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Determinants of Financial Cycle Correlations in Selected EU Member States

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Abstract. *The recent financial crisis illustrated that more attention should be given to the dynamics of the financial cycle and the interactions with the business cycle. The central aim of the study is to assess the driving factors contributing to the correlations and contagion effects between business and financial cycles in selected EU states. For the empirical approach, we use frequency filtering methods and spillover analysis to track correlation and contagion. We measure both financial cycle correlation and spillover factors by looking at trade links, systemic risk episodes and bilateral financial claims. An important result of the paper is that financial cycle correlation is significantly influenced by business cycle correlation, but also by the overlap of financial stress episodes. With regard to the spillover effects between financial cycles, we find that they are strongly influenced by business cycle and financial stress spillovers, as well as by trade linkages and bilateral financial claims. Both in the case of the spillover regression model and in the case of the regression model on correlations, the most significant factors for the links between financial cycles are the business cycles and the financial stress indices. The policy implications for macroprudential authorities entail taking into account cross-border effects and spillovers when implementing instruments for taming the financial cycle.*

Keywords: financial cycle, business cycle, filtering methods, spillover analysis, financial stress indices.

Introduction

The recent Global Financial Crisis has shown that, in addition to the analysis of the economic cycle, a very close attention should be given to the dynamics of the financial cycle. This aspect is very important because a shock at the macroeconomic level can be felt both as a result of an economic crisis but also in the aftermath of a financial crisis. In view of the developments during the last decades, the EU economies have become closely linked, both in terms of trade relations and in terms of business cycle dynamics. During this period, the stimuli from the economic area were also felt in the financial sector, a motivation for the analysis in the present paper - the influence of the correlation between the economic cycles from different states on the correlation between their financial cycles will be analyzed.

A first premise of the empirical approach is that the potential factors to influence the correlation dynamics between Member States' financial cycles could be linked mostly to (i) business cycle synchronization, (ii) overlaps between systemic stress episodes (proxied by the Country-Level Index of Financial Stress (CLIFS) estimated by the European Central Bank), (iii) financial linkages measured through the value of bilateral financial claims (monitored by the Bank for International Settlements), and (iv) trade linkages, through indicators related to bilateral

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international trade. The results of the analysis illustrate that bilateral trade transactions between countries does not generate a statistically significant impact on the correlation between financial cycles, while the strongest determinant of this correlation is business cycle synchronization. Thus, the paper confirms that, once the business cycles in two countries become more synchronized, there is a strong prospect of synchronization of the financial cycles. Moreover, if the index of financial stress in two countries have a similar pattern, then also the dynamics of the financial cycles will follow a similar trend, reinforcing the link between financial cycles and systemic risk.

The rest of the paper has the following structure: the second chapter present the main results obtained in the literature on this topic, in the third chapter we present the methodology and the econometric instruments employed, the fourth chapter presents the results and in chapter five we summarize the main conclusions.

Literature review

In light of the increasing economic interdependence between countries, the idea of cross-country spillovers between financial cycles has recently gained more interest from different research perspectives. Therefore, many studies rely on the subject of "spillovers impact" from different macro-financial areas using a wide array of variables to quantify these effects. In addition, another subject of interest is represented by the impact both of the globalization phenomena and of the concomitant emergence of global value chains, which lead researchers to focus on trade in intermediate inputs used as a determinant of business cycle synchronization. The other important driver of business cycle co-movements is represented by financial integration. For countries in which capital mobility is restricted, lower synchronization of economic activity based on capital flows should be observed, compared to countries that are financially integrated.

The study published by Adarov (2018) aimed at analyzing financial cycles based on a sample of 34 countries (both advanced and developing countries), on a time frame spanning between 1960 Q1 - 2015 Q4. The author used both dynamic and state-space techniques in order to estimate financial cycles in credit, housing, bond and equity markets and build an aggregated financial cycle indicator for each country in the sample. The estimation of financial cycles (specific and aggregate) suggests that activity in financial markets is subject to dynamics with a high degree of persistence and recurrence associated with the accumulation of imbalances followed by a correction, the financial cycle tending to fluctuate at much lower frequencies (9 - 15 years on average) compared to economic cycles. Another important result of the study is that a notable intra-regional synchronization was observed together with some nontrivial co-movement tendencies between European, American and Asian financial cycles.

Another study with a focus on financial cycle synchronization can be found in the monthly report of the Central Bank of Germany from January 2019. Frequency-based analysis methods were used to investigate the properties of financial cycles for selected euro area countries. Wavelet analysis, the method used in this article, is a frequency refining analysis or a spectral analysis. The variables used, considered representative for the financial cycles, were time series for credit aggregates and house prices. The main goal was related to assessing cross-country synchronization of financial cycles, analyzing primarily whether credit and residential real estate prices follow cross-country cycles. The analysis of the relationship between real business cycles and financial cycles reveals that increases in lending, residential real estate prices and real GDP lead to similar fluctuations in the medium term, for the countries under analysis. Therefore, the real financial and economic cycles should not be seen as independent phenomena, but as interdependent. The empirical results for the euro area, presented in this paper, highlighted the correlations between the

variables within countries (viewed individually) but also between countries, but no conclusions could be drawn related to a possible causality.

