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Abstract

Using local projection, this study investigates the dynamic effect of credit risk on the real economy in European countries. We obtain credit spread shocks of financial and non-financial institutions in four major eurozone countries by controlling their endogenous changes caused by fear of the global financial market, the European Central Bank's monetary policy and the anxiety of national government debt. Our first finding is that industrial production responses to the non-financial institution credit spread shock are earlier than that for the financial institution shock. Second, in the case of rising credit risk, Germany, France and Finland increase bank lending to domestic companies. Finally, we find that these two tendencies were mainly due to the European common factor by verifying the impulse response functions to idiosyncratic credit spread shocks. We conclude that credit risks in each country are largely common in the eurozone.

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1 Introduction

The European economy is entering a turbulent era. Many serious incidents have called in to question the creditworthiness of some countries and their companies. In particular have been the global financial crisis, triggered by the United States (US) in 2007, and the European debt crisis in 2010, which originated from the Greek debt crisis. No exit can be seen from large-scale monetary easing measures, including the introduction of a negative interest rate policy by the European Central Bank (ECB); moreover, concerns about the eurozone's banking system are increasing. In such an uncertain economic environment, the accurate measurement of creditworthiness has become an important theme. If the creditworthiness of private enterprises is impaired in the European region with abundant capital movements, then it will affect not only their own country but also other countries in the region.

Since the introduction of the euro, which is a single currency, and the integration of monetary policies, it has been impossible to control the economic situation of a country by adjusting the foreign exchange and interest rates. Therefore, it is unavoidable that if a negative shock occurs in a country within the region, it cannot be solved unilaterally by that country alone and will spread to other countries in the region. By quantitatively clarifying the dynamic influence of rising credit risk of a certain country on its own economy and that of others, it is possible to visualise the spread of a crisis and its pattern of expansion, thus allowing assessment of the relative economic importance of each country in the European region.

Risk-taking channels can be cited as a transmission mechanism to the real economy in the case of the credit spread shocks. It is a route in which asset prices fluctuate due to monetary policy under a low interest rate environment and the risk tolerance of financial institutions changes as capital increases or decreases. As the interest rate rises due to shocks, the price of assets owned by financial institutions falls and the equity capital declines. This will lower the risk tolerance of financial institutions, hence the investment in safe assets will increase. When a credit spread shock of a financial institution occurs, the inter-bank transaction rate rises and the cost of funding rises. This rise in fund procurement costs lowers investment in risk assets and shifts to safe assets. When a credit spread shock of a non-financial institution occurs, the price of the asset held by the financial institution falls and the capital stock decreases. This avoids investing in risky assets and increases investment in safe assets.

In this study, using indicators that represent the credit risk of companies in the four major eurozone countries[1)], we quantitatively analyse the dynamic influence of an increase in credit risk on their own countries and on the credit risk of other countries. Specifically, we use the credit spread, which is an indicator of credit risk, constructed by Gilchrist et al. (2014), to extract and examine the dynamic effects of the credit shock spread on the four major eurozone countries, Northern Europe, Eastern Europe, the UK and Ireland.

To analyse how credit risk affects the real economy, we regress the variables representing what we want to control on the credit spread constructed by Gilchrist et al. (2014) and then obtain the residuals as the pure credit spread shock. Using the VIX, which represents the fear of the global financial market, the major policy rates of the ECB and yields of 10-year government bonds as control variables, we can remove endogenous changes of credit spreads caused by the monetary policy of the ECB and the uncertainty of the global financial market and the national government debt. Next, we calculate the impulse response function

[1)] In Gilchrist et al. (2014), the four major countries are Germany, France, Italy and Spain.

to quantitatively analyse the dynamic influence that the identified credit spread shocks exert on the real economy and compare them for each country. The method used in this study, devised by Jordà (2005), is local projection.

The rest of the study is organised as follows: Section 2 introduces previous studies; Chapter 3 describes the analysis framework and results and Section 4 states conclusions and future tasks and prospects.

2 Previous Studies

Many studies have analysed how the financial crisis affects the real economy after the European debt crisis occurred in 2010. Furceri and Zdzienicka (2011) analysed how the debt crisis affects production in the short- and medium-terms using panel data. Albertazzi et al. (2012) analysed the impact of the debt crisis on the banking sector using data from Italy.

Numerous studies have empirically analysed the nature of influence it will have on the real economy by constructing credit risk indicators. Gilchrist and Zakrajsek (2012) examined the dynamic influence of credit risk on the real economy using data from the American corporate bond market, and Bleaney et al. (2012) focussed on the credit spread of non-financial institutions in Austria, Belgium, France, Germany, Italy, the Netherlands, Spain and the UK.

Borio and Zhu (2012) analysed the linkage between monetary policy and financial institutions' risk-taking action. Bruno and Shin (2013) focused on the relation between bank leverage and monetary transmission mechanism through fluctuations in risk-taking.

Among these, we used Gilchrist et al.'s (2014) study as a benchmark in this study. Gilchrist et al. (2014) used credit spreads in European countries as indicators of credit risk and constructed credit spreads as the difference between the corporate bond yield of the four major eurozone countries and the yield of a German zero coupon bond of the same maturity. Furthermore, to construct credit spreads for the four countries, they took a weighted average of the market value at issuance. They also used the same methodology to construct a credit spread index for the eurozone as a whole. They established a credit spread for financial and non-financial institutions in the four European countries and compared these with other indicators currently used as indicators of credit risk. They described that their credit spreads indicated financial crises, such as the European debt crisis, better than the other credit risk indicators because their data collection methods relied on publicly available information for a number of target companies. Next, they examined whether these credit spreads are effective indicators for predicting the real economy. Using the Factor Augmented VAR (hereinafter, referred to as FAVAR) model, they analysed the nature of dynamic influence credit spreads exert on the real economy.

This study differs from the extant literature in three major ways. First, our analysis targets regional groups of European countries, i.e. Northern Europe and Eastern Europe. Gilchrist et al. (2014) focussed on the impact of overall European credit risk on the whole of Europe and the four major countries. In the European debt crisis of 2010, however, the impact on not only the central countries, such as Germany and France, but also on the peripheral countries, such as Ireland and Spain, was enormous. Therefore, verifying the responses of the four central powers cannot be sufficient to analyse the dynamic impact of the debt crisis on the real economy in detail. Thus, we will examine how these credit spread shocks will affect countries other than the four major regions such as Northern Europe (Finland, Sweden), Eastern Europe (Hungary,

Poland), the UK and Ireland[2)].

Second, when identifying credit spread shocks, we control for factors other than the company side. We control for sustainability and the endogenously changing factors of credit spread constructed by Gilchrist et al. (2014) and eliminate unpredictable parts as the shock. The factors we control for in this research are endogenous changes of credit spreads caused by global financial market anxiety, the monetary policy of the ECB and concerns about the national government debt. We regress the credit spread shock of the eurozone to the identified shocks and obtain residuals as idiosyncratic credit spread shocks. In this way, we can verify whether the impact of the credit spread shock on the real economy is due to factors common to the entire eurozone or to specific countries.

Finally, as we use the credit spread shocks of both financial and non-financial institutions in Germany, France, Italy and Spain, we can compare the effect of credit spread shocks on each real economy. Gilchrist et al. (2014) focussed on how credit spread for the eurozone as a whole affects the real economy in these four major countries; however, they did not consider the impact of specific credit spread shocks for financial and non-financial institutions. It is important to consider credit spread shocks specific to each country, financial institution and non-financial institution in the eurozone that has a strong connection and a common currency and monetary policy. By sorting shocks peculiar to each country by financial institution and non-financial institution, we can analyse how shocks spread not only in the country of origin but also to other countries in the case where the credit risk in one country in the eurozone rises.

3 Analysis

3.1 Analysis Framework

The method used in this analysis is local projection devised by Jordà (2005). In this method, shocks are obtained from outside the equation and used as exogenous variables. The equation is written as follows:

$$Y_{j,t+h} - Y_{j,t-1} = \alpha_j + \sum_{i=1}^{q} \beta_{j,i}(Y_{j,t-i} - Y_{j,t-i-1}) + \gamma_{j,h} SHOCK_{s,t} + \epsilon^h_{j,t+h} \tag{1}$$

where $Y_{j,t}$ represents the real economy of interest for country j[3)] in period t. We take a log difference for each variable to ensure a stationary process. The lag of the explanatory variable was used on the right-hand side, the maximum lag order was set to 4 and q was obtained by Akaike's Information Criterion (AIC). Since lag orders in local projection need not to be common in each prediction period, we skip their description. Here, $SHOCK_{s,t}$ is the credit spread shock and not endogenously determined within Equation (1), but is obtained from outside. $\epsilon^h_{j,t+h}$ represents the error term. The following formula is used to obtain $SHOCK_(s,t)$ in the Equation (1):

$$CRSP_{s,t} = \alpha_s + \sum_{i=1}^{q} \beta_{i,s} CRSP_{t-i} + \delta_s ControlVariables_s + \eta_{s,t} \tag{2}$$

$CRSP_{s,t}$ represents the credit spread of country s (Germany, France, Italy or Spain) while the $ControlVariables_s$ represent what we want to control for in terms of endogenous changes in the credit

[2)] We tried to verify the influence of neighbouring countries such as Portugal and Greece; however, due to the availability of data, the targets for analysis in this study are the aforementioned 10 countries and the whole European region.

[3)] j includes Germany, France, Italy, Spain, the UK, Finland, Sweden, Hungary, Poland, Ireland and eurozone.

spread variables[4]. We use the error term $\eta_{s,t}$ in Equation (2) as $SHOCK_{s,t}$ in Equation (1). In Equation (2), using variables that indicate what we want to control among the factors that cause the credit spread to change as explanatory variables makes the error term $\eta_{s,t}$ be a variable that does not contain such information. We can, therefore, select the factors we want to control freely. Since it is the coefficient ($\gamma_{j,h}$) of the shock variable of Equation (1) that matters in local projection, it is not necessary to consider $\beta_{j,i}$ in Equation (1). The impulse response functions of each variable to shocks are directly obtained with each period h therefore, the impulse response function at the h period ahead after the credit spread shock occurred is expressed as follows:

$$IR(h) = \gamma_{j,h} \tag{3}$$

This method is mainly used in this study because it has the following advantages. Initially, this method allows easy measurement because the estimation result is obtained by reiterating a simple OLS test. The impulse response function by local projection is obtained by estimating $\gamma_(j,h)$ for H times and collecting the obtained predicted values. Instead of sequential substitution of values obtained by one estimation, the impulse response function is calculated by a simple regression for the period to be verified. Next, there is an advantage that it is more robust against misidentification of the model in the data generation process. As the impulse response function is a prediction function expressing how the shock occurring in period t affects through time, misspecification in the data generation process distracts the prediction. However, in the case of sample-based estimation, even when the model is mis-specified it may still produce reasonable one-period-ahead forecasts , a collection of values is said to be more robust against misidentification. These advantages have led various studies to calculate impulse response function by local projection[5]", a collection of values is said to be more robust against misidentification. Because of these advantages, various studies have calculated impulse response function by local projection[6].

