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Financial Integration at Times of Financial Instability*

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Abstract
This article empirically analyzes the phenomenon of financial integration, focusing primarily on assessing the impacts of the current financial crisis. We start our analysis with an overview of cost-benefit considerations associated with the process of financial integration. We go on to examine the relationship between financial integration and financial instability, emphasizing the priority role of financial innovation. The subsequent empirical section provides an analysis of the speed and level of integration of the Czech financial market and the markets of selected inflation-targeting Central European economies (Hungary and Poland) and advanced Western European economies (Sweden and the UK) with the euro area. The results for the Czech Republic reveal that a process of increasing financial integration has been going on steadily since the end of the 1990s and also that the financial crisis caused only temporary price divergence of the Czech financial market from the euro area market.

1. Introduction

Structural changes in the economic environment, such as real synchronization of economies or advanced financial integration, affect economic agents and institutions (i.e., central banks, national governments, and financial institutions) both individually and systematically. Integration can increase the investment opportunities of individual financial institutions, allowing them to make higher returns at the same level of risk. On the other hand, if individual financial institutions are exposed to the same risks, the risks of their portfolios as a whole are not necessarily diversified at all and the positive effect of market integration may thus be reduced. Identical risks arise because of, for example, the choice of a similar portfolio and/or the similarity of "aggregate" risks. These risks are amplified by investors' traditional search for yield. Moreover, the financial sector as a whole may be more vulnerable to systemic risk and contagion risk in conditions of high geographical and sectoral integration of the banking and other financial markets. Whether the benefits of

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deepening financial integration outweigh the risks, and whether this process will lead to increasing financial stability, depends largely on the resilience and flexibility of the financial system itself, which national and international authorities should be working to enhance.

Financial stability can be defined as the condition where the financial system is able to direct capital to its most profitable investment opportunities without major disturbances (ECB, 2007). In other words, the financial system is stable if it is capable of absorbing shocks without disruptions to the financial intermediation process. Otherwise, it can collapse, with a related detrimental impact on the real economy. It follows that the financial system does not meet the stability definition when it is stable but does not have the capability of efficiently allocating capital (Pauer, 2005).

A commonly used definition for "financially integrated market" is that of Baele et al. (2004) and Weber (2006), i.e., the market for a given set of financial instruments and/or services is fully integrated if all potential market participants with the same relevant characteristics: (1) face a single set of rules when they decide to deal with those financial instruments and/or services; (2) have equal access to the above-mentioned set of financial instruments and/or services; and (3) are treated equally when they are active in the market. Most definitions of financial integration are closely linked to the law of one price (i.e., assets having identical risks and returns should be priced identically regardless of where they are transacted). The law of one price allows for operational measures of financial integration, as will be discussed in Section 3. However, fulfillment of the definition based on the law of one price does not automatically mean achievement of full market integration—see the broader definition of financial integration given above. This broad definition of financial integration contains three important features. The first is that it does not require financial structures to be identical within regions. It is natural for individual countries (regions) to have their own financial architecture and this need not be a barrier to financial integration. The second feature is linked with the existence of frictions in the financial intermediation process, which can persist even after a high degree of financial integration has been achieved and which should affect the integrating regions symmetrically. The third feature stems from the separation of the supply of, and the demand for, investment opportunities (the creditor and debtor sides, respectively). A highly integrated market requires the same access to financial intermediation or trading, clearing and settlement platforms for both parties regardless of their country of origin.

Financial stability and financial integration might influence each other via different channels. On the one hand, there is a financially stable system (i.e., financial institutions, markets, and infrastructures), which is part and parcel of effective allocation of capital, and on the other hand, there is the financial integration process, which brings about efficient capital allocation. It appears from this that the effects of financial market integration promote financial stability. The elimination of barriers to entry and the harmonization of regulations (within the EU, for example) intensify competition and the pressure on financial intermediaries to offer price concessions to their customers. This, in turn, reduces transaction costs and consequently facilitates more efficient allocation of financial resources.

This article primarily analyzes the financial integration of the Czech financial market (the money, foreign exchange, government bond, and equity markets) with the financial market of the euro area (or Germany for the government bond market) at times of financial instability. The article also includes analogous results for selected inflation-targeting Central European economies (Hungary and Poland) and advanced Western economies (Sweden and the UK). The article is organized as follows. Section 2 discusses cost-benefit considerations associated with the process of financial integration. Section 3 presents the methodology and the data used to measure financial integration. Section 4 presents the estimation results. The last section concludes.

2. Financial Integration: Cost and Benefit Considerations

Financial integration generates benefits and costs for individual entities, be it directly or indirectly. Many research papers, e.g., Edison et al. (2002), Agénor (2003), Baele et al. (2004), Komárková and Komárek (2007), and ECB (2010), point to the need for detailed knowledge of these costs and benefits in order to maximize the benefits and minimize the costs associated with the financial integration process. The experience of the ongoing financial crisis has increased the importance of this debate. The most frequently mentioned benefits of financial market integration include: (i) consumption smoothing due to international diversification of risks (reduction of large country-specific shocks), (ii) the positive effect of capital flows on domestic investment and economic growth, (iii) improving efficiency of the financial system, and (iv) increasing prudence of financial market agents and the attainment of a high level of financial stability. The major costs include: (i) insufficient access to funding at times of financial instability, including capital concentration and procyclicality, (ii) inappropriate allocation of capital flows, (iii) loss of macroeconomic stability, and (iv) herd behavior among investors, financial contagion, and high volatility of cross-border capital flows.

There is a relatively large body of research on the relationship between financial integration and globalization (see, e.g., Mendoza et al., 2009), but the implications of financial integration for financial stability (and vice versa) remain largely unstudied and less clear. However, the financial crisis has greatly increased the interest of economists and regulators (who are often also monetary policy-makers) in studying the relationship between financial integration and financial stability in depth. The question therefore arises whether financial integration supports financial stability or fosters financial instability, or conversely whether financial instability affects financial integration (see Section 3).

