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A FINANCIAL CONDITIONS INDEX FOR THE CEE ECONOMIES

by Simone Auer*

Abstract

Financial Conditions Indexes (FCIs) are analytical tools devised to synthesize the information contained in a set of financial variables in order to identify how financial conditions affect economic activity. In this paper, for each of the three main Central and Eastern EU member states outside the euro area (Hungary, Poland and the Czech Republic) an FCI is constructed as an unobserved factor estimated using the EM algorithm. After having assessed their performance in providing information about future economic activity (both in-sample and out-of-sample), these FCIs are used to describe the evolution of financial conditions in the three economies between 2001 and 2016. The overall findings of this study support a narrative whereby all three economies, after their integration into the EU, enjoyed very accommodative financial conditions until 2008; the Czech Republic and Hungary subsequently turned out to have been more exposed than Poland to the spillover effects from both the global financial crisis and euro sovereign debt crisis.

JEL Classification: C43, E5, E17, E44, G01.
Keywords: Financial Conditions Index, dynamic factor models, forecasting, macro-financial linkages.

Contents

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1. Introduction[1]

The global financial crisis in 2008-2009 and the euro sovereign debt crisis in 2010 highlighted the relevance of the relationship between the evolution of financial conditions and the real economy. In perfect and complete financial markets, financial shocks would affect the real economy essentially through the *price channel*, i.e., via the opportunity cost for investment and consumption decision. However, the presence of financial market frictions, particularly during crisis periods, creates the scope for a multiplicity of transmission channels, several of which operate mainly through borrowers and lenders' balance sheets (for a comprehensive review see BIS, 2011). An increase in asset prices may indeed pull up consumption and investment directly, through a positive wealth effect, or indirectly, through a greater willingness of credit institutions to lend to households and firms having an increased net worth (*balance sheet channel* or *financial accelerator*; Bernanke et al., 1999). As far as the balance sheet of the lender is concerned, a financial shock that raises the opportunity cost of holding deposits or reduces the bank capital contributes to the decline in lending activities on account of the relative fall in funding sources. Therefore, the *bank lending* and *bank capital channels* affect the cost and availability of credit to households and firms (Gambacorta and Marques-Ibanez, 2011). In times of crisis, a financial shock may also influence the perception and pricing of risk by economic agents and therefore impact their willingness to increase their exposures, affecting financial conditions and ultimately real economic decisions (Borio and Zhu, 2012). In the case of credit institutions, the *risk taking channel* operates, first of all, through lower returns on investments, such as government securities, which may increase incentives for them to take on more risk. Moreover, low interest rates or increasing asset prices have an influence on valuations, incomes and cash flows, which in turn can modify the way banks estimate probabilities of default, loss-given-default and volatilities, i.e., reduce their measure of risk and encourage position-taking. This risk taking channel also has an international dimension, as bank-to-bank credit plays a key role in propagating capital flows (Bruno and Shin, 2015). When the foreign interest rate falls, the difference between the local lending rate and the foreign funding rate increases and this creates greater investment opportunities for cross-border claims. Credit conditions become consequently more accommodating in recipient economies. The financial market can influence the real economy also through financial information frictions, which generate sentiment-driven fluctuations in asset prices and self-fulfilling business cycles by impacting on corporate financing and investment decision (*information channel*; Benhabib et al., 2016).

This summary (and non-exhaustive) review on the potential transmission channels through which a financial shock can affect the real economic activity highlights that prices and quantities of financial assets generally incorporate a great amount of information that is relevant for future economic activity, not only on the short but also in the medium-term horizons (Mayes and Virén, 2001). This information can therefore be exploited as powerful leading indicator. Central banks in many advanced and emerging economies, as well as International Financial Institutions (e.g., IMF, OECD) and private analysts (e.g., Goldman Sachs, Morgan Stanley) have developed analytical tools to monitor, possibly in real time, the status of financial conditions. Over the recent years, the use of so-called 'Financial Conditions Indexes' (FCIs) has become quite widespread. Such tools can be used to synthesize the information contained in the current values of a large set of variables, in order to draw indications on how financial conditions are likely to influence real economy activity, both current and future. Especially during periods in which the link between policy settings and

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financial conditions seems weak, these indicators can also serve monetary authorities as a guide to assess the effective stance of their policy, after taking into account all the other factors that affect financial variables (Hatzius et al., 2010). For the same reason, FCIs are sometimes used to improve the identification of monetary policy shocks, by including them in a small scale VAR (van Roye, 2011; Darracq Pariés et al., 2014). Indeed, this allows to reduce the risk of omitting an important subset of information used by monetary policy authorities in their decision making, while at the same time avoiding the "curse of dimensionality", i.e. the risk of parameter instability resulting from the inclusion of too many variables in the VAR. Moreover the FCI might be particularly useful in forecasting macroeconomic variables, especially during episodes of financial distress (Alessandri and Mumtaz, 2017), or in assessing the impact of unconventional monetary policy on real economic activity (Balfoussia and Gibson, 2015).

The aim of the paper is to first build and then test the performance of FCIs for the Czech Republic, Hungary and Poland, the three main non-euro-area EU member States in Central and Eastern Europe (CEE), covering the period between 2001 and 2016. Subsequently, we use these indexes as proxies of the evolution of financial conditions to try to provide a narrative broadly coherent with the recent evolution in these CEE countries.[2]

Against the backdrop of the transition towards a more market-based economy, in the early 1990s the financial systems in Poland, Hungary and the Czech Republic went through a process of financial deepening, providing new financing opportunities to firms and households. At the beginning of the new century, the process of financial deepening further accelerated, on account of gradual integration with other EU economies. These countries benefited from a general improvement in financial conditions, with capital inflows, especially from the euro area, sustaining bank lending and equity and debt markets. Interest rates gradually converged towards lower nominal and real levels. Between mid-2008 and 2012, tensions arising from the global financial and euro sovereign debt crises propagated to the CEE financial systems, even though with different degrees of intensity across countries. Together with the collapse of international trade, the impairment of domestic and international financial markets contributed to generate a slowdown in real economic activity in Poland, a recession in Hungary and the Czech Republic. This confirms that the presence of particularly adverse (favourable) financial conditions may help produce highly contractionary (expansionary) effects on economic activity. In the CEE economies, the process of financial deepening and the increasing integration with international financial markets has made the interactions between financial conditions and economic activity more difficult to discern. Indeed, the increased complexity of financial markets and their interconnections with foreign markets amplify the transmission channels through which a financial shock may affect financial conditions and therefore economic activity. For these reasons, a synthetic index, such as the FCI, conveying the information contained in several financial variables, could be useful as a tool to monitor, potentially in real time, the evolution of financial conditions and their expected effect on the economic activity of the three CEE countries.

The rest of the paper is organized as follows. **Section 2** provides a broad review of the literature on FCIs and describes the methodologies that are generally used to build them. **Section 3** analyses the main features of the financial systems and monetary policy regimes in the CEE economies, which is an essential guide in the selection of financial variables to be included in the FCIs presented in **Section 4**. This Section also covers the main steps that are followed first to build and then to test the overall performance of the FCIs. **Section 5** uses FCIs to provide a narrative of the evolution of financial conditions in CEE economies. **Section 6** concludes.

[2] The empirical assessment about the contribution that the FCIs could provide to improve the identification of a monetary policy shock in a small scale VAR for the three economies is left for future research.

2. A brief literature review on Financial Conditions Indexes

FCIs can be considered as an evolution of the 'Monetary Condition Indexes' (MCIs) that were developed in the second half of the 90's by some central banks, notably the Bank of Canada, the Reserve Bank of New Zealand, the Sveriges Riksbank and the Norges Bank (see for example Freedman, 1994), to evaluate the impulses transmitted by monetary policy to economic activity. The MCIs included only variables that were most closely related to monetary policy, usually short-term interest rates and the exchange rate, and were built as a weighted average of their variation. By their nature, MCIs are considered to be the precursors of FCIs.[3]

Indeed, the first examples of FCIs, as in Mayes and Virén (2001) or Goodhart and Hofmann (2002), were simply an extension of MCIs with a larger number of financial variables included, so as to capture additional transmission channels through which these variables may influence economic activity. Subsequently, the role of variables closely linked to monetary policy was downplayed, and in recent versions of the FCI they are usually removed from the analysis. Indeed, the main idea behind the construction of the FCI is to draw some indications of the frictions in financial markets that could potentially impair the normal monetary policy transmission channels, and, more broadly, to evaluate the role of financial conditions in influencing and predicting the real economic activity. A measure of financial conditions is needed to assess whether they are too tight or too loose by historical standards, and how they interact with the policy stance implemented by monetary authorities. FCIs have been developed mostly for advanced economies, which have complex financial markets and products and a large amount of available data (Guichard and Turner, 2008; Guichard et al., 2009; Swiston, 2008; Davis et al., 2016). More recently, however, FCIs were also extended to cover several emerging economies, like in Kara et al. (2012) for Turkey, Ho and Lu (2013) for Poland, Hosszú (2016) for Hungary, Gomez et al. (2011) for Colombia, Gaglianone and Areosa (2016) for Brazil and Gumata et al. (2012) for South Africa, among the others. In this case, the coverage of domestic financial markets is generally constrained by limitations on data, which may not be available for a specific segment or cover only a short time span. At the same time, unlike in advanced economies, FCIs for emerging economies are usually built with the inclusion of a certain number of international financial variables. These economies are indeed significantly affected by financial conditions abroad, as they may influence capital flows and, in general, determine a more positive or negative attitude by international investors towards emerging financial markets.

