Are business, credit and interest rate cycles converging or diverging? A comparison of Poland, Hungary, the Czech Republic and the euro area [1]

November 2005

Sanvi Avouyi-Dovi[2], Rafal Kierzenkowski[3], Catherine Lubochinsky[4]

[1] The opinions expressed in this article are those of the authors and do not necessarily reflect the views of the Banque de France or the institutions with which the authors are affiliated. The authors wish to thank Julien Matheron for providing programmes and valuable suggestions.

[2] Economic and Financial Research (RECFIN), Banque de France and CREFED-CERPEM (Paris-Dauphine University)

[3] Monetary Analyses and Statistics (SASM) Division, Banque de France and LASER-LAEC (Montpellier 1 University)

[4] Paris II Panthéon-Assas University and Market Research and Financial Stability (EMSF) Division, Banque de France

Abstract

This paper provides an analysis of co-movements between real and financial variables in three EMU candidate countries (the Czech Republic, Hungary and Poland) and the euro area. It focuses on the co-movement between real credit granted to firms and real industrial output on the one hand, and between the aforementioned variables and a monetary policy indicator (the three-month real interest rate) on the other. We have adopted three different approaches to analyse it: assess whether two variables regularly display a similar pattern during the same phase of the business cycle; break the different series down by isolating their cyclical components with the objective of calculating the simple correlations between the cyclical components of the variables; estimate the dynamic correlations between the different series taken two by two.

The main conclusions drawn from the empirical results are: a) there does not appear to be a high degree of dependence between credit extended to firms and industrial output in the different countries under review; yet, monetary policy seems to smooth out the distribution of credit throughout the cycles; b) credit markets in accession countries are not highly integrated; nevertheless, the co-movement between the credit cycles of accession countries and euro area countries appears more significant, especially in the case of Poland; c) the correlation between the real economy of accession countries and that of the euro area is very high in Hungary, weaker in Poland, and almost insignificant in the Czech Republic; d) in addition, although trade integration between Poland and Hungary is very moderate, their industrial production cycles are highly correlated. This can be attributed to the fact that this synchronisation occurs via the euro area's production cycle or via the globalisation. On the other hand, the significant correlation between Polish and Czech production cycles results from the large bilateral trade flows between the two countries and not from an indirect transmission via the euro area.

1. Introduction

In implementing the full *acquis communautaire*, and under the terms of the Maastricht Treaty, the new member states of the European Union (EU) are expected to join the euro area. Unlike the UK and Denmark, none of the new entrants has been granted an opt-out clause. The challenges of enlarging the euro area are intertwined with those of building an optimum currency area that encompasses the countries of central Europe. Optimum currency area theory offers a set of assessment criteria in this regard, including trade ties with the block of potential partner countries, and the nature – whether symmetric or asymmetric – of shocks. Against this backdrop, recent research has increasingly concentrated on analysing the synchronisation of business cycles in the new EU members with those of the euro area or its main member states.

In a recent paper, Fidrmuc and Korhonen (2004) conduct a meta-analysis that provides a statistical summary of the main findings from 27 papers on business cycle correlation. The favoured approach in this type of literature is to identify supply and demand shocks using bivariate SVAR models and then to calculate correlations between components in the home country and those in the benchmark economy (Germany or the euro area). There has also been a new wave of research devoted to analysing co-movements, based on multi-regime models. In our view, the size and reliability of the available data samples for central European countries are such that the robustness of SVAR or multi-regime model estimates cannot be guaranteed. For this reason, we follow Artis et al. (2004) and Darvas and Szapary (2005) in preferring methods that employ filtering processes. Furthermore, we believe that the classical business cycle approach taken by Artis et al. (2004) for the EMU accession countries offers a rich vein to mine.

In their analysis of eight central European countries and the euro area, Darvas and Szapary (2005) used quarterly series for GDP and its components, whereas Artis et al. (2004) used monthly data on industrial production. The results reveal that, of all the euro candidates, Hungary, Poland and Slovenia have the most closely synchronised business cycles with EMU. This finding holds for GDP, output and exports, but not for consumption and services [5].

This paper makes a three-fold contribution to the existing literature.

First, in addition to studying co-movements in output variables, we also look at credit and interest rate variables. Our decision to do this reflects the existence of an extensive body of literature on the effects of bank credit in the transmission of monetary policy via the role of credit in financing productive investment or via the ability of monetary policy to influence the supply of bank credit. These are key issues for industrialised countries, but they are also relevant for the countries of central Europe, given the low liquidity of their financial markets. Specifically, we examine co-movements in the real industrial production index, bank credit to businesses deflated by producer prices, and a monetary policy indicator (the real three-month interest rate) over the business cycle. We use the real interest rate (rather than the nominal rate); expected inflation is thus priced in by monetary authorities. Furthermore, this ensures consistency between the real variables.

[5] The linkage statistics between the series obtained using the IPI and GDP are qualitatively comparable but are usually higher when the IPI is used.

Second, the paper is both consistent in the data and methods used and exhaustive in its approach. A three-tier analysis is conducted: within the country, between accession countries, and finally between accession countries and the euro area. The goal is to produce a set of stylised facts for three accession countries – Hungary, Poland and the Czech Republic – and the euro area.

Third, given that there is no single definition for the business cycle, we take three different approaches: we estimate a concordance index; we decompose and compare the cyclical components of the series; and we calculate dynamic correlations across the variables. We innovate in our application of dynamic correlations to these questions, building on work done by Croux et al. (2001). Moreover, by comparing the findings from different methods, we should be able to achieve a more reliable analysis. Thus, the results obtained for the business and credit cycles can be considered against the monetary policies applied over the period, with the relationships examined from several angles: first by analysing the behaviour of short-term interest rates during expansion and recession periods in industrial production and credit; second by calculating correlations between the cyclical components of economic activity, credit and interest rates, and the dynamic correlations between these same variables.

The remainder of the paper is organised as follows. Section 2 presents the data and briefly reviews the financial systems in the EMU accession countries. Section 3 deals with the identification of turning points and the calculation of concordance indicators. In Section 4 we study the co-movement of variables using simple and dynamic correlations. The final section concludes.

2. Description of data and brief overview of financial systems in accession countries

To capture real activity, we use real industrial production, the only consistent variable of this type available over the same period, notably for the accession countries in our sample. The credit variable consists of bank lending to non-financial corporate and quasi-corporate enterprises [6]. The interest rate is the three-month interbank rate. For the transformation to real series, these two variables were deflated by the producer price index [7]. The data, which were taken from national and international sources, are monthly and run from January 1994 to September 2004. The Tramo-Seats method was used to seasonally adjust all the series except interest rates. We kept the option of automatic outlier detection and ignored calendar effects [8]. We used the same seasonal adjustment method for all the real and financial series of the analysed countries to avoid any methodological bias resulting from the use of official seasonally adjusted series.

Financing is typically bank-intermediated in the economies of the accession countries considered in our paper. Credit institutions command over 80% of the total assets held by all financial institutions. As a result, banks supply the lion's share of the lending to the economy and channel the bulk of households' savings for investment purposes. Financial markets are tiny and play a

[6] For want of long-run official series, we constructed a euro area credit variable by combining ECB sources (monthly since January 2003, quarterly since September 1997) and national sources drawn from BIS databases.
[7] Overall index for Hungary, Poland and the Czech Republic; index excluding construction for the euro area.
[8] In their study, Artis et al. (2004) made seasonal adjustments by using unobservable components models to better capture specific holidays. We opted for a simpler and more "uniform" approach.

minor role. Market capitalisation stood at around 30% of GDP in the accession countries in 2000 and 2004 compared with 91.5% and 53.3% respectively in the euro area (Table 1). In 2003, corporate debt securities amounted to just 3.3% of GDP in Poland, 0.9% in Hungary and 3.8% in the Czech Republic, compared with 61% in the euro area (ECB, 2005; IMF, 2004).

Tableau 1
Main characteristics of financial systems
(in % of GDP)

		1996	1997	1998	1999	2000	2001	2002	2003	2004
Stock market capitalisation	PL	5.0	7.4	9.2	14.9	18.0	13.9	14.1	14.2	18.8
	HN	na	na	na	30.0	30.7	18.8	17.4	16.8	21.4
	CZ	na	na	na	13.3	23.3	16.0	16.8	22.1	29.6
	EA	31.5	42.2	57.2	68.8	91.5	74.1	58.3	47.4	53.3
Bank assets	PL	53.7	55.0	60.1	61.9	65.8	66.5	64.6	64.7	65.3
	HN	na	na	69.2	69.2	68.7	69.1	70.4	79.6	84.0
	CZ	129.7	135.7	131.3	132.0	133.6	122.3	106.3	100.7	96.0
	EA	na	231.7	237.1	247.6	252.8	264.9	264.8	270.5	280.9
Domestic credit to the private sector	PL	21.0	22.7	24.5	27.6	28.9	28.4	28.6	29.0	27.7
	HN	22.1	24.3	24.2	26.1	32.3	33.7	35.8	43.4	46.6
	CZ	69.8	71.3	62.4	56.8	49.9	41.3	31.4	32.1	33.4
	EA	na	88.9	94.1	99.0	104.1	107.9	108.4	111.4	114.3
Bank credit to non-financial corporations	PL	17.6	18.5	19.6	20.9	21.1	20.4	19.8	19.4	17.4
	HN	18.3	20.8	20.5	21.4	24.2	23.5	22.1	24.0	24.6
	CZ	54.8	55.4	47.9	43.5	39.1	27.5	22.5	21.7	20.9
	EA	35.7	37.0	38.2	38.7	40.7	42.2	41.6	41.5	41.5

Notes : PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area, na = non available
Sources : Eurostat, IMF IFS

Even so, the banking sector is still relatively small and the intermediation process relatively shallow in the accession economies (Table 1). In 2004, bank assets were equivalent to 84% of GDP in Hungary, 65.3% in Poland and 96% in the Czech Republic, compared with 281% in the euro area. Similarly, whereas domestic credit to the private sector stood at between 30% and 45% of GDP in the accession countries at end-2004, the same ratio was around 114% in the euro area. The differences are smaller for bank credit to non-financial corporations as a percentage of GDP. The credit market thus plays a central role in financing current operations and corporate investment. These observations are confirmed by survey data. According to monthly surveys by the National Bank of Poland, for example, in 1998, 77.4% of Polish companies were virtually or completely dependent on bank credit for their current operations, and 81.1% were similarly dependent in respect of their investments. Moreover, the percentage of companies using bank credit has risen, climbing from 80% in 1995 to more than 85% in 1999 (Lyziak, 2001).

Unlike in euro area economies, bank lending to households still occupies a relatively small share of total assets [9], which lends added *a posteriori* support to the study's focus on the corporate sector. While lending to businesses in Poland and Hungary is following a similar path to that in the euro area, outstanding credit to Czech businesses contracted sharply between 1998 and 2003 following the collapse of a dozen or so banks between 1994 and 1996, including the fifth-largest by assets (Pruteanu, 2004).

