Macroeconomic Challenges in the Euro Area and the Acceding Countries

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Abstract

The conduct of effective economic policy faces a multiplicity of macroeconomic challenges, which requires a wide scope of theoretical and empirical analyses. With a focus on the European Union, this doctoral dissertation consists of two parts which make empirical and methodological contributions to the literature on forecasting real economic activity and on the analysis of business cycles in a boom-bust framework in the light of the EMU enlargement. In the first part, we tackle the problem of publication lags and analyse the role of the information flow in computing short-term forecasts up to one quarter ahead for the euro area GDP and its main components. A huge dataset of monthly indicators is used to estimate simple bridge equations. The individual forecasts are then pooled, using different weighting schemes. To take into consideration the release calendar of each indicator, six forecasts are compiled successively during the quarter. We find that the sequencing of information determines the weight allocated to each block of indicators, especially when the first month of hard data becomes available. This conclusion extends the findings of the recent literature. Moreover, when combining forecasts, two weighting schemes are found to outperform the equal weighting scheme in almost all cases.

In the second part, we focus on the potential accession of the new EU Member States in Central and Eastern Europe to the euro area. In contrast to the discussion of Optimum Currency Areas, we follow a non-standard approach for the discussion on abandonment of national currencies—the boom-bust theory. We analyse whether evidence for boom-bust cycles is given and draw conclusions whether these countries should join the EMU in the near future. Using a broad range of data sets and empirical methods we document credit market imperfections, comprising asymmetric financing opportunities across sectors, excess foreign currency liabilities and contract enforceability problems both at macro and micro level. Furthermore, we depart from the standard analysis of comovements of business cycles among countries and rather consider long-run and short-run comovements across sectors. While the results differ across countries, we find evidence for credit market imperfections in Central and Eastern Europe and different sectoral reactions to shocks. This gives favour for the assessment of the potential euro accession using this supplementary, non-standard approach.

Keywords: forecast pooling; weighting scheme; out-of-sample forecast performance; boom-bust cycle; credit market imperfections; EMU enlargement; foreign debt; financing asymmetries; sectoral comovement

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Halle (Saale), July 2010 *Katja Drechsel*

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List of Abbreviations

AIC	Akaike information criteria
ADF	Augmented Dickey–Fuller
AR	autoregressive
BACH	Bank for the Accounts of Companies Harmonised
Baltics	Baltic countries (comprising Estonia, Latvia, and Lithuania)
BEEPS	Business Environment and Enterprise Performance Survey (World Bank)
BIS	Bank for International Settlements
CEECs	Central and Eastern European Countries
CPI	Consumer Price Index
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECB	European Central Bank
ECM	error correction model
EC-term	error correction term
EMU	Economic and Monetary Union
ESCB	European System of Central Banks
EU	European Union
FCS	Financial Crisis Survey (World Bank)
FSI	Financial Soundness Indicators (IMF)
GDP	Gross Domestic Product
GMM	Generalised Methods of Moments
HEGY	Hylleberg, Engle, Granger, and Yoo
IFS	International Financial Statistics (IMF)
IMF	International Monetary Fund
IRC	International Relations Committee (ECB)
IV	instrument variables
JEDH	Joint External Debt Hub
LR	likelihood ratio
MFI	monetary financial institution
MICs	middle-income countries
ML	maximum likelihood
NACE	statistical classification of economic activities in the European Union
NPISH	non-profit institutions serving households
N-sector	nontradable sector
OCA	Optimal Currency Area
OeNB	Österreichische Nationalbank

PPI	Producer Price Index
PSCCF	polynominal serial correlation common feature
sa	seasonally adjusted data
SCCF	serial correlation common feature
SCM	scalar component model
SDR	special drawing right
SECM	seasonal error correction model
SIC	Schwarz information criteria
SME	small and medium-sized enterprises
T-sector	tradable sector
TSLS	two-step-least-square
VAR	vector autoregressive system
VECM	vector error correction model
WBES	World Business Environment Survey
WDI	World Development Indicators (World Bank)
PIGS	Portugal, Italy, Greece, Spain
WGI	Worldwide Governance Indicators (World Bank)

Introduction

Economies all over the world were very adversely affected by the global financial crisis which was mainly triggered by the mortgage crisis in the United States and finally revealed through the failure of Lehman Brothers on September 15 2008. Besides the breakdown of the global financial markets, the crisis had a large impact both on real economy issues and on discussions of the sophistication of economic theory. In particular, the usefulness of theories to forecast and to explain the crisis was challenged. The financial crisis revealed various weaknesses of economies and emphasised the importance of financial-sector monitoring and the necessity to improve the rules for a sustainable stabilisation of the economy to prevent further crises.

Before the crisis, growth rates of Gross Domestic Product (GDP) both in the euro area and particularly in the Central and Eastern European Countries (CEECs) were very substantial, with annual growth rates in 2006 of up to 12 per cent in Latvia and 10 per cent in Estonia. This is positively related to the convergence towards the European Union (EU) and the joining of the European Monetary Union (EMU). However in contrast, the CEECs were even more severely disrupted by the crisis than Western European countries were. Business cycles turned rapidly from excessive growth rates into a recession which was even worse in the Baltic economies. Lithuanian's Gross Domestic Product (GDP) fell by 18 per cent, Latvian GDP by 14.3 per cent and Estonian GDP decreased by 14.1 per cent in 2009. Growth rates in the euro area and in other Central and Eastern European economies, experienced negative average growth rates of up to 4.1 per cent in 2009.[1]

While there are several arguments about why these countries were more severely affected, one major reason is that countries that are tied to the exchange rate mechanism II (ERM II) and (or) currency board regimes do not have the option to use exchange rate adjustments to cushion shocks in the way that countries with floating exchange

[1] Only for Poland did GDP increase slightly by 1.7 per cent in 2009.

rate regimes do. On the other hand, they cannot profit from the common monetary policy measures—including (direct) liquidity support by from the European Central Bank—to cope with the crisis. This is of particular importance when thinking about the enlargement of the European Monetary Union. Further, the current "PIGS crisis"—in Portugal, Italy, Greece and Spain—has revealed that the sustainability of the EMU is a major challenge. Even exit from the common currency area has been discussed. However, the discussion on the stability of the euro area was bolstered by the recent announcement of the European Commission that Estonia fulfils the EMU criteria, and hence may adopt the common currency in January 2011.

Another challenge for the conduct of effective economic policy is an available, accurate forecast of economic output. The major problem is the time lag between the end of the current period and the data publication date. For instance, it may take up to 105 days for the second release of Gross Domestic Product. In addition, the figures are subject to substantial revisions. Only information available at a certain point in time can be used for forecasting. The current crisis stresses the importance of accurate forecasts, because of the criticism in recent years concerning why none of the professional forecasters had foreseen the recession either in its timing or in its dimension. For instance, the professionals participating in the German Consensus Forecast Survey still expected positive, although only minor, growth rates for the euro area after the collapse of Lehman Brothers.

With a focus on the European Union, this dissertation contributes to the analysis of business cycles and economic forecasting. We tackle two specific macroeconomic challenges based on a wide range of empirical analyses which lead us to derive important policy questions.

- First, does the appropriate use of the flow of information and various forecast-pooling methods improve the forecasting performance for euro area GDP?
- Second, should the Eastern European EU member countries adopt the euro in the near future?

Going into more detail, the thesis seeks to offer empirical results with which to assess a number of questions. Can forecast combination provide a useful methodology to improve GDP forecasts? What is the optimum combination weight for various indicator forecasts? Is a direct forecasting procedure better than a bottom-up forecasting approach?

Is it advisable for the EU members in Central and Eastern Europe to join the European Monetary Union as soon as possible? Is there evidence for financial market imperfections that trigger and boost foreign-currency lending? Can this currency mismatch be balanced by banks and firms? Do the various sectors react differently to shocks?

Most of the sections were written prior to (or during) the crisis period using pre-crisis data. The crisis, however, has made the strengths and weaknesses of both the euro and of forecasting accuracy more obvious. It has required immediate responses and substantial changes for the long run. Therefore we attempt to offer suggestions in the light of the crisis as far as data are available.

Structure of This Thesis

To cope with the current macroeconomic challenges, this thesis is divided in two major parts. The first part, containing six chapters, deals with the forecasting of euro area GDP, while the second part, containing the remaining five chapters, analyses the question of the euro area enlargement in the light of a non-standard approach, that is, the boom–bust cycle framework.

The first part, on forecasting in the euro area, involves a short-term GDP forecast for the present euro area member states. Although it is not the first study to consider forecasts for the euro area as whole, it differs considerably from its predecessors in several ways. Following a specific motivation on forecasting issues in Chapter 1, we present the dataset and the methodology that is applied to select the best forecasting equation based on the single-indicator forecasts in Chapter 2. Further, we detail the structure of our forecasting design. To take into account the flow of conjunctural information appropriately in updating the underlying data, in five sequences, to obtain a robust set of equations is one of our major contributions. Chapter 3 discusses several forecast-combination techniques and the weighting schemes that will be applied to sum up the individual forecasts. While this methodology is not new in the forecasting context, it has not been adopted in such detail, and not for different forecasting sequences. Applying various weighting schemes, we describe in Chapter 4 how the weights are allocated to different blocks of series and how the weight composition changes over time when forecasting GDP growth and its main components; that is, forecasting the growth of (private) consumption, investment, and net exports. Based on our out-of-sample forecasting exercise, we assess in Chapter 5 the forecasting performance of the various combination schemes over different sequences and different horizons. In addition, we distinguish between the performance results of the direct

GDP forecast and the bottom-up forecast, where the forecasts of the individual GDP components are aggregated.

Finally, Chapter 6 summarises the findings of the first part and concludes that forecast combination is an appropriate way to optimise the forecasting performance for individual indicators. In particular, financial variables should play a much larger role in economic forecasts, compared to (comparatively) sluggish movements in hard data that are moreover published with substantial delays.

In the second part, we deal with the Eastern European enlargement of the euro area and which theories might be appropriate to form policy recommendations. While the literature on optimum currency areas (OCA) is commonly used to discuss whether the CEECs should join the EMU, we argue in a non-standard framework in which EMU aspirant countries ought to think about the question of joining the EMU soon, and whether they are prepared for this. The country scope comprises ten EU member states in Central and Eastern Europe including the Czech Republic, the Slovak Republic, Hungary, Poland, Slovenia, Estonia, Lithuania, Latvia, Bulgaria, and Romania. Slovenia and Slovakia, while being already part of the European Monetary Union, are included in our analysis to support our arguments. The lack of data, especially for the latest EU member states, does not enable us to analyse all countries equally. This implies that the set of countries can differ slightly in each part of the analysis.

While various empirical and theoretical studies have analysed the readiness of the Central and Eastern European Countries to join the EMU, according to the criteria of the optimum currency areas, the originality of this thesis is that it addresses the questions from a non-standard approach. Given the economic development in the CEECs prior to the crisis, including among others, augmented GDP growth, excessive credit growth, and a high degree of foreign-currency-denominated debt, the boom–bust cycle theory might be an appropriate framework for the analysis of this question from a different point of view. Based on this theory, the second part of this thesis mainly contributes to the literature of an empirical analysis of credit market imperfections and sectoral comovements in Central and Eastern Europe. After a motivation on the euro area enlargement in Chapter 7, we present the current exchange rate regimes in these countries in Chapter 8. Further, we point to the main theories for the analysis of optimum currency areas (Mundell, 1961) and present the framework of the boom–bust cycle approach by Schneider and Tornell (2004). In the case that credit market imperfections are present and the sectors react differently to shocks, the theory of optimum currency areas can be turned around (Lahiri et al., 2006); this implies that it is appropriate to fix the exchange rates. In the remaining chapters of this part the key arguments of the boom–bust approach are picked up and are analysed separately for the CEECs using a set of econometric methods. For comparison, we also present some results for the whole EMU or selected euro area countries.

For a comprehensive analysis of credit market imperfections, in Chapter 9 we start with the documentation of the excessive credit growth in the years prior to the recent crisis. Moreover, we analyse financing asymmetries between sectors of the economy. Due to the fact, that the arguments of the boom–bust approach are based on the firm level, we investigate firm-level survey data to show that credit constraints are more relevant for small firms and those that do not have export opportunities. Further, we show that weak contract enforceability, and in particular the problem of corruption, are evidence for there being (credit) market imperfections in the CEECs. To overcome these constraints and to increase the credit possibilities in general, firms are borrowing large amounts of their debt abroad either directly or in foreign currency. The resulting currency mismatch is discussed theoretically and is analysed empirically, based both on aggregate bank-level data and firm-level data.

The second contribution in this part of the thesis is the empirical analysis in Chapter 10 of sectoral comovement within a country. This is a feature in the overall business cycle analysis that is often neglected, but is indispensable for the analysis in the boom–bust framework. It is argued that the nontradable sector reacts differently to shocks than the tradable sector and that the exchange rate might even amplify these differences. Further, the sectoral asymmetry, that is the nontradables-to-tradables ratio, involves changes in credit through changes in the relative prices of nontradable and tradable goods—the real exchange rate (Tornell and Westermann, 2005). After describing the methodology of sectoral common trends and cycles, we present our data set and the results. Applying many robustness checks, we confirm the major results of our analysis.

Finally, Chapter 11 summarises arguments on whether the elements of the boom–bust cycle model apply for the CEECs and draws tentative conclusions on the suitability of this approach to derive recommendations on whether these countries should join the euro area as soon as possible. Two major challenges in European macroeconomics are tackled throughout the thesis. The main findings of the comprehensive analysis are summarised in the final chapter.

Part I

Flow of Conjunctural Information and Forecast of Euro Area Economic Activity

1 Motivation

The conduct of monetary policy requires the real-time assessment of the current and future state of the economy. Although in most cases national accounts provide the main source of information to do so, they are released on a quarterly basis, published with a lag, and subject to substantial revisions. For the euro area, the flash estimate, which informs only about GDP growth, is published around 45 days after the end of the reference quarter, while 20 supplementary days are necessary to get the first estimate of GDP growth and its components. The second estimate, which contains more information, is released around 105 days after the end of the reference quarter. During these two quarters, from the beginning of the reference quarter to the publication of the second estimate, several indicators will have become available to the policy maker and their synthesis is part of the economist's work.

In this analysis, we investigate how to use the flow of conjunctural information in the most efficient way, that is, to produce the lowest forecasting error while making full use of the available information in a consistent and mechanical way. Since the movements of the components underlying GDP growth are key elements to the outlook, both GDP and its components are forecast separately. Since the ability to forecast with time-series models deteriorates substantially after two quarters (see Darracq Pariès and Maurin, 2008), we focus on the current quarter (nowcast) and the next one. The results are analysed in terms of contribution of the sets of indicators used and in terms of out-of-sample forecasting performance. Indeed, incorporating the differences in publication lags is key to understanding how the forecast changes across the quarter, in term of both composition and quality. Compiling forecasts at different dates of the quarter, we want to show the evolution of the relative weight given to a set of indicators depending on the component forecast and on the information set available.

In the literature, forecasting in a data-rich environment has developed in two main avenues: factor models and forecast pooling.[2] Both methodologies delivered good forecasts and no clear conclusions have been reached regarding the issue of the relative empirical performance of each methodology; thus investigating the two approaches is still worthwhile.

Using approaches based on factor models Giannone et al. (2008) as well as Bańbura and Rünstler (2010), show that the differences in publication lags result in changing the weights allocated to each block of information. As soft data—defined as survey data and financial data—lead hard data—defined as data entering the computation of national accounts—they do contain important information, especially at the beginning of the quarter. We want to extend this conclusion by looking at GDP components and adopting a forecast pooling approach. There are several reasons why forecast pooling can provide better forecasts than individual forecasts can. For instance, when individual forecasts are subject to out-of-sample mean shifts, forecast combinations can offset the instability in the individual forecasts and in effect provide insurance against exogenous, deterministic, structural breaks. Indeed in the literature, the methodology has been found to deliver improved forecasting performance (see, among others, Hendry and Clements, 2004).

This methodology enables us to trace easily the impulse given by each indicator to the pooled forecast and to consider the publication lags which are recognised as an important issue in real-time forecasting. In the first step, each indicator of the dataset is used to estimate simple equations. To analyse the flow of real-time information during each quarter, a sequence of six forecasts is produced, differing in terms of series used, individual equations, and weights applied to aggregate the underlying individual forecasts.

Different to most of the empirical studies on forecast pooling, we use a relatively large number of individual forecasts. Over the relatively short period for which the euro area data are available, the estimated covariance matrix of the forecast errors is poorly estimated. In this case, the literature shows that adding more information, either in the form of constraints or in the form of priors as in Bayesian methods, can improve the forecasts compared to that derived from the application of standard optimizing procedures (see Min and Zellner, 1993). Therefore, the large number

[2] See, among others, Angelini et al. (2008) and Doz et al. (2006) for a comprehensive factor model analysis. While Timmermann (2006) presents various pooling strategies for individual EMU variables, Hülsewig et al. (2008) analyse pooling over countries.

of individual forecasts are aggregated using different weighting schemes, including Bayesian shrinkage techniques.

Merging the indicators into types of information, we study how the weights allocated to the blocks of indicators change during the quarter and how the quality of the forecast improves across time. Moreover, a quasi real-time out-of-sample forecast exercise is carried out to compare the performance of the weighting schemes. Interestingly, we show that the forecast performance varies widely depending on which GDP components and the indicators are used.

This part consists of another five chapters. In Chapter 2, we detail the database, and describe the individual equations estimated and the sequencing of information. In Chapter 3, we present the various weighting schemes used to pool the forecasts. In Chapter 4, we analyse how the weights allocated to the blocks of indicators change during the quarter, depending on the component and the weighting scheme. A quasi real-time out-of-sample forecast exercise is carried out in Chapter 5 to analyse how the forecast performance changes across time; GDP forecasts based on the direct and the bottom-up approach are compared. Finally, Chapter 6 summarises the main findings of our analysis and concludes.

2 The Pool of Equations Estimated

Datasets are constructed for euro area gross domestic product (GDP), private consumption, fixed investment, exports, and imports.[3] To produce a point forecast, euro area GDP and its components are first regressed on each indicator contained in the associated dataset, one by one.[4] More information on this step is provided in the following, where the dataset is detailed, the bridge equations are presented, and the sequencing of monthly information during the quarter is explained. The second step, the pooling of individual forecasts, is considered in the Chapter 3.

2.1 The Dataset

A dataset comprising 114 monthly indicators of activity in the euro area is collected over the longer time period available up to September 2008 (see Appendix A.1).[5] Various sources are used, mainly from the BIS, CPB, Datastream, ECB, European Commission, and Eurostat. Most of the series relate to the euro area: the main components of industrial production (IP), the main producer price indices, monetary and financial data (interest rates, yields, monetary aggregates and loans, stock prices and earnings, nominal, bilateral, and effective euro exchange rates), employment and labour market series, consumer and retail trade surveys, new passenger car registrations, business and construction surveys, and external trade series. A set of series is also added to take into account the economic activity in the United States and the United Kingdom,

[3] All these series are at market prices, chain- linked volumes with reference year 2000, seasonally and partly working-day adjusted. The official Eurostat classification is as follows: GDP (b1gm), household and non-profit institutions serving households (NPISH) final consumption expenditure (p31_s14_s15), gross fixed capital formation (p51), exports of goods and services (p6) and imports of goods and services (p7). Furthermore we renounce forecasting inventories separately, as the share of inventories in total GDP is low.

[4] For a review on density forecasts, see Hendry and Clements (2004).

[5] The euro area is defined by a fixed composition of the EMU12 countries.

the main world commodities markets, and leading indicators or world trade.[6] The individual starting dates vary between January 1985 and January 1995. The series are transformed to ensure that they are stationary. Earnings and stock price series are de-trended, while the growth rate compared to the previous quarter is used for IP, exchange rate, money growth, loans, labour series, and external trade series. Surveys are taken in levels.

While different sub-sets for each GDP component are suggested by Drechsel and Maurin (2008), we prefer to use the same dataset for the euro area GDP as well as its components. This allows for comparability between the components regarding the number of indicators used and in addition does not require us to exclude several series ex ante.

2.2 Selection of the Individual Equations

By definition, a monthly indicator is released three times during a quarter. To address the frequency mismatch between quarterly and monthly data, three equations are estimated for each indicator. Each equation is based on a different quarterly series derived from the monthly indicator. The first equation uses information related to each first month of the quarter, $x_{1,t}$, the second one uses the indicator up to the second month, $x_{2,t}$, and the third one uses information for the whole quarter, $x_{3,t}$.[7] The following generic equation is estimated for each of the monthly series retained in the dataset, with some variants depending on the explanatory variable:[8]

$$y_{t+h} = \theta + \alpha_1.y_{t-1} + \alpha_2.y_{t-2} + \beta_0 x_{i,t} + \beta_1 x_{3,t-1} + \varepsilon_{,t} \qquad i = 1,2,3 \quad (2.1)$$

where y_{t+h} is the quarterly growth in real GDP or one of its components during quarter $t+h$. On the right-hand side, θ is a constant term, $x_{i,t}$ is the i^{th} record of the monthly indicator x in the quarter t and, consistently, $x_{3,t-1}$ is the value taken by x over,

6 Those indicators are estimated and provided by the Netherlands Bureau of Economic Policy Analysis (CPB, 2010).

7 This methodology is implemented by Kitchen and Monaco (2003), who estimate 90 equations, each regressing one monthly indicator on GDP with varying months of information to obtain three sequences of 30 forecasts for current-quarter GDP growth.

