4.2. Thus,$Gx_t = Hx_{t-1} + u_t$, is equivalent to:

$$\begin{bmatrix} A_0 \\ A_1 \\ A_2 \end{bmatrix} \begin{bmatrix} W_0 \\ W_1 \\ W_2 \end{bmatrix} x_t = \begin{bmatrix} B_0 \\ B_1 \\ B_2 \end{bmatrix} \begin{bmatrix} W_0 \\ W_1 \\ W_2 \end{bmatrix} x_{t-1} + \begin{bmatrix} u_{0t} \\ u_{1t} \\ u_{2t} \end{bmatrix}.$$

Note that: $G = A * W$, and $H = B * W$ are square matrices with dimension (8*8) in this example. The matrices A_0 and B_0 are constructed from the estimation of the VECMX*, i.e. Φ_0, Λ_{00} and Λ_{01}, while W_0 is constructed from the data. The G therefore is a mixture of the weights from either financial or trade data and the estimated coefficients in the country specific VECMXs. Thus, both G and H in (7) are impacted by the weighting scheme.

Assuming that G in equation (7) can be inverted, we get:

$$x_t = \mathcal{F} x_{t-1} + \epsilon_t, \tag{10}$$

where $\mathcal{F} = G^{-1}H$, and $\epsilon_t = G^{-1}u_t$.

We can see from the equation that both the residual of the model ϵ_t and $\mathcal{F}$ impact the dynamic responses of the variables which in turn are both affected by G. Using the lag operator we can write (10) into a moving average process AR(1) so that $x_t = (I - \mathcal{F})^{-1}\epsilon_t$, and by iteration forward one can see how $\mathcal{F}$ in particular affects the transmission of country specific shocks.

$$x_{T+s} = \mathcal{F}^s x_T + \sum_{j=0}^{S-1} \mathcal{F}^j (\epsilon_{t-j+s}).$$

<u>The Weak Exogeneity Test</u>

The main assumption underlying the estimation of the individual VARX* (1,1) models is that the foreign specific variables are weakly exogenous with respect to the long run parameters of the error correction model in equation (3). The weak exogeneity assumption implies that the domestic variables and the foreign specific variables are independent of each other whilst at the same time may be dependent on the lagged feedbacks between the two variables in the short run. This implies that the domestic variable do not affect the foreign variable in the long run and are therefore said to be long run forcing for the foreign variables. The test involves a test for joint significance of the estimated error correction terms of each lth element of x_{it}^* in the following equation (Johansen 1992; Harbo et al. 1998).

$$\Delta x_{it,l}^* = a_{il} + \sum_{j=1}^{r_i} \varsigma_{ij,l} E\hat{C}M_{ij,t-1} + \sum_{k=1}^{s_i} \phi_{ik,l} \Delta x_{i,t-k} + \sum_{m=1}^{n_i} \psi_{im,l}' \Delta \tilde{x}_{i,t-m}^* + \eta_{it,l},$$

where $E\hat{C}M_{ij,t-1}$, $j = 1,2,\dots,r_i$, are the estimated error correction terms corresponding to the r_i cointegrating relations in the i^{th}country model, and s_i and n_i are lag orders of the lagged changes for the domestic and foreign variables respectively.

The test for weak exogeneity is an F statistics test with the null hypothesis $\varsigma_{ij,l} = 0, j = 1,2,\dots,r_i$. The results are displayed in Table 12 and indicate that all but eight is not significant at the 5percent significance level. As such, the analysis can assume that the foreign specific variables are weakly exogenous.

The Co-Trending Test

The test of whether the cointegrating relations are trended is done by testing the following r_i restrictions in the VECMX* equation.[18]

$$\beta_i' \gamma_i = 0.$$

The relevant test statistic is given by:

$$LR(\beta_i' \gamma_i = 0) = 2\{l(\hat{\theta}_i; r_i) - l(\tilde{\theta}_i; r_i) - (\hat{\theta}_i; r_i)\} \sim \chi_{ri}^2,$$

where $\theta_i = vec(\beta_i)$, $l(\hat{\theta}_i; r_i)$ is the maximised value of the log-likelihood function when the cointegrating relations are just indentified, and $l(\tilde{\theta}_i; r_i)$ is the maximised value of the log-likelihood function obtained subject to the just identified restrictions plus the additional r_i co-trending restrictions.

The Impulse Response Function

The GIRFs are based on the following definition:

$$\mathcal{GIRF}(x_t; u_{ilt}: n) = E(x_{t+n} | u_{ilt} = \sqrt{\sigma_{ii,ll}} \mathcal{I}_{t-1}) - E(x_{t+n} | \mathcal{I}_{t-1}).$$

[18] The error correction form may also be written as:

$$\Delta x_{it} = c_{i0} - \alpha_i \beta_i' [z_{i,t-1} - \gamma_i (t-1)] + \Lambda_{i0} \Delta x_{it}^* + \Gamma_i \Delta z_{i,t-1} + u_{it},$$

where $z_{it} = (x_{it}', x_{it}^{*'})'$, α_i is a $k_i * r_i$ matrix of r_i, and β_i is a $(k_i + k_i^*) * r_i$ matrix of r_i.

