Macroeconomic Shocks in the European Union: A case study on the German Banking System

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ABSTRACT

The Economic and Financial crisis of 2007/2008 led to a wide spread domino effect that destabilized the banking systems in the European Union countries. This case study documents the transmission and the influence of macroeconomic shocks on the stability of the EU banking systems and especially the German banking system. We use banking indices in order to identify various shocks and the periods in which they were incurred. Moreover we decompose our sample into two sub-samples, the "poor south" countries and the "rich north" countries. So in this case study, as mentioned, we focus on the German banking index and apply the difference-in-difference approach. What would be for example the reaction of this banking index during the entry period of Greece in the European Stability Mechanism (ESM) and the International Monetary Fund (IMF) and with what results? With the aforementioned difference-in-difference approach we try to identify the consequences, the transmission probability and the transmission channels of shocks in the German banking index.

1. Introduction

The recent financial crisis of 2007 led the banks of the European Union into a period of distress and results similar to the Great depression of the 1930s. This period of distress affected banks not only on their balance sheet results, their credit supply and their income, but also on their stock price returns. Stock markets and stock markets indices represent the value and the health of a company or the entire sector. Moreover stocks are quite sensitive to various shocks and information from the market [28, Savor, G.P., 2012]. So with the use of stock performance and stock returns we can measure the effect that causes a shock on banks stock index.

In this paper we examine the behaviour of a specific panel econometrics method – the differences-in-differences approach (hereafter called *diff-in-diff*) which was developed by Rajan, R.G. and Zingalaes, L. [27] (1998). We apply the *diff-in-diff* approach in a banking performance and sustainability context via using stock market returns for the first time; where in this instance the latter works as a proxy of the overall performance and returns of the banking sector in specific countries. This method has been applied recently in labour economics, econometric modelling, developmental and growth economics, banking performance in terms of balance sheet results, in agricultural economics in terms of productivity and more broadly in social sciences [29, Shadish et al. (2002)].

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Furthermore, in the specific context under investigation, we examine the performance of the method for different frequencies of the time series element of the panel data (annually, quarterly and monthly) and for two different types of the treatment effect: permanent and transient. The results of this effort are satisfactory and provide new evidence on using the *diff-in-diff* in stock prices with different frequencies and through introducing transient treatment effects.

The remaining of the paper is structured as follows. Section two covers the relevant literature. Section three describes the *diff-in-diff* method. Section four provides information in the sources for our data while section five presents the empirical analysis and a short discussion of the results. The paper ends with wrapping up the conclusions and highlighting avenues for future research.

2. Background Literature

The literature on the financial and banking crises is rich. Many researchers studied the effects of macroeconomic shocks on the economy and on the operations of banking systems. For example after the Lehman Brothers collapse on September 2008, Laeven and Valencia (2011) [21] studied the effect of policy shocks (e.g. government intervention) on banks income and moreover the effects of such shocks on the banking sector and on the real economy. Cornett, M. et al. (2011) [12] study the way that banks managed the liquidity shock that occurred after the 2007 financial crisis. They show that banks with more cash and deposits managed the shock better and continued lending without problem. In a similar manner to the previous, Kashyap, Rajan and Stein (2002) [19] investigate in their paper the effect that a monetary policy shock could have on banks' lending.

In their study of banking globalization and international propagation of shocks in 2007 and 2009, Cetorelli, N. and Goldberg, L. (2011) [11] provide in their results evidence that banks with global operations are less affected by a possible shock then banks with non-global operations. Also they show that the internal capital market of global banks could be a possible channel of shocks propagation to their affiliates between countries. Canova, F. and Pappa, Evi (2007) [9] investigate the effects and the impact of a possible fiscal shock on the fiscal policy. Calomiris and Mason (2003) [8] study the US Great Depression and the real effects this crisis had on banks.

