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## Spillovers between European markets

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### 1. Introduction

The topic of financial integration attracted research interest after the Asian and Russian crises in the late '90s, and the Great Financial Crisis (GFC) in 2007–2009. However large the economic benefits of integration are (see e.g. Campos et al., 2019), it also makes it harder for investors to diversify portfolios and shield them from financial shocks and contagion. As noted by Raju and Pavto (2019) most of the articles focus on Asian economies and their relationships with the US or the UK. In Europe, attention focused on Greece and Turkey, as well as the Central and Eastern European (CEE) markets. A large bibliometric study performed by Patel et al. (2022) found the main areas of research interest to have been: I) portfolio diversification; II) equity markets integration; III) the impact of crises and other events on financial linkages; IV) time-varying financial integration; V) comovements and spillovers between commodities and financial markets.

Financial markets are considered to be integrated if the assets with the same level of risk offer the same expected returns (Bekaert, Harvey, 1995). Integrated markets experience the same sources and levels of risk, which means the expected returns can be explained by covariance with a benchmark world portfolio. In segmented markets, returns depend on other risk factors, and domestic variance becomes important.

Various measures of financial integration have been proposed. Raju and Pavto (2019) mention Johansen's cointegration test, Granger causality, VAR, VECM, impulse response and variance decomposition (spillover) methods as the most popular in the sample of 223 papers between 1972–2018. There were also attempts to utilize machine learning techniques (Akbari et al., 2021), graphs (Bastidon et al., 2020), or panel models (Boubakri et al., 2012).

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A number of studies found evidence for a strong relationship between developed markets in the 20th century (e.g. Koutmos, Booth, 1995; Kim et al., 2004). However, the focus was always on the integration between developed and developing markets, as it provided the opportunity for investors to diversify their portfolios. At the beginning of the 21st century, researchers moved their attention to CEE countries about to access the European Union: mainly Poland, Hungary, and the Czech Republic. Early research reported ambiguous results: some found low or insignificant dependencies between CEE and EU (Kim et al., 2004; Guidi, Gupta, 2009), while some showed a long-run comovement (Jochum et al., 1999; Vizek, Dadić, 2006; Yang et al., 2006). However, the integration between old and new EU seemed to grow stronger over time (Poghosyan, 2009), especially after the episodes of crisis (Yang, Hamori, 2015; Baumöhl et al., 2018). The literature analysis showed that 5 studies found no change in integration among CEE, 1 decreasing integration, and 46 increasing integration: 24 among CEE markets, 13 among European markets, and 9 between CEE and international markets (Inzinger, Haiss, 2006).

Also, regulatory changes may impact dependencies, mostly by opening up the economy for capital flows. Demian (2011) investigated the accession of CEE markets to the EU. He found that the cointegration increased, but accession provided more of an indirect stimulus for the change in financial and economic factors than a direct cause. Similar results were found by Guidi and Gupta (2009).

Baumöhl et al. (2018) performed a network analysis of a large set of 40 developed, emerging, and frontier markets, using Granger causality. They found that interconnectedness peaked during the GFC in 2008. Indirect relationships turned out to be stronger than direct ones; markets' size, liquidity, openness, and whether they are export or import-driven, played a significant role as well.

The aim of this paper is to analyze how the level of financial integration of European markets has changed through time, and what events could affect the dependencies. Integration is measured through the Spillover Index with rolling window, as in Diebold and Yilmaz (2012), that is, the amount of spillover between a given market's MSCI index and the compound European or World index. This strategy allows to observe the fluctuations in spillover through time, in both a regional and global context. Contrary to most studies of financial spillovers, this one takes a broader perspective, including frontier markets which have been little inspected so far. It spans through two decades, focusing on spillover in years after the Global Financial Crisis. Some preliminary observations about the impact of the COVID-19 pandemic are provided as well.

As expected, the more developed the market, the more financial shocks it exchanges with both European and World indices. Spillover levels rise substantially

during the crises, however, in most cases, it falls back to previous levels afterwards. The study does not support the hypothesis, that the spillover between emerging or frontier and developed European markets has risen in long term due to regulatory or economic integration. This is an important property, as it preserves non-developed markets' role in diversification – despite the fact that they will most likely still experience the transmission of financial shocks in case of a crisis.

The broad perspective of this study is also its main limitation. As I analyze the relationships between European market indices and compound indices for the World and Europe, I can only track the spillovers between a given market and its surroundings as a whole. The details of how shocks are transmitted from market to market are lost in aggregation.

## 2. Data & methodology

### 2.1. MSCI Indices

MSCI methodology groups countries into three categories: developed, emerging, and frontier, including, respectively, 15, 6, and 8 European countries, as listed in Table 1. The dataset consists of daily quotes in € for these three indices and their components, ranging from 01.01.2000 to 26.11.2021 for developed and emerging markets. Due to lacks in data, quotes of Frontier markets' indices are taken from 30.05.2008 onward.