8 Note that the number of lags included in the regression increases the R^2 of the regression considerably, which has an impact on the correlation when we pool the forecasts.

respectively, the previous quarter.[9] Finally, ε_t is the equation residual and h is the forecasting horizon $(h = 0; 1)$.[10]

For each indicator, in addition to equation (2.1), two other equations are estimated, with no lags of order two (α_2=0), and with no lags of order one (α_1 =0 and β_1=0). The lag length retained in the final equation is selected using the AIC criteria. More sophisticated equations could be considered, including more than one regressor, and (or) nonlinear forms. Although this would give more degrees of freedom and improve the in-sample fit, it is likely that such an equation would perform poorly out of sample (Hansen, 2007). Moreover, we do not try to get the best equation, as in this case it would not make sense to pool it with other equations. Regressing each variable individually, we reduce the problem of over-fitting and poor forecasting performance and increase the probability of getting robust estimations, especially out of sample. Indeed, the simple structure implies a small number of coefficients and therefore enables us to use series available over a short period, for example, service surveys and retail trade are available for the euro area since January 1995 only.

The indicator is not forecast (when $h > 0$). It is reasonable to think that, at least for the small number of observations used in each equation, a direct forecast gives better results than an indirect one. In the literature, the separate forecasting of the variables on the right-hand side is not generally found to improve the forecasting performance.[11]

Although equation (2.1) is the generic form estimated for each series in the first step, the final equations used to generate the individual forecasts can differ from one indicator to another, as depending on the nature of the indicator, some constraints are imposed and a selection process is carried out at the level of each equation.

Accordingly, the equation has a dynamic structure as it includes lags of both the dependent variable and the indicator. In the case of *hard data*, the indicator enters without lag, that is, $\beta_1 = 0$.[12] This reflects the fact that by definition, those series

[9] When the indicator enters the equation as a growth rate, it is made homogeneous to quarterly rates: in the first month the growth rate is multiplied by 3, and in the second month, it is multiplied by 1.5. This facilitates the comparison of the three values of the β_0 coefficients in equation (2.1).

[10] Hence, y_{t+0} is the nowcast for the quarterly variable and y_{t+1} is the forecast one period ahead.

[11] For an example for the euro area, see Rünstler and Sédillot (2003). The authors propose a method to combine a quarterly univariate bridge equation for GDP with time-series models that forecast missing observations of monthly indicators using satellite models.

[12] By definition, hard data qualified the data entering the computation of national accounts, industrial production and its components, external trade series, retail trade, and passenger car registrations, among others. Soft data are defined extensively in the paper, in addition to survey data; they also qualify financial data and indicators of the foreign environment.

enter the computation of GDP and components contemporaneously. Moreover, the forecast resulting from the equation is excluded from the pool of equations when the sign of the relationship is not positive, as one would expect by construction.[13]

In the case of *soft data*, the equation includes lags of both the dependent variable and the indicator. It is usually found that the correlation between surveys and hard data is stronger at a lower frequency and also in the cases of indicators of the foreign environment or financial indicators, thus there is no reason why the relationship with hard data should be contemporaneous. For the sake of robustness, however, a maximum delay of two quarters is imposed, and the leading properties of the indicators are estimated by allowing β_1 to be different from 0.

In equation (2.1), the dependent variable y_{t+h} is successively the quarterly growth of real GDP, private consumption, fixed investment, exports and imports, and the contribution of inventories to real GDP growth. For each, chained-linked series are available from the first quarter of 1995 onwards. Before this date, the series are extended using the AWM database provided by the Euro Area Business Cycle Network (EABCN, 2010). The OLS regressions are run over the period starting with the first observation of the indicator after 1993Q1 and ending in 2003Q4, a period which contains at most 44 observations.[14] The values recorded after 2004Q1 are kept out of the estimation period for the purpose of the out-of-sample forecasting exercise.

The best equation for each indicator is selected using the AIC criteria. The estimated equations for the GDP dataset are shown in Table A.2 in the appendix. Along with the estimated coefficients and their standard errors (below the coefficient), the R^2 is reported.[15] Then, in the case where the coefficients are not significant at least at 5%, or where the R^2 is below 25 per cent in the case of the nowcast, or 20 per cent for the forecast one quarter ahead, the equation is dropped and the indicator is not retained in the final pool.[16]

[13] As the weights computed below are by construction positive, this sign restriction also holds for the contribution of the indicator to the pooled forecast.

[14] In some cases, the indicator is available over a longer period, for instance up to 1985 in the case of the EC surveys. However, a longer period would increase the likelihood of structural breaks.

[15] The results are shown only for the nowcast, when h=0 in equation (2.1). However, different equations are used for h=1.

[16] The R^2 threshold is calculated as $0.25 - 0.05 \cdot h$, with h being the forecast horizon.

2.3 Sequencing Information

The indicators are released with a different lag compared to the reference month: for instance, consumer surveys are released at the end of the reference month, while industrial production data are released 45 days after. To take into account this diversity in the publication lags, the series incorporated in the dataset are merged into three groups. The first group of series (*Block 1*) comprises the series released at the end of the month to which they refer, mainly financial data, nominal exchange rate data, and consumer and business surveys. In the second group (*Block 2*), the series are released between 15 and 35 days after the reference date. This group includes monetary and loans data, real exchange rate, and passenger car registrations, and price series. Finally, the series belonging to the third group (*Block 3*) are released with a lag greater than 35 days and include industrial production data, employment and labour market statistics, as well as retail trade and external trade.

Table 2.1: Release Calendar and Sequences of Information

Forecast round	Release date	Block 1	Block 2	Block 3
1	End of month 1	B1month 1		
2	End of month 2	B1month 1 and 2	B2month 1	
3	Middle of month 3	-	-	B3month 1
4	End of month 3	B1full quarter	B2month 1 and 2	-
5	Middle of month 4	-	-	B3month 1 and 2
6	End of month 5	-	B2full quarter	-

Note: During a quarter six forecast rounds are conducted according to the release of new data.

Based on the three blocks, Table 2.1 shows that in each quarter, six information sets can be used to produce forecasts before the publication of the GDP flash.[17] The first information set comprises survey data and financial data referring only to the first month of the quarter. The second bears on the same set of series up to the second month of the quarter as well as money and loans data for the first month. The third set includes series from the three blocks, adding to the second information set the first month of observations of data from the third block (mainly IP and trade data). The fourth information set contains observations over the full quarter for data belonging to the first block, over the first two months for series belonging to the second block and the same information for data belonging to the third block. The fifth information set changes only the data of the third block, substituting the first two months of

[17] Based on their release, the 114 indicators can be allocated to block1: 68; to block2: 24 and to block3: 22.

observations to the first month. Finally, the sixth information set substitutes the full quarter observations of data from the second block to the observations from the first two months. As shown in Table 2.1, the third month of data from the third block is not considered since it is released after the flash estimate of the euro area GDP. Moreover, the first estimate of the lagged quarterly growth in the component is not known before the third forecast round.

Table 2.2: Numbers of Forecasts Retained for GDP and its Main Components (h=0)

	Nowcast						1 quarter ahead					
Forecast round	1	2	3	4	5	6	1	2	3	4	5	6
Possible forecasts	68	92	114	114	114	114	68	92	114	114	114	114
Accepted forecasts												
Real GDP	60	78	97	105	105	107	41	48	60	71	72	80
Investment	64	84	102	102	103	103	17	23	41	78	78	92
Private consumption	24	37	40	45	47	47	32	40	44	42	41	41
Total exports	42	52	71	87	87	97	36	51	60	56	56	55
Total imports	62	79	90	87	87	86	51	59	71	86	85	91
Truncated forecasts												
Real GDP	27	37	50	75	77	86	10	16	19	40	40	41
Investment	5	8	14	17	18	18	4	8	12	18	17	19
Private consumption	4	8	8	9	9	8	4	8	11	13	13	12
Total exports	21	25	34	50	53	58	18	27	29	27	28	28
Total imports	33	39	48	66	66	74	38	42	46	57	57	60

Note: Acceptable forecasts include forecasts that are based on significant estimations and where the sign restriction is fulfilled. Imposing a constraint on the R^2, the number of truncated forecasts is reduced considerably.

Matching the individual indicator equations presented in the previous chapter with the sequence of information, six sets of individual forecasts can be produced each quarter for GDP and its components, based on different series and (or) different equations. Consequently, the dimension of each information set, and the number of indicators used increases during the quarter, differs across components and over the course of the quarter, partly reflecting the differences in the size of the original dataset, and partly reflecting the selection process. As shown in Table 2.2, the number of indicators retained differs widely from one component to another, with more indicators retained for GDP and trade flows. Given the high intensity of external trade in manufacturing goods, this reflects the higher share of industry surveys in the dataset. In almost all cases the number of indicators, and therefore the individual forecasts pooled, increases by up to more than 100 per cent from the first to the sixth forecast. After applying the R^2 threshold to truncate the forecasts, the number of indicators retained declines markedly for fixed investment and private consumption.

3 Pooling the Individual Forecasts

The pioneering work on forecast pooling goes back to Bates and Granger (1969) and since then it has been considerably extended (for a review, see Timmermann, 2006). Basically, forecast pooling implements the following formula:

$$\widehat{y}_{t,t+h} = \sum_{i=1}^{n} \omega_{i,h} f_{i,t,t+h} \quad \text{with} \quad \sum_{i=1}^{n} \omega_{i,h} = 1 \tag{3.1}$$

Where $\widehat{y}_{t,t+h}$ is the combined forecast and $w_{i,h}$ is the weight assigned to $f_{i,t,t+h}$, the forecast based on the i^{th} individual equation described. Although they could be envisaged within this framework, weights moving across time are not considered. The problem of forecast pooling is to estimate the weights, $w_{i,h}$, so as to minimise a penalty function depending on the forecast errors. In our case, the penalty function is simply the root mean square forecast error and as shown by Granger and Ramanathan (1984), the in-sample solution to this problem is the OLS constrained estimator. The optimal weights correspond to the linear projection of y on the forecast space with no constant (so that the underlying forecast has to be unbiased) and with coefficients summing to one. They can be computed from the variance-covariance matrix of the forecast errors Ω, using the optimisation program given by equation (3.2) where 1_n is a column vector of one:

$$Min \;\; \omega^{'}\Omega\omega \quad \text{with} \quad 1_n^{'}\omega = 1 \tag{3.2}$$

The first-order condition associated with the optimisation program states that, at the optimum, each individual forecast makes the same marginal contribution to the variance of the overall forecast. Suppose f_i tends to have higher covariances with other forecasts, that is, the i^{th} row of the covariance matrix of forecast errors tends to have larger elements than other rows. Its marginal contribution to the overall forecast variance, will be larger than that of other individual forecasts.[18] To achieve optimality, its weight needs to be reduced and, conversely, those of the other forecasts need to be increased. Forecast i may even have a negative weight if its covariance with other forecasts is sufficiently high.[19] The optimal individual weights, ω_i, are given by equation (3.3), where $\mathbf{I}_n$ is an identity matrix of dimension n and $\widehat{\sigma}^2_{sum}$ is the forecast error variance.

$$\omega_i = \Omega^{-1}1_n \left(1_n^{\prime}\Omega^{-1}1_n\right)^{-1} \qquad \widehat{\sigma}^2_{sum} = \left(\mathbf{I}_n\Omega^{-1}\mathbf{I}_n\right)^{-1} \tag{3.3}$$

Although, by construction, this method gives the forecast with the smallest squared error in the class of linear aggregators, most of the empirical studies find that it performs poorly out of sample (see, among others, Min and Zellner, 1993). Indeed, Diebold and Pauly (1990) show that a small sample size relative to the number of forecasts can distort the results of combination. When n is large, a strong collinearity among competing forecasts cannot be ruled out and adding more structure to the program can result in a better forecast, so that the determination of the best weighting scheme is an empirical issue. In what follows, the individual forecasts are pooled using different weighting schemes.

3.1 Equal Weights and Trimming

Forecast combinations with equal (mean) weights are often reviewed in the literature and used as a benchmark for different combination schemes. Theoretically, the efficiency of this method depends on two conditions: first, that the forecast error variances are relatively similar; and second, that the correlations between forecast errors are in the same range across pairs. Although these conditions are probably too restrictive to hold, they are often assumed without being tested. Indeed, the use of equal weights can be explained by ease of computation and the simplicity in estimating the contribution of each variable to the overall forecast (see Stock and Watson, 2006; Marcellino, 2004).

[18] $\sum_{j=1}^{n}\omega_j\Omega(i,j)$ is the marginal contribution of forecast i to the overall variance.

[19] Hence, a forecast tends to receive a negative weight in the global forecast if it has higher variance and higher covariances with other forecasts. Strong collinearity between forecasts can generate weights well below zero and well above one.

In the case at hand, the conditions for the optimality of equal weights are clearly not met. First, for each component, the R^2 of the regressions varies over a wide range, and the same can be assumed for the variance of the out-of-sample forecast errors. Second, some regressors co-move more strongly together so that the forecast error covariance varies substantially from one group of regressors to another. For instance, given the correlation between the components of surveys, the forecast errors resulting from the equations using each of their components co-move more strongly among themselves than with those of the models incorporating financial data. The fact that data are structured by block may lead to large differences in the covariance between pairs of series.

However, while equal weights may be under-efficient in theory, the estimation of weights may be inefficient in practice, when using small samples. Since the in-sample covariance matrix is poorly estimated when the number of individual forecasts is large compared to the time span, ignoring the correlation between the forecast errors may result in a better forecast.[20]

In addition to the pooling of all (valid) indicator forecasts, even though with small weight, the trimming approach discards a sub-set of indicators. In general these outliers are the indicators with the worst performance out of sample. According to the literature, we scrap an indicator if the corresponding average of the residuals belong to the 20 per cent of the worst indicators.[21] For robustness, the half of the forecasts are also rejected.

3.2 Estimation Quality Based Weights

While ignoring the covariance between forecast errors, the set of weights based on Akaike Information Criterion (AIC) and R^2 take into account the differences in the variance of forecast errors. Ceteris paribus, more weight is given to the model which has the lowest forecast error variance, and a penalty is imposed on the number of estimated parameters. Atkinson (1980) shows that information-theoretic weights perform well, especially for the long run, as this criterion is an unbiased estimation of the difference

[20] To take an example, 190 parameters are necessary to estimate the variance covariance matrix of forecast error of 20 equations, and when using five years of quarterly data, 400 observations are available, slightly more than twice the number of coefficients to estimate.

[21] In contrast, Armstrong and Collopy (1992) even suggest discarding both the high and low errors, which they refer as "winsorizing".

between the KL distance of two models.[22] Hence, the difference, $\Delta_i = AIC_i - AIC_{\min}$, can be interpreted as the loss in information from the use of model i compared to the best model. From the differences in AIC to weights, the values are simply rescaled in order to sum to one:[23]

$$\omega_i = \frac{\exp\left(-\gamma \cdot \Delta_i\right)}{\sum_{r=1}^{n} \exp\left(-\gamma \cdot \Delta_r\right)} \tag{3.4}$$

The weights are all positive and the model with the lowest AIC obtains the highest weight. Taking $\gamma = 0.5$, the ratio expresses the relative likelihood of model i compared to the best model (see Kapetanios et al., 2008). It can be interpreted as the probability that model i is in fact the best model for the data.

For a univariate model, it can be shown that the Akaike criterion is composed of two parts. A part proportionate to the standard deviation of the residuals, and therefore to the R^2, and a penalty function depending on the number of estimated parameters. As in the equations estimated, the number of coefficients varies in a narrow range; the AIC weights are close to a weighting scheme based on R^2. Accordingly, comparing two models, M_1 and M_2, with the same number of parameters:

$\Delta AIC = \widehat{V}(y)(ln(1 - R_1^2) - ln(1 - R_2^2))$, so that $\omega_1/\omega_2 = (1 - R_{M2}^2)/(1 - R_{M1}^2)$,

where R_i^2 and ω_i are respectively the R-squared and the weight of model i.

For the same reason, using weights based on the Schwarz information criteria does not substantially change the results.

[22] AIC is an asymptotic measure of two times the likelihood in absolute terms. $AIC = -2l/T + 2k/T$, where l is the estimated likelihood, T is the number of observations and k is the number of estimated parameters. The Kullback-Leibler (KL) distance is used for selecting from different models taking into account the information gain.

[23] AIC_i refers to the estimation i and $AIC_{\min}$ denotes the minimum of all estimated AIC values in the set of pooled equations.

3.3 Variance-covariance Approach and Optimised Constrained Weights

As shown by Jagannathan and Ma (2003), adding a positivity constraint to the optimisation problem given by equation (3.2) can improve the out-of-sample performance by correcting for abnormally large covariance errors. This weighting scheme has the advantage of incorporating the information given by the variance covariance matrix of the in-sample forecast errors.

The authors show that solving the constrained optimisation problem (3.2) with positivity constraints on the weights, ω, is equivalent to solving the optimisation problem (3.5) without those constraints and based on $\widetilde{\Omega}$.

$$Min \;\; \omega'\widetilde{\Omega}\omega \quad \widetilde{\Omega} = \Omega - \left(\lambda 1_n' + 1_n \lambda'\right) \tag{3.5}$$

Whenever the non-negativity constraint is binding for forecast i, the associated Lagrange multiplier, λ_i, is positive. In this case, the covariance of the forecast i with the forecast j is reduced by $\lambda_i + \lambda_j$ and its variance is reduced by $2\lambda_i$. The new estimate of the covariance matrix is constructed by shrinking the large covariances that would otherwise imply negative weights towards the average covariance. In cases where the largest covariance estimates are caused by large estimation errors, the shrinkage reduces the out-of-sample forecast error.

3.4 Bayesian Weights

The problem of finding the optimal weights can also be cast in a Bayesian framework (see Min and Zellner, 1993) and, recently, Bayesian methods have been widely used to combine forecasts. Assume a prior belief for the probability that among n models, i is the right one, $p(M_i)$. After observation of the data, $p(M_i/D)$ is updated. The posterior probability that model i is the right one is computed using the Bayes theorem:

$$p(M_i/D) = \frac{p(D/M_i) \cdot p(M_i)}{\sum_{j=1}^{n} p(D/M_j) \cdot p(M_j)} \quad with \quad p(D/M_i) = \int p(D/\theta, M_i) p(\theta/M_i) d\theta, \tag{3.6}$$

where $p(D/M_i)$ is the marginal likelihood of the model i, $p(\theta/M_i)$ is the prior density of the parameter vector in the model, and $p(D/\theta, M_i)$ is the likelihood of model i. The posterior probabilities can be used to weight the individual forecasts, $\omega_i \propto p(M_i/D)$. In the Bayesian context, the weights can be computed once the model prior, $p(M_i)$, and the parameter priors, $p(\theta/M_i)$, have been specified.

This approach permits the integration of prior information into the estimation of the weights. A convex combination of least-squares and equal weights can be obtained by shrinking towards equal weights. Large deviations of the estimated coefficients in the covariance matrix and hence positive and negative errors can be compensated, while the weights are not forced to be equal.

For the following analysis, equation (3.1) can be written in the form of a standard linear multivariate regression model (where h is the forecast horizon):

$$\hat{y} = f \cdot \omega_h + \varepsilon \quad \text{with } \varepsilon \sim N(0, \sigma_h^2 I) \tag{3.7}$$

Under the assumption of a standard normal-gamma conjugate prior for ω_h and σ_h^2, where $\sigma_h^2 \sim G(s_h^2, \upsilon_h)$ and $\omega_h/\sigma_h \sim N(\omega_h, \Phi)$, one obtains the posterior probability density function of ω_h and σ_h (see Zellner, 1971). From this, one can show that the marginal posterior of ω_h is a multivariate Student distribution and the conditional posterior is

$$\begin{aligned} p(\omega_h/\sigma_h, f) &\propto \left[1 + \frac{(\omega_h - \overline{\omega}_h)' \, s_1^{-2} \, (\Phi + f'f) \, (\omega_h - \overline{\omega}_h)}{T + \upsilon_h}\right]^{-(n+T+\upsilon_h)/2} && (3.8) \\ \overline{\omega}_h &= (\Phi + f'f)^{-1} \left(\Phi\omega_0 + f'f\omega^{ols}\right) && (3.9) \end{aligned}$$

Where $\overline{\omega}_h$ is the mean vector of ω_h, ω^{ols} are the weights derived from OLS ($\omega^{ols} = (f'f)^{-1} f'y$), ω_0 is the vector of equal weights, $1/n$, and υ_h is the number of degrees of freedom, $n - k$ (k is the number of estimated coefficients). Assuming a g-prior for Φ, $\Phi = g.f'f$, with $g > 0$, equation (3.9) can be simplified and the mean posterior weight can be expressed as:

$$\overline{\omega}_h = \omega_0 + \frac{\omega^{ols} - \omega_0}{1 + g} \tag{3.10}$$

This formula expresses $\overline{\omega}_h$ as the OLS estimate shrunk towards the uniform prior. The computation of the weights requires the estimation of g. The smaller it is, the larger is the weight given to the data and therefore to the OLS estimation. In the literature two cases have brought more attention, cases that assume uninformative priors for the models (equal weights, $p(M_i) = 1/n$): the case envisaged by Diebold and Pauly (1990) and the case presented by Wright (2003).