By partioning β_i as $\beta_i = (\beta_{ix}' \beta_{ix*}')'$ comformable to z_{it}, the error correction terms defined by the above equation can be written as $\beta_i'(z_{it} - \gamma_i t) = \beta_{ix}' x_{it} + \beta_{ix*}' x_{it}^* - (\beta_i' \gamma_i) t$, which allows for the possibility of cointegration both within x_{it} and between x_{it} and x_{it}^* and consequently across x_{it} and x_{jt} for $i \neq j$ (di Mauro & Smith 2013).

Where $\mathcal{I}_{t-1}$ is the information set at time $t-1$, $\sigma_{ii,ll}$ is the diagonal element of the varianace-covariance matrix $\sum u$ corresponding to the lth equation in the ith country, and n is the horizon. It follows that the GIRFs of a unit (one standard error) shock at time t to the lth equation in the above model on the jth variable at time $t+n$ is given by the jth element of

$$\mathcal{GIRF}(x_t; u_{ilt}: n) = \frac{\mathbb{e}_j' \mathbb{A}_n \mathbb{G}_0^{-1} \sum_u \mathbb{e}_l}{\sqrt{\mathbb{e}_l' \sum_u \mathbb{e}_l}}, n = 0,1,2,..; l, j = 1,2, \dots, k,$$

where $\mathbb{e}_l = (0,0, \dots, 0,1,0, \dots, 0)$' is a vector with unit as the lth element in the case of a country-specific shock. The $\mathbb{A}_n$ matrices are calculated recursively as $\mathbb{A}_n = \mathbb{F}_1 \mathbb{A}_{n-1} + \mathbb{F}_2 \mathbb{A}_{n-2} + \cdots + \mathbb{A}_{n-p}$, $n = 1,2, \ldots$, with $\mathbb{A}_0 = \mathbb{I}_m, \mathbb{A}_n = 0$, for $n < 0$ (di Mauro & Smith 2013).

References

Al-Haschimi, A., Dees, S., 2013. Macroprudential applications of the GVAR. in Pesaran, M.H., di Mauro, F (eds), The GVAR handbook structure and applications of a macro model of the global economy for policy analysis, Oxford University Press, Oxford, pp. 151-165.

Backé, P., Feldkircher, M., Slacik, T., 2013. Economic spillovers from the Euroarea to the CESEE region via the financial channel : a GVAR approach. Focus on European Economic Integration, Q4/13.

Barisitz, S., 2013. Nonperforming loans in Western Europe – a selective comparison of countries and national definitions. Focus on European Economic Integration, Q1/13.

Basel Committee on Banking Supervision., 2011. The transmission channels between the financial and real sectors: a critical survey of the literature. BIS Working Paper no. 18, February.

Beck, R., Jakubik, P., 2013. Nonperforming loans: what matters in addition to the economic cycle ?. ECB Working Paper no. 1515, February.

Bernanke, B.S., Blinder, A.S., 1988. Credit , money , and aggregate demand. The American Economic Review 78, 435–439.

Borio, C., Drehmann, M., 2009. Towards an operational framework for financial stability : " fuzzy " measurement and its consequences. BIS Working Paper no. 284, June.

Brookes, M., Dicks, M., Pradhan, M., 1994. An empirical model of mortgage arrears and repossessions. Economic Modelling 11, 134–144.

Canova, F., Ciccarelli, M., 2013. Panel vector autoregressive models a survey. ECB Working Paper no. 1507, January.

Carey, M., 1998. Credit risk in private debt portfolios. The Journal of Finance 53, 1363–1387.

Castrén, O., Fitzpatrick, T., Sydow, M., 2009. Assessing portfolio credit risk changes in a sample of EU large and complex banking groups in reaction to macroeconomic shocks. ECB Working Paper no. 1002, February.

Cesa-Bianchi, A., Pesaran, M.H., Xu, T., 2009. On the transmission of global shocks to Latin America before and after China's emergence in the world economy. in the ECB workshop on International linkages and the macroeconomy: applications of the GVAR modelling approaches. European Central Bank, Frankfurt.

Chen, Q., Gray, D., N'Diaye., Oura, H., Tamirisa, N., 2010. International transmission of bank and corporate distress, IMF Working Paper no.10/124, May.

Chudik, A., Fratzscher, M., 2011. Identifying the global transmission of the 2007–2009 financial crisis in a GVAR model. European Economic Review 55, 325–339.

De Bock, R., Demyanets, A., 2012. Bank asset quality in emerging markets: determinants and spillovers. IMF Working Paper no. 12/71, March.

Dees, S., di Mauro, F., Peseran, M.H., Smith, L.V., 2007. Exploring the international linkages of the Euroarea: a global VAR analysis. Journal of Applied Econometrics 22, 1–38.

di Mauro, F., Smith, V., 2013. The basic GVAR DdPS model. in Pesaran, M.H,. di Mauro, F (eds), The GVAR handbook: structure and applications of a macro model of the global economy for policy analysis. Oxford University Press, Oxford, pp. 12-34.