The existing literature on stock prices analyses the impact that information, credit, liquidity, lending and other exogenous shocks could have on stock returns. Pritamani and Signal (2001) [26] investigate stocks that have been affected by large prices movements in the years of 1990 to 1992; they obtained their data from NYSE and Amex. Jayanti and Whyte (1996) [17] study stocks from various British and Canadian banks in order to analyse the effects of a possible failure in other banking systems on their stock value. Moreover they show that banks that have big debt are more affected by a possible exogenous shock. Madura and McDaniel (1991) [23] studied the effects of the announcements of bank loan losses on the stock prices of 13 British banks. They find that British banks with activities in the US banking system are more negative affected than banks with less activities in the US banking system. Karafiath, Mynatt and Smith (1991) [18] investigate the effects of the Brazilian debt moratorium (1987) on 46 US Bank stocks. In the same manner as the previous studies Bremer and Sweeney (1991) [5], Park (1995) [25], Brown, Harlow and Tinic (1988) [6] and Atkins and Dyl (1990) [2] investigate in their papers the effect of exogenous shocks on stock returns. Savor, P. (2012) [28] analyses the effect of the information on stock returns. He shows that if an investor receives information about a company then he underreacts to this; if he receives information that is caused by a shock than he overreacts.

In the banking crisis literature the *diff-in-diff* method is used as an identification strategy. The first effort of the method was made by Obenauer and von der Nienburg in 1915 [24] in order to study employment effects in minimum wage in Oregon. Card, D. and Krueger, A.B. (1994) [10] also used this approach in Labour economics in order to find if a change in New Jerseys minimum wage at fast food restaurants affected or changed the employment rates in fast food restaurants in Pennsylvania and respectively in New Jersey. In their results they show that the employment is not going to be affected by a possible rise in the minimum wage.

The actual model was developed by Rajan, R.G. and Zingales, L. (1998) [27]. They investigate whether or not industrial growth was affected by financial sector development. Duygan-Bump et al. (2012) [14] study the impact of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) on the

Net Flows into the Money Market Mutual Funds (ABCP). In their results they show that the evaluation of AMLF affected effectively the Money Market Mutual Funds (ABCP) and also the ABCP yield. Beck, T. (2003) [3] compares in his study the market-based system with bank-based financial system and analyse the impact that capital markets and banks have on the economic development. Dell' Ariccia et al. (2008) [13] investigates industrial sector growth is going to be affected by a possible financial shock and Levintal, O. (2013) [22] studies if an income shock on banks' balance sheet has effects on the real economy. Brunnermeier, M. et al. (2012) [7] uses the *diff-in-diff* method in order to examine the relationship of non-interest banking income pre-crisis with the stock returns of a bank during the crisis.

We employ the *diff-in-diff* method in order to test whether the financial crisis of 2007/2008 had real effects on banks and especially on their stock prices returns. Furthermore we test if this method could be applied in stock indices in order to analyse the influence of the crisis. To the best in our knowledge this is the first time that this econometric method is going to be tested on stock prices returns and also to be applied on different contexts.

3. Method

In this paper we apply the *diff-in-diff* method proposed by Rajan, R.G. and Zingales, L. (1998) [27] in order to study the influence of an exogenous shock from the financial crisis of 2007/2008 on stock price indices returns. From the literature we know that this method was applied after a policy intervention or a shock which remained durable after the period the intervention occurred. The most difficult part in our study was to capture this intervention in stock indices, because stocks and indices are characterized from transient effects. So we decide to test our method for two different types of effects, the permanent or durable and the transient effects. The *diff-in-diff* method investigates the reaction of stock returns between the banking indices and the general stock price indices. We try to provide evidence that this method could be used on stock prices and that the results that the method gives us are satisfactory and significant. The basic model that we estimate for our sample of countries has the following form:

$$rPI_{sct} = a + \beta_1 banksindx\_dummy_{sc} * crisis\_dummy_t + \varepsilon_{sct}, \quad (1)$$