Borowski et al. (2020) analyzed the impact of foreign bank ownership on the synchronization of business cycles between the euro area and EU countries for the 1998-2016 period. The main conclusion of the article is related to economies with a higher share of foreign bank assets which are more cyclically synchronized with the euro area, mainly due to an alignment of investment cycles. The results of the article suggest that foreign banks, originated mainly in the EU, treat host countries as an extension of the local market, which leads to a standardization of lending behavior in those two countries. Another author studied the relationship between the capital mobility and synchronization of business cycle in the euro area (Beck, 2021), investigating four channels: the way how business cycles look like in short run, the impact of specific risks, the foreign direct investment impact on international integration and contagion. The results show that capital mobility is associated with business cycle synchronization in the long-run, in the EU.

On the "spillovers" perspective, various papers studied this concept also looking at the main influence factors. For example, Abosedra et al. (2020) studied GDP growth volatility spillovers across 120 countries during the 1960-2017 period. These countries were ranked based on the ratios of growth rate to standard deviation, in three categories: high-, midsize-, and o low-income growth. The authors used a spillover index, based on variance decompositions under a vector autoregressive framework, for analyzing the sources of growth volatility dynamics worldwide, related to the level of volatility from and to others. The main finding was that high-income growth countries are net transmitters and the low-income growth countries are net recipients of growth volatility. In addition, they discovered that the low-income growth countries needed several years in order to absorb the growth shocks of a global nature. Furthermore, Fang et al. (2021) published a study investigating spillovers in stock, bond, and foreign exchange markets between China and the G7 countries for the 2000-2018 period. One of the main findings was that the financial spillovers represent one of the driving factors of variations in the aforementioned market segments, highlighting the importance of international spillovers effect in asset price dynamics. Furthermore, it was ascertained that spillovers from the G7 countries to China are still higher than the spillbacks from China.

Some evidence on the relevance of global uncertainty, risk aversion and the importance of US interest rates for the global financial and business cycles are displayed in the Gomez-Pineda (2020). They found that both global uncertainty and global risk aversion are the main volatility factors in all economies considered in the study. Another paper, which study the impact of uncertainty, by Skeunjaric et al. (2020), estimates the spillover effects of shocks in the economic policy uncertainty index (EPU) and stock market returns and risks for selected Central and Eastern European markets (Bulgaria, Czechia, Estonia, Hungary, Lithuania, Poland, Croatia, Slovakia and Slovenia). The authors noted that the largest spillover between risk, return and EPU series were observed for the Czechia, Lithuania, Slovenia and Poland, potentially signaling that stock markets in these countries react much more to changes in uncertainty compared to other countries in the analysis. Given that the CEE group is comprised of mostly developing countries, economic policies should take into account that the EPU shocks lead to a significantly greater impact compared to developed countries.

Kubinschi and Barna (2019) published a paper aimed at a better understanding the way in which the industrial sectors in different countries influence each other and influence of Western European markets on the growth of emerging economies, especially in the CEE countries. They assessed the effects of spillovers between several European countries, using the industrial

production index, concluding that after 2009-2011, the individual contributions of the production index for each country decreased in importance in explaining the total dynamics, which led to the fact that the spillovers contribution in other countries increased.

Other authors sought to gain a better understanding on the links between financial cycle synchronization, spillovers and macroprudential policy. From this point of view, an article related to financial cycle synchronization is Gammadigbe (2022), investigating the synchronization and convergence of financial cycles in WAEMU (West African Economic and Monetary Union) over the period 2005 Q1-2020 Q4. In contrast to mainstream literature, the main finding of the paper is a lack of financial cyclical convergence, which implies that a common and homogenous macroprudential policy should take into account specificities in country level financial cycles. Chari et al. (2022) argued that a restrictive *ex ante* macroprudential stance can amplify the consequences of global risk shock on both bond and equity flows (during turmoil episodes, the level of the outflows is significantly higher, while the level of inflows is greatly diminished). These amplification effects are more stringent at the "extreme" side (regulations that target specific risks instead of generalized cyclical buffer). For estimating these relationships, the authors used a policy-shock approach that corrects for reverse causality by combining weekly data on portfolio investment with high-frequency risk measures and a new measure of macrorpudential that indicates the intensity of policy stance. The main results highlighted that the macrorpudential regulation can reduce both the volume and volatility of bank flows, but it can also increase the vulnerabilities in other parts of the financial system.

Methodology

The main goal of the paper is to assess correlations between EU selected countries (20 countries were selected), from a financial cycle perspective. The macroeconomic and financial variables selected are: (i) the correlation of economic cycles, (ii) the correlation of the systemic stress indicators, (iii) the value of bilateral claims between states and (iv) a measure related to trade links via imports and exports.

For the empirical approach, we used two methods of financial cycle estimation: Hodrick-Prescott (HP) filter and Band-Pass (BP) filter. The Band-Pass filter has the capacity to eliminate both the high and low frequencies of time series. We used the BP filter because we wanted to isolate the financial cycle components considering the uncertainty related to the optimal length of financial cycle in the literature. In addition, we used the traditional HP filter for computation of business cycle, using a standard value for smoother parameter ($\lambda = 1600$) following, in this way, the literature mainstream in which the economic cycle has an approximate length of 8 years. In accordance with BIS and CERS recommendations, also we computed the credit-to-GDP (value of the nominal credit relative to nominal GDP) deviation for financial cycle estimation.