As a recent development of the method, it can be combined with the FAVAR model by adding a factor estimated from the big data as the control variable and with a method using instrument variables[7].

3.2 Dataset

We use the dataset of credit spread constructed by Gilchrist et al. (2014) as an indicator of the credit risk of the four European countries. The data have been updated on the homepage of Simon Gilchrist of Banque de France and, at the time of writing this study, monthly data from January 1999 to August 2016 were available[8]. All other data were acquired from January 1999 to August 2016 according to the period of the credit spreads. Other variables include the reference interest rate (i.e. main policy interest rate of the ECB), the VIX representing the fear of the global financial market and the yield of 10-year government bonds in each country. These data were obtained from Bloomberg. When verifying the dynamic impact on the real economy using the identified shock of the credit spread, we used the industrial production index of each country, bank lending from domestic financial institutions to domestic enterprises and bank lending to

[4] Variable factors of credit spreads are selected referring to Collin-Dufresne et al. (2001).

[5] See Stock and Watson (1999).

[6] Sekine and Tsuruga (2014), Furceri and Zdzienicka (2011) and Auerbach and Gorodnichenko (2011) used local projection to analyse dynamic effects in their studies.

[7] Recent empirical analyses including local projection are referred to by Ramey (2016).

[8] For the detailed description and the construction of credit spreads, see Gilchrist et al. (2014).

other countries[9]. The source of these data is Datastream. Since bank lending is not seasonally adjusted, they were done using ARIMA 13.

3.3 Shock Identification

Here, we obtain the shock variable of Equation (1) to calculate the impulse response function by local projection. We calculate the fitted value of the credit spread using a variable representing the factor to be controlled to identify the unique shock of the credit spread as an explanatory variable. Subsequently, we subtract these theoretical values from the actual credit spreads and make this a credit spread shock variable.

In this analysis, we use the main policy rate of the ECB, the VIX and the rate of annual change of the yield of 10-year government bonds in each country as the control variables. By using the ECB's main policy interest rate, we control for factors that cause credit spreads to change endogenously by the monetary policy of the ECB. VIX is used to control parts of the world's uneasiness among credit spread fluctuation factors used to extract the country's specific risks. In addition, the rate of change in the yield of 10-year government bonds in each country (year-on-year) is used to control endogenous change in credit spread due to vigilance and distrust of government debt. The sustainability of the shock was removed by adding the lag of the credit spread. We use these variables to regress the credit spread and obtain the residual as the credit spread shock.

[Figure 1]
[FIgure 2]

We will consider each obtained credit spread shock for financial and non-financial institutions. In the credit spread shock of financial institutions, it can be seen that the rise in credit risk due to the Lehman Brothers shock is controlled for, to some extent, by using the VIX. Observing the descriptive statistics of Table 1 and Figure 1, the credit spread shocks of Italian financial institutions are considerably higher around the European debt crisis than that in other countries. This may be because the credit risk of Italian financial institutions has unexpected factors that cannot be fully explained by the fear of global financial markets and the vigilance and distrust of government debt. Banks in Italy have even higher non-performing loan ratios and leverage ratios among the eurozone countries, with a considerably higher non-performing loan ratio and leverage ratio than the US and Japan. We deduce that these unstable financial sectors may have promoted damage in the European debt crisis. Although the largest variance was in Italy, credit spread shocks by Spanish financial institutions fluctuate throughout and signify the constant instability of Spanish financial institutions. It is seen that the fluctuations in Italy and Spain are still larger than in Germany and France. It can be reconfirmed that Germany and France are the main countries for financial institutions in the eurozone. The fact that major banks in Germany and France have recently faced management difficulties can be imagined.

Next, we consider the credit spread shock of non-financial institutions (Figure 2)[10]. The major differences from financial institutions' credit spread shocks are in 2002 and in the latter half of 2008. The credit spread shock of non-financial institutions has risen in late 2008 in all four countries. Although we use the VIX to control the endogenous change in credit spread due to the global financial market anxiety, the influence

[9] Although we verified using unemployment rates, stock prices, the Harmonized Index of Consumer Price and core inflation, we do not show the results in this study due to space limitations.

[10] In the following graphs, non-financial institution is expressed as NFI.

of the Lehman Brothers shock on non-financial institutions cannot be fully explained. As another feature, it can be seen that the shocks of Spain, Italy and France are becoming more volatile in 2002. The global economic recession triggered by the collapse of the IT bubble in the US caused the fluctuation of credit spread shocks in each country to increase. As VIX controls for endogenous fluctuations due to global fear, a specific shock to the credit spread representing the collapse of the IT bubble in the US was extracted. It can be inferred that there were factors that could not be measured by VIX alone. In addition, Spain's credit spread shock is high around 2002, which is consistent with the time of Argentina's currency debt crisis.

3.4 Impulse Response Function

In this subsection, we calculate the impulse response function in order to verify the dynamic effect on the real economy by using the shock variable extracted by the analysis above. The impulse response function by local projection can be derived from Equation (1). Y contains the industrial production index, bank lending to home country and bank lending to other countries. We take the logarithms of the above variables and multiply by 100. $SHOCK_{s,t}$ is the credit spread shock of the four countries identified in previous analyses, which is standardised to compare financial institutions and non-financial institutions between countries. In local projection, the impulse response function of each variable to shock is directly obtained; thus, $\gamma_{j,h}$ represents the response of each variable at period h compared with period $t-1$. In the following figures, solid lines represent the response of the real economy to a 1 standard daviation increase in the credit spread shocks and broken lines represent the 95 percent confidence intervals[11)].

[Figure A.1]
[Figure A.2]
[Figure A.3]
[Figure A.4]
[Figure A.5]
[Figure A.6]
[Figure A.7]
[Figure A.8]

Figures A.1 and A.2 show the responses of industrial production indices in each country to German credit spread shocks. German financial institutions' credit spread shocks lower the industrial production index of each country about one year after the shock, excluding France and Ireland. As German financial institutions, located in stable countries in Europe, are actively lending and operating with high leverage, we realised that the effect of the decline in creditworthiness spillovers not only domestically but also enormously to other countries. It can be seen from Figure A.2 that the credit spread shock of German non-financial institutions causes the industrial production to decline faster than when the financial institution shock occurs. The industrial production index began to decline about six months after the credit spread shock of non-financial institutions. Unlike financial institutions, this implies the relation to distance in transactions with companies involved in industrial production. In a financial institution, when the credit risk rises, there is a time lag between examining within the company and actually lowering the loan to decrease the production of the company; however, in the case of non-financial institutions, the increase in credit risk is actually occurring between companies and this reduces transactions quickly. It is Hungary in Eastern Europe that shows the

[11)] In this analysis, the confidence interval of the impulse response function is taken as 95% confidence interval of HACSE.

largest reaction and demonstrates a high dependence on German companies.

Figures A.3 and A.4 show the responses of each country's industrial production index to French credit spread shock. The French financial institution shock has less of an impact than for those in Germany, but it decreases production about one year after excluding its own country. As we look closely at Italy and Spain, they began to decline after six months and it can be inferred that the relationship between France, Italy and Spain is stronger than that in other countries. The French non-financial institution shock did not have a significant influence except on the Nordic countries. As the impact on Nordic countries is also limited, it can be seen that the creditworthiness of French non-financial institutions does not have much impact.

Figures A.5 to A.8 show the responses of industrial production indices of each country to credit spread shocks of Italy and Spain. The rise in the credit risk of Italian financial institutions did not have a significant influence even on its own country; however, non-financial institution shocks had a significant negative influence on Germany, the eurozone, Finland and Sweden, apart from influencing their own countries. In Italy, the rise in the credit risk of non-financial institutions causes more negative effects than that of financial institutions. In Spain, as opposed to Italy, it was found that the influence of credit risk shock in financial institutions and has a significant negative impact on Germany, Italy, the home country, the eurozone, the UK and Hungary.

[Figure A.9]
[Figure A.10]
[Figure A.11]
[Figure A.12]

Figures A.9 and A.10 show the responses of bank lending in each country to the credit spread shock of Germany. The most interesting are the responses of Germany, France and Finland to the financial institution credit spread shock: each increases lending to their own country. This is to take action to raise home bias by the credit crisis in Germany and they actually decreased lending to other European countries after the European debt crisis[12)]. In other countries, the financial institution shocks have a significant effect except the UK and Finland. In the shocks of non-financial institutions, home biases are not observed and it proved to have a negative impact on Spain, the eurozone, the UK and Ireland. Especially in Spain, bank lending declined after a few months following the occurrence of the German non-financial institution shock.

Figures A.11 and A.12 show the responses of each country's lending to French credit spread shocks. The financial institution shock is very similar to the German shock and Germany, France and Finland show home bias to increase their lending against shocks. Differences from the German shock were seen in non-financial institution shocks. Germany and Finland negligibly decrease domestic loans between 12 months and 18 months after the shock. Bank lending in Spain and the United Kingdom continues to decrease against the German non-financial institution shock, but it turned out to be a temporary and limited decrease for French shocks.

Credit shocks of both institution types in Italy and Spain do not have a significant impact on domestic bank lending, including in their own country. Thus, we omitted the results due to space limitation.

[Figure A.13]
[Figure A.14]
[Figure A.15]

[12)] See Niccolo et al. (2012) for systemic risk and home bias.

[Figure A.16]

[Figure A.17]

[Figure A.18]

Figures A.13 and A.14 show the responses of bank lending to other countries to Germany's credit spread shock. A remarkable point in the German credit spread shock is that response to the non-financial institution shock is faster than that to credit spread shock of financial institutions. We find that bank lending to other countries will decline quickly as the cost of financing of German non-financial institutions rises rather than the fact that the financing cost of German financial institutions rises.

From Figures A.15 and A.16, it can be seen that the credit spread shock of French financial institutions has a more negative influence than the non-financial institution shock except for the UK. In the financial institution shock, France, Italy, Spain and the eurozone will decrease bank lending after one year and Hungary will decrease about one and a half years later. In the non-financial institution shocks, only France and the UK showed a significant negative response, whereas Germany, Italy and the eurozone showed a small response.