Figure 1 presents the values of the Compound Indices of developed, emerging, and frontier markets. The latter starts with June 2002, while the former two in January 2001. Despite differences in scale, all of the indices seem to follow a similar path: they dropped down at the beginning of the century, then took a turn in 2002, which can be attributed to recovery from the Asian and Russian crises in the late '90s. The indices peaked in 2007, just before a sharp decline during the GFC. Around 2012 they began to part ways: while the Developed Index rose steadily to reach before-crisis levels at the end of the sample, the other two remained around the post-crisis levels. However, all of them plummeted during the 2020 crisis caused by the COVID-19 pandemic.

Table 2 presents descriptive statistics of daily logarithmic return rates of the MSCI indices. Typically for return rates, most of them concentrate around zero, with a relatively small standard deviation, negative skewness, and large kurtosis. This means that most of the time a return rate would fall just above zero, with few yet severe losses. All of the series are stationary, tested with the Augmented Dickey–Fuller test with a p-value < 0.01.

**Table 1**  
MSCI Market Classification

Developed Markets	Emerging Markets	Frontier Markets
Austria	Czech Republic	Croatia
Belgium	Greece	Estonia
Denmark	Hungary	Iceland
Finland	Poland	Lithuania
France	Russia	Kazakhstan
Germany	Turkey	Romania
Ireland		Serbia
Italy		Slovenia
Netherlands		
Norway		
Portugal		
Spain		
Sweden		
Switzerland		
United Kingdom		

Source: MSCI

**Table 2**  
Descriptive statistics of MSCI indices' returns

Market	Median	Mean	Standard deviation	Skewness	Kurtosis	Minimum	Maximum
Developed	0.0005	0.0000	0.0132	-0.3866	12.1863	-0.1406	0.1070
Emerging	0.0008	0.0000	0.0177	-0.5236	14.6250	-0.1993	0.1860
Frontier	0.0005	0.0002	0.0114	-0.6861	12.4091	-0.1005	0.0817
World	0.0006	0.0001	0.0102	-0.6305	14.5434	-0.1044	0.0910
Austria	0.0005	0.0001	0.0174	-0.3863	11.6645	-0.1665	0.1335
Belgium	0.0003	0.0000	0.0148	-0.7374	14.1544	-0.1822	0.1066
Denmark	0.0005	0.0004	0.0137	-0.3633	9.8979	-0.1351	0.1071
Finland	0.0001	-0.0001	0.0199	-0.4393	11.3465	-0.2007	0.1591
France	0.0005	0.0001	0.0152	-0.2568	10.7663	-0.1490	0.1184

Table 2 cont.

Germany	0.0005	0.0001	0.0155	-0.2548	9.5576	-0.1509	0.1159
Ireland	0.0002	-0.0001	0.0171	-0.7524	13.2824	-0.1893	0.1360
Italy	0.0003	-0.0001	0.0164	-0.6059	13.7485	-0.2054	0.1247
Netherlands	0.0005	0.0001	0.0144	-0.2951	10.0757	-0.1209	0.1053
Norway	0.0006	0.0001	0.0179	-0.5227	10.8998	-0.1422	0.1539
Portugal	0.0002	-0.0001	0.0141	-0.3303	10.6520	-0.1383	0.1182
Spain	0.0001	0.0000	0.0164	-0.2742	12.4291	-0.1722	0.1601
Sweden	0.0003	0.0001	0.0179	-0.1321	8.5432	-0.1481	0.1405
Switzerland	0.0003	0.0002	0.0115	-0.2221	10.0796	-0.1133	0.0973
UK	0.0004	0.0000	0.0135	-0.3903	14.1749	-0.1421	0.1216
Czech Republic	0.0005	0.0003	0.0163	-0.3394	15.8372	-0.1675	0.1972
Greece	0.0000	-0.0007	0.0233	-0.5241	12.6481	-0.2506	0.1717
Hungary	0.0005	0.0002	0.0205	-0.2014	12.2612	-0.2035	0.2031
Poland	0.0001	0.0000	0.0187	-0.3521	8.6748	-0.1765	0.1423
Russia	0.0006	0.0002	0.0228	-0.4731	15.1032	-0.2559	0.2398
Turkey	0.0001	-0.0002	0.0265	-0.3013	12.1492	-0.2742	0.2201
Croatia	0.0001	0.0001	0.0130	-0.3190	13.4326	-0.1207	0.1059
Estonia	0.0000	0.0002	0.0152	-0.1141	11.1351	-0.1317	0.1254
Kazakhstan	0.0000	0.0003	0.0227	0.0591	11.9553	-0.1530	0.1868
Lithuania	0.0000	0.0000	0.0131	0.8607	46.9624	-0.1466	0.2342
Romania	0.0002	0.0001	0.0186	-1.6035	29.2707	-0.3162	0.1253
Serbia	-0.0003	-0.0005	0.0174	-0.1559	20.9048	-0.1622	0.1889
Slovenia	0.0003	0.0002	0.0136	-0.1568	12.7391	-0.1262	0.1467