After having selected the set of financial variables, the information they convey is synthetized in a single index. According to the recent literature, the aggregation is generally performed adopting one of the two following approaches.

The first approach is based on a static or dynamic factor model, which is used to extract the principal component that explains a significant part of the co-movement of the chosen financial variables (English et al., 2005; Hatzius et al, 2010; Brave and Butters, 2011; Matheson, 2012; Erdem and Tsatsaronis, 2013; Darracq Pariés et al., 2014). By using a broad set of information, the latent factor may provide a comprehensive view of the evolution of financial conditions. As the financial variables are endogenously

[3] The FCI is also closely linked to the 'Financial Stress Index' (FSI; for a review see, for example, Lo Duca and Peltonen, 2011, and Holló et al., 2012). The FSIs are generally built in order to capture information on the presence and relative magnitude of vulnerabilities and/or fragilities in the financial markets, generally interpreted as a high exposure to adverse shocks. These indices are therefore used mainly to anticipate the outbreak of a financial crisis. The purpose of the two different types of indicators – FCIs and FSIs – results in a different selection of variables and/or method of aggregation, as well as in the assessment of their relative performance. It is clear, however, that the presence of vulnerabilities and/or weakness in the financial markets has an impact per se on the status of financial conditions and, therefore, the real economy. That is why FCIs and FSIs are often strongly correlated (see Kliesen et al., 2012).

related to the evolution of past economic activity, a first step in the derivation of the FCI usually consists in recovering only the exogenous part of their variation, before extracting the common factor. In this way the FCI could be interpreted as a measure of a financial shock, i.e. an exogenous shift in financial conditions that may influence future economic activity. A more recent approach integrates these two steps, the purge of the data and the extraction of the latent component, in a single econometric procedure by estimating a Factor Augmented VAR (Koop and Korobilis, 2014; Delle Monache et al., 2016).

The second approach consist in building the FCI as a weighted average of financial variables, with weights that reflect their contribution to the change in real GDP, once other sources of variation are taken into account. These weights are generally computed from the impulse response functions resulting from the estimation of a series of VAR models in which each financial variable is put in relation with a restricted number of macroeconomic variables (Swiston, 2008; Guichard and Turner, 2008; Osorio et al., 2011) or of a single VAR model in which the variables are all grouped together (Ho and Lu, 2013). In this case, the issue of endogeneity of financial variables can be tackled, as in Swiston (2008), by applying the weights directly to the financial shock, which is generally identified in a structural VAR with a Cholesky decomposition.[4] Alternatively, in line with the VAR approach, the weights to aggregate the financial variables are obtained from a stylized macro model where the behavioural relationships that link the different GDP components are explicitly formalized and connected to some underlying financial shocks (Hatzius et al., 2016).

An advantage of the factor model approach over the VAR model approach is that the former allows covering a wider spectrum of the financial markets, as there are no constraints on the number of variables that can be included. In the VAR approach, the inclusion of a large set of financial indicators, as for example in Ho and Lu (2013), increases the risk of incurring in the curse of dimensionality, which results in the instability of estimated parameters. When the structural financial shock attached to each variable is instead derived estimating a series of 3-variable models and with an identification strategy based on the Cholesky decomposition, like in Swiston (2008), the approach is not able to properly take into account the interlinkages between the financial and the real variables. The estimation of a large scale macro model for each country would be in theory more appropriate, but it could be a daunting task, especially if one wants to effectively cover and ensure a meaningful role of all the potential transmission channels through which asset prices and quantities may influence aggregate demand and inflation (Gauthier et al., 2004). For the purpose of this paper, the factor model approach is preferable, as it has no constraints in the number of variables that can be included in the FCI and is not dependent on a specific theoretical model. However, once the relevant information included in a large set of financial variables are extracted and summarized in a single index, one needs to assign a meaning to it. In order to properly characterize this index as an FCI, i.e. as a proxy of the evolution of financial conditions, its performance is generally assessed by looking at the signs of the factor loadings and by testing whether it has the ability to explain and help predicting the evolution of real GDP growth.

3. The financial system and monetary policy framework in the CEE economies

CEE financial systems share some common elements in the process of financial deepening and in their current structural features (e.g. the overall size and relative importance of the different segments). Moreover, these countries went through a similar process of increasing financial integration with the European Union,

[4] In Osorio (2011), for example, the weights derived from IRFs are applied to the difference between each financial variable and its average over the whole sample period considered, therefore not properly addressing the issue of endogeneity.

and especially the euro area, which makes their financial systems highly exposed to external shocks.[5] For these reasons, it is meaningful to jointly analyse the evolution of financial conditions in the CEE economies in recent years.

Since the early 1990s, CEE economies have experienced substantial changes in the structure of their financial markets and institutions (Arcalean et al., 2007). A process of financial deepening during their transition towards a more market-based economy was largely expected, due to the low degree of development of their banking sectors and capital markets. Catching up with the EU countries provided new financing opportunities to firms and households, which were previously severely constrained. The process of financial deepening benefited from both supply-side factors, such as the great wave of institutional reforms (deregulation, liberalization and privatization) that also supported the entry of foreign players, and demand factors, such as the stabilization of macroeconomic conditions and a general increase in personal incomes. At the beginning of the new century, the financial systems had already a total size above 100% of GDP in Poland and 150% in the Czech Republic and Hungary, with the capital markets still relatively underdeveloped.[6] Fifteen years later, the size of financial systems had further increased and the differences across countries had become somewhat less significant. The financial system's total size was just above 200% of GDP in the Czech Republic and in Hungary and close to 180% in Poland (**Figure 1**). While most of the domestic supply and demand factors have continued to provide a fairly constant support to the development of financial markets, the external factors mainly contributed to a large extent to a boom-bust financial cycle which was not adequately countered by the implementation of prudential policies (Bakker and Gulde, 2010).

In 2015, the financial systems in the three CEE economies were still largely dominated by the banking sector, which accounted for slightly more than half of the total size in each country (banking claims to the private sector ranging between 40 and 60% of GDP). The debt securities markets, which made up between 30 and 40% of the financial system in the CEE economies in 2015, represented a reliable source of financing options available to domestic borrowers. They also provided a great investment opportunity for both domestic and foreign lenders, which had an open access to these markets. The equity markets had been characterized by a greater volatility, with a huge boost before the global financial crisis and a sharp contraction immediately afterwards. This volatility had been caused not only by the instability of underlying economic fundamentals, but also by the key role played by foreign investors, especially from the euro area (see below). Overall, in 2015 the market capitalization of listed domestic companies was close to 25% of GDP in Poland and the Czech Republic, about 15% in Hungary. Thus, even if stock market are smaller than in the other main emerging economies (Auer et al., 2016), equity financing is another relevant source of funding for domestic firms in the CEE economies.

A common feature of CEE banking systems is the high share of loans denominated in foreign currencies, generally euro and Swiss franc. For many years, the outstanding amount of foreign currency loans even exceeded that of domestic currency loans in Hungary, while it was lower but still close to 30% of total loans in Poland. Only in the Czech Republic, this phenomenon was less significant (below 10%), probably due to stricter regulation which prevented banks from lending in foreign currency to unhedged borrowers. In Poland and Hungary, households in particular were highly exposed to financial risks during periods of sharp fluctuations of the nominal exchange rate, as their income was generally denominated in national currency. Only in recent years have the Polish and Hungarian supervisory authorities introduced regulatory

[5] The Czech Republic, Hungary and Poland joined the European Union in 2004.
[6] The total size of the financial system is here defined as the sum of total assets of domestic banks, outstanding debt securities issued by residents in domestic and international markets and stock market capitalization.

amendments which significantly reduced the amount of loans denominated in foreign currencies, through a (voluntary or compulsory) conversion into local currency, and discouraged foreign currency lending hereafter.

The financial sectors of CEE economies are highly integrated with those of other EU, and especially euro area, economies. The main channel of integration operates through the banking sectors. Indeed, the market share of foreign owned banks is particularly high in these economies (in 2015 it was 90% of total banking assets in the Czech Republic and close to 60 and 50% in Poland and Hungary, respectively) and the majority of these branches and subsidiaries are controlled, directly or indirectly, by credit institutions in the euro area.[7] If we look at the BIS data, in 2015 foreign claims in the CEE economies, which include both claims originated domestically from foreign owned banks and cross-border lending, represented almost 85% of GDP in the Czech Republic and around 50% in Hungary and Poland. Overall, the largest share originated from reporting countries in the euro area, close to 90% of total foreign claims, and especially from Austria, Italy, France and Germany.

The financial integration between the CEE economies and the euro area can be gauged also by looking at CPIS data on the outstanding amount of portfolio investments, provided by the IMF. The Czech Republic, Poland and Hungary are still significantly dependent on foreign funding: in 2015 total portfolio investment liabilities were about 17, 26 and 38% of GDP, respectively. The euro area countries were the main foreign creditors, with a share of total portfolio investment close to 60% in the Czech Republic and to around 50% in Poland and Hungary. If we consider debt securities only, the share was even higher for the Czech Republic (above 70%).

