The financial and fiscal stress interconnectedness : the case of G5 economies

Magkonis, G and Tsopanakis, A

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Abstract: In this paper, we focus on the financial and fiscal stress transmission for the G5 economies. Using financial and fiscal stress indexes, we assess the spillovers within each economy, as well as the cross-sectional effects. Two supplementary methodologies, measuring the degree of interconnectedness, are employed. Our findings indicate that the interactions between these two kinds of distress are intensive, especially during and after the Global Financial Crisis outbreak. The above reiterates the necessity for coordinated macroprudential policies, as a means to confine the adverse effects of excessive financial and fiscal stress.

Keywords: Financial stress, Fiscal stress, Spillover index, Causality index, Macroprudential Policies

JEL Classification: E44, F42, F47, G01

1. Introduction

The recent global financial crisis has emphatically shown that excessive financial risk-taking can pose a serious threat for the global financial stability. At the same time, it can also have substantial adverse effects to the world's economic activity. There is an ongoing debate on whether business cycle is related with the financial cycle. A few recent studies aim to investigate this potential relation of business and financial cycles (Claessens *et al.*, 2012, Tagkalakis, 2013, Andrian *et al.*, 2010).

Moreover, governments are increasingly concerned with the policy challenges posed by the financial cycle. Especially, given the emergence of systemic risk issues as a major threat for financial and banking markets around the world, there is a trend for the adoption of the most appropriate macroprudential policies to safeguard these markets. As Borio (2012) put it, "Macroeconomics without the financial cycle is very much like Hamlet without the Prince: a play that has lost its main character", meaning that macroeconomic policies would not be effective, as long as the financial cycle and its pro-cyclical nature are not taken into account by the authorities.

Within the previously described framework, this paper aims to contribute to the examination of the potential interactions between financial conditions and their ensuing effects on the fiscal position of five major economies. In particulate, we model the financial and fiscal stress spillovers for the G5 countries. There is some evidence in the literature, indicating the existence of interactions of financial and economic cycles (Magkonis and Tsopanakis, 2014, Dovern and van Roye, 2014). We try to build upon this literature, in several dimensions. First, we use a set of aggregate indicators, namely the financial and fiscal stress indices, as proxies of the effects of financial cycle and real economy swings. Second, we employ innovative econometric approach, which is able to capture the stress volatility spillovers within each economy. Then, beyond the country level analysis, potential cross-national spillover effects are examined, so that further light can be shed in the potential

channels of instability transmission on a global scale. Fourth, network analysis is used, employing the dynamic causality index as proposed by Billio *et al.* (2012). The aim is to provide further evidence and enhance the reliability of our main empirical findings. Finally, our dataset cover a long period, up until the most recent events in the global economy.

Our findings indicate that there is a strong interconnection between the financial and fiscal stress shocks for all economies in the sample. Depending on the case, the financial stress is prominent, compared to the fiscal distress. It is also identifiable the fact that all spillover effects become more intensive during and after the initiation of the Global Financial Crisis. Especially for the case of the international spillover effects, the degree of interconnectedness between the G5 economies has reached an unprecedented level in the last few years.

This paper is organized as follows. Section 2 discusses the most relevant literature in the topic examined here. The construction methodology for the financial and fiscal stress indexes is developed in section 3, while section 4 introduces the methodology employed for the spillover analysis. The results from the baseline model, both for the national as well as the international spillover effects, are discussed in section 5. The network analysis is presented in section 6, while section 7 concludes.

2. Measuring Financial-Fiscal stress Interactions and their real economy effects

This brief overview of the literature is focused on the most recent research, related to the financial and business cycles interactions, their importance for the economic conditions and the fiscal position of the global economy. The growing importance of the financial cycles is recently recognised by academics and monetary authorities, after identifying the inexorable effects of financial market conditions on

the global economic stance. The Euro Area crisis is a critical economic event, underlying the importance of this area of research.

Claessens *et al.* (2011) analyse the financial cycles for 21 advanced economies over the previous few decades. The authors find that the financial cycles downturns last between five and eight quarters, while the upturns are longer and slower. Moreover, the global synchronization of downturns leads to longer and deeper recessions. In their next paper, Claessens *et al.* (2012) investigate the financial and business cycles interactions. Their research covers a period of fifty years again, from 1960 to 2010, with forty four countries in their dataset. In this paper, their main finding is a strong link between the different phases of the two types of cycles, while exacerbated recessions are related with house and equity prices. In terms of their duration and effects, they point out that financial cycles are deeper than the business ones, with more pronounced effects on the emerging markets rather than the developed economies.

Further evidence on the financial cycle duration and the effects of house and equity price fluctuations are provided by Drehmann *et al.* (2012). According to this paper, financial cycles last about sixteen years, with gradually increasing life span since the mid 80's. Kannan (2012) study the effects on the economy's recovery phase from a recession, when a financial crisis is to be blamed for this recessionary period. Based on industry – level data, the author shows that recessions caused by financial turmoils can lead to higher output losses in developed economies, with a longer recovery period compared to cases where the recession is not due to adverse financial conditions.

A number of studies attempted to empirically analyse the relation of financial cycle and financial stress with, either, the real economy or the financial markets. For instance, Chen *et al.* (2012) study the interest rates, output, asset prices and credit nexus for the US economy using a multivariate unobserved component model. The main finding here is that those variables' cycles are closely related. Karfakis (2013) studies the relationship of credit and business cycles for Greece, showing that credit

is a useful indicator for monitoring future changes in the Greek business cycle. Also, credit limited availability was one of the factors that worsened the Greek economy's recession, during the recent crisis. Evidence that fiscal position of OECD economies significantly deteriorate due to financial crises is provided by Tagkalakis (2013). This effect is more persistent for economies with well functioning financial markets, while the debt burden of those economies increases together with the outbreak of financial crashes.

An explicit use of financial stress indexes, as metrics of the financial market conditions, is materialized by Dovern and van Roye (2014). In this paper, the authors analyze the international transmission of financial stress, while they also model its effect on the real economic activity. After indicating a significant comovement of financial stress for the 20 economies in the sample, they use a GVAR modelling approach to show that US financial stress shocks have a significant effect on the global economy, with its maximum impact being reached after almost 6 months in most cases. More recently, Hippler and Kabir Hassan (2015) examine the importance of macroeconomic and financial stress on US financial firms. Using a panel regression model for modelling firms' profitability and stock returns, the authors show that financial institutions are prone to excessive financial and macroeconomic stress, with non-depository institutions (such as investment firms and real estate companies) being the major sources of the financial instability.

The previously discussed papers establish the theoretical and empirical link of financial conditions with business cycles, while there is also clear evidence that financial stress have an effect on the financial markets. It is also important to underline the importance of financial conditions on the governments' fiscal stance. The recent Euro Area crisis indicated that economic policy making should also monitor the evolving situation with the public sector finances, together with their interrelation with financial spillovers. Such early warning indicators are the fiscal stress indexes that we employ in this paper. The following papers are relevant to the

fiscal prudence literature and the importance of monitoring the state of fiscal and business cycle conditions.

The need to monitor a broad array of fiscal conditions indicators is emphasised by Hemming and Petrie (2000). Fiscal sustainability is emphasized, based on theoretical and practical policy considerations providing a number of useful metrics. For example, the overall fiscal balance to GDP ratio and net financial debt to GDP, together with the maturity and currency composition of national debt, are some of the indicators put forward by the authors. Additionally, revenue indicators, along with indices related to primary balance and the future demographic changes of an economy, are proposed as well. The authors, finally, suggest a set of criteria, according to which fiscal vulnerability indicators should be chosen for monitoring. These are the initial fiscal position of the economy, the short-term fiscal risk, the long-term sustainability and the relevant structural weaknesses.