An integrated market fosters financial stability by improving access to international capital markets and thereby increasing the opportunities for investors, creditors or debtors to diversify their investment risks. Financial stability is also aided by easier growth in the size of financial intermediaries through the removal of barriers to free trade, making use of economies of scale and scope, or as a result of stronger stimuli emanating from expanded markets. Larger (and/or cross-border) institutions can better reap the benefits of an expanded and integrated market and can also better withstand potential shocks than institutions of local significance.[1] Under certain conditions, however, a strongly integrated market does not foster financial

stability if the financial system is not sufficiently resilient and flexible to cross-border financial shocks (e.g., contagion risk, systemic risk, or more risk-taking and higher volatility in financial markets caused by market participants having stronger incentives), which are transmitted more rapidly through an integrated market. The more active financial institutions are in the international financial markets, the more likely it is that those institutions will be systemically relevant. If they get into difficulties themselves they can undoubtedly contribute to financial instability by creating a shock to the capital of other banks (to the balance sheets of interconnected banks). The (cross-border) spillover of shocks across bank balance sheets may result in a reduction in lending to firms and consumers in an economic environment with consequent negative impacts on the real economy (Popov and Udell, 2010).[2] What is more, the cross-border contagion and systemic risks grow even larger and more rapidly if the number and size of cross-border active institutions rises. Alongside the problematic concentration of stability risks, there can also be a threat concerning systemically important financial institutions. The management of these institutions can be tempted to succumb to moral hazard if their businesses are simply too big to fail. On the other hand, larger financial institutions usually have more advanced risk management systems that promote financial stability better. Nevertheless, the current crisis has already proved that the risk management systems currently being used are not advanced enough.

The spreading contagion is experienced not only across institutions, but also across different financial markets. The concept of cross-market integration is not part of the definition provided above (which is the pure concept of geographic integration), but the academic literature has already pointed out that this type of integration contributes to the phenomenon of systemic risk and is therefore completely relevant to the link between integration and stability. Cross-market interdependency is usually associated with the activities of hedge funds and private equity companies and derives from the nature of funding and asset market liquidity (Praet and Herzberg, 2008; Brunnermeier and Pedersen, 2009). Expressed simply, if these financial firms make losses, then they affect both the providers of funding liquidity (through collateral) and the providers of asset liquidity (through the falling prices of assets resulting from fire sales).

On the one hand there is a positive effect from the activities of these investment firms. They increased the market liquidity in markets where relatively illiquid assets were being traded (for instance, CDOs or other innovative products, see below), and their arbitrage activities also further enhanced cross-market integration. On the other hand, there are also negative implications for financial instability. Although the investment strategies of financial institutions are usually heterogeneous, their behavior could be quite similar during times of stress when they use

[1] Nowadays, modern financial innovations require relatively large initial investment costs, which often leads to mergers between different financial intermediaries (horizontal as well as vertical integration of financial institutions; a bank and an insurance company into a bancassurance firm, for example). The merger is generally justified by the expected synergy effects and a higher degree of risk diversification.

[2] They discovered, among other things, that bank capital in Central and Eastern Europe was hit by financial distress in the relatively early stages of the 2007–2008 crisis. These banks therefore had to reduce lending to firms and consumers and yet this was an economic environment that was uncorrelated with the origins of that shock.

quite coordinated asset fire sales to meet margin calls or investor redemptions (hedge funds) in response to large initial shocks to general funding and asset liquidity (accelerating "liquidity spirals"). This highly correlated behavior can seriously affect systemic stability (ECB, 2010). Another negative consequence is the lack of transparency in the positions of financial institutions, which may lead to the further introduction of counterparty credit risk in the system as a whole (supporting systemic crises), therefore it could be very difficult for markets to assess the magnitude of counterparty risk and indeed other risks.

The financial integration process has also been fostered over the past decade by massive financial development, especially through financial innovations. The financial system is affected both by financial integration and by financial development. Financial integration affects, for example, the competitiveness of individual financial institutions and increases the room for risk diversification and risk sharing, even when market frictions are assumed to be present. Financial development helps to eliminate such frictions —see Hartmann et al. (2007). In the past, such innovations tended to foster diversification of risks (especially credit risk) within the national economy and thus stabilization of the financial system. In recent years, however, the increased popularity of financial innovation has fostered misallocation of capital and risk across market participants. One of the main innovative products—and simultaneously a stimulant of international financial integration and a cause of the current crisis—has been securitization. Securitization is a process whereby a set of illiquid assets producing a known or at least sufficiently accurately predictable cash flow (e.g., mortgages, leases, credit card debt, consumer loans, and even copyrights) is transformed into a marketable security. It was securitization that enabled the integration of various financial market segments, such as the illiquid mortgage market with the liquid bond market.

Another innovative product (complex financial securities) which supported financial market integration from a general perspective was resecuritization. Resecuritization involves packaging already securitized products into a single investment for subsequent (re)selling. This product, or rather its complexity, was simultaneously a cause of the crisis. In particular, such investments were difficult to value and, furthermore, their value did not take into account the enormous systemic risk they actually bore. The vast majority of investors relied on the results of rating agencies using similar valuation models heavily dependent on several input assumptions. In the deteriorating economic conditions, each resecuritized security could be rated variously. Moreover, with the pressure of systemic risk rising, slight inaccuracies in the parameter estimates generated high probabilities of default even for securities with high ratings—see ECB (2010). A security that cannot be correctly valued quickly loses its liquidity and book value when the market gets nervous, leading to large losses in holders' balance sheets. "Mark-to-market" (fair-value) accounting, which was originally meant to help investors quickly obtain information on the value of their balance sheet assets, ultimately proved misleading for balance-sheet valuations under conditions where the market was unable to value assets correctly (Cifuentes et al., 2005; Plantin et al., 2008).

The last, but no less significant point concerning financial innovations is the increasing popularity of financial derivative agreements. Financial derivatives, as

well as the innovations mentioned above, play an important role in the efficient allocation of capital, as they help overcome financial frictions through reducing the number and size of discontinuities in the spectrum of available financial instruments, which, in turn, erodes some of the differences between different forms of financial intermediation (ECB, 2010). However, financial derivatives are traded on exchanges or over the counter and especially the latter means that there is an evident lack of transparency resulting from the predominant over-the-counter market structure. In other words, market participants could be extremely interconnected by financial derivatives traded over-the-counter without them being able to effectively recognize this fact in any way. Credit default swaps are very often cited as being over-the-counter financial derivatives, large exposures of which can be associated with substantial systemic risks. More specifically, counterparty credit risk and the potential amount at risk if a counterparty fails is the main concern because the failure of one important participant in the CDS market could destabilize the financial system as a whole (CNB, 2010, Box 4).

A fundamental challenge for the regulatory and supervisory authorities is therefore to minimize the negative impacts of financial market integration on financial stability without reducing the benefits of this process. Examples include increasing market transparency, limiting over-complicated financial instruments, and introducing macro-prudential supervision to ensure timely warnings of the formation of imbalances or contagion across markets.