Source: own analysis; source of data: MSCI

Most of the developed European countries are members of both the EU and Eurozone. The group of emerging economies contains only one old member with a Euro currency – Greece. The rest of them joined in 2004 and did not adopt the Euro (Czech, Hungary, Poland), or did not join at all (Turkey, Russia). Among frontier economies, there are three that joined in 2004 as well (Estonia, Lithuania, and Slovenia), two that joined later on (Croatia and Romania), and two outside of the community (Kazakhstan, Serbia).

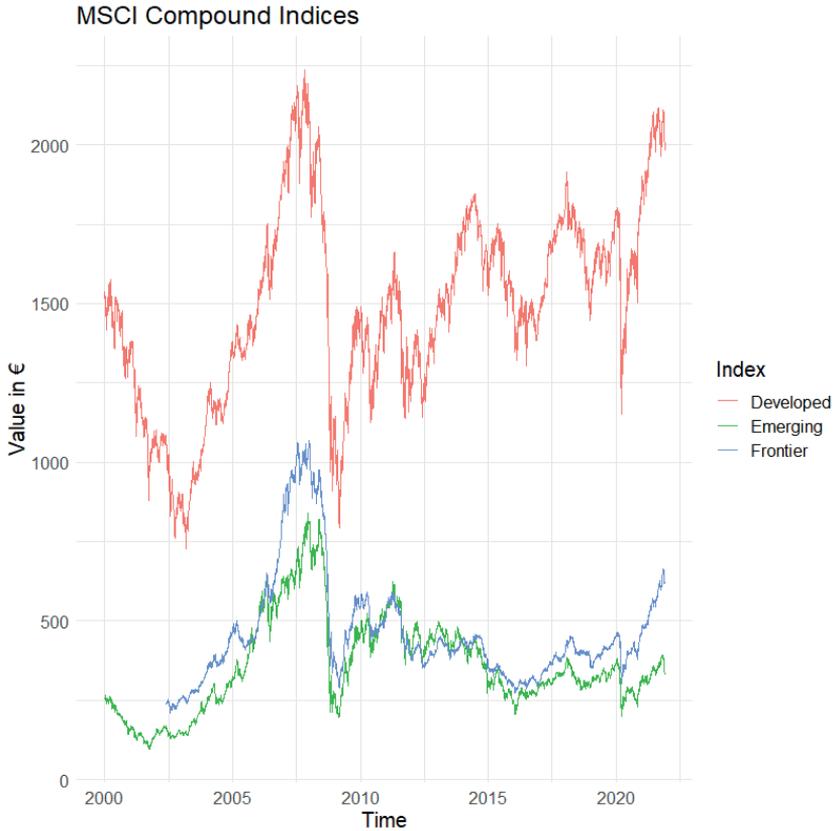


Figure 1. MSCI Compound Indices; source: MSCI

## 2.2. Financial integration

There are several well-described methods of measuring markets' integration, divided by two main types: *de facto* and *de jure*. *De jure* methods capture the regulations, restrictions, and openness of financial markets (see, for example, Schindler, 2008). It has been noticed, however, that formal restrictions are not the only ones limiting market integration, and financial compatibility is not the same as actual dependence (Quinn et al., 2011; Bekaert, Harvey, 1995). *De facto* methods are typically based on Causality, Correlation, Cointegration, VECM, or VAR models.

The method used in this paper is based on the Variance Decomposition from the VAR model, proposed by Diebold and Yilmaz (2012, 2008), further called the

DY method. In order to omit the problem with variable ordering, their proposition is based on the generalized VAR(p) model (Sims, 1980), given by equation:

$$x_t = \sum_{i=1}^p \Phi_i x_{t-i} + \epsilon_t \quad (1)$$

where  $\epsilon$  is a vector of independently and identically distributed disturbances. It can be expressed as a moving average:

$$x_t = \sum_{i=0}^{\infty} A_i E_{t-1} \quad (2)$$

$A_i$  is an  $N \times N$  coefficient matrix:

$$A_i = \sum_{j=1}^p \Phi_j A_{i-j} \quad (3)$$

with  $A_0$  being an identity matrix, and  $A_i = 0$  for  $i < 0$ .