The bank sector is also concentrated, reflecting a wave of mergers and acquisitions, chiefly since the second half of the 1990s. In 2003, the top five banks had a 52.3% share of the total assets of credit institutions in Hungary and Poland and a 65.8% share in the Czech Republic, compared

[9] Although it did show a sustained increase between 2002 and 2003 from 21.4% to 26.3% in Hungary, from 16.7% to 21.1% in the Czech Republic and from 37.4% to 38.9% in Poland (ECB, 2005).

with 22% in Germany, 47% in France and 33% in the UK [10] (ECB, 2004, 2005). The low level of financial intermediation and a series of bank privatisation programmes opened up a wealth of profitable opportunities for foreign investors. Non-residents have built up considerable equity interests in the three countries, and controlled 96% of total bank assets in the Czech Republic, 83.3% in Hungary and 67.8% in Poland [11] in 2003. The presence of foreign banks, especially from euro area countries, creates a pathway towards full financial integration.

The figures for external trade reveal pronounced real integration. In 2004, when external trade was equivalent to 113.2% of GDP in Hungary, 69.6% in Poland and 125% in the Czech Republic (Table A1, Appendix A), exports of goods to the EU-15 accounted for between 79% and 86% of the total, while the share of imports from the EU stood at between 68% and 74% (Table 2). Additionally, the structure of trade is broadly comparable across the accession countries (Table A2, Appendix A). Exports and, to a lesser extent, imports are primarily concentrated in industrial products, including manufactured products and transport machinery and equipment. This specialisation appears to increase over time across all the countries.

Table 2
Trade with the European Union's 15 countries
(in %)

		1990	1995	2000	2004
Share of exports to the EU	PL	56.0	77.2	80.5	79.1
	HN	45.2	71.7	81.6	79.2
	CZ	na	62.9	85.1	86.4
Share of imports from the EU	PL	55.9	71.0	68.7	68.4
	HN	48.8	69.0	65.3	71.3
	CZ	na	64.3	77.3	74.8$^{(1)}$

Note : (1) data for the year 2003 ; PL = Poland, HN = Hungary, CZ = Czech Republic, na = non available
Source : WIIW

More generally, in some cases (Table A1, Appendix A) the main real and nominal macroeconomic indicators for the accession countries and the euro area seem to be converging. We will now extend our study of these linkages, looking at variables for credit, short-term interest rates and production.

3. Concordance in business cycles and credit cycles

The classical approach defines the business cycle directly by analysing the change in the level of a variable, characterising the cycle as a succession of expansions and recessions. Formally, an expansion is defined as the period of time separating a trough from a peak; conversely, a recession is the period between a peak and a trough. What is crucial in this approach, then, is to precisely define and identify the turning points, i.e. the peaks and troughs [12]. Using these points, a recession (expansion) is defined as the time separating a peak (trough) from a trough (peak).

Though it fell out of fashion after the 1970s, this view of the cycle has recently been the subject of several papers, which proposed a simple method for analysing the concordance between two

[10] In the Netherlands and Belgium, the top five had shares above 80%.
[11] In Poland, state-owned banks had a 24.4% asset share in 2003.
[12] See Appendix C1 for more details.

series, i.e. the simultaneous presence of the two series in the same recessionary or expansionary phase of the cycle [13]. Before compiling the concordance index, we first have to define a function to indicate the phases of increase (or decline), $s_{y,t}$, of a variable, y for example, which we will use to calculate the index: $s_{y,t} = 1$ if y increases at t, and 0 otherwise. We use a statistic developed by Harding and Pagan (2002a, b) as the concordance index (see Avouyi-Dovi and Matheron (2003) for a recent application).

The concordance index for x and y, written c_{xy}, is defined as the average number of periods in which two variables x and y coincide at the same phase of the cycle, i.e.:

$$c_{xy} = \frac{1}{T}\sum_{t=1}^{T}\left[s_{x,t}s_{y,t} + (1 - s_{x,t})(1 - s_{y,t})\right]. \tag{1}$$

The index has a value of 1 if x and y are always in the same phase, i.e. the two series are in perfect concordance, with expansions and contractions perfectly juxtaposed. If the index reads 0, x and y are always in opposite phases, i.e. the two series are in perfect discordance, with either a pronounced lag or a total contrast in phase.

In general, the distributional properties of c_{xy} are unknown. To calculate the significance levels for these indices, we use the method suggested by Harding and Pagan (2002b), which we detail below. Let μ_{si} and σ_{si}, $i = (x,y)$ denote the empirical mean and the empirical standard deviation of $s_{i,t}$ respectively. If ρ_s denotes the empirical correlation between $s_{x,t}$ and $s_{y,t}$, it can be shown that the concordance index is equal to:

$$c_{xy} = 1 + 2\,\rho_s\sigma_{s_x}\sigma_{s_y} + 2\,\mu_{s_x}\mu_{s_y} - \mu_{s_x} - \mu_{s_y} \tag{2}$$

According to this equation, c_{xy} and ρ_s are linked in such a way that either of these two statistics can be studied to the same effect. To estimate ρ_s, Harding and Pagan suggest estimating the linear relationship:

$$\left(\frac{s_{y,t}}{\sigma_{s_y}}\right) = \eta + \rho_s\left(\frac{s_{x,t}}{\sigma_{s_x}}\right) + \mu_t, \tag{3}$$

where η is a constant and μ_t a residual. The estimation procedure for equation (3) must be robust to serial correlation in the residuals, because μ_t inherits the serial correlation properties of $s_{y,t}$ under the null hypothesis $\rho_s = 0$. We therefore use the ordinary least squares method augmented with an HAC procedure to estimate equation (3).

The estimated turning points are shown in Appendix B in Chart B1 for credit (in real terms) and Chart B2 for industrial production (in volume terms). The industrial production series are more volatile than the credit series, suggesting a greater number of recessionary phases in the real economy. The turning points observed on the credit markets are either less frequent than (Hungary, euro area) or equivalent to (Poland) the turning points in industrial production, but

[13] Cf. Cashin et al. (1999), who apply the method in analysing the concordance of goods prices, and McDermott and Scott (2000) for a comparison of business cycles in the main OECD countries.

span broadly comparable lengths of time. The Czech Republic is a case apart. Restructuring of the banking system there in the 1990s caused many institutions to close their doors, leading, as mentioned earlier, to a sharp decline in credit outstandings.

There is a visible mismatch between business and credit cycles in all the economies. That said, contractions and expansions in credit and industrial production sometimes coincide either between the accession countries or relative to the euro area. Tables B1-B3 (Appendix B) contain the concordance indices, which reveal any co-movements in production and credit variables.

Note the lack of concordance in industrial production and credit in the Czech Republic and the euro area. In both cases, however, downturns in industrial production are sometimes preceded by credit squeezes. The cycles appear to be weakly synchronised in Poland, while synchronisation is more strongly anchored in Hungary, at a higher confidence threshold. Remember that this study uses a restrictive indicator of real activity – the industrial production index – so caution is required when interpreting the empirical results.

The accession countries do not appear to be characterised by significant concordance in their credit variables. There seems to be a more marked linkage in industrial production, however. Specifically, we see a discordance (i.e. an almost total absence of co-movements in the variables in the same phases of the cycle) in Czech credit distribution relative to Hungary and weak concordance in industrial production. A stronger link is observed between industrial activity in Poland and Hungary, at the higher confidence level of 20%.

Similarly, we see a strong linkage between the euro area production cycle and the cycles in Hungary and, to a lesser extent, Poland. By contrast, we did not detect any concordance between the euro area industrial production index and the Czech index. Meanwhile, only Poland's credit cycle exhibits a significant and high concordance with the euro area cycle.

Even so, the absence of significant concordance does not necessarily mean that the cycles as analysed in pairs are distinct or disconnected phenomena. The result merely underscores the fact that periods of expansion or recession in, say, industrial production and credit, do not coincide.

Chart B3 describes the relationship between business and credit cycles and monetary policy, captured via real money market rates. Strikingly, we see a marked interdependence between credit contractions and interest rate adjustments in all countries. In particular, each recessionary phase identified in the euro area coincides with a decline in interest rates. The situation is more mixed for industrial production. In Poland, recessionary phases occur alongside falling interest rates. In Hungary and the Czech Republic, by contrast, interest rates sometimes rise when activity is slowing.

As previously mentioned, concordance indices allow us to measure the degree to which two time series are juxtaposed, while avoiding the question of trends in the variables (i.e. the problem of non-stationarity). However, this is just one aspect of the cycle. We can extend our analysis, maintaining the notions of phase and duration, but without confining ourselves to indicators as limiting as concordance indices. To this end, we propose a second approach centred on calculating correlations between the stationary components of the variables. For this, we define the business cycle with reference to the generally accepted definition used in the literature.

4. Correlations between cyclical components and dynamic correlations

The classical approach defines the business cycle directly by analysing changes in the level of a variable, with the attendant risk of establishing a relationship between trends in the variables. The modern or "growth cycle" approach, meanwhile, defines the business cycle as a set of movements that recur within a given period of time. In the wake of research by the NBER, this interval is usually set at 18-96 months for US data. Anas et al. (2004), however, use an interval of 18-72 months for their analysis of euro area industrial production.

We use the same definition for the variables studied in this paper. Though somewhat constraining, this choice reflects, *inter alia*, the size of our sample, for we have only a decade or so of observations. Still, the ranges that we selected do match the frequencies of the business cycle.

More generally, the recent macroeconomic literature defines the movements of a variable according to the time frequency with which its components recur. The cyclical component corresponds to the business cycle and is obtained after stripping out long-run movements attributable to structural economic factors and short-run movements caused by random shocks. In their construction, cyclical components obtained by means of filtering techniques are detrended, i.e. stationary. We use the band pass filter recently proposed by Christiano and Fitzgerald (2003)[14] to identify them.

Specifically, we identify a cyclical component for each variable and compute correlations between the cyclical portions of the different series[15]. The robustness of the analysis is supported by estimating the dynamic correlations between the variables (Croux et al., 2001).

We adopted the following convention to calculate correlations between cyclical components. Let x_t be the cyclical component of credit and y_{t+k} the cyclical component of industrial production with a lead or lag of k periods. For $k = 0$, a significantly positive correlation indicates procyclical behaviour in credit, while a significantly negative correlation indicates a countercyclical impact. A maximum correlation for $k = -1$ (+1), for example, indicates that the cyclical component of the credit series leads (lags) industrial production by one month. Our values for k range from -12 to +12 months. The correlations are estimated using the generalised method of moments augmented with the HAC procedure proposed by Andrews and Monahan (1992). The correlations are presented in Appendix B (Tables B4 to B10).

The intra-country analyses reveal that credit to businesses is countercyclical in the euro area and Poland. In Poland, lending to businesses leads industrial production by three to four months (Table B4). Conversely, bank lending appears to be relatively acyclical in Hungary and the Czech Republic. Looking at credit developments across accession countries (Table B5), we see that credit moves procyclically between Poland and Hungary, with a lag of eight to ten months. Credit distribution in the Czech Republic appears to be significantly countercyclical compared with

[14] See Appendix C2 for further details.

[15] The permanent component is driven by a trend. So to avoid obtaining spurious relationships, it is necessary to examine the growth rate of the permanent components. Because of the small sample used in the analysis, however, these growth rates are highly persistent, in some cases causing non-convergence in the algorithms. For this reason, we elected not to study the correlations between the growth rates of the permanent components of the variables.