3. Measuring Financial Integration: Methodological and Data Issues

In line with the curtailed definition of financial integration based on the law of one price, two methods were used to measure financial integration: (i) price-based measures, and (ii) news-based measures. Both methods are described in detail in Babetskii et al. (2007) and CNB (2009). Another approach to measuring financial integration is that based on quantity-based measures. This approach, which is beyond the scope of the present study, involves monitoring the cross-border barriers (analyzing the cross-border activity of market participants and also "home bias") faced by financial market participants. Regarding price and news-based measures, the more the individual segments of the euro-candidates' financial markets are integrated with the euro area, the more the prices of these assets will be affected by common (global) factors rather than by local (national) factors. It can also be expected that with growing integration the individual segments of the financial markets will be a less likely source of asymmetric shocks.

The law of one price, which the measures used are based on, implies that assets with the same risk should have the same expected return (cash flows) regardless of the residence of the asset issuer or holder (measurements of the state of integration using equilibrium prices). Returns on a specific sort of asset in one country can differ from returns on the same sort of assets in other countries owing to an important source of risk. The risk of an asset's return can be split into idiosyncratic and systematic risk. Although the former can be quite easily diversified, the latter cannot. However, as there is some doubt about the ability to identify the systematic risk factors (the results are too dependent on the particular asset pricing model correcting systematic risks), we did not filter the systematic risk

factors out of the used asset's return and apply the measures based on the law of one price in spite of the fact that the risk characteristics of the assets used are not accurately comparable. Being well aware of that drawback, we take into account that the results are influenced by exchange rate considerations, different national monetary policies, and different inflation rates, for instance.[3] Nevertheless, even between different countries with independent monetary policies nominal yields, especially at longer asset maturities (see *Appendix 1*), can be offset through international arbitrage opportunities (covered interest arbitrage, carry trades;[4] simply put, the "search-for-yield" effect) under the condition that the country credit risks of the residence of the assets used are sufficiently comparable. We acknowledge that not all the analyzed countries have comparable credit risk (Hungary, for example), as reflected by some differences in credit ratings (CNB, 2010), and the results of that country may therefore be more burdened by this sort of risk than is the case for other countries.

The equity market contains further specific features. As discussed in Adam et al. (2002), any proper measure of financial integration on equity markets should account for asset pricing, which is empirically difficult to operationalize. We follow a common practice by examining links between stock market returns while leaving asset pricing aspects aside. Therefore, our results obtained for the stock market should be interpreted as evidence of synchronization rather than of integration. Thus, we are not able to distinguish whether there is an underlying process of financial integration or whether financial shocks become stronger (or if there are changes in country risk premia). Nevertheless, keeping this caveat in mind, this assessment of financial synchronization still provides a new piece of evidence on the interdependencies among the economies covered in our study.

Price-based measures are applied in accordance with Adam et al. (2002), who used the concepts of beta-convergence and sigma-convergence. The terms beta-convergence and sigma-convergence originate in the economic growth literature; see, for example, Barro and Sala-i-Martin (1992). The concept of beta-convergence enables identification of the speed at which differences in yields are eliminated on individual financial markets. A negative beta coefficient signals the existence of convergence, and the magnitude of the beta coefficient expresses the speed of convergence, i.e., the speed of elimination of shocks to the yield differential of individual asset prices vis-à-vis the euro area. The closer the value of the beta coefficient is to –1, the higher is the speed of convergence. The concept of sigma-convergence captures the dispersion of the differences between the yields on identical assets in different countries at a given moment in time and thus identifies the degree of

[3] Aside from the introduced risk factors, various other barriers to international investment may prevent discount factors from equalizing: different tax rates, the considerable fragmentation in trading, settlement, and payment systems across countries, accounting and reporting standards, and corporate governance practices, for example (Baele et. al., 2004).

[4] "Carry trades became a phenomenon in 2006 H2 and 2007 H1. This speculative transaction can be described generally as an investment in a high-yielding currency financed by a loan in a low-yielding currency. The classic case was investment in currencies such as the British pound and the Australian or New Zealand dollar financed by loans in Japanese yen or Swiss francs. Owing to low interest rates in the Czech Republic, the Czech koruna became another popular currency for financing such trades at the start of 2007." (CNB, 2010, FSR 2007, Box 5, p. 36)

integration vis-à-vis the euro area achieved at that moment by the individual financial market segments in the countries under review. Sigma-convergence arises if and when the sigma coefficient falls to zero. Beta-convergence may, but need not, be accompanied by sigma-convergence. In fact, sigma-divergence may occur. Both concepts must therefore be tracked concurrently in order to assess financial integration.

For quantification of beta-convergence, common regression analysis or the panel estimation method is applied (as in Babetskii et al., 2007), in the form of the equation:

$$\Delta R_{i,t} = \alpha_i + \beta R_{i,t-1} + \sum_{l=1}^{L} \gamma_l \Delta R_{i,t-l} + \varepsilon_{i,t} \tag{1}$$

where $R_{i,t} = Y_{i,t} - Y_{i,t}^{B}$ is the difference between the asset yields of country i and a selected reference territory (a benchmark, B) at time t, Δ is the difference operator, α_i is a dummy variable for the respective country, L is the maximum lag, and $\varepsilon_{i,t}$ is a random term. The asset yield is calculated as $Y_{i,t} = \left[\ln\left(A_{i,t}\right) - \ln\left(A_{i,t-1}\right) \right]$, where A is the price index of the relevant asset (expressed as a basic index). The size of coefficient β may be interpreted as a direct measure of the convergence speed. A negative β coefficient indicates the occurrence of convergence. The β coefficient can take values ranging from –2 to 0. The closer the value of the β coefficient to –1, the higher the speed of convergence. If $\beta = -2$ or $\beta = 0$, no convergence is observed. β values from –1 to 0 indicate monotonous convergence, while oscillating convergence occurs for values from –2 to –1.

For quantification of σ convergence, a calculation of the (cross-section) standard deviation (σ) is used, according to the formula:

$$\sigma_t = \sqrt{\left(\frac{1}{N}\right) \sum_{i=1}^{N} \left[\log\left(Y_{i,t}\right) - \log\left(\overline{Y_t}\right) \right]^2} \tag{2}$$

where Y is the asset yield, $\overline{Y_t}$ is the mean value of the yield over time t, and i stands for the individual countries (i = 1, 2, …, N). For the purposes of this analysis, we introduce N = 2, i.e., we examine the evolution of σ convergence over time between the euro area and one of the countries under review. For pairs of countries, the calculated values in each period are essentially equal to half the square of the yield differential. Variable σ takes only positive values in theory. The lower is σ, the higher is the level of convergence. In theory, full integration is achieved when the standard deviation is zero—this occurs, for example, on the money and foreign exchange markets for countries entering the euro area on a given date—while high (several digit) values of σ reflect a very low degree of integration. For graphical illustration, the results were normalized over the whole time period and filtered using the Hodrick-Prescott filter with the recommended weekly time series coefficient: λ = 270,400.