The fraction of  $H$ -step-ahead forecast error variance of  $x_i$  caused by shocks in  $x_j$  is defined as follow:

$$\Theta_{ij}^{\otimes}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=1}^{H-1} \left( e_i' A_h \sum e_j \right)^2}{\sum_{h=1}^{H-1} \left( e_i' A_h \sum A_h' e_i \right)} \quad (4)$$

As the shocks are not orthogonalized, the sum of variance decomposition elements may not be equal to 1. To achieve this property, they can be normalized:

$$\widetilde{\Theta}_{ij}^{\otimes}(H) = \frac{\Theta_{ij}^{\otimes}(H)}{\sum_{j=1}^N \Theta_{ij}^{\otimes}(H)} \quad (5)$$

Directional spillover index can be simply computed as the sum of spillovers transmitted from all markets  $j$  to market  $i$ , or from market  $i$  to all markets  $j$ , normalized as above.

High spillover between two given markets can be interpreted as the sign of high integration in the sense most meaningful to investors, i.e. how much the disturbances in one market/instrument will affect the other. However, it could be pointed out that the measure itself depends on the presence of those disturbances. In turbulent times, the integration would be higher, even if *de jure* measures stayed the same (meaning that the restrictions have not change and markets did not become more open).

In this article the financial integration of market  $i$  will be defined as the amount of spillover from MSCI Developed Europe index to MSCI index of that country, plus the spillover of country's index to Developed Europe. Highly integrated

markets would be the ones that easily exchange volatility shocks with leading European markets. Such defined Spillover Index will be computed in 260-day-long rolling windows, so that the index's value for a given time point can be interpreted as the amount of spillover between market's index and the Developed Europe index in the last year.

### 3. Results

Table 3 presents the Total Spillover Index for the period from 2008 to 2021, where all MSCI indices were available. (However, the values for developed and emerging markets computed for the whole period did not differ much). It is apparent, that the markets with high spillover with Europe tend to have high spillover with the World Index as well, however, the spillover with Europe is always higher. Unsurprisingly, the biggest spillovers are found among the largest developed economies. Among emerging markets, some (namely Poland and Hungary) represent levels of spillover similar to smaller developed economies, while Turkey and Greece stay more at the level of frontier markets. EU membership and whether or not a country adopted euro, do not seem to play a role.

The last two columns contain measures of distance between rolling spillover with European and World Indices. Distance is measured with the Dynamic Time Warping method, as described by Giorgino (2009), normalized for series' length. Most Frontier markets (but also Russia and Turkey) have more similar spillovers with both indices, compared to developed and emerging markets, where the discrepancies tend to be bigger.

Next, I compute the rolling spillover in order to analyze changes in time. In result I get a time series for each market, representing the level of spillover in one year time frame. All of the series for developed and emerging markets seem to have a low, but significant positive trend ( $p$ -value  $< 0.001$ ). However, it is most likely due to a huge increase in spillover during the GFC, as the series exhibit a significant structural break, and in the post-crisis period the trend is significantly negative (although still very low). These findings do not support the hypothesis that the spillover increase in time, as the markets integrate – at least in the period considered.

The Rolling Spillover Indices are presented in five groups:

- developed markets that adopted the Euro in 2002 (Fig. 2);
- developed markets that retained their national currencies (Fig. 3);
- emerging markets (Fig. 4);
- frontier markets that adopted the Euro (Fig. 5);
- frontier markets with their national currencies (Fig. 6).

Note that the last two groups only cover the years 2008–2021.

The first group consists of Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain. At the beginning of the considered period, values of the Spillover Index cover the span of 0 to almost 50. However, they rise steeply after 2004 to above 20, clearing the lower part of the plot. They also share a similar behavior in times of crisis. There are visible jumps in 2007, 2010, 2011, 2016, and 2020, impacting all of the indices in the same way. Interestingly, the spillover did not fall back after the Euro crisis in 2012. It seems contrary to the decrease of banks' cross-border activity and financial integration (potential channels for spillovers), noted, among others by Lane and Millesì-Ferrati (2018). However, as the authors point out, direct foreign inflows actually increased, mainly due to the expansion of international companies and moving capital to financial centers with favorable taxation.

The second group consists of Denmark, Norway, Sweden, Switzerland, and the UK. Denmark and Sweden belong to the EU, as well as the UK for most of the considered period (up to 2020). The reactions to crisis events are quite similar to those shown in Figure 2, however, the levels of spillover tend to fall back to almost pre-crisis levels.

The emerging group consists of the Czech Republic, Greece, Hungary, Poland, Russia and Turkey. All of the indices follow roughly the same path, with small values at the beginning, the highest and the most prolonged increase during GFC and Eurozone Debt Crisis, as well as shorter jumps in 2016 and 2020.

There are three frontier markets - Estonia, Lithuania, and Slovenia, that have joined EU and adopted euro. Their Spillover Indices are shown in Figure 5. The time series starts in 2009 due to lack of MSCI data from before. The values are generally low (most below 20). At the beginning of the period, they are the highest and most volatile, in the middle (2014–2018) - the lowest. There is a significant jump in 2020 due to the COVID-19 pandemic. All three indices share a similar behavior.