The filter computation using BP is based on the value of weights, which minimizes the distance between the estimation weights and the empirical ones:

$$Q= \int_{-\pi}^{\pi} |\beta(\omega) - a_K(\omega)|^2 \qquad (1)$$

In the case of the HP filter, the trend component is estimated by minimizing the following function:

$$\sum_1^T (y_j - \tau_t)^2 + \lambda \sum_2^{T-1} [(\tau_{t+1)} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \qquad (2)$$

The value of the smoothing parameter was established by Hodrick and Prescott (1981) for estimating the trend in the case of the business cycle, which lasts between 1 year and 8 years. From

an economic perspective, the value used for smoothing parameter implies that the cyclical evolutions with a length of over 8 years are attributed to the trend component.

The central aim of the study is to assess how the driving factors contribute to the correlations and contagions between financial cycles. Therefore, after the computation of the two cyclical measures for all the countries included in the sample, we estimated the correlation matrices for the financial cycle, business cycle and the CLIFS indicators. In addition, we use the methodology developed by Diebold and Yilmaz (2010) for computing contagion indices for the same variables as above. In case of matrices estimations, we used the VAR model with one lag (for quarterly data) and with three or two lags (for monthly data).

The Generalised Forecast Error Variance Decomposition (GFEVD), defined by Koop et al. (1996) and Pesaran and Shin (1998), was applied due to its desirable order-invariant property. The authors define the generalized impulse response function and forecast error variance decompositions as follows:

$$\Upsilon_j^g(h) = \frac{1}{\sqrt{\sigma_{jj}}} A_h \sum e_j \text{ and } \theta_{ij}^g(H) = \frac{\sigma_{ij}^{-1} \sum_{h=1}^{H=1} (e_j' A_h \sum e_j)^2}{\sum_{h=1}^{H=1} (e_j' A_h \sum A_h' e_j)^2} \qquad (3)$$

The next step is the computation of a weighted average using the sum of all contribution in order to see the relative contribution to each country from itself and other countries:

$$\tilde{\theta}_{ij}^g(H) = \frac{\theta_{ij}^g(H)}{\sum_{j=1}^{N} \theta_{ij}^g(H)} \qquad (4)$$

It is important to mention that in the correlation case, matrices are symmetrical and because of this characteristic, the elements below the principal diagonal were eliminated to avoid the duplication of information. In the case of the contagion matrices, the indices are unidirectional, representing the contributions of each country in other country dynamic. Because of this reason, we estimated two independent regressions (cross-section regression): (1) using the correlations which contain the matrices related to: financial and business cycles, the CLIFS indicators and the symmetrical import-export matrix (by reporting the weights exclusively from the perspective of exports); (2) using the contagious indices in which we included the matrices related to: financial and business cycles, the CLIFS indicators and the import-export matrix and the financial relationships represented by the claims matrix.

The statistical variables used in this article are the nominal volume of lending using a quarterly frequency from the ECB, the nominal and real GDP - quarterly data from Eurostat, the CLIFS[1] indicator estimated by ECB with monthly frequency, commerce indicators[2] (the nominal volume of export and import from IMF) and the bilateral claims[3] from the BIS. The period selected for analyses is 2004-2021 and the sample of countries was selected to ensure maximum data availability, including the following: Austria, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxemburg, The Netherlands, Poland, Portugal, Romania, Slovenia, Spain and Sweden.

[1] Country-Level Index of Financial Stress - The CLIFS includes six, mainly market-based, financial stress measures that capture three financial market segments: equity markets, bond markets and foreign exchange markets.

[2] The main indicator was computed as the sum of import and export for a country in relationship with each country from the sample, and after that this value was divided by the value of all the imports and the exports of that country with all the states of the sample. Basically, this indicator is a proxy for the intensity of bilateral trade relationship between countries.

[3] Claim on residents of countries other than the country where the controlling parent is located, ie a claim of a domestic bank on non-residents of the reporting country. Foreign claims comprise local claims of the bank's offices abroad as well as cross-border claims of the bank's offices worldwide.

Results and discussions

A first step in the analysis was to determine the level of correlation between the financial cycles of the analyzed Member States. The results show that the states for which the highest level of correlation was obtained are Germany and Austria. A high level of correlation was registered also between the financial cycles of Finland and Austria, Lithuania and Greece as well as Romania and France (Table 1). On the other side, there were cases in which the correlation coefficient of financial cycles from different states was negative. Among the strongest negative correlations is the one between the financial cycle of Hungary and Luxembourg.

A similar analysis was carried out at the level of the correlation between business cycles. In this case, the correlation coefficients are generally higher than those for financial cycles. The highest level of synchronization was recorded between the economic cycles of Belgium and Greece but also in the case of Lithuania and Belgium. A high level of correlation was also recorded between the economic cycles of Romania and France, Lithuania and Greece, Poland and Austria, but also Sweden and Poland (Table 2). On the other hand, the least correlated business cycles are those in Romania and Luxembourg, Slovenia and Italy, but also Hungary and Luxembourg.

Another way of analyzing how the dynamics of the financial cycle in one state is influenced by that of the financial cycles in other Member States is by determining the spillover effects. In countries such as Italy and Hungary, more than half of the financial cycle dynamics could be attributed to internal factors. However, for the rest of the analyzed states the situation is opposite, some examples in this regard are Romania, Austria, France and Finland, for which less than 13 percent of the dynamics of the financial cycle can be attributed to the internal factors (Table 3). In the case of Romania, a large part of the financial cycle dynamics can be attributed to the dynamics of the financial cycle in Austria, France and Greece, states where many of the banks operating in Romania have their headquarters.