Diebold and Pauly (1990) weights

To compute the g prior estimator in a closed form, Diebold and Pauly (1990) consider forecast weights which depend on the sample size relative to the number of cross-sectional models to be combined. Assuming: $\Phi = \tau^2 \left(f'f\right)^{-1}$, substituting in equation (3.9) the estimated variance of the forecast error to σ^2, and assuming a certain value for $\hat{\tau}^2$ shown in equation (3.4), one can show that g in the Bayes rule given by equation (3.10) is equal to σ^2/τ^2. Using the following estimates for $\hat{\tau}^2$ and $\hat{\sigma}^2$:

$$\hat{\sigma}^2 = \frac{\left(y - f \cdot \omega^{ols}\right)' \left(y - f \cdot \omega^{ols}\right)}{T} \text{ and } \hat{\tau}^2 = \frac{\left(\omega^{ols} - \omega_0\right)' \left(\omega^{ols} - \omega_0\right)}{tr\left(f'f\right)^{-1}}$$

the Bayesian combination weights can be computed:

$$\overline{\omega}_h = \omega_0 + \left[1 - \frac{\hat{\sigma}^2}{\hat{\sigma}^2 + \hat{\tau}^2}\right] \left(\omega^{ols} - \omega_0\right) \tag{3.11}$$

Diebold and Pauly (1990) refer to this as "empirical Bayes estimator" while the estimator given in equation (3.10) is titled as "g-prior estimator". The method yields a convex combination of OLS and equal weights with often a huge shrinkage to equal weights. For the case that $\hat{\sigma}^2/\hat{\tau}^2 \to 0$ we are close to the OLS estimator; on the contrary if $\hat{\sigma}^2/\hat{\tau}^2 \to \infty$ we obtain an equal weight estimate. Finally the authors show that the empirical Bayes estimator given in equation (3.11) is equivalent to the least squares estimator on transformed data.

Due to the small sample size, which increases $\hat{\sigma}^2$, the g-prior is close to zero. Since the shrinkage procedure gives a very small weight to the individual forecasts, the corresponding weights are similar to these given by equal weights. Therefore the results of this method will not be detailed.[24]

[24] For the performance of Diebold-Pauly weights with other weighting schemes, see, among others, Drechsel and Maurin (2008).

Wright (2003) weights

The author assumes an improper prior for σ^2 which is proportional to $1/\sigma^2$ and a prior distribution of ω_h/σ_h normal and centred around zero, the case where the weights are shrunk towards zero, the case of no predictability.[25] In this case, it can be shown (see Zellner, 1971) that

$$\omega_h \propto (1+\phi)^{-n/2} \cdot S^{-T+1} \text{ with } S^2 = y\prime y - y\prime \widehat{y}^{ols} \frac{\phi}{1+\phi} \text{ and } \widehat{y}^{ols} = f \cdot \omega^{ols\prime}$$

The shrinkage, g, is governed by ϕ, which controls the relative weights of data and prior when computing the posterior. When ϕ is zero, $p(D/M_i)$ is equal for all models so that the posterior probability of each model is equal to the prior probability. More generally, a small value means more shrinkage. Conversely, the larger is ϕ, the larger the move from the model priors following what is given by the data, making the-uninformative-prior more informative. Very little has been written about the size and choice of ϕ in the literature. Wright (2003) as well as Kapetanios et al. (2008) consider $\phi = 20$ and $\phi = 2$. However, applying these two values Drechsel and Maurin (2008) found that the results are very sensitive to the values used, and therefore the value of ϕ is determined numerically to minimise the in-sample forecast error over the estimation period of the individual equations. We found that the optimised values are concentrated around $\phi = 5$.

25 $p(\omega_h/\sigma_h, f) \sim N(0, \phi\sigma_h^2(f^{'}f)^{-1})$. The author also introduces a geometric autocorrelation in the residuals of equation 3.7, $cov(\varepsilon_t, \varepsilon_{t-j}) = \sigma^2\frac{h-j}{h}, j \leq h-1$.

4 Weight Changes Allocated to Individual Information

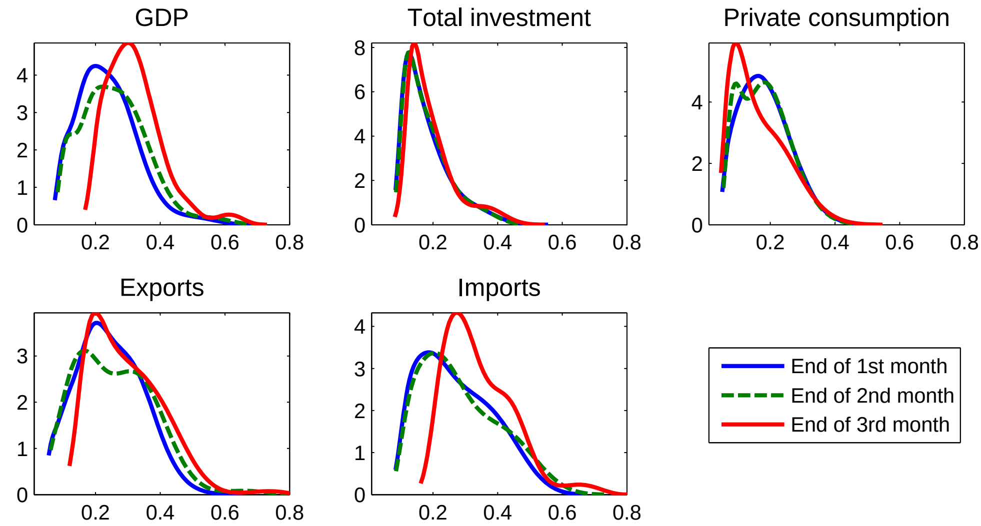
4.1 Impact on the Estimation Performance

Before we turn to the weights associated with each block, we look at the underlying individual equations. Figure 4.1 plots the R^2 distributions of the individual equations for GDP and its components for the nowcast.[26] Although from the first month to the third month, the distributions tend to shift slightly towards the right, where the R^2 are higher, the shift is relatively minor from the first to the second month, so that the informational content of each indicator increases slightly. For GDP and exports and imports, the improvement of R^2 is comparably large. Moreover, for each indicator, the dynamic structure of the equation as well as the coefficients appear remarkably stable in the course of the quarter, with little change in their significance ratio either (see Table A.2 in the appendix for GDP).

It appears that the changes experienced in the weights across the six forecasts are mainly explained by the availability of the indicator and are not due to a change in the performance of a forecast obtained using it.

[26] These figures include all equations, that is, also equations where the R^2 of the estimation is below 25 per cent (in the case of the nowcast).

Figure 4.1: Successive R-squared Distributions of Individual Equations



Note: A kernel smoothing method is applied over the interval [0,1] to estimate the distribution of R^2. The figures include all estimated equations.

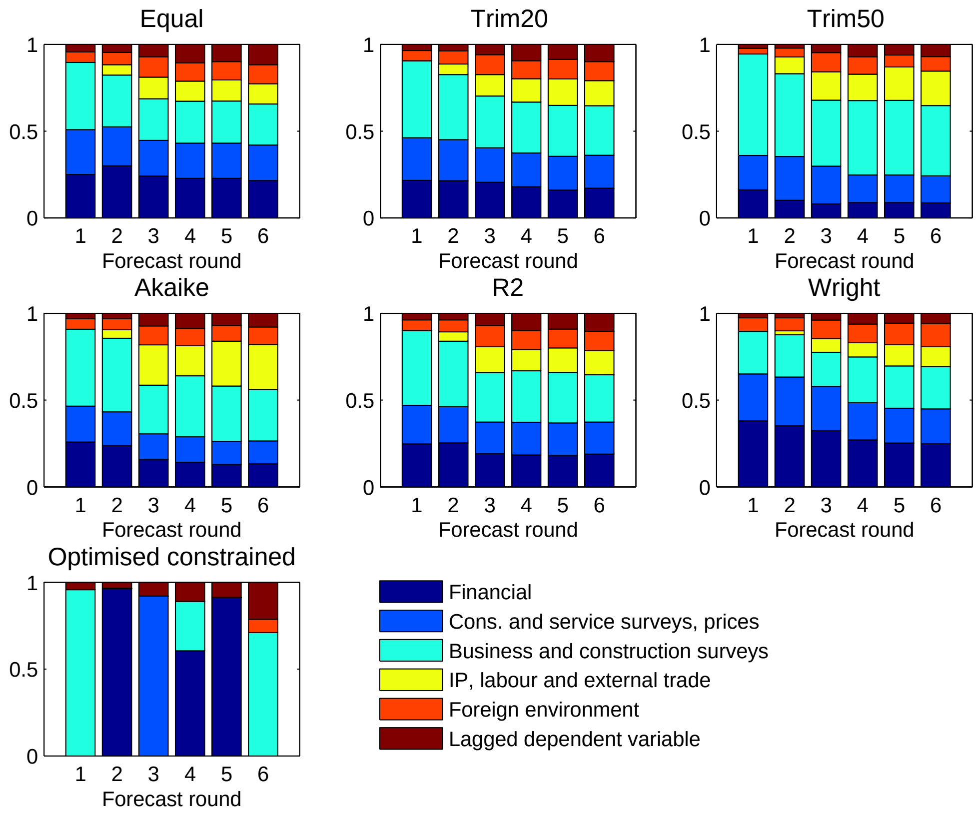
4.2 Impact on the Forecast Weights

For horizons h varying from 0 to 1 and for the whole sequence of six forecasts generated during the quarter, the weights are computed using the various schemes exposed for euro area GDP and its components. In the case where an estimate of the covariance matrix of errors is needed, the in-sample forecasts generated over the period 1994Q1-2003Q4 are used.[27]

In each equation, only one explanatory variable is included as well as sometimes the lagged explained variable. In this case, the weight given to an equation also indicates the importance of the signal associated with the indicator involved in the equation. Since the indicators are too numerous to be analysed separately, we group them into five groups depending on their nature: (i) financial variables; (ii) consumer and service surveys, retail trade and prices; (iii) business and construction surveys; (iv) industrial production, orders, labour and external trade; and (v) foreign environment. The sum of the individual weights of the series belonging to each block of information represents the contribution of the block to the pooled forecast. As well as those five blocks, the weight given to (vi), the lagged variable, is also considered by dividing the weight

[27] As the residuals from all the equations are necessary to compute the covariance matrix, the shortest time series used to generate an individual forecast is binding.

Figure 4.2: GDP: Weights Allocated to Each Block



Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds.

given to the equation in the contribution of the indicator, and of the lagged variable proportionately to the R^2 obtained with and without the lagged variable.

The weights of each block are shown in Figure 4.2 to Figure 4.6 for the nowcasts of GDP and the selected components.[28] The bars (which sum to one) indicate the division of the weight into the six blocks considered, over the six forecast rounds which are represented on the horizontal axis. By construction, in each figure, the chart with equal weights indicates the relative number of indicators retained from each block.

Overall, our results show that incorporating the differences in the publication lags modify substantially the weight given to the indicators in the conjunctural assessment during the quarter. Surveys are especially relevant in the months previous to the publication of hard data (in our third forecast round). Depending on the component, the most important surveys differ in their nature, with business and construction surveys being more important for investment, exports and imports, and with consumer and

[28] The corresponding weights are shown in Figure A.1 to Figure A.5 in the appendix.

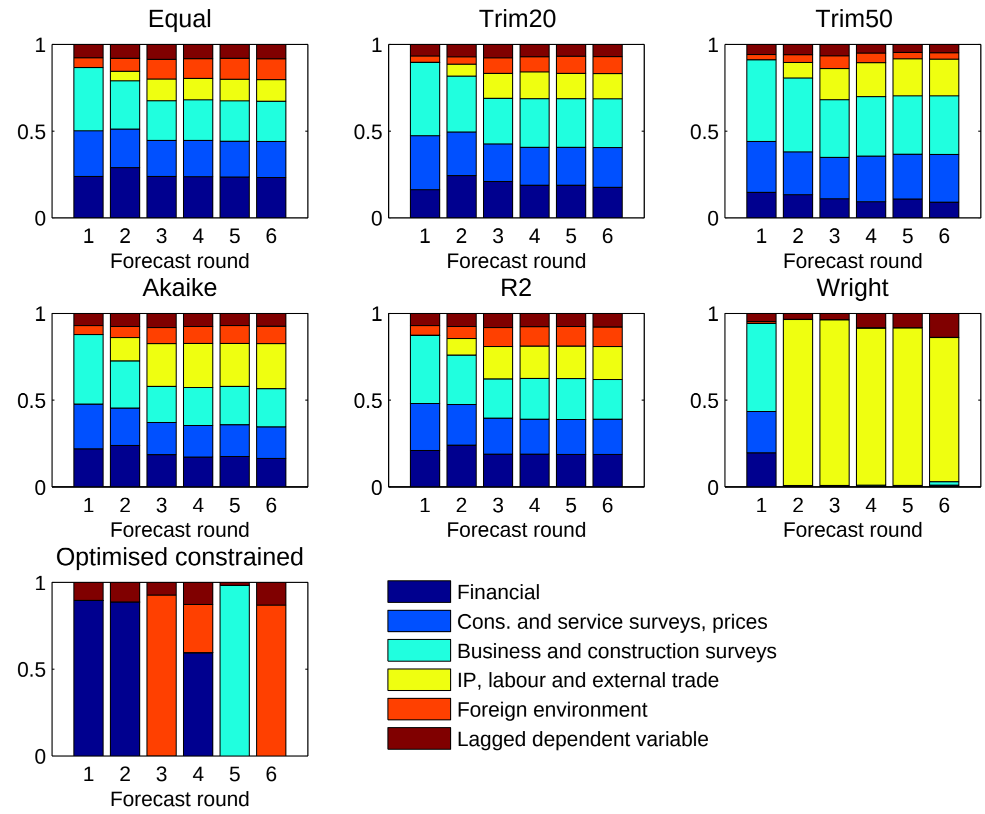
retail trade surveys being more important for private consumption. While all blocks are relevant, the impact of the lagged dependent variable on the pooled forecast is around 10 per cent in the case of GDP and fixed investment, and even more in the case of trade flows. Looking at the individual equations, it appears that the coefficient on the lagged dependent variable is negative in most cases. More generally, the differences observed across methods in terms of weights allocated to the indicators raise the issue of the relative forecasting performances of the schemes. Equal weights, weights based on discarding the worst 20 per cent of the forecast (Trim20), Akaike weights and R^2 weights yield relatively similar results and for these weights, the structure of the blocks does not change substantially after the third forecast round. The concentration of the weights is much stronger when the optimised constrained or Wright weights are used. The implementation of the optimised constrained methodology reduces sharply the number of individual forecasts retained, less than 10 in most cases, well below the number of indicators retained by the other methods.[29] However, the pattern given by the optimised constrained weights is difficult to describe and even more difficult to explain.

While all types of indicators provide information for GDP growth (see Figure 4.2), the weight of the business and construction survey variables appears relatively high, around 30 per cent, in most of the methods except optimised constraint weights. It is higher than the weight given to consumer and service surveys. The weight given to hard data remains below 20 per cent in all methods while the importance given to financial series remains stable at around 20 per cent. In the Wright weighting scheme, the financial variables are more important in the first forecast round with almost 40 per cent, and then decrease slightly in the following rounds.

The results differ for the individual components, weighting schemes, and forecast rounds. Large changes in the allocation of weights appear in the third round and, to a lesser extent in the fifth round in the cases of private consumption, exports, and imports. This coincides with the incorporation of, respectively, the first and the second month of hard data (industrial production and external trade series, among others). The change is much less pronounced in the fifth round, when the second month of hard data is released. This can be explained by the fact that, abstracting from revisions, two-thirds of the quarterly growth rate of a monthly series is known when its first observation in the quarter is released.

29 In the case of optimised weights without a positivity constraint (derived from OLS), the weights vary in a wide range, much outside the $[0, 1]$ bound.

Figure 4.3: Fixed Investment: Weights Allocated to Each Block



Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds.

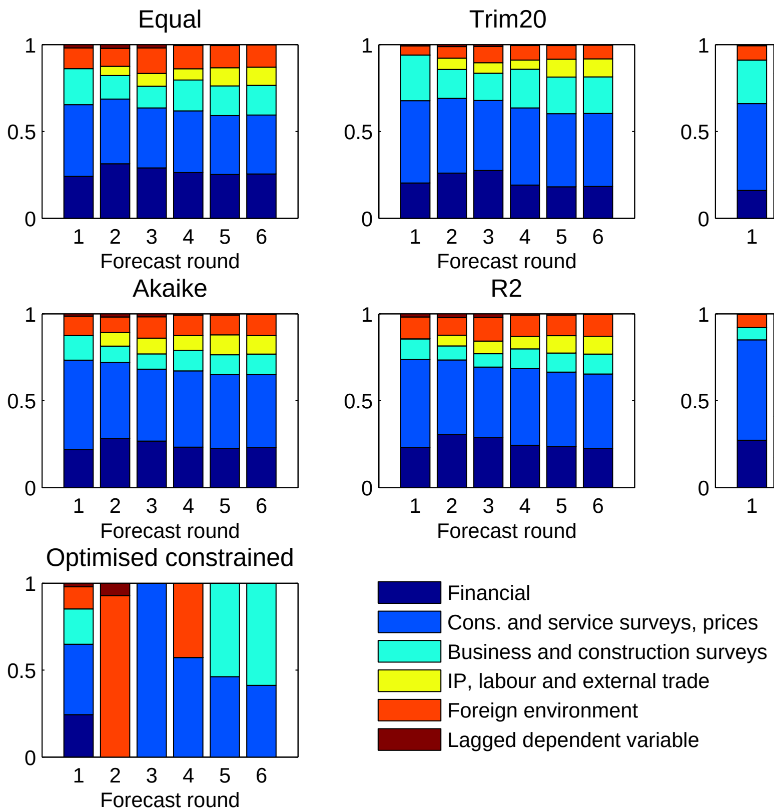
Forecasting investment (Figure 4.3) requires giving less weight to the information conveyed by soft data (surveys, financial variables, and international environment) than forecasting private consumption (see Figure 4.4).

For fixed investment, the most relevant indications are given by the business and construction surveys on the one hand, and financial variables on the other.[30] The availability of hard data in the third round (IP and labour) results in a decline of 10 to 20 percentage points in the weight of business surveys, while the weight of financial variables and lagged dependent variable remains stable. In the case of private consumption, business surveys, financial variables, and the international environment appear relatively less important, while the weight of consumer and retail trade surveys appears larger (up to 50 per cent for AIC weights). Interestingly, the role of the lagged dependent variable is small for private consumption. Compared to the weights for the GDP forecast above, the figures show that the block comprising industrial production,

[30] The high performance of construction surveys in forecasting investment can be explained by the fact that construction investment accounts for roughly half of total euro area investment.

orders, and labour has a large impact when using Wright weights as soon as the data become available. For fixed investment, nearly all information is gathered by this block in the second and third forecast rounds.

Figure 4.4: Private Consumption: Weights Allocated to Each Block

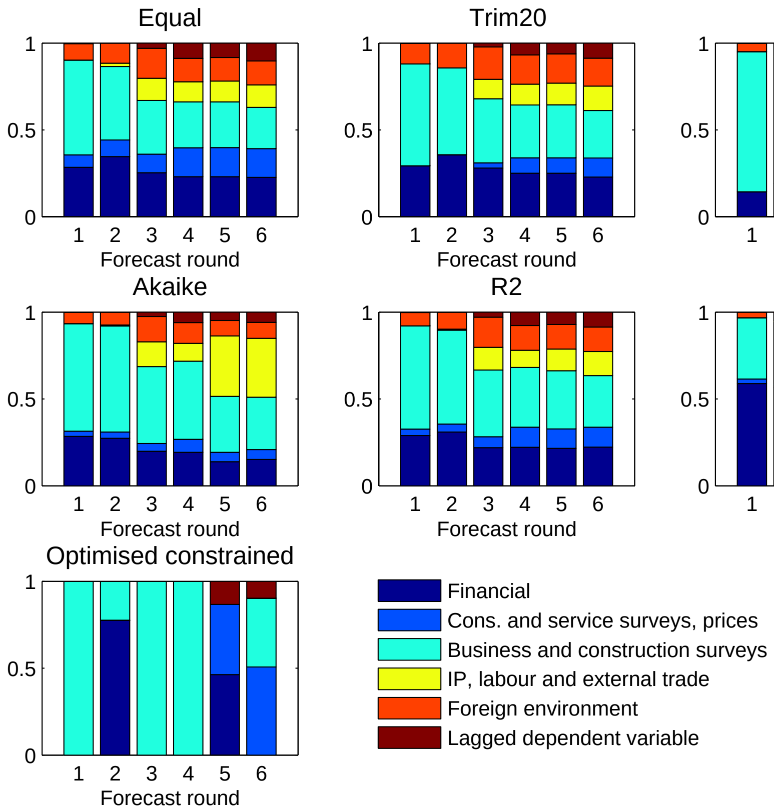


Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds.

