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Crisis severity and the international trade network

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Abstract: In this paper we analyse the role of the international trade network for the strength of the global recession across countries. The novelty of our paper is the use of value-added trade data to capture the importance of trade network structure. We estimate with BMA techniques how far network indicators measuring interlinkages in terms of value added trade has explanatory power both for the length and the depth of the recent crisis once we control for pre-crisis macroeconomic fundamentals. Our main findings are that the macroeconomic control variables with the strongest explanatory power for the length and the depth of the crisis are the growth rates of credit and of the real effective exchange rate in the pre-crisis period and, though to a lesser extent, GDP and inflation growth over the same period and pre-crisis foreign exchange reserves. Government debt, the GVC participation index and net foreign assets have very little explanatory power in the BMA estimations. The models' performance increases when we introduce interaction terms of credit growth with other vulnerability measures. The results demonstrate that the coincidence of vulnerabilities matters a lot. Credit growth deepens the crisis mainly if accompanied with pre-crisis GDP growth or low reserves, while the crisis tends to be longer if credit growth has led to large leverage or the accumulation of net foreign liabilities. Finally, we find evidence that value added trade linkages have an impact on the severity of the crisis. While the increasing connectivity or openness of the country makes the crisis longer, the same characteristics of the neighbours makes it also deeper. The tendency to interact with already connected countries lowers or increases the impact of the crisis depending on the position of the country. Altogether we have mixed results on the direct trade channel, but we demonstrate the importance of network structure beyond the countries' own openness. In addition, we are also able to improve results by using gross value added instead of gross trade data.

JEL codes: F14, C45, C52, C67

Key words: Network indicators, value added trade, crisis indicators, Bayesian model averaging, WIOD.

Non-technical summary

The strength of the Great Recession has partly been attributed to the rising role of international linkages. On the one hand, international trade linkages and the increasing role of global value chains with the delocalisation of parts of the production and the subsequent import of intermediate goods across different production stages increased possible repercussions from a disruption of production or consumption in one of the participating counties. On the other hand, the increasing internationalisation of financial flows played a particularly important role during the most recent global recession.

While this is generally agreed, empirical research has found some evidence for financial links, but surprisingly little on trade links. In this paper we analyse the role of the international trade network in explaining the strength of the global recession across countries. In particular, we analyse whether the position of a country and its trade partners in the international trade network played a role for the depth and the length of the recession in a large number of countries. At the same time, we control for a large number of variables with the potential to also have a bearing on the length and the depths of the crisis. We use alternative specifications with a number of different indicators for the length and the depths of the crisis as dependent variable. These measures are based on country specific starting and ending dates of the recession using seasonally adjusted quarterly GDP growth. The countries in our analysis are most G20 countries and other EU countries (39 countries). Given the limited number of observations (39), and the large number of potential control variables, we use Bayesian model averaging. This method allows us to deal with model uncertainty, as it is not clear which indicators should be included in the model.

Our main findings are that the macroeconomic control variables with the strongest explanatory power for the length and the depth of the crisis are the growth rates of credit and of the real effective exchange rate in the pre-crisis period and, though to a lesser extent, GDP and inflation growth over the same period and pre-crisis foreign exchange reserves. Government debt, the GVC participation index and net foreign assets have very little explanatory power in the BMA estimations. The explanatory power of the equations increases when we introduce interaction terms of credit growth with other vulnerability measures. The results demonstrate that the coincidence of vulnerabilities matters a lot. Credit growth deepens the crisis mainly if accompanied with strong pre-crisis GDP growth or low reserves, while the crisis tends to be longer if credit growth has led to large indebtedness or the accumulation of net foreign liabilities. Finally, we find evidence that value added trade linkages have an impact on the severity of the crisis. Altogether we have weak results on the trade channel, as trade openness affects only the length of the crisis. At the same time other network characteristics are also found to play a role. Beyond openness the increasing connectivity of the country also makes the crisis longer while the same characteristics of the neighbours make it also

deeper. The tendency to interact with already connected countries lowers or increases the impact of the crisis depending on the position of the country. Many of the results diminishes when we move to network indicators based on gross trade data, demonstrating the importance and differences of value added trade data.

1. Introduction

Global linkages played a crucial role in the Great Recession. While this is generally agreed, with financial and trade links being at the core of the discussion, empirical research has found convincing evidence mainly on financial links, but surprisingly little on trade links.

The aim of this project is to learn more about the potential role of the international trade network in explaining the strength of the global recession across countries. In particular, we intend to answer the question, whether the position of a country and of its trade partners within the trade network – strength, connectivity - played a role during the Great Recession. After controlling for fundamentals we test the significance of network measures in explaining the cross-country heterogeneity observed in countries' output loss during the crisis. The collapse in trade and the fall in financial flows were two major features of the recent crisis. Accordingly, the empirical studies added trade and financial exposures to the list of vulnerability indicators having been used in the financial crisis literature. In addition, recognizing the recent findings on the importance of network structures in transmitting shocks, many papers included network measures to better explain cross-country differences, or to forecast crisis incidences (see Chinazzi et al 2013, Kali and Reyes 2005, Minoiu et al (2013), Caballero (2012)). All those studies focused on the financial network, except Kali and Reyes 2005, who use trade network measures. However, the latter focuses on the stock market impact. Our paper contributes to this stream of the literature by filling this gap and linking crisis performance to the position of countries in the trade network. Another novelty of our paper is the use of value added trade instead of gross trade flows.

Our main findings are the following. The fall in output was largest in countries, which experienced high pre-crisis growth rates of private sector credit, an appreciation of their currency, overheating and a low level of foreign reserves. Allowing for non-linearity improves the model's explanatory power greatly but also refines the findings. E.g. credit growth deepens the crisis mainly if accompanied with pre-crisis GDP growth or low reserves, while the crisis tends to be longer if credit growth has led to large leverage or the accumulation of net foreign liabilities. We also find evidence that value added trade linkages have an impact on the severity of the crisis. The connectivity and openness of the country have an impact on the length of the crisis, at the same time the same average characteristics of the neighbours also affect the depth of the crisis. The tendency to have neighbours who are also connected and the countries' position in such clusters also determine their performance. The results

slightly change – but only in terms of significance, not in terms of direction of impact - when we add the Rest of the World, allow for non-linear impact or change the threshold used to decide on the links to include. Altogether we have mixed but rather weak evidence on the trade channel: in the baseline specification openness affects only the length of the crisis. At the same time when non-linearity is allowed or more links are dropped, openness (but only the import-share) also has an impact on the depth of the crisis. When the network characteristics are defined using gross bilateral instead of value added trade data, only a few network indicators have effect and only on the length but not on the depth of the crisis.

This paper is organised as follows: first we give an overview over the related literature (Section 2). The data and estimation methodology is described in Section 3, then the results are summarised (Section 4).

2. Literature

In this paper we combine two different strands of literature: one trying to explain the cross-country heterogeneity of growth performance during the 2008/2009 crisis, also using trade linkages; and the second on network theory and empirical studies linking network indicators to the severity or incidence of crises.

Regarding the first strand of literature, Feldkircher (2014) analyses the determinants of vulnerability to the global financial crisis. He defines four measures of crisis severity (cumulative loss in real output, depth of crisis, and two long-term measures) and includes a large number of macroeconomic, external, fiscal and financial variables, using Bayesian model averaging. The most influential drivers of the vulnerability to the crisis are the growth in pre-crisis credit, a combination of strong credit growth and exposure to external funding from developed countries, buoyant pre-crisis real activity, and international reserves.

Cecchetti et al. (2011) also analyse factors explaining how differently countries went through the financial crisis. They extract the first principal component of quarterly GDP growth and compute as measure of the crisis the part of each country's GDP growth that is not explained by the first principal component, i.e. the cumulative deviation from the global trend over the crisis. They find evidence that a better capitalised banking sector, lower loan to deposit ratios, a current account surplus, high foreign exchange reserves and low growth of credit to GDP helped in reducing the vulnerability of countries. However, they do not find a significant effect of trade openness.

Catao et al. (2013) investigate the predictors of external[2] crises, covering the period of 1970-2011. The paper focuses on the role of foreign liabilities and their composition. Net foreign liabilities (NFL) were found to be a significant predictor, with some threshold effect. The risk of crisis increases sharply if the NFL/GDP ratio exceeds 50% or the country-specific historical mean by 20 percentage points. The effect of NFL is mainly attributed to foreign debt, while the result on equity is weaker and FDI liabilities rather act as an offsetting factor. They find that the current account is a powerful predictor of crisis, while foreign exchange reserves lower the probability of crisis. Other factors like REER, GDP per capita and fiscal gap were also found significant.

Berkmen et al. (2012) look for factors explaining cross-country differences in the impact of the global financial crisis on the growth performance after the crisis and find that leverage, strong credit growth and more short-term debt are important factors. The trade channel is not important for emerging market countries, while it is important for more open non-emerging developing countries. Exchange rate flexibility and a stronger pre-crisis fiscal position lower the impact.

Hausmann-Guil et al. (2014) test the significance of trade and financial openness on crisis performance on an extensive dataset of 110 countries. They focus on countries' performance in 2009 and use the deviation of actual growth from the forecast as a crisis measure and the usual set of variables to control for initial conditions. They find that trade and financial integration has no continuous (neither linear, nor non-linear) impact on crisis performance, while integration above a threshold did cause deeper recession. This result is strong and robust for both trade and financial openness and also for a joint dummy of the two.

Altomonte et al. (2012) use transaction-level data for France which contains information on cross-border transactions matched with data on worldwide intra-firm linkages to analyse the development of global value chains during the trade collapse in 2008/2009. They find that the drop and subsequent recovery in intra-group trade in intermediates was stronger than trade between groups.

Kuroiwa and Kuwamori (2010) use Asian international input-output tables for 2008 to analyse the impact of the US downturn on Asian output, replacing final demand with US imports. They find significant effects on industrial output, a lot via triangular trade with China importing parts from neighbouring East Asian countries to export final products to the US and Europe.

Regarding the second strand of literature, papers on network theory focus on the fragility of networks. Even so, their findings have implications when exploring the heterogeneity of individual countries' performance following a shock. The earlier literature (Allen and Gale 2010) suggested that the more complete a network is, the more resilient it becomes to systemic failures. In contrast, later studies

[2] External crises are defined as default and rescheduling events and resort to large IMF support.

question that connectivity always brings "diversification" benefits and emphasize the importance of the heterogeneity in interconnectedness, the size of the shock and other characteristics of network structure. For example, Acemoglu et. al (2015) and Cabrales and Gottardi (2014) show, that the distribution of shocks has a bearing on the optimality of network structure – highly connected networks with minimal segmentation is optimal only if the distribution of shocks has thin tail. In a recent study Elliott et al. (2014) discuss both integration (size of exposure) and diversification (number of exposure) and argue that they are linked to vulnerability in a non-linear and non-monotonic way. Starting from a lower level, the increase of connectivity first might raise vulnerability by exposing the country to more shocks. Diversification benefits kick in later. The same non-linearity can be expected in the case of integration. The latter study is our primary reference when formulating our empirical exercise, as we are going to use measures of connectivity and integration both of individual countries and their neighbours, but also adding various clustering coefficients to capture local structure.

Empirical papers modelling contagion and vulnerability using network indicators are sparse and mostly focus on financial networks. One exception is Kali and Reyes (2010), who try to explain stock market returns with network based measures of connectedness to analyse whether the participation in international trade amplifies or cushions the impact of adverse shocks on a country's financial market. They estimate a model with abnormal stock market returns as dependent variable, and node importance, node centrality and macroeconomic control variables as explanatory variables and find a statistically significant and large effect of both network indicators. In a second model they seek to explain stock market returns with the maximum flow measure from the epicentre country to the target country and control variables. In this case, the network variable is still significant but smaller than the two measures above. Overall they find that being integrated into the International Trade Network amplified the impact of the shock on other countries, but helped to dissipate the impact for the epicentre country.