One of the first efforts to construct an aggregate fiscal stress index is done by Baldacci *et al.* (2011a). Here, the authors provide a set of variables as early warning indicators of fiscal strain and rollover risk that can be included in a relevant aggregate index. In this way, they develop a fiscal monitoring framework, through the construction of two aggregate indices (namely, a fiscal vulnerability and a fiscal stress index)[1]. Using annual data for the period 1970-2010, Baldacci *et al.* (2011b) extend the previously mentioned work, by producing fiscal stress indexes for advanced and emerging economies. Their empirical analysis reveals that the best tools for predicting fiscal imbalances for advanced economies are the gross financing needs and the fiscal solvency risks variables. As far as the emerging economies are concerned, public debt structure and the spillover risks from the international financial markets play a crucial role. Focusing on the current crisis, the authors

[1] The theoretical framework is found at the work of Cottarelli (2011), where the three major reasons of government's rollover risks are analysed.

provide evidence of heightening fiscal stress for both groups of countries, while the leaders of this increase are Europe and North America[2].

Two recent papers, employing fiscal stress indices for studying the Euro Area experience with fiscal vulnerabilities, are those by Berti *et al.* (2012) and Hernandez de Cos *et al.* (2014). Here, the signalling approach is used in order to construct fiscal stress indexes for the EU and nine more advanced economies (only for 11 EMU economies in the second paper). The results are in favour of using aggregate stress indexes as early warning tools, while the usage of country specific characteristics are also crucial in setting the crises alarming thresholds for the model. Until now, the only paper employing both financial and fiscal stress indices to study the financial cycle and fiscal position interactions for the G7 economies is the one by Magkonis and Tsopanakis (2014). Using a SVAR model and two different identification methods, the authors show that fiscal and financial stress shocks have a negative effect on key macroeconomic variables. On top of that, a weak feedback effect is identified, between financial and fiscal sector shocks.

3. The Financial and Fiscal Stress Indices

Our dataset consists of a set of Financial (FSI) and Fiscal (FiscSI) stress indices. These are aggregate indicators, summarizing information from a wider set of stand-alone indicators, representing different types of financial risks and fiscal conditions. Their value added, compared to stand alone indicators, is the ability to capture different sources of instability that can lead to episodes of excessive financial bottlenecks and fiscal strain, into one single variable. In this way, an accurate and timely representation of the economic and financial conditions is offered, while the effects of many different financial markets (in the case of the FSIs) and fiscal vulnerability

[2] Schaechter *et al.* (2012) provide a good example of how this kind of research can be used for policy making.

indicators (in the case of FiscSIs) are offered. Based on these indexes, we can investigate the relationship between financial and fiscal stress.

In order to construct these indices, we employ the approach used by Magkonis and Tsopanakis (2014). The financial stress indexes are constructed followed the equal-variance approach. According to this, the FSI is a composite indicator, in which each variable contributes to the aggregate index, based on its standardized value. That is, we deduct the mean and divide by its standard deviation. In this way, measurement problems are avoided, while the contribution of each single indicator is measured to deviations from its mean value. Each standardized component has assigned weight of equal importance to the final stress index. Kliesen *et al.* (2012) summarize a number of aggregation approaches for the building-up of such composite indicators. Nevertheless, the equal–variance approach is as efficient as any other methodology, in terms of the accurate depiction of financial stress episodes, as well as the most cost effective, in terms of easiness and effectiveness of the indexes produced.

The components of the FSI are discussed below. First, we include the banking sector beta. It is calculated as the ratio of the moving covariance of year-over-year percentage change of each country's banking sector equity index, with the general equity index, over the moving variance of the general stock index. Also, the TED spread is the difference between the uncovered (3-month LIBOR) and covered (respective Treasury bill rate) investments for the interbank markets. Moreover, the inverted term spread (Treasury bill rate difference from the long-term government bond yield) is used. The two aforementioned indicators are the most well known ones capturing liquidity risk exposure. For the securities markets, we employ three measures: the corporate bond spread, defined as the yield difference of the long-term corporate bonds from the governmental ones, along with stock returns and the stock returns volatility (calculated as a GARCH(1,1) model of the general equity index. As a proxy of the exchange rate risk, the real effective exchange rate volatility

is incorporated to our index[3]. The mathematical representation of the financial stress index is the following:

$$\begin{aligned} \text{FSI} = \beta + & \text{ TED spread} + \text{ Inverted term spread} + \\ & \text{Corporate Bond spread} + \text{Stock market returns} + \\ & \text{Stock market volatility} + \textit{E}\text{xchange rate market volatility} \end{aligned} \quad (1)$$

For the case of FiscSI, the aggregation methodology resembles the one used for the FSI indexes while the metrics involved capture three important characteristics of the economic activity (Baldacci *et al.*, 2011a); 1) the fiscal burden of the economy, 2) the long term trends on their fiscal position (based on the fertility rate and the governmental funding needs for social security issues) and 3) each country's financing needs. Our indices consist of five variables. First, it is the difference of the government debt payments rate (r) from the growth rate of the economy (g), representing the degree of economy's solvency and the closeness to a fiscal crisis outbreak. An economy needs to service its debt obligations and its ability to do it depends on the level of its growth rate. Then, the general government structural balance, defined as the cyclically adjusted balance, is part of the aggregate fiscal conditions measure. Finally, the general government net debt is calculated as the difference between the gross debt of the country from any relevant financial assets that correspond to debt instruments. All three variables are expressed as percentages of the country's GDP.

Long term fiscal trends are approximated by the total fertility rate and the old age dependency ratio. The average number of children per woman is the proxy for total fertility rate, while the old dependency ratio reflects the projections for the share of population that will be over 65 in the next 30 years, as a percentage of the total adult population. These indices importance lies on the economies tax base projections that they offer. On top of that, they also represent the number of people contributing to the fiscal sustainability of a country, through their contribution to the

[3] Here, the BIS database of effective exchange rates has been used. The estimation is the same with the one followed for the stock return volatility.

healthcare and pension systems. Overall, the FiscSI are indexes providing an overall picture of the short and long term conditions that are expected to prevail on the fiscal performance of each economy's government.

The aggregation method is similar to the one followed for the financial stress index. The only difference is that the mean and the standard deviation used are the 10-year peer group average. This formula can shortly be written as follows:

$$\text{FiscSI} = (r-g) + \text{structural balance} + \text{net debt} + \text{fertility rate} + \text{depedency ratio} \qquad (2)$$

Our sample is the G5 economies; Canada, Germany, Japan, United Kingdom and United States. The dataset consists of quarterly observations, covering a period from the beginning of 1980's until the first quarter of 2014.

The following two graphs exhibit the financial and fiscal stress indexes for the G5 economies. A strong co-movement of the indices throughout the period examined can be identified. Some variations might be identified, but overall, most of these economies represent similar financial conditions for the last four decades. The 80's, for instance, was a period of relatively tranquil conditions in the financial markets, and lasted until after the mid 90's. In the particular time, the Asian financial crisis led to increasing financial bottlenecks for all the economies of the sample. The most notable even of the following time period is, without any question, the Global Financial crisis, initiated on 2007. It is interesting to note the value added of the FSI indexes, as early warning indicators of the gradually deteriorating financial conditions. For all G5 economies, indexes have started to climb as early as 2004.