For exports, the block business surveys provides important indications, as it contains surveys on export order books (see Figure 4.5). The significance of this block is remarkable for all weighting schemes. In addition, the block financial variables and foreign environment also plays an important role in the forecast, as it includes exchange rates and the economic situation in the United States and the United Kingdom. The contribution of the financial block is almost 60 per cent in the first round, and decreases slightly over the forecast rounds. In the cases of Akaike and Wright weighting schemes, the first and second months of hard data result in a significant increase in the weight of this block, mainly at the expense of business surveys, which still explain more than one-third of the forecast in the sixth round.

For imports, the lagged dependent variable contributes up to 10 per cent of the forecast (see Figure 4.6) for all weighting schemes. A more detailed analysis shows that this results from the external trade series which belong to this group and, to a smaller extent, from industrial production data. Furthermore, the impact of business and construction surveys is significant, with around 50 per cent. Despite of a negative coefficient, stock assessments from business surveys also give good indications, with the R^2 from the resulting equations being above 30 per cent. This may be explained by the strong negative correlation between imports and inventories.

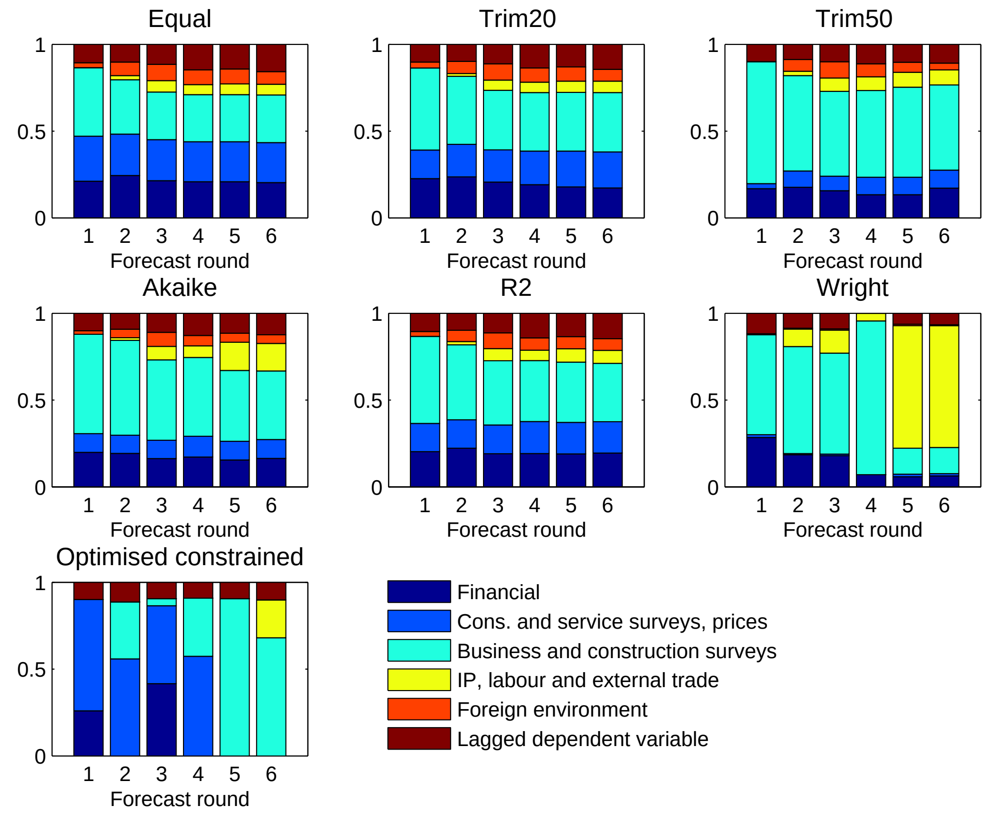
Figure 4.5: Total Exports: Weights Allocated to Each Block



Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds.

In addition, the weight composition for the truncated forecasts are shown in Figures A.1 to A.5. Compared to the previous results, the findings are mixed. Overall, one can show that the weight composition by equal, Trim20, Akaike, and R^2 weights is very similar, and for GDP and some components even for Wright weights. However, the weight blocks given by the optimised constraint weighting scheme are totally different. While they have an ever-changing pattern for GDP and all its components using non-truncated forecasts (see figures 4.2 to 4.6), these weights are more in line with the

Figure 4.6: Total Imports: Weights Allocated to Each Block



Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds.

weight blocks given by the other weighting schemes, especially for fixed investment and private consumption (see Figures A.1 to A.5 in the appendix). The figures show that for truncated forecasts the weighting blocks are larger. For example, total investment is dominated by the industrial production block with more than 50 per cent, almost half of the private consumption forecast is covered by consumption and service surveys and the trade forecast by the business and construction surveys.

Overall, while implementing a different methodology, we find support for the conclusions reached by Bańbura and Rünstler (2010) on the euro area GDP at the level of each component, namely that incorporating the differences in the publication lags modifies the weight given to the indicators in the conjunctural assessment during the quarter. Business surveys are especially relevant in the months prior to the publication of hard data (in our third forecast round). Depending on the component, the most important surveys differ in terms of their nature, with business and construction surveys being more important for investment; exports and imports, and consumer and retail trade surveys are more important for private consumption. The contribution of the lagged dependent variable to the forecast can remain relatively high in some cases thereby explaining the small gain in forecasting performance compared to autoregressive models noted by Koop and Potter (2003). More generally, the differences observed across methods in terms of weights allocated to the indicators raise the issue of the relative forecasting performance of the weighting schemes.

5 Relative Performance of Weighting Schemes Out of Sample

The empirical literature on forecast combination is usually based on a relatively small number of elementary forecasts. This literature shows that while combining methods typically outperform individual forecasts in the panel, often by a wide margin, simple methods, such as the simple mean, often perform as well as more sophisticated ones. This stylised fact has become the "forecast combining puzzle" since it is at odds with existent statistical theories, which show that it is possible to improve upon simple combination methods.

We use a relatively large number of individual forecasts (see Table 2.2), and in this context, we want to compare our results with those in the literature that are based on a small number of forecasts. More precisely, running a pseudo real-time forecast comparison exercise, we want to provide answers to three questions.[31] First, we want to evaluate the relative performance of the weighting schemes out of sample, partly to check whether equal weights provide a relatively good benchmark. Second, we want to analyse the extent to which adding information during the quarter improves forecasting performance. Finally, we want to assess how the forecast performance varies across components and across the forecast horizon.

While the pseudo out-of-sample real-time forecasting exercise does not take into consideration revisions in the underlying data, it can be seen as providing a superior limit to the forecast errors. By construction, a forecast based on model averaging should be less sensitive to data revisions in the case where these are uncorrelated

[31] The terminology "pseudo" indicates that the datasets used are truncated versions of the same final dataset so that the revisions are not taken into consideration.

noise.[32] Moreover, in a proper real-time forecast, the elementary equations would be estimated over the full period, and updated each quarter with new coefficients, new elementary equations, and hence, new weights.

As mentioned above, the sample is divided into two sub-samples, enabling us to perform an out-of-sample forecasting exercise. The first sub-sample includes the observations available until 2003Q4. It is used to fix the specification, that is, to specify the individual equations and to estimate the weights. The second sub-sample which covers the period from 2004Q1 to 2008Q2 is used to generate the forecasts and to compute the forecast errors. Over this period, six sequences of out-of-sample forecasts of GDP and the main GDP components are computed for each observation, that is, 18 forecasts (tf) of quarterly increases. The forecasting performance is then compared to that of an AR(1) model using the relative squared forecast error $(RSFE)$:

$$RSFE_h = 1 - \frac{\sum_{t=t0}^{tf} \left(\widehat{y}_{t+h}(\omega) - y_{t+h}\right)^2}{\sum_{t=t0}^{tf} \left(\widehat{y}_{t+h}^{AR} - y_{t+h}\right)^2}. \tag{5.1}$$

Where the AR forecast, $\widehat{y}_{t+h}^{AR}$, is based on an estimated equation comprising a constant and the lagged value of the explained variable and is estimated over the same period as the equations, that is, from 1993Q1 to 2003Q4. Finally for robustness, the correlation between the forecast and the observation is considered

$$CORR = \frac{cov(\widehat{y}_t, y_t)}{\sigma_{\widehat{y}_t}\sigma_{y_t}}. \tag{5.2}$$

This performance measure belongs to [0,1], and the higher the value the better is the forecast. In the following section we detail the results based on the truncated number of forecasts, that is, we only use the equations where the R^2 is higher than the critical value.[33]

[32] This is confirmed by Diron (2008) who studies the implications of data revisions for forecasting euro area GDP growth using monthly indicators. After examining the performance of eight bridge equations relating output growth to various macroeconomic, financial, and survey data, the author concludes that the use of revised data does not bias the overall reliability of the assessment of short-term GDP forecasts and that, in most cases, data revisions contribute less to forecast errors than model mi-specification does.

[33] We reject an equation if the R^2 is below 25 per cent in the case of the nowcast or below 20 per cent for the forecast one quarter ahead.

5.1 Comparison across Components

Table 5.1 shows the gain in percentage terms compared to the AR forecast for, respectively, the nowcast and the forecast one quarter ahead.[34] A value above zero indicates that the pooled forecast performs better. For both the nowcast and the forecast one quarter ahead, the forecasting performance varies widely across components and weighting schemes, and to a lesser extent across forecasting rounds.

Starting with the nowcast, in all cases the forecasting performance of the pooled forecast increases when more data become available. However, consistently with the small improvements observed at the level of each equation, the bulk of the improvement is achieved between the first and the fourth rounds, with a relatively strong improvement during the third round. This can be explained by recalling that for most hard data the first month is released during this round. After the fourth round, the improvement is marginal. Compared with the relative squared forecast error of the AR forecast, in some cases the performance decreases slightly over the forecasting rounds, especially for the optimised constrained weights. Consistently with the small improvements observed at the level of each equation, the improvement remains minor in the cases of trade flows. It seems quicker and stronger for private consumption and total investment, with an improvement of 20 per cent and 15 per cent, respectively. Overall, the pooled forecast is better than the AR forecast; this is especially so for the trade flows, where the pooling approach outperforms the AR forecast, being up to 68 per cent better than the AR forecast.[35]

Comparing the results across weighting schemes, the optimised and constrained weights perform worse than all the other methods over the forecasting rounds, and relatively badly in the cases of GDP (being only 8 per cent better than the AR forecast in the last forecasting session).[36] More generally, the differences between the weighting schemes are relatively minor in the first forecast, but increase over time and reach a difference of over 20 per cent in many cases in the last round. The in-sample weighting schemes are very similar during the first forecasting round, but are dominated by the performance of Akaike weights for most of the components in the last one. Across

34 Compared to a mean forecast, the AR model improves the nowcast performance by 27 per cent for GDP and 17 per cent for fixed investment. The performance worsens by less than 2 per cent for private consumption and 17 per cent for trade flows. For the forecast one quarter ahead, the AR forecast is better than the mean forecast only for fixed investment.

35 See Kurz-Kim (2008) for the lower efficiency of AR forecasts.

36 The results obtained by applying the optimised weights, without constraint, are much worse for the GDP components.

Table 5.1: Out-of-sample Forecast Performance I

	Nowcast						1 quarter ahead					
Forecast round	1	2	3	4	5	6	1	2	3	4	5	6
Real GDP (direct)												
Equal	29.0	29.0	27.3	26.0	27.8	26.1	46.3	48.5	49.2	43.0	43.1	43.2
Trim20	28.9	30.3	30.4	30.9	32.8	30.8	42.0	50.1	50.5	45.6	45.6	45.8
Trim50	23.3	25.4	28.6	33.5	35.5	36.3	41.7	45.7	46.5	45.6	45.2	44.5
Akaike	32.3	32.0	34.3	36.2	43.4	43.0	48.5	51.2	51.5	49.0	49.0	49.2
R^2	30.0	30.0	29.3	29.2	31.7	30.4	47.4	49.8	50.3	45.0	45.1	45.3
Wright(opt)	30.4	32.0	35.1	37.2	40.2	40.2	46.3	48.5	49.2	46.5	46.7	46.9
Opt.-constr.	29.0	29.0	14.7	8.5	-10.6	7.8	46.4	48.5	49.1	17.8	23.3	8.5
Total investment												
Equal	21.3	26.0	29.9	36.1	36.9	39.7	36.8	38.6	37.6	32.8	33.2	32.8
Trim20	18.3	23.8	29.4	34.9	35.9	39.3	34.5	38.1	38.0	30.5	30.8	31.8
Trim50	17.3	19.8	23.2	26.2	31.6	37.9	34.5	39.3	38.8	35.7	38.0	37.8
Akaike	21.2	28.1	32.3	36.7	38.5	42.5	36.1	38.6	38.1	35.2	35.8	35.4
R^2	21.3	27.3	31.0	36.3	37.6	40.6	36.7	38.8	37.9	34.4	34.9	34.5
Wright(opt)	19.0	22.6	24.6	13.2	12.6	19.6	36.7	31.9	29.1	29.0	30.3	31.6
Opt.-constr.	21.3	25.8	29.7	36.9	37.9	40.4	36.8	38.6	37.4	32.6	33.0	32.6
Private consumption												
Equal	33.4	43.8	43.8	47.8	47.8	47.6	27.3	39.6	43.3	43.0	43.6	45.2
Trim20	32.8	45.2	45.2	49.6	49.6	49.0	25.5	36.0	42.2	41.6	41.5	43.2
Trim50	32.8	43.9	43.9	51.3	51.3	48.9	25.5	30.6	37.4	34.1	34.1	37.4
Akaike	33.1	44.5	44.5	49.3	49.3	47.9	27.2	38.3	41.6	42.7	43.4	44.9
R^2	33.3	44.4	44.4	48.7	48.7	48.3	27.4	39.5	43.1	43.3	44.0	45.5
Wright(opt)	33.4	43.1	43.1	51.3	51.3	46.0	25.7	33.3	32.6	38.3	39.1	40.7
Opt.-constr.	33.4	43.0	43.0	46.7	46.7	46.6	27.3	39.9	43.6	43.2	43.9	45.5
Total exports												
Equal	51.3	52.7	53.5	55.0	56.1	55.7	34.4	34.8	36.2	41.3	41.3	42.4
Trim20	49.3	52.0	51.9	55.0	56.0	56.1	33.5	34.8	35.5	37.3	37.4	38.9
Trim50	46.7	51.2	52.9	55.1	57.4	58.3	30.2	31.4	34.6	38.1	38.4	38.4
Akaike	51.4	52.8	54.2	56.2	64.6	64.3	37.3	38.5	39.6	42.9	43.3	44.1
R^2	51.3	52.8	53.9	55.6	57.3	57.0	36.1	36.7	37.8	41.9	42.1	43.2
Wright(opt)	53.6	55.5	58.0	58.8	67.9	67.7	40.6	43.4	44.8	43.5	44.5	44.6
Opt.-constr.	51.5	53.0	53.8	50.7	46.4	45.1	34.6	34.9	36.2	41.9	41.9	43.1
Total imports												
Equal	52.7	52.7	51.8	48.4	49.3	47.9	41.6	42.3	42.3	46.3	46.1	45.8
Trim20	53.2	53.0	53.7	50.1	51.2	50.6	41.5	42.1	42.0	46.8	46.5	46.2
Trim50	52.2	52.4	52.9	53.5	55.1	53.9	41.2	42.1	42.2	47.2	47.6	47.3
Akaike	55.6	55.5	55.3	53.1	55.5	54.9	42.7	43.6	43.6	48.5	48.4	48.3
R^2	53.8	53.9	53.1	50.1	51.3	50.2	42.2	42.9	42.9	47.4	47.3	47.2
Wright(opt)	56.1	55.9	55.8	45.3	55.4	55.3	35.3	41.4	41.4	46.5	46.3	46.1
Opt.-constr.	52.5	48.8	56.1	32.9	46.8	40.3	36.3	29.8	29.8	46.1	44.0	18.0

Note: The gain compared to an AR(1) forecast is given in per cent. Results for truncated forecasts are shown.

the components, the largest difference is given for investment, with respectively 4 per cent in the first round and more than 23 per cent in the last one. Indeed, given that more information becomes available during the quarter, the importance given to the pooling methodology becomes larger. For imports we find that the performance in RSFE worsens over time.

Comparing the results for the components using optimal Wright weights is the best method for pooling the forecasts for exports. This supports the importance of the ϕ parameter, as better results are obtained when they are more towards the uninformative prior. For all other components and GDP the weights based on the information criteria yield the best results.

Moving from the nowcast to the one-quarter ahead forecasts results in a general worsening and a smaller improvement during the quarter. However, for GDP the performance of the forecast is better than the nowcast and can be explained by a poorer AR forecast for GDP compared to the mean forecast. The best improvement during the forecast sequences is found for private consumption, with a change of 18 per cent. As for the nowcast, there is no clear evidence on which weighting scheme is the best; the results differ among components as well as forecasting sequences. The results by AIC weights are the best for the one-period-ahead forecast as well, which confirms the long-run gain for AIC weights discussed in Kapetanios et al. (2008). For exports, the Wright weights do best both for the nowcast as well as for the forecast. As for the nowcast, the aggregation based on optimised and constrained weights gives the highest forecasting errors and hence, the lowest improvement compared to the AR forecast.

Table 5.2 shows the correlation between the forecast and the observation both for the nowcast as well as the forecast.[37] The coefficient increases over the forecasting rounds. The highest correlation is obtained for almost all components using Akaike weights. Only for private consumption trimming the 50 per cent worst forecasts produces higher correlation. There are large differences between weighting schemes. Already in the first forecasting round, the correlation coefficient differs between various weighting schemes by 4 per cent for GDP and by 36 per cent for total exports. The correlation dimension varies between the components; for example, in the first round the correlation between the GDP forecast and the observation is already 77 per cent, whereas for private consumption, Wright weights only yield a correlation coefficient of 21 per cent. Correlation hardly increases across forecasting rounds; the greatest improvement is found for private consumption with an increase of 26 per cent. As for forecasting performance, correlation decreases with the forecasting horizon; it remains over 70 per cent only for GDP and investment.