Minoiu et al. (2013) exploit financial connectedness measures as early warning indicator of crisis, using 27 network indicators. The results indicate that network based measures of financial interconnectedness are helpful in predicting banking crisis. In particular, an increase in a country's financial interconnectedness and a decrease in its neighbours' connectedness are associated with a higher probability of banking crisis. Caballero (2015) also finds that measures of financial integration (based on interbank syndicated loan market) have predictive power for the incidence of banking crisis.

Chinazzi et al. (2013) show first that the crisis changed the topology of international financial networks, while the disassortativity and the core-periphery structure remained unchanged. Second, the position of each country in the network helps to explain the severity of the crisis which is defined as the output loss during 2008-2009. Higher interconnectedness reduces it as the effect of the shock

dissipates more quickly. However, being central may make countries that are not members of a 'rich club' more vulnerable. They find strong non-linearity once heterogeneity is taken into account.

3. Data

In our dataset, the crisis measures are defined using quarterly real GDP data for the period 1997-2013, pre-crisis observations are taken for the explanatory control variables. These quarterly data were seasonally adjusted using the X12 seasonal adjustment program of the U.S. Census Bureau's provided in EViews. The main source of other financial and macroeconomic variables is Haver Analytics. Information on external assets and liabilities and the current account is taken from Catao and Milesi-Ferretti (2013), private sector credit data is from the World Bank.

For the trade network indicators, we use the World Input Output Database (WIOD), as they should better reflect the importance of cross country linkages - through which demand shocks exert their influence - than bilateral gross trade data. The WIOD covers 40 countries on an annual basis from 1995 to 2011; for the calculation of our network indicators we use data for 2007.

Our sample includes 39 countries, a choice which is mainly based on the countries available in the WIOD data, while we had to drop Taiwan for which we did not have data for some of the control variables.[3] As the WIOD data start only in 1995, we decided to consider only the 2007/2008 global crisis, rather than including several crisis episodes in our sample. The small number of observations (39) is clearly a limitation to our results which should hence be taken with caution. One option would have been to extend the sample along the time dimension. However, the global recession we are analysing is very different to previous crisis episodes for most countries examined here. We would lose information on country characteristics helping to explaining the depths and the length of the crisis by using a set of very heterogeneous crisis events. In particular, financial factors are thought to have been more prominent in the global financial crisis than in previous episodes. In addition, the crisis was global, and there are no other events with a global strong decline in growth between 1995 and 2011, the sample we have to choose because of the WIOD data. From 1995 to 2011, the global financial crisis is the only episode where quarterly GDP growth is negative for more than one quarter in more than 5 countries. As explained later on we will use Bayesian Model Averaging techniques to alleviate the problem of very limited number of observations.

[3] The countries included are: Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Mexico, Netherlands, Poland, Portugal, Republic of Korea, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Turkey, United Kingdom, United States.

3.1. Crisis measures

The literature follows different approaches in defining crisis performance measures. Some papers have focused on a fixed crisis period for all the countries, others have used country specific crisis dates. The literature also differs in terms of whether the length or the depths of the crisis is taken into account. Finally, while some papers use actual observations to define the output loss, others rely on the deviation of actual from forecasted output. We decided to use a definition of the crisis period which differs across countries, and to use several measures of the crisis both in terms of length and depth. The forecast error approach was discarded, because of the limited availability of forecasts from a given source.

The start of the crisis is defined as the first quarter at which GDP growth starts being negative for at least two consecutive quarters between 2007Q4 and 2009Q4. With this definition, there was no crisis in Australia, Indonesia and India as they only had one quarter of negative growth, therefore we took the period of 1-quarter of negative growth as a crisis for those countries. The trough is identified as the quarter when GDP hits its lowest level, or in other words, the last crisis quarter with negative growth. We define the length of the crisis in two different ways, the first one taking as end of the crisis the quarter, following which GDP first exceeds its pre-crisis peak level, and the second where GDP starts increasing again. The table below shows the start of the crisis for the sample countries.

Table 1 Start date of the crisis

2007Q4	GBR, ROU
2008Q1	DNK, IRL
2008Q2	AUT, ESP, FIN, GRC, ITA, JPN, LUX, LVA, PRT, TUR
2008Q3	BEL, DEU, FRA, LTU, MEX, NLD, RUS, SVN, SWE, USA
2008Q4	AUS, BGR, BRA, CAN, CHN, CZE, EST, HUN, IDN, KOR, MTA, POL, SVK
2009Q1	CYP, IND

The large variation of starting dates underscore the importance to define crisis measures by countries instead of focusing on their performance in 2008/2009, as done in many papers.

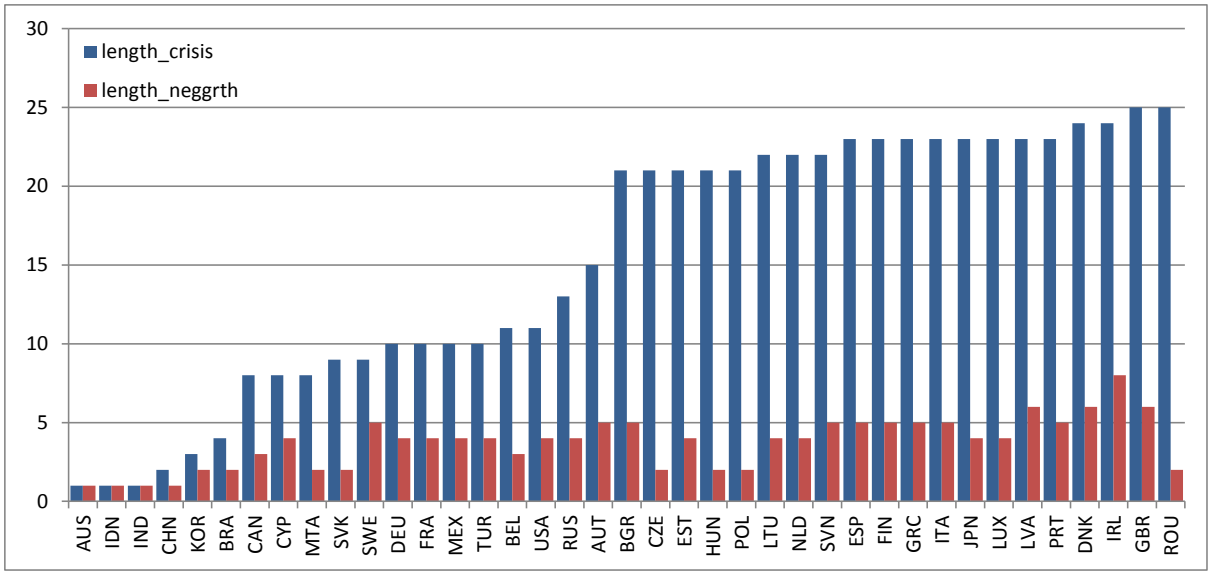
Based on this definition of the crisis, we use six different crisis measures, following a similar approach as Feldkircher (2014) and Cecchetti et al. (2009)[4]. The first two measures capture the length of the crisis in terms of the number of quarters until GDP reaches its pre-crisis level, and the number of quarters with negative growth.

[4] In Cecchetti et al. (2011) the deviation from global trend growth defined from the first principal component is used as measure of each country's idiosyncratic performance. They take the sum of this measure for the period 2008Q1 to 2009Q4 and estimate how poorly each economy weathered the crisis relative to other countries. While this is a method which helps taking out the cycle of the data, it has the inconvenience of imposing the same timing of the crisis across countries.

1) Length of crisis: quarters with GDP below pre-crisis peak
2) Length negative growth: quarters with negative GDP growth

Figure 1 shows the results across countries for the above two measures. For European countries, the difference between the number of quarters until their GDP growth reaches pre-crisis levels and the number of successive quarters with negative growth tends to be much higher, as it took longer for them to recover due to the sovereign debt crisis.

Figure 1. Length of the crisis



In addition, to capture not just the length but also the depth of the crisis, we define the cumulated loss, the depth of the crisis and include two definitions for the loss from trend growth.

The cumulated loss is the sum of losses observed from the start of the crisis till the trough, relative to the pre-crisis peak

3) Cumulated loss (from pre-crisis level)

$$cumloss = 100 * \frac{\sum_{t=crisis\_start}^{trough} \left(y_t - y_{crisis\_start-1} \right)}{y_{crisis\_start-1}}$$

Instead of taking the cumulated losses, one might measure the impact of the crisis by taking the largest fall – the difference between the pre-crisis peak and the trough:

4) Depth of the crisis from peak to trough

$$depth\_pt = 100 * \frac{y_{trough} - y_{crisis\_start-1}}{y_{crisis\_start-1}}$$

A modified version of the depth measure is, where instead of the peak, a 3 years' average is used.

5) Depth of the crisis from pre-crisis average (12 quarters before the start of the crisis) to trough

$$depth\_avg = 100 * \frac{y_{trough} - \bar{y}}{\bar{y}}$$

6) Loss compared to pre-crisis trend growth

For this measure we have calculated the trend component of GDP using an HP filter for the period from 1997Q1 up to the start of the crisis for each country. The loss is then defined as the average difference between observed GDP growth during the crisis and the average growth in the trend for the period from 1997Q1 up to the crisis. Put otherwise, the measure shows how much lower GDP growth is compared with a situation where it would have continued to grow according to the average trend observed up to the crisis:

$$trendd\_pre = 100 * \frac{\text{GDP}_{crisis} - \text{precrisis trend GDP}}{\text{precrisis trend GDP}}$$

7) Loss compared to total period trend growth

The definition is the same as above, except that we calculate trend growth over the total sample instead of the period from 1997Q1 up to the crisis:

$$trendd\_tot = 100 * \frac{\text{GDP}_{crisis} - \text{trend GDP}}{\text{trend GDP}}$$

3.2. Network indicators

We use network measures and metrics based on the WIOD dataset, using value added instead of gross trade data. Previous studies - like Dueñas and Faggiolo (2013) and De Benedictis et al. (2013) who described trade networks or Kali and Reyes (2010) who used network indicators - all employed gross trade data. The novelty of our approach is the use of value added data, which does alter the binary structure in addition to the weights of the network. Given our interest in the real impact of demand shocks, the value added in trade might better capture the potential role of the trade channel.

Although global measures are also likely to be important in shaping the shock transmission and the vulnerability of the system to shocks, since we focus on country heterogeneity, mainly local measures, such as strength and connectivity, are employed. Nevertheless, the performance of a country could be affected not just by its own exposure or connectivity, but that of its neighbours too. Therefore, we use network indicators of individual countries and of their trade partners, including clustering coefficients. The calculation of network indicators is described in Appendix B.

We use both binary and weighted directed network indicators calculated for the year 2007[5]. Following the latest results on network theory, we focus on connectivity and integration – introduced by Elliott et al. (2014). Based on their results a priori we don't know whether connectivity was a source of increasing vulnerability or provided rather diversification benefits and thus lowered the fall of GDP in case of more connected countries.

Connectivity is measured by the number of links of the node and its neighbours (Node Degree (k) and by Average Nearest Neighbour Degree (ANND)). We focus on outgoing (export) and incoming (import) links separately and on their sum, resulting in three versions of the Node Degree indicator: kin, kout and ktot. In case of ANND the following combinations are generated, depending on whether import (in) or export (out) links of the country and its neighbours are considered: ANNDoutout, ANNDoutin, ANNDinin, ANNDinout. For example ANNDinout for country X considers all the countries from where X imports, and calculates the average number of export links of those countries. Degree indicators are normalized by the number of countries minus one (N-1).

Integration in the network is captured by the indicator of Node Strength (s) and of Average Nearest Neighbours' Strength (anns). These indicators consider the size of all the incoming or outgoing links (called "weights") of each country and of its export or import targets and are scaled by the country's GDP. Just like in the case of degree measures, various versions are employed, depending on the direction of the links considered.