Figure 1 here

Financial stress reach its peak during the third quarter of 2008, coinciding with the Lehman Brothers collapse, with two more periods of excessive financial stress in early 2010 and in the second half of 2012. For some economies, like Canada

and UK, the index is back towards its long run value, faster than the others. Overall, only Germany's case shows an upward turn in the most recent period.

In case of the FiscSI indexes, G5 countries show a significant worsening of their fiscal stance during the recent financial crisis. Japan is in the worst position, given the fiscal trends shown here. The conditions of this economy constantly grow gloomier, since mid 90's. On the other hand, Canada's case follows the opposite direction, with a significant improvement in the last four years. The other three countries of our sample (Germany, UK, USA), demonstrate a positive value for their indices (even though the German index was below zero for most of the 1990's). Nevertheless, they did not remain untouched in the recent years, showing increasing fiscal burden. Still, they manage to contain these fiscal trends within manageable level of fiscal risks.

Figure 2 here

4. Methodology

We use the spillover analysis developed by Diebold and Yilmaz (2012, 2015). The analysis is based on VAR modeling and the corresponding estimation of variance decompositions. The main advantage of this method is that it provides information about the contribution of shocks to variables to the forecast error variances of all the variables of the model. This model is briefly written as *N*-variable VAR:

$$Y_t = \sum_{k=1}^{K} \mathrm{A} Y_{t-1} + \varepsilon_t \tag{3}$$

where $Y_t = (Y_{1t}, Y_{2t}, ..., Y_{Nt})$ is the vector of the N endogenous variables and ε_t is the vector of disturbances that independently distributed over time. A useful alternative specification that is based on (3) is the moving average representation that is equal to

$$Y_t = \sum_{j=0}^{\infty} \Theta_j e_{t-j} \tag{4}$$

where $\Theta_j = \Phi_1 \Theta_{j-1} + \Phi_2 \Theta_{j-2} + ... + \Phi_p \Theta_{j-p}$. In this paper, according to Diebold and Yilmaz (2012), we use the generalized VAR modelling approach that based on Koop *et al*. (1996) and Pesaran and Shin (1998). Under this framework, the variance decompositions are invariant to the variable ordering. More specifically, the *ij* entry of the *H*-step-ahead variance decomposition is equal to

$$z_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' \Theta_h e_j)^2}{\sum_{h=0}^{H-1} (e_i' \Theta_h \Sigma \Theta_h' e_i)} \tag{5}$$

where σ_{jj} is the standard deviation of *e* for the j^{th} equation, Σ is the variance matrix of e. The drawback of the generalized VAR modelling is that the own and cross-variable variance contributions shares do not equal to one. This is circumvented by using the normalization;

$$\tau_{ij}(H) = \frac{z_{ij}(H)}{\sum_{j=1}^{N} z_{ij}(H)} \tag{6}$$

where

$$\sum_{j=1}^{N} \tau_{ij}(H) = 1 \text{ and } \sum_{i,j=1}^{N} \tau_{ij}(H) = N$$

Given the above the total spillover index is equal to

$$SI = \frac{\sum_{i,j=1, i \neq j}^{N} \tau_{ij}(H)}{\sum_{i,j=1}^{N} \tau_{ij}(H)} \cdot 100 \tag{7}$$

The number of this index shows the average contribution of spillovers from shocks to all variables to the total forecast error variance. Alternatively, the spillover index gives the degree of the connectedness of the K-variables system. The main advantage of this analysis is that the directional spillover effects can be easily calculated. For instance, for the case of variable *i* and the effects from all the other variables, the computation should be

$$DSI_{i\leftarrow j} = \frac{\sum_{j=1, i\neq j}^{N} \tau_{ij}(H)}{\sum_{i,j=1}^{N} \tau_{ij}(H)} \cdot 100 \tag{8}$$

On the other hand, the directional spillover transmission from variable i to all the rest is defined as

$$DSI_{i\rightarrow j} = \frac{\sum_{j=1, i\neq j}^{N} \tilde{z}_{ji}(H)}{\sum_{i,j=1}^{N} \tilde{z}_{ij}(H)} \cdot 100 \tag{9}$$

Finally, in order to examine whether one variable is net receiver or transmitter of shock, the net spillover effects are calculated as

$$NSI_i = DSI_{i\rightarrow j} - DSI_{i\leftarrow j} \tag{10}$$

All the above described measures are static. This means that they are calculated for the whole period under study. The period that we examine in this study contains certain sub-periods of special interest, like the financial turmoil starting in August 2007 in US. Therefore, static analysis may omit several aspects of stress transmission. For this reason, we provide the dynamic version of spillover analysis using rolling estimation with a 200-months window. In the next section we report the results from the dynamic analysis. We firstly start with the estimation of financial and fiscal stress spillovers for each country separately. Successively, we

proceed by estimating the cross-national effects. In other words, we let cross-sections interactions of the two kinds of stress among the examined economies.

5. Results

5.1 National Spillover Effects

Figures 3-7 show the gross spillovers from financial and fiscal stress indexes for G5 economies. Starting from Canada (Figure 3), our findings suggest that financial spillovers prevail throughout the whole time period. Despite this fact, both financial and fiscal spillovers follow a similar pattern. More precisely, they reach a peak in early 2000's that coincides with dot-com bubble. After a period of gradual decrease followed by a steep drop around early 2005, financial spillovers have been increased since 2008. So, the evidence is close to our expectation regarding the period of global financial crisis.

On the other hand fiscal conditions are found less volatile. After a tranquil period, fiscal spillovers exhibited an abrupt increase until 2002. A period of declining trend followed until late 2009, where the peak was reached in early 2011. A steadily declining trend is observed until the end of the sample. Interestingly enough, while fiscal spillovers decline during 2011, financial stress spillovers start deescalating after on the second half of 2013. This is an indication of the fact that financial markets remain volatile quite a longer time after the government intervention.

Figure 4 shows a different picture for Germany. Both spillover indexes follow a declining trend for the whole period. The magnitude of financial spillovers are found be slightly lower than the fiscal ones. However, after 2005 until 2014 both are roughly the same. This evidence indicates that Eurozone crisis has not any serious effect on financial and fiscal stress spillovers. Germany, being the powerhouse and the biggest economy of Europe, was seen by international financial investors as a safe haven choice. Despite the European sovereign debt crisis that culminated in

2011-12, German financial and fiscal stress spillovers remain significantly low without any increasing trend. Part of this explanation is the fact that German sovereign borrowing became even cheaper. Overall, the prudent macroeconomic policies followed as result of Maastricht treaty led German fiscal and financial spillovers at constantly declining levels.

As far as the Asian representative of our sample is concerned, stress transmission from the fiscal side of the economy prevailing for a significant period of time (Figure 5). This may be viewed as a reflection of Japanese attempts to escape for the anaemic growth and deflationary environment. Since late 2009, however, financial stress spillovers have become prominent and significantly higher than fiscal ones until 2014. This suggests that the outbreak of financial turbulence of 2008-9 has also contributed to the reversal of fiscal and financial spillovers effects.