Overall, forecasting performance varies more across components than across weighting schemes, with relatively better results obtained for trade flows for the nowcast and for

37 Correlation coefficients are multiplied by 100.

Table 5.2: Out-of-sample Forecast Performance II

	Nowcast						1 quarter ahead					
Forecast round	1	2	3	4	5	6	1	2	3	4	5	6
Real GDP (direct)												
Equal	76.4	79.0	82.2	86.2	87.5	87.7	78.9	78.1	80.6	75.0	74.9	75.0
Trim20	75.5	78.1	81.6	85.4	86.9	87.3	75.2	79.9	81.7	79.4	79.4	79.4
Trim50	72.5	75.6	80.7	84.4	85.0	86.0	79.9	77.4	75.9	79.5	79.4	78.9
Akaike	77.0	78.2	82.8	86.4	89.9	90.3	79.8	79.6	81.9	81.2	81.0	81.0
R^2	76.5	78.7	82.4	86.2	88.0	88.3	80.0	79.3	81.7	77.0	76.9	77.0
Wright(opt)	76.9	78.9	83.4	84.4	86.3	86.0	78.9	78.1	80.6	77.7	78.2	78.4
Opt.-constr.	76.6	79.3	52.8	47.3	16.9	74.2	78.6	77.7	80.4	16.0	31.4	18.5
Total investment												
Equal	71.4	76.3	82.1	86.1	87.3	87.9	70.0	78.9	83.2	80.8	80.5	80.5
Trim20	66.8	74.3	80.3	84.0	85.6	86.2	64.7	77.5	83.1	79.6	79.3	80.0
Trim50	42.1	44.3	44.8	55.8	55.1	57.4	59.6	60.5	60.6	57.3	57.6	58.2
Akaike	71.2	78.4	82.8	86.1	87.6	88.3	68.6	78.6	83.6	82.3	82.1	81.9
R^2	71.3	77.8	82.6	86.3	87.7	88.2	69.6	79.1	83.6	81.8	81.5	81.3
Wright(opt)	68.9	68.2	71.1	58.3	58.1	62.6	69.8	69.9	66.9	79.9	80.4	80.6
Opt.-constr.	71.4	76.0	81.6	86.0	87.3	87.6	70.0	78.8	83.1	80.7	80.4	80.4
Private consumption												
Equal	33.7	31.1	31.4	46.8	45.4	46.8	54.7	56.1	56.1	49.1	49.4	48.3
Trim20	38.5	61.3	61.3	66.9	66.9	64.8	27.5	46.6	58.9	56.1	55.9	57.5
Trim50	38.5	58.3	58.3	73.6	73.6	65.1	27.5	33.9	49.8	43.1	43.1	48.8
Akaike	39.8	60.1	60.1	67.1	67.1	61.9	31.0	50.9	59.2	58.6	59.9	60.9
R^2	39.7	60.3	60.3	66.0	66.0	63.0	30.3	53.4	62.1	60.3	61.5	62.4
Wright(opt)	39.7	60.1	60.1	73.2	73.2	58.6	30.2	40.5	39.6	48.0	49.9	52.1
Opt.-constr.	20.8	24.4	25.6	31.9	27.3	30.4	47.7	46.7	46.4	44.9	44.6	45.5
Total exports												
Equal	67.4	69.5	74.1	76.8	78.2	78.5	52.7	51.8	53.3	60.8	61.1	62.2
Trim20	63.9	68.2	71.5	75.2	76.5	76.7	52.5	52.2	52.8	54.5	55.0	55.7
Trim50	59.0	63.8	69.2	72.2	74.0	75.2	49.0	49.2	51.7	56.9	57.4	57.4
Akaike	67.1	69.0	73.9	75.4	84.6	84.8	54.3	54.6	55.7	62.3	62.8	63.5
R^2	31.6	30.6	32.9	45.0	38.7	41.6	49.0	50.5	51.5	44.4	44.4	45.3
Wright(opt)	65.4	67.6	72.2	71.6	80.0	79.5	51.2	51.4	54.5	59.7	61.0	61.4
Opt.-constr.	67.9	69.9	74.5	63.3	60.1	44.0	52.4	51.5	53.1	61.4	61.7	62.9
Total imports												
Equal	69.7	70.3	76.0	76.9	76.9	75.8	62.0	63.4	65.4	66.5	66.1	66.0
Trim20	69.6	69.2	75.2	75.2	75.3	74.9	62.0	62.2	62.0	66.7	66.1	65.0
Trim50	39.6	40.7	41.8	53.6	52.0	54.5	56.8	58.1	58.6	53.7	53.8	54.6
Akaike	70.6	70.2	75.9	77.8	81.2	81.4	61.6	61.9	63.3	64.1	64.0	64.1
R^2	70.1	70.5	76.0	77.3	78.0	77.5	61.8	62.7	64.5	65.5	65.2	65.3
Wright(opt)	69.6	67.0	69.3	60.4	75.4	75.2	48.9	56.8	56.8	66.1	65.7	65.6
Opt.-constr.	69.6	68.9	68.6	35.4	61.1	53.8	53.5	39.3	39.3	63.1	62.9	22.3

Note: The table shows the correlation coefficient between the forecast and the actual value. Values are multiplied by 100.

GDP one period ahead. Similar but even poorer are the results for the "un-trucated" forecasts. Tables A.3 and A.4 in the appendix show the improvement in terms of RSFE compared to the AR forecast and the correlation results. For GDP, Akaike weights yield the best performance, both in terms of RSFE and correlation. For export and import the Wright weights do best.

However, comparing the results for truncated, that is, with a constraint on the R^2, and "un-truncated" forecast, that is, allowing any R^2 value, we find that the weights blocks differ the across components, as well as across forecasting rounds. For the truncated forecasts, the optimised constrained weights are more in line with the weight blocks given by the other weighting schemes.

These results confirm the previous findings, as shown in Figure 4.1, that mainly reflect the differences in the performances of the underlying indicators. The figure shows that the distribution of R^2 is tilted towards higher values for imports, exports and GDP, and lower R^2 for private consumption and investment.

5.2 Bottom-up versus Direct Approach

In this section, we compare the GDP forecasts obtained either directly or through the bottom-up approach. In the former case, GDP is forecast individually, using the methodology described above. In the bottom-up approach, the GDP forecast is obtained by aggregating the forecasts of the main components, computed independently. The growth rate of each component is then weighted by its share in euro area GDP over the period from 2002Q1 to 2008Q2: investment (21.1 per cent), private consumption (57.3 per cent), exports (41.7 per cent), imports (-40.3 per cent), with inventories being computed as a contribution (0.05 per cent). As no forecast is made for government consumption, the mean average contribution over the period is added to the sum of the forecasted contributions.[38]

While providing detailed information of the composition of GDP growth and using relevant information for each component, it is not certain that the bottom-up method yields superior results to the direct one. Indeed, in the literature, the results obtained when comparing bottom-up and direct forecasts have appeared highly conditional on the dataset. Moreover, differences in the forecasts resulting from the two methods may indicate uncertainty. The performance of the bottom-up forecasts is given in Table 5.3 using the same criteria as before.

As for the components, the forecast performance depends on the method used but improves only marginally over time for both the direct and bottom-up approach. For

[38] The average share of government consumption is 20 per cent in the period from 2002Q1 to 2008Q2. Based on a calculation without government consumption, the GDP component shares are as follows: investment (26.6 per cent), private consumption (71.6 per cent), exports (52.1 per cent), and imports (-50.4 per cent).

Table 5.3: Out-of-sample Forecast Performance (bottom-up)

	Nowcast						1 quarter ahead					
Forecast round	1	2	3	4	5	6	1	2	3	4	5	6
							Real GDP (bottom-up)					
Equal	27.2	23.4	30.7	38.6	36.0	40.2	65.1	64.4	64.5	62.5	62.4	63.2
Trim20	18.8	8.3	15.3	26.6	23.1	26.1	59.1	57.8	58.1	56.1	56.0	56.4
Trim50	3.5	1.5	9.7	13.2	6.5	11.6	54.6	55.3	54.6	51.4	51.0	52.1
Akaike	16.4	8.7	19.1	26.9	19.9	23.9	60.6	59.9	60.5	56.1	55.9	57.1
R^2	24.5	19.5	27.6	35.8	32.4	36.4	64.1	63.5	63.7	60.8	60.7	61.6
Wright(opt)	10.6	-7.8	1.1	-83.8	-30.1	-29.7	40.7	45.1	44.9	52.8	52.6	53.7
Opt.-constr.	28.9	34.3	6.9	12.8	-0.7	23.1	27.7	50.9	50.9	41.4	60.2	18.7

Note: The gain compared to an AR(1) forecast is given in per cent. Negative values indicate that the bottom up approach is worse than the AR forecast. Results for truncated forecasts are shown.

the nowcast using the bottom-up approach, the largest improvement is obtained with equal weights and amounts up to 13 percentage points over the course of the forecast rounds. Overall, the relative performance of the GDP direct forecast is on the lower bound of the results obtained for the components.[39] Accordingly the performance of the bottom-up forecast is slightly better, in particular for the nowcast.

Comparing the results of Table 5.1 (direct GDP forecast) and Table 5.3 (bottom-up GDP forecast), we find that for the direct forecast, the performance across schemes is more concentrated than for the bottom-up approach. While in the former case the difference between the best-performing method, Akaike, and the worst one, optimised constrained, is 21 percentage points in the sixth forecast round, it is almost 70 percentage points in the latter case, with equal weights being the best and the Wright weights the worst performers. Indeed, the weighting scheme has a much more important impact on the forecasting performance in the case of a bottom-up forecast.

In some cases, the bottom-up forecast is even worse than the AR forecast and therefore worse than a direct forecast. This is the case for optimised constrained weights and Wright. In contrast, the results obtained with equal weights after the second round and with R^2 after the fourth are better than those obtained with the direct approach; they result in a gain of more than 40 per cent and 36 per cent in the forecast performance, compared to an AR forecast in the sixth round, respectively.

The performance of the bottom-up approach one quarter ahead is surprisingly strong. The gain amounts to over 65 per cent compared to the AR forecast, and almost 20 per cent compared to the direct GDP forecast. However, we should take into account

39 Only the performance for total investment is poorer in the first forecast rounds.

that the relatively large GDP component of government consumption is not included in the forecast.

A different conclusion is reached in the correlation between the bottom-up GDP forecast and the observation. The average of the weighting schemes ranges from 33 per cent in the first sequence up to 35 per cent in the sixth forecasting round for the nowcast, and from 21 per cent to 46 per cent, respectively in the forecast of one quarter ahead.

6 Summary

In this part, we have analysed the forecasts obtained by pooling a relatively large number of equations, for euro area GDP and its components. Special attention was given to the flow of information during the quarter, as well as to the weighting scheme adopted to aggregate the forecasts.

Although the results differ widely from one weighting scheme to another, no single scheme emerges as universally the best. In contrast, the optimised and constrained weights provide by far the worst scheme. The results militate in favour of two weighting schemes: those based on Akaike information criteria and on the Wright scheme.

We have shown that while the successive releases of monthly indicators result in an improvement of the forecast for the components, the improvement is relatively minor for the current quarter and is negligible for the next quarter for GDP. However, using the flow of information efficiently results in substantial changes in the weight given to a special indicator across the quarter.

The forecasting performance, measured relative to the AR forecast, varies from one component to another, with private consumption being the most difficult to forecast. For GDP as a whole, we found that using Akaike weights results in an improvement of 43 per cent in the forecasting performance for the current quarter and 49 per cent for forecasts one quarter ahead compared to an AR forecast (direct approach). Using equal weights, the performance of the bottom-up GDP forecast increases by 40 per cent compared to the AR forecast.

We departed somewhat from the literature by selecting the individual models used to generate the forecasts retained in the pool from a large number of models. While relatively large compared to most of the studies, the number of models could be substantially extended by using data related to a euro area country, or by adding new types of equations, and including nonlinear ones. In such an approach, before computing the weights, the selection criteria may play an even more prominent role and thus require further research. Finally, in the literature on forecasting the financial crisis starts to play a more prominent role. Thus, new methods and extensions of common approaches should be applied in the context of forecasting euro area GDP growth. These should take into account structural breaks at unknown times (Andrews, 2003; West, 2006), and they should test whether gains compared to the benchmark forecast are statistically significant (Giacomini and White, 2006).[40]

[40] See Drechsel and Scheufele (2010) for a recent application of these suggestions in the context of forecasting German GDP and industrial production. The authors have shown that those indicators with a good performance record prior to the crisis remained robust during the crisis. Survey data and interest rate spreads provided useful indicators during the crisis (Drechsel and Scheufele, 2010).

Appendix A:
Forecasting Euro Area Activity

Table A.1: Total Dataset of Indicators

Block	Name
Finance	S&P 500
	Stock price
	Yields
Exchange rate	Effective exchange rate
	Effective exchange rate (var.)
	Exchange rate: USD
	Exchange rate: GBP
	Exchange rate: JPY
	Exchange rate: USD (var)
	Exchange rate: GBP (var)
	Exchange rate: JPY (var)
Foreign	US, Treasury bills, 3-month
	US, 10 years Yields on US Treasury notes and bonds
Interest rate	Long-term bond yield
	Diff l0-year bond yield (bp)
	Short-term interest rate
	Diff short-term interest rates (bp)
Survey	Economic Sentiment Indicator
	Business Climate Indicator
Consumer survey	Savings over next 12 months
	Savings at present
	Statement on financial situation of household
	Financial situation over next 12 months
	Financial situation over last 12 months
	General economic situation over last 12 months
	General economic situation over next 12 months
	Price trends over last 12 months
	Price trends over next 12 months
	Unemployment expectations over next 12 months
	Major purchases at present
	Major purchases over next 12 months
	Consumer Confidence Indicator
Retail trade survey	Present business situation

To be continued...

Block	**Name**
	Assessment of stocks
	Orders placed with suppliers
	Expected business situation
	Retail confidence indicator
	Employment expectations
Industry survey - Consumer Goods	Assessment of order-book levels (CG)
	Assessment of export order-book levels (CG)
	Assessment of stocks of finished products (CG)
	Production expectations for the months ahead (CG)
	Selling price expectations for the months ahead (CG)
	Employment expectations for the months ahead (CG)
	Industrial Confidence Indicator (CG)
Industry survey - Intermediate Goods	Assessment of order-book levels (IG)
	Assessment of export order-book levels (IG)
	Assessment of stocks of finished products (IG)
	Production expectations for the months ahead (IG)
	Selling price expectations for the months ahead (IG)
	Employment expectations for the months ahead (IG)
	Industrial Confidence Indicator (IG)
Industry survey - Capital goods	Assessment of order-book levels (KG)
	Assessment of export order-book levels (KG)
	Assessment of stocks of finished products (KG)
	Production expectations for the months ahead (KG)
	Selling price expectations for the months ahead (KG)
	Employment expectations for the months ahead (KG)
	Industrial Confidence Indicator (KG)
Construction survey	Trend of activity compared with preceding months
	Assessment of order books
	Price expectations for the months ahead
	Construction Confidence Indicator
	Construction employment
Foreign	US, Production expectations
	US, Consumer expectations
	World market price of raw materials in Euro
	World market price of raw materials excluding energy in Euro
Financing	NFC loans, total outstanding
	NFC loans, $<$ 1 year outstanding
	household house purchase credit
	household loans, total outstanding
	household consumer credit loans
Monetary aggregates	M1
	M2
	M3
Foreign	World market price of crude oil (USD)
Passenger car registration	New passenger cars
	New commercial vehicles
	New heavy commercial vehicles
	New light commercial vehicles
Consumer	Overall HICP-index
	HICP - Energy
	Retail trade
Exchange rate	Real effective exchange rate (CPI)

To be continued. . .

Block	**Name**
	Real effective exchange rate (CPI, var.)
Labour	Unemployment rate, Total
	Unemployment
Foreign	UK, unemployment rate
	UK, Retail trade
	US, Retail trade
	US, unemployment rate
New orders (non dom.)	Manufacture of machinery and equipment (n.e.c.)
External trade	Intra exports
	Extra exports
	Intra imports
	Extra imports
Industrial production	Construction
	Intermediates
	Capital
	Energy
	Manufacturing
	Durable Consumer Goods
	Non-durable Consumer Goods
PPI	Energy
	Intermediate Goods Industry
	MIG Non-durable Consumer Goods
Foreign	US, manufacturing production
External trade	US, imports
	Japan, imports
	Other countries, imports
	US, exports
	Japan, exports
	Other countries, exports

Table A.2: Estimated Individual Equations for GDP

		1st month only					Up to the 2nd month					Full quarter				
		β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)
Stock prices	S&P 500	0.01		0.21		25.8	0	0.01	0.19		27.5	0.000	0.01	0.34		32.8
		[0.00]***		[0.11]*			[0.01]	[0.01]*	[0.11]			[0.00]	[0.00]*	[0.12]***		
Finance	Eurostoxx	0.00	0.01			37.9	0.00	0.01			37.7	0.00	0.01	0.20		40.8
		[0.01]	[0.01]**				[0.00]	[0.00]***				[0.00]	[0.00]***	[0.12]		
	Yields	-0.38				35.5	-0.38				34.6	-0.31		0.20		37.6
		[0.07]***					[0.07]***					[0.08]***		[0.13]		
Exchange rate	Effective exchange rate	-3.77	-4.97	0.29		29.3	-3.38	-5.22	0.28		29.3	-2.13	-4.35	0.37		32.3
		[2.22]*	[1.89]***	[0.11]***			[2.01]	[1.84]***	[0.11]***			[1.81]	[1.84]***	[0.12]***		
	Effective exchange rate (var.)	-0.07	0.07	0.34		21.4	-0.06	0.06	0.31		19.8	-0.04	0.04	0.44		26.3
		[0.02]***	[0.02]***	[0.12]***			[0.02]***	[0.02]***	[0.12]***			[0.02]**	[0.02]*	[0.12]***		
	Exchange rate: USD	-1.98	1.78	0.3		14.8	-0.31		0.3		11.4	-0.24		0.47		22.3
		[1.15]*	[1.2]	[0.12]***			[0.26]		[0.12]***			[0.24]		[0.12]***		
	Exchange rate: GBP	-5.21	4.88	0.29		15.8	-5.41	4.98	0.28		17.1	-4.11	3.71	0.43		26.2
		[2.52]**	[2.57]*	[0.12]***			[2.35]***	[2.37]**	[0.12]***			[2.08]**	[2.07]*	[0.12]***		
	Exchange rate: JPY	-0.02	0.02	0.32		17.2	-0.02	0.02	0.35		19.9	-0.02	0.02	0.37	0.18	30.2
		[0.01]***	[0.01]**	[0.12]***			[0.01]***	[0.01]***	[0.12]***			[0.01]***	[0.01]***	[0.13]***	[0.12]	
	Exchange rate: USD (var)	-1.17	-2.64	0.25		20.3	-0.95	-2.69	0.25		20.0	-0.65	-2.26	0.41		28.1
		[1.29]	[1.13]***	[0.12]**			[1.19]	[1.13]***	[0.12]**			[1.05]	[1.08]**	[0.12]***		
	Exchange rate: GBP (var)	-0.86	-5.09	0.26		27.7	-1.57	-4.83	0.26		28.5	-1.37	-4.01	0.37		33.7
		[1.85]	[1.61]***	[0.11]***			[1.69]	[1.57]***	[0.11]***			[1.49]	[1.52]***	[0.12]***		
	Exchange rate: JPY (var)	-1.58	-2.07	0.31		23.1	-1.96	-2.01	0.33		25.7	-1.74	-1.55	0.31	0.19	33.2
		[1.06]	[0.87]***	[0.11]***			[0.95]**	[0.85]***	[0.11]***			[0.83]**	[0.84]*	[0.13]***	[0.12]	
Foreign	US, Treasury bills, 3-month	0.44	-0.35			34.2	0.36	-0.27			33.3	0.27	-0.19	0.23		36.4
		[0.11]***	[0.11]***				[0.09]***	[0.1]***				[0.08]***	[0.08]***	[0.13]*		
	US,10 years Yields on US Treasury	0.32	-0.23	0.24		24.0	0.32	-0.22	0.25		25.5	0.09		0.38		27.5
	notes and bonds	[0.13]***	[0.13]*	[0.12]**			[0.12]***	[0.12]*	[0.12]**			[0.04]***		[0.12]***		
Interest rate	Long-term bond yield	0.25	-0.24	0.24		13.1	0.26	-0.24	0.24		14.3	0.01		0.48		21.1
		[0.16]	[0.15]	[0.13]*			[0.14]*	[0.14]*	[0.13]*			[0.02]		[0.12]***		
	Diff l0-year bond yield (bp)	0	0	0.23		13.4	0	0	0.22		14.6	0	0.01	0.45		25.3
		[0.00]	[0.00]	[0.13]*			[0.00]	[0.00]	[0.13]*			[0.00]	[0.00]*	[0.12]***		
	Short-term interest rate											-0.01		0.48		21.3
												[0.03]		[0.12]***		
	Diff short-term interest rates (bp)	0		0.26		10.2	0.01		0.20		12.3	0.01		0.39		23.7
		[0.00]		[0.13]**			[0.00]		[0.14]			[0.00]		[0.14]***		
Survey	Economic Sentiment Indicator	0.07	-0.06			39.7	0.06	-0.05			42.5	0.06	-0.04			46.5
		[0.01]***	[0.01]***				[0.01]***	[0.01]***				[0.01]***	[0.01]***			
	Business Climate Indicator	0.73	-0.63			31.6	0.67	-0.56			34.7	0.62	-0.49			40.6
		[0.14]***	[0.14]***				[0.12]***	[0.11]***				[0.1]***	[0.09]***			
Consumer survey	Savings over next 12 months	0.01		0.25		10.5	0.06	-0.05	0.23		14.7	0.05	-0.04	0.38		25.5
		[0.01]		[0.13]*			[0.03]*	[0.03]	[0.13]*			[0.03]*	[0.03]	[0.13]***		

To be continued...