Unfortunately, degree type measures cannot be calculated using the original network generated from WIOD, because that forms a complete network – all the countries have both incoming and outgoing links to any other country. Since we do not want to disregard the connectivity issues, we drop links below a certain threshold. Two thresholds are used: 1% and 0.5% of GDP of the exporting or importing country, depending on the direction of the links.[6] The resulting network is used to calculate all the indicators. We face another data issue, that of the treatment of the Rest of the World (RoW). The WIOD includes 40 countries plus the RoW. RoW has a large share in total trade, but it distorts some indicators – for example RoW as a neighbour is assigned an inflated exposure value, since it sums the exposure of all the included countries. To remedy these issues two versions of the indicators are calculated, one including and another excluding the links with the RoW.

Clustering denotes the tendency in a network to be linked to countries which themselves are connected. In general, if clustering is high, the "local" network is close to being complete and as such might allow diversification benefits. In case of directed networks several versions of the clustering

[5] The network structure changes slowly during normal times. Averages of indicators over 2005-2007 are highly correlated with the indicators used in the regression (2007).

[6] After applying the 0.5% threshold, we loose 71% of the links respectively, however 79% of trade value is kept.

coefficient are developed (see Fagiolo 2006) reflecting the position of the country considered (in, out, middle, cycle). If a country tends to take a middle position (one incoming and one outgoing link with connected countries) it is likely to transmit external shocks and thus we do not expect it to matter for the country's own performance. On the other hand, if a country tends to have a link of the same direction with connected countries, it might increase its exposure to external shocks. Overall we do not have clear expectations on the direction of impact of various clustering coefficients.[7]

3.3. Control variables

Utilising the findings of previous studies several measures on vulnerability and institutions are controlled for in the estimation: we use GDP per capita, foreign exchange reserves, net financial assets, government debt, the fiscal deficit, the current account - all in percent of GDP -, GDP growth, private sector credit in percent of GDP and its growth, the change in real effective exchange rate and inflation, and the GVC participation index. For all variables the 2007 observations are used, except for growth rates which are calculated over the period 2004 to 2007. Initially, we also enter FDI and dummies for the foreign exchange system and for inflation targeting into the equation but we have to drop the least promising variables because of the low number of observations in our sample.

4. Methodology

Given the limited number of observations (39), and the large number of potential control variables, we use, similar to Feldkircher (2014), Bayesian Model Averaging (BMA). This allows us to deal with model uncertainty, as it is not clear which indicators should be included in the model. As suggested in Zeugner (2011), we use the EBL g-prior, which estimates a local empirical Bayes g-parameter (see also Lian et al (2008)). This is a model specific g prior which uses information contained in the data to estimate g via maximum likelihood. We use the random model prior which is preferable under a strong prior believe on the model size, and put the prior model size to 2 variables, both due to the small number of observations. As the sum of the posterior inclusion probabilities (PIP) is equal to the average model size, the significance of each variable for explaining the length and the depth of the crisis has to be seen relative to other variables by comparing the respective PIPs. In addition, it has been argued that a mean divided by the standard deviation larger than 1.96 in absolute value corresponds to a confidence level of 99%, 1.65 to 95% and 1.28 to 90% (see also Masanjala and Parageorgiou (2008)). We regard a variable significant if either it has a mean/sd above 1.28 or its PIP is among the top 5.

[7] We also investigated the role of Gate Keeping Potential, introduced by A.C. Joseph (2014), but neither the country's or its neighbours' average GKP measure had any impact on the severity of the crisis.

We normalize both the crisis measures and the explanatory variables to mean zero and variance one. In this case the standardized coefficients also show the importance of the variable. The dependent variable is defined such that a decrease in the variable means the crisis gets worse – i.e. the length of the crisis measures are multiplied with minus one.

The estimation is carried out in the following steps. First all the macro variables are used to run BMA. Then those which are not significant by either of the two criterion for at least one crisis measure are dropped. In the next step interaction terms are added, to see if the model's explanatory power is improved by controlling for non-linearity - the coincidence of various vulnerabilities. Again, the variables and terms found significant at least for one crisis measure are kept. Next, various versions of the network indicators are added, one by one. Finally, the non-linearity of the indicators is investigated by adding their squared term. To elaborate on the explanatory power and fit of the model, the shrinkage statistics is used – as shown by Feldkircher and Zeugner (2009) in case of EBL prior the average shrinkage factor offers the interpretation of goodness of fit. A model is said to be satisfactory, if the shrinkage statistics is above 0.9. And we talk about improvement if adding a new variable increases the shrinkage statistics.

5. Estimation results

5.1. BMA with macro variables

Table 2 shows the results with the variables, which were found significant for at least one crisis measure. With the prior model size of 2, the posterior mean number of regressors is between 2 and 4, which is not too large for our small sample. As a result, the posterior inclusion probability (PIP) of the individual variables is low, as the sum of the PIPs is equal to the mean number of regressors. The effects found are intuitive in almost all of the cases and go into the expected direction. The PIPs are relatively high in all regressions for the growth of credit (dcredit0407) and the growth in the real effective exchange rate (dreer0407), suggesting that these variables have a strong explanatory power for both the length and the depths of the crisis. Countries, which experienced large credit growth and an appreciation of their currency preceding the crisis (probably indicating exchange rate misalignment) encountered a stronger crisis. Their impact is material in economic terms: a 1 standard deviation increase in credit growth corresponds to a 0.6 / 0.4-0.6 standard deviation longer/deeper crisis. In addition, overheating, indicated by high inflation and GDP growth, is also followed by deeper crisis, while foreign exchange reserves might have provided a buffer to withstand the shocks. There is some weaker evidence that large current account deficits and private sector indebtedness were accompanied by deeper crisis. Fiscal surplus before the crisis was followed by larger output loss, which is rather counterintuitive, as larger fiscal space for manoeuvre should facilitate countercyclical

policies. Government debt and the GVC participation index[8] (not shown) and net foreign assets have the least explanatory power in the equations. We kept the latter nonetheless among the control variables to test whether they yield some effect when entered in a non-linear way.

Table 2 Results with macro-variables

	q_crisis		q_neggrth		cumloss		depth_pt		depth_avg		trendd_pre		trendd_tot	
	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean
ca_gdp07	0.17	0.06	0.24	0.03	**0.30**	0.23	0.15	0.10	**0.34**	**0.28** *	0.16	0.09	0.16	-0.10
credit07	**0.30**	**-0.23** *	**0.53**	**-0.31** ***	0.22	-0.12	0.14	0.04	0.18	0.00	0.17	-0.10	0.14	0.08
dcpi0407	0.15	0.02	0.36	**-0.25** *	**0.41**	**-0.32** ***	**0.30**	**-0.28** ***	0.25	-0.17	**0.38**	**-0.32** ***	**0.38**	-0.34
dcredit0407	**0.93**	**-0.58** ***	**0.66**	**-0.38** ***	**0.64**	**-0.39** ***	**0.88**	**-0.52** ***	**0.64**	**-0.42** ***	**0.94**	**-0.55** ***	**0.94**	-0.54
dreer0407	**0.83**	**0.46** ***	**0.66**	**0.41** ***	**0.47**	**0.34** ***	**0.54**	**0.38** ***	**0.65**	**0.41** ***	**0.58**	**0.39** ***	**0.45**	0.37
dyera_nc0407	0.22	0.15	0.21	0.08	**0.30**	**-0.22** *	**0.22**	-0.19	0.25	0.15	**0.28**	**-0.23** ***	**0.21**	-0.18
fdi_net_gdp07	0.17	-0.09	**0.46**	**-0.31** ***	0.22	-0.12	0.14	-0.07	0.21	-0.10	0.20	-0.15	0.16	-0.13
fiscbal07	0.19	-0.11	0.24	-0.11	0.24	-0.12	**0.22**	-0.15	0.21	-0.10	**0.22**	-0.14	**0.20**	-0.14
fxres_gdp07	**0.24**	0.16	**0.58**	**0.33** ***	0.24	0.14	0.14	0.06	**0.28**	0.18	0.17	0.10	0.13	-0.01
gdp_cap07	**0.27**	-0.22	0.27	-0.14	0.25	-0.18	0.14	-0.05	0.27	-0.20	0.20	-0.16	0.13	-0.03
infl_targ07	0.17	-0.08	0.34	-0.20	0.23	-0.13	0.16	-0.10	**0.30**	-0.18	0.18	-0.13	0.15	-0.09
nfa_gdp07	0.21	0.16	0.26	0.16	0.19	0.02	0.13	-0.02	0.20	0.01	0.14	0.00	0.16	-0.13
Mean no. regr	3.86		4.80		3.70		3.18		3.79		3.62		3.21	
Shrinkage Stats	Av=0.834		Av=0.82		Av=0.664		Av=0.804		Av=0.681		Av=0.849		Av=0.851	

*Note: PIP is red/bold when it is among the five largest PIPs or when it is at least 0.5. Absolute value of mean/s.d. larger than 1.96 corresponds to a confidence level of 99% (indicated with ***), 1.65 to 95% (**) and 1.28 to 90% (*). ca_gdp07 is the current account in percent of GDP, credit07 is private sector credit in percent of GDP (both in 2007), dcpi0407 is CPI inflation from 2004-2007, dcredit0407 is the growth from 2004 to 2007 in private sector credit to GDP, dreer0407 is the change from 2004 to 2007 in the real effective exchange rate, dyera_nc0407 is the growth from 2004 to 2007 in national currency denominated GDP, fdi_net_gdp07 is net FDI in percent of GDP, fiscbal07 is the fiscal balance in percent of GDP in 2007, fxres_gdp07 is foreign exchange reserves in percent of GDP in 2007, gdp_cap07 is GDP per capita in 2007 , infl_targ07 is a dummy for inflation targeters, and nfa_gdp is net foreign assets in percent of GDP.*

The shrinkage statistics is rather low in all regressions (below 0.9), which indicates that the crisis is not explained well by our explanatory variables. Therefore, as a next step, we introduce interaction terms, similar to the approach followed by Feldkircher (2014). In particular, in addition to the above mentioned variables we interact credit growth with GDP growth, GDP per capita, exchange rate appreciation, net foreign liabilities, the current account deficit, and foreign exchange reserves. We also introduce an interaction between government debt and the fiscal deficit. Table 12 in the Appendix A shows the full BMA results with these interaction terms. The table below shows the BMA results only with those variables which were found significant in at least one of the equations.

[8] Note that the results were rather similar when using the GVC position index rather than the participation index.