Figures A.17 and A.18 show the responses of bank lending to other countries to Italy's credit spread shock. Foreign lending significantly decreases in France and the eurozone due to credit spread shocks of both financial and non-financial institutions. On the other hand, the response of Italy, the country of origin in this case, is different for financial and non-financial institution shocks. Although the financial institution shock showed a reaction that could not be considered significant, in the non-financial institution shock, it decreased significantly after one year. In the case of a credit crisis in a non-financial institution in Italy, it was estimated that Italy will lower its loans to other countries a year later[13)].

3.5 Idiosyncratic Shock

Based on the above analysis results, it was found that the credit spread shocks of the four major European countries have a significant effect of depressing the real economy. However, it seems that all reactions by shocks of each country are similar. In identifying credit spread shocks, we used the policy rate of the ECB, the VIX and the rate of change of government bonds to extract the portion where the cost of fund procurement fluctuates due to the factors of the pure enterprises in each country; however, it is very likely that common factors across Europe and the factors unique to each country are mixed. Therefore, we calculate the correlation coefficient of the obtained shock.

[Table 2]

It can be seen from Table 2 that the credit spread shock of each country has a high correlation. It may cause some problems to use such a shock variable that allowed high correlation. For example, when seeing the influence of Spain's shock, it cannot judge whether it depends largely on shocks common to the four countries or on shocks peculiar only to Spain.

Therefore, by regressing the credit spread shock of the eurozone as a whole to that of each country, it decomposes into common factors to the four countries and idiosyncratic factors to each[14)]. The regression

[13)] We cannot obtain remarkable results from the impulse response functions of foreign lending to Spain's credit shock and, therefore, do not show them due to space limitations.

[14)] A principal component analysis was also carried out; however, the expected results were not obtained. This study, therefore, appointed a simple regression method with credit spread shock across the European region as a whole.

formula is very simple as follows:

$$SHOCK_{s,t} = \alpha_s SHOCK_{euro,t} + \xi_{s,t} \tag{4}$$

$SHOCK_{s,t}$ is the credit spread shock of the four countries obtained as the residual of Equation (2) and $SHOCK_{euro,t}$ is the credit spread shock of the eurozone as a whole, which can be calculated using Equation (1). This will eliminate the part described by eurozone credit spread shocks in each credit spread shocks. Therefore, $\xi_{s,t}$ can be extracted as an idiosyncratic shock representing the factors unique to each country.

[Table 3]
[Table 4]

As can be seen from Table 4, the correlations reduced overall by regressing the credit spread shock of the eurozone as a whole. However, despite controlling the credit spread shock of the eurozone as a whole, it cannot be said that each shock is independent ($-$ 0.485 between Germany and Spain in non-financial institution shocks, $-$ 0.469 between France and Italy, etc.). Since the factors that cause each credit spread shock to fluctuate due to the common credit spread shock in the eurozone are controlled, we think that the reason why the correlations remain is that they are correlated independently of each other irrespective of the factors common among the countries in the entire eurozone.

Therefore, in this study we express the shock $\xi_{s,t}$ obtained here as idiosyncratic shock for convenience. To verify the ratio occupied by the common factors in credit spread shock of each country, we calculate as follows:

$$R_s^2 = \frac{\sum_{t=1}^{T} \alpha_s SHOCK_{euro,t}}{\sum_{t=1}^{T} \alpha_s SHOCK_{s,t}}$$

R_s^2 represents the contribution of four countries' common factors $\alpha_s SHOCK_{euro,t}$ to the fluctuation of each credit spread shock.

[Table 5]

Except for Spanish financial institutions, the share of common factors of each country's credit spread shock proved to be extremely high. This is also because German and French companies are used more than those in other countries (Gilchrist et al., 2014).

3.6 Impulse Response Functions to Idiosyncratic Shocks

In this subsection, we calculate the impulse response function using $\xi_{s,t}$ obtained above for the shock variable in Equation (1). In the overall view, as a result of regressing credit spread shocks throughout the eurozone on the credit spread shocks of each country, the impact of Italian and Spanish credit spread shocks is not seen in most countries. Although some degree of influence remained in Germany and France, it was found that the factors caused by common factors in the eurozone as a whole are large, especially in bank lending. We introduce only the remarkable results because ofdue to the limited space in this study.

The responses of the industrial production index showed that the portion that responded earlier to the financial institution shock than to the non-financial institution shock was due to the common credit spread shock of the eurozone as a whole.

[Figure B.1]

[Figure B.2]
[Figure B.3]
[Figure B.4]

Looking at Figures B.1 to B.4, the influence of France's credit spread shock loses its effect in most countries by controlling eurozone common shocks as a whole. On the other hand, the effect of the German credit spread shock on financial institutions remains to some extent although its impact is weakened. From this result, it was quantitatively reconfirmed that the influence of German financial institutions is extremely large throughout Europe as well.

In addition, in Figure B.3, it can be seen that the influence of the shock peculiar to French financial institutions is little and the shock specific to French non-financial institutions has no significant effect except for Poland (Figure B.4). Poland does not lower the industrial production index against the shock and increases about one year later[15)].

[Figure B.5]
[Figure B.6]

In the case of credit spread shock not controlled by the eurozone as a whole, there was a home bias to increase bank lending to the domestic companies in Germany, France and Finland; however, we found that these were due to the credit spread shock common to the four countries.

Comparing Figures A.9 and B.5, the German financial institution shock, which includes common factors throughout the eurozone, showed a home bias for Germany to raise its banking loan domestically for about one year; however, it was found that its home bias became limited in the idiosyncratic shocks.

Comparing Figures A.11 and B.6, France's financial institution shock, including common factors throughout the eurozone, increased bank lending in the home country for about half a year after the shock; however, in response to the special shock, home bias ceased to be observed. From these results, it turned out that the reason why the home bias disappears when it is decomposed into national specific factors is that it is common shock that increases domestic bank lending. Because the positions of Germany and France in Europe as a whole are relatively safe, they use bank lending to their own country as a safe source of funds when the overall risk rises, but for the idiosyncratic shocks in Germany and France, they tend not to increase the loans[16)].

[Figure B.7]
[Figure B.8]
[Figure B.9]

It was found from Figures B.7 to B.9 that factors that significantly decreased bank lending to other countries were due to common credit spread shocks across Europe. Details will be discussed individually for each shock. The German financial institution credit spread shock has changed particularly in the four countries, France has decreased the lending to other countries and the influence disappeared in Italy and Spain. No influence was seen on the German non-financial institution shock. In France, even if it is a financial

[15)] Idiosyncratic credit shocks of both institution types in Italy and Spain do not have a significant impact on industrial production. Therefore, we omitted the results due to space limitations.

[16)] Broyer et al. (2012) showed that Germany is still considered safe in Europe after the European crisis, based on bond yields.

institution shock, the influence which was significant before controlling common factors has disappeared[17]. No significant influence was seen to shocks of Spain and Italy except that bank lending to other countries by Spain will rise in one year to Italian financial institution shocks.

Based on the above results, the responses of bank lending to other countries disappeared by using the idiosyncratic credit spread shock to each country, which proved that foreign lending would decrease due to common factors in the whole of Europe. Again, since capital movement is extremely free in the European region, if a credit risk shock occurs in one country, then it is likely that there is a tendency to shift the loans from one country to others and not to reduce the total lending to other countries.

4 Conclusion

In this study, we quantitatively analysed the dynamic impact of the credit risk of four major European countries on the real economy, with local projection using the credit spread constructed by Gilchrist et al. (2014). By controlling for the credit spread by ECB policy interest rate, VIX and the yield on government bonds, we identified a unique credit spread shock which fluctuates according to pure corporate behaviour and verified the influence on the real economy. The industrial production index responded more quickly to non-financial institution shocks than to financial institution shocks. We found that there was a tendency for home bias to increase bank lending to the home country in relatively stable countries, such as Germany and France, in the case of rising credit risks.

Furthermore, to obtain the impulse response function to the idiosyncratic shock for each country, we decomposed the credit spread shock into the common factors of the eurozone and each country's individual factors. Using this method, we found that non-financial institution shock affecting industrial production prior to the financial institution shock was due to the common credit spread shock in the European region. We also realised that factors making bank lending a home bias were also the result of shocks common to the European countries. In addition, as the share of common factors in each country's credit spread shock was extremely high, it can be said that the creditworthiness of each European country is largely common throughout Europe.

In this study, it was found that the damage to creditworthiness among the four major European countries will put pressure on the real economy. The European economy, which had been unstable since the European debt crisis in 2010, has experienced the EU withdrawal decision by the British referendum, the non-performing loan problem of Monte Paschi and a slump in management by Deutsche Bank in 2016. Germany, which is said to be safe and stable, is now a cause for worry. The distrust of the European economy will not disappear easily; therefore, it is necessary to pay attention to it.

Three tasks are listed for future research. The first task is to acquire shocks completely independent of other countries in identifying the credit spread shock. In this analysis, it was impossible to obtain a shock while completely eliminating correlation with other countries even by extracting the shock peculiar to each country. Because the credit spread shock was regressed by the common credit spread shock in the eurozone, the factors that fluctuate due to common eurozone factors were eliminated, but it was insufficient to obtain an independent shock for each country. Therefore, we would like to use other methods to identify credit spread shocks. For example, the methods using factors obtained from the numerous data representing the financial markets and the real economy of each country may be a good approach.

[17] We obtained the same results in using non-financial institution credit spread shock.

Second, comparing the impulse response function obtained by methods other than local projection should be helpful in understanding the dynamic impacts of credit risks. In this study, local projection is used as a method to calculate the impulse response function, but we hope that further discovery can be made by comparing it with the impulse response function using other methods.

Third, in this study, we considered banks' domestic and foreign lending; however, we can carefully follow fund transfers in the European countries by verifying it by country or region. Furthermore, by examining how credit against the US changes due to the rise in credit risk in Europe, we can verify the importance of Europe in the global financial market.