A similar outcome is found for the UK economy in Figure 6. Fiscal transmission spillovers are higher for almost one decade. From 2008, however, until the end of the sample financial spillovers become much higher. Financial spillovers reached their climax between 2009 and 2011 indicating the significance of excessive financial stress. Finally, regarding the US spillovers (Figure 7), we find a very close comovement of both measures. This almost parallel movement is characterised by a constant increase since 2006. The credit crunch and overall financial strain are reflected to the increase of both spillover indexes. The fiscal stress transmission is de-escalating during 2010, only after the deployment of quantitative easing and bailout policies.

In the addition to the above results, we also report the net spillover effects, shown in panel B of Figures 3-7. When positive values appear in the net graphs, this means that financial stress shocks are transmitted to fiscal stress and vice versa. We can identify three distinct cases of stress transmission. Firstly, for Canada and Japan, financial shocks deepen fiscal deterioration. Especially for Canada this effect holds for almost the whole sample, whilst for Japan is more evident for the last six years. Secondly, an opposite effect is found for Germany, where the net spillover index is

persistently negative; an indication that fiscal sector's stress is predominant. Since 2006 the index becomes positive but remains close to zero. Finally, there is no clear pattern for the UK and US cases as both types of stress seem to be lead transmitters interchangeably.

Figures 3-7 here

5.2 Cross-National Spillover Effects

So far we have analysed each country separately. One lesson from the recent crisis was that international transmission has been severely intensified. In order to examine the transnational pattern of risk transmission we estimate fiscal and financial spillovers across all G5. This means that the equation (3) contains now 10 variables. Figure 8 exhibits the total dynamic spillover index. According to the results, there is an increasing trend for most of the examined period. Initially, the index exhibits constantly declining values until early 2000s. After a sharp increase in 2001, followed by a relatively tranquil period, the spillover index started to escalate. This can be interpreted as an early warning indicator for the forthcoming financial meltdown. The highest value is 75% and was reached in 2011q1. After that there is a sharp decline; the index reaches a value of 60% in the end of the sample. Still, the index level remains significantly high.

Figure 8 here

This evidence underlines a number of issues. Firstly, the degree of interconnectedness among G5 economies is high for all the examined period. During the late 1990s the degree is around 50% which shows a high interdependence even for a period that it is considered to be the last part of the so-called Great Moderation. Secondly, as in the case of Canada, Japan, UK and US, the total spillover increased the period after the Global Financial crisis. Finally, our evidence tends to show that the stress level seems to be less pronounced. However, the value still remains high.

This indicates that the period of financial and fiscal tranquillity has not yet fully achieved.

6. Further Evidence

As a way to test the validity of the previous findings, we use a different methodology that can be viewed as a supplementary to Diebold-Yilmaz spillover analysis. We employ the Dynamic causality index (DCI) proposed by Bilio *et al*. (2012). This method is based on Granger-causality networks and provides information about the interdependence of the examined variables. Its main feature is that does not depend on variance-decomposition analysis and, thus, there is no need for identifying assumptions. The restriction is, however, that it is focusing only on pairwise relations. Despite these differences between these two methods, we use DCI as an alternative proxy to measure the interdependence of international stress indicators.

In particular, DCI is the ratio of pairwise relationships that are found to be statistically significant to the total number of pairs. As we examined in the last section, we focus on the cross-sectional effects so we examine 10 series (fiscal and financial stress for G5). This means that we have $90 = 10!/(10-2)!$ pairs in total. We calculate the causality index for the same 200-months rolling window. A helpful way to illustrate the empirical outcomes is though network visualisation. Network graphs provide better insights regarding the degree of stress interconnectedness of the examined economies. Granger-causality relations are drawn as straight lines connecting two variables[4].

In order to take into account the potential effects from the Global Financial crisis, we proceed with a subsample analysis. That is, we plot two network graphs; one for the pre-crisis period and one for the post-crisis period. We consider as the

[4] The codes that we used to calculate the DCI provide only the causal relationship, without specifying the direction of causality. Hence, no arrows have been used in the network graphs.

cut-off point the Lehman Brothers collapse in September 2008. Figures 8 and 9 present the causal relationships for 2005q1 and 2010q3[5].

Figure 9 here

Figure 10 here

Comparing the two networks we can discern that for the latter period the interconnectedness has slightly increased. From 19 causal relationships in the pre-crisis sample, the number is increased to 21 for the post-crisis one. So, the total interconnectedness as measured by the DCI has not significantly changed. Focusing on the exact causal relations, we find that the more interconnected variables seem to be the German fiscal and financial stress for the sample before crisis. After crisis, however, the connectedness of American financial stress is found to play a predominant role; a financial stress is connected with almost all the remaining series.

7. Conclusions

The aftermath of the global financial crisis has shown that there should be linkages between financial and fiscal sectors. In this paper we examine the potential channels of interaction between financial and fiscal conditions for the G5 economies. In order to do so, we construct a set of financial and fiscal stress indexes as proxies of financial and fiscal distress. Our contribution is twofold. Firstly, we model the interactions between these two indexes within each economy. Then, we proceed with the cross-sectional interconnections between economies.

We estimate the stress indexes' interactions using the methodology developed by Diebold-Yilmaz. In this way, we capture the spillover effects of financial stress to fiscal stress and vice versa. According to our findings, Canadian and Japanese fiscal conditions are more prone to financial stress shocks. The opposite holds for

[5] For robustness issues, we experimented with alternative cut-off points. The results remain quantitatively the same.

Germany, where fiscal spillovers are dominant. For UK and US both kinds of shocks are eminent. Despite the differences, the intensity of spillover effects becomes greater after the global financial crisis outbreak. This is consistent with the outcome from the cross-country stress transmission analysis. Overall, both methodologies highlight that the interconnectedness of financial and fiscal stress has been increased.

Our work suggests that economies are not immune to financial conditions and fiscal stance of other countries. It also underlines the necessity for global policy coordination. Macroprudential policies, along with measures aiming to safeguard financial stability should be incorporated to central banks' mandates. A step towards this direction is the effort to establish homogeneous regulatory framework for large groups of countries, such as Euro Area, as well as the implementation of the Basel Accord requirements. Overall, such initiatives aim to the right direction, which is the synchronization of international financial cycle.