Table 3 Results with interaction terms

	q_crisis Post		q_neggrth Post		cumloss Post		depth_pt Post		depth_avg Post		trendd_pre Post		trendd_tot Post	
	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean
ca_gdp07	0.1	0.0	0.2	-0.1	0.1	0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	**0.3**	-0.3 ***
credit07	0.2	-0.2	0.3	-0.2	0.2	-0.2	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	0.0
credit07_dcr	**0.4**	-0.4 ***	**0.6**	-0.5 ***	**0.2**	-0.3	0.1	0.1	0.1	0.0	0.1	-0.2	0.1	0.1
dcpi0407	0.1	0.0	0.2	-0.2	**0.2**	-0.3 ***	0.1	-0.2	0.2	-0.2	**0.1**	-0.2 *	**0.2**	-0.3 ***
dcredit0407	**0.3**	-0.5 ***	0.2	-0.1	0.2	0.3	**0.1**	0.4	**0.4**	0.6 ***	0.1	0.4	0.1	0.4
dreer0407	**0.6**	0.5	**0.6**	0.4 ***	**0.3**	0.3 ***	**0.6**	0.4 ***	**0.8**	0.4 ***	**0.4**	0.3 ***	**0.4**	0.3 ***
dreer0407_dcr	0.2	-0.3	0.2	-0.2	0.2	0.2	**0.1**	0.2	0.2	0.2	**0.1**	0.2	0.1	0.1
dyera_nc0407	0.2	0.2	0.2	0.2	0.1	0.0	0.1	0.1	**0.9**	0.5 ***	0.1	0.0	0.1	0.1
dyera_nc0407_dcr	0.2	-0.3	0.2	-0.2	**0.9**	-0.8 ***	**1.0**	-0.9 ***	**1.0**	-1.1 ***	**1.0**	-0.9 ***	**1.0**	-0.9 ***
fdi_net_gdp07	0.1	-0.1	**0.4**	-0.3 ***	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	0.1	-0.1
fiscbal07	0.1	-0.1	0.2	-0.1	0.1	-0.1	0.1	-0.2 *	0.2	-0.1	0.1	-0.2	0.1	-0.1
fxres_gdp07	0.2	0.2	**0.5**	0.4 ***	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0
fxres_gdp07_dcr	0.1	-0.2	0.2	0.1	**0.4**	0.5 ***	**0.2**	0.4 ***	**0.3**	0.4 *	**0.4**	0.5 ***	**0.2**	0.4 ***
gdp_cap07	0.2	-0.3	0.2	-0.3	0.2	-0.2	0.1	-0.1	0.2	-0.2	0.1	-0.2	0.1	-0.1
gdp_cap07_dcr	**0.3**	-0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2
nfa_gdp07	0.2	0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1	-0.1
nfa_gdp07_dcr	**0.3**	0.4 ***	**0.3**	0.4 *	0.2	0.3	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1
Mean no. regressors	3.96		4.79		3.69		2.93		5.12		3.24		3.01	
Shrinkage-Stats	Av=0.8368		Av=0.8403		Av=0.862		Av=0.9386		Av=0.8958		Av=0.9376		Av=0.9441	

*Note: PIP is red/bold when it is among the five largest PIPs or when it is at least 0.5. Absolute value of mean/s.d. larger than 1.96 corresponds to a confidence level of 99% (indicated with ***), 1.65 to 95% (**) and 1.28 to 90% (*). Variables with _dcr at the end are multiplied with credit growth.*

When interaction terms are included, the shrinkage statistic increases, suggesting that the explanatory power of the model becomes sufficient in particular in terms of depths, while the variables reflecting (also) the length of the crisis (q_crisis, q_neggrth and cumloss) have shrinkage statistics below 0.9. With the same prior for the model size, we also get a mean number of regressors between 2 and 4. Therefore, with more variables included, the PIP for each variable is lower than before.

While a pre-crisis appreciation of the exchange rate continues having a large negative effect on both the length and the depth of the crisis, credit growth is now less important as a single variable. However, its interaction terms with other variables exert a large impact on crisis severity. Different interaction terms are important for the depth and the length measures: credit growth coupled with pre-crisis GDP growth or low reserves deepens the crisis, while credit growth accompanied by large leverage or large net foreign liabilities lengthens the crisis. At the same time the credit growth itself remains detrimental for q_crisis only, in all the other cases it either loses its significance or changes its sign. Implying that credit growth deepens the crisis only if coupled with other vulnerabilities – like overheating or low reserves.

A similar difference arises between the results on crisis length and depth regarding the impact of foreign reserves. For one length measure foreign reserves keep their role as a buffer, while for the depth measures the interaction with credit turns out to be significant. The negative parameter of the

interaction term implies that low foreign reserves are detrimental only if coupled with large growth in indebtedness before the crisis.

While the net foreign assets variable was not among the significant drivers of crisis performance, when interacted (as liability) with credit growth, it becomes important for the length measures. That is having large foreign liabilities together with large credit growth was accompanied with worse outcomes of the crisis.

Although the models are slightly different for length and depth measures, in both cases we find evidences for non-linear impacts. While the models seem to be satisfactory for the majority of depth measures, the shrinkage statistics – albeit improved – still falls below 0.9 for the length measures.

5.2. BMA with network indicators

Using our preferred model with interaction terms we move to the inclusion of the network indicators. As these indicators are highly correlated (see Annex Table 8), only one type is included at a time. Table 4 summarises the results, showing the ranking by PIP and the mean coefficient only for the network indicators to simplify the representation. Remember that each coefficient is entered separately, i.e. each case in the table shows the result of a separate BMA estimation.

We have highlighted in the table those PIPs which were among the six highest for each regression and means, which are significant by the mean/s.d. statistic.

The inclusion of network indicators does result in some further improvement in the shrinkage statistics for some crisis measures.

The results show that both the connectivity and openness of the country have some explanatory power for the length of the crisis (q_crisis and q_neggrth). That is, the larger the number of export and import partners, and the higher the country's export and import share, the longer the crisis. The former results imply that no diversification benefit is found in our sample. The latter result supports the importance of trade openness. Nevertheless, the trade channel matters significantly for the crude length crisis measures, but for none of the output loss measures. Apparently using value added instead of gross export data does not help solving the puzzle on the irrelevance of the trade channel with respect to the output loss experienced during the crisis.

At the same time, we find evidence that the average connectivity and openness of neighbours matter not just for the length but also for the depth of the crisis. The increasing connectivity of neighbours leads to longer crisis; that of the export targets (anndout) leads even to deeper crisis. As to the integration of neighbours (anns), it was found to have a more robust impact on both the length and the depth of the crisis.

Table 4 Results with network indicators

	q_crisis		q_neggrth		cumloss		depth_avg		depth_pt		trendd_pre		trendd_tot	
	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king
kin07	-0.27	5	-0.21	8	-0.16	11	-0.12	13	-0.10	12	-0.10	15	0.02	18
kout07	-0.27	3	-0.15	13	-0.16	10	-0.12	12	-0.15	7	-0.14	11	-0.07	16
ktot07	-0.29	3	-0.19	8	-0.17	10	-0.13	11	-0.14	8	-0.14	11	-0.04	18
sin_07	-0.34	5	-0.53	3	-0.29	6	-0.15	12	-0.11	12	-0.27	8	-0.01	16
sout_07	-0.24	5	-0.17	12	-0.13	15	-0.08	16	-0.09	12	-0.12	14	-0.05	18
stot_07	-0.32	4	-0.36	5	-0.22	10	-0.12	13	-0.12	11	-0.23	8	-0.04	18
cc_out07	0.18	11	0.15	13	0.21	5	0.18	6	0.16	7	0.22	4	0.12	12
cc_in07	-0.20	6	-0.22	5	-0.45	1	-0.36	3	-0.32	2	-0.26	4	-0.21	4
cc_cycle07	-0.08	17	-0.14	14	-0.12	13	0.01	18	0.00	18	-0.13	11	-0.01	18
cc_middle07	-0.01	18	-0.07	18	-0.06	18	-0.13	8	-0.09	11	-0.06	16	-0.10	14
anndoutout07	-0.23	5	-0.09	18	-0.21	7	-0.15	8	-0.19	5	-0.12	14	-0.12	13
anndoutin07	-0.25	5	-0.20	8	-0.12	15	-0.11	14	-0.13	8	-0.10	15	-0.08	17
anndinout07	-0.25	5	-0.17	10	-0.22	7	-0.18	7	-0.19	8	-0.13	14	-0.09	16
anndinin07	-0.32	3	-0.21	8	-0.19	11	-0.17	8	-0.17	8	-0.13	14	-0.04	18
annsoutout07	-0.21	5	-0.11	18	-0.25	5	-0.18	6	-0.20	4	-0.15	10	-0.15	8
annsoutin07	-0.28	3	-0.23	5	-0.22	6	-0.18	7	-0.19	7	-0.16	11	-0.12	12
annsinout07	-0.30	3	-0.25	5	-0.22	5	-0.18	7	-0.15	8	-0.16	11	-0.08	16
annsinin07	-0.38	1	-0.30	5	-0.24	5	-0.19	7	-0.17	8	-0.16	11	-0.04	18
Avg of avg shrinkage stats	0.838		0.841		0.862		0.895		0.938		0.937		0.945	
Max of avg shrinkage stats	0.855		0.867		0.905		0.921		0.939		0.938		0.945	
Avg shrink. stats w/o netwc	0.837		0.840		0.862		0.939		0.896		0.938		0.944	

Indicators are calculated by using the 0.5% GDP threshold to drop links. RoW is excluded.

Regarding the clustering coefficients, the tendency to be linked to already connected countries helped to withstand the crisis if the country was mainly an exporter, however the opposite applies to those who tended to be importer. As the recent crisis brought about large demand shocks, these results are difficult to interpret; even if we ignore the direction and interpret them as a local measure of completeness.

It seems that the connectivity and openness of a country has some explanatory power only for the length of the crisis, while the same average characteristics of the neighbours and various clustering coefficients are better at explaining the depth of the crisis as well.

5.3. BMA with network indicators – non-linearity

The potential non-linearity of the impact of network characteristics was investigated by adding squared indicator values. In general, we observe further improvements in explanatory power, but in case of the first two crisis measures the shrinkage still fails to go above 0.9 (see Table 5). The direction of the estimated impact does not change in any of the significant cases. More importantly, the inclusion of squared indicators provides more support to the importance of connectivity and

integration with respect to the losses suffered, not just the length of the crisis. Connectivity (kout_sq and ktot_sq) is picked as significant for two depth measures, on the other hand integration matters for the depth of the crisis only in case of importshare (sin). That is, although we do not find evidence on the trade channel, when openness is defined as total trade over GDP, the import share seems to drive the output loss during the crisis.

Table 5 Results with network indicators including non-linearities

	q_crisis		q_neggrth		cumloss		depth_avg		depth_pt		trendd_pre		trendd_tot	
	Post Mean	ran-king	Post Mean	ranking	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king
kin07	-0.24	7	-0.27	8	-0.07	15	0.08	13	0.00	13	-0.09	16	0.04	19
kout07	-0.25	5	-0.08	15	-0.04	13	0.32	9	-0.02	9	-0.10	12	-0.04	18
ktot07	-0.21	5	-0.20	10	0.01	12	0.36	9	0.17	9	-0.11	13	0.00	19
sin_07	-0.34	7	-0.54	3	-0.19	12	-0.09	15	-0.04	13	-0.21	12	0.03	17
sout_07	-0.32	6	-0.18	14	-0.13	16	-0.06	18	-0.10	12	-0.12	14	-0.05	18
stot_07	-0.32	6	-0.37	5	-0.17	13	-0.07	16	-0.08	13	-0.21	12	-0.02	19
kin07_sq	-0.32	4	-0.07	14	-0.27	10	-0.33	7	-0.23	8	-0.12	14	0.01	18
kout07_sq	-0.26	4	-0.21	12	-0.26	9	-0.48	6	-0.25	6	-0.18	11	-0.11	15
ktot07_sq	-0.35	3	-0.16	12	-0.33	7	-0.55	6	-0.41	6	-0.17	11	-0.08	18
sin_07_sq	-0.34	11	-0.41	6	-0.47	6	-0.26	9	-0.24	9	-0.39	6	-0.09	15
sout_07_sq	-0.01	15	-0.09	17	-0.08	17	-0.07	17	-0.05	16	-0.09	16	-0.02	19
stot_07_sq	-0.29	9	-0.28	6	-0.29	11	-0.16	14	-0.18	9	-0.25	8	-0.05	18
cc_out07	-0.32	13	0.26	14	0.24	6	0.36	7	0.18	7	0.33	4	0.21	12
cc_in07	-0.18	10	-0.21	6	-0.26	4	0.06	7	0.06	5	-0.17	6	-0.18	6
cc_cycle07	-0.07	19	-0.04	16	-0.03	14	0.03	18	0.02	19	-0.07	12	0.01	19
cc_middle07	-0.14	18	-0.29	17	-0.40	11	-0.26	7	-0.17	8	-0.23	14	-0.12	14
cc_out07_sq	0.59	10	0.00	15	0.14	7	-0.05	8	0.12	8	0.06	5	0.01	14
cc_in07_sq	-0.23	9	-0.19	10	-0.56	1	-0.56	2	-0.55	1	-0.40	2	-0.29	4
cc_cycle07_sq	-0.09	16	-0.22	8	-0.21	6	-0.02	19	-0.06	18	-0.19	4	-0.05	18
cc_middle07_sq	0.15	19	0.24	19	0.38	14	0.13	14	0.07	16	0.20	16	-0.03	17
anndoutout07	-0.27	6	-0.46	18	-0.20	12	0.05	11	-0.20	8	-0.16	14	-0.10	15
anndoutin07	-0.36	7	-1.84	6	-0.44	15	-0.21	14	-0.35	8	-0.56	14	-0.31	15
anndinout07	-0.24	7	-0.12	14	1.09	8	1.06	9	0.22	9	0.40	15	0.16	17
anndinin07	-0.26	4	-0.12	9	0.72	9	1.11	8	0.35	9	0.11	15	0.16	19
annsoutout07	-0.18	8	-0.35	18	-0.56	5	-0.31	7	-0.41	4	-0.37	10	-0.30	9
annsoutin07	-0.38	4	-1.90	5	-0.56	7	-0.34	7	-0.45	6	-0.82	8	-0.47	12
annsinout07	-0.41	3	-0.62	6	-0.27	7	-0.33	8	-0.29	8	-0.26	11	-0.20	17
annsinin07	-0.41	2	-0.46	5	0.08	7	0.29	8	0.05	9	-0.11	12	0.02	19
anndoutout07_sq	-0.2	7	0.3	19	-0.2	11	-0.3	9	-0.2	9	-0.1	15	-0.1	14
anndoutin07_sq	-0.1	8	1.7	8	0.2	16	0.0	15	0.1	9	0.4	15	0.2	17
anndinout07_sq	-0.2	8	-0.2	13	-1.4	7	-1.3	7	-0.6	8	-0.6	14	-0.3	16
anndinin07_sq	-0.4	3	-0.3	8	-1.0	7	-1.3	6	-0.6	7	-0.4	13	-0.3	17
annsoutout07_sq	-0.2	7	0.2	19	0.2	7	0.0	8	0.1	6	0.1	12	0.0	10
annsoutin07_sq	-0.1	6	1.8	6	0.2	10	0.0	10	0.1	8	0.7	12	0.3	14
annsinout07_sq	-0.1	5	0.2	8	-0.1	9	0.0	10	0.0	9	0.0	12	0.1	18
annsinin07_sq	-0.3	4	-0.1	6	-0.5	5	-0.6	7	-0.4	8	-0.2	11	-0.1	18