The CEE economies share some commonalities also in terms of their monetary policy frameworks. The three countries have all adopted Inflation Targeting (IT) regimes, in line with the experience in many other emerging and advanced economies. Their previous monetary policy regimes were characterized by different combinations of exchange rate and monetary targets. The transition towards the IT framework was completed in the late 1990's by the Czech National Bank (May 1997) and the National Bank of Poland (February 1998), and somewhat later, in June 2001, by the National Bank of Hungary. Accordingly, these central banks currently have an explicit public commitment to maintaining price stability as their primary policy objective. The IT framework has been gradually complemented with a floating exchange rate regime, with central banks not directly reacting to exchange rate movements vis-à-vis the euro, unless they significantly affect the outlook for price stability (through second-round effects).[8]

[7] Part of the literature linked the relevant presence of non-resident players in the CEE banking system to the high share of loans denominated in foreign currencies. Indeed, the comparisons of cross-country data document higher shares of FX lending in countries where banks have larger cross-border liabilities (Basso et al., 2011).

[8] After the adoption of IT, the Hungarian forint was not immediately allowed to float freely: its fluctuations against the euro were first constrained under a crawling peg regime (with the forint oscillating within a ±2.25% band around a depreciating trend), in place until September 2001, and then under a regime, similar to ERMII mechanism, that allowed the currency to oscillate within a ±15% band around its central parity (until February 2008). An intermediate solution (a crawling peg with a large fluctuation band) was initially adopted also by Poland, which then moved to free floating in April 2001. In the Czech Republic, on the other hand, the transition to IT took place almost simultaneously with the move to a flexible exchange rate regime, which was implemented in May 1997. Since November 2013, the Czech National Bank has adopted a minimum exchange rate against the euro with the aim of avoiding an appreciation of the national currency and maintaining accommodative monetary conditions, in a context of a benchmark interest rate close to zero.

4. Building a Financial Conditions Index for the CEE economies

The building of an FCI generally involves four basic steps: (i) the choice of the financial variables to be included in the FCI, (ii) the purge of the data in order to remove the component linked to the economic cycle, (iii) the use of the selected methodology to extract the information and synthesize it into a single index and (iv) the analysis of its performance based on the relationship between the FCI and the economic activity.

4.1. Selection of financial variables

The analysis of the main structural features of the financial system and monetary policy regime in the Czech Republic, Hungary and Poland, performed in **Section 3**, is an essential guide to figure out which data should be included in the FCI to better evaluate the evolution of financial conditions in the CEE economies. In selecting the financial variables, we need to identify the data that best represent the complexity of the financial systems in the three countries and cover a large part of the potential transmission channels through which a financial shock may affect the economic activity. For each variable we try to discern which role it is expected to play in the assessment of the evolution of financial conditions according to economic theory. The selection of financial variables also takes into account data availability, so as to cover at least the period from 2000 onward, and the necessity to maintain a certain degree of homogeneity across the three countries, in order to be able to better compare the evolution of the FCIs in the three economies in **Section 5**. Financial data can be grouped into four main categories:[9]

1) *Price measures*.

   In this group we include the financial indicators which reflect the evolution of asset prices, especially equities and bonds. An increase in the equity price index and a decrease in short- and long-term interest rates should indicate an easing of the financial conditions, as they make it less expensive for firms and households to finance their investment and consumption decisions. Moreover, this may generate a positive wealth effect on domestic equity and bond holders and trigger the financial accelerator mechanism.[10] The real effective exchange rate is also included in this category. In this case it is more difficult to interpret its variation in terms of the evolution of the financial conditions based on economic theory. A depreciation of the domestic currency generally makes domestic goods more attractive for non-residents through the trade channel. At the same time, it may be associated with negative wealth effects and a decrease in creditworthiness for domestic borrowers with a net open position in foreign currency (Bianchi, 2010; Kara et al., 2012). Moreover, a rapid depreciation of the domestic currency may induce financial stress in economies with high levels of overseas borrowing. Therefore, a depreciation could also be interpreted as having a negative effect on the financial conditions.

2) *Quantity measures.*

   In this category, the outstanding amounts of loans to non-financial corporations and households are included. When markets are not perfect, such loans may provide supplementary information about

[9] A detailed list of the variables is provided in the Appendix. Only the data finally included in the FCI for the three economies are described. Other financial variables were tested but then excluded from the list, as they were negatively affecting the overall performance of the FCIs.

[10] Active interest rates on loans to households and firms are not available for all the three economies on an adequately long time span. They are therefore not included in the derivation of the FCI.

additional constraints potentially faced by banks in their credit supply. An increase in loans to non-financial corporations and households should be generally interpreted as an easing of financial conditions.[11]

3) *Spreads*.

In this group we include the dollar denominated sovereign bond spread and the differentials between interest rates in local currency and euro. When financial markets are deeply integrated, these indicators may reflect a measure of borrower risk or country risk. Therefore, an increase in credit spreads could be normally interpreted as a tightening of financial conditions. However, when the widening of the interest rate differential between two currencies is not equal to that between the forward and spot exchange rates (i.e. the covered interest parity does not hold), there could be an arbitrage opportunity window for foreign investors. The resulting wave of financial flows could therefore be interpreted as an easing of financial conditions for those agents who fund themselves issuing securities denominated in their own currencies to non-residents.[12] An increase in interest rate differentials may also contribute to an easing of credit standards by foreign owned banks, which would be in a position to increase their market shares and their profit margins by borrowing abroad at a lower cost, in order to fund their credit supply in the domestic economy (Basso et al., 2011).

4) *External variables.*

Following other examples in the literature (Gumata et al., 2012), this category includes the external variables whose evolution may broadly influence the propensity to invest/disinvest in the CEE economies by non-residents, therefore indirectly affecting the domestic financial conditions. In doing this, the fact that the euro area is the main source of funding for the Czech Republic, Hungary and Poland is adequately taken into account. The external variables include, for the emerging economies, a broad measure of risk aversion (the Composite EMBI spread) and, for the euro area, an index of general market risk (the EuroStoxx50 equity price index) and a proxy of credit risk and liquidity conditions (the EURIBOR-OIS spread), which was particularly affected during the global financial and the euro sovereign debt crises.[13]

The data have a monthly frequency and span between January 2001 and November 2016, with some missing values at the end of the sample. They are all transformed in order to ensure stationarity of the series (see the Appendix).

4.2. Purging the data

After having selected the financial variables to be included in the FCIs, the next step is to purge the data from the direct effect of past domestic economic activity. As mentioned before, in order to interpret the FCI as a measure of a financial shock, it is necessary to extract only the information contained in the exogenous

[11] A more direct indicator of credit standards, such as the one originating from bank lending survey, is not available with a long time span for the three economies, e.g. in the Czech Republic the first data were published in July 2012.
[12] Borio et al. (2016) provide some evidence on the failure of the covered interest parity theory, especially after the global financial crisis in 2007.
[13] The inclusion of other measures of risk and aggregate economic uncertainty (such as the VIX or the VSTOXX) was also considered, but it negatively affected the analysis of factor loadings, and therefore the possibility to interpret the synthetic indexes as proxies of the evolution of financial conditions, without providing any significant improvement in the forecasting performance.

variation of the financial variables and remove their endogenous reaction to past economic activity, which by itself would help predict future activity (Hatzius et al., 2010).

For this reason, the following regressions are performed separately for each country:

$$x_t = A(L)Y_{t-1} + v_t \,, \tag{1}$$

where x_t is a $n \times 1$ vector containing the selected financial variables at time t, Y_{t-1} is a 3×1 vector including two macroeconomic indicators (the 3-month growth rate of manufacturing production and 12-month CPI inflation) and a constant, and $A(L)$ is a lag polynomial. In our case, coherently with Hatzius et al. (2010), we set the number of lags as equal to 2. However, the possibility of a simultaneous relation between real and financial variables in equation (1) is in this case excluded for two reasons: firstly, it is reasonable to assume that economic activity influences financial variables with a delay of at least one month; in addition, as financial variables are generally available sooner than manufacturing production and CPI inflation, by assuming no simultaneous relation, the information contained in the more recent observations is kept included.

4.3. A Kalman filter to extract the unobserved component

The next step regards the derivation of a single index, which would synthetize the information contained in the purged financial variables. In particular, the FCI is extracted as an unobserved factor which explains a large part of the co-movement of the data obtained in the previous step. In this case, a Dynamic Factor Model is estimated applying the methodology proposed in Bańbura and Modugno (2014).

Let $z_t = [z_{1,t}, z_{2,t}, \dots, z_{n,t}]'$, $t = 1, \dots, T$ be a vector containing all the purged financial indicators $v_{i,t}$ at time t, standardised so as to have mean 0 and a unit variance. It is assumed that z_t admits the following factor model representation:

$$z_t = \Lambda f_t + \epsilon_t \,, \tag{2}$$

where f_t is a $r \times 1$ vector of (unobserved) common factors, $\epsilon_t = [\epsilon_{1,t}, \epsilon_{2,t}, \dots, \epsilon_{n,t}]'$ is the idiosyncratic component and Λ is a $n \times r$ matrix containing the factor loadings.[14] In addition, it is assumed that the common factors f_t follow a stationary VAR process of order 1:

$$f_t = Bf_{t-1} + \eta_t \,, \qquad \eta_t \sim i.i.d.\mathcal{N}(0, Q), \tag{3}$$

where B is a r × r matrix of autoregressive coefficients.