where rPI_{sct} are the (log-differences) stock indices returns of sector s in country c and at time t and a is a constant, $banksindx\_dummy_{sc}$ is a dummy variable that equals to one if the sector is banks and zero otherwise, $crisis\_dummy_t$ is a dummy variable that equals to one for the years 2008 to 2012 and zero otherwise and ε_{sct} is a stochastic error term. Because we are going use more frequencies in the model then for our quarterly data t would represent the period from 2007q4-2009q2 and for the monthly data from 2007m10-2009m6. Furthermore we test for different types of treatment effects (shocks), the permanent and the transient. The permanent treatment effect represents the aforementioned t; in the case of the transient treatment effect, t represents years 2008 and 2011 for the yearly data, 2007q4-2009q2 and 2011q1-2011q4 for the quarterly data and 2007m12-2009m6 and 2011m1-2011m12 for the monthly data. The $\beta_1$coefficient (interaction term) shows the size by which stock indices returns differ between bank indices and general stock price indices after the exogenous shock (in our case the financial crises of 2007/2008, which was started by the failure of Bear Stearns and the Lehman Brothers collapse). In this case we would expect that $\beta_1 < 0$, because of the negative effect on stock returns following the shock.

In order to capture the relative decrease of banks indices to the general stock price indices and the average changes in stock price returns, after the exogenous shock, we extent our model and run our regression with the following form:

$$rPI_{sct} = a + \beta_1 banksindx\_dummy_{sc} + \beta_2 crisis\_dummy_t + \beta_3 (banksind_{dummy} * crisis\_dummy)_{sct} + \varepsilon_{sct}, \quad (2)$$

where, as mentioned $banksindx\_dummy_{sc}$ and $crisis\_dummy_t$ are dummy variables , t represents the time, with the aforementioned characteristics, β_1 coefficient is the average pre-shock (treatment) difference in the average price index return between banks indices and general stock price indices, β_2 coefficient shows the average change in bank indices returns after the shock (treatment). The β_3 coefficient is the same with the β_1 coefficient, as the in model (1), where a negative and significant β_3 shows the financial crisis (shock in our case) has greater impact on the specific sector index than the general index. We include in a third regression

model the unemployment rate as a variable, in order to see the country-year effect and the possibility that this variable is going to affect the returns of the indices. The third model has the form:

$$rPI_{sct} = a + \beta_1 banksindx\_dummy_{sc} + \beta_2 crisis\_dummy_t + \beta_3 (banksind_{dummy} * crisis\_dummy)_{sct} + unemployment_{ct} + \varepsilon_{sct} \quad (3)$$

4. Data

The Data for the current Case Study are obtained from the Thomson-Reuters DataStream database. Data on Bank sector price indices and General stock price indices are taken for 3 different European countries, Germany, Belgium and Greece. The general stock price indices are consisting from the "blue chips" companies which have the biggest market cap in each of the mentioned countries. Germany represents a "rich" north country with a strong economy in Europe; Greece faces in the worst way the effects of the recent financial crisis and represents a "poor" south country with a weak economy, while Belgium is a country placed in the heart of Europe between the aforementioned two countries. The unemployment rate for the three countries is obtained from the statistical office of the European Union (Eurostat).

Fama, E., (1965) [15] uses in his study 30 stocks from the Dow-Jones Industrial Average and calculates the first differences of their natural logarithms in order to analyse their distribution. Furthermore he claims that the use of log price change has some advantages; that the log price change represents the yield during the period of keeping the stock, and that the log price change is very close to the price change in percentage terms. Harris, L. (1989) [16] uses log prices differences in order to calculate the stock returns. In accordance to the previous we calculate the returns of the two stock price indices, to do so we calculate for each index the first differences of logarithms as follows:

$$rPI_t = \log(PI)_t - log(PI)_{t-1}, \quad (4)$$

where rPI_t is the logarithmic stock indices return, $\log(PI)_t$ is the logarithm of the index price at the end of day t and $log(PI)_{t-1}$ is the logarithm of the index price at the end the previous day $t-1$.