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Data Appendix

	Germany		France		Italy		Spain	
	BANK	NFI	BANK	NFI	BANK	NFI	BANK	NFI
Mean	0.000	0.000	0.001	0.003	0.002	0.005	0.000	0.002
Std	0.103	0.195	0.165	0.143	0.387	0.189	0.315	0.264
Max	0.585	1.735	0.953	1.185	3.691	1.041	1.339	1.561
Median	-0.011	-0.007	-0.006	-0.001	-0.015	-0.004	-0.005	-0.008

Table 1 The Descriptive Statistics of Identified Credit Spread Shocks

Bank Shock	Germany	France	Italy	Spain
Germany	1.000	0.680	0.716	0.378
France	0.680	1.000	0.641	0.551
Italy	0.716	0.641	1.000	0.369
Spain	0.378	0.551	0.369	1.000
NFI Shock	Germany	France	Italy	Spain
Germany	1.000	0.491	0.426	0.780
France	0.491	1.000	0.732	0.622
Italy	0.426	0.732	1.000	0.617
Spain	0.780	0.622	0.617	1.000

Table 2 The Correlation of Identified Credit Spread Shocks

	Germany		France		Italy		Spain	
	BANK	NFI	BANK	NFI	BANK	NFI	BANK	NFI
Mean	0.000	0.001	0.001	0.002	0.002	-0.001	0.000	-0.004
Std	0.055	0.070	0.095	0.086	0.170	0.148	0.278	0.176
Max	0.242	0.401	0.493	0.625	0.604	0.681	1.317	0.861
Median	-0.005	-0.002	-0.005	0.004	0.010	0.003	0.015	-0.005

Table 3 The Descriptive Statistics of Shocks Regressed by Eurozone Credit Spread Shocks

BANK	Germany	France	Italy	Spain
Germany	1.000	-0.040	-0.182	-0.046
France	-0.040	1.000	-0.368	0.325
Italy	-0.182	-0.368	1.000	-0.141
Spain	-0.046	0.325	-0.141	1.000
NFI	Germany	France	Italy	Spain
Germany	1.000	-0.192	-0.361	-0.485
France	-0.192	1.000	-0.469	0.063
Italy	-0.361	-0.469	1.000	0.044
Spain	-0.485	0.063	0.044	1.000

Table 4 The Correlation of Shocks Regressed by Eurozone Credit Spread Shocks

	Germany	France	Italy	Spain
BANK	0.713	0.669	0.802	0.226
NFI	0.751	0.722	0.667	0.605

Table 5 The Ratio of Common Factors in Each Countries' Credit Spread Shocks

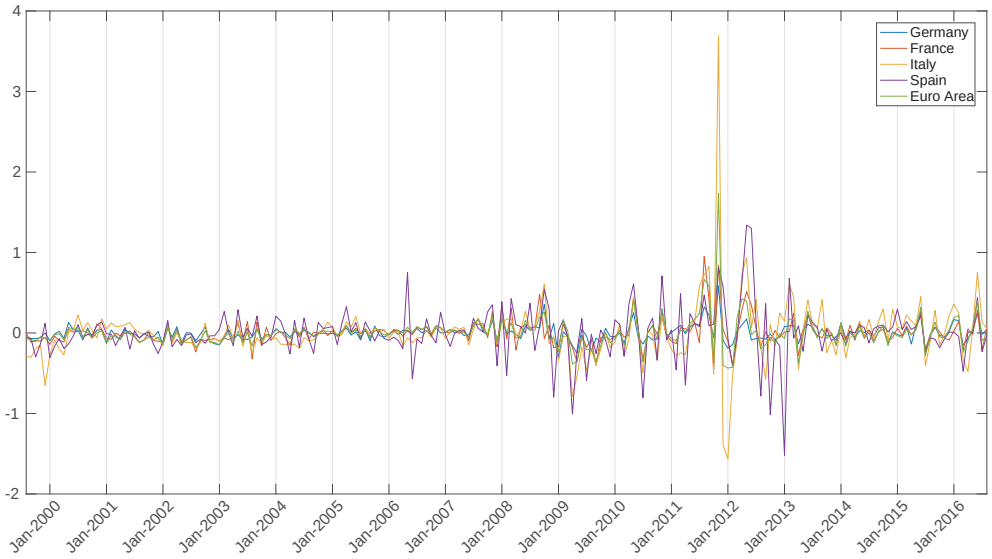


Figure 1 Bank Credit Spread Shock

From August 1999 to August 2016

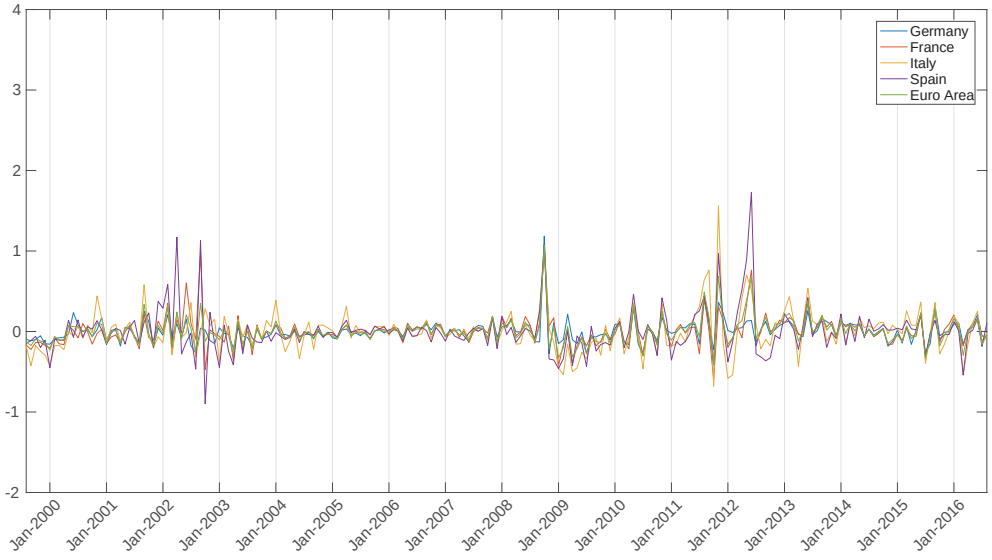


Figure 2 NFI Credit Spread Shock

From August 1999 to August 2016

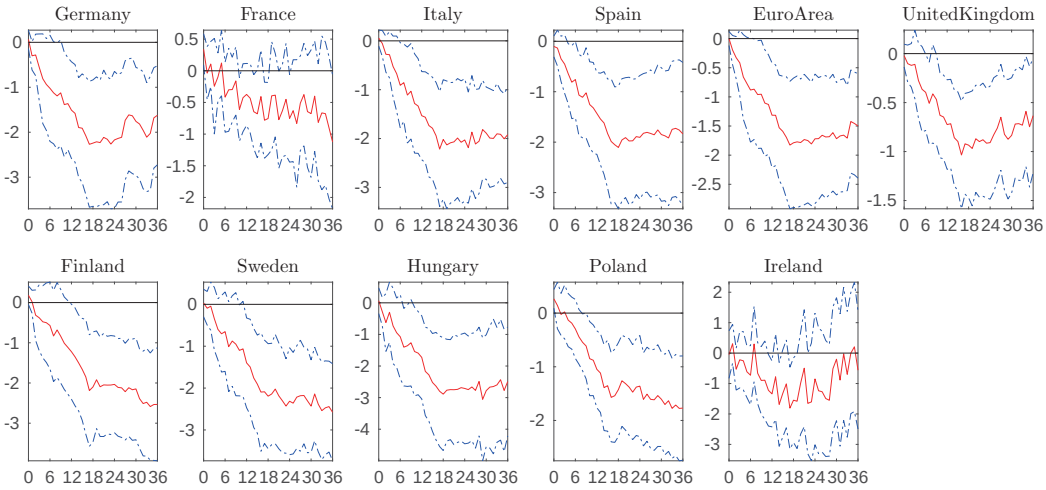


Figure A.1 Response of IIP to Germany Bank Shock

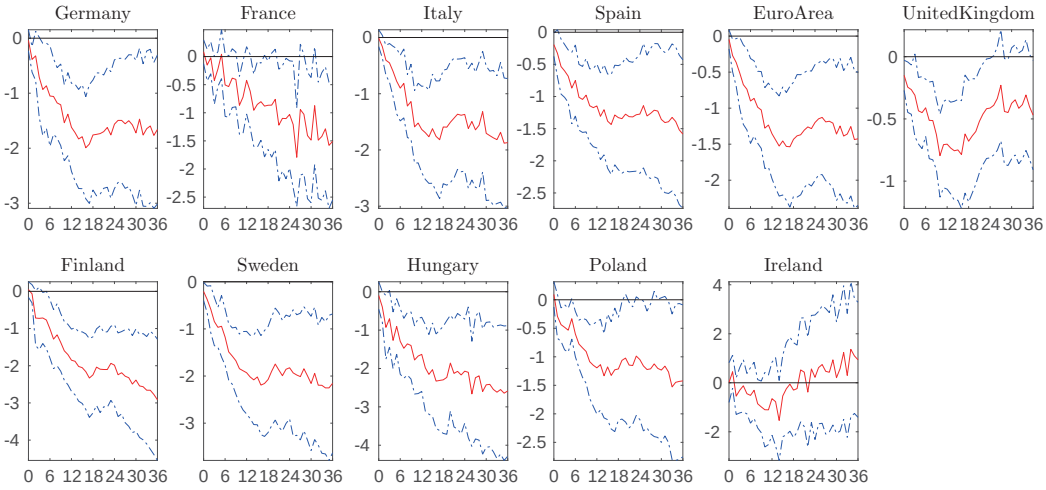


Figure A.2 Response of IIP to Germany NFI Shock

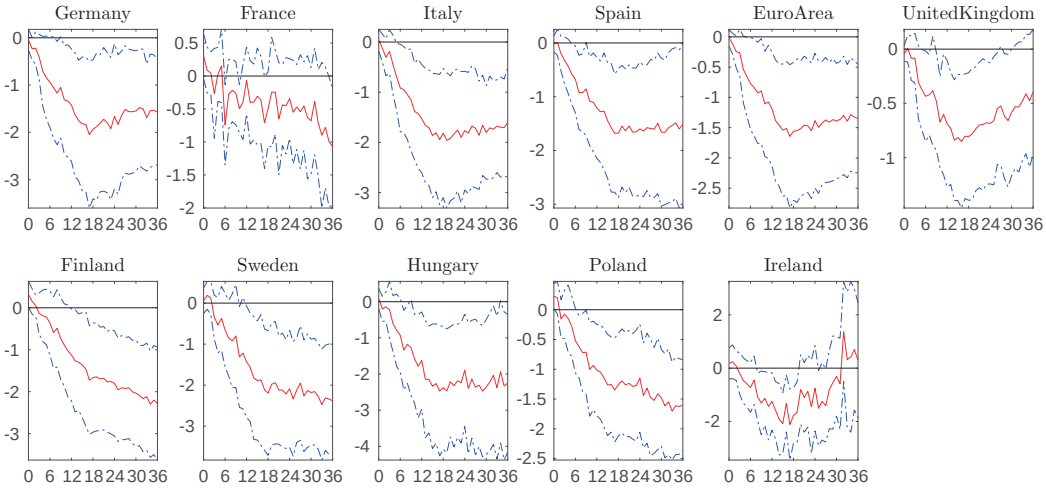
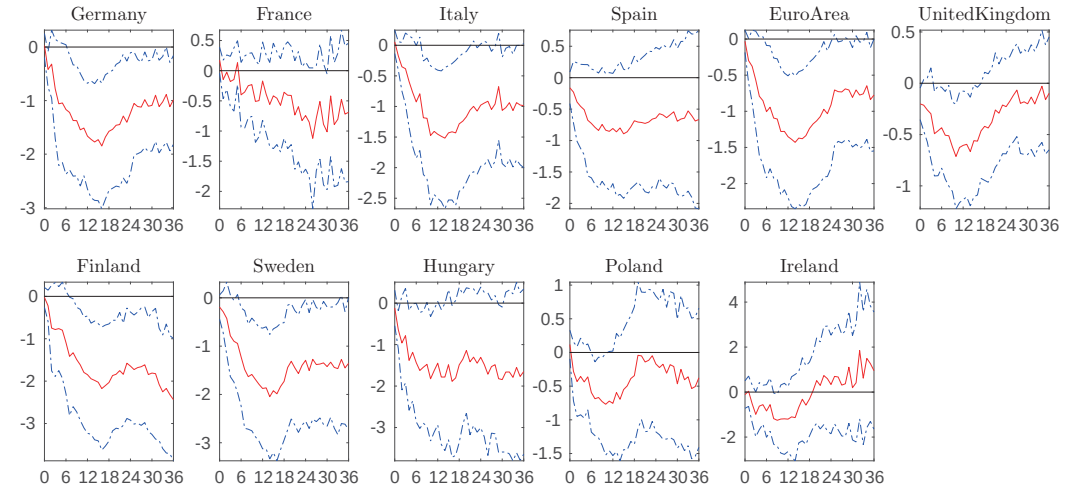