[14] It is assumed that ϵ_t is normally distributed and serially uncorrelated. In equation (2), we considered factor loadings as constant over time. Recent papers in the literature, as Koop and Korobilis (2014) and Delle Monache et al. (2016), allowed for time variations in the parameters and stochastic volatility to better tackle the structural instability which may be related, for instance, with the Great Recession and the European sovereign debt crisis. However, Bates et al. (2013) show that the estimation of the factor f_t has a considerable amount of robustness even when a high degree of time variations in the factor loadings is ignored.

The maximum likelihood estimation of the unobserved factors f_t is based on an Expectation-Maximisation (EM) algorithm, which was introduced by Dempster et al. (1977) as a general solution to problems for which incomplete or latent data make the likelihood intractable or difficult to deal with. The essential idea is to write the likelihood as if the data were complete and to iterate between two steps: in the Expectation step the missing data are filled in the likelihood using the estimates from the previous iteration, while in the Maximization step this expectation is re-optimized to derive a new estimate of the parameters. Under some regularity conditions, the algorithm converges towards a local maximum of the likelihood.[15] The estimation procedure based on EM algorithm in Bańbura and Modugno (2014) is more suitable than others to deal with an arbitrary pattern of missing observations. Matheson (2012), for example, applies the methodology proposed in Giannone et al. (2008), which is less straightforward to apply to datasets with series of different lengths or, in general, with any pattern of missing data. Indeed, in that case, the factor loadings estimation is based on static principal components analysis on a truncated dataset, i.e. a balanced sub-sample of the original data.[16]

In the estimation with the EM algorithm, the number of factors *r* is equal to 3, as we need to explain a sufficiently large portion of variance of the purged financial indicators in order to properly deal with the missing observations.[17] Then, as in Wacker et al. (2014), the first factor is interpreted as a proxy of the financial conditions (i.e. as the FCI) for each of the three CEE economies.[18] This factor explains between 28 and 33% of the total variance of the purged financial data (see **Table 1**).

4.4. The performance of the FCI

The analysis of the performance of an FCI is generally based on two steps. First of all, the signs of the estimated factor loadings are analysed, in order to gauge if one can get an economic interpretation of the synthetic index, i.e. if its increase could be interpreted as a tightening or easing of the financial conditions. Then, the relationship between the FCI and the economic activity is assessed, both *in-sample* and *out-of sample*. If it provides some useful information in a forecasting exercise, one can be reasonably confident in using the FCI as an effective tool in monitoring, potentially in real-time, the evolution of the financial conditions and in evaluating their expected effects on economic activity.

As in Hatzius et al. (2010), **Figure 2** shows the estimated factor loadings, both in actual and absolute values, for the first factor. The lambdas indeed reflect the weight that each financial indicator has in the building of the FCIs. The signs for the domestic variables are broadly in line with an interpretation of the first factor as a proxy of the relative looseness of the financial conditions in the CEE economies, i.e., its increase should be expected to signal an improvement in economic activity in perspective. Indeed, a negative lambda is generally attached to domestic interest rates, while a positive coefficient is linked to the loans to the private sector, both to households and to non-financial corporations, and the equity price index. As stated

[15] The EM algorithm is a valid approach for the maximum likelihood estimation of factor models as it is robust, easy to implement and computationally feasible for large datasets (Doz et al., 2012). In our case each step involves a pass of the Kalman smoother and two multivariate regressions. See Bańbura and Modugno (2014) for a detailed description of how the procedure works.

[16] Differently from Giannone et al. (2008), the methodology proposed in Bańbura and Modugno (2014) is also straightforward to apply to cases of mixed frequency datasets.

[17] The portion of variance explained by the common factors is about 74% in Hungary, 72 in Poland and 62 in the Czech Republic.

[18] An alternative option would be to define the FCI as a sum of the 3 factors weighted by their share of total variability explained, as in Angelopoulou et al. (2013). This would probably increase the overall performance of the FCIs as leading indicators of economic activity, but at the cost of losing the economic interpretation of the indexes and therefore reducing their practical use in monitoring the evolution of financial conditions.

in **Section 4.1**, a negative lambda for the domestic spreads is also in line with economic theory, as an increase in the borrower risk could be interpreted as having a negative effect on overall financial conditions. Finally, a positive value for the factor loading of the real effective exchange rate in the three countries, even if less intuitive, can still be reasonable, if one considers the balance sheets effects that may be associated with an appreciation of the national currency. As for the signs of the factor loadings attached to the external variables, an increase in the FCI is generally associated with a higher growth of the equity index, a lower EURIBOR/OIS spread in the euro area and a lower EMBI spread for Emerging economies.[19] In terms of the absolute values of the lambdas, to be considered as an indicator of the relative relevance of each variable in the building of the FCIs, we have a low weight for domestic equity price index and (especially) domestic credit growth, while a higher weight is attributed to interest rates and spreads, both domestic and foreign. This is probably a direct consequence of the fact that these variables are relatively more numerous. The first factor is therefore highly correlated with them and explains a large part of their co-movements. As the signs of the lambdas are broadly in line with economic rationale, however, this does not affect the interpretation of FCIs as proxies of the evolution of financial conditions in the three CEE economies.[20]

The *in-sample* performance is first assessed by means of a Granger causality test between the FCI and real GDP growth.[21] We therefore estimate the equation:

$$y_t = \alpha + \beta_i \sum_{i=1}^{p} y_{t-i} + \gamma_i \sum_{i=1}^{p} f_{t-i} + \mu_t \qquad (4)$$

and test whether we can reject the null hypothesis that the γ_i are jointly equal to zero. The number of lags p in equation (4) is set equal to 3, which is the maximum number of lags selected according to the Schwarz Criterion when a two-variables VAR with the real GDP growth and the FCI is estimated for each of the three countries. **Table 2** shows the *F-test* statistics and the *p-values*, leading to the conclusion that the Granger causality test is passed in all the cases at a 5% level of significance.[22] This can be considered as a first indication that the FCI helps to predict real GDP growth.

The result is confirmed by looking at the performance of the FCI in a predictive regression analysis, where we explicitly forecast the real GDP growth at different time horizons by augmenting an AR(p) process only with the inclusion of FCI at time t. In this case, we therefore estimate for each country the following equation:

$$y_{t+h} = \alpha + \beta_i \sum_{i=1}^{p} y_{t+1-i} + \gamma f_t + \mu_t \,, \qquad (5)$$

where the forecast horizon h is set to 1, 2 and 4. Here the significance and the sign of the coefficient γ, attached to the FCI, is assessed in order to check whether an increase in the index could effectively be

[19] Only in the case of Poland, the factor loading relative to EURIBOR/OIS spread is positive.
[20] Various options regarding the increase in the number of financial variables have been considered, but some constraints have emerged in terms of time span (as in the case of credit standards) or the signs of the factor loading (as for the distinction between loans denominated in foreign and domestic).
[21] In this section, an FCI at quarterly frequency is calculated by using for each quarter the three-month average at monthly frequency.
[22] A unidirectional Granger causality from FCI to real GDP growth holds for Poland and the Czech Republic, but not for Hungary.

interpreted as an easing of the financial conditions, in line with the factor loading analysis.[23]

The coefficient γ is significantly positive in all the specifications considered (see **Table 3**), confirming that an increase in the FCI is supposed to have an expansionary effect on the economy in the next few quarters.[24] The partial R^2, which provides information on the amount of variance that is explained only by the FCI once the p autoregressive terms have been accounted for, shows a non-negligible contribution.[25] This is especially the case for Hungary, where the partial R^2 is above 16% at all the forecast horizons considered.

In order to finalize the assessment of the FCI, this *in-sample* analysis is then to be complemented with the evaluation of its performance in an *out-of-sample* forecasting exercise. Due to data limitation, however, only a *pseudo-out-of-sample* exercise is constructed, as in Wacker et al. (2014). Therefore, first the FCI is computed over the whole timespan (between 2001Q1 and 2016Q3); then it is used to perform a *rolling window forecasting* exercise, which could better account for instability in coefficients, especially during the period of the global financial and euro sovereign debt crises. As a benchmark, a rolling window with a width of 34 quarters (8 years and a half) is considered. Therefore, when the forecast horizon h is equal to *1*, the coefficients in the AR(1) model augmented by the FCI, as in equation (5), are first estimated using information between 2001Q1 and 2009Q3, and then used to compute the forecast of real GDP growth in 2009Q4. The last estimation uses information between 2007Q4 and 2016Q2 to forecast the real GDP growth in 2016Q3. The same procedure is replicated with a simple AR(1) model, without the inclusion of the FCI. The performance of the FCI is then assessed by means of the relative root mean squared error (RMSE).