Poland and Hungary, although the correlation is weak (but significant) in the case of Hungary. Industrial production cycles seem to be more synchronised across the accession countries (Table B6). Correlations are generally positive and are particularly strong between Polish and Hungarian industrial production, weaker between Poland and the Czech Republic, and non-significant between Hungary and the Czech Republic.

There is a significant linkage between the credit and industrial production cycles of the accession countries and the euro area (Tables B7 and B8). The EMU credit cycles are positively correlated with those of Poland and Hungary, and negatively correlated with those of the Czech Republic. While there is no lead or lag relative to Poland, the euro area cycles lead Hungary and the Czech Republic by five to six months. Real activity in the industrial sector in the accession countries exhibit even greater integration with EMU, especially in Hungary and, to a lesser extent, Poland. Industrial production in the euro area coincides with the Hungarian cycle, displays a one-month differential with Poland and a two-month differential with the Czech Republic.

Comparing movements in real market interest rates with changes in credit distribution reveals a strongly stabilising monetary policy in the euro area and, to a lesser degree, in Hungary and Poland (Table B9). Monetary policy exerts this stabilising effect with no lead or lag in the euro area, a lag of three to four months in Hungary, and an 11-month lead in Poland, which reflects a forward-looking monetary policy. By contrast, interest rate adjustments are significantly countercyclical in the Czech Republic.

We also noted a two-month-lagged countercyclical relationship between the cyclical component of interest rates and the cyclical component of industrial production in Hungary (Table B10). Monetary policy seems to have a stabilising effect in Poland and the Czech Republic, though transmission efficiency differs in the two countries. Spikes in activity are followed by rate hikes, which lead a significant decline (in Poland only) in the cyclical component of production.

It would be interesting to examine how sensitive the above results are to the definition used for the cycle. Unfortunately, the size of the sample makes it impossible to test whether switching from 18-72 months (the European cycle) to 18-96 months (the US cycle) would corroborate the above findings. Still, dynamic correlations largely support the conclusions of the previous analysis (Charts B4 to B10). A business cycle of between 1.5 and 6 years corresponds to frequencies ranging from $\pi/36$ to $\pi/9$. Thus, frequencies under $\pi/36$ correspond to the long term and those over $\pi/9$ to the short term.

There does not seem to be a significant relationship between credit and production as measured on an intra-country basis. In particular, while credit may play a countercyclical role in Poland and the Czech Republic, as well as in the euro area in the medium and long term, the relationship is not statistically significant (Chart B4). Similarly, the credit cycles of the accession countries do not appear to be synchronised to a statistically significant degree. Indeed, the Polish and Czech cycles seem to be significantly out of synchronization in the medium and long term (Chart B5). However, estimates confirm the existence of a significant linkage in industrial production between Poland and Hungary on the one hand, and between Poland and the Czech Republic on the other (chart B6).

The dynamic correlations bear out the findings from the analysis of correlations between the cyclical components of credit and production variables in the accession countries compared with those of the euro area. Thus, euro area credit cycles appear to be significantly correlated with those of the accession countries: positively in the medium and long term in the case of Poland and Hungary, and negatively in the Czech Republic (Chart B7). The integration of the real economies is even more pronounced: the relationship is positive and large for Hungary, smaller in Poland and statistically non-significant for the Czech Republic (Chart B8).

Last, dynamic correlations between real three-month interest rates and bank lending to the corporate sector are significantly positive in Poland, Hungary and especially in the euro area, reflecting the stabilising impact on the credit market of interest rate adjustments (Chart B9).

5. Conclusion

Looking ahead to an enlarged euro area takes us back to the question of the extent to which accession countries are integrated with the EMU economies. In this paper, we proposed a view of integration via an analysis of the linkage between business cycles, credit cycles and interest rate cycles. We took a three-tiered approach, looking at linkages within individual countries, between accession countries, and relative to the euro area. For that, we used three tools to measure co-movements across series.

We began by taking a classical view of the business cycle, defined as a succession of expansions and contractions. We compared the cycles identified in this way by calculating concordance indices for paired variables. Then, we proposed analysing the linkages between the different series via a growth cycle approach, first identifying the cyclical components and calculating the correlations between them, and then estimating the dynamic correlations between the series.

Several conclusions emerge from our analyses. Credit and activity do not appear to be heavily interdependent in the countries studied. The fact that monetary policy is stabilising in Poland, Hungary and especially in the euro area, i.e. seeks to smooth the financing flows provided by banks, may go some way to explaining this result. Furthermore, we used industrial production as our variable for activity, thereby excluding services, a sector of major importance in the euro area and one that is enjoying rapid growth in the accession countries. This may skew comparisons with the credit indicator, which has a broader scope. Indeed, industrial production accounts for a small share of GDP, although its share is higher in the accession countries than in the four main euro area economies [16].

The corporate credit markets of the accession countries do not appear to share major determining factors, although the Czech Republic's credit crunch since the late 1990s complicates cross-country comparisons. However, these markets are more integrated with the euro area, especially in Poland and, to a lesser extent, Hungary. The sizeable equity interests held by euro area banks in the Polish and Hungarian banking systems may be a key factor in this regard.

Business cycles, however, appear to be better integrated. Industrial production cycles are shown to be significantly and positively correlated, especially between Poland and Hungary, and, to a lesser extent, between Poland and the Czech Republic. At the same time, we find Hungarian industrial

[16] 32.2% in Poland, 30.6% in Hungary, 41.7% in the Czech Republic in 2004, compared with 24.8% in France, 26.4% in Germany, 28.8% in Italy and 28.4% in Spain.

production to be strongly correlated with that of the euro area, confirming that Hungary's manufacturing system is heavily oriented towards EMU countries. Polish production is less strongly correlated with euro area production, while for the Czech Republic, the relationship is non significant.

It is therefore likely that euro area business cycles (or globalisation) are driving the integration of the Polish and Hungarian cycles. If the integration of production cycles can be traced back to trade, then this conjecture is borne out by the fact that Hungary is not one of Poland's top ten trade partners in exports or imports. Meanwhile, the significant correlation between Polish and Czech activities probably has more to do with large bilateral trade flows between the two countries [17] than with indirect transmission effects channelled via the euro area.

In summary, the results obtained here have major implications for the conduct of monetary policy in an enlarged EMU. For looking ahead to an extended euro area takes us back to the question of the optimality of a currency area that includes the countries of central Europe. A range of assessment criteria are generally used in this regard. Notably, are the shocks affecting these economies asymmetric, and are the economies flexible enough to respond to them? A comparative analysis of credit, business and interest rate cycles delivers an initial response to these questions. In particular, our analysis highlights some convergence in the cyclical movements of the variables studied and in the reaction of the monetary authorities to these movements.

In all the countries that we looked at, the credit cycle appears to play an important part in the reaction function of the monetary authorities, which seek to smooth the distribution of bank financing to prevent excessive contractions or booms. This immediately suggests a convergence of objectives in the direction of monetary policies within the European System of Central Banks. Furthermore, if the credit cycles of the euro area, Poland and Hungary were to become more closely synchronised in the future, this would facilitate decision-making in an enlarged monetary union.

This conclusion also holds for the real economy. Although an imperfect indicator is used for activity, the correlation of industrial production in Hungary and Poland with that of the euro area suggests a low risk of asymmetric shocks. These observations contrast with those obtained for the Czech Republic, where credit cycles appear to be out of synchronization, while industrial production cycles are weakly correlated with those of the current EMU. In the latter case, this probably reflects the exchange rate crisis of 1997, which delivered a major shock to the country's main macroeconomic balances. However, efforts to clean up the banking system, together with the similarity of economic structures and the Czech economy's considerable openness to the euro area should pave the way for better convergence in the future.

[17] At end-2004, the Czech Republic was Poland's leading trade partner of all the central and eastern European countries (excluding Russia). On an all-countries basis, it was fifth-ranked for exports and sixth for imports.

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Appendix A: Descriptive statistics

Table A1
Main macroeconomic indicators

		1996	1997	1998	1999	2000	2001	2002	2003	2004
GDP (yoy real growth rate, in %)	PL	6.0	6.8	4.8	4.1	4.0	1.0	1.4	3.8	5.4
	HN	1.3	4.6	4.9	4.2	5.2	3.8	3.5	2.9	4.2
	CZ	4.2	-0.7	-1.1	1.2	3.9	2.6	1.5	3.2	4.4
	EA	1.5	2.6	2.9	2.8	3.7	1.7	0.9	0.7	2.0
Domestic demand (yoy real growth rate, in %)	PL	9.6	9.1	6.4	5.0	2.7	-1.8	0.7	2.1	4.6
	HN	0.3	4.8	8.2	5.0	4.5	1.8	5.6	6.0	1.8
	CZ	7.7	-0.7	-1.5	1.3	4.6	4.5	3.8	4.0	3.6
	EA	1.1	1.9	3.5	3.5	3.2	1.1	0.3	1.4	1.9
Final consumption expenditure (yoy real growth rate, in %)	PL	7.2	6.2	4.2	4.5	2.5	1.8	2.8	2.5	2.9
	HN	-3.2	2.3	3.9	4.4	4.4	5.9	8.9	7.2	1.7
	CZ	6.6	1.5	-1.4	3.1	2.1	3.0	3.3	4.4	0.9
	EA	1.8	1.6	2.5	2.9	2.9	2.0	1.3	1.2	1.4
CPI inflation rate (harmonized index, yoy growth rate, in %)	PL	na	15.0	11.9	7.2	10.1	5.4	1.9	0.7	3.6
	HN	23.6	18.5	14.3	10.0	9.9	9.1	5.3	4.7	6.8
	CZ	9.1	8.0	9.8	1.8	3.9	4.5	1.4	-0.1	2.6
	EA	2.3	1.6	1.2	1.2	2.1	2.3	2.3	2.1	2.2
PPI inflation rate (yoy growth rate, in %)	PL	13.2	12.2	7.3	5.5	7.8	1.7	1.1	2.7	7.0
	HN	21.8	20.3	11.4	5.0	11.7	4.8	-1.4	2.4	3.6
	CZ	4.9	4.8	5.0	1.0	4.9	2.8	-0.5	-0.3	5.6
	EA	0.4	1.1	-0.6	-0.4	5.3	2.1	0.0	1.5	2.1
Unemployment rate	PL	13.2	10.9	10.2	13.4	16.4	18.5	19.8	19.2	18.8
	HN	9.6	9.0	8.4	6.9	6.3	5.6	5.6	5.7	5.9
	CZ	4.0	4.8	6.4	8.6	8.7	8	7.3	7.8	8.3
	EA	10.7	10.6	10.0	9.2	8.2	7.9	8.3	8.7	8.9
Government deficit (as a % of GDP)	PL	na	-4.0	-2.1	-1.4	-0.7	-3.9	-3.6	-4.5	-4.8
	HN	na	-6.8	-8.0	-5.6	-3.0	-3.7	-8.5	-6.2	-4.5
	CZ	na	-2.5	-4.2	-3.4	-3.7	-5.9	-6.8	-11.7	-3.0
	EA	-4.3	-2.6	-2.2	-1.3	0.1	-1.8	-2.5	-2.8	-2.7
Government gross nominal consolidated debt (as a % of GDP)	PL	na	44.0	39.1	40.3	36.6	36.7	41.2	45.4	43.6
	HN	na	64.2	61.9	61.2	55.4	52.2	55.5	56.9	57.6
	CZ	na	12.2	12.9	13.4	18.2	27.2	30.7	38.3	37.4
	EA	75.2	74.9	74.2	72.8	70.4	68.9	68.8	70.1	70.6
Current account balance (as a % of GDP)	PL	-2.2	-3.8	-4.1	-7.6	-6.0	-2.9	-2.6	-2.2	-1.5
	HN	-6.7	-6.3	-2.1	-2.3	-4.9	-5.4	-5.6	-4.8	-5.1
	CZ	-3.9	-4.4	-7.2	-7.8	-8.7	-6.3	-7.1	-8.9	-9.4
	EA	1.1	1.5	1.0	0.3	-0.7	0.1	0.8	0.4	0.6
Openness ratio (exports+imports of goods, as a % of GDP)	PL	40.1	44.2	48.6	45.9	50.6	49.1	52.5	60.8	69.6
	HN	74.4	87.1	104.7	111.1	129.5	124.9	110.4	109.7	113.2
	CZ	81.1	88.0	89.5	92.2	109.9	115.0	107.0	110.0	126.0
	EA	45.5	48.9	50.2	51.0	57.9	57.3	54.9	53.6	56.1
Foreign direct investment (in US dollars, billions)	PL	4.5	4.9	6.4	7.3	9.3	5.7	4.1	4.1	6.2
	HN	3.3	4.2	3.3	3.3	2.8	3.9	3.0	2.2	4.2
	CZ	1.4	1.3	3.7	6.3	5.0	5.6	8.5	2.5	na
	EA	na	na	101.6	209.7	404.8	175.7	171.2	158.2	86.4
Gross Capital Formation (at constant prices, as % of GDP)	PL	20.6	23.1	25.1	25.5	25.6	22.1	20.3	20.1	21.9
	HN	25.2	27.3	31.3	32.1	32.3	28.8	26.8	26.4	26.3
	CZ	34.4	32.5	32.1	30.4	31.9	33.0	33.7	33.0	34.1
	EA	20.1	20.2	21.1	21.6	21.7	20.9	20.0	20.3	20.7
Official reserves, excluding gold (in US dollars, billions)	PL	17.8	20.4	27.3	26.4	26.6	25.6	28.6	32.6	35.3
	HN	9.7	8.4	9.3	11.0	11.2	10.7	10.3	12.7	15.9
	CZ	12.4	9.7	12.5	12.8	13.0	14.3	23.6	26.8	28.3
	EA	-	-	-	256.8	242.3	235.0	247.0	222.7	211.3