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Figures

Figure 1-Financial Stress Indexes

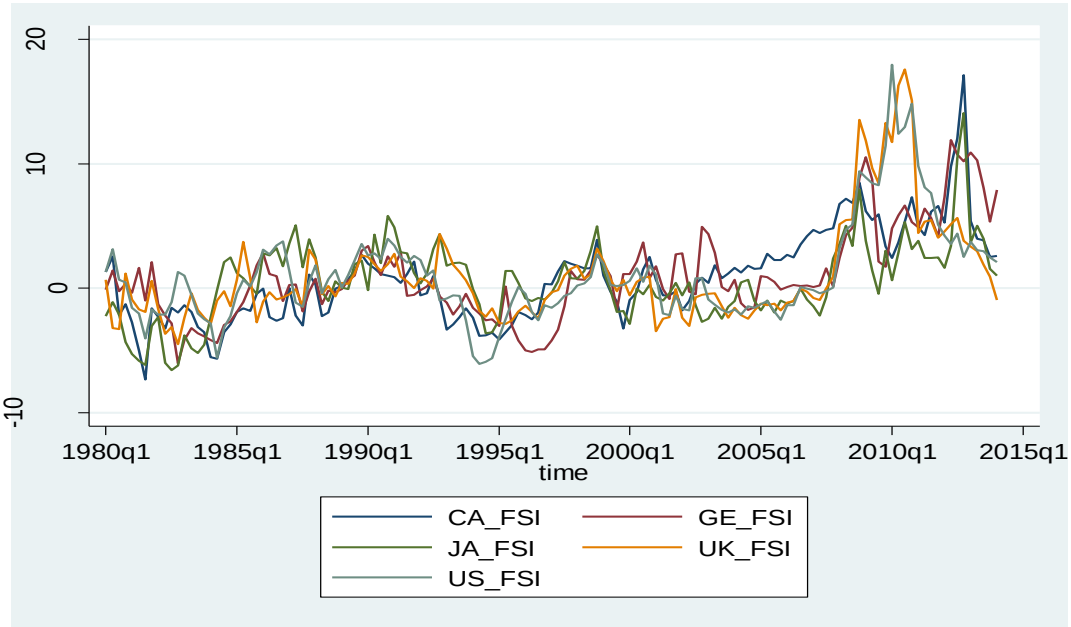

Figure 2-Fiscal Stress Indexes

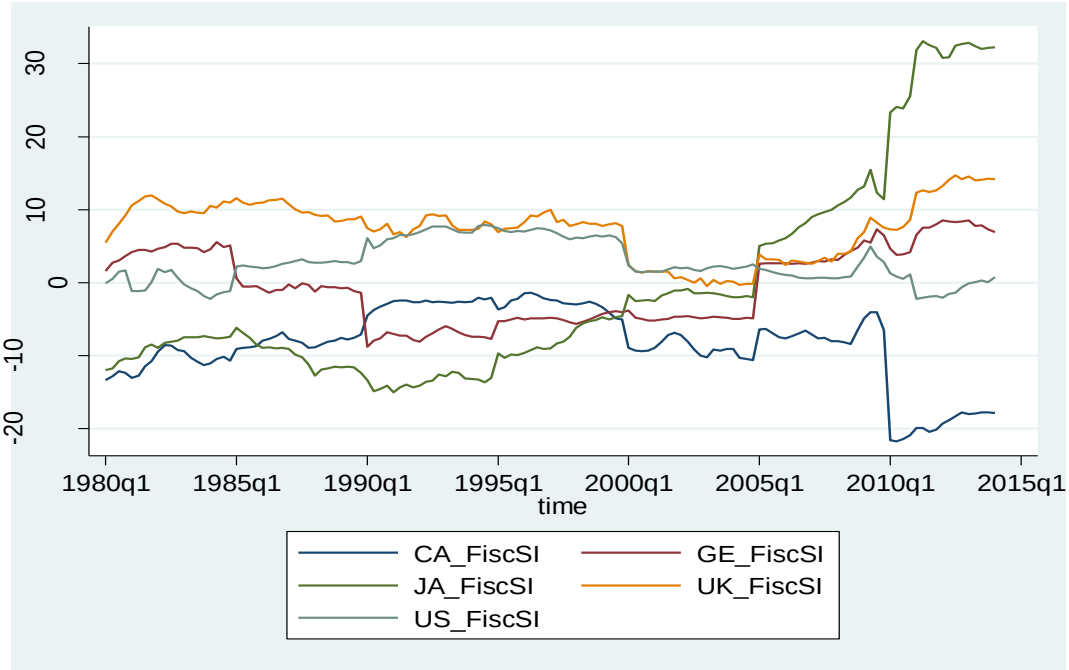

Figure 3A-Canada Financial & Fiscal Gross Spillovers

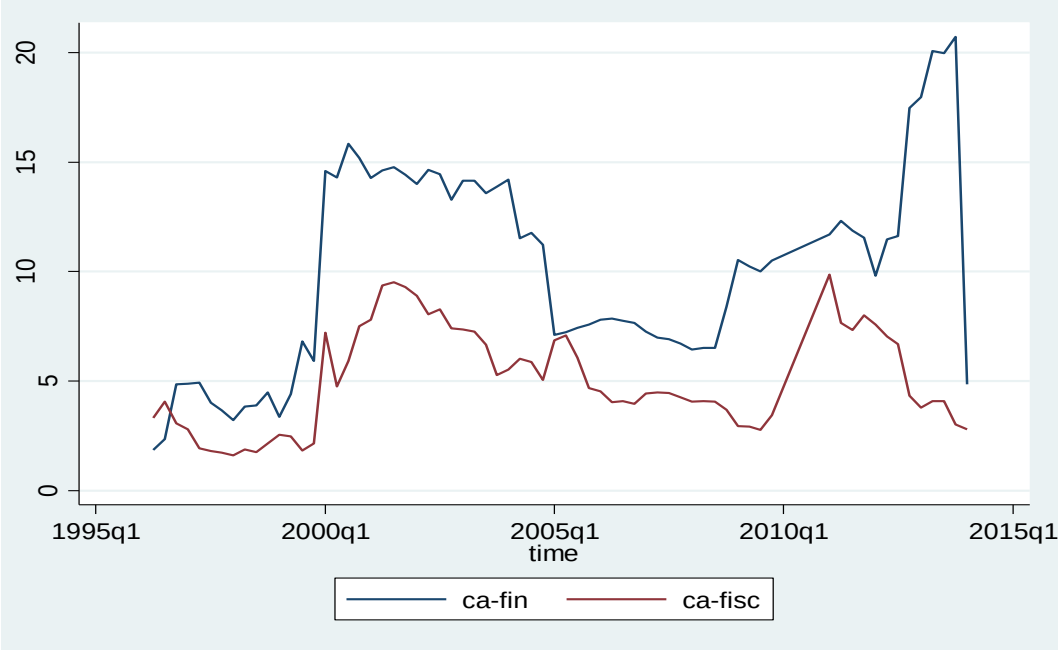

Figure 3B-Canada Net Spillovers