News-based measures originate in Baele et al. (2004) and simply monitor the sensitivity of asset prices to local and global news. The technique is based on the assumptions that in a fully financially integrated area portfolios are perfectly diversified and the degree of systematic risk is identical across assets in different

geographical parts of the integrated area and so local factors are not significant. For individual countries, sensitivity is measured by gamma, which expresses the degree of sameness of reaction to news between prices of domestic assets and prices of foreign (benchmark) assets. Asset prices are monitored at the aggregate level. It is assumed that the benchmark asset reacts only to global news. Put differently, gamma represents the proportion of the change in asset prices which can be explained by common factors. Higher values of this parameter signal greater integration. Values greater than 1 indicate a multiplication effect, i.e., a stronger response of the price of a local asset relative to the benchmark asset. Negative values express an asymmetric response to news (shocks).

Quantification of the degree of shock integration can be estimated (as in Baele et al., 2004) for the money, foreign exchange, and government bond markets using the following regression:

$$\Delta Y_{i,t} = \alpha_{i,t} + \gamma_{i,t}\Delta Y_{b,t} + \phi_{i,t} \tag{3}$$

where $Y_{i,t}$ represents individual asset yields in country i at time t, and b denotes the benchmark country (Germany for the government bond market, otherwise the euro area). $\alpha_{i,t}$ is a specific constant for each country, Δ denotes the difference operator, and $\phi_{i,t}$ is a random term. An increase in this type of integration requires α to converge to zero, γ to converge to one, and the proportion of the variance of coefficients γ (for benchmark and national assets) to be close to one. The time-varying parameters γ were estimated using recursive estimation.

To quantify the degree of equity market shock integration between the countries under review and the euro area, the above equation must be adjusted for the impact of the U.S. equity market on the monitored markets and the euro area market. This is due to the lower comparability of the individual national equity indices relative to the other monitored assets (exchange rates, money market rates, and government bonds). The modified equation for the equity market has the following form:

$$\Delta Y_{i,t} = c_{i,t} + \gamma_{i,t}^{b}\Delta Y_{b,t} + \gamma_{i,t}^{US}\Delta Y_{us,t} + \upsilon_{i,t} \tag{4}$$

The magnitude of parameters γ expresses the degree of identical response of an asset of a selected country and a comparable benchmark asset to certain news.

Finally, in this section we construct the so-called Composite Indicator of Financial Integration (CIFI, ω), which on the whole evaluates the separate results from price-based measures of financial integration (the beta and sigma parameters) and news-based measures of financial integration (the gamma parameter). The main idea follows from the separate definition of full integration, i.e., (i) the beta parameter is equal to –1 from the interval $\beta = \langle 0, -2 \rangle$; (ii) the sigma parameter is equal to 0 from the interval $\sigma = \langle 0, \infty \rangle$, and (iii) the gamma parameter is equal to 1 from the interval $\gamma = \langle -1, 1 \rangle$. Due to the ambiguous exact importance among these parameters, we construct the following variants of the CIFI (ω):

$$\omega = \frac{1}{3}\beta' + \frac{1}{3}\sigma' + \frac{1}{3}\gamma' \tag{5}$$

Table 1 Data Sources, January 1999–July 2010

	Money market	Foreign exchange market	Government bond market	Equity market
	1999–2010	1995–2010	2001–2010	1995–2010
CZ	PRIBK3M	PRUSDSP	BMCZ05Y	CZPXIDX
DE	–	–	BMBD05Y[B]	–
HU	HNIBK3M	HNUSDNB	BMHN05Y	BUXINDX
PL	POIBK3M	POUSDSP	BMPO05Y	POLWIGI
UK	LDNIB3M	UKDOLLR	BMUK05Y	FTSE100
SW	SIBOR3M	SDUSDSP	BMSD05Y	SESEALI
EA	BBEUR3M[B]	USECBSP[B]	–	DJES50I[B]
US	–	–	–	S&PCOMP[B]

Notes: CZ–Czech Republic, HU–Hungary, PL–Poland, SW–Sweden, UK–United Kingdom, EA–euro area, US–United States. B–benchmark. The acronyms stand for the Thomson Reuters codes of the series.

Source: Thomson Reuters.

where β', σ', and γ' are the rescaled and normalized beta, sigma, and gamma parameters, so that the minimum (i.e., zero) values correspond to the highest convergence. There is obviously the question of how to choose the optimal weights. We opt for employing two alternative weighting schemes under which the weights for the beta, sigma, and gamma parameters are set: (i) equal across all four segments of the financial markets, and (ii) specific to each of the four segments, that is, the money market, FX market, government bond market, and equity market.

The calculations for all measures of financial integration were carried out using weekly data (daily data averages) from Thomson Reuters covering the period January 1999 to July 2010. Three-month interbank rates were used for the money market, national currencies quoted against the U.S. dollar for the foreign exchange market, five-year government bonds for the bond market, and national stock indices for the equity market (see *Table 1*).[5] The relevant time series were adjusted for exchange rate effects.

4. Results

This section examines whether, and how quickly, individual segments of the financial markets (the foreign exchange, money, government bond, and equity markets) of the Czech Republic and selected inflation-targeting countries of the Central European region (Hungary and Poland) and advanced Western economies (Sweden and the UK) are integrating with the euro area and what impact the current financial crisis has had on this integration process. In order to analyze the impact of financial stability on financial integration the estimation period is divided into a pre-crisis period (January 1995–July 2007)[6] and a crisis period (August 2007–July 2010).[7]