Notes : PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area, na = non available
Sources : Eurostat, IMF IFS, OCDE

Table A2
The structure of exports and imports of Poland, Hungary, Czech Republic during the transition period
(in % of total amount)

			Exports				Imports			
			1990	**1995**	**2000**	**2003**	**1990**	**1995**	**2000**	**2003**
(1)	Food and live animals	PL	10.9	9.2	7.5	7.6	5.6	8.0	5.2	4.6
		HN	19.8	17.9	6.5	6.2	6.3	4.7	2.5	2.8
		CZ	5.4	4.9	2.9	2.7	5.9	5.6	4.0	4.0
(2)	Beverages and tobacco	PL	0.5	0.7	0.4	0.3	1.6	0.7	0.4	0.3
		HN	1.3	2.4	0.4	0.3	0.8	0.5	0.2	0.3
		CZ	0.5	0.8	0.7	0.6	0.9	0.8	0.6	0.5
(3)	Crude materials, inedible, except fuels	PL	6.8	4.5	2.8	2.6	6.5	5.4	3.4	3.0
		HN	4.7	4.8	2.1	1.8	5.3	4.1	2.0	1.8
		CZ	3.3	5.2	3.5	2.8	6.8	4.5	3.2	2.8
(4)	Mineral fuels, lubricants, etc.	PL	10.7	8.2	5.1	4.3	21.9	9.1	10.8	9.1
		HN	3.1	3.2	1.8	1.6	14.2	11.7	8.4	7.7
		CZ	4.9	4.3	3.1	2.9	17.9	7.9	9.7	7.5
(5)	Animal and vegetable oils, fats, waxes	PL	0.2	0.2	0.1	0.0	0.5	0.7	0.3	0.4
		HN	1.2	0.7	0.3	0.2	0.1	0.3	0.2	0.2
		CZ	0.4	0.2	0.1	0.1	0.7	0.3	0.2	0.3
(6)	Chemicals and related products	PL	9.1	7.7	6.8	6.5	8.6	15.0	14.1	14.7
		HN	12.4	11.8	6.6	6.9	14.9	14.2	8.8	9.7
		CZ	7.9	9.3	7.1	5.9	9.0	11.8	11.2	11.4
(7)	Manufactured goods class. by materials	PL	22.9	27.5	24.8	23.7	11.5	21.6	20.0	21.0
		HN	18.5	17.4	10.7	10.3	15.5	23.0	16.5	16.1
		CZ	24.4	32.3	25.4	23.1	11.1	20.2	20.8	20.1
(8)	Machinery and transport equipment	PL	26.2	21.1	34.2	37.8	37.5	29.9	37.0	38.0
		HN	25.6	25.6	60.0	61.1	34.6	30.8	51.5	51.6
		CZ	37.7	30.3	44.5	50.1	30.8	37.1	40.0	42.8
(9)	Miscellaneous manufactured articles	PL	7.5	20.8	18.3	17.1	6.3	9.3	8.6	8.7
		HN	10.7	16.2	11.5	10.6	7.8	10.6	9.8	9.4
		CZ	12.9	12.6	12.5	11.8	11.8	11.8	10.3	10.6
(10)	Commodities not classified by kind	PL	5.1	0.0	0.0	0.0	0.0	0.3	0.2	0.1
		HN	2.6	0.0	0.0	0.8	0.4	0.0	0.0	0.5
		CZ	2.6	0.1	0.1	0.1	5.1	0.1	0.0	0.0
		PL	**56.7**	**69.5**	**77.3**	**78.6**	**55.3**	**60.8**	**65.6**	**67.7**
	Sum : **(7)+(8)+(9)**	**HN**	**54.8**	**59.2**	**82.3**	**82.1**	**57.9**	**64.4**	**77.8**	**77.1**
		CZ	**75.0**	**75.2**	**82.4**	**85.0**	**53.7**	**69.1**	**71.1**	**73.5**

Notes : PL = Poland, HN = Hungary, CZ = Czech Republic
Source : WIIW

Appendix B: Estimation results

Table B1
Concordance indices between industrial production and loans to non-financial corporations, within individual countries

	Poland	Hungary	Czech Republic	euro area
	0,57364 (***)	0,82171 (*)	0,41860	0,58140

Note : Coefficient significant at 20 % (*), 10 % (**), 5 % (***)

Table B2
Concordance indices between accession countries

Variable	Hungary – Poland	Czech Republic – Poland	Czech Republic – Hungary
Loans to non-financial corporations	0,68992	0,34884	0,22481 (***)
Industrial production	0,79845 (*)	0,64341	0,55039 (***)

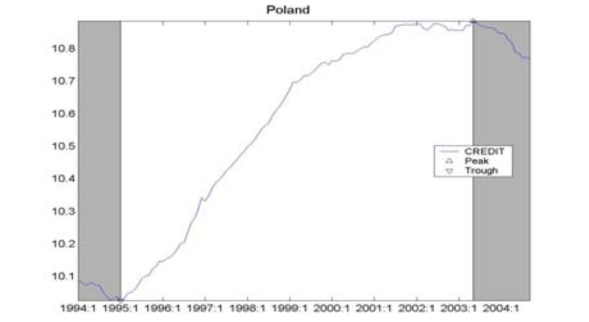
Note : Coefficient significant at 20 % (*), 10 % (**), 5 % (***)

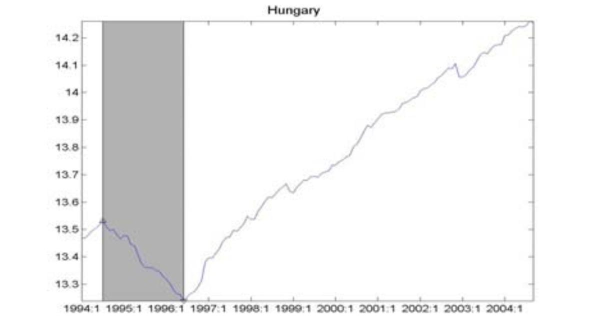
Table B3
Concordance indices: Euro area and accession countries

Variable	euro area – Poland	euro area – Hungary	euro area – Czech Republic
Loans to non-financial corporations	0,85271 (***)	0,74419	0,38760
Industrial production	0,72093 (*)	0,82946 (***)	0,55039

Note : Coefficient significant at 20 % (*), 10 % (**), 5 % (***)

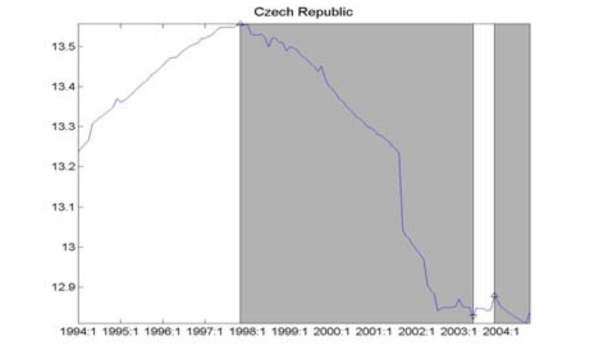
Chart B1
Turning points in loans to non-financial corporations (January 1994 – September 2004)

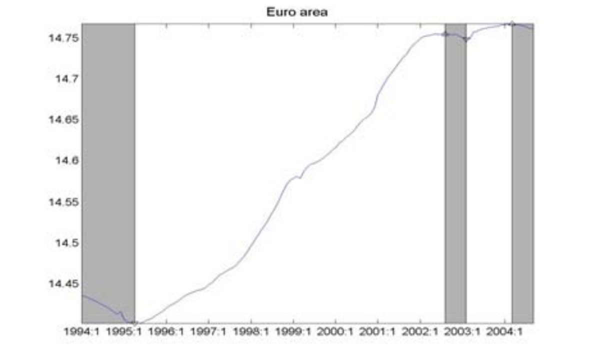




Note : Peak (2003:5), trough (1995:1)

Note : Peak (1994:7), trough (1996:6)