Figure A.3 Response of IIP to France Bank Shock



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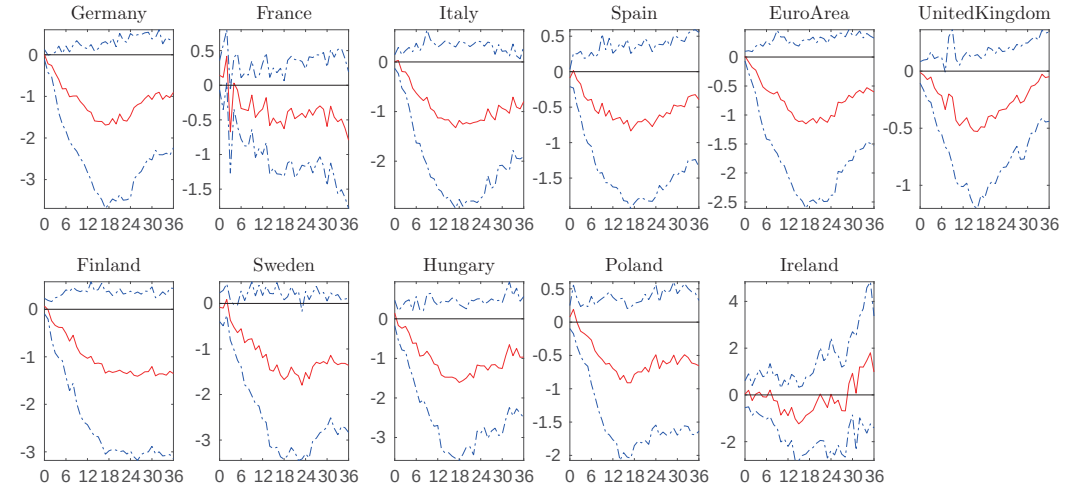


Figure A.5 Response of IIP to Italy Bank Shock

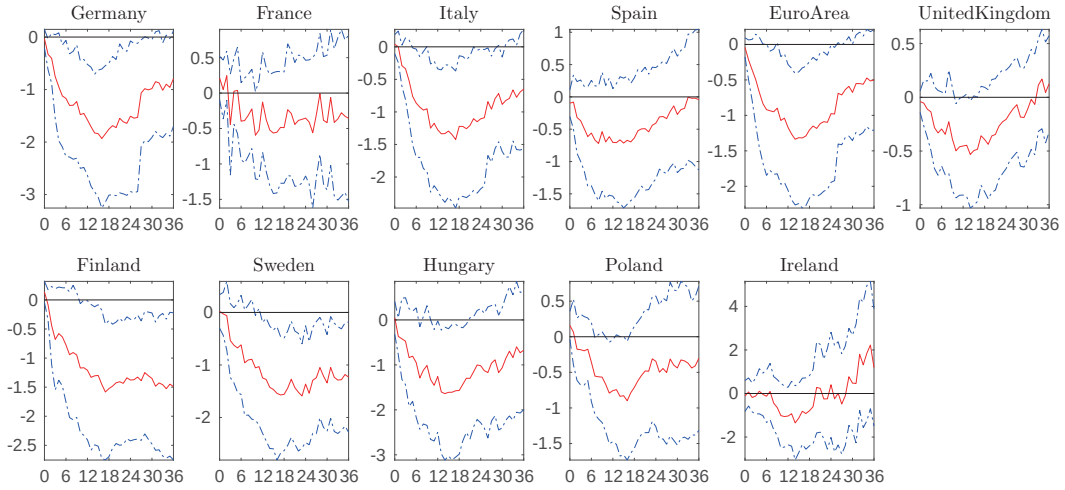


Figure A.6 Response of IIP to Italy NFI Shock

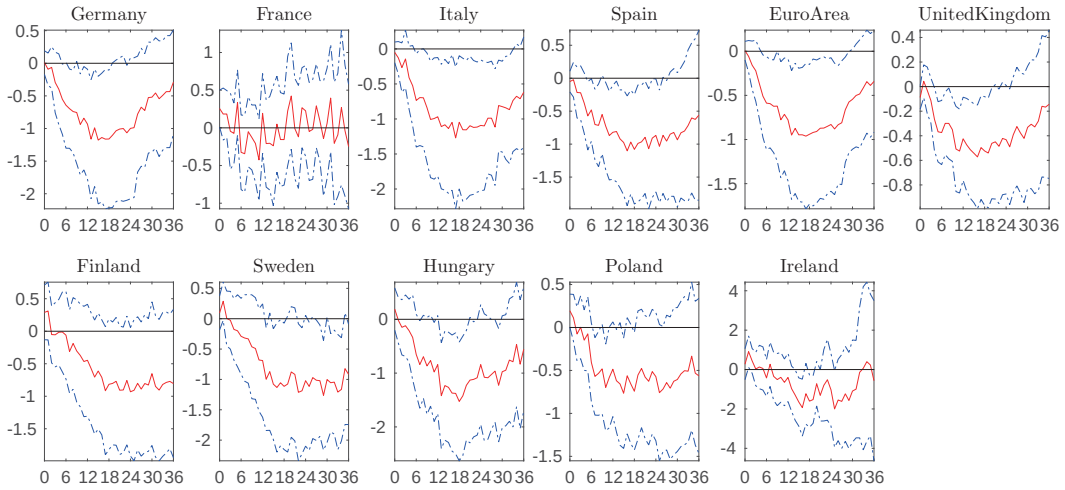
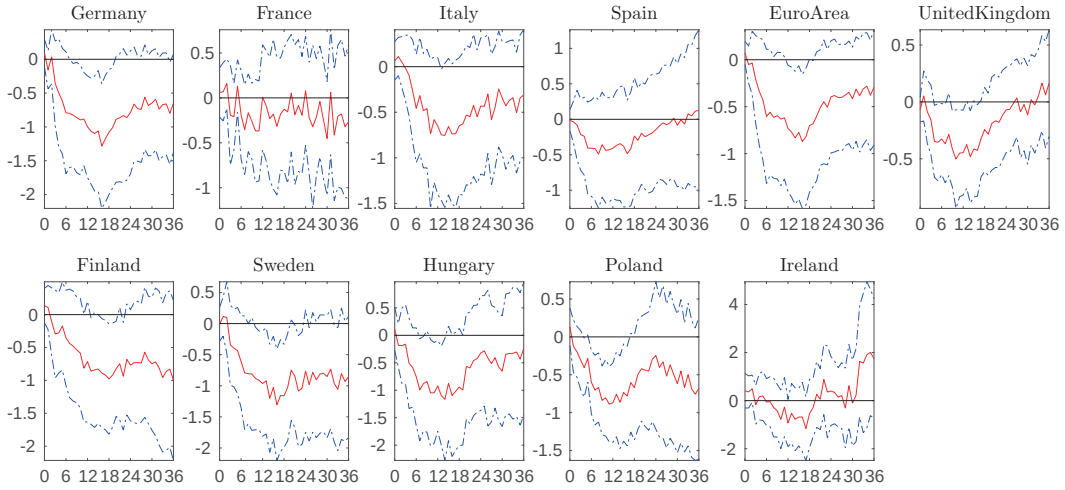


Figure A.7 Response of IIP to Spain Bank Shock



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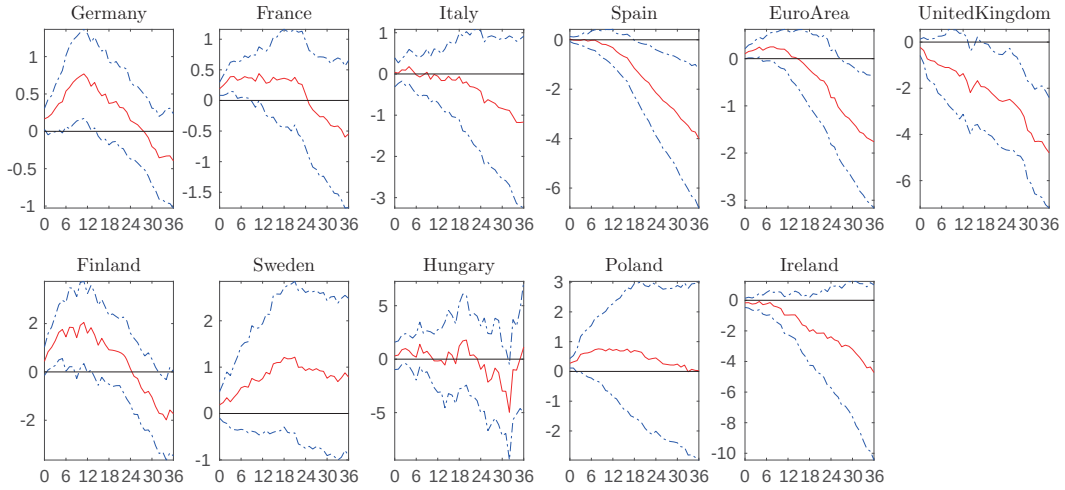