Avg of avg shrinkage stats	0.838	0.839	0.861	0.893	0.938	0.937	0.946
Max of avg shrinkage stats	0.861	0.869	0.930	0.941	0.947	0.938	0.946
Avg shrink. w/o network ind.	0.837	0.840	0.862	0.939	0.896	0.938	0.944

5.4. Robustness of the results

The robustness of the results on network characteristics is investigated by:

(i) changing the threshold to drop links (1% instead of 0.5%)
(ii) including the RoW
(iii) using gross trade values to generate network indicators
(iv) using different priors

Regarding the first, when the threshold to drop links is raised to 1%, results regarding the length of the crisis do not change – both node and neighbour connectivity and integration matter. On the other hand, in case of crisis depth we find more evidence on node characteristics and less on that of neighbours. While the export-share and total trade over GDP do not have an impact on the depth of the crisis, import-shares do. It seems that the results are somewhat sensitive to the changes in threshold, but many of the findings remain robust.

Regarding the second, there is some variation in the results between the versions with and without the RoW (see Table 13 in Appendix A). However, these are minor at lower thresholds (0.5%) but get larger when the threshold is raised to 1% - more significant result is found when RoW is included in the calculation of network indicators (see Table 14 and Table 15).

To answer the question whether it makes any difference if we use value added instead of gross trade data, the same estimations were run with network indicators calculated on direct gross export data. When gross trade data is used to calculate the indicators, we are less 'successful' in finding significant impact. We find some evidence that the countries' and its neighbours' connectivity and integration affect the length of the crisis, but none on the depth of the crisis (see Appendix A Table 16). This finding does not change even if we alter the threshold to drop links or include the RoW (not reported).

Finally, we make some robustness checks by using different priors. For easier presentation, we use the version without network indicators but with interaction terms to perform these robustness checks. First, we modify the hyperparameter on Zellner's g-prior for the regression coefficients: instead of using the EBL as suggested in Zeugner (2011), we use the BRIC which has been proposed by Fernandez et al. (2001) and is equal to the maximum of the number of observations (39 in our case) and the square of the number of regressors (17x17 in our case), hence in our case it is 289.

Table 6 Results without network indicators using BRIC

	q_crisis Post		q_neggrth Post		cumloss Post		depth_pt Post		depth_avg Post		trendd_pre Post		trendd_tot Post	
	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean
ca_gdp07	0.0	0.2	0.0	0.1	0.0	0.2	0.0	-0.1	0.0	0.2	0.0	-0.1	**0.0**	-0.3 ***
credit07	0.0	-0.4 ***	**0.1**	-0.4 ***	0.0	-0.3 ***	0.0	-0.1	0.0	-0.1	**0.0**	-0.3 ***	0.0	-0.1
credit07_dcr	**0.5**	-0.5 ***	**0.3**	-0.5 ***	**0.1**	-0.4 ***	0.0	0.0	0.0	-0.1	0.0	-0.2	0.0	0.1
dcpi0407	0.0	0.2	0.0	-0.1	0.0	-0.2	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.0	-0.2
dcredit0407	**0.2**	-0.6 ***	0.0	-0.3	0.0	-0.2	**0.0**	0.4	**0.1**	0.6 *	0.0	0.3	**0.0**	0.5
dreer0407	**0.2**	0.5 ***	**0.1**	0.4 ***	**0.1**	0.4 ***	**0.4**	0.4 ***	**0.7**	0.5 ***	**0.2**	0.4 ***	**0.1**	0.3 ***
dreer0407_dcr	0.0	-0.4	0.0	-0.1	**0.0**	0.3 ***	**0.1**	0.3	**0.1**	0.4 ***	**0.1**	0.3 ***	0.0	0.3 ***
dyera_nc0407	0.0	0.3 ***	0.0	0.3 ***	0.0	-0.1	0.0	0.0	**0.7**	0.5 ***	0.0	0.0	0.0	0.0
dyera_nc0407_dcr	0.0	-0.4 ***	0.0	-0.2	**0.8**	-0.7 ***	**1.0**	-0.8 ***	**0.8**	-1.0 ***	**1.0**	-0.8 ***	**1.0**	-0.8 ***
fdi_net_gdp07	0.0	-0.1	**0.2**	-0.4 ***	0.0	-0.2	0.0	-0.1	0.0	-0.1	0.0	-0.2 ***	0.0	-0.2 ***
fiscdef07	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.2 ***	0.0	-0.1	0.0	-0.2 ***	0.0	-0.2 ***
fxres_gdp07	0.0	0.2 ***	**0.3**	0.5 ***	0.0	0.2 *	0.0	0.1	0.0	0.3 ***	0.0	0.2	0.0	0.0
fxres_gdp07_dcr	0.0	-0.2	0.0	0.0	**0.1**	0.6 ***	**0.1**	0.4 ***	0.0	0.3	**0.2**	0.5 ***	**0.0**	0.4 ***
gdp_cap07	**0.1**	-0.5 ***	0.1	-0.5 ***	0.0	-0.2	0.0	-0.1	0.0	-0.4	0.0	-0.2 ***	0.0	-0.1
gdp_cap07_dcr	0.0	-0.4 ***	0.0	0.3	0.0	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
nfa_gdp07	0.0	0.2	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.2 *
nfa_gdp07_dcr	**0.1**	0.5 ***	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.1	0.0	-0.1
Mean no. regressors	1.24		1.33		1.37		1.66		2.70		1.72		1.38	
Shrinkage-Stats	Av=0.9966		Av=0.9966		Av=0.9966		Av=0.9966		Av=0.9966		Av=0.9966		Av=0.9966	

Table 6 shows that the mean number of regressors is now somewhat smaller than in the benchmark regression, with mostly between 1 and 2 regressors. Therefore, the posterior inclusion probability (PIP) of the individual variables is also somewhat smaller. The shrinkage statistic is much higher than in the benchmark regression. The most important explanatory variables for the respective crisis measure remain, however, almost identical to those in the baseline regressions.

Our results are hardly changed when using the hyper prior instead, which has been proposed by Liang et al. (2008) and puts a prior on the shrinkage factor with the theoretical advantage that despite putting prior assumptions on g, the latter is being updated.

Next, we check whether using the fixed model prior instead of the random one modifies the results (Table 7). The resulting average number of regressors is higher than in the previous results, between 2 and 4, but still somewhat below that of the benchmark regression. Again, our results in terms of the most relevant regressors for the depths and the length of the crisis remain broadly unchanged.

Table 7 Results without network indicators using fixed model prior

	q_crisis Post		q_neggrth Post		cumloss Post		depth_pt Post		depth_avg Post		trendd_pre Post		trendd_tot Post	
	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean
ca_gdp07	0.1	0.1	0.1	0.0	0.1	0.1	0.0	-0.1	0.0	0.1	0.0	-0.1	**0.2**	-0.3 ***
credit07	0.1	-0.3	**0.2**	-0.3 ***	0.1	-0.2 *	0.0	-0.1	0.1	-0.1	**0.1**	-0.2 ***	0.0	0.0
credit07_dcr	**0.4**	-0.4 ***	**0.6**	-0.5 ***	**0.1**	-0.3 ***	0.0	0.0	0.1	0.0	0.1	-0.2	0.0	0.1
dcpi0407	0.1	0.1	0.1	-0.1	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.2
dcredit0407	**0.4**	-0.5 ***	0.1	-0.2	0.1	0.2	**0.1**	0.4	**0.2**	0.6 ***	0.1	0.4	**0.1**	0.4 *
dreer0407	**0.5**	0.5 ***	**0.4**	0.3 ***	**0.3**	0.3 ***	**0.6**	0.4 ***	**0.8**	0.4 ***	**0.4**	0.3 ***	**0.3**	0.3 ***
dreer0407_dcr	0.1	-0.3	0.1	-0.1	**0.1**	0.3	**0.1**	0.3	**0.2**	0.4 ***	**0.1**	0.3 ***	0.1	0.2
dyera_nc0407	0.1	0.2 *	0.1	0.2	0.1	0.0	0.0	0.0	**0.9**	0.5 ***	0.0	0.0	0.0	0.0
dyera_nc0407_dcr	0.1	-0.3	0.1	-0.2	**0.9**	-0.7 ***	**1.0**	-0.8 ***	**1.0**	-1.0 ***	**1.0**	-0.9 ***	**1.0**	-0.8 ***
fdi_net_gdp07	0.1	-0.1	**0.4**	-0.4 ***	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2 *	0.1	-0.2
fiscdef07	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1 *	0.1	-0.1	0.1	-0.1	0.1	-0.1
fxres_gdp07	0.1	0.2	**0.4**	0.4 ***	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0
fxres_gdp07_dcr	0.1	-0.2	0.1	0.0	**0.3**	0.5 ***	**0.2**	0.4 ***	0.1	0.3	**0.3**	0.5 ***	**0.1**	0.3 ***
gdp_cap07	**0.2**	-0.4 ***	0.2	-0.4	0.1	-0.2	0.0	-0.1	0.1	-0.3	0.1	-0.2	0.0	-0.1
gdp_cap07_dcr	0.2	-0.3	0.2	0.3	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.1
nfa_gdp07	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	-0.1
nfa_gdp07_dcr	**0.3**	0.4 ***	0.2	0.3 ***	0.1	0.2	0.0	0.0	0.1	0.2	0.0	0.1	0.0	0.0
Mean no. regressors	3.03		3.30		2.74		2.51		3.80		2.64		2.41	
Shrinkage-Stats	Av=0.859		Av=0.8586		Av=0.8832		Av=0.9453		Av=0.911		Av=0.9453		Av=0.9504	

While we have chosen in the main part of the results to use the full set of possible results, the programming language R© also provides the possibility to reduce the time for running the programs by approximating the results with the help of an MCMC sampler. The default in R© is indeed to use the birth and death sampler from a number of 15 regressors onwards, which is the case in our study. Therefore, we also test in how far the results differ when using this approximation (see Table 8).