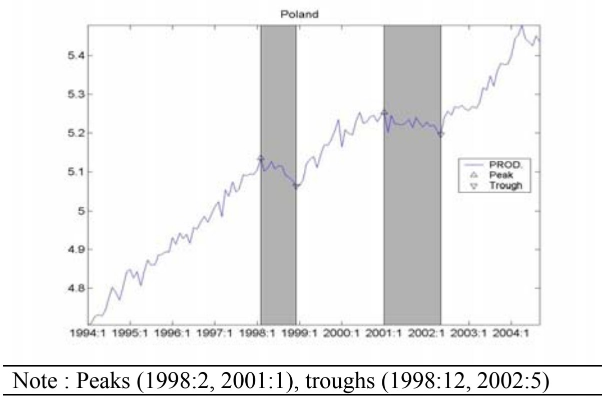


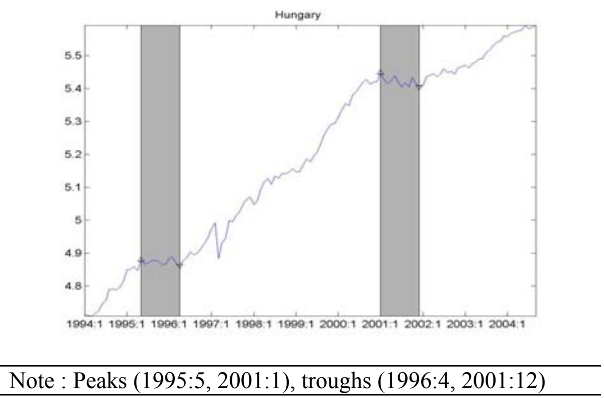


Note : Peaks (1997:11, 2003:11), troughs (2003:5)

Note : Peaks (2002:8, 2004:3), troughs (1995:4, 2003:2)

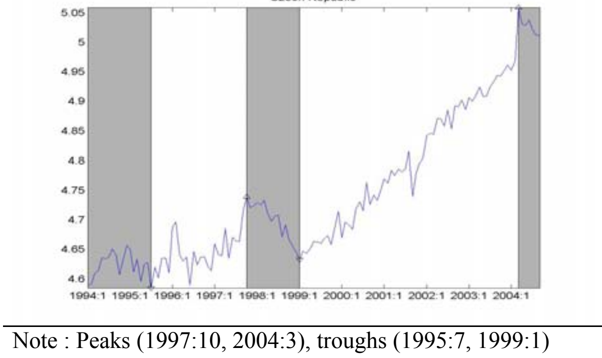
Chart B2
Turning points in industrial production (January 1994 – September 2004)

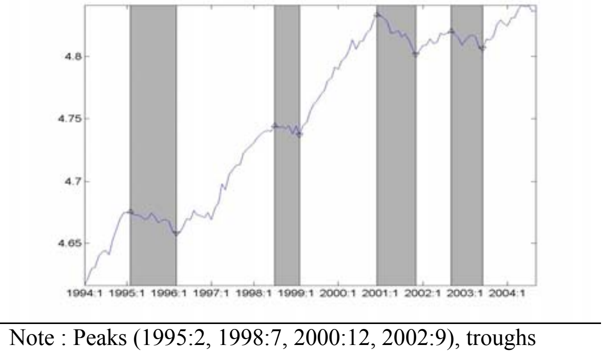




Note : Peaks (1998:2, 2001:1), troughs (1998:12, 2002:5)

Note : Peaks (1995:5, 2001:1), troughs (1996:4, 2001:12)





Note : Peaks (1997:10, 2004:3), troughs (1995:7, 1999:1)

Note : Peaks (1995:2, 1998:7, 2000:12, 2002:9), troughs (1996:3, 1999:2, 2001:11, 2003:6)

Chart B3

Turning points in credit (charts on left-hand-side) and industrial production (charts on right-hand-side) and real 3-month money market interest rates (January 1994 – September 2004)

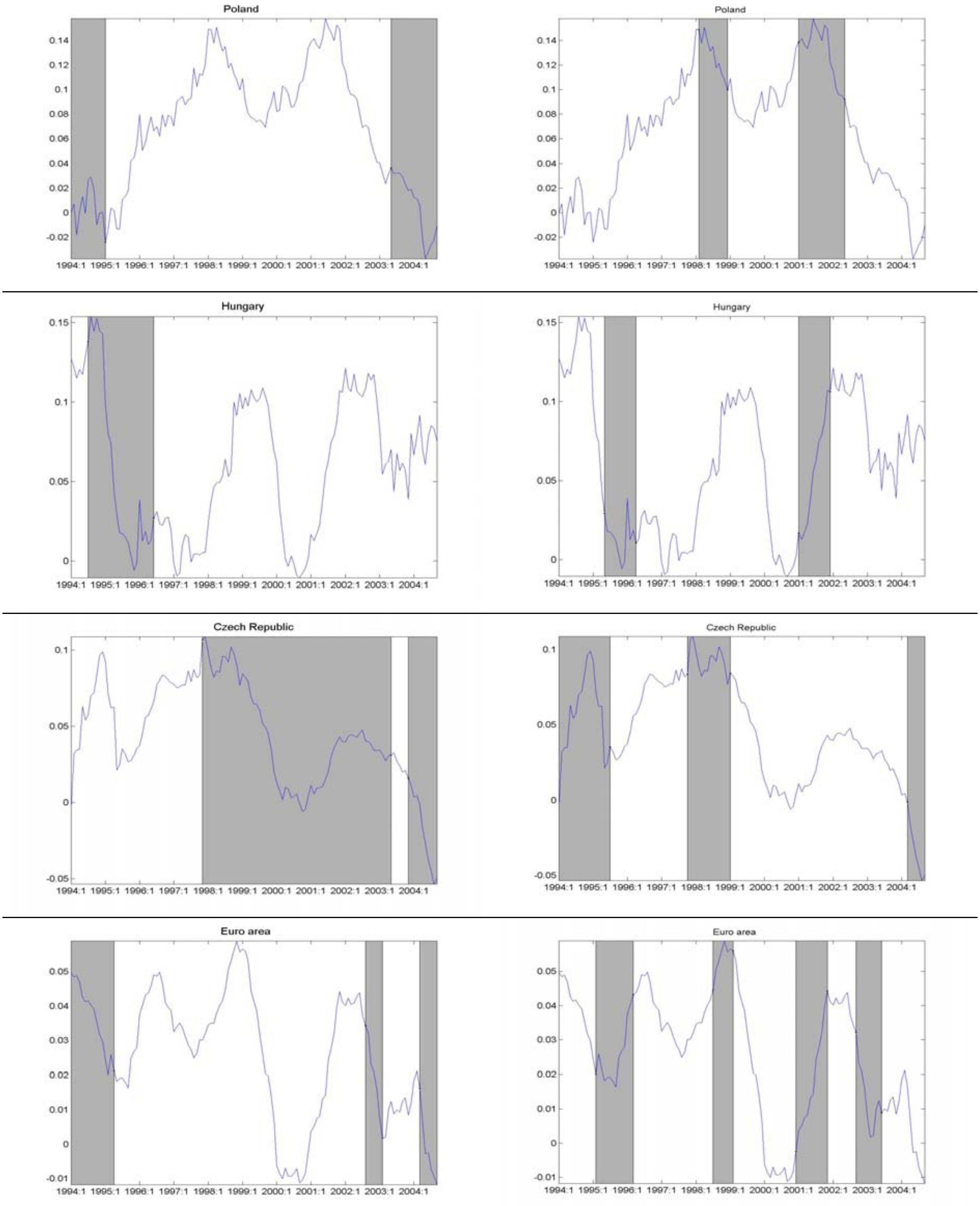


Table B4

Correlations between cyclical components loans to non-financial corporations (*t*) – industrial production (*t*±*k*), within individual countries

k	PL	HN	CZ	EA
– 12	-0,09	-0,41	-0,19	0,34 (*)
– 11	-0,17	-0,38	-0,19	0,27
– 10	-0,24	-0,35	-0,18	0,19
– 9	-0,32 (*)	-0,31	-0,18	0,10
– 8	-0,39 (**)	-0,27	-0,17	-0,01
– 7	-0,45 (**)	-0,22	-0,17	-0,12
– 6	-0,51 (**)	-0,17	-0,16	-0,23
– 5	-0,54 (**)	-0,12	-0,15	-0,33 (*)
– 4	-0,57 (**)	-0,08	-0,14	-0,43 (**)
– 3	-0,57 (**)	-0,03	-0,13	-0,52 (**)
– 2	-0,55 (**)	0,01	-0,13	-0,58 (**)
– 1	-0,52 (**)	0,05	-0,12	-0,63 (**)
0	-0,47 (**)	0,08	-0,11	-0,66 (**)
+ 1	-0,39 (**)	0,12	-0,11	-0,65 (**)
+ 2	-0,30 (*)	0,15	-0,10	-0,63 (**)
+ 3	-0,21	0,17	-0,09	-0,58 (**)
+ 4	-0,12	0,19	-0,07	-0,53 (**)
+ 5	-0,04	0,20	-0,05	-0,46 (**)
+ 6	0,03	0,20	-0,02	-0,39
+ 7	0,09	0,20	0,01	-0,31
+ 8	0,13	0,20	0,05	-0,22
+ 9	0,16	0,19	0,08	-0,14
+ 10	0,18	0,18	0,11	-0,06
+ 11	0,18	0,17	0,14	0,01
+ 12	0,17	0,15	0,16	0,08

Note : * (**) coefficient significant at 10 % (5 %), PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area

Table B5

Correlations between cyclical components of loans to non-financial corporations of accession countries

k	HN (*t*) – PL (*t*±*k*)	CZ (*t*) – PL (*t*±*k*)	CZ (*t*) – HN (*t*±*k*)
– 12	0,57 (**)	-0,21	-0,06
– 11	0,59 (**)	-0,25	-0,07
– 10	0,60 (**)	-0,29	-0,07
– 9	0,60 (**)	-0,32 (*)	-0,07
– 8	0,60 (**)	-0,35 (*)	-0,08
– 7	0,58 (**)	-0,38 (**)	-0,08
– 6	0,56 (**)	-0,40 (**)	-0,09
– 5	0,52 (**)	-0,42 (**)	-0,09
– 4	0,47 (**)	-0,44 (**)	-0,10
– 3	0,42 (**)	-0,46 (**)	-0,12
– 2	0,35 (**)	-0,47 (**)	-0,13
– 1	0,28 (*)	-0,48 (**)	-0,15
0	0,20	-0,49 (**)	-0,17
+ 1	0,12	-0,46 (**)	-0,18 (*)
+ 2	0,03	-0,44 (**)	-0,19 (*)
+ 3	-0,05	-0,41 (**)	-0,20 (**)
+ 4	-0,12	-0,39 (**)	-0,20 (**)
+ 5	-0,19	-0,36 (**)	-0,20 (**)
+ 6	-0,25	-0,33 (*)	-0,19 (*)
+ 7	-0,29	-0,30	-0,19 (*)
+ 8	-0,33	-0,28	-0,17 (*)
+ 9	-0,36	-0,25	-0,16
+ 10	-0,38	-0,23	-0,15
+ 11	-0,40	-0,20	-0,14
+ 12	-0,41	-0,17	-0,12

Note : * (**) coefficient significant at 10 % (5 %), PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area