Regarding the spillover effects for the economic cycle, we find that, in general, the importance of internal factors is much lower than in the case of the financial cycle. The countries for which the share of domestic factors is at the highest level are the Netherlands and Italy. However, there are also states for which the impact of internal factors in the dynamics of the national economic cycle is relatively low, in this respect Poland and Finland could be mentioned (Table 4). At the same time, there are countries that influence the business cycle of Poland or Finland stronger than internal economic factors. In the case of Poland and Finland, the strongest influence is generated by Lithuania's economic cycle.

In addition to the business cycle, another important element that provides signals about the dynamics of the financial cycle is the financial stress index (CLIFS). The country for which the financial stress index is strongly influenced by internal factors is Hungary. Also, countries for which there are strong influences from the domestic economy on the dynamics of CLIFS are Sweden, Italy, Slovenia and Ireland (Table 5). On the other hand, countries for which the influence of internal factors in the dynamics of CLIFS is relatively low are Austria, Lithuania, Greece and Germany. In the case of Romania, in addition to internal factors, the strongest influences on the dynamics of CLIFS come from the evolution of financial stress in countries such as Italy, Greece and France, states whose banks operate in the Romanian financial system.

The results of the first cross-section regression model illustrate that two of the factors that significantly influence the correlation between the financial cycles of the Member States are the level of correlation between the economic cycles and the correlation between the indices of financial stress (Table 6). Thus, an increase in the link between two economies, materialized in a higher correlation of economic cycles has an important impact in increasing the level of correlation

of financial cycles. Moreover, if systemic risks and financial stress materialize synchronously in two Member States, this generates an increase in the link between the financial cycles of the two countries. However, it should be noted that the influence of the trade link between the two economies, materialized in the bilateral level of exports and imports, does not significantly influence the correlation of their financial cycles.

For the robustness of the results, the regression model was analyzed also in the conditions in which the financial cycles were calculated with a Hodrick-Prescott filter (Table 7). In this case, the variables that significantly influence the correlation of financial cycles are the correlations between the economic cycles of the countries, but also the correlations between their financial stress indices. However, different from the results of the first regression model, in this case the impact of the two variables on the correlation of financial cycles is lower. Moreover, the impact of the variable on bilateral international trade does not have a significant impact on the correlation of financial cycles.

In the case of models on spillover effects, all independent variables are statistically significant (Table 8). Thus, an increase in the value of claims between two states generates an increase in the spillover effect on their financial cycle. Another important element, which shows an even greater impact than bilateral claims, is the bilateral trade between countries. Thus, an intensification of the level of imports or exports between two countries generates an increase in the spillover effects on the financial cycle. A strong and significant effect on the financial cycle spillovers is also given by the spillover effects recorded at the level of the financial stress index. Thus, the more the systemic risks and financial stress within one state influence the dynamics of the financial stress index in another state, we find stronger spillovers for the financial cycles at the level of the two states.

However, the most important but also the most significant impact on the spillover effect of the financial cycle comes from the economic cycle spillovers. Thus, as the economic cycles in two states become tighter, then a similar effect is observed regarding the dynamics of the financial cycles in these states.

In order to analyze the robustness of the results regarding the regression model on spillover effects, the analysis was performed taking into account only a part of the independent variables. The extended results of all 14 combinations of cross-section regression models are presented in Table 9. The variable on bilateral claims between states is statistically significant for all models and has a positive coefficient in all variants. Two other variables that are statistically significant for each of the models they were part of are the spillover effect on the financial stress index and the spillover effect on the business cycle. The coefficient of the bilateral trade variable illustrates that an intensification of the trade between two countries generates an increase in the spillover effect at the level of financial cycles, only for some of the combinations of models analyzed.

Table 10 extends the robustness exercise for the case of correlation-based models, where different combinations of models were analyzed. The only variable whose coefficients are statistically insignificant for all the models in which it was integrated is the one regarding bilateral trade. Conversely, both the correlation between financial stress indices and between economic cycles tend to have a significant impact on the correlation between financial cycles in all models they were included.

Conclusion

The recent financial crisis illustrated that more attention should be given to the dynamics of the financial cycle but also to the potential contagion effects that can occur between the financial

markets. In this regard, the paper aims to illustrate the most important factors of the correlations between EU members' financial cycles. A first result of the paper is that the correlation between financial cycles is significantly influenced by the correlation between business cycles but also by the correlation between the financial stress indices. This result is valid both in the situation where the cycles are determined through the Band-Pass as well as the Hodrick-Prescott filtering methodologies.

With regard to the spillover effects between financial cycles, we find that they are strongly influenced by business cycle and financial stress spillovers, as well as by bilateral trade linkages and bilateral financial claims. Both in the case of the spillover regression model and in the case of the regression model on correlations, the most significant factors for the links between financial cycles are the business cycles and the financial stress indices. The policy implications for macroprudential authorities entail taking into account cross-border effects and spillovers when implementing instruments for taming the financial cycle.

Future studies could extend the analysis to other countries whose financial markets significantly influence the financial cycles of the European Union countries (e.g. USA, UK, China or Japan). Moreover, in order to provide a higher level of robustness, the estimation of financial cycles could be done using several other types of filtering methods.