Duca, M. Lo., Peltonen, T., 2011. Macro-financial vulnerabilities and future financial stress assessing systemic risk and predicting systemic events. ECB Working Paper no. 1311, March.

DZ Bank Group., 2012. Annual report. DZ bank group N.V, Frankfurt. Retrived from http://www.geschaeftsbericht.dzbank.de/2012/gb/files/pdf/en/DZ_BANK_Group_Annual_Report_2012.pdf on 12 May 2014.

Eickmeier, S., Ng, T., 2011. How do credit supply shocks propagate internationally ? a GVAR approach. Bundesbank Discussion Paper Series 1: Economic Studies no. 27/2011.

Espinoza, R., Prasad, A., 2010. Nonperforming loans in the GCC banking system and their macroeconomic effects. IMF Working Paper no. 10/224, October.

Foglia, A., 2009. Stress testing credit risk: a survey of authorities' approaches. International Journal of Central Banking September 2009, 1-45.

Forbes, K.J., Chinn, M., 2004. A decomposition of global linkages in financial markets over time. Review of Economics and Statistics 86, 705–722.

Harbo, I. et al., 1998. Asymptotic inference on cointegrating rank in partial systems. Journal of Business and Economic Statistics 16, 388–399.

Henry, J., Kok, C., 2013. A macro stress testing framework for assessing systemic risks in the banking sector. ECB Occasional Paper no. 152, October.

Hoggarth, G., Sorensen, S., Zicchino, L., 2005. Stress tests of UK banks using a VAR approach. Bank of England Working Paper no. 282, November.

IMF., 2007. Amendments to the financial soundness indicators (FSIs): compilation guide. Retrieved from http://www.imf.org/external/pubs/ft/fsi/guide/2008/pdf/071408.pdf on May 12, 2014.

ING Group., 2012. Annual report. ING group N.V, Amsterdam. Retrieved from http://www.ing.com/Investor-relations/Annual-Reports.htm on 12 May 2014.

Jakubík, P., Reininger, T., 2013. Determinants of nonperforming loans in Central , Eastern and Southeastern Europe. Focus on European Economic Integration, Q3/13.

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

KBC Group., 2012. Annual report. KBC group NV, Brussels. Retrieved from https://multimediafiles.kbcgroup.eu/ng/published/KBCCOM/PDF/COM_03_Jaarverslag_2012_KBC_Groep_en.pdf? on 12 May 014.

Klein, N., 2013. Nonperforming loans in CESEE: determinants and impact on macroeconomic performance. IMF Working Paper no. 13/72, March.

Lawrence, E.C., 1995. Consumer default and the life cycle model. Journal of Money, Credit and Banking 27, 939–954.

Louzis, D.P., Vouldis, A.T., Metaxas, V.L., 2012. Macroeconomic and bank-specific determinants of non-performing loans in Greece: a comparative study of mortgage, business and consumer loan portfolios. Journal of Banking and Finance 36, 1012–1027.

Nkusu, M., 2011. Nonperforming loans and macrofinancial vulnerabilities in advanced economies. IMF Working Paper no. 11/161, July.

Pesaran, M.H., Schuermann, T., Weiner, S.M., 2004. Modelling regional interdependencies using a global error-correcting macroeconometric model. Journal of Business and Economics Statistics 22, 129–162.

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

Pesaran, M.H., Smith, R., 2005. Macroeconometric modelling with a global perspective. IEPR Working Paper no. 06.43, February.

Pritsker, M., 2014. Enhanced stress testing and financial stability, Mimeo, Federal Reserve Bank of Boston.

Rinaldi, L., Sanchis-arellano, A., 2006. Household debt sustainability: what explains household nonperforming loans? An empirical analysis. ECB Working Paper no.570, January.

Sgherri, S., Galesi, A., 2009. Regional financial spillovers across Europe: a global VAR analysis. IMF Working Paper no 09/23, February.

Smith, L.V., Galesi. A., 2011. GVAR toolbox 1.1: Retrieved from www.cfap.jbs.cam.ac.uk/research/ gvartoolbox on 12 May 2014.

Smith, L.V., Galesi. A., 2011. GVAR toolbox 1.1 User guide: Retrieved from www.cfap.jbs.cam.ac.uk/research/ gvartoolbox on 12 May 2014.

Societe Generale., 2013. Consolidated financial statements. Societe Generale N.V, Paris. Retrieved from http://www.societegenerale.com/sites/default/files/documents/R%C3%A9sultats%20fin anciers/2013/Soci%C3%A9t%C3%A9%20g%C3%A9n%C3%A9rale%20Etats%20Fi%20%26%20Notes%2031.12.2013%20GB.pdf on 12 May 2014.

Unicredit Bank AG., 2012. Reports and accounts. Unicredit Bank AG, Munich. Retreieved from https://www.unicreditgroup.eu/content/dam/unicreditgroup/documents/en/investors/financial-reports/2012/Unicreditspa2012_reportsandaccounts.pdf on May 2014.