Table B6

Correlations between cyclical components of industrial production of accession countries

k	HN (*t*) – PL (*t*±*k*)	CZ (*t*) – PL (*t*±*k*)	CZ (*t*) – HN (*t*±*k*)
– 12	-0,13	0,01	-0,25
– 11	0,00	0,06	-0,22
– 10	0,13	0,12	-0,19
– 9	0,26 (**)	0,18	-0,15
– 8	0,39 (**)	0,24 (*)	-0,11
– 7	0,50 (**)	0,30 (**)	-0,07
– 6	0,60 (**)	0,36 (**)	-0,02
– 5	0,69 (**)	0,41 (**)	0,02
– 4	0,75 (**)	0,44 (**)	0,06
– 3	0,79 (**)	0,45 (**)	0,10
– 2	0,81 (**)	0,45 (**)	0,14
– 1	0,81 (**)	0,42 (**)	0,17
0	0,78 (**)	0,38 (**)	0,19
+ 1	0,73 (**)	0,30 (**)	0,20
+ 2	0,66 (**)	0,21 (*)	0,20
+ 3	0,57 (**)	0,10	0,18
+ 4	0,48 (**)	-0,02	0,16
+ 5	0,37 (**)	-0,15	0,12
+ 6	0,27	-0,27 (*)	0,07
+ 7	0,16	-0,38 (**)	0,01
+ 8	0,06	-0,48 (**)	-0,05
+ 9	-0,04	-0,56 (**)	-0,12
+ 10	-0,13	-0,62 (**)	-0,18
+ 11	-0,21	-0,65 (**)	-0,24
+ 12	-0,28 (*)	-0,65 (**)	-0,29

Note : * (**) coefficient significant at 10 % (5 %), PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area

Table B7

Correlations between cyclical components of loans to non-financial corporations: Euro area and accession countries

k	EA (*t*) – PL (*t*±*k*)	EA (*t*) – HN (*t*±*k*)	EA (*t*) – CZ (*t*±*k*)
– 12	-0,11	-0,07	0,29
– 11	-0,06	-0,05	0,26
– 10	0,01	-0,03	0,22
– 9	0,08	-0,02	0,17
– 8	0,16	0,00	0,11
– 7	0,25 (*)	0,03	0,04
– 6	0,33 (**)	0,05	-0,03
– 5	0,41 (**)	0,08	-0,12
– 4	0,49 (**)	0,11	-0,21
– 3	0,56 (**)	0,15	-0,30 (**)
– 2	0,62 (**)	0,19	-0,39 (**)
– 1	0,66 (**)	0,23	-0,47 (**)
0	0,69 (**)	0,27 (*)	-0,55 (**)
+ 1	0,66 (**)	0,30 (**)	-0,61 (**)
+ 2	0,63 (**)	0,33 (**)	-0,65 (**)
+ 3	0,58 (**)	0,35 (**)	-0,68 (**)
+ 4	0,53 (**)	0,37 (**)	-0,70 (**)
+ 5	0,47 (**)	0,38 (**)	-0,71 (**)
+ 6	0,41 (**)	0,39 (**)	-0,71 (**)
+ 7	0,34 (*)	0,38 (**)	-0,69 (**)
+ 8	0,28	0,37 (**)	-0,66 (**)
+ 9	0,23	0,36 (*)	-0,62 (**)
+ 10	0,17	0,34	-0,56 (**)
+ 11	0,12	0,31	-0,50 (**)
+ 12	0,08	0,28	-0,42 (**)

Note : * (**) coefficient significant at 10 % (5 %), PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area

Table B8
Correlations between cyclical components of industrial production: Euro area and accession countries

k	EA (*t*) – PL (*t*±*k*)	EA (*t*) – HN (*t*±*k*)	EA (*t*) – CZ (*t*±*k*)
– 12	-0,03	-0,25	-0,30
– 11	0,07	-0,15	-0,23
– 10	0,18	-0,04	-0,15
– 9	0,29 (**)	0,07	-0,06
– 8	0,39 (**)	0,20	0,03
– 7	0,49 (**)	0,32 (*)	0,13
– 6	0,58 (**)	0,44 (**)	0,23
– 5	0,65 (**)	0,55 (**)	0,32 (**)
– 4	0,71 (**)	0,66 (**)	0,39 (**)
– 3	0,74 (**)	0,74 (**)	0,44 (**)
– 2	0,75 (**)	0,81 (**)	0,48 (**)
– 1	0,74 (**)	0,86 (**)	0,49 (**)
0	0,71 (**)	0,89 (**)	0,47 (**)
+ 1	0,64 (**)	0,89 (**)	0,43 (**)
+ 2	0,56 (**)	0,86 (**)	0,37 (**)
+ 3	0,46 (**)	0,80 (**)	0,30 (*)
+ 4	0,35 (**)	0,72 (**)	0,21
+ 5	0,23 (*)	0,63 (**)	0,12
+ 6	0,11	0,52 (**)	0,03
+ 7	-0,01	0,40 (**)	-0,06
+ 8	-0,12	0,27 (*)	-0,15
+ 9	-0,22	0,14	-0,23
+ 10	-0,30 (*)	0,01	-0,29 (*)
+ 11	-0,38 (**)	-0,11	-0,35 (**)
+ 12	-0,43 (**)	-0,23	-0,39 (**)

Note : * (**) coefficient significant at 10 % (5 %), PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area

Table B9
Correlations between cyclical components 3-month money market interest rate (*t*) – loans to non-financial corporations (*t*±*k*), within individual countries

k	PL	HN	CZ	EA
– 12	-0,46 (**)	0,26	-0,08	-0,26 (*)
– 11	-0,43 (*)	0,30	-0,14	-0,14
– 10	-0,39 (*)	0,34	-0,20	-0,01
– 9	-0,34	0,37	-0,26	0,12
– 8	-0,29	0,40 (*)	-0,32 (*)	0,27 (*)
– 7	-0,23	0,42 (**)	-0,36 (**)	0,40 (**)
– 6	-0,16	0,44 (**)	-0,41 (**)	0,54 (**)
– 5	-0,09	0,45 (**)	-0,44 (**)	0,66 (**)
– 4	-0,02	0,46 (**)	-0,48 (**)	0,76 (**)
– 3	0,05	0,46 (**)	-0,50 (**)	0,84 (**)
– 2	0,12	0,45 (**)	-0,52 (**)	0,90 (**)
– 1	0,18	0,44 (**)	-0,54 (**)	0,94 (**)
0	0,25	0,42 (**)	-0,55 (**)	0,94 (**)
+ 1	0,30 (**)	0,40 (**)	-0,55 (**)	0,91 (**)
+ 2	0,34 (**)	0,37 (**)	-0,55 (**)	0,86 (**)
+ 3	0,38 (**)	0,34 (**)	-0,54 (**)	0,78 (**)
+ 4	0,41 (**)	0,31 (*)	-0,53 (**)	0,69 (**)
+ 5	0,44 (**)	0,27	-0,51 (**)	0,58 (**)
+ 6	0,46 (**)	0,23	-0,48 (**)	0,46 (**)
+ 7	0,48 (**)	0,19	-0,45 (**)	0,33 (**)
+ 8	0,50 (**)	0,14	-0,40 (*)	0,20
+ 9	0,51 (**)	0,10	-0,35	0,07
+ 10	0,52 (**)	0,05	-0,28	-0,05
+ 11	0,53 (**)	0,00	-0,21	-0,17
+ 12	0,52 (**)	-0,05	-0,14	-0,27 (**)

Note : * (**) coefficient significant at 10 % (5 %), PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area

Table B10
Correlations between cyclical components 3-month money market interest rate (*t*) – industrial production (*t*±*k*), within individual countries

k	PL	HN	CZ	EA
– 12	0,55 (**)	0,05	0,35	0,44 (**)
– 11	0,56 (**)	-0,05	0,40 (*)	0,36 (**)
– 10	0,56 (**)	-0,15	0,43 (**)	0,26
– 9	0,54 (**)	-0,26	0,46 (**)	0,15
– 8	0,52 (**)	-0,36 (**)	0,48 (**)	0,03
– 7	0,48 (**)	-0,45 (**)	0,48 (**)	-0,09
– 6	0,43 (**)	-0,53 (**)	0,48 (**)	-0,21
– 5	0,36 (*)	-0,60 (**)	0,46 (**)	-0,33 (**)
– 4	0,29	-0,64 (**)	0,44 (**)	-0,43 (**)
– 3	0,21	-0,67 (**)	0,40 (**)	-0,53 (**)
– 2	0,13	-0,68 (**)	0,36 (**)	-0,60 (**)
– 1	0,03	-0,67 (**)	0,30 (**)	-0,66 (**)
0	-0,06	-0,63 (**)	0,25	-0,70 (**)
+ 1	-0,15	-0,58 (**)	0,19	-0,72 (**)
+ 2	-0,25	-0,51 (**)	0,14	-0,71 (**)
+ 3	-0,34 (**)	-0,43 (**)	0,08	-0,69 (**)
+ 4	-0,43 (**)	-0,34	0,03	-0,66 (**)
+ 5	-0,51 (**)	-0,25	-0,01	-0,61 (**)
+ 6	-0,58 (**)	-0,15	-0,05	-0,55 (**)
+ 7	-0,64 (**)	-0,04	-0,07	-0,48 (**)
+ 8	-0,69 (**)	0,06	-0,09	-0,40 (**)
+ 9	-0,73 (**)	0,16	-0,09	-0,31 (*)
+ 10	-0,75 (**)	0,25	-0,09	-0,23
+ 11	-0,75 (**)	0,34 (*)	-0,09	-0,13
+ 12	-0,74 (**)	0,41 (**)	-0,09	-0,04

Note : * (**) coefficient significant at 10 % (5 %), PL = Poland, HN = Hungary, CZ = Czech Republic, EA = euro area

Chart B4
Dynamic correlations loans to non-financial corporations – industrial production, within individual countries

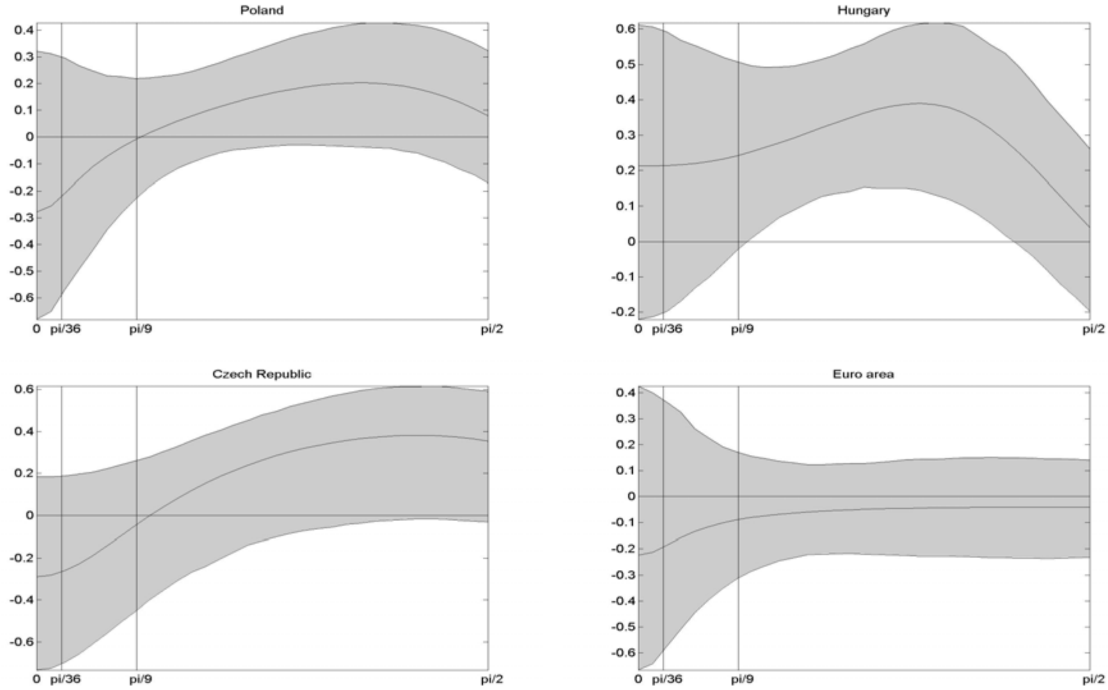


Chart B5
Dynamic correlations of loans to non-financial corporations of accession countries