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Appendix

Table 1. Correlation matrix of financial cycles

	Austria	Belgium	Bulgaria	Czech Rep.	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Netherlands	Poland	Portugal	Romania	Slovenia	Spain	Sweden
Austria		18%	17%	36%	82%	66%	85%	68%	21%	63%	21%	63%	20%	2%	46%	30%	73%	38%	56%	42%
Belgium	18%		32%	48%	6%	41%	25%	59%	-3%	21%	7%	42%	43%	49%	3%	36%	11%	38%	33%	8%
Bulgaria	17%	32%		53%	24%	20%	36%	42%	-29%	51%	50%	49%	23%	51%	5%	57%	29%	34%	39%	47%
Czech Rep.	36%	48%	53%		48%	50%	48%	59%	-12%	53%	38%	57%	44%	51%	33%	68%	47%	59%	69%	50%
Finland	82%	6%	24%	48%		55%	78%	64%	10%	59%	17%	69%	15%	16%	55%	49%	76%	34%	63%	57%
France	66%	41%	20%	50%	55%		49%	79%	27%	60%	29%	64%	20%	10%	46%	25%	82%	72%	50%	53%
Germany	85%	25%	36%	48%	78%	49%		57%	-11%	63%	24%	61%	36%	14%	41%	51%	57%	37%	65%	35%
Greece	68%	59%	42%	59%	64%	79%	57%		25%	59%	35%	82%	22%	39%	50%	46%	72%	54%	54%	62%
Hungary	21%	-3%	-29%	-12%	10%	27%	-11%	25%		1%	-12%	23%	-37%	-3%	1%	-19%	29%	-4%	-7%	5%
Ireland	63%	21%	51%	53%	59%	60%	63%	59%	1%		57%	55%	32%	24%	22%	49%	65%	63%	58%	64%
Italy	21%	7%	50%	38%	17%	29%	24%	35%	-12%	57%		16%	22%	25%	18%	22%	24%	41%	35%	63%
Lithuania	63%	42%	49%	57%	69%	64%	61%	82%	23%	55%	16%		11%	47%	37%	57%	74%	43%	46%	53%
Luxembourg	20%	43%	23%	44%	15%	20%	36%	22%	-37%	32%	22%	11%		40%	-10%	29%	-2%	51%	42%	16%
Netherlands	2%	49%	51%	51%	16%	10%	14%	39%	-3%	24%	25%	47%	40%		-10%	49%	9%	27%	22%	37%
Poland	46%	3%	5%	33%	55%	46%	41%	50%	1%	22%	18%	37%	-10%	-10%		23%	52%	11%	42%	42%
Portugal	30%	36%	57%	68%	49%	25%	51%	46%	-19%	49%	22%	57%	29%	49%	23%		29%	38%	67%	43%
Romania	73%	11%	29%	47%	76%	82%	57%	72%	29%	65%	24%	74%	-2%	9%	52%	29%		51%	45%	57%
Slovenia	38%	38%	34%	59%	34%	72%	37%	54%	-4%	63%	41%	43%	51%	27%	11%	38%	51%		51%	53%
Spain	56%	33%	39%	69%	63%	50%	65%	54%	-7%	58%	35%	46%	42%	22%	42%	67%	45%	51%		47%
Sweden	42%	8%	47%	50%	57%	53%	35%	62%	5%	64%	63%	53%	16%	37%	42%	43%	57%	53%	47%	

Source: author's calculations based on data provided by ECB.

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Table 2. Correlation matrix of business cycle

	Austria	Belgium	Bulgaria	Czech Rep.	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Netherlands	Poland	Portugal	Romania	Slovenia	Spain	Sweden
Austria		92%	77%	85%	92%	86%	81%	92%	52%	88%	36%	93%	60%	65%	94%	85%	85%	68%	82%	87%
Belgium	92%		67%	80%	87%	90%	72%	96%	57%	88%	42%	96%	49%	73%	89%	83%	88%	59%	83%	83%
Bulgaria	77%	67%		89%	74%	79%	80%	63%	62%	78%	42%	69%	70%	57%	85%	73%	69%	82%	67%	87%
Czech Rep.	85%	80%	89%		86%	90%	83%	76%	64%	89%	55%	84%	64%	66%	93%	82%	83%	74%	84%	93%
Finland	92%	87%	74%	86%		79%	90%	86%	38%	88%	38%	90%	71%	71%	90%	74%	76%	61%	91%	87%
France	86%	90%	79%	90%	79%		67%	88%	71%	87%	45%	92%	39%	63%	91%	88%	95%	69%	75%	86%
Germany	81%	72%	80%	83%	90%	67%		68%	36%	74%	39%	76%	81%	72%	85%	66%	63%	63%	84%	87%
Greece	92%	96%	63%	76%	86%	88%	68%		51%	85%	33%	95%	44%	66%	86%	80%	86%	58%	76%	81%
Hungary	52%	57%	62%	64%	38%	71%	36%	51%		63%	43%	53%	32%	54%	66%	55%	65%	77%	37%	64%
Ireland	88%	88%	78%	89%	88%	87%	74%	85%	63%		46%	86%	64%	67%	89%	79%	82%	73%	83%	88%
Italy	36%	42%	42%	55%	38%	45%	39%	33%	43%	46%		43%	35%	49%	48%	37%	36%	30%	59%	48%
Lithuania	93%	96%	69%	84%	90%	92%	76%	95%	53%	86%	43%		45%	68%	92%	83%	91%	56%	85%	86%
Luxembourg	60%	49%	70%	64%	71%	39%	81%	44%	32%	64%	35%	45%		67%	63%	36%	28%	67%	62%	71%
Netherlands	65%	73%	57%	66%	71%	63%	72%	66%	54%	67%	49%	68%	67%		68%	50%	53%	57%	73%	73%
Poland	94%	89%	85%	93%	90%	91%	85%	86%	66%	89%	48%	92%	63%	68%		85%	89%	76%	83%	94%
Portugal	85%	83%	73%	82%	74%	88%	66%	80%	55%	79%	37%	83%	36%	50%	85%		88%	60%	71%	78%
Romania	85%	88%	69%	83%	76%	95%	63%	86%	65%	82%	36%	91%	28%	53%	89%	88%		59%	71%	81%
Slovenia	68%	59%	82%	74%	61%	69%	63%	58%	77%	73%	30%	56%	67%	57%	76%	60%	59%		45%	79%
Spain	82%	83%	67%	84%	91%	75%	84%	76%	37%	83%	59%	85%	62%	73%	83%	71%	71%	45%		82%
Sweden	87%	83%	87%	93%	87%	86%	87%	81%	64%	88%	48%	86%	71%	73%	94%	78%	81%	79%	82%	