The sample period refers from 2002 until 2012, and for our analysis we use three different frequencies, yearly data, quarterly data and monthly data. In order to specify the exactly recession period that the financial crisis occurred and hit the indices as a shock, we mention in or study the recession period defined by the National Bureau of Economic Research (NBER). NBER defines the recession cycle from December 2007 to June 2009 with duration of 18 months. Brunnermeier, M. et al. (2012) [7] uses in their study the aforementioned recession period in order to analyse banks stock returns.

Insert Figure 1

Insert Figure 2

Insert Figure 3

From the above three figure we can verify the recession periods in our study. The noise of our indices is relative constant during the sample period except from two periods that a large dip incurred. The financial crisis displays significant movements during the years of 2008 and 2011. The first dip in 2008 was caused by the failure of Bear Stearns and the Lehman Brothers collapse with negative consequences in Europe. The second dip in 2011 was caused in Europe because of the financial problems that EU countries faced during and after the recession of 2007, and furthermore by Europe's inability in order to address these specific problems.

If we go down from the yearly time path (Figure 1) to the monthly time path (Figure 3) then the two periods become more visible. As mentioned we test three frequencies, from the above figures we can confirm the recession period by NBER, so the dates used for the yearly data are 2008 and 2011, for quarterly data from 2007q4-2009q2 and 2011q1-2011q4 and for monthly data from 2007m12-2009m6 and 2011m1-2011m12.

5. Empirical Results – Discussion

The recent financial crisis was transmitted around the countries of the EU and several stock markets decreases abruptly. Some EU countries faced deeper problems in their economy and asked for rescue in the EU and the IMF (in our sample Greece). The method used in this paper is a simple version of the *diff-in-diff* approach. Levintal, O., (2013) [22], Dell'Ariccia et al. (2008) [13] and Krozner et al. (2007) [20] used in their studies this approach in order to define the effects of the financial crisis on banks.

Insert Table 1

In our empirical analysis we examine the effect that causes the financial crisis as an exogenous shock, on the returns of banks sector indices. In Table 1 we present the regression results of the *diff-in-diff* model with annual data. In column 2 we estimate the basic model (1) and the results show that the coefficient of the interaction term in the permanent treatment is negative and significant at the 1% level, indicating that banks sector returns rely more heavily on exogenous shocks (the financial crisis) than the returns of general sector indices. In columns 3 and 4 we include the unemployment as a variable of the country-year effect. The results of the third (3) model show us no significant changes and the model did not perform better. For this reason we did not include this variable in the other regressions. Regarding the second type of treatment effect we tested, the transient effect, the results in columns 5 and 6 show us a negative and significant interaction term at the 1% level confirming our hypothesis for a negative and significant interaction term ($\beta < 0$). Furthermore we show that the R-squared is bigger in the transient treatment effect model in addition to the permanent effect model, and that is because we capture the two dips in the indices better and the results given are stronger.

Insert Table 2

In Table 2 we present the estimates, tested in quarterly data from the period of 2002 to 2012. In the permanent treatment effect (columns 1 and 2) the results given in column 2 show us a negative and significant β-coefficient at the 1% level. In column 3 and 4 are presented the results of the transient treatment effect model and we can conclude that in both columns the interaction term is negative and significant at the 10% and 1% level, respectively. The results of the monthly data are presented in Table 3, the results given are similar to the quarterly data but with smaller R-squared because of the used frequency in our sample. The interaction term is also negative and significant at the 1% level in columns 2 and 4 and negative and significant at the 5% level in column 3.

Insert Table 3

In the basic version of the *diff-in-diff* model the regression coefficients were statistical significant (at 95%), so we were able to confirm that the tested method can be applied in this new context of banking performance, where the latter is measured in terms of stock market sector returns.

We observed that the method runs satisfactorily in all the three aforementioned frequencies of the time-series element of our panel data. As expected the β-coefficients get smaller absolute values for higher frequencies; thus the β-coefficient for annually data is larger from the β-coefficient for quarterly data and even larger than the β-coefficient for monthly data as the latter captures the cumulative effect of one trading month while the former of three and twelve months respectively. Furthermore, as we show, the R-squared is smaller when the method runs on monthly data, gets higher when the method runs on quarterly data and even higher when the method runs on annually data; this is also well expected that as the higher the frequency of the data the more noisy these are, and thus less variance can be explained from the fitted models.