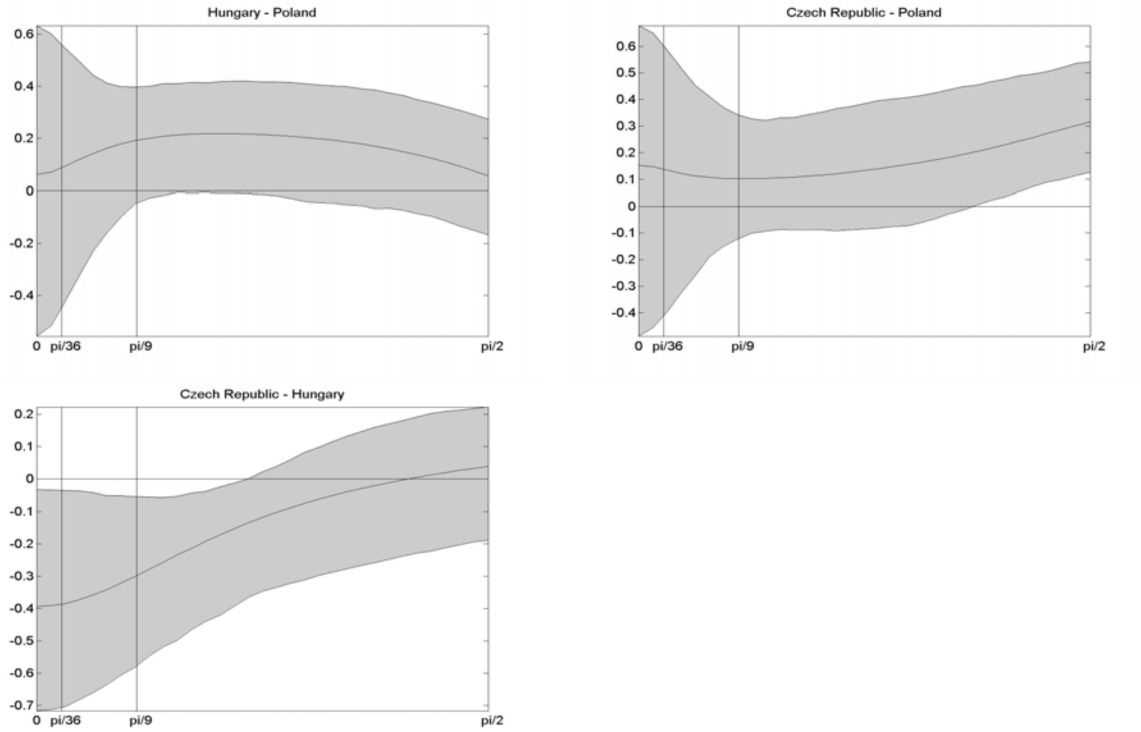


Chart B6
Dynamic correlations of industrial production of accession countries

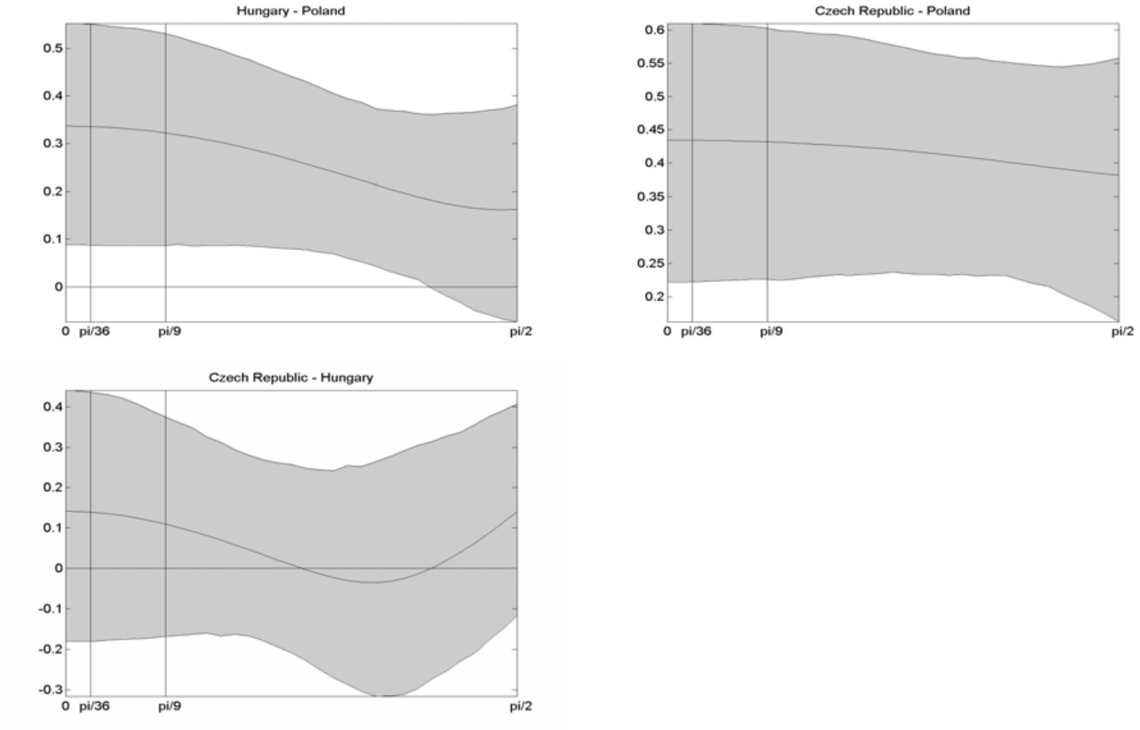


Chart B7
Dynamic correlations of loans to non-financial corporations: Euro area and accession countries

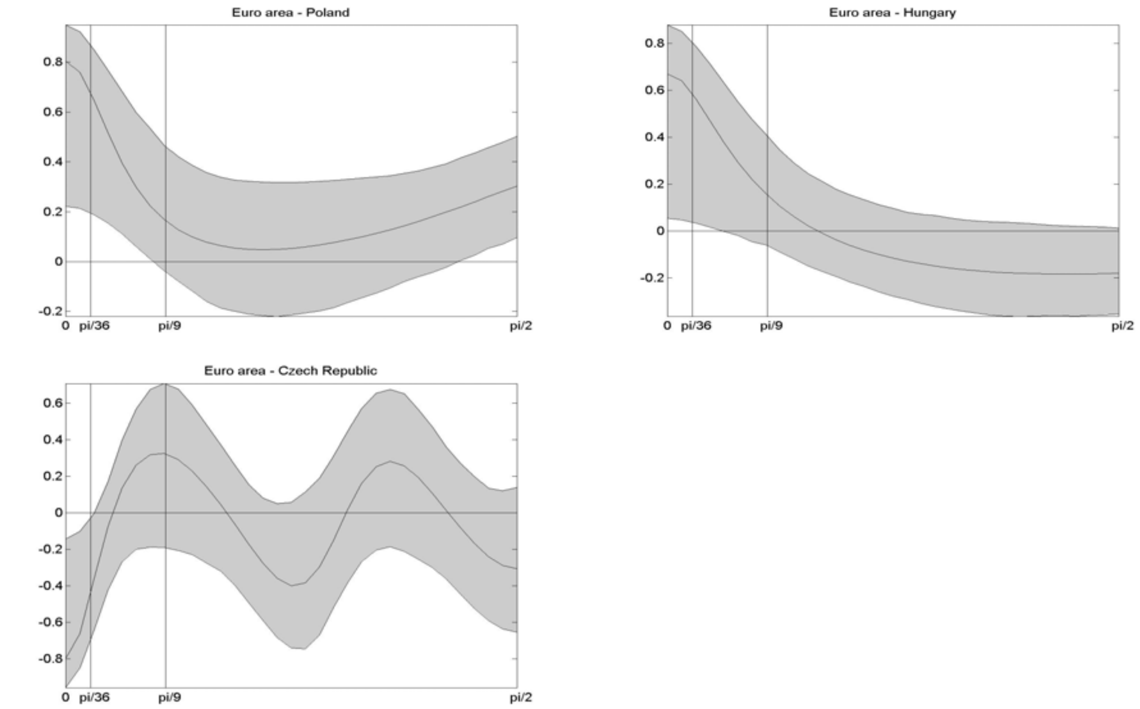


Chart B8
Dynamic correlations of industrial production: Euro area and accession countries

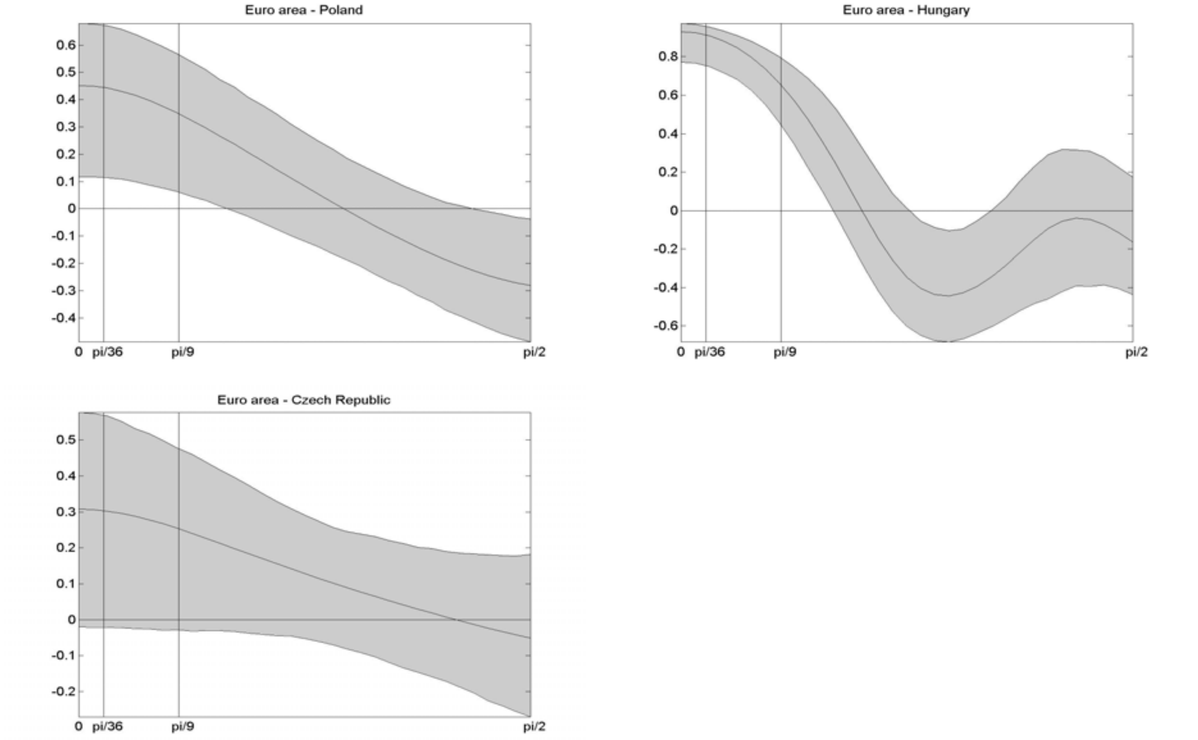


Chart B9
Dynamic correlations 3-month money market interest rate – loans to non-financial corporations, within individual countries