Source: author's calculations based on data provided by Eurostat.

Table 3. Financial cycle's spillover effects matrix

	Austria	Belgium	Bulgaria	Czech Rep.	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Netherlands	Poland	Portugal	Romania	Slovenia	Spain	Sweden
Austria	12 %	6%	0%	5%	9%	8%	10 %	7%	4%	6%	0%	7%	7%	3%	4%	5%	6%	6%	4%	5%
Belgium	5%	16 %	1%	5%	6%	6%	5%	7%	1%	3%	0%	6%	5%	7%	5%	2%	5%	4%	3%	5%
Bulgaria	0%	0%	42 %	2%	0%	1%	0%	1%	3%	2%	6%	1%	1%	1%	0%	1%	1%	1%	1%	3%
Czech Rep.	6%	4%	4%	15 %	3%	4%	3%	4%	4%	6%	6%	3%	6%	5%	3%	7%	4%	5%	6%	3%
Finland	7%	6%	1%	6%	12 %	7%	8%	6%	1%	5%	0%	6%	6%	5%	7%	6%	8%	5%	6%	7%
France	8%	8%	2%	7%	9%	12 %	8%	9%	1%	5%	1%	9%	5%	4%	7%	6%	10 %	9%	7%	6%
Germany	9%	4%	0%	4%	8%	5%	18 %	4%	0%	4%	3%	4%	10 %	2%	6%	7%	4%	4%	7%	3%
Greece	9%	11 %	6%	6%	9%	11 %	8%	15 %	3%	5%	2%	11 %	4%	6%	11 %	4%	11 %	8%	5%	10 %
Hungary	1%	1%	6%	0%	0%	1%	0%	0%	55 %	0%	3%	1%	0%	1%	2%	1%	1%	1%	1%	0%
Ireland	4%	3%	1%	5%	3%	3%	3%	2%	5%	21 %	2%	2%	1%	0%	2%	6%	3%	2%	5%	1%
Italy	0%	0%	7%	2%	0%	0%	1%	1%	4%	1%	55 %	0%	2%	0%	0%	0%	0%	2%	1%	0%
Lithuania	7%	8%	4%	5%	8%	8%	7%	10 %	4%	4%	0%	17 %	3%	8%	6%	4%	10 %	7%	4%	7%
Luxembourg	2%	2%	1%	3%	2%	2%	5%	1%	2%	2%	4%	1%	28 %	6%	0%	1%	2%	4%	2%	1%
Netherlands	3%	4%	0%	3%	4%	2%	2%	3%	2%	1%	1%	5%	6%	29 %	1%	1%	4%	4%	1%	6%
Poland	3%	3%	2%	3%	3%	3%	3%	5%	2%	2%	1%	3%	0%	1%	24 %	5%	4%	0%	3%	4%
Portugal	4%	3%	2%	5%	3%	3%	4%	2%	1%	6%	1%	2%	1%	2%	5%	21 %	2%	3%	8%	2%
Romania	6%	7%	5%	7%	9%	9%	5%	8%	2%	6%	1%	9%	5%	6%	6%	4%	13 %	6%	4%	6%
Slovenia	3%	2%	1%	6%	2%	4%	2%	2%	1%	3%	7%	2%	5%	5%	1%	4%	2%	17 %	5%	5%
Spain	4%	5%	1%	5%	3%	4%	3%	3%	3%	8%	2%	1%	1%	1%	3%	10 %	3%	4%	20 %	1%
Sweden	4%	5%	11 %	5%	6%	5%	3%	7%	2%	4%	4%	7%	2%	7%	5%	4%	6%	6%	4%	24 %

Source: author's calculations based on data provided by Eurostat.