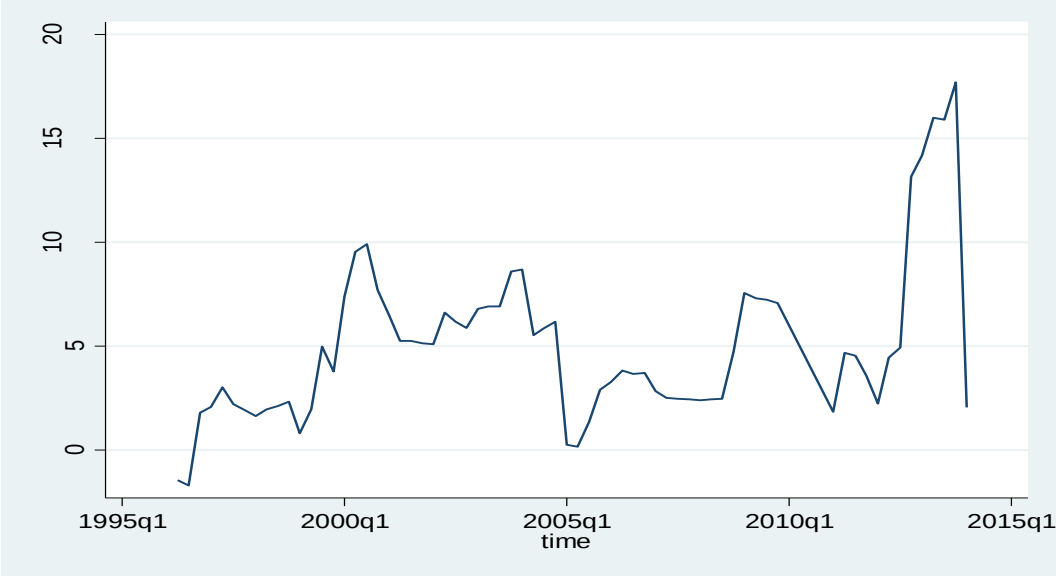

Figure 4A-Germany Financial & Fiscal Gross Spillovers

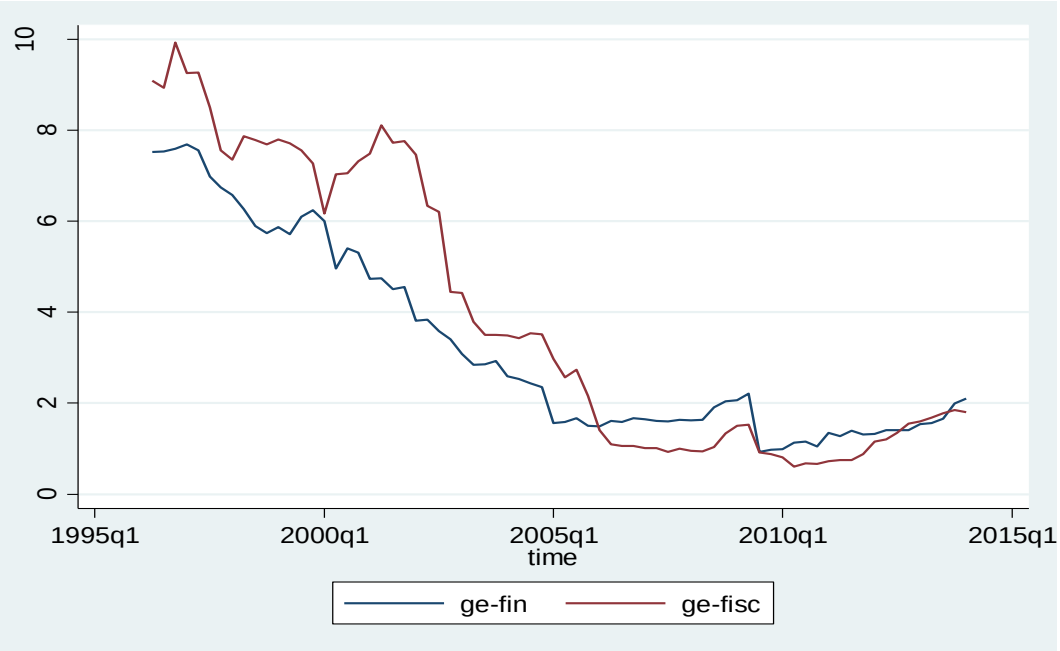

Figure 4B- Germany Net Spillovers

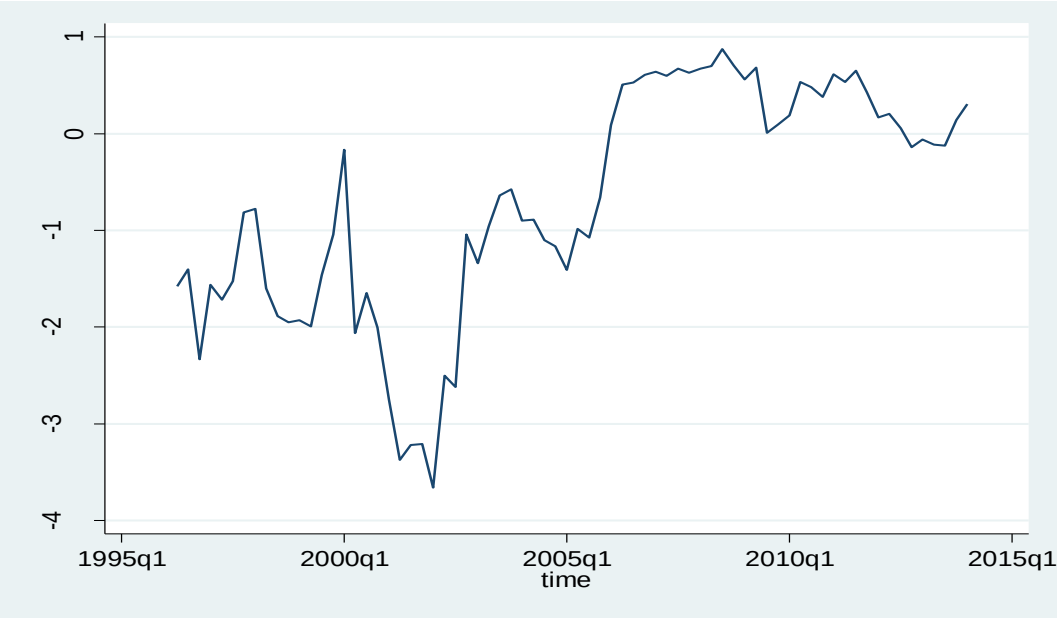

Figure 5A-Japan Financial & Fiscal Gross Spillovers

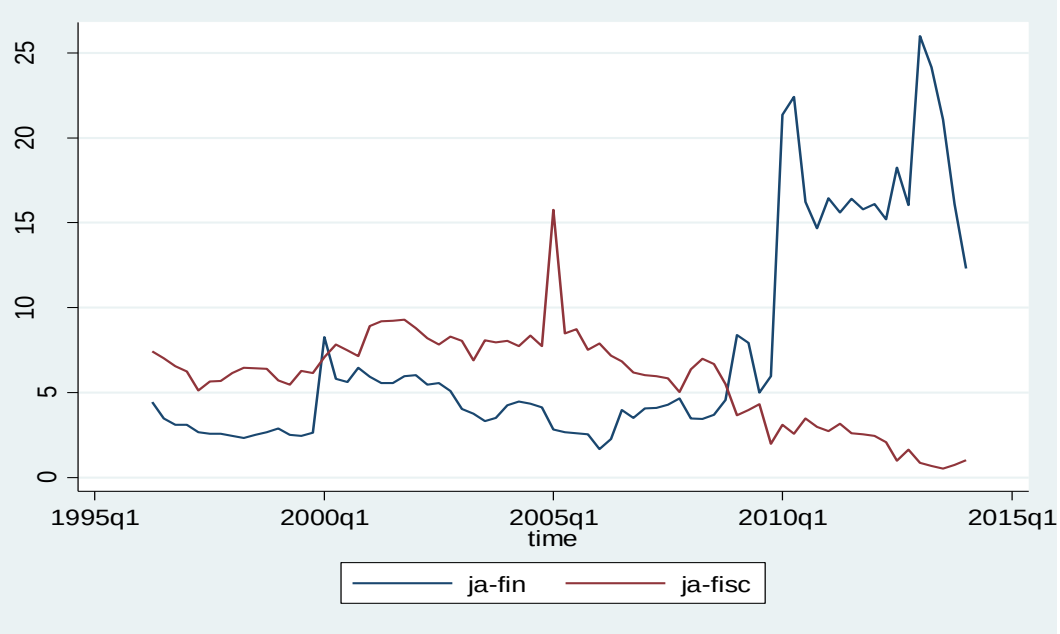

Figure 5B-Japan Net Spillovers