The frontier markets with their national currencies are: Croatia, Kazakhstan, Romania, and Serbia. Here, as well, the spillover is generally low, with higher values before 2014 and spike in 2020, although Romania and Serbia experienced high values also in the period in-between.

In almost all markets, no matter the group, the spike related to the COVID-19 pandemic was one of the steepest in the considered period. In most cases the biggest increase happened on March 12<sup>th</sup>, which can be attributed to the crash on the American stock market, one of the biggest in history. It is a clear example of how the shocks can be transmitted through the information and investors' panic, as the spillover happened almost instantly in all of European markets, regardless of observed COVID-19 cases or imposed restrictions. Interestingly, the impact of the pandemic on spillovers' levels ended in March 2021, way before the end of the underlying health crisis.

**Table 3**  
Total Spillover Index

Market	Spillover with European Index	Spillover with World Index	Distance (whole period)	Distance (short period)
Austria	19.89	15.56	1.23	2.52
Belgium	20.23	15.65	2.6	1.94
Denmark	18.41	14.34	1.45	1.84
Finland	20.56	15.96	1.96	1.37
France	23.63	18.31	4.53	5.16
Germany	22.97	18.21	3.77	4.81
Ireland	18.09	14.4	2.1	1.48
Italy	22.05	16.31	3.92	4.14
Netherlands	22.61	18.06	2.59	2.77
Norway	19.65	16.09	0.99	1.33
Portugal	18.77	13.9	1.91	1.98
Spain	21.69	16.19	3.36	2.57
Sweden	21.69	17.19	1.98	2.67
Switzerland	21.29	16.74	2.23	2.46
UK	22.77	18.43	2.72	2.1
Czech Republic	15.27	11.95	1.06	1.31
Greece	10.67	8.18	0.8	1.15
Hungary	16.29	12.9	0.85	1.81
Poland	17.49	13.64	0.94	1.9
Russia	14.19	12.75	0.44	1.01
Turkey	11.37	9.45	0.47	0.8
Croatia	10.68	9.19	-	0.74
Estonia	7.8	6.41	-	0.45
Kazakhstan	6.03	6.71	-	0.36
Lithuania	8.52	7.26	-	0.81
Romania	11.72	9.63	-	1.13
Serbia	5.37	5.0	-	0.69
Slovenia	8.78	7.81	-	0.97

Source: own analysis



Figure 2. Rolling Spillover Index between European Index and developed markets that adopted euro

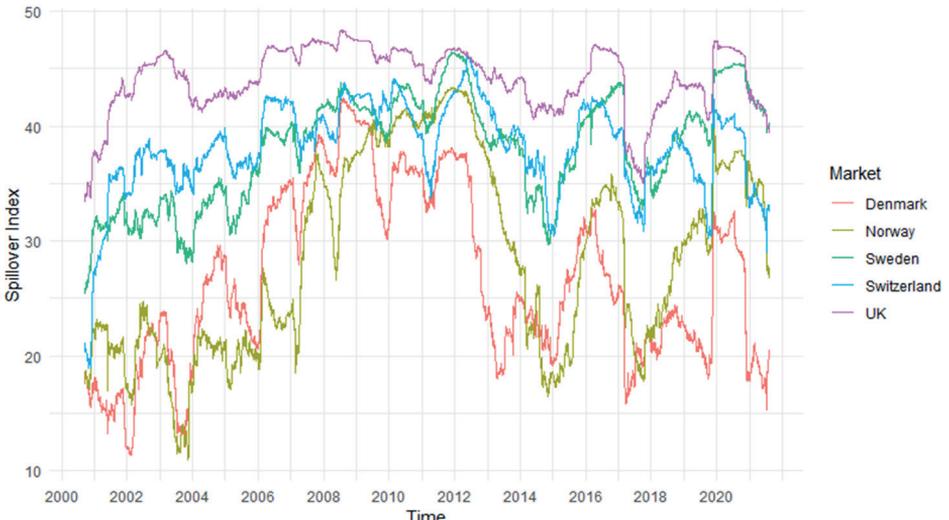


Figure 3. Rolling Spillover Index between European Index and developed markets that have not adopted euro