Table 4. Financial cycle's spillover effects matrix

	Austria	Belgium	Bulgaria	Czech Rep.	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Netherlands	Poland	Portugal	Romania	Slovenia	Spain	Sweden
Austria	8%	6%	5%	5%	6%	6%	4%	7%	5%	6%	6%	7%	3%	3%	6%	7%	7%	4%	6%	5%
Belgium	7%	7%	6%	6%	6%	7%	5%	7%	6%	6%	5%	7%	4%	5%	6%	7%	7%	5%	6%	6%
Bulgaria	4%	4%	9%	4%	3%	4%	4%	4%	3%	4%	2%	4%	4%	3%	4%	4%	4%	4%	3%	4%
Czech Rep.	6%	6%	7%	9%	6%	7%	5%	6%	6%	7%	6%	6%	4%	3%	6%	6%	7%	6%	7%	7%
Finland	5%	6%	5%	5%	7%	5%	5%	5%	4%	5%	2%	6%	4%	4%	5%	4%	6%	5%	5%	5%
France	6%	7%	6%	6%	6%	7%	3%	7%	5%	7%	4%	7%	2%	3%	6%	6%	7%	5%	6%	6%
Germany	3%	2%	3%	3%	4%	2%	14%	2%	2%	2%	1%	3%	8%	5%	3%	2%	2%	4%	3%	3%
Greece	7%	8%	7%	7%	7%	8%	5%	8%	7%	7%	5%	8%	3%	5%	7%	7%	8%	6%	7%	6%
Hungary	4%	4%	3%	4%	4%	4%	4%	4%	13%	4%	3%	4%	6%	8%	5%	3%	3%	7%	4%	5%
Ireland	5%	5%	5%	5%	5%	5%	2%	5%	4%	7%	4%	5%	3%	2%	5%	5%	5%	5%	5%	5%
Italy	2%	2%	1%	3%	1%	2%	1%	2%	2%	2%	27%	2%	1%	0%	2%	3%	2%	1%	3%	2%
Lithuania	8%	8%	6%	7%	8%	8%	6%	8%	7%	7%	5%	8%	4%	6%	8%	7%	8%	6%	8%	7%
Luxembourg	1%	1%	2%	1%	1%	1%	5%	1%	2%	1%	0%	1%	17%	5%	1%	0%	0%	4%	1%	2%
Netherlands	4%	4%	4%	4%	5%	3%	13%	4%	7%	3%	1%	4%	12%	27%	5%	3%	3%	6%	4%	6%
Poland	6%	5%	5%	6%	6%	6%	4%	6%	4%	6%	5%	6%	3%	2%	7%	6%	6%	5%	5%	5%
Portugal	4%	4%	2%	3%	3%	3%	1%	4%	2%	3%	7%	3%	1%	2%	3%	10%	4%	2%	3%	3%
Romania	6%	6%	5%	6%	5%	6%	3%	6%	3%	6%	4%	6%	1%	1%	5%	6%	8%	3%	5%	5%
Slovenia	3%	3%	4%	3%	3%	3%	4%	3%	6%	4%	2%	3%	6%	4%	3%	3%	2%	10%	3%	4%
Spain	5%	5%	6%	6%	6%	6%	6%	5%	5%	6%	7%	6%	4%	3%	6%	5%	5%	5%	10%	6%
Sweden	6%	7%	9%	7%	7%	7%	7%	6%	8%	7%	4%	6%	9%	7%	7%	6%	6%	8%	7%	10%

Source: author's calculations based on data provided by Eurostat.

Table 5. CLIFS's spillover effects matrix

	Austria	Belgium	Bulgaria	Czech Rep.	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Lithuania	Luxembourg	Netherlands	Poland	Portugal	Romania	Slovenia	Spain	Sweden
Austria	10%	5%	2%	2%	4%	5%	5%	5%	7%	2%	4%	6%	3%	3%	7%	3%	4%	4%	1%	5%
Belgium	8%	13%	6%	7%	6%	7%	5%	7%	5%	8%	6%	6%	3%	9%	5%	7%	5%	7%	4%	7%
Bulgaria	1%	2%	16%	4%	4%	1%	2%	2%	1%	3%	1%	1%	3%	3%	1%	2%	0%	4%	5%	1%
Czech Rep.	4%	6%	8%	16%	8%	3%	5%	5%	1%	9%	7%	4%	9%	6%	4%	7%	5%	5%	12%	3%
Finland	7%	7%	10%	11%	16%	5%	5%	8%	3%	10%	6%	6%	9%	6%	6%	7%	3%	7%	13%	2%
France	6%	6%	5%	5%	5%	14%	7%	6%	6%	5%	6%	9%	3%	6%	6%	4%	7%	6%	4%	7%
Germany	4%	4%	3%	3%	3%	4%	13%	4%	3%	1%	4%	5%	4%	5%	6%	3%	5%	2%	2%	3%
Greece	9%	8%	7%	6%	8%	7%	6%	12%	5%	6%	7%	7%	6%	5%	8%	7%	7%	8%	6%	6%
Hungary	4%	3%	1%	1%	2%	5%	6%	2%	34%	1%	2%	4%	1%	3%	3%	2%	6%	6%	0%	6%
Ireland	4%	3%	5%	7%	7%	2%	1%	4%	1%	21%	1%	3%	5%	3%	2%	6%	2%	3%	9%	2%
Italy	6%	6%	8%	6%	6%	7%	6%	6%	3%	4%	22%	7%	4%	6%	7%	4%	6%	4%	5%	4%
Lithuania	7%	6%	6%	5%	6%	8%	6%	7%	5%	5%	6%	12%	4%	6%	8%	4%	6%	5%	4%	5%
Luxembourg	2%	2%	2%	2%	3%	1%	5%	3%	1%	1%	2%	2%	19%	1%	4%	3%	3%	2%	3%	1%
Netherlands	3%	5%	3%	3%	2%	4%	5%	3%	5%	3%	3%	4%	3%	16%	2%	5%	3%	2%	2%	3%
Poland	7%	6%	5%	5%	6%	5%	7%	6%	4%	4%	5%	7%	5%	3%	15%	3%	5%	3%	3%	3%
Portugal	5%	5%	3%	4%	4%	3%	3%	5%	4%	9%	3%	3%	4%	4%	3%	20%	4%	3%	4%	5%
Romania	6%	6%	3%	5%	4%	9%	7%	7%	5%	4%	8%	8%	5%	6%	8%	4%	19%	4%	3%	7%
Slovenia	3%	3%	5%	4%	4%	2%	3%	3%	3%	2%	2%	2%	3%	2%	2%	1%	2%	21%	4%	1%
Spain	2%	2%	3%	3%	3%	1%	2%	2%	1%	1%	2%	1%	6%	3%	1%	5%	2%	4%	14%	3%
Sweden	3%	3%	1%	1%	0%	5%	2%	2%	5%	1%	2%	3%	1%	3%	3%	2%	5%	1%	1%	25%