		1st month only					Up to the 2nd month					Full quarter				
		β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)
	Savings at present											0 [0.01]		0.48 [0.12]***		21.0
	Statement on financial situation of household	0.10 [0.06]*	-0.11 [0.06]*	0.3 [0.12]***		15.2	-0.01 [0.01]		0.3 [0.12]***		10.2	-0.01 [0.01]		0.47 [0.12]***		21.6
	Financial situation over next 12 months	0.13 [0.04]***	-0.12 [0.04]***	0.18 [0.13]		24.7	0.15 [0.04]***	-0.12 [0.04]***			26.7	0.10 [0.03]***	-0.09 [0.03]***	0.29 [0.13]***		34.1
	Financial situation over last 12 months	0.09 [0.03]***	-0.08 [0.03]***	0.19 [0.13]		22.8	0.10 [0.03]***	-0.08 [0.03]***			22.1	0.07 [0.03]***	-0.06 [0.03]***	0.31 [0.13]***		31.1
	General economic situation over last 12 months	0.05 [0.01]***	-0.04 [0.01]***			28.5	0.05 [0.01]***	-0.04 [0.01]***			33.2	0.04 [0.01]***	-0.03 [0.01]***			34.1
	General economic situation over next 12 months	0.05 [0.01]***	-0.04 [0.01]***			28.6	0.05 [0.01]***	-0.03 [0.01]***			28.3	0.04 [0.01]***	-0.03 [0.01]***	0.23 [0.14]		33.9
	Price trends over last 12 months	-0.01 [0.00]***		0.19 [0.11]*		28.0	-0.01 [0.00]***		0.19 [0.11]*		28.3	-0.01 [0.00]***		0.34 [0.12]***		32.6
	Price trends over next 12 months	-0.01 [0.01]		0.30 [0.12]***		11.8	-0.01 [0.01]		0.31 [0.12]***		11.1	0 [0.01]		0.49 [0.12]***		21.9
	Unemployment expectations over next 12 months						-0.03 [0.01]***	0.03 [0.01]***	0.20 [0.15]		27.7	-0.02 [0.01]***	0.02 [0.01]***	0.30 [0.14]**		32.9
	Major purchases at present	0.04 [0.01]***	-0.03 [0.01]*			22.5	0.04 [0.01]***	-0.02 [0.01]*			23.3	0.03 [0.01]***	-0.02 [0.01]	0.31 [0.13]***		31.3
	Major purchases over next 12 months	0 [0.04]	0.06 [0.04]			16.1	0.07 [0.02]***				19.5	0.05 [0.02]***		0.34 [0.13]***		28.2
	Consumer Confidence Indicator	0.09 [0.02]***	-0.08 [0.02]***			30.3	0.08 [0.02]***	-0.07 [0.02]***			33.1	0.08 [0.01]***	-0.06 [0.01]***			35.9
Retail trade survey	Present business situation	0.03 [0.01]***	-0.03 [0.01]***	0.29 [0.13]***		19.9	0.03 [0.01]***	-0.03 [0.01]***	0.26 [0.13]*		19.1	0.02 [0.01]*	-0.02 [0.01]*	0.39 [0.14]***		26.1
	Assessment of stocks											0.01 [0.03]		0.49 [0.12]***		21.1
	Orders placed with suppliers	0.03 [0.01]***				16.5	0.03 [0.01]***				15.1	0.04 [0.01]***	-0.02 [0.01]	0.36 [0.13]***		29.6
	Expected business situation	0.01 [0.01]***				8.8	0.04 [0.01]***	-0.02 [0.01]**			20.0	0.03 [0.01]***	-0.02 [0.01]***	0.39 [0.13]***		31.2
	Retail confidence indicator	0.05 [0.02]***	-0.05 [0.02]***	0.25 [0.14]*		19.6	0.08 [0.02]***	-0.06 [0.02]***			23.3	0.06 [0.02]***	-0.05 [0.02]***	0.33 [0.14]***		30.5
	Employment expectations	0.02 [0.02]	-0.02 [0.02]	0.21 [0.15]		13.4						0.03 [0.02]**	-0.03 [0.01]**	0.47 [0.13]***		26.7
Industry survey - Consumer goods	Assessment of order-book levels (CG)	0.07 [0.01]***	-0.06 [0.01]***			33.1	0.08 [0.01]***	-0.06 [0.01]***			37.7	0.07 [0.01]***	-0.06 [0.01]***			46.7
	Assessment of export order-book levels (CG)	0.02 [0.02]	-0.03 [0.01]***	0.34 [0.16]**		17.3	0.04 [0.02]***	-0.04 [0.01]***	0.26 [0.16]		21.5	0.04 [0.01]***	-0.04 [0.01]***	0.26 [0.15]*		32.0
	Assessment of stocks of finished products (CG)	-0.09 [0.03]***	0.09 [0.03]***	0.24 [0.14]*		20.1	-0.1 [0.03]***	0.1 [0.03]***	0.28 [0.14]**		25.0	-0.11 [0.03]***	0.11 [0.03]***	0.29 [0.13]***	0.22 [0.13]*	39.6

To be continued...

		1st month only					Up to the 2nd month					Full quarter				
		β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)
	Production expectations for the months ahead (CG)	0.05 [0.02]***	-0.03 [0.02]*			18.4	0.06 [0.02]***	-0.04 [0.01]***			26.7	0.08 [0.01]***	-0.05 [0.01]***			40.1
	Selling price expectations for the months ahead (CG)	0.04 [0.02]***	-0.06 [0.02]***	0.34 [0.12]***		29.5	0.04 [0.02]***	-0.06 [0.02]***	0.31 [0.12]***		30.2	0.03 [0.01]*	-0.04 [0.01]***	0.34 [0.13]***	0.18 [0.12]	38.2
	Employment expectations for the months ahead (CG)	0.07 [0.02]***	-0.06 [0.02]***			21.9	0.08 [0.02]***	-0.07 [0.01]***			31.7	0.07 [0.02]***	-0.06 [0.01]***	0.26 [0.13]**		40.3
	Industrial Confidence Indicator (CG)	0.10 [0.02]***	-0.08 [0.02]***			30.7	0.11 [0.02]***	-0.09 [0.02]***			37.3	0.11 [0.02]***	-0.09 [0.01]***			48.6
Industry survey - Intermediate goods	Assessment of order-book levels (IG)	0.03 [0.01]***	-0.03 [0.01]***			28.7	0.03 [0.01]***	-0.03 [0.01]***			32.4	0.03 [0.00]***	-0.02 [0.00]***			38.3
	Assessment of export order-book levels (IG)	0.03 [0.01]***	-0.03 [0.01]***	0.24 [0.16]	0.25 [0.16]	30.3	0.03 [0.01]***	-0.03 [0.01]***	0.22 [0.16]	0.23 [0.16]	32.6	0.02 [0.01]***	-0.02 [0.01]***	0.22 [0.15]		35.1
	Assessment of stocks of finished products (IG)	-0.06 [0.02]***	0.04 [0.02]***			19.5	-0.05 [0.01]***	0.04 [0.01]***	0.21 [0.15]		27.1	-0.05 [0.01]***	0.03 [0.01]***	0.26 [0.14]*		34
	Production expectations for the months ahead (IG)	0.05 [0.01]***	-0.03 [0.01]***			32.3	0.04 [0.01]***	-0.02 [0.01]***			36.0	0.04 [0.01]***	-0.02 [0.01]***			39.5
	Selling price expectations for the months ahead (IG)	0.02 [0.01]**	-0.02 [0.01]***	0.32 [0.14]***		17.3	0.02 [0.01]***	-0.02 [0.01]***	0.31 [0.14]***		21.6	0.02 [0.01]***	-0.02 [0.01]***	0.36 [0.13]***	0.21 [0.13]	32.5
	Employment expectations for the months ahead (IG)	0.06 [0.01]***	-0.05 [0.01]***			30.0	0.06 [0.01]***	-0.05 [0.01]***			32.7	0.06 [0.01]***	-0.05 [0.01]***			37.6
	Industrial Confidence Indicator (IG)	0.05 [0.01]***	-0.04 [0.01]***			31.2	0.05 [0.01]***	-0.04 [0.01]***			34.7	0.04 [0.01]***	-0.03 [0.01]***			39.3
Industry survey - Capital goods	Assessment of order-book levels (KG)	0.05 [0.01]***	-0.04 [0.01]***			28.8	0.04 [0.01]***	-0.04 [0.01]***			31.4	0.04 [0.01]***	-0.03 [0.01]***			34.1
	Assessment of export order-book levels (KG)	0.03 [0.01]***	-0.03 [0.01]***	0.26 [0.15]*		27.1	0.03 [0.01]***	-0.03 [0.01]***	0.21 [0.15]		30.3	0.04 [0.01]***	-0.03 [0.01]***			31.6
	Assessment of stocks of finished products (KG)	-0.02 [0.02]	0.03 [0.02]	0.37 [0.15]***		14.0	-0.04 [0.02]**	0.04 [0.02]***	0.31 [0.15]**		18.6	-0.03 [0.02]*	0.03 [0.02]**	0.39 [0.14]***		26.1
	Production expectations for the months ahead (KG)	0.03 [0.01]***	-0.03 [0.01]***	0.33 [0.16]**		24.4	0.03 [0.01]***	-0.03 [0.01]***	0.30 [0.16]*		27.2	0.02 [0.01]***	-0.02 [0.01]***	0.25 [0.15]	0.24 [0.15]	34.0
	Selling price expectations for the months ahead (KG)	-0.02 [0.01]***		0.40 [0.12]***		22.2	-0.02 [0.01]***		0.41 [0.12]***		20.7	-0.02 [0.01]***		0.42 [0.13]***	0.23 [0.13]*	30.7
	Employment expectations for the months ahead (KG)											0.03 [0.01]***	-0.03 [0.01]***	0.28 [0.15]*		30.3
	Industrial Confidence Indicator (KG)						0.04 [0.01]***	-0.04 [0.01]***	0.24 [0.15]		30.7	0.04 [0.01]***	-0.03 [0.01]***	0.23 [0.15]		34.3
Construction survey	Trend of activity compared with preceding months	0.03 [0.01]***	-0.03 [0.01]***	0.25 [0.13]*		25.6	0.04 [0.01]***	-0.04 [0.01]***	0.25 [0.13]**		27.8	0.03 [0.01]***	-0.03 [0.01]***	0.38 [0.12]***		37.0
	Assessment of order-books	0.03 [0.01]***	-0.03 [0.01]***	0.24 [0.13]*		16.8						0 [0.00]		0.48 [0.12]***		21.0
	Construction Confidence Indicator	0.05 [0.01]***	-0.05 [0.01]***	0.20 [0.12]		25.6						0.03 [0.01]**	-0.03 [0.01]***	0.39 [0.13]***		27.2

To be continued. . .

		1st month only					Up to the 2nd month					Full quarter				
		β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)
	Construction employment						0.04	-0.04	0.24		25.0	0.04	-0.04	0.37		31.6
							[0.01]***	[0.01]***	[0.12]**			[0.01]***	[0.01]***	[0.12]***		
Foreign	US, Production	0.01		0.27		20.0	0.01		0.29		20.9	0.01		0.32	0.18	31.0
	expectations	[0.00]***		[0.12]***			[0.00]***		[0.11]***			[0.00]***		[0.13]***	[0.12]	
	US, Consummer expectations	0.01				26.9	0.01				23.8	0.01		0.34		32.3
		[0.00]***					[0.00]***					[0.00]***		[0.12]***		
	World market price of raw materials	0		0.35		15.7	0		0.34		15.1	0		0.4	0.18	26.9
	in Euro	[0.00]**		[0.12]***			[0.00]**		[0.12]***			[0.00]*		[0.13]***	[0.13]	
	World market price of raw materials	0.03	-0.04	0.40		29.3	0.03	-0.03	0.40		32.1	0.02	-0.03	0.34	0.26	40.0
	excl. energy in Euro	[0.01]***	[0.01]***	[0.12]***			[0.01]***	[0.01]***	[0.11]***			[0.01]***	[0.01]***	[0.12]***	[0.12]***	
Financing	NFC loans, total outstanding	3.71		0.25		10.2	3.76		0.24		10.4	1.12		0.46		21.1
		[4.58]		[0.14]*			[4.21]		[0.14]*			[3.39]		[0.13]***		
	NFC loans, <1 year outstanding	2.26		0.25		10.5	2.89		0.23		11.6	2.02		0.43		22.4
		[2.4]		[0.13]*			[2.3]		[0.13]*			[1.94]		[0.13]***		
	HH house purchase credit	9.29		0.29		18.2	10.06		0.29		18.4	8.04		0.42		26.1
		[3.66]***		[0.12]***			[3.91]***		[0.12]***			[4.02]**		[0.12]***		
	HH loans, total outstanding	10.86	9.11	0.20		20.4	11.9	9.13	0.20		20.8	8.29	8.46	0.35		27.1
		[5.17]**	[6.04]	[0.12]			[5.47]***	[6.02]	[0.12]			[5.73]	[5.63]	[0.13]***		
	HH consumer credit loans	4.25		0.27		11.3	4.35		0.26		11.6	2.65		0.45		22.0
		[3.61]		[0.12]**			[3.4]		[0.13]**			[3.1]		[0.13]***		
Monetary aggregates	M1	9.21		0.30		16.0	5.44	6.36	0.34		17.0	6.49		0.50		24.7
		[4.24]***		[0.12]***			[4.83]	[4.53]	[0.12]***			[3.83]*		[0.12]***		
	M2						-7.53		0.28		10.6	-4.54		0.46		21.6
							[7.72]		[0.12]***			[6.51]		[0.13]***		
	M3	-9.37		0.29		10.8	-11.0		0.29		12.0	-7.1		0.46		22.6
		[9.11]		[0.12]***			[8.01]		[0.12]***			[6.39]		[0.12]***		
Foreign	World market price of crude oil											-0.13		0.49		21.2
	(USD)											[0.35]		[0.12]***		
Passenger car	New pass. cars	3.18		0.29		21.5	3.36		0.31		19.0	2.87		0.5		29.3
registration		[1.05]***		[0.11]***			[1.27]***		[0.12]***			[1.1]***		[0.12]***		
	New commercial vehicles	3.50		0.26		23.9	4.62		0.25		26.0	3.56		0.43		32.1
		[1.04]***		[0.11]***			[1.27]***		[0.11]***			[1.16]***		[0.11]***		
	New heavy commercial vehicles	2.74		0.26		17.2	3.53		0.25		20.5	2.69		0.44		28.8
		[1.15]***		[0.12]***			[1.23]***		[0.12]**			[1.07]***		[0.12]***		
	New light commercial vehicles	0.64		0.30		16.2	1.48		0.30		17.9	2.05		0.42		29.70
		[0.29]***		[0.12]***			[0.60]***		[0.12]***			[0.76]***		[0.12]***		
Consumer	Overall HICP index	-46.03	-25.40	0.28		21.1	-33.24	-28.68	0.28		19.2	-38.31		0.48		27.9
		[22.85]**	[18.03]	[0.12]***			[20.31]	[18.01]	[0.12]***			[16.3]***		[0.12]***		
	HICP - Energy											-1.27		0.5		21.6
												[1.97]		[0.12]***		
	Retail trade	0.09	-0.10	0.29		17.5	-0.01		0.32		12.8	0.08	-0.08	0.45		25.9
		[0.05]*	[0.06]*	[0.12]***			[0.01]		[0.12]***			[0.05]	[0.05]	[0.12]***		

To be continued...

		1st month only					Up to the 2nd month					Full quarter				
		β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)
Exchange rate	Real effective exchange rate (CPI)	-0.05	0.04	0.29		19.0	-0.04	0.04	0.29		19.1	-0.03	0.03	0.44		27.40
		[0.02]***	[0.02]**	[0.12]***			[0.02]***	[0.02]**	[0.12]***			[0.02]**	[0.02]*	[0.12]***		
	Real effective exchange rate (CPI, var.)	0		0.30		9.9	0		0.3		10.1	0		0.48		21.6
		[0.00]		[0.12]***			[0.00]		[0.12]***			[0.00]		[0.12]***		
Labour	Unemployment	-13.46				26.9	-19.92	6.81			37.6	-18.07	9.39	0.22		46.7
		[2.89]***					[4.16]***	[3.52]*				[3.53]***	[3.32]***	[0.13]		
Foreign	UK, unemployment rate	-0.96	0.96	0.26		17.3	-0.77	0.77	0.27		16.7	-0.56	0.55	0.41		25.3
		[0.5]*	[0.49]**	[0.13]**			[0.43]*	[0.42]*	[0.13]**			[0.36]	[0.35]	[0.13]***		
	US, unemployment rate	-0.98	0.83			27.6	-1.1	0.91			41.6	-1.06	0.85			47.6
		[0.24]***	[0.24]***				[0.19]***	[0.18]***				[0.16]***	[0.15]***			
Exports	Intra exports	3.03		0.44		23.0	6.68		0.32		29.5	8.08		0.26		37.3
		[2.47]		[0.12]***			[2.52]***		[0.13]***			[2.08]***		[0.12]**		
	Extra exports	3.59		0.46		26.3	5.68		0.37		32.6	5.9		0.31		36.2
		[1.75]**		[0.12]***			[1.8]***		[0.12]***			[1.59]***		[0.12]***		
Imports	Intra imports	0.19		0.48		21.0	4.05		0.37		24.8	5.48		0.31		29.0
		[2.19]		[0.13]***			[2.35]*		[0.14]***			[2.14]***		[0.13]***		
Industrial production	Construction	5.10		0.44	0.16	35.9	5.17		0.47		34.2	6.36		0.46		39.4
		[1.47]***		[0.12]***	[0.12]		[1.52]***		[0.11]***			[1.51]***		[0.11]***		
	Intermediates	19.13		0.19	0.28	54.6	18.89		0.10	0.18	57.4	16.23		0.10	0.17	61.6
		[3.01]***		[0.11]*	[0.1]***		[2.76]***		[0.11]	[0.09]*		[2.13]***		[0.1]	[0.09]*	
	Capital	8.42		0.32		32.2	12.86		0.20		40.9	16.21				49.1
		[2.72]***		[0.12]***			[2.91]***		[0.12]			[2.15]***				
	Manufacturing	21.04		0.21	0.19	49.8	23.15		0.16		55.9	21.82		0.14		63.1
		[3.77]***		[0.11]*	[0.1]*		[3.41]***		[0.1]			[2.68]***		[0.09]		
	Durable Consumer Goods	12.11		0.29	0.18	46.3	13.54		0.30		49.1	14.49		0.24		58.5
		[2.4]***		[0.12]***	[0.11]		[2.39]***		[0.1]***			[2]***		[0.09]***		
	Non-durable Consumer Goods	9.23		0.49		27.1	11.65		0.44		29.5	15.04		0.42		33.9
		[4.17]***		[0.12]***			[4.42]***		[0.12]***			[4.46]***		[0.11]***		
PPI	PPI - Energy	-0.55		0.48		21.1	-0.56		0.49		21.1	-0.64		0.49		21.2
		[1.91]		[0.12]***			[1.77]		[0.12]***			[1.62]		[0.12]***		
	PPI - Intermediate Goods Industry	0.45		0.48		21.0	1.46		0.47		21.1	8.78	-11.95	0.4	0.19	26.4
		[6.37]		[0.13]***			[5.36]		[0.13]***			[6.65]	[6.84]*	[0.14]***	[0.13]	
	PPI-MIG Non-durable Consumer Goods	47.33	-46.91	0.48		31.1	47.64	-52.25	0.47		34.1	41.13	-51.93	0.46		34.4
		[23.19]**	[16.3]***	[0.12]***			[18.12]***	[15.54]***	[0.11]***			[15.32]***	[15.25]***	[0.11]***		
Foreign	US, manufacturing production	22.5		0.28	0.17	38.8	18.3		0.27	0.18	37.7	15.7		0.25	0.2	39.9
		[5.75]***		[0.13]***	[0.11]		[4.89]***		[0.13]**	[0.11]		[3.85]***		[0.13]*	[0.11]*	
External trade	US, imports	1.77	6.4	0.33		36.2	2.87	5.91	0.26	0.16	39.4	3.39	5.45	0.24	0.17	40.6
		[2.29]	[1.93]***	[0.12]***			[2.1]	[1.97]***	[0.13]**	[0.11]		[1.93]*	[2]***	[0.13]*	[0.11]	
	Japan, imports	2.65		0.51		25.4	2.91		0.50		25.4	2.80		0.48		24.8
		[1.44]*		[0.12]***			[1.57]*		[0.12]***			[1.64]*		[0.12]***		
	Other countries, imports	0.70		0.48		21.2	2.60		0.46		23.6	3.29		0.44		25.8
		[1.79]		[0.12]***			[1.86]		[0.12]***			[1.69]*		[0.12]***		

To be continued...

	1st month only					Up to the 2nd month					Full quarter				
	β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)	β_0	β_1	α_1	α_2	R^2 (%)
US, exports	1.66	4.34	0.40		31.5	0.56	4.36	0.40		30.5	1.16	4.20	0.39		31.0
	[1.72]	[1.57]***	[0.12]***			[1.7]	[1.58]***	[0.12]***			[1.6]	[1.6]***	[0.12]***		
Japan, exports	3.86		0.49		29.5	4.07		0.48		30.2	3.91		0.47		31.2
	[1.45]***		[0.12]***			[1.47]***		[0.11]***			[1.33]***		[0.11]***		
Other countries, exports	0.79	3.19	0.42		24.9	2.09	2.96	0.41		26.0	4.25		0.34	0.20	28.0
	[2.14]	[2.04]	[0.13]***			[2.17]	[2.02]	[0.12]***			[2.01]**		[0.14]***	[0.13]	

Note: The best equations are selected by the Akaike criteria. β_0, β_1 are the coefficients of the indicators, either contemporaneous or lagged, and α_1, α_2 are the coefficients of the lagged GDP growth by one or two periods. *,**,*** indicate significance at the 10%, 5% or 1% levels.