Figure A.9 Response of Domestic Loan to Germany Bank Shock

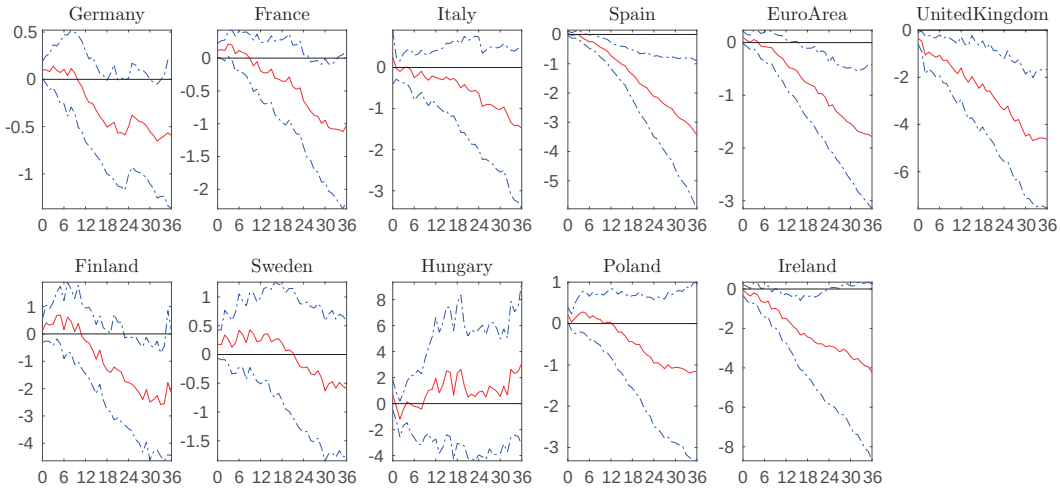


Figure A.10 Response of Domestic Loan to Germany NFI Shock

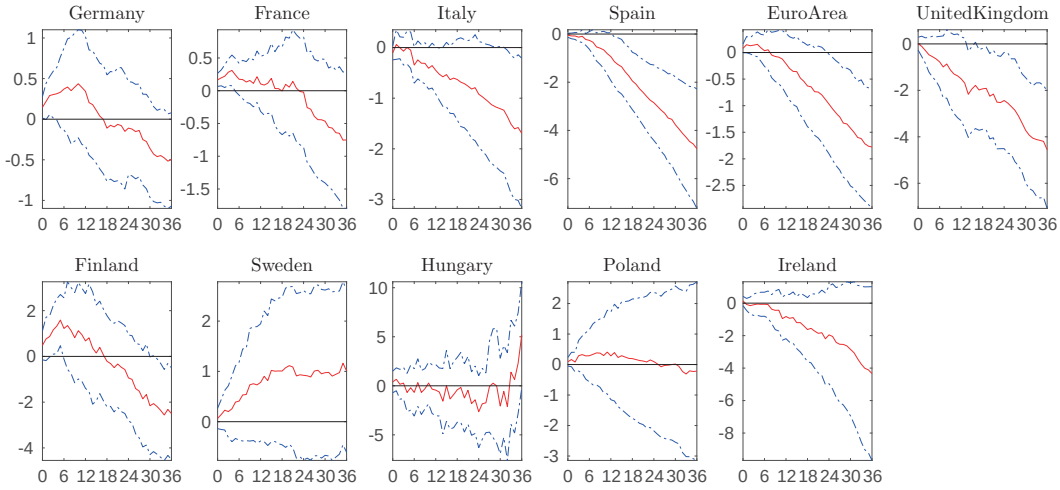


Figure A.11 Response of Domestic Loan to France Bank Shock

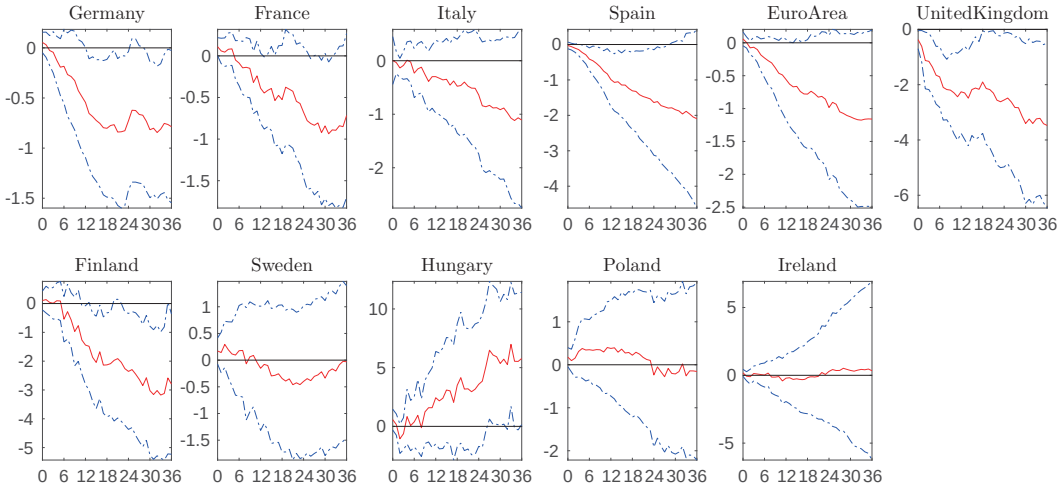


Figure A.12 Response of Domestic Loan to France NFI Shock

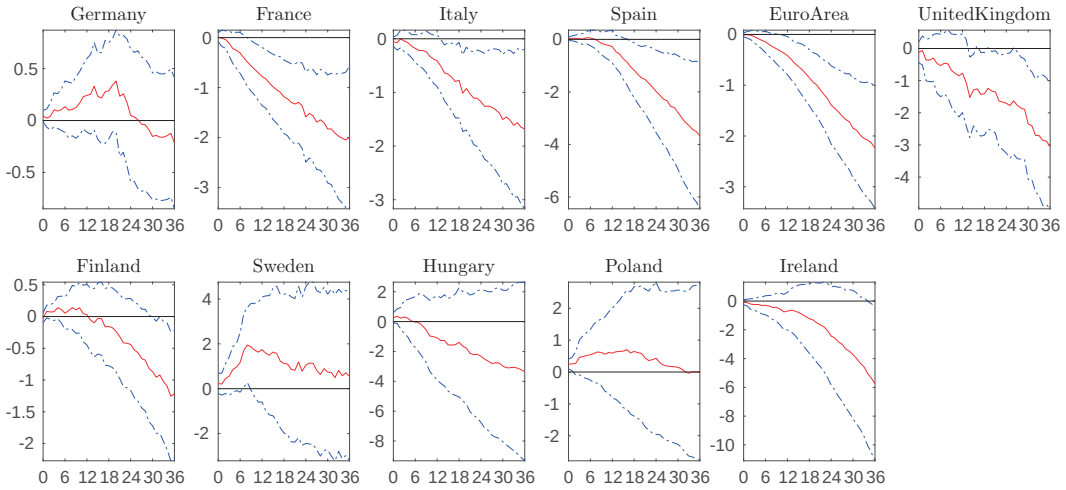


Figure A.13 Response of Foreign Loan to Germany Bank Shock

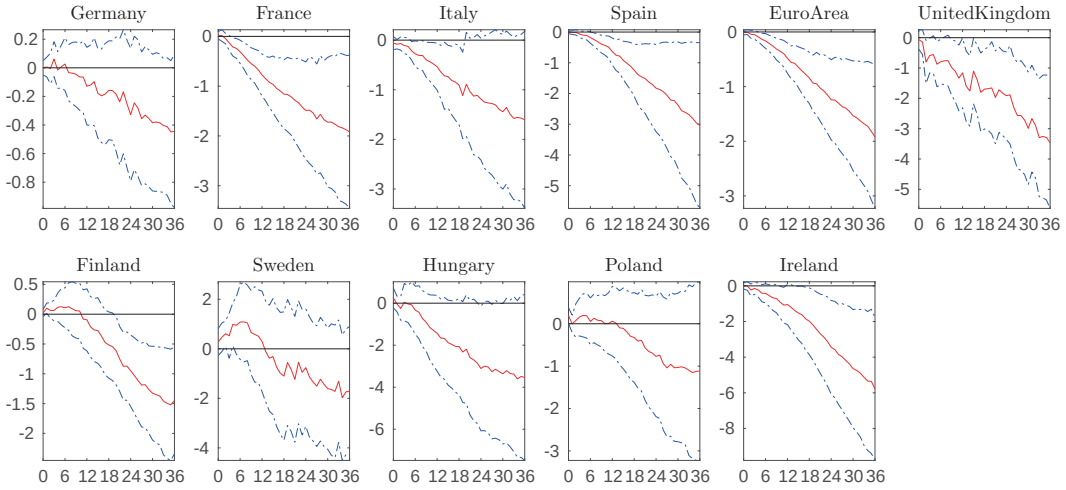


Figure A.14 Response of Foreign Loan to Germany NFI Shock