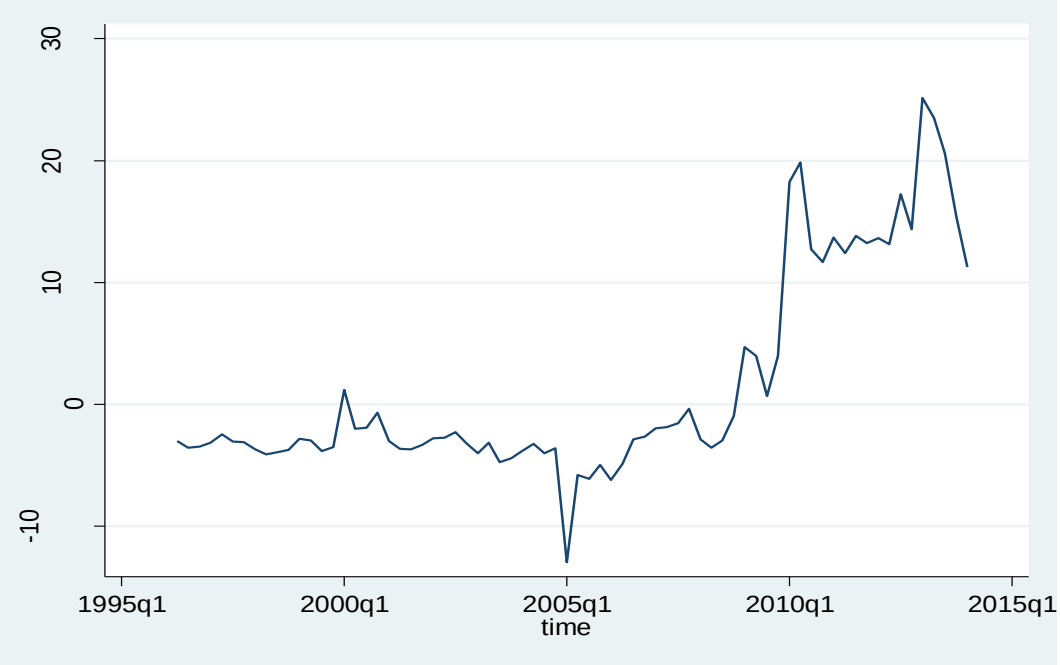

Figure 6A-UK Financial & Fiscal Gross Spillovers

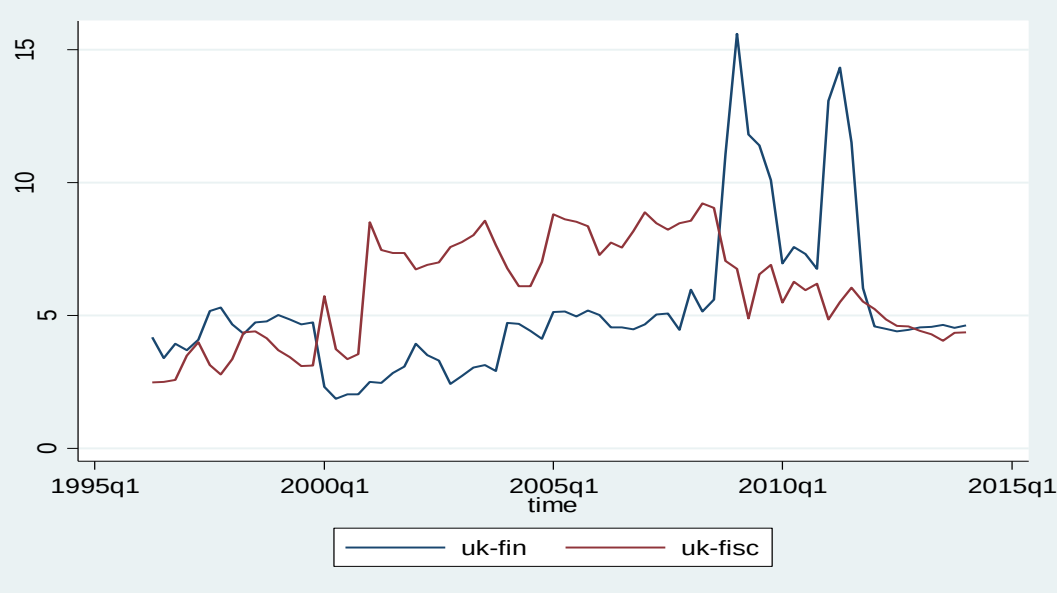

Figure 6B-UK Net Spillovers

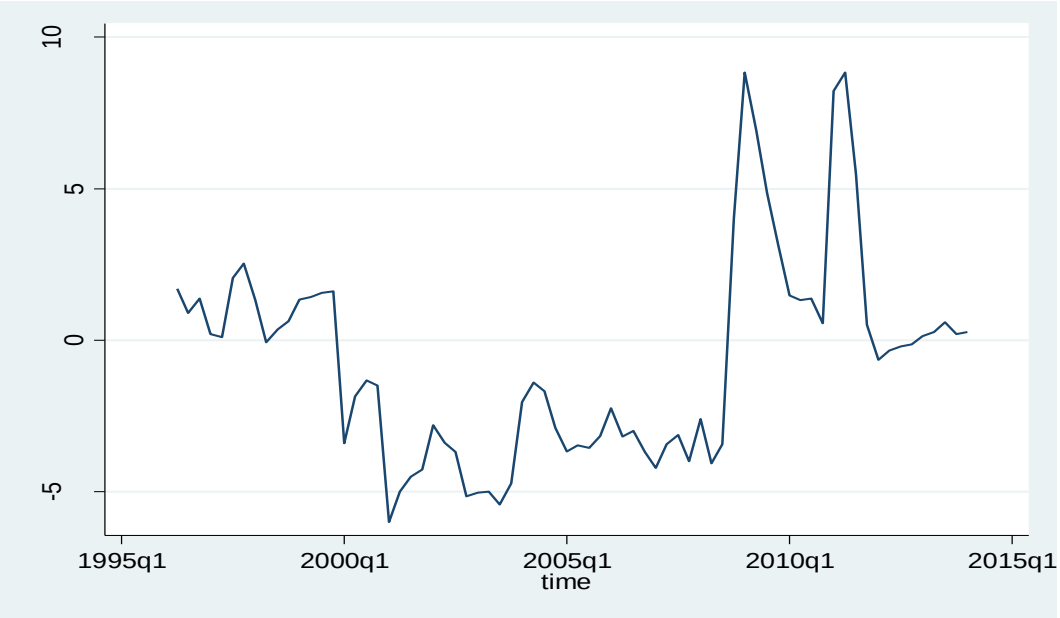

Figure 7A-US Financial & Fiscal Gross Spillovers

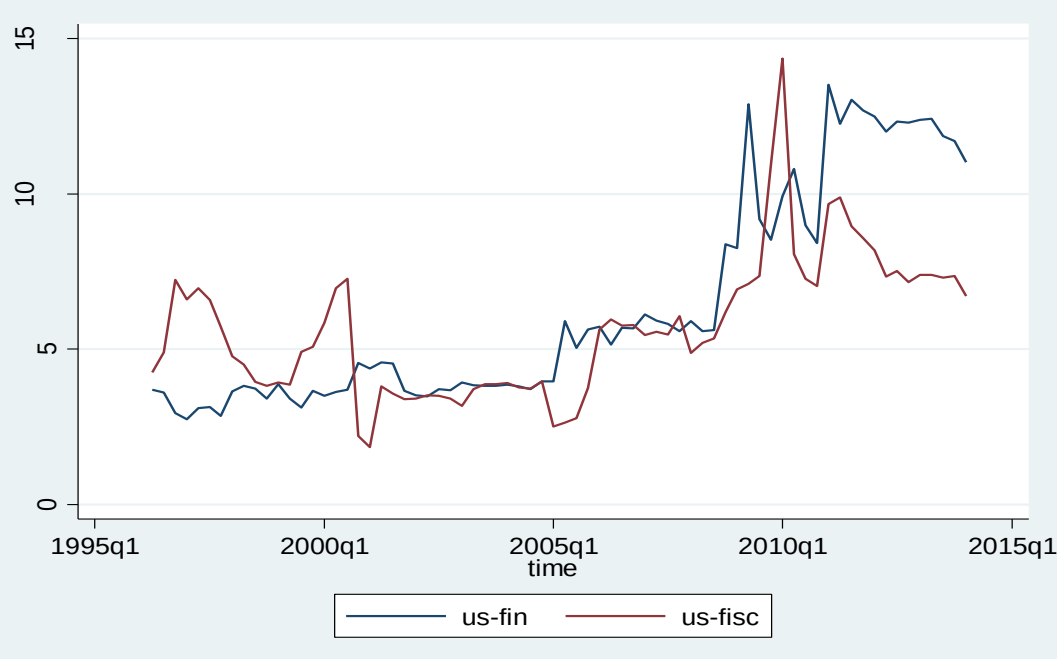

Figure 7B-US Net Spillovers