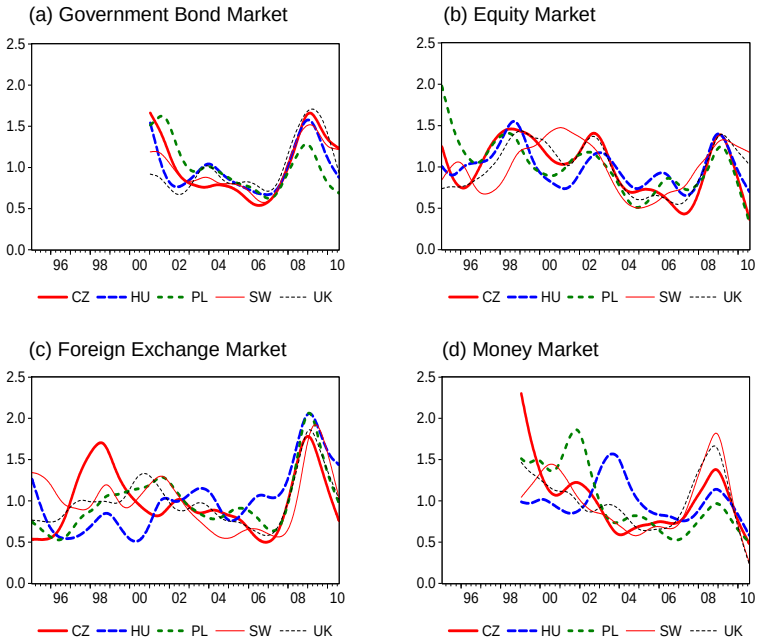
Table 2 shows the beta-convergence analysis results for the individual segments of the financial markets in the defined periods, while *Figure 1* shows those for

[5] The results for other compared assets can be found in *Appendix 1*.

[6] For the money market in 1999–2007 and the government bond market in 2001–2007.

[7] The split of periods was chosen due to the strong impact of the current global financial crisis on global financial system stability. We note that even the "pre-crisis period" experienced some financial crises (the dot-com crisis, for example); however, the impact of the current crisis is unique in its scope.

Figure 1 Sigma Coefficients (Level of Convergence)



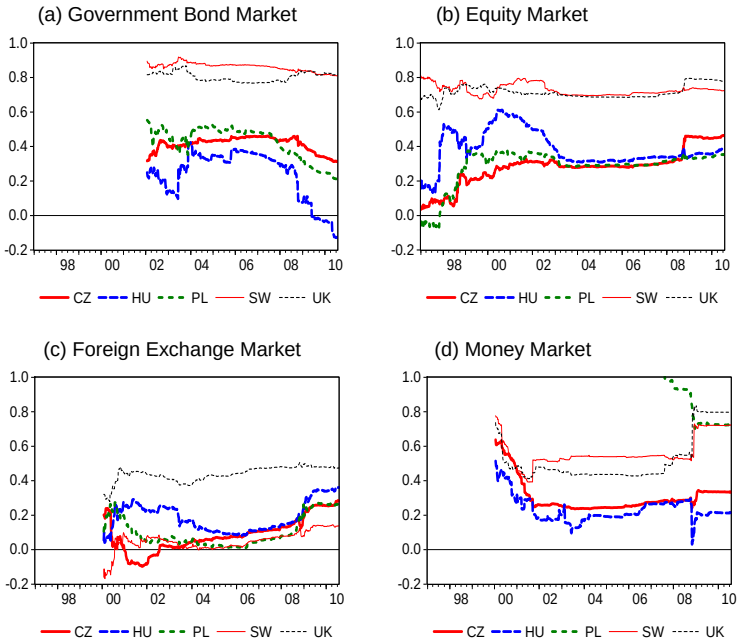
Notes: CZ–Czech Republic, HU–Hungary, PL–Poland, SW–Sweden, UK–United Kingdom.
Sources: Authors' calculation based on Thomson Reuters data.

σ convergence. *Figure 2* presents the results of the news-based analysis. The analysis is enriched by the results of the composite indicators, whose results are presented in *Table 5* and *Table 6* (see *Appendix 2*).

4.1 Pre-Crisis Period

This period was characterized by gradually increasing convergence across all the markets and countries under review in terms of both convergence level (sigma) and convergence speed (beta), with some breaks in times of temporary crisis only (see the equity markets during the 1998–1999 and 2002–2003 periods, or the Hungarian money market during the 2002–2004 period, for instance). The comparatively high beta coefficients (excluding money markets) indicate that the individual financial markets of the economies under review were integrating relatively quickly with the markets of the euro area (or Germany in the case of government bonds). The beta coefficients were broadly similar in value for the given countries and markets. The money market was converging the slowest and the foreign exchange and equity markets were converging the fastest, on average. In the case of the equity market, quite strong convergence can be seen from the moment the bubble burst in the U.S. equity markets in 2002 (the dot-com bubble). Nevertheless, the analysis shows that the integration process of the equity market has been progressing in waves throughout this period. In the case of all the other markets the value of the sigma coefficient suggests that just before the crisis the level of integration differed only slightly on

Figure 2 Gamma Coefficients (Asset Prices Sensitivity to Global News)



Notes: CZ–Czech Republic, HU–Hungary, PL–Poland, SW–Sweden, UK–United Kingdom. Positive (negative) and increasing (decreasing) gammas indicate co-directional (counter-directional) sensitivity to news, and values close to zero indicate indifference.

Sources: Authors' calculation based on Thomson Reuters data.

average. The exceptions were all the sigma coefficients for Hungary, which were not unambiguously falling during the pre-crisis period. The main reason was probably the effort to trade off two independent monetary policy targets—on the one hand, the constantly appreciating Hungarian forint exchange rate, and on the other hand, the high inflation. During this period the Hungarian money and foreign exchange markets were both considerably volatile.[8] In the case of the Czech Republic, the highest level of integration was achieved, according to this analysis, by the foreign exchange market, followed by the equity and government bond markets. The lowest level of integration was attained just before the crisis broke out by the money market (as in the UK and Sweden). The analysis indicates to some extent that regardless of period type the money market—at least in the cases of the Czech Republic, Sweden, and the UK—is autonomous, with a strong local factor effect in the form of national monetary policy. However, the money market reached its highest level of integration immediately after the Czech Republic joined the EU and subsequently started to diverge slightly, unlike the Polish and Hungarian money markets.

The news-based convergence analysis indicates that in the pre-crisis period the financial markets of the UK and Sweden achieved the highest level of integration

[8] The more volatile development on the Hungarian markets can also be seen by analyzing the other maturities (see *Appendix 1*).

Table 2 Beta Coefficients (Speed of Convergence)

	Money market		Foreign exchange market		Government bond market		Equity market	
	1/99–7/07	8/07–7/10	1/95–7/07	8/07–7/10	1/01–7/07	8/07–7/10	1/95–7/07	8/07–7/10
CZ	-0.57	-0.38	-0.93	-0.90	-0.73	-0.69	-0.79	-0.77
DE	–	–	–	–	B	B	–	–
HU	-0.79	-0.95	-0.87	-0.97	-0.87	-0.62	-0.81	-0.95
PL	-0.68	-0.72	-0.87	-1.01	-0.82	-0.78	-0.82	-0.88
UK	-0.71	-0.82	-0.81	-0.91	-0.93	-0.96	-0.89	-0.83
SW	-0.60	-0.90	-0.95	-0.85	-0.86	-0.93	-0.95	-0.90
EA	B	B	B	B	–	–	B	B

Notes: CZ–Czech Republic, HU–Hungary, PL–Poland, SW–Sweden, UK–United Kingdom. Estimates are statistically significant at the 1% level. Euro area assets were used as the benchmark for the money market (3M interbank rates) and the foreign exchange market (exchange rates against USD), while the German asset was used as the benchmark for the government bond market (yields on 5Y benchmark bonds). For the equity market (main national equity indices) two assets were used as benchmarks—euro area assets and United States assets.