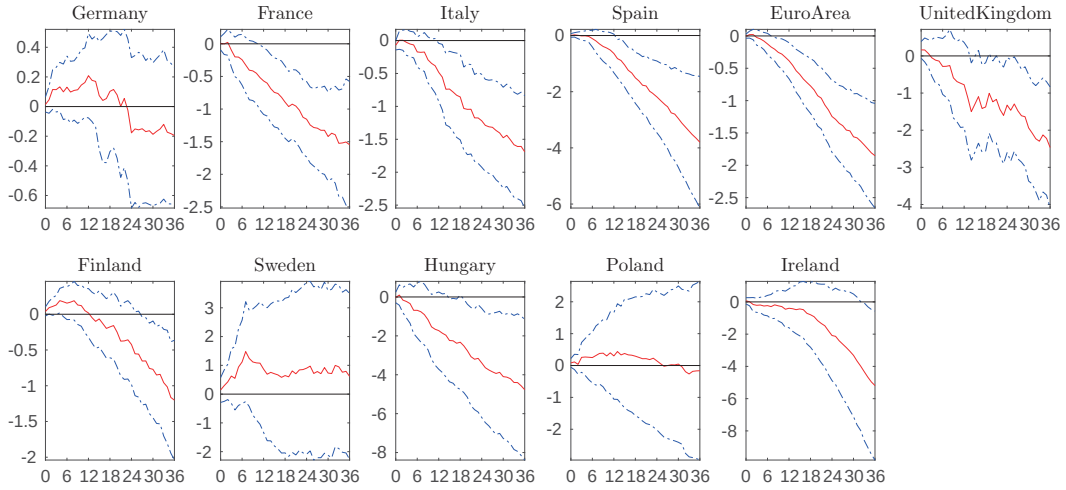


Figure A.15 Response of Foreign Loan to France Bank Shock

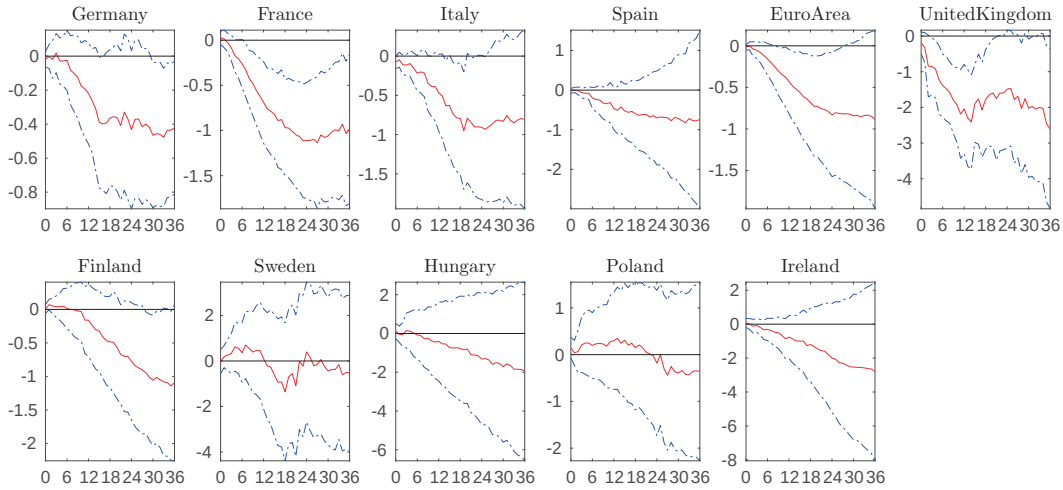


Figure A.16 Response of Foreign Loan to France NFI Shock

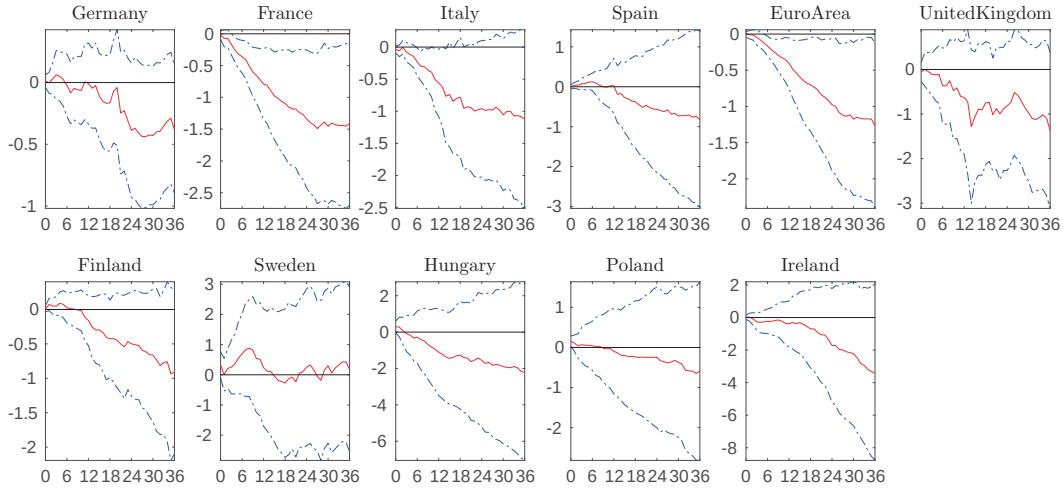
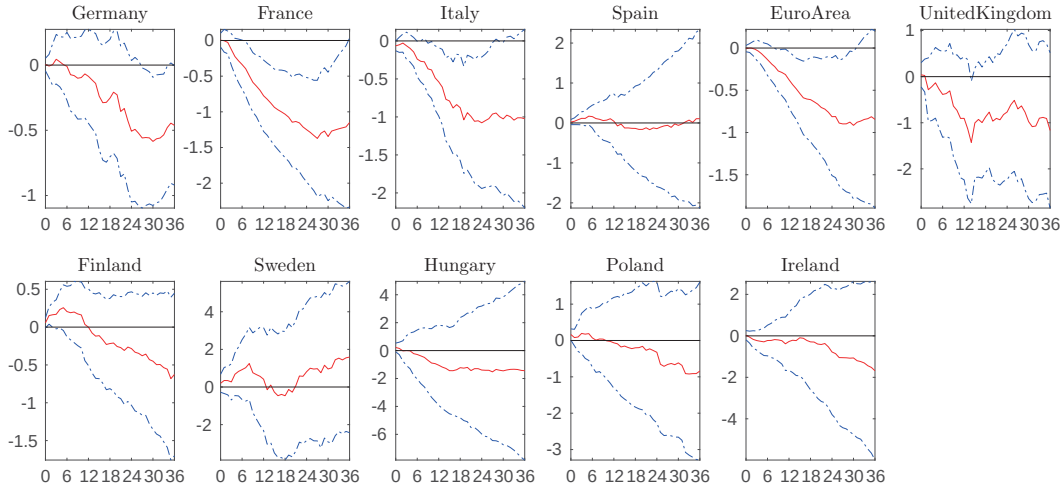


Figure A.17 Response of Foreign Loan to Italy Bank Shock



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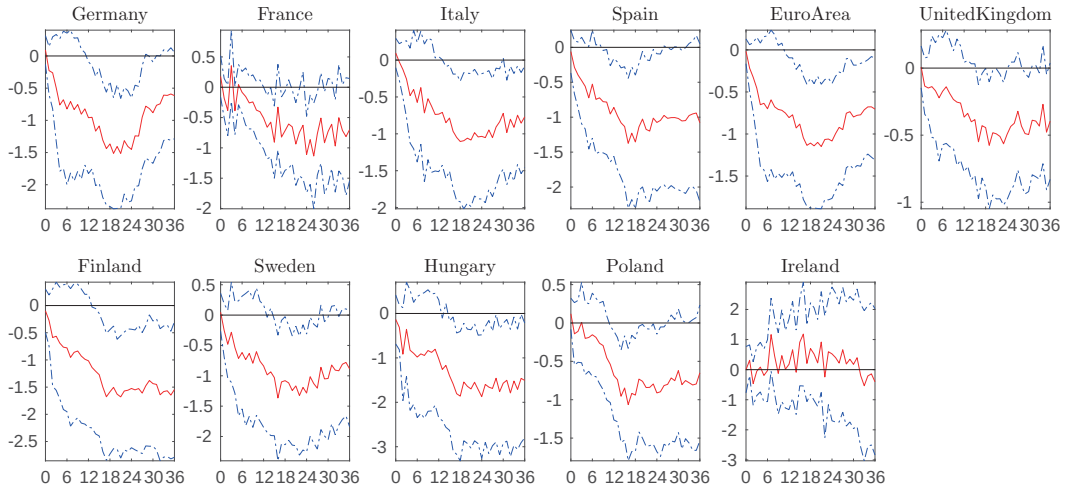


Figure B.1 Response of IIP to Germany Bank Shock

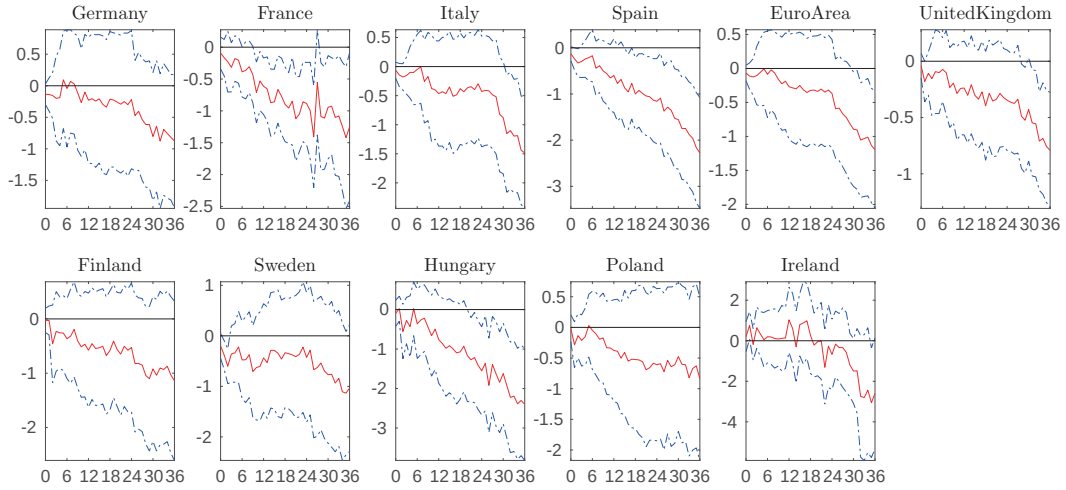
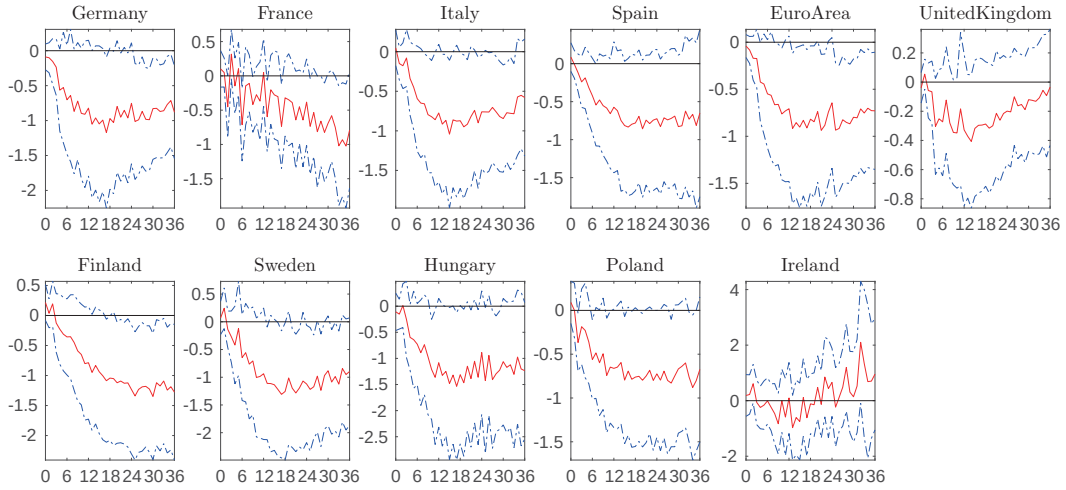