When we added in our model one country-specific effect (i.e. the unemployment rate in the respective countries) then the model (3) did not perform much better, but this could be expected as in the economics literature there is ambiguous evidence on the impact of unemployment in the stock market. However we have not tried other country-specific or sector-specific variables as to be included in the third version of our model; we leave this step for future research.

As far as the effect of the treatment type, we have illustrated that the method not only works for permanent treatments, but also in transient treatment and in our context it seems to work better; this is also comes as no surprise as we knew from economic theory that the banking crisis was of transient nature and in fact we experienced a double-dip in 2011 and a triple-dip in early 2013, as these lines were written.

6. Conclusion and further research

In this paper we studied the effects of an exogenous shock (e.g. the financial crisis of 2007/2008) on three bank sector country indices and find that banks are more affected by a shock in comparison to the general stock price index which is consisting by the "blue chips" companies. We find evidence that the *diff-in-diff* method runs satisfactory in our test and that our hypothesis of a negative and significant β-coefficient is going to be confirmed. Furthermore, in this study we tested for the first time the performance of the *diff-in-diff* method:

- In the context of banking performance, measured in returns, using stock market data
- For different frequencies of the time series element of the panel data: yearly, quarterly and monthly.
- For two different types of the treatment effect: permanent and transient.

All the above empirical investigation reconfirmed that the *diff-in-diff* method is a very versatile and robust method that can be applied in many different contexts and with almost any kind of panel data, giving in most situations useful and insightful results.

In some additional results (that we are not presenting in this journal), we can see that German banks were less affected in comparison to other two countries – Belgium and Greece. This is a well-expected result as Germany is one of the strongest economies in the Eurozone and thus it makes sense to be affected less during the two periods of the banking crisis.

As far as the future of similar investigations is concerned, we propose that the method should be tested for Heteroscedasticity on the standard errors using the White (1980) [30] correction method. Bertrand et al, (2004) [4] mention that the standard errors are characterized by inconsistence and as a solution they propose to use placebo interventions in Monte Carlo simulations. Moreover after the implementation of the two previous methods on the standard errors, we propose that the *diff-in-diff* method should be tested with higher frequencies (weekly, daily and intraday), including more types of fixed effects (country-time, sector-time etc.) and with bigger dimension of the panel data, introducing more sectors (Pharma, Construction, Automobile etc.) and more countries of the European Union or of Global Markets. Furthermore the *diff-in-diff* method could be compared with other models, for example the *Changes-in-Changes* approach. The *CIC* was developed and proposed by Athey and Imbens (2006) [1] and applies in panel data or cross section and gives more prescriptions about what the effect of a treatment would be if it were applied on the control group.

Table 1
Main results (annual data)

Regression No.	(1)	(2)	(3)	(4)	(5)	(6)
		Permanent treatment effect (2008+)			Transient treatment effect (2008 and 2011)	
Dependent variable: rPI_{sct}						
banksindx_dummy	0.0086		0.0086		0.0127	
	(0.05)		(0.05)		(0.14)	
crisis_dummy	-0.3423+		-0.3432+		-0.7414**	
	(-1.87)		(-1.86)		(-5.35)	
banksindx_crisis_dummy	-0.2716	-0.4941**	-0.2716	-0.2716	-0.6995**	-1.3515**
	(-1.05)	(-3.23)	(-1.04)	(-1.04)	(-3.57)	(-8.38)
unemployment			0.0016	0.0016		
			(0.09)	(0.09)		
Constant	0.1882	0.0770	0.1738	0.1738	0.1654**	0.0887+
	(1.45)	(1.01)	(0.87)	(0.87)	(2.67)	(1.74)
Observations	60	60	60	60	60	60
R-squared	0.22	0.15	0.22	0.22	0.71	0.55

Notes: t-statistics in parentheses. The result of the regressions refers to annual data. In columns 1-4 are the regression results by the permanent treatment effect; in columns 5-6 are the results by the transient treatment effect. In columns 3 and 4 we include the unemployment as a variable (country-specific effect). The crisis_dummy refers to the post treatment effect. The banksindx_dummy refers to the bank indices among the countries.