A value lower than 1 for all the specifications implies that the FCI provides a positive contribution in helping forecasting the real GDP growth with respect to the simple AR(1) process (see **Table 4**).[26] However one cannot always conclude that the augmented model has a better forecast accuracy that the autoregressive model alone. Indeed, the Diebold-Mariano test, computed with heteroskedasticity and autocorrelation robust (HAC) standard errors, is passed only in the case of Hungary and the Czech Republic, and with a forecast horizon of 4 quarters.[27] To get a better understanding of the behaviour of the two competing forecasts over the time span considered, their time series are plotted together with the actual value of real GDP growth, focusing on the case of a forecast horizon of one quarter (h = 1). By comparing them, it seems that the inclusion of the FCI to the simple AR(1) model does help forecasting the real GDP growth, especially during periods in which the financial tensions were particularly acute, i.e., during the euro area sovereign debt crisis (see **Figure 3**).

This is quite clear in the case of the Czech Republic and Hungary, where the functioning of financial markets was severely impaired during that period (see **Section 5**). On the contrary in Poland, which was more insulated from the effects of the crisis and, unlike the other two countries, did not experience a severe contraction in economic activity, the FCI does not seem to add any relevant information with respect to the AR(1) model. This consideration may partially explain the different performance of the FCI in the *pseudo-*

[23] In the Granger causality test, the potential multicollinearity between the lagged regressors can have an impact on the reliability of the estimates of the single coefficients attached to the FCIs.
[24] The result is shown for p equal to one, which avoids losing too many observations; this result is robust to the inclusion of a higher number of autoregressive terms of real GDP growth in the predictive regression.
[25] The partial R^2 is obtained as the R^2 of a regression of the residuals of real GDP growth with respect to its own lags on the residuals of the FCI with respect to the same lagged variables. Therefore, it measures the mutual relationship between real GDP growth h-step ahead and the FCI when the other variables are held constant.
[26] The result of the *pseudo-out-of-sample* forecasting exercise is quite robust to both an increase in the number of autoregressive terms and a variation in the width of the rolling window.
[27] Giacomini and White (2006) show that the Diebold and Mariano (1995) test statistic is valid even for nested models, if the estimation window does not grow with the sample size, as in this paper with a rolling window forecasting exercise.

out-of-sample forecasting exercise in the three economies. The suggested motivation is somehow coherent with Aramonte et al. (2017), whose findings show that the predictive power of several FCIs built to monitor the evolution of financial conditions in the US is rather weak when the period of the global financial crisis is not included in the sample. In order to obtain some evidence on the presence of a threshold effect in the three CEE countries, **Figure 4** plots the FCIs at time *t* together with real GDP growth realization at time *t+1*, splitting the whole sample into two parts: the red dots are tail events potentially associated with periods of severe financial stress, i.e., with an FCI below the value corresponding to the 16th percentile of its distribution, while the green dots are the remaining observations. As the figure shows, in Hungary and the Czech Republic the positive correlation between FCI and the one-period ahead actual real GDP growth is stronger in the tail events, which are effectively largely associated with the periods of financial tensions erupted between mid-2008 and 2012. This is not the case in Poland, where the left tail of the distribution of the FCI is mostly associated with the early stage of economic and financial integration with the European Union.

5. The evolution of financial conditions in Poland, Hungary and the Czech Republic

Having tested the usefulness of FCIs in predicting economic activity in the Czech Republic, Hungary and Poland, this section analyses the evolution of financial conditions in the three CEE economies, covering a period of almost fifteen years, between 2001 and 2016. Having built the indexes from a similar set of domestic and external variables allows a comparison across countries, so as to highlight more easily the differences. Moreover, an assessment can be made on which group of variables, as described in **Section 4.1**, had a greater impact on the evolution of the FCIs by looking at their contribution in different periods. The FCIs are reported in **Figure 5** on a common scale, after their standardization. Indeed, the absolute level of the index has no specific interpretation per se, it is just the deviation from its mean (zero) that matters and provides information about the relative tightness/looseness of financial condition. Having set the standard deviation equal to one makes it easier to identify those events that were particularly extreme on a historical basis.

In the period between 2001 and 2003, the financial conditions in the Czech Republic and Poland were relatively tight, with all the groups of variables, both domestic and external, contributing negatively to the level of the FCIs. At the beginning of the period, the interest rates were quite high, both in absolute terms and relative to the euro area, but they declined significantly over the following years, mainly due to the process of real and, especially, financial integration with the EU, which induced a certain degree of convergence also in the interest rates. Moreover, the full implementation of an inflation targeting regime facilitated a gradual reduction in policy rates by monetary authorities, due to the gained credibility in defending price stability (Svensson, 2007). In the Czech Republic, bank loans to the private sector were also significantly contributing to tighter financial conditions, as the credit supply was still impaired by the legacy of the late 1990s banking crisis, with a high share of non-performing loans (Fraint et al., 2011). In the case of Hungary, financial conditions over the same period were on average closer to neutral or slightly expansionary, due to effects arising in particular from the price and spread components, as interest rates, already more in line with those abroad, further declined and the exchange rate appreciated in the same period.

Between 2004 and 2008, financial conditions became relatively loose in all three CEE economies, and especially in Poland and the Czech Republic. All the components, both domestic and foreign, were contributing to this evolution. On the domestic side, while in Hungary the dominant effect was arising from

price variables, in the Czech Republic and Poland it was more related to the reduction in spreads. In this period all the CEE economies experienced a boom in bank credit and asset prices, fuelled and financed by large capital inflows (see IMF, 2010). The reduction in the perceived borrower risks was one of the main drivers behind the large inflows of cross-border claims in this period, as the expected returns were still benefiting from positive interest rates differentials with the euro area and from the prospect of increasing loan volumes along the process of financial deepening. Indeed, in this period the favourable financial conditions were also a result of the evolution of the quantity variables, i.e., loans to households and non-financial corporations, which were adding a significant positive contribution especially in Poland and the Czech Republic.[28] Finally, the exchange rate appreciation of domestic currencies vis-à-vis the euro was expected to endure, even if at a slower pace than the past, as economic and financial convergence with the EU economies had already brought some results after the completion of their accession process in 2004.

In the period between September 2008 and late 2012, which includes the global financial and the euro sovereign debt crises, in Hungary and the Czech Republic almost all variables that had contributed to the boom phase turned around dramatically. It is interesting to note that in these countries the domestic components continued to have sizeable tightening effects on financial conditions even in the period between the two crises, when the tensions in international financial markets eased somewhat. The evolution of financial conditions between 2008 and 2012 was significantly different in Poland, as the external component had a reduced relevance, especially due to relatively low factor loading attached to EURIBOR-OIS spread, and domestic components were neutral or even positively contributing, as in the case of the price component, to the evolution of the FCI. Poland was indeed more insulated and less affected by the change in international investors' risk perceptions: for example, Poland was the only EU country to record positive GDP growth in 2009 (ECB, 2010) and it did not experience a severe recession during the propagation of the euro debt sovereign crisis.

Over the last few years (2013-2016), the financial conditions were overall relatively loose in all three CEE economies, and both external and domestic components were positively contributing to this evolution. However, some differences emerged overtime, especially from mid-2015. Indeed, financial conditions in the Czech Republic and Poland were negatively affected by the evolution of external conditions, as their indexes proved relatively more sensitive to the increase in risk aversion toward emerging economies that occurred in that period. By looking at the domestic components, in Poland financial conditions were relatively tighter, especially due to a negative contribution from spreads. Indeed, this was a period characterized by an increase in policy uncertainty following the announcement of some controversial initiatives affecting the banking system, such as, the proposed mandatory conversion of foreign currency mortgages into local currency (IMF, 2016). By contrast, in the Czech Republic and Hungary domestic components contributed to a loosening of financial conditions, with both the price and the spread components playing a significant role in this direction. In Hungary the decrease in interest rates and the increase in equity prices partly reflected the abundant liquidity arising from unconventional monetary policy measures, but this was also the result of the attenuation of political and economic uncertainty which had characterized the previous years.[29]

[28] In the case of Hungary, the factor loadings regarding loans to households and firms are too small to get any visible indication of a meaningful contribution to the evolution of the financial conditions in this period.

[29] As mentioned before, the Czech National Bank has adopted a minimum exchange rate against the euro since November 2013. The National Bank of Hungary launched the *Funding for Growth Scheme* in June 2013, with the aim of alleviating the persistent disruptions in lending to SME. More recently, since October 2016, it has reduced the maximum volume offered at the three-month deposit instrument tenders in order to stimulate the interbank market and facilitate the targeted easing of monetary conditions.

6. Conclusion

The financial systems in the Czech Republic, Hungary and Poland have experienced a rapid process of integration with the other EU economies, mainly due to the accession process. Together with domestic drivers of financial deepening, this contributed to a more developed and better functioning financial markets and a broader range of instruments became available to finance investment and consumption for firms and households. As a consequence, the financial shocks now propagate through a greater variety of channels and are more likely to deeply influence real economy. Indeed, also in these countries the recent global financial and euro sovereign debt crises have shown how relevant financial conditions can be in significantly affecting the economic activity.