Table A.3: Out-of-sample Forecast Performance I (all)

	Nowcast						1 quarter ahead					
Forecast round	1	2	3	4	5	6	1	2	3	4	5	6
Real GDP (direct)												
Equal	13.0	13.6	12.2	14.3	16.7	16.4	33.2	35.1	33.1	35.2	35.3	33.5
Trim20	17.6	19.8	18.8	21.5	24.7	24.1	34.4	37.1	36.0	37.2	37.2	35.8
Trim50	25.1	25.5	26.1	30.5	33.2	33.7	37.6	39.3	40.0	41.9	41.7	40.9
Akaike	23.3	24.1	26.6	30.8	38.6	38.2	37.3	40.5	39.5	43.2	43.1	42.1
R^2	19.0	20.0	19.1	21.5	24.6	23.4	36.0	38.5	37.3	39.4	39.4	38.4
Wright(opt)	25.7	26.5	30.1	35.6	38.9	39.8	36.7	40.4	41.1	38.5	38.7	38.7
Opt.-constr.	-1.5	-42.5	-3.9	11.0	-24.6	-5.6	22.5	39.9	-3.3	53.5	9.9	13.7
Total investment												
Equal	0.2	0.7	1.9	5.0	6.0	6.7	25.9	25.9	19.6	10.7	10.4	8.8
Trim20	4.6	5.3	6.7	10.6	11.9	12.9	24.8	27.2	24.3	14.5	14.2	12.2
Trim50	9.4	11.5	13.9	20.2	21.8	22.6	26.9	30.7	29.0	21.2	20.9	19.9
Akaike	4.3	7.1	10.8	15.1	15.9	18.5	28.1	29.2	24.1	16.4	16.4	14.7
R^2	4.7	6.0	8.2	11.4	12.4	13.6	28.7	29.7	24.4	16.1	16.0	14.5
Wright(opt)	7.6	22.5	23.6	11.4	11.3	17.3	23.5	24.3	24.5	23.6	25.0	25.6
Opt.-constr.	-17.4	-21.5	-27.8	-16.1	8.5	-18.2	25.7	25.7	-5.2	-10.4	4.9	-6.4
Private consumption												
Equal	33.5	35.6	36.1	36.6	36.3	35.9	28.1	31.7	32.8	34.8	35.2	35.9
Trim20	31.3	34.7	35.6	36.3	35.5	35.3	27.6	32.2	33.1	34.6	35.1	35.6
Trim50	32.4	35.8	36.6	36.7	36.6	36.3	31.0	32.7	33.3	32.1	32.1	32.2
Akaike	35.1	38.7	39.1	41.0	40.9	40.0	30.3	33.9	35.1	37.3	37.8	38.4
R^2	35.6	38.7	39.1	40.7	40.7	40.2	30.6	33.5	35.0	36.7	37.1	37.7
Wright(opt)	34.7	43.1	43.1	51.2	51.2	44.4	29.6	31.9	32.1	35.2	35.4	35.6
Opt.-constr.	33.7	15.3	17.3	30.6	25.3	17.6	28.1	16.1	16.6	33.9	22.7	30.4
Total exports												
Equal	48.7	49.6	46.8	44.7	46.5	44.4	29.5	30.5	30.5	34.0	34.5	35.8
Trim20	49.7	51.4	49.7	49.5	51.5	49.3	29.4	30.2	30.4	33.8	34.4	35.8
Trim50	46.3	51.0	52.7	54.3	56.0	55.6	29.9	30.3	30.7	35.3	35.7	36.5
Akaike	50.8	52.6	51.3	52.0	61.1	60.0	33.2	34.9	35.0	38.2	38.8	40.0
R^2	50.0	52.0	49.7	48.9	51.1	49.5	31.9	33.3	33.6	36.9	37.3	38.8
Wright(opt)	52.5	54.3	56.7	58.1	67.6	67.5	40.5	43.3	44.8	41.6	43.2	43.1
Opt.-constr.	30.8	41.0	36.4	41.1	34.0	43.2	29.4	13.4	17.8	12.3	35.7	38.0
Total imports												
Equal	43.5	42.3	42.2	42.9	43.7	44.3	37.9	37.8	35.4	38.2	38.3	37.9
Trim20	47.2	45.9	45.9	46.0	46.6	47.2	39.2	38.4	37.9	42.0	41.8	41.8
Trim50	51.9	50.7	50.8	50.9	52.5	52.4	39.7	39.7	40.0	46.2	46.2	45.7
Akaike	52.0	51.8	51.5	50.7	53.2	53.2	41.1	41.7	40.5	45.8	45.9	45.5
R^2	48.3	47.6	47.2	46.6	47.7	47.7	39.8	40.0	38.7	43.2	43.2	42.8
Wright(opt)	55.7	55.7	55.7	45.3	55.0	55.2	34.7	40.7	40.6	42.5	42.4	42.1
Opt.-constr.	41.2	35.5	37.7	39.1	43.8	47.4	20.2	20.4	20.4	22.4	38.7	4.2

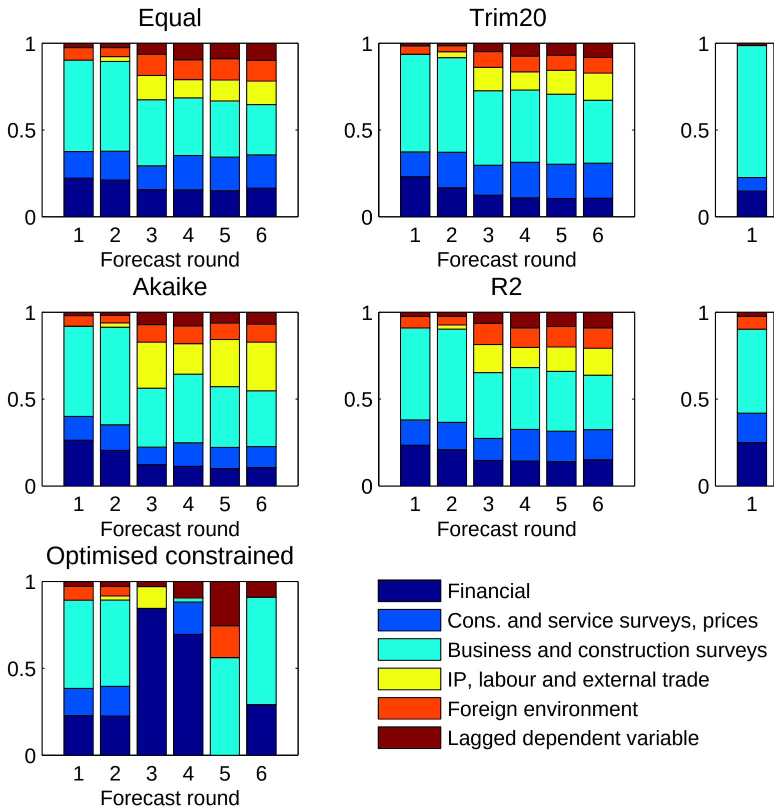
Note: The gain compared to an AR(1) forecast is given in per cent. Results for all forecasts are shown.

Table A.4: Out-of-sample Forecast Performance II (all)

	Nowcast						1 quarter ahead					
Forecast round	1	2	3	4	5	6	1	2	3	4	5	6
Real GDP (direct)												
Equal	77.6	81.7	84.6	86.3	87.7	87.5	70.3	72.3	72.5	73.1	73.4	73.1
Trim20	78.0	81.8	84.1	86.2	87.6	87.4	73.4	74.7	75.3	79.0	78.8	77.5
Trim50	75.8	80.5	83.1	84.8	86.4	86.6	75.3	75.0	76.8	78.8	77.8	78.2
Akaike	77.9	80.4	84.3	86.5	90.0	90.2	75.1	76.7	77.3	79.7	79.6	79.5
R^2	77.6	81.2	84.3	86.3	88.1	88.2	74.0	74.9	75.5	75.5	75.6	75.4
Wright(opt)	73.9	76.1	81.6	83.4	85.6	85.6	67.3	70.2	72.4	73.0	73.2	72.6
Opt.-constr.	48.0	35.7	38.9	64.0	-11.5	34.4	47.4	61.2	0.8	69.5	30.1	30.3
Total investment												
Equal	69.5	73.5	78.2	78.4	79.3	79.3	74.7	76.2	78.6	73.1	73.1	73.1
Trim20	70.5	74.1	78.7	78.8	79.5	79.7	71.0	75.5	78.2	74.4	74.5	74.9
Trim50	42.0	48.1	45.9	46.9	45.2	44.1	47.3	52.9	57.8	53.8	54.1	55.4
Akaike	70.6	77.5	82.6	82.8	83.2	83.6	74.2	77.4	80.2	77.0	77.1	77.1
R^2	70.3	75.6	80.7	81.2	82.0	82.1	75.5	78.0	80.4	75.9	75.9	76.0
Wright(opt)	64.6	67.1	68.9	56.2	56.2	59.8	60.3	64.0	65.0	77.2	79.0	78.7
Opt.-constr.	26.3	-23.5	0.9	31.4	57.4	22.7	74.9	76.3	9.8	-26.2	42.4	-11.2
Private consumption												
Equal	38.9	44.0	42.3	44.8	42.8	41.0	51.3	54.5	56.8	48.4	49.9	49.5
Trim20	42.3	53.6	55.8	61.6	62.1	60.9	47.5	50.5	55.3	57.7	57.5	59.5
Trim50	44.8	55.2	56.1	59.3	61.0	60.0	52.7	52.5	53.9	55.8	55.7	57.0
Akaike	45.8	57.7	59.9	65.8	66.6	63.6	45.7	51.5	56.0	59.4	59.5	60.4
R^2	47.5	58.3	60.5	65.2	66.0	64.2	48.2	52.6	57.5	60.5	60.4	61.1
Wright(opt)	40.3	60.1	60.1	73.3	73.3	57.4	30.3	36.0	36.5	41.4	42.0	42.1
Opt.-constr.	27.7	36.6	33.9	37.5	33.6	31.2	54.7	51.5	54.9	42.7	42.6	43.3
Total exports												
Equal	69.9	72.7	76.3	77.5	78.5	78.3	48.8	52.0	54.5	59.7	60.0	61.7
Trim20	70.0	72.1	76.0	77.3	78.4	78.0	48.3	51.6	54.3	58.5	58.8	60.5
Trim50	64.8	69.1	73.8	75.8	76.6	77.6	50.0	48.7	49.5	56.0	57.1	58.1
Akaike	68.4	70.6	75.1	75.8	84.8	84.9	52.2	54.6	56.2	61.7	62.1	63.2
R^2	19.6	21.4	22.7	30.4	20.5	22.3	34.4	38.2	43.9	30.7	30.4	33.4
Wright(opt)	62.5	65.5	70.8	70.6	79.2	78.9	50.8	51.2	54.2	54.9	57.0	56.7
Opt.-constr.	44.6	37.4	54.8	57.7	29.3	59.6	48.5	30.5	31.3	9.0	38.9	43.0
Total imports												
Equal	68.0	68.8	74.2	76.1	76.4	76.1	61.4	62.2	64.0	65.5	64.9	64.6
Trim20	68.9	68.6	73.7	75.1	75.3	75.2	61.3	61.3	63.4	65.1	65.0	65.1
Trim50	36.3	41.4	40.5	45.9	43.1	44.0	48.0	52.5	56.0	48.0	48.0	49.7
Akaike	70.2	70.0	75.7	77.7	81.2	81.4	61.4	61.6	62.9	64.0	63.8	63.8
R^2	69.3	69.8	75.2	77.1	77.8	77.6	61.6	62.2	63.8	65.1	64.7	64.7
Wright(opt)	69.2	66.2	68.0	60.4	74.9	75.1	47.9	55.5	55.4	63.2	63.0	62.7
Opt.-constr.	53.9	63.6	53.5	45.5	53.1	61.9	40.9	35.6	21.3	30.3	69.4	-26.6

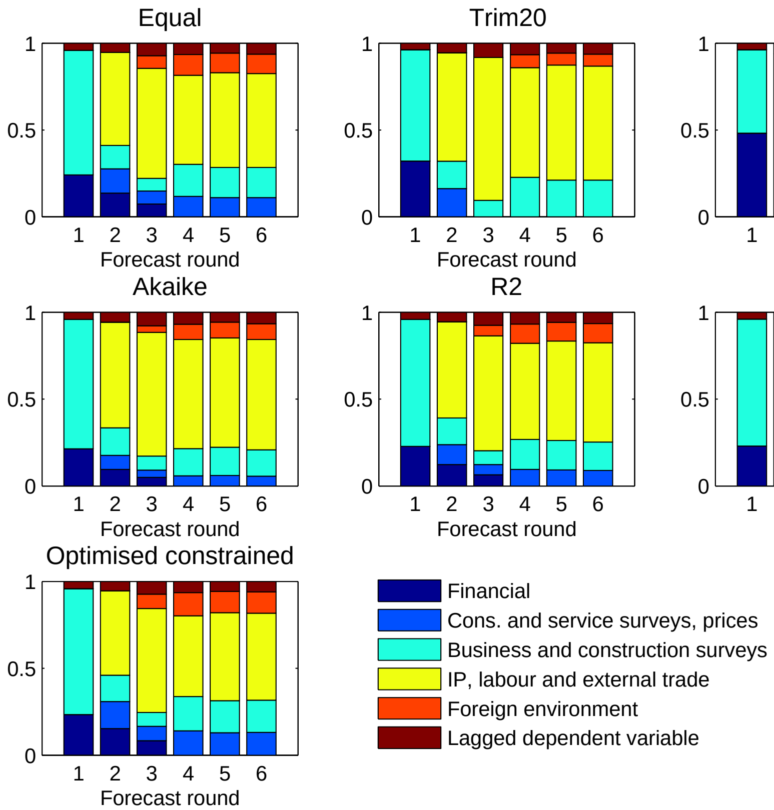
Note: The table shows the correlation coefficient between all forecasts and the actual value. Values are multiplied by 100.

Figure A.1: GDP: Weights Allocated to Each Block (truncated)



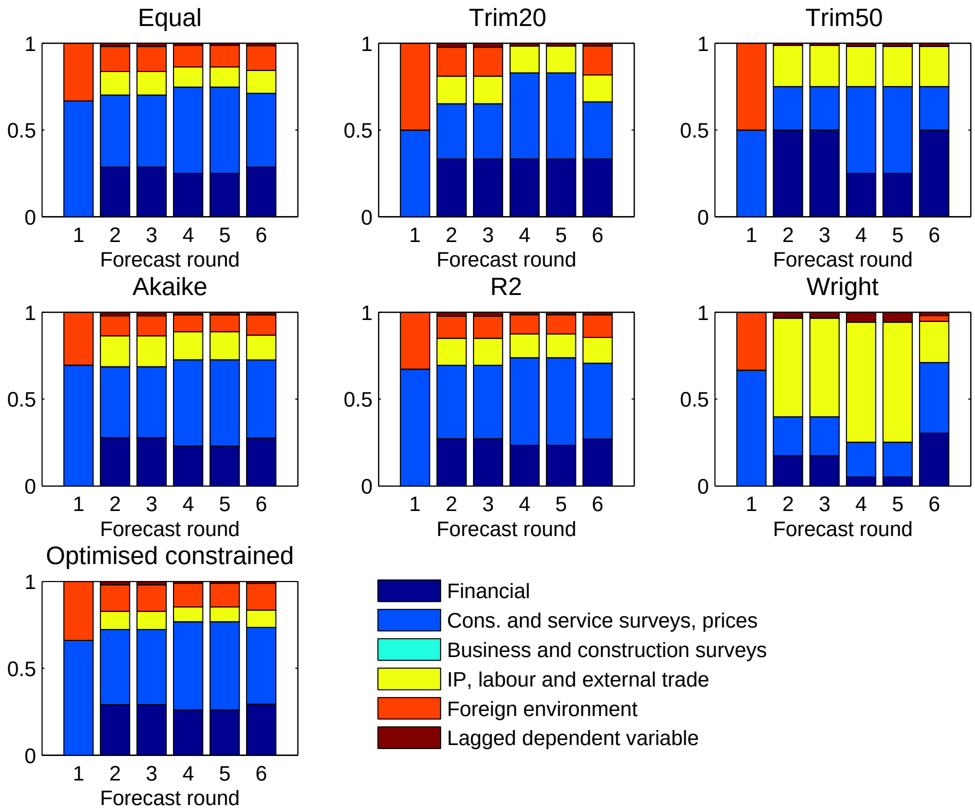
Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds. Weights are based on truncated forecasts.

Figure A.2: Fixed Investment: Weights Allocated to Each Block (truncated)



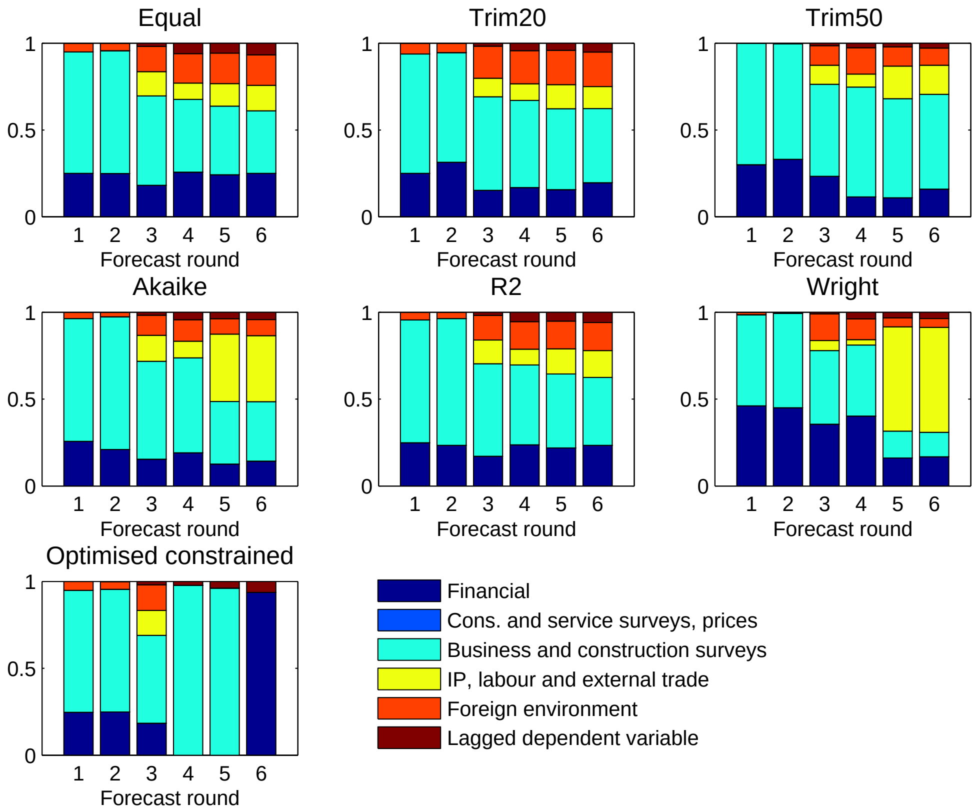
Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds. Weights are based on truncated forecasts.

Figure A.3: Private Consumption: Weights Allocated to Each Block (truncated)



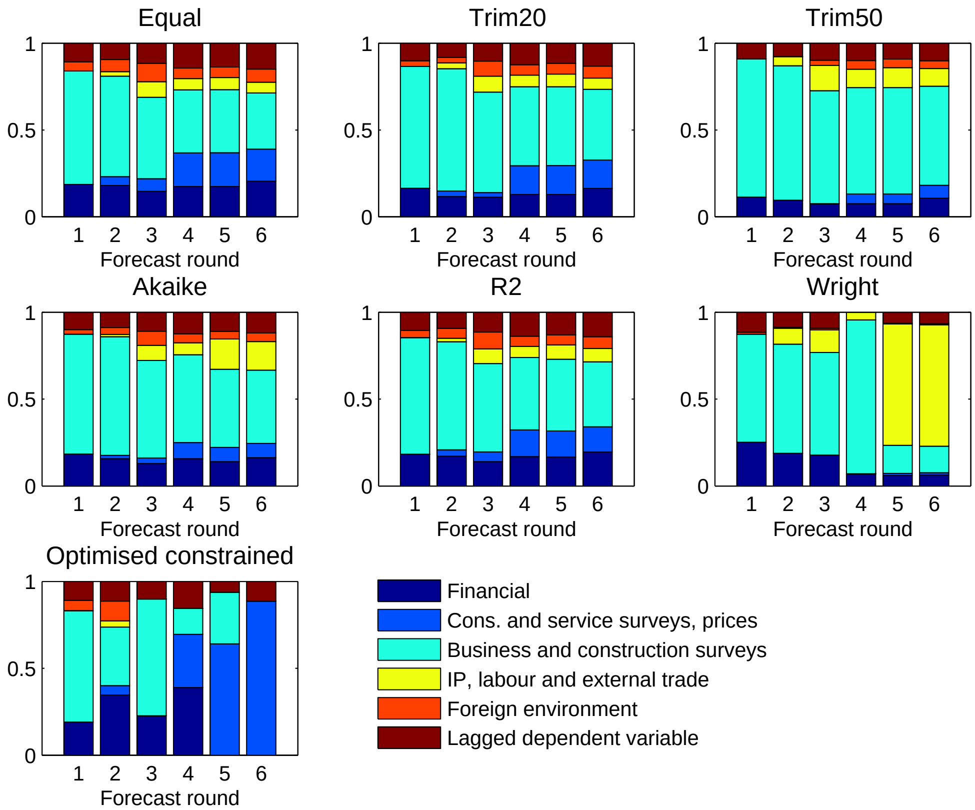
Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds. Weights are based on truncated forecasts.