Figure B.2 Response of IIP to Germany NFI Shock



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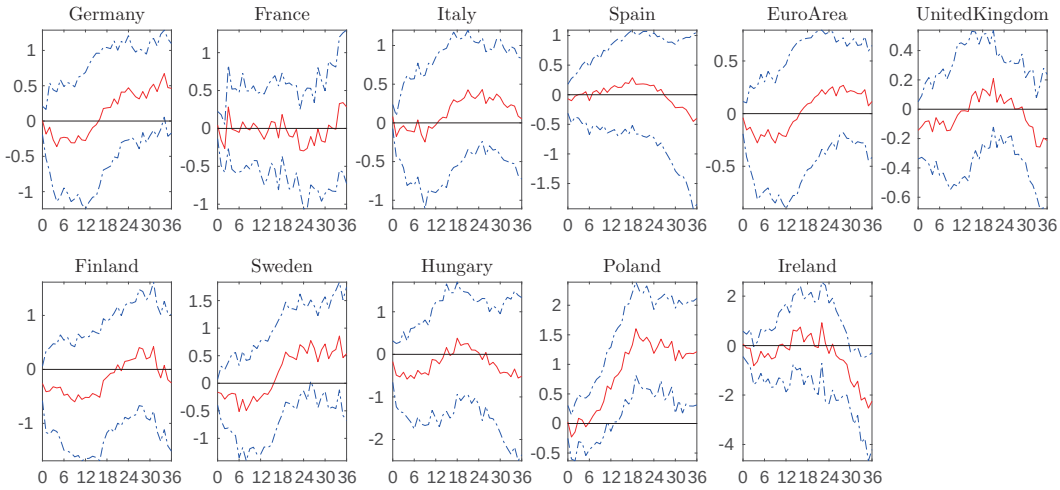

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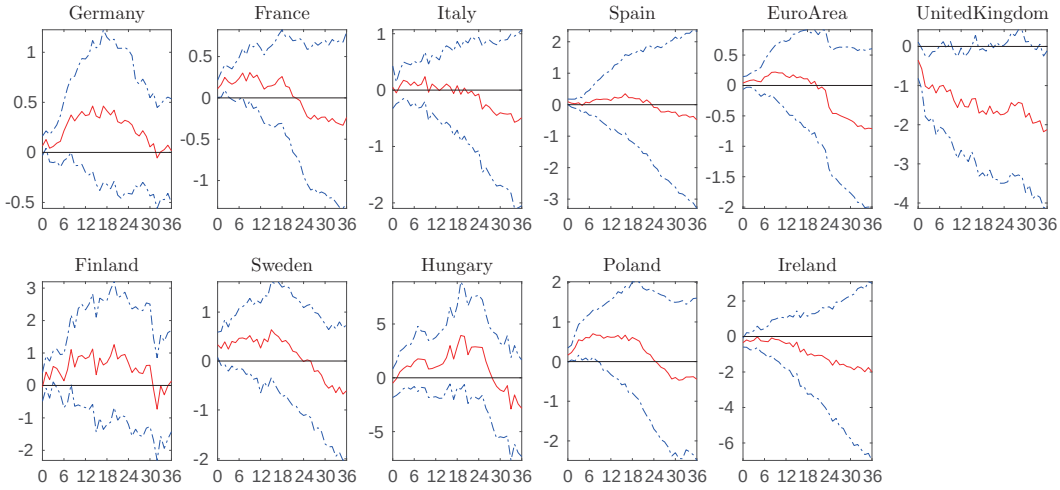

Figure B.5 Response of Domestic Loan to Germany Bank Shock

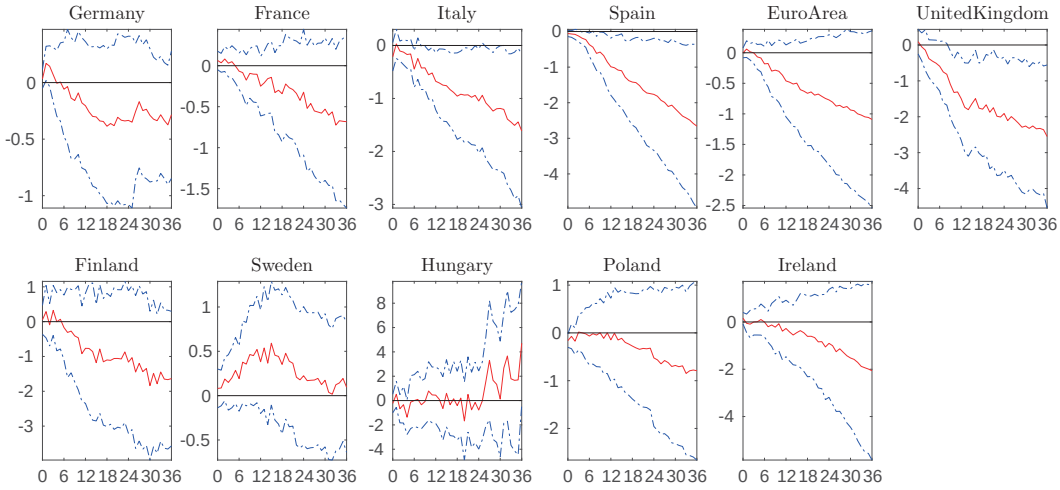

Figure B.6 Response of Domestic Loan to France Bank Shock

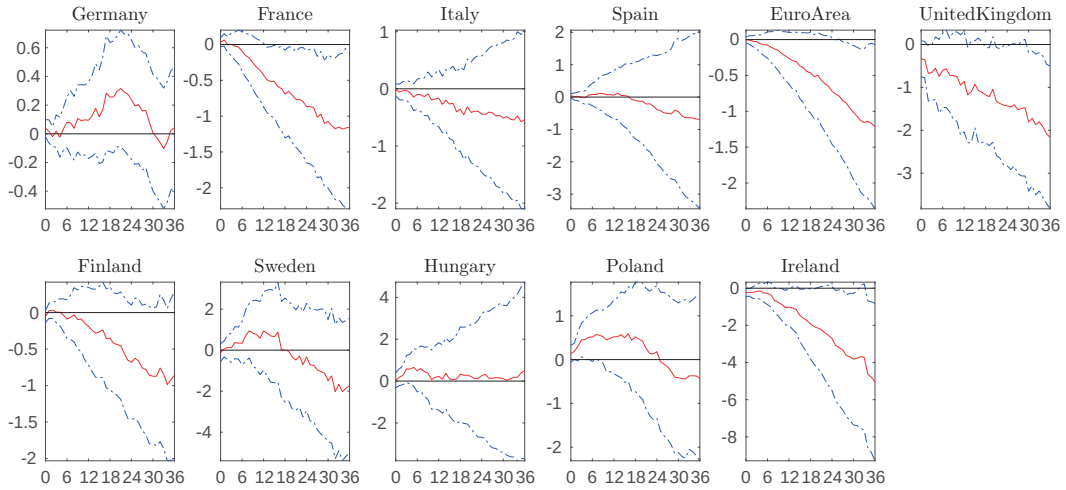

Figure B.7 Response of Foreign Loan to Germany Bank Shock

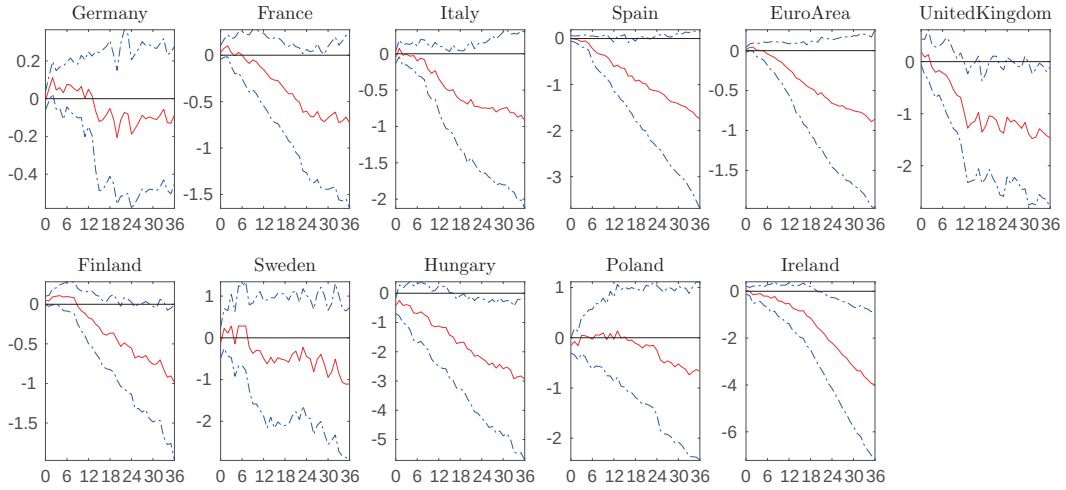

Figure B.8 Response of Foreign Loan to France Bank Shock

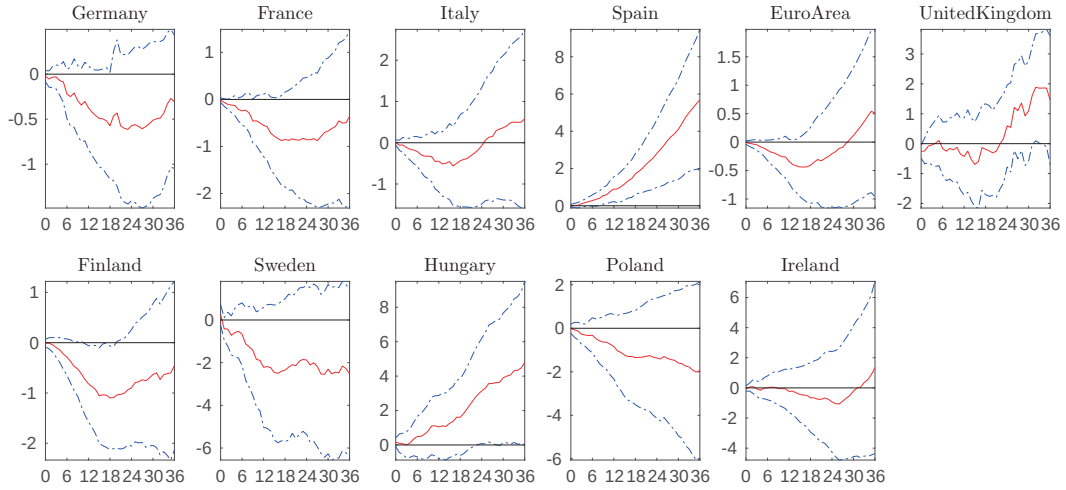

Figure B.9 Response of Foreign Loan to Italy Bank Shock