Sources: Authors' calculation based on Thomson Reuters data.

on average (see *Figure 2*). Their government bond and equity markets in particular reacted to similar factors as the benchmark markets. This analysis confirmed the results of the price-based analysis, which indicated that in the pre-crisis period the Czech Republic achieved the highest degree of convergence in the case of the foreign exchange market and the lowest degree of convergence in the case of the money market, with the effect of local news (national monetary policy) prevailing, similarly as in Sweden (see also *Appendix 2* for a preferable comparison).

4.2 Crisis Period

The ongoing financial crisis had a negative effect on all the financial segments across all the countries analyzed in relation to the euro area, albeit with different intensity. Similar estimates were conducted symmetrically for the USA as the benchmark territory. The results were not very far from those of the selected countries vis-à-vis the euro area presented here. This indirectly suggests strong integration of the euro area and U.S. markets. The probably temporary, yet strong, disintegration potential of the crisis is indicated most clearly by the results of the price-based approach (see *Figure 1*). This period can be characterized by increased nervousness among market participants and related increased volatility of market asset prices. Concerned about their liquidity positions, both investors and investment services intermediaries reined in their market activity, including cross-border activity (growth in the home-bias effect, i.e., a preference for domestic assets) and thus weakened the integration process to a greater or lesser extent. This nervous behavior and geographical discrimination, with more risky participants concentrating more on domestic markets, most affected the foreign exchange market and the government bond market (see *Figure 1*), as these markets started to diverge quite significantly and quickly. The convergence trend was regained only after central banks and governments adopted fundamental measures to reduce liquidity and credit risk. This led to a considerable decrease in the volatility of market asset prices (a decline in sigma coefficients).

By contrast, the results of the news-based approach indicated that the integration of the financial markets (except for the Polish and Hungarian government bond markets) of the countries under review did not decrease (gamma coefficients—see *Figure 2*); in fact, it increased continuously in the case of the equity market. The simple conclusion of this approach might therefore be that financial instability simply does not affect the level of financial integration of the countries under review, or conversely increases it. However, the aforementioned results of the price-based approach (beta and sigma coefficients—see *Table 2* and *Figure 1*) indicated that the interpretation of this seeming paradox may be more complex.

The benchmark financial markets reacted to news coming in during the core crisis period (strong risk aversion, pooling of liquidity, high counterparty risk, etc.) almost exclusively negatively (with a declining trend). It is apparent from the stability/growth of the gamma coefficient that the financial markets of the countries under review also reacted to the same news. This may have been due to economic and asset integration between them and the benchmark territory. Investors are susceptible to herd behavior at times of major market turbulence caused by the reactions of over-sensitive investors (fed constantly by pessimistic economic forecasts for the integrated region). This behavior usually amplifies similar trends in seemingly different markets and can be a source of financial contagion. In the extreme case, herd behavior can result in a financial market reacting to global news that does not relate directly to that market.

Also significant, however, is the intensity with which the markets reacted, or rather the differences in the growth in volatility between individual market prices (a rise in the sigma coefficient and a fall in the beta coefficient). The different intensity of response of the individual markets to common (global) factors can be explained by, for example, the change in the composition of market participants at the time of the crisis, the different levels of development of the individual markets, and by a preference for diversifying total portfolio risk across countries (Brooks and Del Negro, 2002) rather than across sectors.

As indicated above, the measures adopted by some central banks and governments, especially in late 2008 and spring 2009, generated optimistic expectations and a general calm-down in the financial markets. With few exceptions, the coefficients we are studying (sigma, beta, and gamma) improved. The money market reacted relatively intensively to these measures (see *Figure 1*, except Hungary), especially in the cases of Sweden and the UK, and quickly lost its originally high sigma values. The gamma coefficients (see *Figure 2*) also clearly show the money markets' response to the authorities' measures, which, especially in the case of the ECB, were not merely local in nature. A relatively small impact and a weak, or opposite, reaction to common news by the money market can be observed for Poland. An increased reaction to global news is also visible in the equity market. The reaction in the government bond market differs across countries. In the cases of the Czech Republic and Poland, local news starts to prevail in the government bond market and negative global shocks are transmitted to a decreasing extent. In the cases of Sweden and the UK, European news still prevails (high gamma coefficients). However, a still rising sigma coefficient for the UK suggests that even though the yields on UK government debt are highly sensitive to European news, the intensity of reaction of these yields is getting more and more distant from the intensity of reaction of euro

area debt yields. In the case of Hungary's national debt, the coefficient for the rate of transmission of global news is still low, reflecting strong domestic shocks overshadowing European shocks (increased risk aversion). In the foreign exchange market the convergence trend is returning only slowly (see *Figure 1*). Except in the case of the UK, however, the significance of European news is constantly rising, and in the case of Poland it has actually strengthened since the world authorities introduced their measures. Although this empirical analysis shows that the financial market situation is generally returning to an integration trend and major European news is more or less common to the countries under review, the commonly used indicators of market conditions reveal that the impact of the current crisis on the financial markets has not necessarily faded fully yet.

5. Conclusions

This article analyzed the financial integration process primarily at times of financial instability. It showed that financial integration and financial instability are interconnected processes; increasing financial integration does not necessarily lead to financial instability, and financial instability does not necessarily lead in the long term to financial market segmentation. In the past few years, financial integration has been stimulated by the development and implementation of financial innovations, whose incautious use—especially in the developed nations—contributed to the recent financial crisis. Assessments of the experience of the ongoing financial crisis have further modified perceptions about the integrated market. The importance of integration across segments of the financial market (integration between the foreign exchange, money, government bond, and equity markets) is now being emphasized, while the accent on separate examination of integration from the geographical perspective in the national market (e.g., the relationship between the Czech and European equity markets) is being suppressed. Given the experience of the unwinding financial crisis, therefore, the previously underestimated link between integration of individual financial market segments seems to be the cardinal condition for financial integration between countries.