Table 8 Results without network indicators using birth depths model sampler

	q_crisis Post		q_neggrth Post		cumloss Post		depth_pt Post		depth_avg Post		trendd_pre Post		trendd_tot Post	
	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean	PIP	Mean
ca_gdp07	0.1	0.1	0.1	0.0	**0.1**	0.2	0.1	-0.1	0.1	0.0	0.1	0.0	**0.4**	-0.3 ***
credit07	**0.2**	-0.2 *	**0.4**	-0.3 ***	0.1	-0.1	0.1	0.0	0.1	0.0	0.2	-0.1	0.1	0.0
credit07_dcr	0.0	-0.1	0.0	-0.4	0.0	-0.4	0.0	-0.1	0.0	-0.2	0.0	-0.3	0.0	0.1
dcpi0407	0.1	0.0	0.1	-0.2	**0.2**	-0.3 ***	0.2	-0.2	0.1	-0.1	**0.2**	-0.3 ***	0.3	-0.3 ***
dcredit0407	**0.9**	-0.6 ***	**0.5**	-0.3 ***	**0.5**	-0.3 *	**1.0**	0.2 ***	**1.0**	0.6 ***	**1.0**	-0.1 ***	**1.0**	0.2 ***
dreer0407	**0.8**	0.5	**0.4**	0.4	**0.3**	0.3	**0.5**	0.3 ***	**0.9**	0.4 ***	**0.5**	0.3 ***	**0.5**	0.3 ***
dreer0407_dcr	0.1	-0.3	0.1	-0.2	0.0	-0.1	0.1	-0.2	0.1	0.0	0.1	-0.1	0.1	-0.2
dyera_nc0407	0.2	0.2	0.1	0.1	**0.2**	-0.1	**0.7**	0.1 ***	**1.0**	0.6 ***	**0.6**	0.0	**0.8**	0.1
dyera_nc0407_dcr	0.0	-0.2	0.0	-0.2	0.1	-0.9 ***	**0.7**	-1.3 ***	**1.0**	-1.4 ***	**0.5**	-1.1 ***	**0.8**	-1.3 ***
fdi_net_gdp07	0.1	-0.1	**0.2**	-0.3 ***	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	0.1	-0.1
fiscdef07	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.2	-0.2	0.1	-0.1	0.2	-0.1	0.2	-0.1
fxres_gdp07	**0.2**	0.2	**0.6**	0.4 ***	0.1	0.1	**0.2**	0.0	**0.2**	0.1	0.2	0.0	0.2	-0.1
fxres_gdp07_dcr	0.0	-0.2	0.0	0.0	0.0	0.4	0.1	0.6 ***	0.1	0.4	0.1	0.6 ***	0.1	0.7 ***
gdp_cap07	**0.2**	-0.3	0.2	-0.2	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.2	-0.2	0.2	-0.1
gdp_cap07_dcr	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.4
nfa_gdp07	0.1	0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.2	-0.1
nfa_gdp07_dcr	0.0	0.2	0.0	0.3	0.0	0.4	0.0	0.3	0.0	0.1	0.0	0.5	0.1	0.4
Mean no. regressors	3.29		3.14		2.26		4.32		5.14		4.28		4.93	
Shrinkage-Stats	Av=0.8308		Av=0.7585		Av=0.5415		Av=0.8739		Av=0.8993		Av=0.8708		Av=0.899	

While again pointing to the same variables being relevant for explaining the depth and the length of the crisis as in the baseline regression, the shrinkage statistics is somewhat lower, pointing to an overall lower ability of the variables to explain the crisis. Hence, we conclude that it is preferable to enumerate all potential variable combinations to obtain posterior results.

6. Concluding remarks

In this paper we have analysed the role of the international trade network for differences in the length and depths of the recent 2008/2009 crisis across 39 countries . Several innovations were introduced. First, we have defined the timing of the crisis individually for each country. Second, we have introduced network indicators based on value added trade from the World Input Output Database (WIOD) to measure interdependencies of countries before the crisis. Third, we have used Bayesian Model Averaging to estimate the effect of the network indicators on seven different crisis measures, controlling also for macroeconomic fundamentals measured before the start of the crisis. We estimate with BMA techniques in how far network indicators measuring interlinkages in terms of value added trade help explaining cross country differences of the length and the depth of the recent crisis once we control for pre-crisis macroeconomic fundamentals. The macroeconomic control variables with the strongest explanatory power for the length and the depth of the crisis are the pre-crisis growth rates of private sector credit and the real effective exchange rate, and the level of foreign reserves. The explanatory power of the equations increases when we introduce interaction terms of credit growth with other indicators, indicating that the combination of credit growth in particular with pre-crisis appreciation, strong GDP growth and low foreign reserves amplifies the losses. Results are somewhat different when the length of the crisis is investigated. The crisis was longer if credit growth was accompanied by large indebtedness or the accumulation of net foreign liabilities. We also find evidence that value added trade linkages have an impact on the severity of the crisis. The connectivity and openness of the country have an impact on the length of the crisis, at the same time the average characteristics of the neighbours also affect the depth of the crisis. We find some evidence for non-linear effects of the network indicators: including squared indicators increases the importance of connectivity and integration for the loss during the crisis.

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Appendix A

Table 9 Crisis measures by countries

country	q_crisis	q_neggrth	depth_pt	depth_avg	cumloss	trendd_pre	trendd_tot
AUS	-1	-1	-0.21	4.14	-0.21	-0.01	-0.01
AUT	-12	-5	-5.13	-0.52	-14.43	-0.11	-0.08
BEL	-10	-3	-4.33	-1.13	-7.39	-0.08	-0.07
BGR	-20	-2	-6.24	0.59	-12.47	-0.12	-0.09
BRA	-4	-2	-5.45	2.77	-9.08	-0.09	-0.10
CAN	-8	-3	-3.96	-1.63	-8.34	-0.08	-0.06
CHN	-2	-1	-1.22	15.06	-1.22	-0.05	-0.05
CYP	-8	-4	-2.98	1.34	-9.06	-0.09	-0.05
CZE	-21	-3	-5.59	-0.24	-12.51	-0.11	-0.09
DEU	-11	-4	-6.80	-2.57	-10.81	-0.11	-0.10
DNK	-22	-4	-7.97	-5.88	-20.29	-0.13	-0.10
ESP	-23	-7	-4.96	-0.82	-20.65	-0.15	-0.06
EST	-25	-5	-19.80	-11.25	-55.87	-0.27	-0.16
FIN	-24	-6	-10.40	-4.37	-25.65	-0.21	-0.15
FRA	-11	-5	-3.98	-1.26	-11.49	-0.09	-0.06
GBR	-23	-6	-7.19	-3.85	-28.82	-0.16	-0.10
GRC	-11	-4	-3.49	-0.40	-9.11	-0.10	-0.04
HUN	-22	-5	-8.29	-6.35	-27.35	-0.17	-0.10
IDN	-1	-1	0.00	8.81	0.00	-0.01	-0.02
IND	-1	-1	-1.30	9.22	-1.30	-0.04	-0.04
IRL	-24	-8	-11.51	-5.47	-55.06	-0.33	-0.14
ITA	-23	-5	-7.22	-5.65	-20.11	-0.12	-0.08
JPN	-23	-4	-9.24	-6.73	-18.30	-0.14	-0.13
KOR	-3	-2	-2.68	2.64	-5.31	-0.07	-0.06
LTU	-22	-4	-15.59	-8.27	-32.98	-0.31	-0.22
LUX	-23	-4	-9.31	-2.84	-21.36	-0.19	-0.14
LVA	-23	-6	-24.08	-16.98	-75.79	-0.51	-0.33
MEX	-10	-4	-7.76	-3.16	-19.24	-0.14	-0.13
MLT	-7	-2	-5.61	0.28	-7.74	-0.09	-0.09
NLD	-23	-5	-4.98	-0.04	-10.97	-0.11	-0.08
POL	-2	-1	-0.41	7.14	-0.41	-0.02	-0.02
PRT	-24	-5	-4.16	-1.53	-6.95	-0.09	-0.06
ROM	-21	-3	-8.20	0.85	-17.62	-0.17	-0.12
RUS	-13	-4	-10.85	-0.36	-27.70	-0.23	-0.18
SVK	-9	-1	-8.47	-0.28	-8.47	-0.13	-0.13
SVN	-22	-4	-9.63	-2.32	-22.86	-0.19	-0.14
SWE	-11	-5	-7.60	-2.61	-16.92	-0.16	-0.12
TUR	-10	-4	-14.98	-6.35	-35.74	-0.27	-0.25
TWN	-7	-2	-6.20	6.43	-11.80	-0.11	-0.11
USA	-11	-4	-4.19	-2.43	-11.44	-0.09	-0.06

Table 10 Control variables by countries

country	gdp_cap07	fxres_gdp07	nfa_gdp07	ca_gdp07	debtgvt07	fiscdef07	fdi_net_gdp07	dyera_nc0407	credit07	dcredit0407	dreer0407	dcpi0407	gvc_part07
AUS	52.44	2.62	-59.53	-6.25	9.70	1.43	-4.93	10.70	120.67	17.32	14.80	8.83	0.51
AUT	43.41	2.85	-21.55	3.51	60.20	-1.32	-3.52	10.09	115.44	8.93	-0.72	6.03	0.59
BEL	41.08	2.26	29.72	1.53	84.00	0.05	-35.52	7.48	90.89	27.67	6.36	6.54	0.66
BGR	4.77	39.07	-89.13	-27.12	18.60	1.12	-87.84	20.59	62.78	77.34	10.48	22.18	0.66
BRA	2.67	13.13	-36.43	0.11	65.20	-2.80	-12.28	13.77	47.85	65.29	46.79	15.38	0.44
CAN	44.20	2.81	-11.81	0.78	66.50	1.38	-5.60	7.99	124.46	-24.86	12.38	6.48	0.42
CHN	1.05	43.79	24.43	10.11	19.60	0.06	-16.82	43.18	107.49	-10.49	5.29	11.44	0.45
CYP	19.16	28.11	14.41	-8.41	58.80	3.20	-37.41	13.66	250.12	20.30	1.05	7.61	0.50
CZE	15.67	19.14	-43.66	-4.40	27.90	-0.69	-57.54	20.80	46.28	47.67	10.97	7.48	0.68
DEU	39.00	1.33	25.70	7.47	65.20	0.31	8.96	7.82	105.25	-6.80	-3.11	5.52	0.52
DNK	54.51	10.45	-6.78	1.42	27.10	5.02	7.51	7.60	202.50	28.04	2.80	5.53	0.58
ESP	30.00	0.80	-84.44	-10.01	36.30	2.00	-0.26	11.56	187.89	50.48	3.83	10.01	0.54
EST	13.79	14.82	-77.48	-15.91	3.70	2.40	-48.05	28.73	91.33	50.26	4.69	15.85	0.63
FIN	44.77	2.87	-30.51	5.39	35.20	5.13	10.07	13.19	81.52	20.59	3.75	5.00	0.61
FRA	39.61	1.77	-4.30	-1.03	64.20	-2.54	21.17	6.72	105.58	16.52	-0.94	4.99	0.51
GBR	44.54	1.73	-23.06	-2.51	43.70	-2.97	20.27	9.71	184.29	23.25	0.94	6.85	0.50
GRC	26.08	0.21	-104.21	-14.58	107.20	-6.72	-7.05	11.73	93.91	32.67	7.57	9.95	0.53
HUN	12.56	17.61	-97.47	-7.32	67.00	-5.08	-46.06	8.13	62.57	36.20	3.98	16.08	0.68
IDN	0.93	12.72	-46.19	2.43	35.10	-1.03	-14.98	18.58	25.46	-3.55	32.38	32.93	0.43
IND	0.89	23.01	-27.76	-0.70	74.00	-4.41	-5.32	31.11	44.82	26.01	7.22	17.71	0.49
IRL	57.53	0.30	-21.08	-5.35	24.90	0.23	-20.73	17.48	199.17	49.17	0.91	11.67	0.57
ITA	34.34	1.33	-29.43	-2.42	103.30	-1.53	1.94	4.89	100.57	18.55	0.70	6.01	0.49
JPN	34.95	21.87	50.05	4.86	183.00	-2.09	9.41	5.28	181.33	1.03	-17.16	0.02	0.46
KOR	21.64	24.98	-21.88	2.07	30.70	2.17	-4.50	14.92	134.88	22.87	12.26	7.72	0.59
LTU	10.65	19.22	-60.15	-14.48	16.80	-1.00	-34.31	27.59	59.99	108.65	9.33	12.59	0.55
LUX	97.33	0.28	102.47	10.15	6.70	4.21	-66.83	17.72	184.77	74.03	6.62	7.64	0.75
LVA	9.97	19.38	-80.05	-22.42	7.80	-0.61	-34.61	34.40	88.67	74.62	17.05	25.23	0.57
MEX	9.74	8.42	-35.16	-1.38	37.60	-1.15	-19.92	11.59	21.59	43.89	9.63	12.05	0.48
MLT	17.19	49.21	20.54	-4.11	60.70	-2.27	-90.78	10.58	117.26	10.50	0.65	7.22	0.65
NLD	45.91	1.31	-8.60	6.70	45.30	0.18	22.39	9.65	188.06	19.15	6.51	4.53	0.60
POL	9.94	14.80	-57.40	-6.23	45.00	-1.90	-36.93	17.54	39.44	40.13	16.16	5.70	0.59
PRT	20.77	0.54	-99.90	-10.13	68.40	-3.01	-20.51	4.65	162.50	19.54	-0.50	8.11	0.53
ROM	5.69	21.80	-47.83	-13.53	12.70	-2.90	-36.12	19.45	34.79	122.87	47.89	21.83	0.55
RUS	10.67	35.91	-12.44	5.49	8.50	6.75	-9.30	24.88	38.74	59.33	28.35	34.72	0.62
SVK	11.66	24.00	-63.60	-5.46	29.40	-1.92	-54.34	27.68	42.42	39.42	9.02	10.28	0.71
SVN	22.04	2.07	-25.84	-4.85	23.10	-0.07	-13.38	17.75	78.78	64.48	-0.37	8.78	0.64
SWE	48.03	5.83	-2.44	10.07	40.20	3.34	8.14	11.16	121.47	19.88	1.77	4.05	0.57
TUR	1.12	11.31	-48.49	-5.82	39.90	-1.52	-22.02	21.28	29.50	70.71	9.37	31.26	0.49
TWN	0.00	68.76	131.70	8.94	0.00	-0.03	26.08	17.00			-3.19		0.44
USA	48.97	0.42	-14.35	-5.06	64.00	-3.55	8.61	8.01	206.26	12.16	-6.31	9.78	