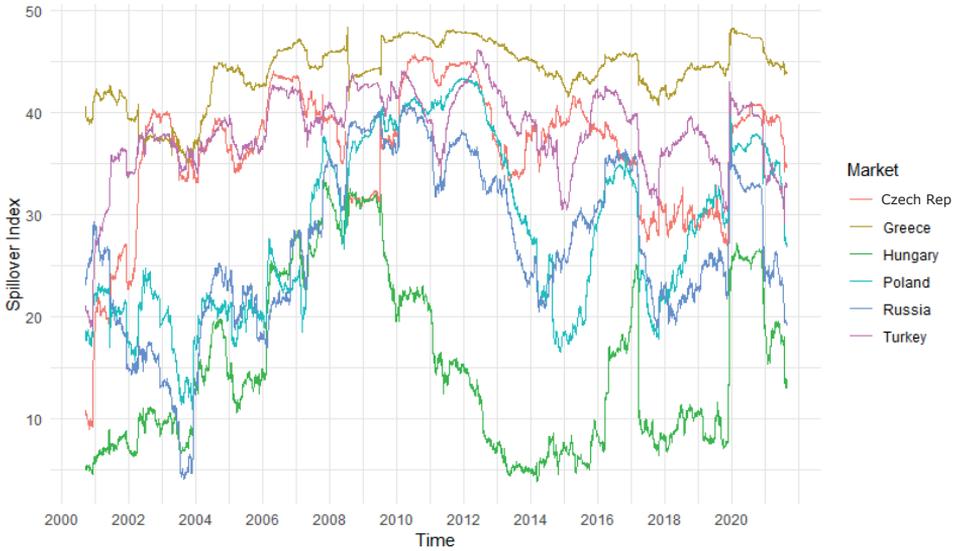


Figure 4. Rolling Spillover Index between European Index and emerging markets

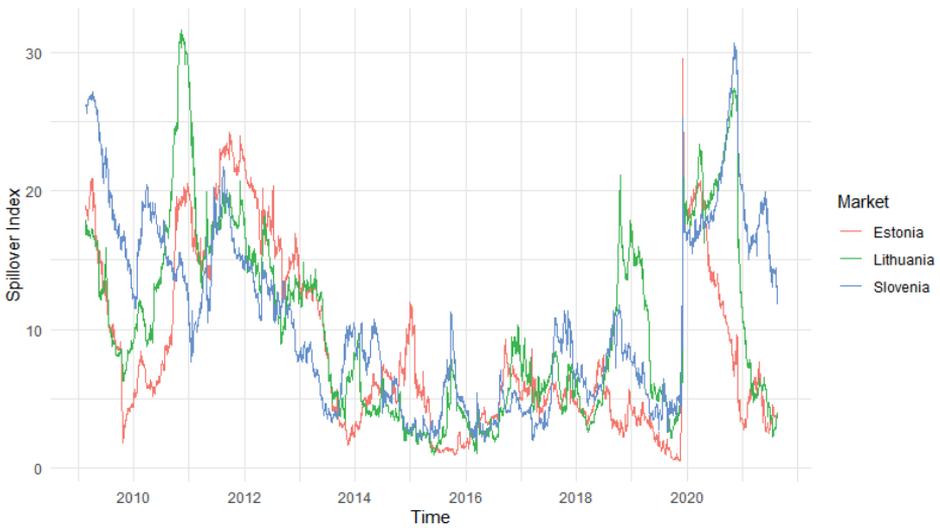
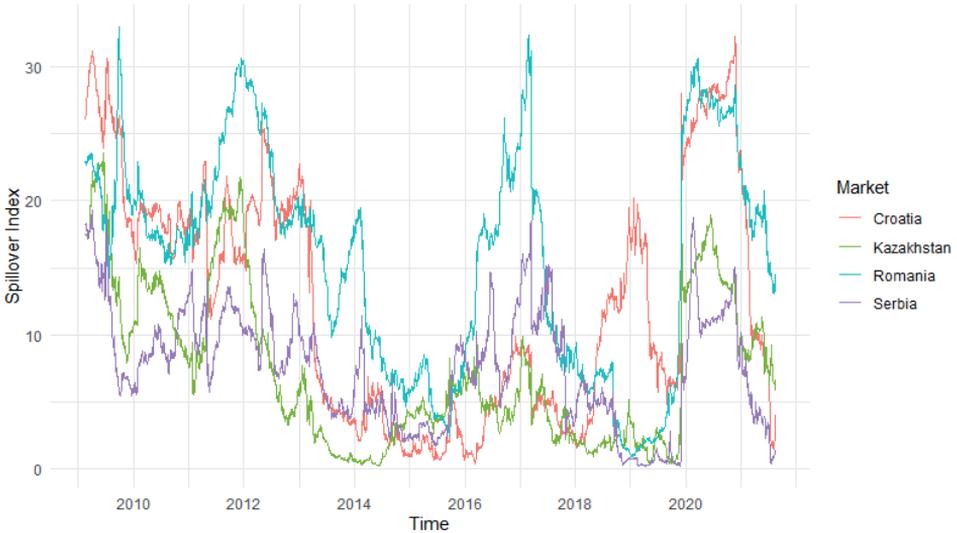


Figure 5. Rolling Spillover Index between European Index and frontier markets that adopted euro