In order to monitor the evolution of the financial condition, potentially in real-time, FCIs for the Czech Republic, Hungary and Poland were constructed as a latent component in a Dynamic Factor Model explaining a large part of the co-movements of several financial variables. The EM algorithm was used as an iterative method to find the maximum likelihood estimates of the parameters, in order to tackle the potential issue of an arbitrary pattern of missing observations. Having interpreted the FCIs by looking at the signs of the factor loadings and their relationship with economic activity, their overall performance was assessed by finally testing their ability to add some information in a pseudo-out-of-sample forecasting exercise.

The analysis of the evolution of the FCIs is coherent with the prevailing narrative. Coming from a period of relatively tight financial conditions in the early 2000s, the CEE economies benefited from the positive effects of their process of real and financial integration with the EU economies. Thus, in the years after EU accession, financial conditions gradually became more accommodating, contributing to a boom phase fuelled by foreign capital inflows. Then, during the global financial crisis and the subsequent euro sovereign debt crisis, global risk aversion increased sharply and the functioning of international financial markets was severely impaired, resulting in different effects for the three CEE economies; while Poland appeared to be more insulated, in Hungary and the Czech Republic the interaction with a worsening of domestic financial conditions contributed to a contraction in economic activity. Only in recent years do the FCIs signal a gradual loosening of the financial conditions in the two countries, partly related to the implementation of unconventional monetary policies. In Poland, a more recent tightening could be partly explained by the policy uncertainty following the announcement of some controversial initiatives affecting the banking system.

On the basis of this evidence, these FCIs could be confidently used as analytical tools to improve the understanding of the role of financial markets in influencing economic activity in the three CEE economies. FCIs can also help evaluate whether or not the overall financial conditions are evolving in line with the intended policy stance announced by monetary authorities. We leave for possible future research the assessment of whether (and to what extent) the inclusion of FCIs in a structural VAR can positively contribute to the identification of a monetary policy shock.

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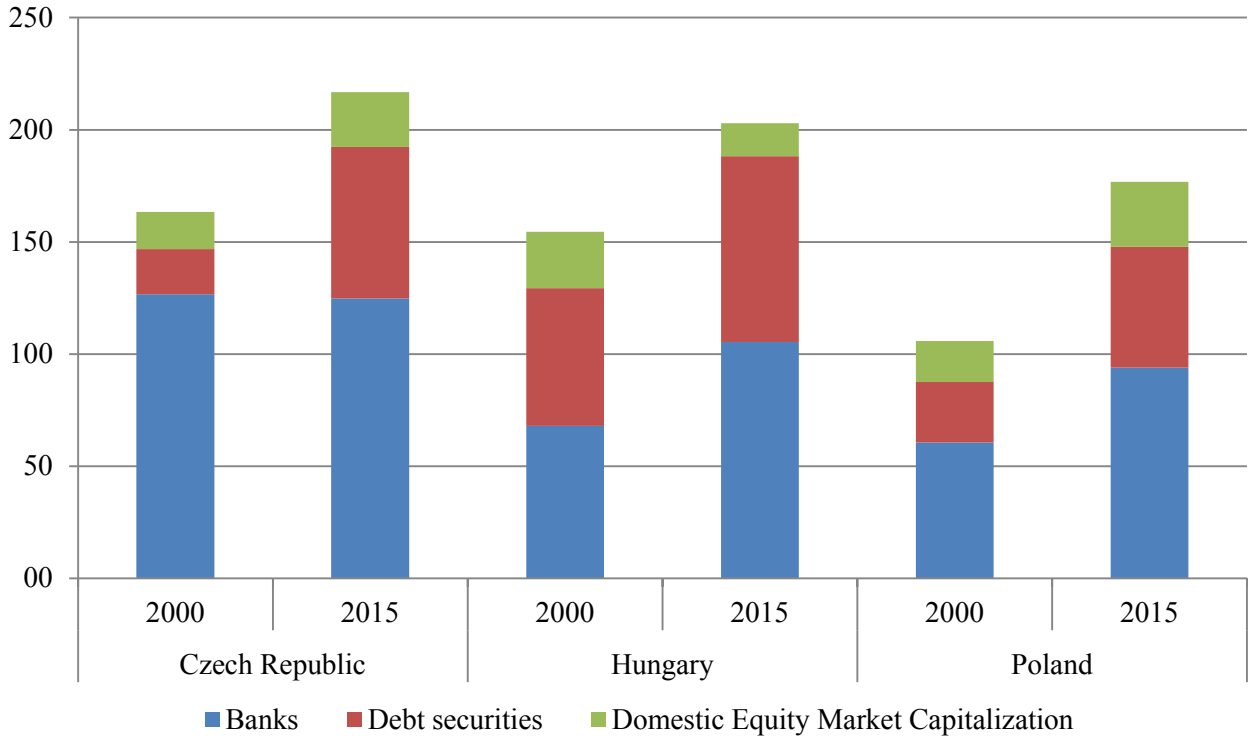
Appendix

Variable Definitions and Sources:

Variable	Description	Transformation	Source	CZ	HN	PO
1) Price measures						
eig	Domestic stock market price index	y-o-y growth rate	Datastream	✓	✓	✓
reerg	Real effective exchange rate	y-o-y growth rate	JPMorgan	✓	✓	✓
ir3m	3-month interest rate	level	Datastream	✓	✓	✓
ir10y	10-year interest rate	level	Datastream	×	✓	✓
s10y3m	Difference between 10Y and 3M interest rates	level	Datastream	✓	×	×
2) Quantity measures						
lfog	Outstanding amount of loans to firms	y-o-y growth rate	Central banks	✓	✓	✓
lhog	Outstanding amount of loans to households	y-o-y growth rate	Central banks	✓	✓	✓
3) Spreads						
dembi	Domestic EMBI spread	level	JPMorgan	×	✓	✓
spr3m	Difference between domestic and euro area 3M interest rates	level	Datastream	✓	×	✓
spr10y	Difference between domestic and euro area 10Y interest rates	level	Datastream	✓	✓	✓
4) External variables						
embi	Emerging Economies (Composite) EMBI spread	level	JPMorgan	✓	✓	✓
euroois	EURIBOR-OIS spread	level	Datastream	✓	✓	✓
stoxx50g	EuroStoxx50 price index	y-o-y growth rate	Datastream	✓	✓	✓

Figures and Tables

Figure 1: The Financial systems in the CEE economies



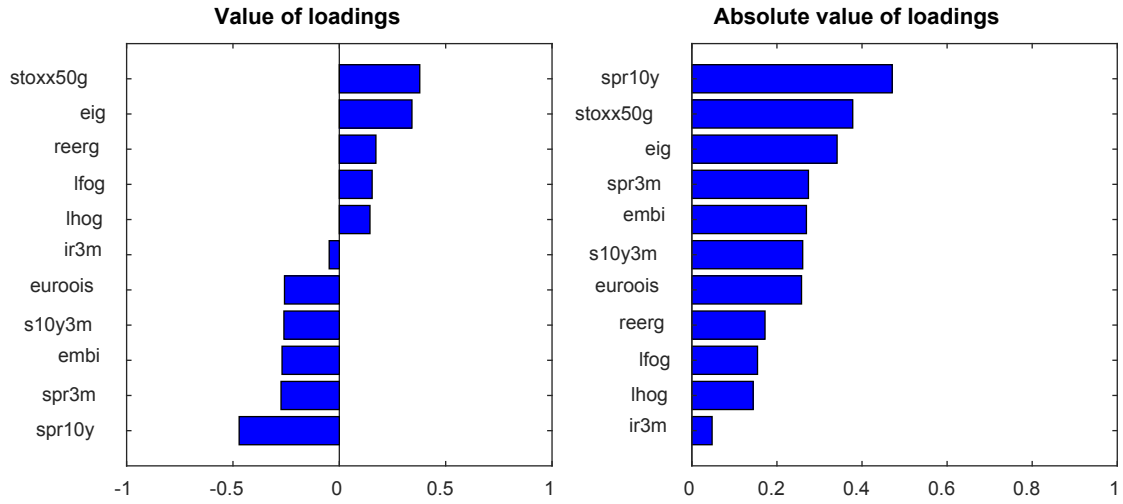
Source: BIS, IMF *International Financial Statistics* and *World Economic Outlook*, National Central Banks, WB *World Development Indicators* and World Federation of Exchanges.