** significant at 1% level ($p<0.01$), * significant at 5% level ($p<0.05$), + significant at 10% level ($p<0.10$)

Table 2
Main results (quarterly data)

Regression No.	(1)	(2)	(3)	(4)
	Permanent treatment effect (2007q4-2009q2)		Transient treatment effect (2007q4-2009q2 and 2011q1-2011q4)	
Dependent variable: rPI_{sct}				
banksindx_dummy	-0.0209		-0.0027	
	(-0.74)		(-0.09)	
crisis_dummy	-0.1124*		-0.1228**	
	(-2.27)		(-3.07)	
banksindx_crisis_dummy	-0.0597	-0.1735**	-0.1091+	-0.2154**
	(-0.85)	(-3.65)	(-1.93)	(-5.74)
Constant	0.0130	-0.0065	0.0261	0.0069
	(0.65)	(-0.48)	(1.29)	(0.51)
Observations	258	258	258	258
R-squared	0.07	0.05	0.15	0.11

Notes: t-statistics in parentheses. The result of the regressions refers to annual data. In columns 1-4 are the regression results by the permanent treatment effect; in columns 5-6 are the results by the transient treatment effect. In columns 3 and 4 we include the unemployment as a variable (country-specific effect). The crisis_dummy refers to the post treatment effect. The banksindx_dummy refers to the bank indices among the countries.

** significant at 1% level ($p<0.01$), * significant at 5% level ($p<0.05$), + significant at 10% level ($p<0.10$)

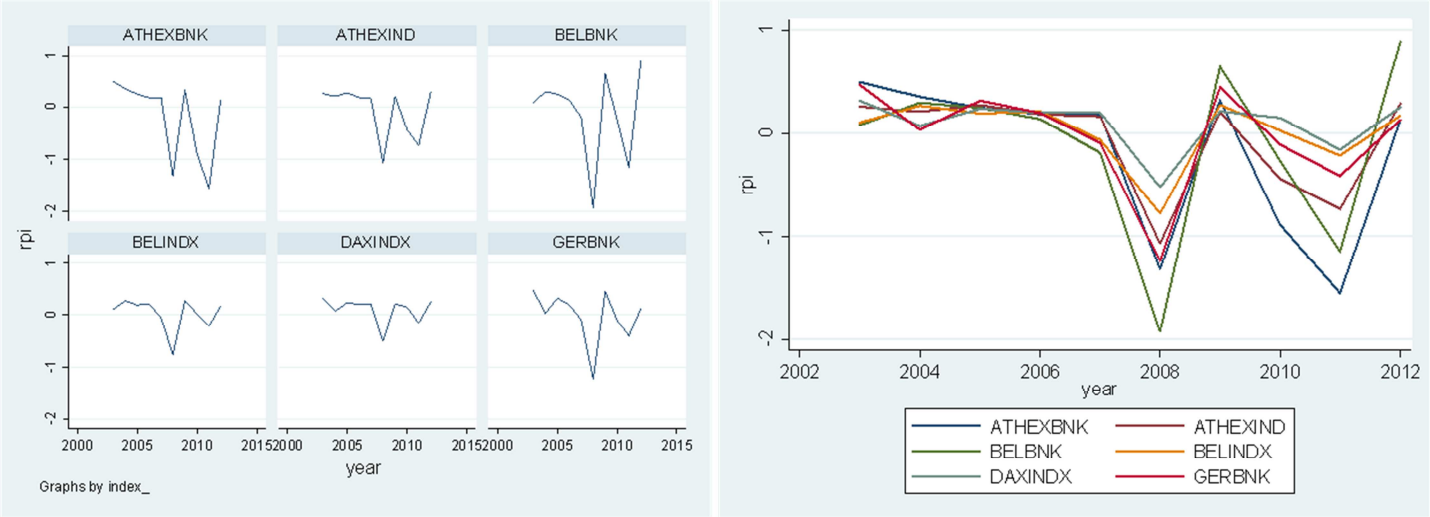
Table 3
Main results (monthly data)