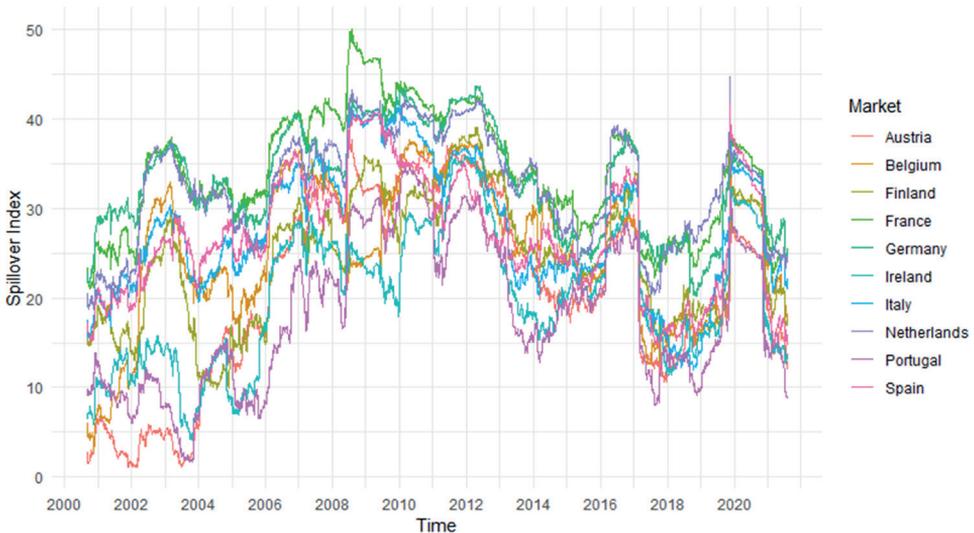
**Figure 6.** Rolling Spillover Index between European Index and frontier markets that have not adopted euro

The same analysis of rolling spillover between markets and the World Index yielded almost identical results, which can be partly due to a fact that the World and European Index are highly correlated (Pearson’s correlation coefficient of the differences equals 0.82). The main difference was noticeable in the group of developed markets with the Euro, presented in Figure 7, where the amount of spillover was substantially lower, and fell back almost to the pre-crisis levels in 2014.

The difference is, that for developed markets, the indices fell down after the 2007–2012 period, while the spillovers with European Index stayed at a high level afterward. Also, the spillover with the World Index was generally lower in the years 2014–2019 and reacted more strongly to the COVID-19 pandemic (especially in non-developed markets).

Figure 8 provides a comparison of the Rolling Spillover Index with Developed Europe Index and the World Index for three chosen markets. As can be seen in Table 3, France had the highest summary difference between the spillovers with Europe and the World. The pattern of ups and downs is quite similar, but the spillover with Europe is always much higher – with the exception of a brief period

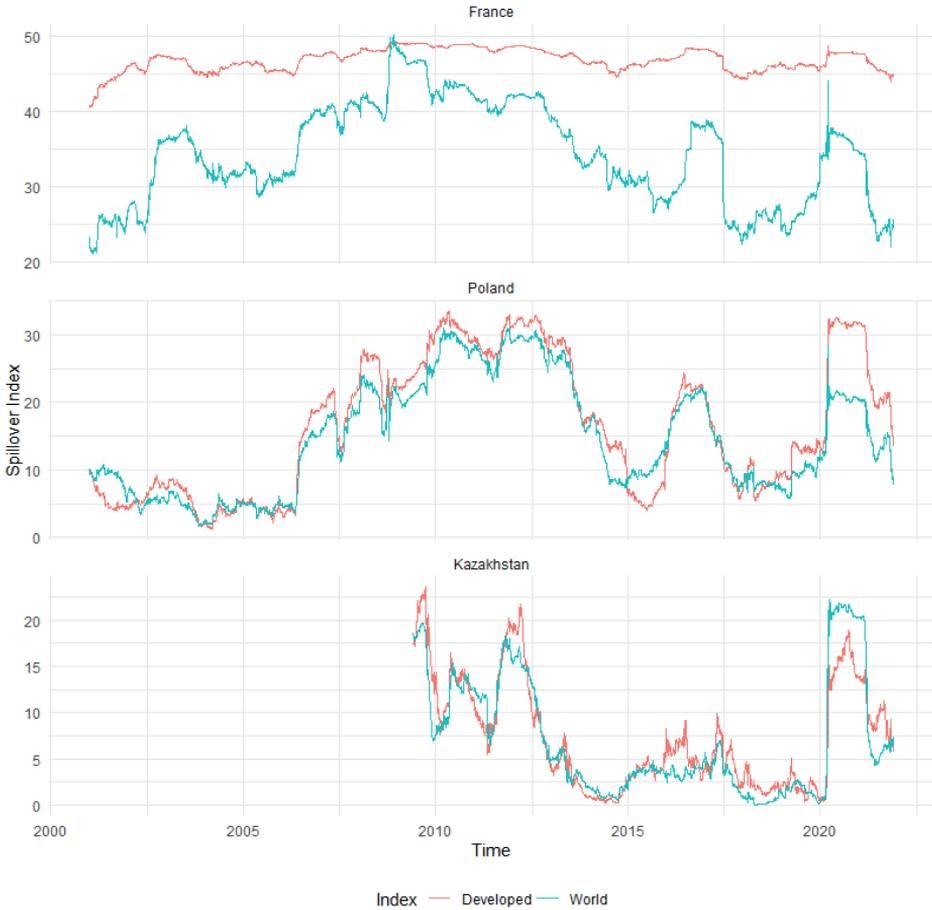
at the beginning of the GFC. The Spillover with World Index is also characterized by higher volatility.