Table 11 Correlation matrix

	kin	kout	ktot	sin	sout	stot	anndoutout	anndoutin	anndinin	anndinout	annsoutout	annsoutin	annsinin	annsinout	cc_in	cc_out	cc_cycle	cc_middle
kin	1.00																	
kout	0.67	1.00																
ktot	0.92	0.91	1.00															
sin	0.87	0.62	0.82	1.00														
sout	0.42	0.86	0.69	0.57	1.00													
stot	0.75	0.82	0.86	0.91	0.86	1.00												
anndoutout	0.59	0.58	0.64	0.49	0.41	0.51	1.00											
anndoutin	0.87	0.67	0.85	0.77	0.46	0.71	0.82	1.00										
anndinin	0.90	0.66	0.86	0.79	0.39	0.69	0.74	0.90	1.00									
anndinout	0.79	0.58	0.75	0.66	0.32	0.57	0.80	0.84	0.93	1.00								
annsoutout	0.33	0.46	0.43	0.28	0.41	0.38	0.79	0.53	0.42	0.52	1.00							
annsoutin	0.81	0.70	0.83	0.74	0.53	0.73	0.80	0.92	0.81	0.78	0.75	1.00						
annsinin	0.91	0.63	0.85	0.80	0.40	0.70	0.69	0.87	0.95	0.90	0.51	0.87	1.00					
annsinout	0.71	0.50	0.67	0.62	0.33	0.56	0.68	0.73	0.80	0.86	0.65	0.81	0.91	1.00				
cc_in	-0.36	-0.65	-0.54	-0.46	-0.62	-0.60	-0.09	-0.22	-0.26	-0.17	-0.22	-0.38	-0.29	-0.20	1.00			
cc_out	0.31	0.19	0.28	0.17	-0.02	0.09	0.33	0.31	0.37	0.34	0.28	0.35	0.35	0.25	-0.13	1.00		
cc_cycle	-0.31	-0.01	-0.18	-0.15	0.28	0.05	-0.27	-0.37	-0.31	-0.38	-0.04	-0.27	-0.25	-0.20	-0.03	-0.19	1.00	
cc_middle	-0.16	-0.12	-0.15	-0.32	-0.15	-0.28	0.14	-0.05	0.01	0.07	0.09	-0.12	-0.04	0.02	0.46	0.42	0.21	1.00

Beware that the weighted network indicators are scaled by the involved countries' GDP, not by total world trade. This results in a correlation structure different from the one reported by the network literature.

Table 12 Results for control variables with interaction terms - full

	q_crisis		q_neggrth		cumloss		depth_pt		depth_avg		trendd_pre		trendd_tot	
	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean	PIP	Post Mean
ca_gdp07	0.10	0.04	0.13	-0.07	0.09	0.11	0.05	-0.09	0.12	0.14	0.05	-0.07	**0.20**	**-0.31**
credit07	0.13	-0.20	**0.23**	-0.26	0.14	-0.20	0.05	-0.07	0.12	-0.12	**0.11**	**-0.20**	0.04	-0.04
credit07_dcr	**0.42**	**-0.41**	**0.57**	**-0.51**	**0.15**	-0.29	0.04	0.06	0.12	-0.04	0.06	-0.14	0.06	0.14
dcpi0407	0.09	0.04	0.17	-0.22	**0.15**	**-0.27**	0.07	-0.18	0.14	-0.17	0.10	-0.22	**0.12**	**-0.27**
dcredit0407	**0.28**	**-0.50**	0.13	-0.17	0.07	0.17	0.06	0.38	0.14	-0.05	0.05	0.31	0.05	0.34
debtgvt07	0.10	-0.13	0.10	-0.07	0.07	0.03	0.04	-0.06	0.19	**-0.24**	0.04	-0.01	0.05	-0.10
debtgvt07_fiscdef	0.08	-0.06	0.10	-0.07	0.07	-0.06	0.05	-0.06	0.11	0.01	0.06	-0.10	0.06	-0.13
dreer0407	**0.56**	**0.48**	**0.50**	**0.41**	**0.29**	**0.32**	**0.56**	**0.37**	**0.71**	**0.46**	**0.40**	**0.33**	**0.32**	**0.34**
dreer0407_dcr	0.18	0.37	0.17	0.23	0.14	-0.19	**0.11**	-0.20	0.14	0.02	**0.12**	-0.21	0.09	-0.16
dyera_nc0407	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**
dyera_nc0407_dcr	0.14	-0.26	0.13	-0.14	**0.87**	**-0.71**	**1.00**	**-0.82**	**0.77**	**-0.62**	**0.99**	**-0.85**	**1.00**	**-0.81**
fdi_net_gdp07	0.09	-0.07	**0.38**	**-0.34**	0.09	-0.13	0.05	-0.11	0.13	-0.11	0.09	-0.16	0.07	-0.14
fiscdef07	0.10	-0.13	0.12	-0.12	0.10	-0.14	**0.09**	-0.17	0.13	-0.15	0.09	-0.16	0.08	-0.15
fxres_gdp07	0.16	0.20	**0.48**	**0.37**	0.10	0.11	0.05	0.08	**0.31**	**0.27**	0.07	0.09	0.04	0.02
fxres_gdp07_dcr	0.11	0.19	0.12	-0.03	**0.31**	**-0.48**	**0.16**	**-0.39**	0.12	0.01	**0.31**	**-0.46**	**0.12**	**-0.34**
gdp_cap07	0.20	**-0.35**	0.18	-0.31	0.11	-0.21	0.05	-0.12	**0.30**	**-0.42**	0.09	-0.20	0.05	-0.11
gdp_cap07_dcr	**0.21**	-0.34	0.22	0.31	0.09	0.04	0.05	0.11	0.18	0.30	0.05	0.05	0.06	0.17
infl_targ07	0.09	-0.09	0.16	-0.18	0.07	-0.07	0.05	-0.09	**0.31**	**-0.26**	0.05	-0.06	0.06	-0.10
nfa_gdp07	0.13	0.18	0.13	0.10	0.07	0.04	0.04	-0.02	0.11	0.07	0.04	-0.02	0.07	-0.14
nfa_gdp07_dcr	**0.26**	**-0.43**	0.23	-0.33	0.12	-0.27	0.04	-0.07	0.15	-0.26	0.06	-0.17	0.05	-0.07
Mean no. regressors	3.50		4.35		3.15		2.66		4.39		2.87		2.62	
Shrinkage-Stats	Av=0.819		Av=0.826		Av=0.857		Av=0.942		Av=0.797		Av=0.942		Av=0.949	

Table 13 Estimation results with network indicators, with RoW

	q_crisis		q_neggrth		cumloss		depth_avg		depth_pt		trendd_pre		trendd_tot	
	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king
kin07	**-0.27**	**5**	-0.21	8	-0.16	11	-0.12	13	-0.10	12	-0.10	15	0.02	18
kout07	**-0.27**	**3**	-0.15	13	-0.16	10	-0.12	12	-0.15	7	-0.14	11	-0.07	16
ktot07	**-0.29**	**3**	-0.19	8	-0.17	10	-0.13	11	-0.14	8	-0.14	11	-0.04	18
sin_07	-0.27	9	**-0.37**	**5**	-0.17	15	-0.09	15	-0.06	15	-0.13	14	0.06	15
sout_07	**-0.30**	**5**	-0.17	14	-0.16	15	-0.08	16	-0.10	12	-0.14	14	-0.05	17
stot_07	**-0.31**	**5**	-0.27	8	-0.18	14	-0.09	15	-0.10	12	-0.19	11	-0.02	18
cc_out07	**0.23**	**5**	0.16	12	**0.21**	**5**	0.17	7	0.16	7	**0.21**	**4**	0.10	14
cc_in07	-0.14	13	-0.16	10	**-0.40**	**1**	**-0.33**	**4**	**-0.28**	**3**	**-0.21**	**4**	**-0.18**	**6**
cc_cycle07	-0.01	18	-0.08	18	-0.09	16	0.02	18	0.01	18	-0.09	15	-0.01	18
cc_middle07	-0.01	18	-0.07	18	-0.06	18	-0.13	7	-0.09	11	-0.06	15	-0.10	14
anndoutout07	**-0.19**	8	-0.08	18	-0.21	8	-0.17	7	**-0.19**	7	-0.10	15	-0.12	13
anndoutin07	-0.21	8	-0.19	9	-0.11	15	-0.13	13	-0.13	9	-0.08	15	-0.09	16
anndinout07	**-0.22**	7	-0.14	14	-0.23	7	**-0.20**	**6**	**-0.21**	8	-0.13	14	-0.11	15
anndinin07	**-0.31**	**3**	-0.18	10	-0.21	8	-0.20	7	-0.21	7	-0.14	14	-0.07	17
annsoutout07	**-0.19**	7	-0.09	18	**-0.27**	**5**	**-0.20**	**6**	**-0.21**	**4**	-0.15	11	-0.14	9
annsoutin07	**-0.25**	**5**	-0.20	8	-0.22	**6**	-0.20	**6**	-0.20	7	-0.14	11	-0.13	13
annsinout07	**-0.28**	**3**	**-0.21**	8	**-0.25**	**5**	**-0.20**	**6**	-0.17	8	-0.16	11	-0.10	15
annsinin07	**-0.39**	**1**	**-0.28**	**5**	**-0.27**	**5**	**-0.22**	**6**	**-0.21**	7	-0.17	11	-0.07	17
Avg of avg shrinkage stats	0.837		0.838		0.861		0.894		0.894		0.894		0.945	
Max of avg shrinkage stats	0.858		0.844		0.888		0.919		0.919		0.919		0.945	
Avg shrink. w/o network ind.	0.837		0.840		0.862		0.939		0.896		0.938		0.944	