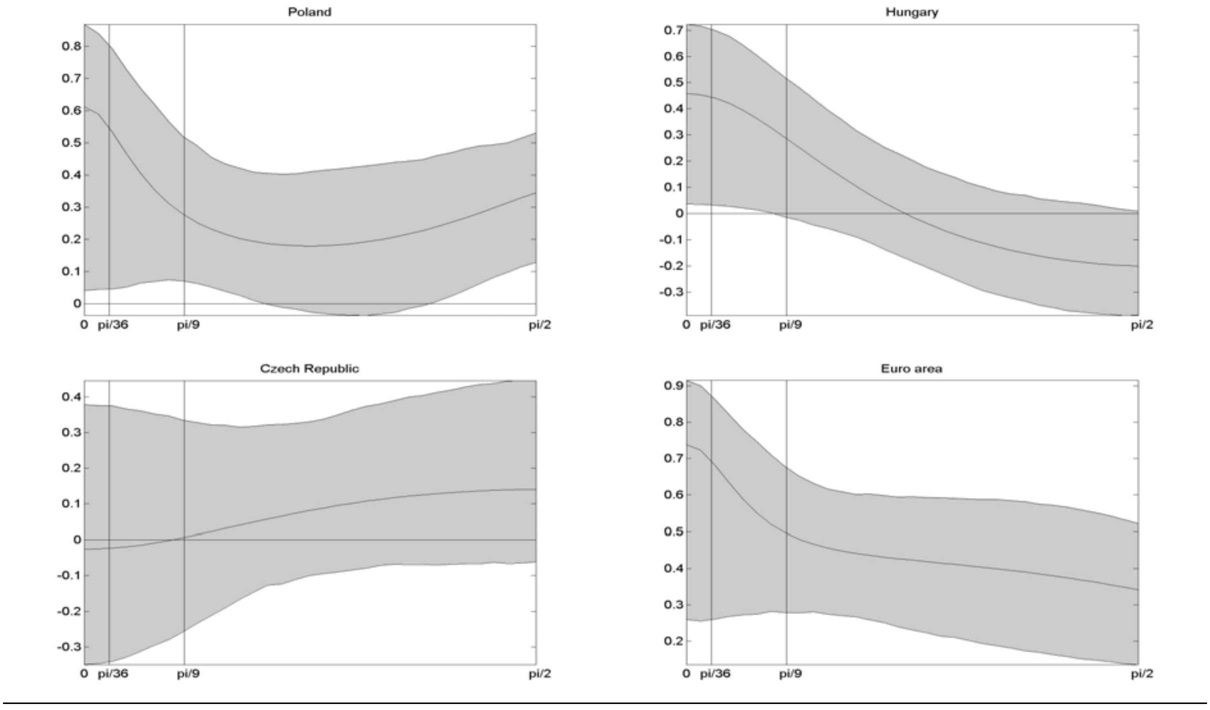
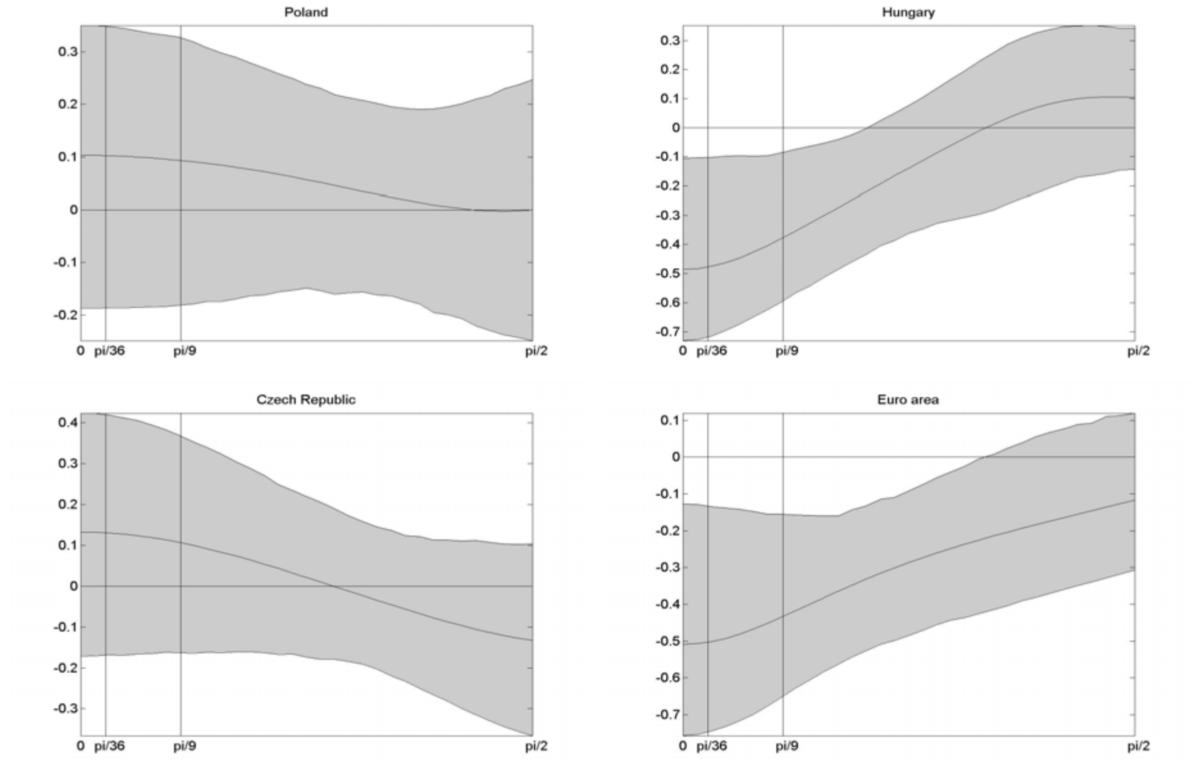


Chart B10
Dynamic correlations 3-month money market interest rate – industrial production, within individual countries



Appendix C: Theoretical underpinnings

C1) Turning points identification: a brief synopsis of the approach

Bry and Boschan (1971) determined an algorithm that made it possible to replicate the contraction start dates identified by a committee of experts from the NBER. We used a variation of this algorithm, developed by Harding and Pagan (2002a,b), whose steps are as follows.
– A peak/trough is reached at *t* if the value of the series at date *t* is superior (inferior) to the previous *k* values and to the following *k* values, where *k* is a natural integer that varies according to the type of series studied and its sampling frequency.
– A procedure is implemented to ensure that peaks and troughs alternate, by selecting the highest (lowest) consecutive peaks (troughs).
– Cycles whose duration is shorter than the minimum time *m* are stripped out, as are cycles whose complete recurrence period (number of periods separating a peak from a peak or a trough from a trough) is lower than the prespecified number of periods *M*.

– Complementary rules are applied:
– the first peak (trough) cannot be lower (higher) than the first point in the series, and the last peak (trough) cannot be lower (higher) than the last point in the series;
– the first (last) peak (trough) cannot be positioned at less than *e* periods from the first (last) point in the series studied.

As a general rule, the more the parameters *k*, *e*, *m* et *M* are weak, the more it is likely that all absolute declines in the level of the series will be identified as troughs, all the more so as the original variable is not too smooth. Conversely, if these are set to large values, the procedure will come up with almost no turning points. We set the value for the parameters in line with the existing literature, i.e. $e = 6$, $k = 5$, $m = 5$ and $M = 15$.

C2) The Band Pass Filter

The ideal band pass filter used to isolate cyclical movements, whose recurrence periods are between the interval [b_i, b_s], is defined by the following equation:

$$y_t^{ct} = B(L)y_t, \qquad B(L) = \sum_{k=-\infty}^{k=+\infty} B_k L^k, \qquad L^k y_t = y_{t-k},$$

where B_k are expressed as:

$$B_k = \frac{\sin(2k\pi / b_i) - \sin(2k\pi / b_s)}{\pi k}$$

In order to interpret the role played by the filter, we introduce the concept of *spectral density*. The spectral density of the stationary stochastic process y_t, denoted $S_y(\omega)$, is interpreted as the decomposition of the variance of y_t in the frequency domain. As y_t can be decomposed into a sum of orthogonal cyclical movements that each appear at a different frequency, we can interpret $S_y(\omega)$ as the variance of y_t, explained by the cyclical movements operating at frequency ω.

A classic result of spectral analysis shows us that, under certain conditions, the equation $y_t^{ct} = B(L)y_t$ implies that the spectral density of the process y_t^{ct}, $S_{y^{ct}}(\omega)$, is deduced from that of y_t, $S_y(\omega)$, using the formula:

$$S_{y^{ct}}(\omega) = \left\| B(e^{-i\omega}) \right\|^2 S_y(\omega),$$

where $\left\| B(e^{-i\omega}) \right\|^2$ is the squared module of $B(e^{-i\omega})$. Given the definition of B_k, a direct calculation shows that:

$$B(e^{-i\omega}) = \begin{cases} 1 \text{ for } \omega \in [2\pi/\mathrm{b_s}, 2\pi/\mathrm{b_i}] \cup]-2\pi/\mathrm{b_i}, -2\pi/\mathrm{b_s}[\\ 0 \text{ otherwise} \end{cases}.$$

From this formula it can be observed that the spectral density of y_t is not zero on the frequency band $[2\pi/\mathrm{b_s}, 2\pi/\mathrm{b_i}] \cup]-2\pi/\mathrm{b_i}, -2\pi/\mathrm{b_s}[\subset]-\pi, \pi[$, and zero everywhere else. In other words, all the variance of y_t^{ct} is explained by cyclical movements whose recurrence periods are between b_i et b_s.

The definition of the filter $B(L)$ imposes a major limitation, as it requires a dataset of infinite length. In practice, we work with a finite sample and must therefore make an appropriate approximation of $B(L)$. Starting from a finite number of observations $\{y_1,..., y_T\}$ of the stochastic process y_t, Christiano and Fitzgerald (2003) define the optimal linear approximation $\overline{y}_t^{ct}$ of y_t^{ct} as the solution to the problem:

$$\min \mathrm{E}\left[\left(\mathrm{y_t^{ct}} - \overline{y}_\mathrm{t}^{\mathrm{ct}}\right)^2 | \{y_1,..., y_T\}\right]$$

The method therefore consists in minimising the mathematical expectation of the square error between the ideally filtered series and the approximately filtered series, where the expectation is conditioned on all the available data.