**Figure 7.** Rolling Spillover Index between World Index and developed markets that adopted euro

Kazakhstan, on the other hand, had the most similar spillovers. The only noticeable disparity was during the COVID-19 pandemic, where the spillover with World Index become higher than with Developed Europe. Among emerging markets, the relation between spillover with World and European Indices is similar. Both follow a nearly identical path and only diverge during the pandemic, when the spillover with European Index went much higher.

In addition to the conclusions from Figure 7 and Table 3, this shows that developed markets are more connected to the region, while the others received the shocks from World and developed Europe in a similar way. In conclusion, the origin of the crisis is more important for developed markets, as they will be more affected if the shocks are transmitted from other developed markets from the region.



**Figure 8.** Comparison between Rolling Spillover Indices with World and European Index for three selected markets

### 4. Conclusions

The aim of this paper was to analyze spillovers between European markets, the European Index, and the World Index, over a period of two decades (2000–2021). Because of the missing data for some of the frontier markets before 2008, they were analyzed in a shorter time frame. All of the indices, as well as market classifications, are provided by MSCI.

In Europe, markets with higher spillover with European Index tend to have high spillover with World Index as well, although the latter is usually lower. Both measures showed a pronounced dependency on crisis events. Especially the turbulent time started by Global Financial Crisis and stretched by the Eurozone Debt Crisis caused higher spillover levels for many years. Between the developed markets and the European Index this shift was even permanent (e.g. lasted at least to the end of the considered period). Some smaller events, like the COVID-19 pandemic, raised the spillover for a while, but plummeted almost to the previous level afterwards.

Changes in spillover in times of Great Financial Crisis, Eurozone Debt Crisis, and the COVID-19 pandemic are noticeable across all European markets. On the contrary, in 2016 there were jumps in spillover in all developed and emerging markets, but the reactions among Frontier markets were mixed.

Three main points can be driven from this analysis.

Firstly, it proves that although European frontier and (to a smaller extent) emerging markets still offer some diversifying potential, they are not fully shielded from the effects of widespread financial and non-financial crises, as the spillover rises substantially in turbulent times. This is an important property for investors, as it can undermine their diversification attempts just when they are most needed. On the other hand, spillover levels in tranquil periods did not substantially increase in the last two decades, despite ongoing integration with developed European markets. It suggests that the transmission of financial shocks may happen more due to stock markets' panic, than the changes in transmission channels – and so the non-developed markets would continue to provide diversification opportunities for the years to come.

Secondly, after a crisis, spillovers usually fall back to roughly pre-crisis levels. The exception was found in the group of developed markets in Eurozone, which continued to have high levels of spillover with European Index after the European Debt Crisis – despite the known contraction of cross-border banks' activity. This can be due to an increase in multinational companies and moving financial activities to the countries with more favorable taxation, which creates cross-border channels for spillovers. The effect was not observed for the World Index, where the spillover reduced after the crisis.

Lastly, I draw some preliminary findings about the effect of COVID-19 pandemic in the context of financial spillovers. In all European markets, its beginning was marked by a high spike in spillovers to the levels observed during the GFC. It lasted about a year and fell back just as suddenly. The almost identical reaction to the pandemic across markets may suggest that a global panic had a more pronounced effect on stock markets than local economic restrictions – although a more precise study would need to be carried out to test this hypothesis.

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### Summary

Financial integration has been proven to benefit European economies. However, it may obstruct diversification attempts, and so attracts the attention of investors and researchers. The aim of this paper is to analyze changes in spillovers between European markets, the European Index, and the World Index, over a period of two decades (2000–2021), with regard to the level of development. Mature markets have higher spillovers than emerging and frontier ones. The main finding is that non-developed markets' spillover levels in tranquil periods did not substantially increase in the last two decades, despite ongoing integration with developed European markets. However, spillover rises in time of global or regional crisis (e.g. Great Financial Crisis, Eurozone Debt Crisis, COVID-19 pandemic) for all markets, regardless of economic development, which can undermine diversification attempts just when they are most needed. Afterwards, the transmission of shocks falls back to the pre-crisis level, with the exception of the spillover between Eurozone markets and European Index, which remained very high even after the end of the particular crisis.

*JEL codes:* F15, F36, G01

**Keywords:** *spillovers, European markets, financial crisis, financial integration*