Regression No.	(1)	(2)	(3)	(4)
	Permanent treatment effect (2007m12-2009m6)		Transient treatment effect (2007m12-2009m6 and 2011m1-2011m12)	
Dependent variable: rPI_{sct}				
banksindx_dummy	-0.0078		-0.0009	
	(-0.94)		(-0.10)	
crisis_dummy	-0.0376*		-0.0405**	
	(-2.54)		(-3.29)	
banksindx_crisis_dummy	-0.0191	-0.0576**	-0.0363*	-0.0715**
	(-0.91)	(-4.07)	(-2.09)	(-6.24)
Constant	0.0044	-0.0024	0.0083	0.0020
	(0.75)	(-0.59)	(1.34)	(0.50)
Observations	798	798	786	786
R-squared	0.03	0.02	0.06	0.05

Notes: t-statistics in parentheses. The result of the regressions refers to annual data. In columns 1-4 are the regression results by the permanent treatment effect; in columns 5-6 are the results by the transient treatment effect. In columns 3 and 4 we include the unemployment as a variable (country-specific effect). The crisis_dummy refers to the post treatment effect. The banksindx_dummy refers to the bank indices among the countries.

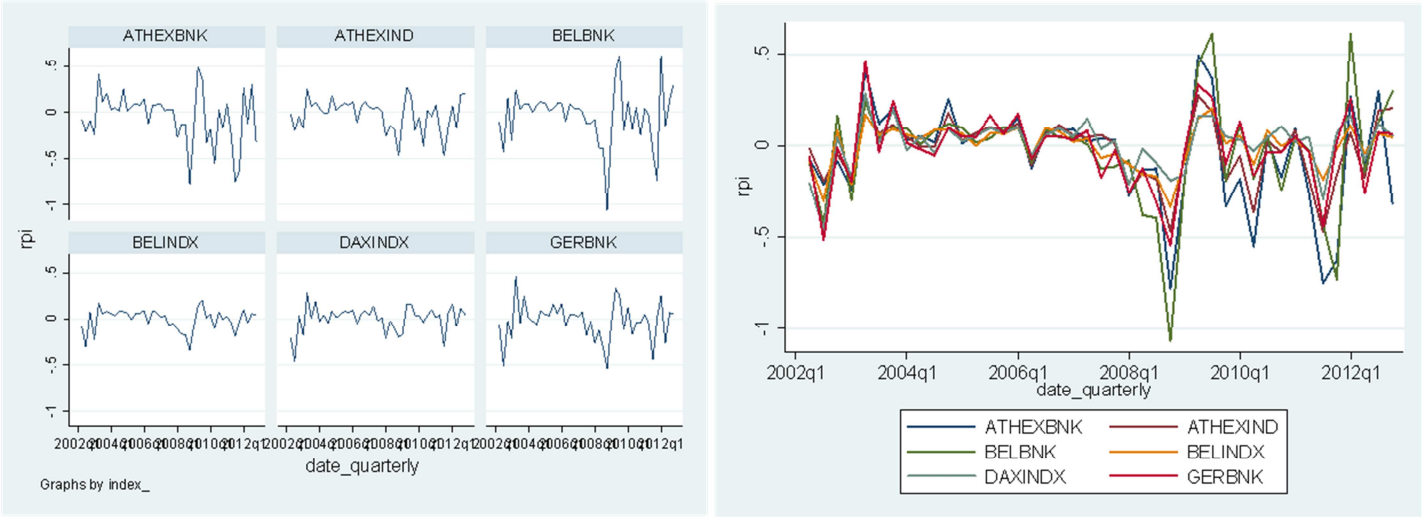
** significant at 1% level ($p<0.01$), * significant at 5% level ($p<0.05$), + significant at 10% level ($p<0.10$)

Figure 1: Time path of crises, yearly data from 2002-2012.