The empirical analysis—based on the price-based and news-based methods[9]—revealed that: (i) a process of increasing financial integration has been going on steadily in the Czech Republic since the end of the 1990s; (ii) the financial crisis caused temporary price divergence of the Czech financial market from the markets of the euro area (in the cases of the equity, money, and foreign exchange markets) and Germany (in the case of the government bond market); (iii) results similar to those for the Czech Republic were generally obtained for the other selected inflation-targeting countries; and (iv) the overall consequences of the financial crisis for financial stability were not significant in the Czech Republic, thanks mainly to restraint in the use of financial innovations and to the general soundness and prudent behavior of Czech financial institutions.

[9] The current global market environment could make price-based measures problematic, as these measures may not perfectly control for underlying risk characteristics, and so do not adequately distinguish the effects stemming from changes in the credit of the issuers from the effects of financial integration itself. Therefore, it is necessary under stressed market conditions to treat the results of this analysis with some caution.

Appendix 1 Robustness Testing for Alternative Maturities

Table 3 Data Sources, February 2001–July 2010

	Money market: interbank lending rates		Money market: interest rate swap rates		Government bond market	
	One-month maturity	Twelve-month maturity	One-year maturity	Ten-year maturity	Two-year maturity	Ten-year maturity
CZ	PRIBK1M	PRIBK1Y	CKSW1	CKSW10	BMCZ02Y	BMCZ10Y
HU	HNIBK1M	HNIBK1Y	HFSW1	HFSW10	BMHN02Y	BMHN10Y
PL	POIBK1M	POIBK1Y	PZSW1	PZSW10	BMPO02Y	BMPO10Y
UK	LDNIB1M	LDNIB1Y	BPSW1	BPSW10	BMUK02Y	BMUK10Y
SW	SIBOR1M	SIBOR1Y	SKSW1	SKSW10	BMSD02Y	BMSD10Y
DE	–	–	–	–	BMBD02Y[B]	BMBD10Y[B]
EA	EIBOR1M[B]	EIBOR1Y[B]	EUSA1[B]	EUSA10[B]	–	–
Source	Thomson Reuters		Bloomberg		Thomson Reuters	

Notes: CZ—Czech Republic, HU—Hungary, PL—Poland, SW—Sweden, UK—United Kingdom, EA—euro area, DE—Germany, B—benchmark. The acronyms stand for the Thomson Reuters and Bloomberg LP codes of the series.

Sources: Thomson Reuters and Bloomberg LP as indicated in the last raw of the table.

Table 4 Beta Coefficients (Speed of Convergence)

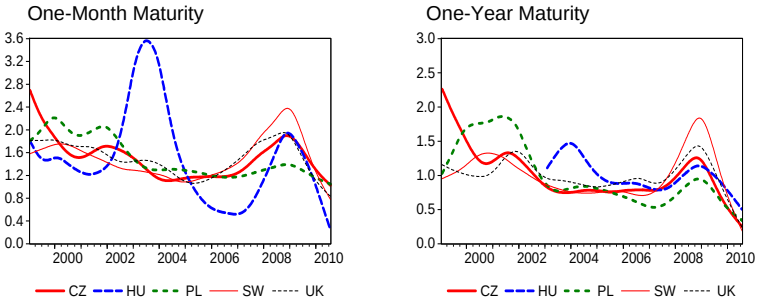
		Money market: interbank lending rates		Money market: interest rate swap rates		Government bond market	
		One-month maturity	Twelve-month maturity	One-year maturity	Ten-year maturity	Two-year maturity	Ten-year maturity
CZ	2/01–7/07	-0.63	-0.62	-0.64	-0.88	-0.73	-0.83
	8/07–7/10	-0.48	-0.33	-0.68	-0.93	-0.71	-0.74
HU	2/01–7/07	-0.76	-0.79	-0.87	-0.78	-0.91	-0.89
	8/07–7/10	-0.88	-0.91	-0.67	-0.93	-0.67	-0.94
PL	2/01–7/07	-0.94	-0.89	-0.56	-0.72	-0.84	-0.71
	8/07–7/10	-0.70	-0.64	-0.81	-1.01	-1.42	-1.00
UK	2/01–7/07	-0.84	-1.03	-0.78	-0.85	-0.84	-0.92
	8/07–7/10	-0.61	-0.64	-0.71	-0.71	-0.92	-0.90
SW	2/01–7/07	-0.61	-0.69	-0.65	-1.04	-0.87	-0.96
	8/07–7/10	-0.86	-0.92	-0.66	-0.95	-0.77	-1.05

Notes: CZ—Czech Republic, HU—Hungary, PL—Poland, SW—Sweden, UK—United Kingdom. Estimates are statistically significant at the 1% level. Euro area assets were used as the benchmark for the money market, while the German asset was used as the benchmark for the government bond market.

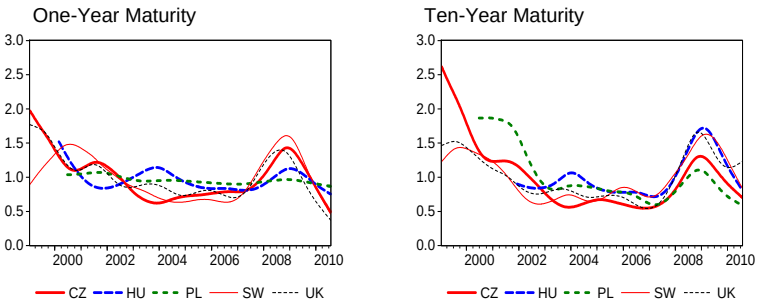
Sources: Authors' calculation based on Thomson Reuters and Bloomberg LP data.