Table 14 Estimation results with network indicators, 1% threshold, w.o. RoW

	q_crisis		q_neggrth		cumloss		depth_avg		depth_pt		trendd_pre		trendd_tot	
	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king
kin07	-0.30	5	-0.37	5	-0.27	5	-0.21	7	-0.15	8	-0.19	11	0.00	17
kout07	-0.26	4	-0.11	17	0.00	18	-0.02	18	-0.05	17	-0.04	17	0.00	18
ktot07	-0.33	3	-0.26	5	-0.13	15	-0.12	13	-0.11	11	-0.12	14	0.01	18
sin_07	-0.35	6	-0.60	2	-0.39	5	-0.18	12	-0.13	11	-0.35	6	-0.02	16
sout_07	-0.24	6	-0.15	14	-0.07	18	-0.04	18	-0.05	17	-0.08	15	-0.02	18
stot_07	-0.34	4	-0.39	5	-0.21	12	-0.10	14	-0.10	12	-0.23	8	-0.02	18
cc_out07	-0.10	15	-0.04	18	-0.04	18	0.05	18	-0.01	18	-0.02	18	-0.02	18
cc_in07	-0.13	13	-0.25	4	-0.19	6	-0.12	11	-0.21	4	-0.25	4	-0.34	2
cc_cycle07	-0.23	5	-0.08	18	0.06	18	0.06	18	0.02	18	0.01	18	0.01	18
cc_middle07	-0.23	4	-0.13	14	-0.04	18	-0.10	13	-0.06	17	-0.09	15	-0.10	14
anndoutout07	-0.28	2	-0.18	8	-0.16	10	-0.11	13	-0.18	5	-0.14	11	-0.13	11
anndoutin07	-0.30	2	-0.23	5	-0.15	11	-0.10	13	-0.15	7	-0.12	14	-0.09	15
anndinout07	-0.24	5	-0.22	7	-0.14	12	-0.10	13	-0.09	12	-0.12	14	-0.02	18
anndinin07	-0.36	2	-0.24	5	-0.13	15	-0.12	13	-0.08	12	-0.09	15	0.04	17
annsoutout07	-0.22	5	-0.09	18	-0.09	16	-0.07	17	-0.13	8	-0.09	14	-0.11	12
annsoutin07	-0.32	2	-0.22	7	-0.17	11	-0.14	8	-0.19	5	-0.13	12	-0.09	15
annsinout07	-0.15	13	-0.07	18	-0.05	18	-0.05	17	-0.01	17	-0.04	16	0.04	17
annsinin07	-0.34	3	-0.20	8	-0.13	15	-0.16	10	-0.09	12	-0.09	15	0.05	16
Avg of avg shrinkage stats	0.839		0.842		0.860		0.893		0.939		0.938		0.945	
Max of avg shrinkage stats	0.850		0.876		0.861		0.894		0.939		0.938		0.952	
Avg shrink. w/o network ind.	0.837		0.840		0.862		0.939		0.896		0.938		0.944	

Table 15 Estimation results with network indicators, 1% threshold, with RoW

	q_crisis		q_neggrth		cumloss		depth_avg		depth_pt		trendd_pre		trendd_tot	
	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king
kin07	-0.30	5	-0.37	5	-0.27	5	-0.21	7	-0.15	8	-0.19	11	0.00	17
kout07	-0.26	4	-0.11	17	0.00	18	-0.02	18	-0.05	17	-0.04	17	0.00	18
ktot07	-0.33	3	-0.26	5	-0.13	15	-0.12	13	-0.11	11	-0.12	14	0.01	18
sin_07	-0.27	11	-0.42	5	-0.22	12	-0.11	15	-0.07	15	-0.18	12	0.05	15
sout_07	-0.31	6	-0.15	14	-0.09	18	-0.05	18	-0.07	17	-0.11	15	-0.03	18
stot_07	-0.33	5	-0.28	8	-0.16	15	-0.08	17	-0.08	15	-0.19	11	0.00	18
cc_out07	0.03	18	-0.03	18	-0.02	18	0.00	18	-0.02	17	0.00	17	-0.05	17
cc_in07	-0.14	13	-0.25	4	-0.19	6	-0.13	11	-0.22	4	-0.25	3	-0.35	2
cc_cycle07	0.04	18	0.16	8	0.19	5	0.24	4	0.22	3	0.22	4	0.23	4
cc_middle07	-0.09	15	0.00	18	0.06	18	0.00	18	0.06	17	0.02	18	0.00	18
anndoutout07	-0.22	5	-0.15	9	-0.19	6	-0.22	5	-0.27	3	-0.16	7	-0.19	4
anndoutin07	-0.27	3	-0.24	5	-0.18	9	-0.23	6	-0.22	4	-0.12	14	-0.11	14
anndinout07	-0.33	2	-0.24	5	-0.26	4	-0.24	6	-0.23	4	-0.19	7	-0.12	14
anndinin07	-0.43	1	-0.22	8	-0.18	11	-0.24	6	-0.17	8	-0.12	14	-0.02	17
annsoutout07	-0.13	13	0.00	18	-0.11	15	-0.16	7	-0.22	4	-0.10	14	-0.18	6
annsoutin07	-0.11	15	-0.08	18	-0.16	11	-0.23	5	-0.21	4	-0.09	15	-0.11	14
annsinout07	-0.19	9	-0.07	18	-0.13	14	-0.16	7	-0.12	8	-0.10	14	-0.04	18
annsinin07	-0.31	3	-0.09	18	-0.15	13	-0.25	6	-0.17	8	-0.09	15	-0.02	17
Avg of avg shrinkage stats	0.837		0.839		0.860		0.894		0.938		0.938		0.945	
Max of avg shrinkage stats	0.863		0.850		0.861		0.899		0.939		0.938		0.954	
Avg shrink. w/o network ind.	0.837		0.840		0.862		0.939		0.896		0.938		0.944	

Table 16 Estimation results with network indicators calculated on gross export data, 0.5% threshold, w.o. RoW

	q_crisis		q_neggrth		cumloss		depth_avg		depth_pt		trendd_pre		trendd_tot	
	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king	Post Mean	ran-king
kin07	-0.25	5	-0.20	8	-0.12	15	-0.06	17	-0.05	17	-0.09	15	0.03	18
kout07	-0.23	5	-0.14	13	-0.14	11	-0.08	14	-0.11	8	-0.12	11	-0.05	18
ktot07	-0.25	4	-0.17	10	-0.14	13	-0.08	15	-0.09	12	-0.12	14	-0.02	18
sin_07	-0.64	2	-0.46	5	-0.16	15	-0.12	14	-0.08	15	-0.19	14	-0.02	16
sout_07	-0.22	7	-0.14	14	-0.11	16	-0.08	14	-0.08	15	-0.10	15	-0.03	18
stot_07	-0.37	5	-0.26	8	-0.14	16	-0.10	14	-0.08	15	-0.14	14	-0.03	18
cc_out07	0.08	17	0.14	12	0.16	10	0.11	12	0.10	8	0.18	4	0.11	12
cc_in07	-0.39	1	-0.06	18	-0.17	12	-0.21	7	-0.12	11	-0.12	14	-0.12	15
cc_cycle07	-0.17	12	0.14	13	0.21	5	0.16	7	0.17	6	0.18	5	0.18	6
cc_middle07	-0.19	9	0.14	14	0.03	18	-0.05	17	-0.04	17	0.05	16	0.00	18
anndoutout07	-0.27	3	-0.13	14	-0.09	16	-0.05	18	-0.08	14	-0.04	18	-0.01	18
anndoutin07	-0.30	2	-0.24	5	-0.11	15	-0.05	17	-0.08	14	-0.07	15	-0.03	18
anndinout07	-0.27	4	-0.20	8	-0.10	16	-0.05	18	-0.06	17	-0.06	18	0.02	18
anndinin07	-0.32	2	-0.20	8	-0.09	16	-0.03	18	-0.03	17	-0.05	17	0.06	17
annsoutout07	-0.19	8	-0.04	18	-0.03	18	0.05	17	0.04	17	0.03	18	0.10	14
annsoutin07	-0.23	5	-0.10	18	-0.06	18	0.01	18	0.00	17	0.00	18	0.05	18
annsinout07	-0.26	4	-0.16	10	-0.04	18	0.01	18	0.03	17	0.00	18	0.09	15
annsinin07	-0.30	3	-0.21	8	-0.06	18	0.00	18	0.00	17	-0.03	18	0.08	15
Avg of avg shrinkage stats	0.838		0.837		0.859		0.894		0.939		0.938		0.945	
Max of avg shrinkage stats	0.851		0.843		0.860		0.894		0.939		0.938		0.945	
Avg shrink. w/o network ind.	0.837		0.840		0.862		0.939		0.896		0.938		0.944	

Appendix B

Calculation of indicators.

A is the adjacency matrix, where $a_{i,j} = 1$ if country i export to country j, otherwise 0

W is the weight matrix, where $w_{i,j}$ denotes the value if country i's export to country j

N: number of countries

$kin_i = \left(\sum_{j=1}^{N} a_{j.\mathrm{i}}\right)/(N-1)$ $\quad$ $kout_i = \left(\sum_{j=1}^{N} a_{i.\mathrm{j}}\right)/(N-1)$

$sin_i = \left(\sum_{j=1}^{N} w_{j.\mathrm{i}}\right)/\mathrm{GDP}_i$ $\quad$ $sout_i = \left(\sum_{j=1}^{N} w_{i.\mathrm{j}}\right)/\mathrm{GDP}_i$

$anndoutout_i = \left(\frac{\sum_{j=1}^{N} a_{i.\mathrm{j}} * \mathrm{kout}_j}{\mathrm{kout}_i}\right)/(N-1)$ $\quad$ $anndoutin_i = \left(\frac{\sum_{j=1}^{N} a_{i.\mathrm{j}} * \mathrm{kin}_j}{\mathrm{kout}_i}\right)/(N-1)$

$anndinin_i = \left(\frac{\sum_{j=1}^{N} a_{i.\mathrm{j}} * \mathrm{kin}_j}{\mathrm{kin}_i}\right)/(N-1)$ $\quad$ $anndinout_i = \left(\frac{\sum_{j=1}^{N} a_{i.\mathrm{j}} * \mathrm{kout}_j}{\mathrm{kin}_i}\right)/(N-1)$

$annsoutout_i = \left(\sum_{j=1}^{N} a_{i.\mathrm{j}} * \mathrm{sout}_j\right)/\mathrm{dout}_i$ $\quad$ $annsoutin_i = \left(\sum_{j=1}^{N} a_{i.\mathrm{j}} * \mathrm{sin}_j\right)/\mathrm{dout}_i$

$annsinin_i = \left(\sum_{j=1}^{N} a_{j.\mathrm{i}} * \mathrm{sin}_j\right)/\mathrm{din}_i$ $\quad$ $annsinout_i = \left(\sum_{j=1}^{N} a_{j.\mathrm{i}} * \mathrm{sout}_j\right)/\mathrm{din}_i$

$cc\_in_i = (A^T AA)_{ii}/(\mathrm{din}_i * (\mathrm{din}_i - 1))$ $\quad$ $cc\_out_i = (AAA^T)_{ii}/(\mathrm{dout}_i * (\mathrm{dout}_i - 1))$

$cc\_mid_i = (AA^T A)_{ii}/(\mathrm{din}_i * \mathrm{dout}_i - d_i))$ $\quad$ $cc\_cycle_i = (AAA)_{ii}/(\mathrm{din}_i * \mathrm{dout}_i - d_i))$

Where din and dout stand for the unscaled kin and kout respectively; and $d_i = A_{ii}^2$.

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