Table 1: Portion of variance explained by the unobserved factors

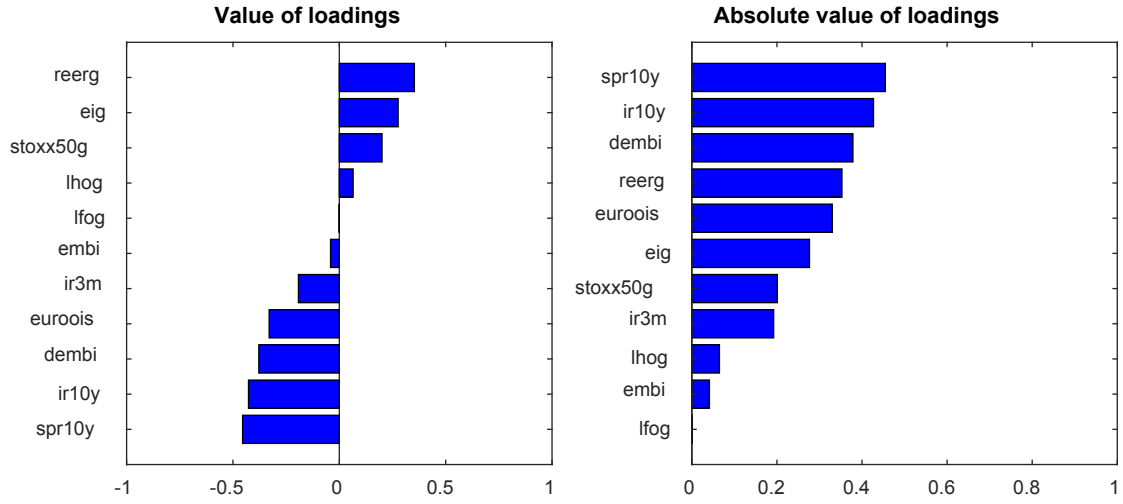
	1st Factor	2nd Factor	3rd Factor	Total % of explained variance
Czech Republic	27.9	20.8	13.6	62.3
Hungary	32.6	27.3	14.2	74.1
Poland	33.3	25.5	13.0	71.8

Figure 2: Rankings of variables by their loadings in the first factor

Czech Republic



Hungary



Poland

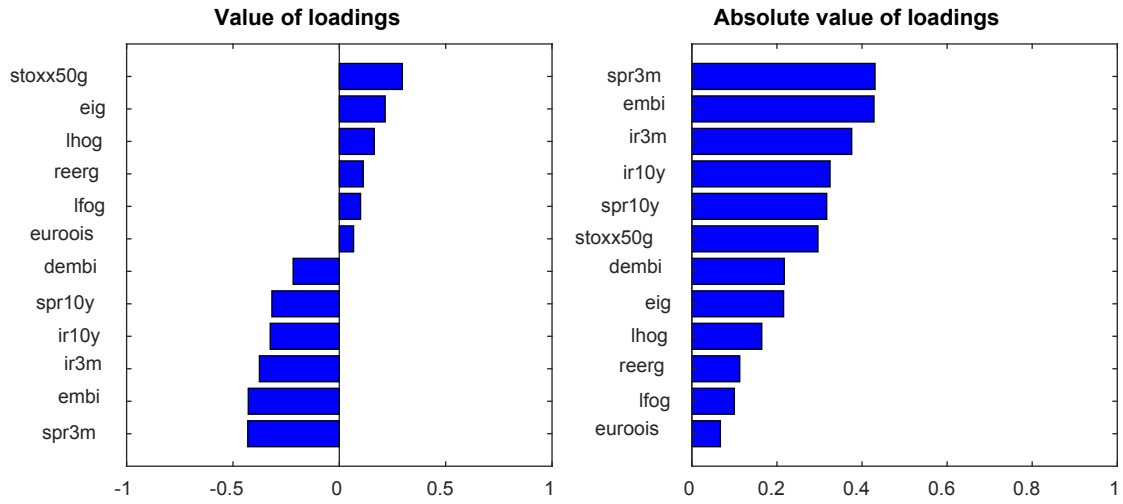


Table 2: Granger causality test

	n° of lags = 3	
	F-stat	P-value
Czech Republic		
FCI does not Granger cause GDP	3.83	0.01 **
GDP does not Granger cause FCI	0.57	0.64
Hungary		
FCI does not Granger cause GDP	4.05	0.01 **
GDP does not Granger cause FCI	4.71	0.01 **
Poland		
FCI does not Granger cause GDP	2.74	0.05 **
GDP does not Granger cause FCI	2.15	0.11

(*) represents significance at 10 percent, (**) at 5 percent.

Table 3: In-sample predictive tests

	γ	t-stat	P-value	Partial R2
Czech Republic				
h = 1	0.30	2.46	0.02 **	0.09
h = 2	0.41	2.26	0.03 **	0.08
h = 4	0.47	1.81	0.08 *	0.06
Hungary				
h = 1	0.34	3.36	0.00 **	0.16
h = 2	0.64	4.09	0.00 **	0.22
h = 4	0.74	3.26	0.00 **	0.16
Poland				
h = 1	0.23	2.74	0.01 **	0.11
h = 2	0.27	2.50	0.02 **	0.10
h = 4	0.34	2.49	0.02 **	0.10

(*) represents significance at 10 percent, (**) at 5 percent.

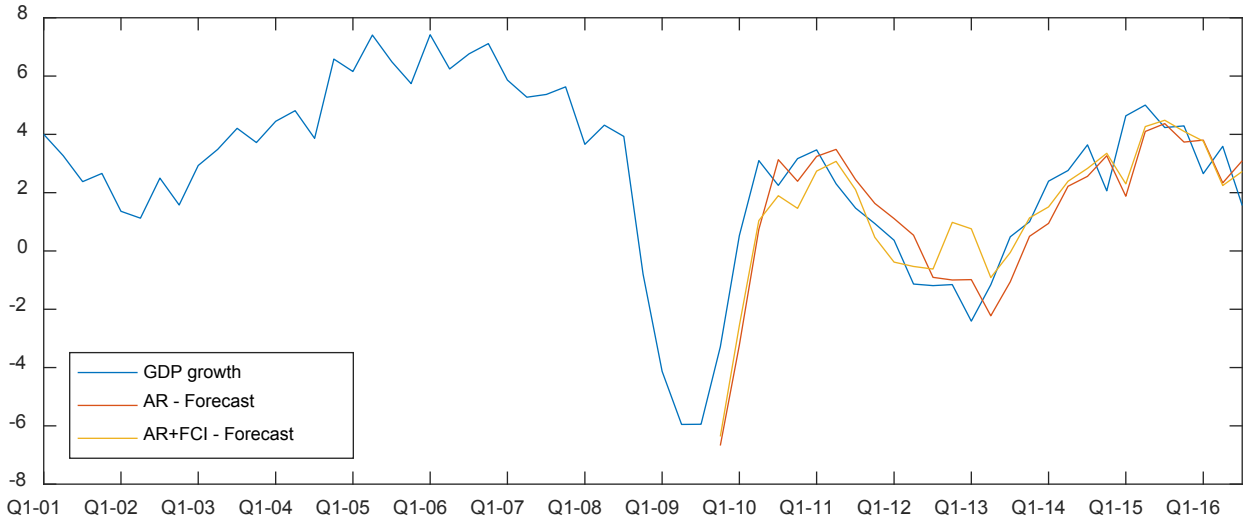
Table 4: Relative RMSE – AR(1) + FCI model vs. AR(1) model

	h = 1	h = 2	h = 4
Czech Republic	0.954	0.946	0.828 *
Hungary	0.912	0.827	0.824 *
Poland	0.982	0.946	0.986

(*) indicates that the null hypothesis of the Diebold-Mariano test that the two forecasts have the same accuracy is rejected at 5 percent level of significance.

Figure 3: Pseudo-out-of-sample forecast with h = 1

Czech Republic



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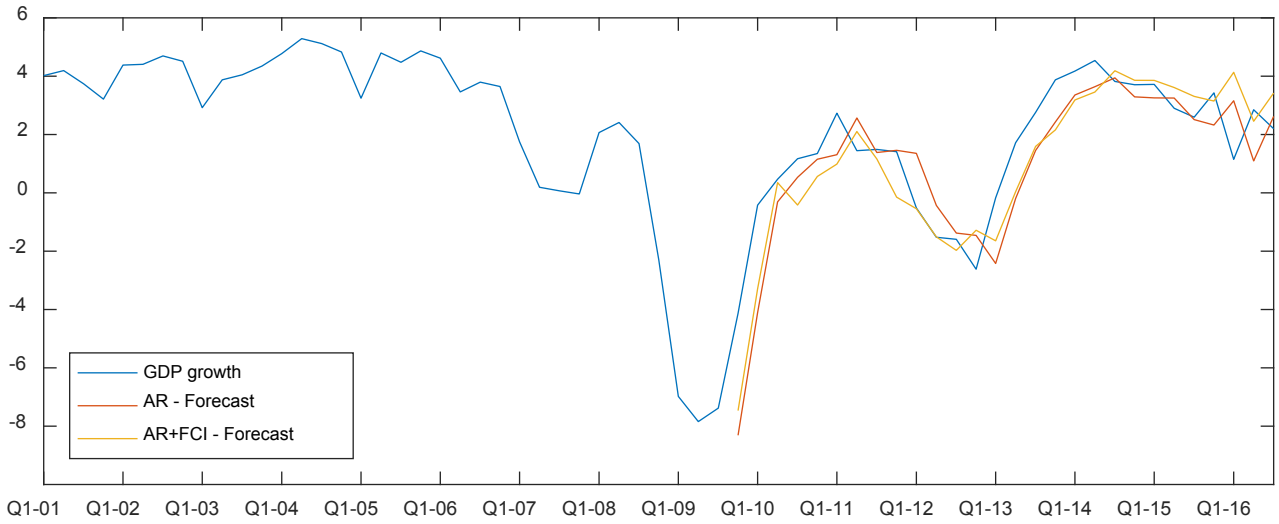
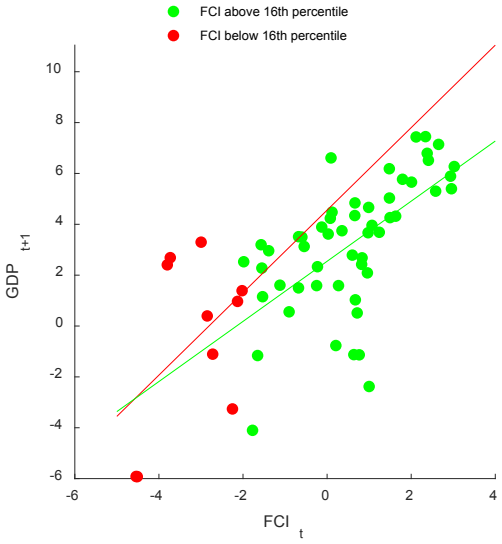