Figure 3 Sigma Coefficients (Level of Convergence)

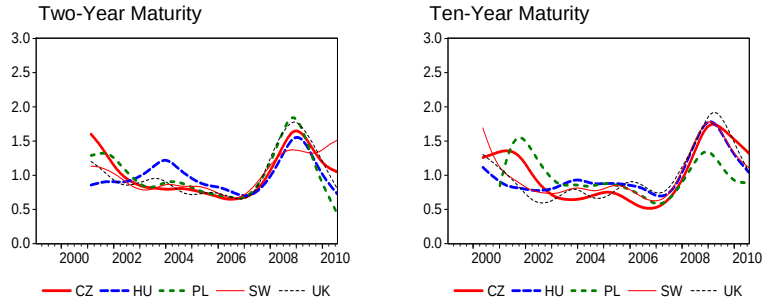
(a) Money Market: Interbank Lending Rates



(b) Money Market: Interest Rate Swap Rates



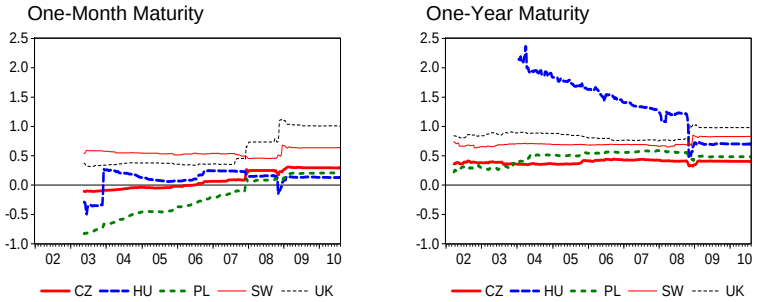
(c) Government Bond Markets



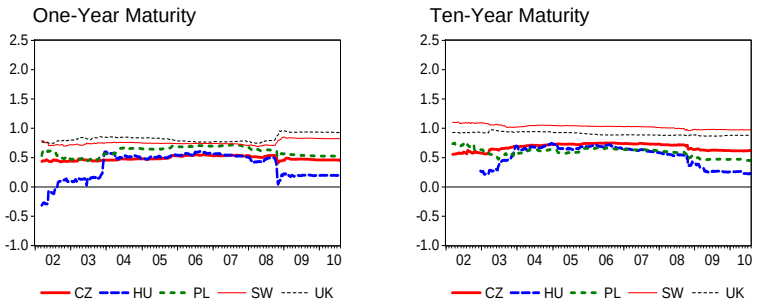
Notes: CZ–Czech Republic, HU–Hungary, PL–Poland, SW–Sweden, UK–United Kingdom.
Sources: Authors' calculation based on Thomson Reuters and Bloomberg LP data.

Figure 4 Gamma Coefficients (Sensitivity of Asset Prices to Global News)

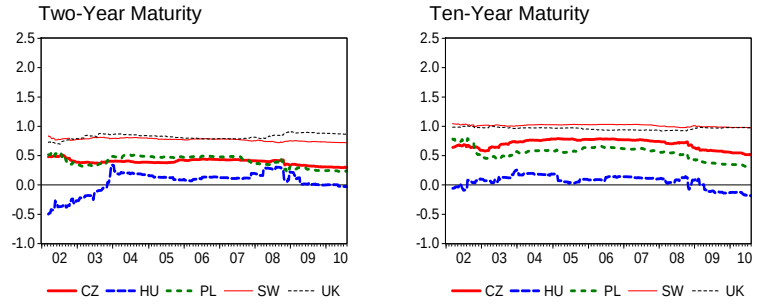
(a) Money Market: Interbank Lending Rates



(b) Money Market: Interest Rate Swap Rates



(c) Government Bond Markets



Notes: CZ–Czech Republic, HU–Hungary, PL–Poland, SW–Sweden, UK–United Kingdom. Positive (negative) and increasing (decreasing) gammas indicate co-directional (counter-directional) sensitivity to news, and values close to zero indicate indifference.

Sources: Authors' calculation based on Thomson Reuters and Bloomberg LP data.

Appendix 1 Composite Indicator of Financial Integration

The composite indicators of financial integration obtained with the two weighting schemes are shown in *Tables 5* and *6*, respectively. Among the five countries under review, Sweden and the UK exhibit the highest degree of financial integration with respect to the euro area (Germany for the government bond market), while the Czech Republic is characterized by the lowest degree of financial integration. However, the current crisis hit the financial markets of all the analyzed markets. While the government bond market demonstrated the highest degree of financial integration during the period 1/1995–7/2007, for the later period it switched to the lowest degree of integration among the four financial markets analyzed in this study.

Table 5 Composite Indicator of Financial Integration, Equal Weights

(a) Country and Market-Specific Indicators

	Money market		Foreign exchange market		Government bond market		Equity market	
	1/95-7/07	8/07-7/10	1/95-7/07	8/07-7/10	1/95-7/07	8/07-7/10	1/95-7/07	8/07-7/10
CZ	1.53	1.89	0.98	1.06	1.11	1.36	1.17	1.08
HU	1.16	0.84	1.00	1.02	0.93	1.62	1.04	0.81
PL	1.05	0.89	1.07	0.95	0.96	1.13	1.12	0.90
SW	1.32	0.78	0.96	1.22	0.60	0.64	0.54	0.71
UK	1.17	0.89	0.98	0.92	0.51	0.62	0.67	0.81

(b) Aggregated across Markets

	1/95-7/07	8/07-7/10
CZ	1.20	1.35
HU	1.03	1.07
PL	1.05	0.97
SW	0.85	0.84
UK	0.83	0.81

(c) Aggregated across Countries

	1/95-7/07	8/07-7/10
Money market	1.25	1.06
Foreign exchange market	1.00	1.03
Government bond market	0.82	1.07
Equity market	0.91	0.86

Notes: CZ—Czech Republic, HU—Hungary, PL—Poland, SW—Sweden, UK—United Kingdom. Lower values correspond to higher convergence.

Source: Authors' calculation based on Thomson Reuters data.

Table 6 Composite Indicator of Financial Integration, Market-Specific Weights

(a) Country and Market-Specific Indicators

	Money market		Foreign exchange market		Government bond market		Equity market	
	1/95-7/07	8/07-7/10	1/95-7/07	8/07-7/10	1/95-7/07	8/07-7/10	1/95-7/07	8/07-7/10
CZ	1.29	1.52	0.90	1.04	1.17	1.43	1.34	1.24
HU	1.09	0.89	1.05	0.90	1.02	1.72	1.18	0.89
PL	0.84	0.71	1.09	0.80	1.02	1.21	1.27	1.01
SW	1.08	0.76	0.85	1.28	0.61	0.65	0.59	0.79
UK	1.01	0.81	1.16	0.94	0.53	0.64	0.76	0.92

(b) Aggregated across Markets

	1/95-7/07	8/07-7/10
CZ	1.18	1.31
HU	1.08	1.10
PL	1.05	0.93
SW	0.78	0.87
UK	0.87	0.83

(c) Aggregated across Countries

	1/95-7/07	8/07-7/10
Money market	1.06	0.94
Foreign exchange market	1.01	0.99
Government bond market	0.87	1.13
Equity market	1.03	0.97

Notes: CZ—Czech Republic, HU—Hungary, PL—Poland, SW—Sweden, UK—United Kingdom. Lower values correspond to higher convergence.

Source: Authors' calculation based on Thomson Reuters data.

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