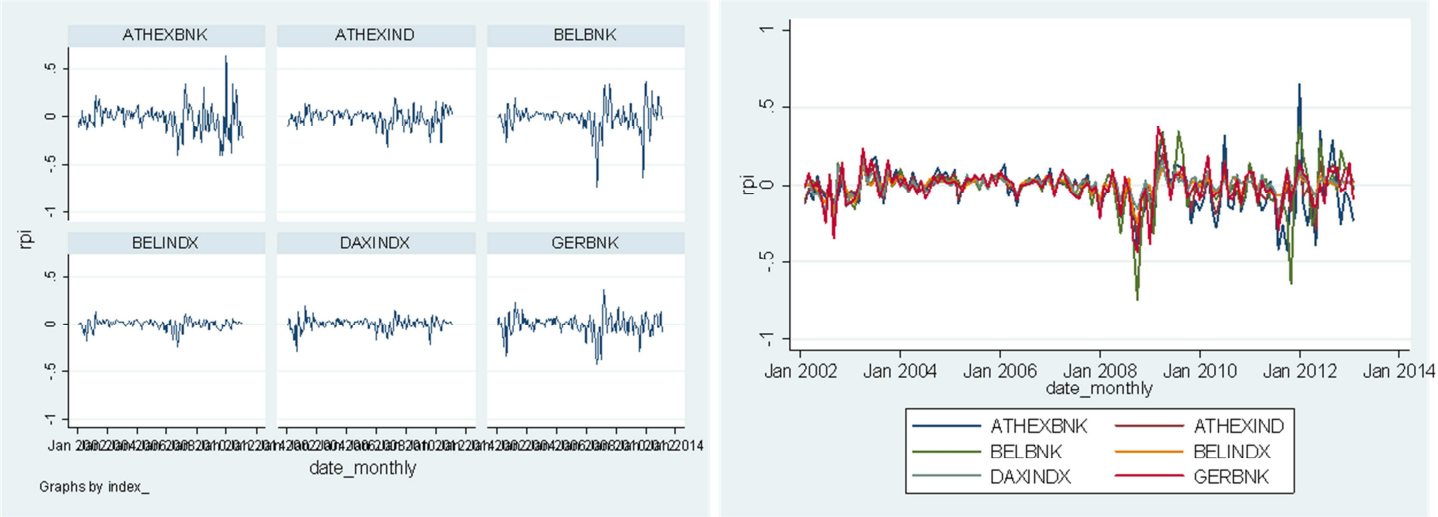
Notes: From this figure we can identify the two shocks in our yearly data; the indices are relative constant over the sample period except of two large dips in 2008 and 2011. ATHEXBNK and ATHEXIND represent the bank sector index and general stock index in Greece, BELBNK and BELIND represent the bank sector index and general stock index in Belgium and DAXBNK and DAXIND represent the bank sector index and general stock index in Germany.

Figure 2: Time path of crises, quarterly data from 2002-2012.



Notes: From this figure we can identify the two shocks in our quarterly data; the indices are relative constant over the sample period except of two large dips in the period of 2007q4-2009q2 and 2011q1-2011q4. ATHEXBNK and ATHEXIND represent the bank sector index and general stock index in Greece, BELBNK and BELIND represent the bank sector index and general stock index in Belgium and DAXBNK and DAXIND represent the bank sector index and general stock index in Germany.

Figure 3: Time path of crises, monthly data from 2002-2012.



Notes: From this figure we can identify the two shocks in our monthly data; the indices are relative constant over the sample period except of two large dips in the period of 2007m12-2009m6 and 2011m1-2011m12. ATHEXBNK and ATHEXIND represent the bank sector index and general stock index in Greece, BELBNK and BELIND represent the bank sector index and general stock index in Belgium and DAXBNK and DAXIND represent the bank sector index and general stock index in Germany.

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