Source: author's calculations based on data provided by Eurostat.

Table 6. Results of the regression model with cycles determined using the Band-Pass filter

Financial cycle correlations				
	Estimate	SE	t-stat	p-value
Intercept	-0.715	0.1061	-6.7393	1.94E-10
Trade links (Exp-Imp)	0.052234	0.19433	0.26879	0.78839
Systemic stress correlations (CLIFS)	0.95373	0.15431	6.1805	3.95E-09
Business cycle correlations	0.58237	0.098801	5.8944	1.74E-08
Number of observations: 190				
Error degrees of freedom: 186				
Root Mean Squared Error: 0.217				
R-squared: 0.377				
Adjusted R-Squared: 0.367				
F-statistic vs. constant model: 37.5				
p-value = 5.56e-19				

Source: author's calculations based on data provided by BIS, Eurostat, ECB and IMF.

Table 7. Results of the regression model with cycles determined using the Hodrick-Prescott filter

Financial cycle correlations				
	Estimate	SE	t-stat	p-value
Intercept	-0.51036	0.091937	-5.5512	9.67E-08
Trade links (Exp-Imp)	-0.01934	0.1684	-0.11483	0.90871
Systemic stress correlations (CLIFS)	0.78985	0.13372	5.9068	1.63E-08
Business cycle correlations	0.49518	0.085615	5.7838	3.04E-08
Number of observations: 190				
Error degrees of freedom: 186				
Root Mean Squared Error: 0.188				
R-squared: 0.362				
Adjusted R-Squared: 0.352				
F-statistic vs. constant model: 35.2				
p-value = 4.67e-18				

Source: author's calculations based on data provided by BIS, Eurostat, ECB and IMF.

Table 8. Results of the regression model on spillover effects

Financial cycle spillovers				
	Estimate	SE	t-stat	p-value
Intercept	-0.01179	0.005797	-2.0342	0.043113
Financial Claims	0.045599	0.014627	3.1174	0.002065
Trade links (Exp)	0.056685	0.015291	3.7072	0.000264
Systemic stress spillovers (CLIFS)	0.26613	0.083494	3.1875	0.001641
Business cycle spillovers	0.65866	0.088738	7.4225	2.40E-12
Number of observations: 228				
Error degrees of freedom: 223				
Root Mean Squared Error: 0.0249				
R-squared: 0.322				
Adjusted R-Squared: 0.31				
F-statistic vs. constant model: 26.5				
p-value = 5.73e-18				

Source: author's calculations based on data provided by BIS, Eurostat, ECB and IMF.

Table 9. Extended results of the regression models on spillover effects using all model combinations

Financial cycle spillovers					
Model combination	**Intercept**	**Financial Claims**	**Trade Links**	**Systemic Stress (CLIFS)**	**Business Cycle Spillovers**
M1000	0.03719373***	0.065158***			
M0100	0.040042969***		0.032677*		
M0010	0.020389364***			0.465769***	
M0001	0.008593124*				0.68782***
M1100	0.033242908***	0.06941***	0.040788**		
M1010	0.019454511***	0.047521***		0.39889***	
M1001	0.006035901	0.051676***			0.648219***
M0110	0.018369888***		0.027722	0.457241***	
M0011	-0.004925685			0.355744***	0.61403***
M1110	0.016848694***	0.051868***	0.034598**	0.382129***	
M1101	-0.003076275	0.056885***	0.062621***		0.711601***
M1011	-0.004900442	0.039356***		0.30383***	0.594639***
M0111	-0.011153638*		0.051197***	0.329136***	0.674631***
M1111	-0.011792041**	0.045599***	0.056685***	0.266135***	0.65866***

*10% significance level; **5% significance level; ***1% significance level.
Source: author's calculations based on data provided by BIS, Eurostat, ECB and IMF.

Table 10. Extended results of correlation-based regression models

Financial cycle correlations				
Model combination	Intercept	Trade Links	Systemic Stress correlation (CLIFS)	Business Cycle correlations
M100	0.356659***	-0.0255		
M010	-0.51262***		1.270818335***	
M001	-0.20901***			0.790081***
M110	-0.50923***	-0.08232	1.272878261***	
M101	-0.22179***	0.139062		0.796627***
M011	-0.71178***		0.95673209***	0.579255***
M111	-0.715***	0.052234	0.953733574***	0.582375***

*10% significance level; **5% significance level; ***1% significance level.
Source: author's calculations based on data provided by BIS, Eurostat, ECB and IMF.