Poland

Figure 4: Thresholds effect

Czech Republic



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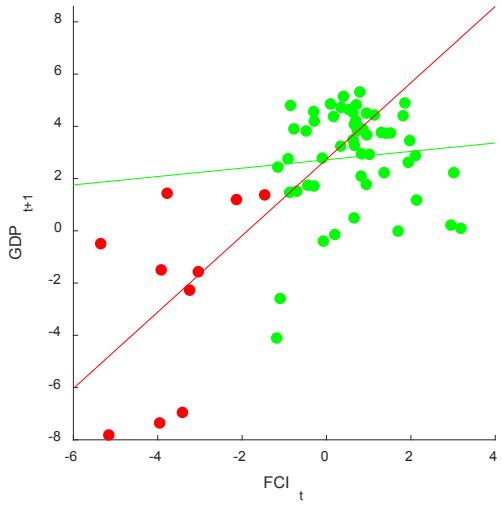
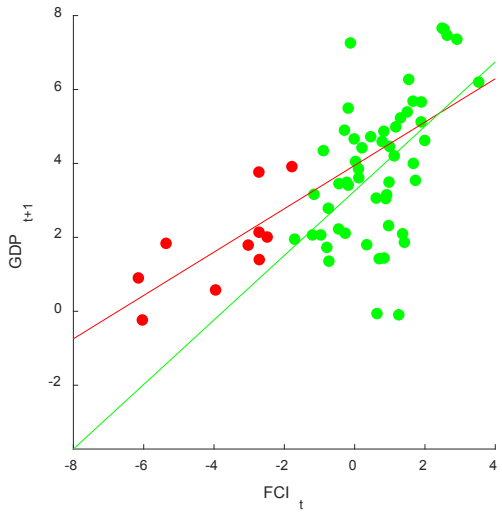


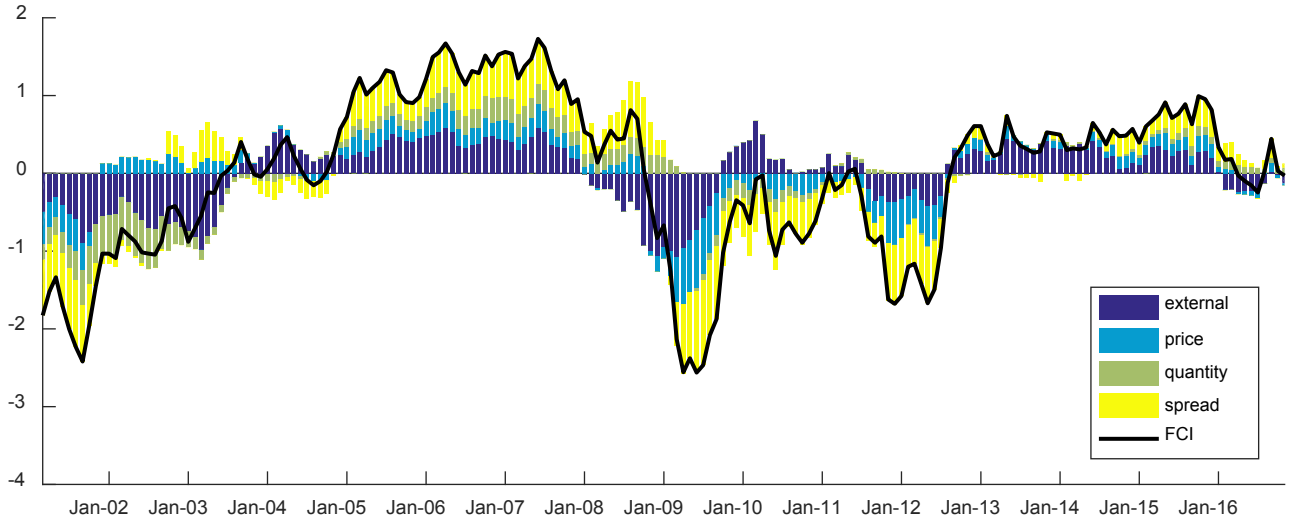
Poland



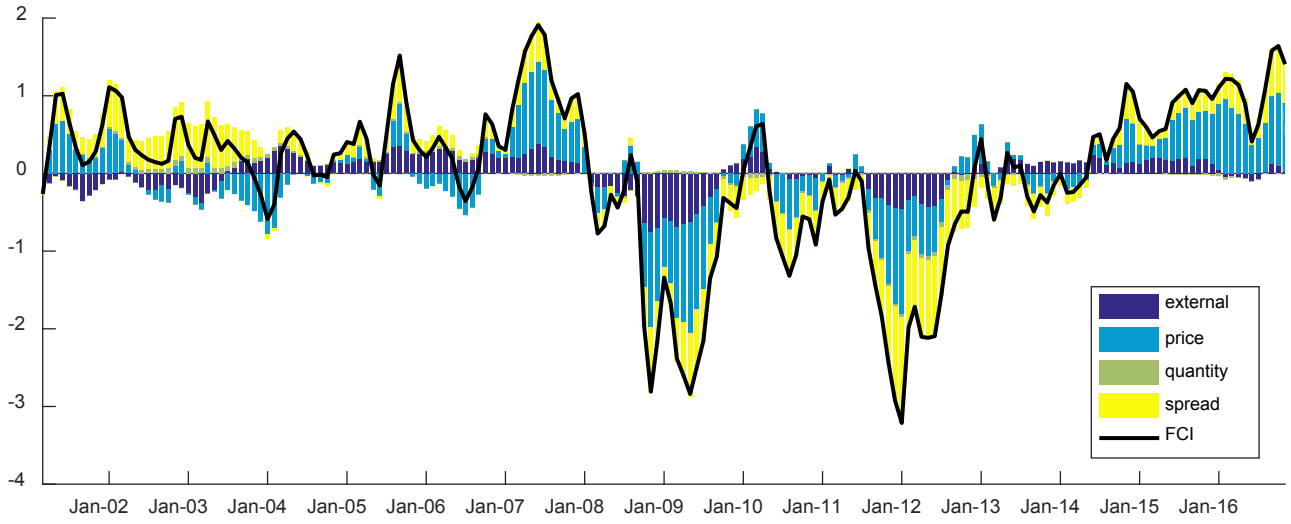
Note: the green (red) dots are associated with an FCI above (below) the value which corresponds to the 16th percentile of its distribution.

Figure 5: FCI in the CEE economies

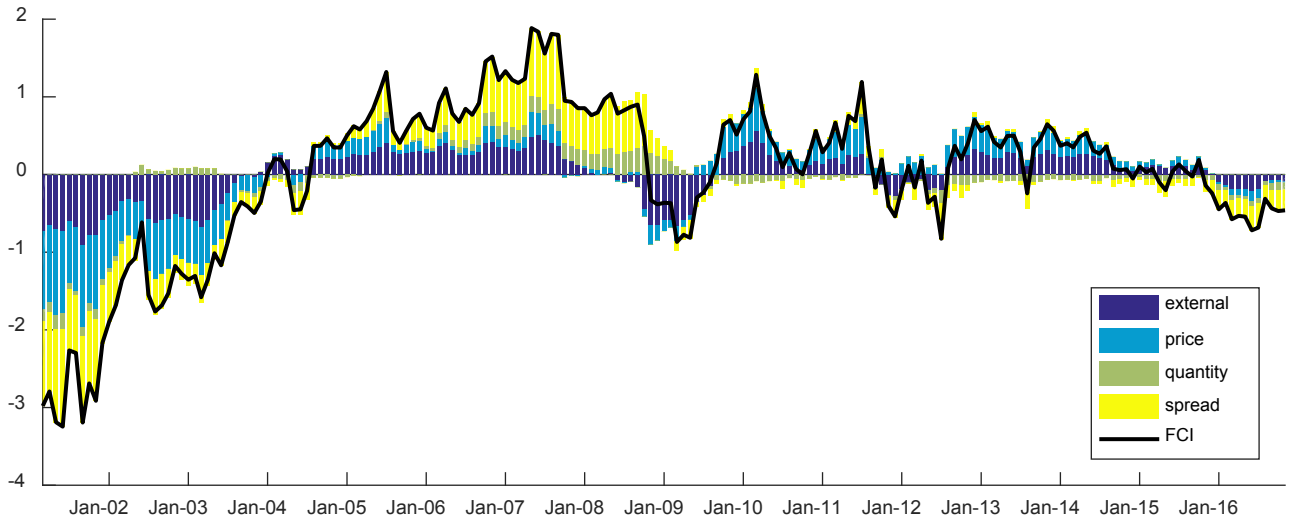
Czech Republic



Hungary



Poland



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