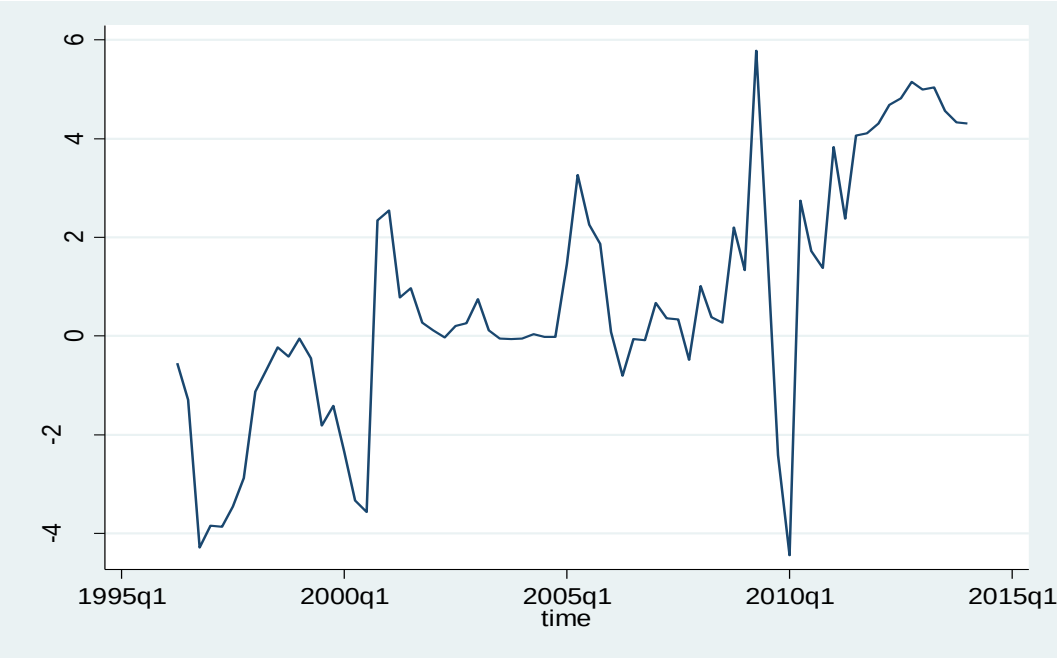

Figure 8-Cross-Sectional Financial & Fiscal Gross Spillovers

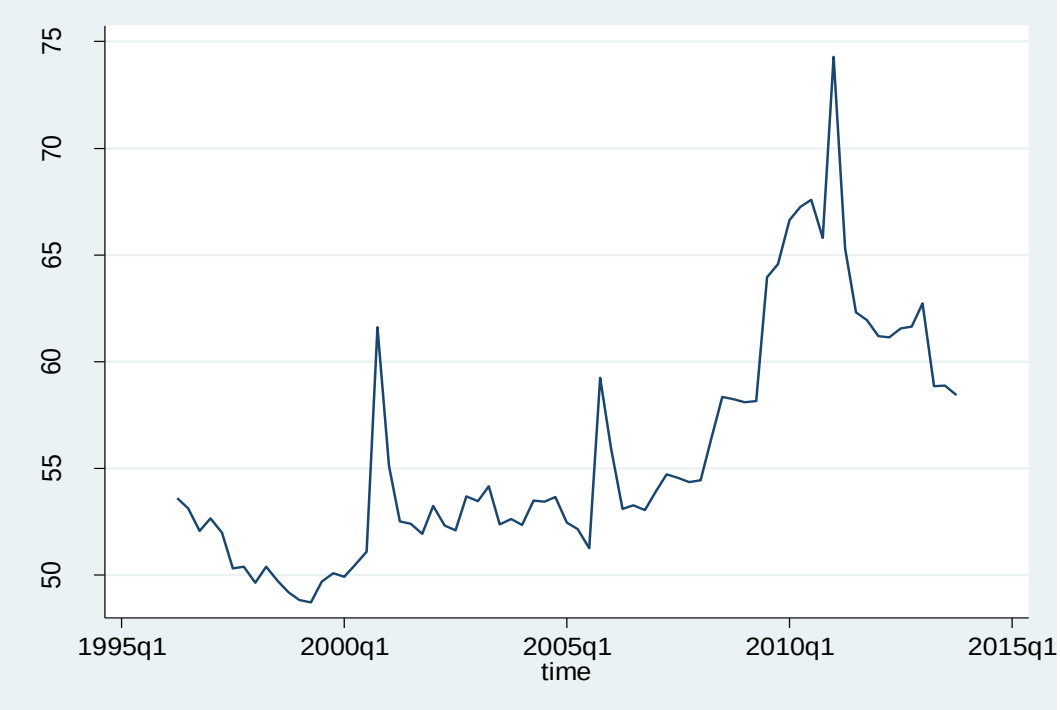

Figure 9-Network diagram of Granger-causality relationships for pre-crisis sample

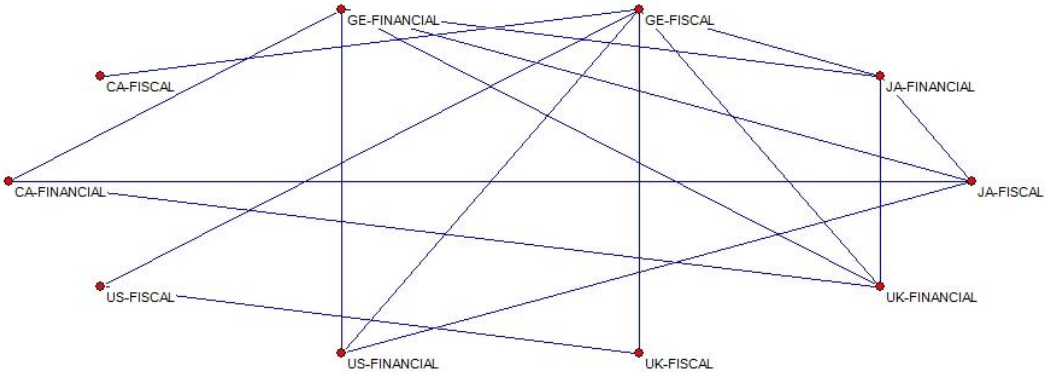

Figure 10-Network diagram of Granger-causality relationships for post-crisis sample