Figure A.4: Total Exports: Weights Allocated to Each Block (truncated)



Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds. Weights are based on truncated forecasts.

Figure A.5: Total Imports: Weights Allocated to Each Block (truncated)



Note: For each weighting scheme, the division of the weight into six blocks is shown over the six forecasting rounds. Weights are based on truncated forecasts.

Part II

The Road to the Euro in Central and Eastern Europe — An Analysis in the Boom–Bust Framework

7 Motivation

Over 10 years ago, on January 1 1999, a single European money market emerged with the introduction of the euro in 11 EU Member States.[41] Since then, the European Monetary Union (EMU) has increased continuously and currently comprises 16 Member States. The EU accession of the Central and Eastern European economies in 2004 and 2007 also implies that these countries will sooner or later join the EMU, and for most of the EU countries outside the European Monetary Union the euro has become even more attractive during the recent crisis.

The traditional Optimum Currency Area (OCA) literature would suggest keeping the exchange rate flexible to stabilise the individual business cycles, and would recommend the adoption of a common currency only if business cycles between the euro area and the new EU members are well synchronised. The contribution of this part is that we argue in an unconventional manner that policy makers should alter the way in which they think about an early adoption of the euro for Eastern Europe. Our analysis suggests that the exchange rate might just do the opposite to what is expected in the OCA-literature—it might amplify country-specific shocks. We link the recent literature on optimal monetary policy under fixed and flexible exchange rate regimes in the presence of credit market imperfections (see Lahiri et al., 2006) with our empirical findings both for the CEECs and selected euro area countries to derive tentative policy implications.

In Chapter 8, we present an overview of the current exchange rate regimes in Central and Eastern European Countries (CEECs) and show that over past years the countries have experienced a real appreciation. We review briefly the standard textbook theory of optimum currency areas by Mundell (1961) and McKinnon (1963) and present the framework of a non-conventional approach—the boom–bust cycle theory—to consider

41 Greece fulfilled the convergence criteria later and adopted the euro in 2001. Notes and coins of the common currency were launched on January 1 2002.

whether the CEECs should join the common currency area in the near future. Finally, we discuss the problem of euroisation.

Following up on the hypothesis of the boom–bust cycle model, we discuss the key arguments of the model in detail—credit market imperfections and sectoral comovements—through undertaking a large set of descriptive and empirical analyses.

The first issue—credit market imperfections—has recently been discussed by a growing literature that investigates the effects of these imperfections on episodes of boom–bust cycles in emerging markets. It is argued, that in the presence of credit market imperfections, firms (and banks) will find it optimal to denominate their debt in foreign currency in order to overcome credit constraints. The exchange rate, then, might amplify the business cycle fluctuations, as the value of debt affects the ability of firms to borrow from the banking system (see Schneider and Tornell, 2004). Evidence on this mechanism, mostly from Latin America and Asia, has been provided by Tornell and Westermann (2002) and by the IMF (2005). In the years prior to the financial crisis, some authors raised the question of whether some Eastern European countries might be the next ones to experience boom–bust cycle episodes, in particular in the run-up to euro adoption (see Eichengreen and Steiner, 2008). In the present analysis, we investigate whether this hypothesis can be sustained, by looking at both macroeconomic and firm-level data. Moreover, the impact of the recent financial crisis on the boom–bust mechanism is discussed.

Taking up the stylised facts of the boom–bust cycle theory we start our empirical analysis in Chapter 9 with the documentation of the excessive credit growth in the private sector for a set of 10 countries—Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia (see Section 9.1). In Section 9.2, World Bank survey data sets on perceived credit constraints are used to show for the CEECs that severe credit constraints exist. However, these credit constraints are not uniform across sectors of the economy (Guajardo, 2008). In particular, small and non-exporting firms, as well as firms operating in sectors that are conventionally classified as nontradable, such as construction and transportation, report that access to financial markets is a major obstacle to running their business. This finding can also be established in a more formal analysis of the determinants of credit constraints that control for country effects, the age of the firms, and other variables. Finally, the results are compared to those for selected countries in Western Europe. Based on a recent survey by the World Bank we further analyse how these credit constraints have changed during the crisis. We document contract enforceability problems in the CEECs in Section 9.3 and analyse how corporate governance measures can affect emerging financial markets. Typically, weak law and corruption raise the opportunity for excessive credit demand and large amounts of foreign-currency debt. In Section 9.4 we investigate the nature of foreign debt. After a general discussion of the foreign debt challenge we explain the problem of currency mismatch. This issue is considered from various perspectives: on the one hand by investigating the general external debt, and on the other hand the level of foreign debt in the banking sector and on firms' balance sheets. Finally, in Section 9.5, we emphasise the problem of currency mismatches, in particular on firms' balance sheets, by considering the exchange rate developments in the CEECs over the last few years. All the findings of this chapter indicate that the recent pre-crisis episode in Eastern Europe indeed appeared reminiscent of the experiences that were observed in several emerging markets during lending booms that typically preceded twin banking and currency crisis.

The second issue—sectoral comovement—has been so far neglected in the analysis of business cycles of the Central and Eastern European Countries. However, the latter have been the subject of many empirical studies, particularly within and after the period of the European Union enlargement in 2004 (see for example, Darvas and Szapáry, 2008; Fidrmuc and Korhonen, 2006). With regard to the optimum currency area theory, a high degree of business cycle synchronisation is an important criterion for participation in the European Monetary Union. Most of the authors investigate the degree of (financial and) economic integration and find increasing synchronisation between the CEECs and the EMU both for GDP and for industrial production.[42] However, for a successful enlargement of the monetary union the economies should react in a similar way to exogenous shocks (Buch and Döpke, 2000). Trotignon (2003), for instance, shows that in spite of trade liberalisation for countries in transition, there is no evidence for convergence of the production structure towards the EMU. Therefore, we examine in Chapter 10 the behaviour of different sectors during the cycle within each country and we discuss in which way a common sectoral cycle influences the pathway to the common currency as the non-standard approach.

According to the boom–bust cycle mechanism, asymmetric financing opportunities across sectors lead to cyclical ups and downs in the sectoral composition of output. During the boom period, the nontradable sector grows faster, and during the bust it falls into a more severe and longer recession than the tradable sector does (see, among others, Tornell and Westermann, 2005). However, as aggregate GDP is often used

[42] Buch and Döpke (2000) analyse the degree of integration with regard to Germany using industrial production, exchange rates, and interest rates.

as a key indicator for economic policy, a possible diverging pattern at the sectoral level is concealed, although the sectoral composition is highly relevant for an adequate monetary policy.[43] Therefore, we compare in this section the cyclical sectoral patterns of Eastern European countries with those in selected Western European countries and show that cyclical fluctuations at the sectoral level are indeed different in Eastern Europe. We employ recent time-series techniques to distinguish formally between common and idiosyncratic components of sectoral business cycles in Eastern Europe. While Johansen cointegration tests (Johansen, 1988, 1991) show that long-run trends between sectors in the CEECs are less evident than in Western Europe, common-features tests (Engle and Kozicki, 1993; Cubadda, 1999a) show that neither for Eastern nor for Western Europe can convincing evidence be found of common cycles across sectors. The results of the analysis of the business cycles at the sectoral level are therefore consistent with the view that the domestic nontradable sector is catching up during a lending boom to the tradable sector. The latter is largely unaffected by domestic financial conditions due to its capability to raise finance on international capital markets. We document that sectoral cycles in Eastern Europe are much more volatile than in Western Europe and that—in countries experiencing a lending boom—there is a long-run trend towards nontradable goods production. Finally, we have taken into account the most recent data to assess whether and to what extent the crisis has affected common trends and common cycles.

Overall, we find that Eastern Europe is indeed a region where the settings for the experience of boom–bust cycles were present prior to the crisis, although the degree to which this is an immediate concern varies across countries and exceptions are found for each part of the analysis.

[43] See van Riet et al. (2004) for the impact of the sectoral structure on macroeconomic shocks, inflation developments, and growth.

8 Exchange Rate Fundamentals and Currency Areas

This chapter provides an overview on the exchange rate fundamentals and presents the theoretical framework that will be used for the empirical analysis. It reveals the linkages and relationships between the individual blocks that are presented in the following chapters.

8.1 The EMU and the Eastern Enlargement of the Eurozone

With the accession of the Central and Eastern European Countries to the European Union in May 2004, and in the later enlargement in January 2007, membership in the EMU is implied in due course for these countries.[44] These countries do not have the possibility to stay out of the EMU, as was possible earlier for the United Kingdom and Denmark—the so called *opt-outs*. However, countries are committed to participate in the EMU if they are deemed to have fulfilled the convergence criteria, as given in Article 121(1) of the European Community (EC Treaty) and Protocol No. 21 annexed to the Treaty.[45] This ensures that the economic conditions of the candidates are well prepared and the integration into the common monetary regime will pass smoothly without a risk of disruption for either the acceding country or the euro area as whole. In accordance with Article 122(2) of the EC Treaty, the ECB and the European Commission must

[44] In 2004 Cyprus and Malta joined the EU as well and adopted the euro in 2008. However, these countries are outside the scope of this thesis. Bulgaria and Romania joined the EU in the 2007 enlargement wave; hence they are euro-aspirant countries.

[45] The Treaty of Lisbon that came into force on 1 December 2009 amended the Treaty on the European Union and the Treaty on the Functioning of the European Union. In the latter, the convergence criteria are stated in Article 140(1) and in Protocol 13(1) annexed to the Treaty.

report every two years to the Council of the European Union on the progress that the Member States made regarding the achievement of these requirements (ECB, 2010a; European Commission, 2010). Besides the government finance criteria (government deficit and debt), the long-term interest rate criterion, the inflation criterion, and the exchange rate criterion have to be achieved before EMU participation is allowed by the European Commission. The reference criteria for sound and sustainable public finance imply that the government deficit is less than 3 per cent of GDP and government debt does not exceed 60 per cent of GDP. Further, price stability is given if the harmonised inflation rate is not more than 1.5 percentage points above the rate of the three best-performing Member States.[46] The long-term interest rate, measured by government bond yields, ensures the durability of convergence with a value that does not exceed by more than 2 percentage points the rate of the three best-performing Member States in terms of price stability.

Table 8.1 gives an overview of the convergence criteria in the analysed countries including Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, and Romania. For the sake of completeness, Slovakia and Slovenia, which adopted the euro in January 2009 and January 2007 respectively, are included and support our results. The table shows that almost all candidate countries do not meet the required Maastricht criteria. Accordingly, lasting policy adjustments will be necessary to achieve the target values. Given the current reference value of 1 per cent for inflation, only the Czech Republic, Estonia, Latvia and Slovak Republic fulfil this criterion. Additionally, the Czech Republic does not exceed the reference value of 6 per cent for the long-term rate.[47] In particular, long-term interest rates increased sharply in Latvia and Lithuania, reaching historically high interest rate differentials vis-à-vis the euro area average at above 800 basis points. A sound government budget position—a government deficit with less than 3 per cent of GDP—is only reached in Bulgaria and Estonia. Further, while the debt-to-GDP ratios have increased over the last few years in all CEECs, Hungary is the only country that currently exceeds the target value of 60 per cent of GDP. Finally, if one of the countries tries to stay out of the common currency union and postpones their EMU membership indefinitely, it is possibly because of a failure on one of these criteria.

In the following we focus on the Maastricht exchange rate criterion, which indicates that the aspirant countries must participate for at least two years in the exchange rate

[46] Those countries where inflation is negative are counted as having zero inflation.

[47] The reference values refer to the period April 2009–March 2010 and are calculated by the ECB (2010a). Note that for Estonia, no harmonised interest rate is available.

Table 8.1: Convergence Indicators

			Bulgaria	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovak Republic	Slovenia
Price Stability	HCPI Inflation	2006	7.4	2.1	4.4	4.0	6.6	3.8	1.3	6.6	4.3	2.5
		2007	7.6	2.9	6.7	7.9	10.0	5.8	2.6	4.9	1.9	3.7
		2008	12.0	6.3	10.6	6.1	15.3	11.1	4.2	7.9	3.9	5.5
		2009	2.5	0.6	0.2	4.0	3.3	4.2	4.0	5.6	0.9	0.9
		2010	1.7	0.3	-0.7	4.8	0.1	2.0	3.9	5.0	0.3	0.9
Government budgetary position	General government surplus (+) or deficit (-)	2006	3.0	-2.6	2.9	-9.2	-0.5	-0.4	-3.9	-2.2	-3.5	-1.3
		2007	0.1	-0.6	2.7	-4.9	-0.4	-1.0	-1.9	-2.5	-1.9	0.5
		2008	1.8	-2.7	-2.7	-3.8	-4.1	-3.3	-3.7	-5.4	-2.3	-1.7
		2009	-3.9	-5.9	-1.7	-4.0	-9.0	-8.9	-7.1	-8.3	-6.8	-5.5
		2010	-2.8	-5.7	-2.4	-4.1	-8.6	-8.4	-7.3	-8.0	-6.0	-6.1
	General government gross debt	2006	22.7	29.6	4.3	65.6	10.7	18.0	47.7	12.4	30.4	26.7
		2007	18.2	28.9	3.5	65.8	9.0	17.0	44.9	12.7	29.4	23.4
		2008	14.1	30.0	4.6	72.9	19.5	15.6	47.2	13.3	27.7	22.6
		2009	14.8	35.4	7.2	78.3	36.1	29.3	51.0	23.7	35.7	35.9
		2010	17.4	39.8	9.6	78.9	48.5	38.6	53.9	30.5	40.8	41.6
Exchange rate		2006	0.0	4.9	0.0	-6.5	0.0	0.0	3.2	2.6	3.6	-
		2007	0.0	2.0	0.0	4.8	-0.6	0.0	2.9	5.3	9.2	-
		2008	0.0	10.1	0.0	-0.2	-0.4	0.0	7.1	-10.4	7.4	-
		2009	0.0	-6.0	0.0	-11.4	-0.5	0.0	-23.2	-15.1	-	-
		2010	0.0	2.6	0.0	4.5	-0.4	0	8.4	2.9	-	-
Long-term interest rate		2006	4.2	3.8	5.0	7.1	4.1	4.1	5.2	7.2	4.4	3.9
		2007	4.5	4.3	6.1	6.7	5.3	4.6	5.5	7.1	4.5	4.5
		2008	5.4	4.6	8.2	8.2	6.4	5.6	6.1	7.7	4.7	4.6
		2009	7.2	4.8	7.8	9.1	12.4	14.0	6.1	9.7	4.7	4.4
		2010	6.9	4.7	7.7	8.4	12.7	12.10	6.1	9.4	4.5	4.2

Note: Average annual percentage changes are given for inflation and the exchange rate. For exchange rate changes, a negative value denotes a depreciation and a positive value an appreciation vis-à-vis the euro. The government budgetary positions are a percentage of GDP. Data for 2010 refer to the average of the period April 2009–March 2010. The interest rate for Estonia is non-harmonised.
Source: Eurostat (2010); European Commission (2010); ECB (2010a) and the author's calculations.

mechanism II (ERM II) before their planned euro adoption.[48] According to this criterion the normal fluctuation margins have to be a maximum of $\pm$ 15 per cent around a fixed exchange rate against the euro. To maintain the stability of exchange rates between the common currency and the individual aspirant currencies, the devaluation of the currency is not allowed unilaterally.

Table 8.2 presents the actual exchange rate systems that are more detailed in Box A for the analysed countries. While in Slovakia and Slovenia the euro has been adopted already, the accession date for the other eight countries considered is unknown. Some non-euro members have stated their interest in joining the EMU by directly

48 With the introduction of the common currency the former European Monetary System (EMS) was replaced by the ERM II.

Table 8.2: Progress in Euro Adoption

	Current Exchange Rate Regimes	Possible Date of Euro Adoption
Bulgaria	euro-based currency board	no target date and no preparations for adoption of the euro
Czech Republic	managed floating with the euro as the reference currency	no target date for adoption, but first version of the National Euro Changeover Plan was adopted on 11 April 2007
Estonia	ERM II (currency board with fixed peg to the euro)	National Euro Adoption Plan (7^{th} updated version) was adopted on 25 June 2009; European Commission has recommended the euro adoption by January 2011
Hungary	float in combination with inflation targeting	National Changeover Plan in July 2008 (1^{st} ed.) without target date for adoption
Latvia	ERM II (exchange rate fluctuation band of +/-1%)	update of the National Euro Changeover Plan in September 2007, national target date is set for January 2014
Lithuania	ERM II (currency board with fixed peg to the euro)	no specific target date for the adoption, National Changeover Plan was updated in April 2007
Poland	free float with inflation targeting	previous plan to accession to ERM II by mid 2009 was not implemented
Romania	managed float with the euro as the reference currency	target date is set for January 2015, but changeover preparations have not started yet
Slovak Republic	member of EMU (since January 2009)	-
Slovenia	member of EMU (since January 2007)	-

Note: As at May 2010. Several countries withdrew their preliminary target dates.
Source: European Commission (2008, 2009c); ECB (2008a) and national central banks.

participating at ERM II after their accession to the EU.[49] It is obvious that the euro retains its position as exchange rate anchor for the euro area neighbouring countries. The determination to use the euro as the anchor currency is a unilateral decision, except for those countries which have joined the ERM II. While the second column of Table 8.2 lists the exchange rate regimes as at May 2010, the right column presents information on national efforts by the national governments and national central banks to join the EMU. Obviously the announcement and the attempted dates differ from responses to the 2007 OeNB Euro Survey (see Dvorsky et al., 2008).[50] Remarkably, for Bulgaria the survey responses show that the population expected to join the EMU in 2009–10.

[49] Lithuania, Estonia, and Slovenia had joined the ERM II already by June 2004. Latvia entered in May 2005 and the Slovak Republic in November 2005.

[50] In this survey more than 1000 people are interviewed in each country about their currency composition and the amounts of foreign-currency holdings. The micro data obtained for different sex and age groups present various motives for holding foreign currency cash and deposits. See ECB (2009) for a discussion of recent survey results.

In fact, Bulgaria has not joined ERM II yet. However, once the European Commission has recommended the accession, the launch of the euro can start very quickly, as for example the case of Slovakia has shown, where the joining was recommended by the European Commission in May 2008 and put into practice at the beginning of 2009. Accordingly, the recent statement by the European Commission that Estonia fulfils the EMU criteria and their recommendation to the Council on Estonia's euro readiness in 2011 points to Estonia as the next EMU candidate (European Commission, 2010).[51]

Box A: Description of Exchange Rate Regimes

- Bulgaria, Estonia, and Lithuania follow a **currency board regime**. In this regime the currency is fixed against the Euro and the base money is financed by foreign reserves. Hence an increase in the monetary aggregates is possible to the extent of foreign reserves. Since 1999 the new Bulgarian lev is unilaterally fixed at a rate of 1.9558 to the euro[a], while the Estonian kroon keeps a fixed rate at 15.6466 to the euro. The Lithuanian litas was fixed to the US dollar before 2002 and was fixed at a rate of 3.4582 to the euro after that. This exchange rate regime is clear evidence that government economic policy is aimed at exchange rate stability. It can be seen as a euroisation process (see Section 8.2.4).
- Hungary and Latvia maintain a **fixed parity regime** against the euro, with very narrow fluctuation bands. Fixed exchange rates offer a nominal anchor so that domestic prices cannot move far away from international ones. In 2001, the crawling peg regime was abandoned in Hungary and the Hungarian forint was set at 282.36 to 1 euro. The fluctuation band was set to $\pm 15\%$. The exchange rate of the Latvian lats is determined by a fixed link with special drawing rights (SDR), hence the depreciation of the currency can be explained by the fall in the value of US dollar and the Japanese yen (both are currencies in the SDR basket) against the euro.
- The Czech Republic, Romania, and Poland have a **floating exchange rate regime**, where the exchange rate is determined by foreign exchange supply and demand. While the first two countries follow a managed float—that is the central bank intervenes in foreign exchange markets—the latter has a freely floating regime. Due to high inflation rates, the Romanian leu is losing value against the euro. Before the adoption in Slovenia and the Slovak Republic, both countries followed a managed float.

[a] For the new Bulgarian Lev the former currency was divided by 1000.

Source: National Central Banks.

While assuming that the CEECs comply with legal and economic requirements at a certain time, this thesis does not deal with the pros and cons of euro participation in general (for example to reduce the susceptibility to currency crises or a loss of an independent monetary policy), rather it deals with the main question: whether

[51] Interestingly, Estonia is almost the only country in the EU that meets the common currency criteria (The Economist, 2010, May 13th).

the CEECs should adopt the euro as soon as possible or not.[52] The literature on Optimum Currency Areas (OCA) favours the participation, if the business cycles are almost synchronised with the EMU cycle (Mundell, 1961). In this case, the common currency will eliminate the exchange rate risk and will smooth business cycles even more. Further, it is argued that for the countries with pegged exchange rates to the euro, namely Estonia, Latvia, Lithuania, and Bulgaria, the effect on the single currency will be minor due to the size of these countries.[53] However, it should be taken into account that the countries might weaken the euro anyhow by their early entry. This indicates the importance of a comprehensive (empirical) analysis.

8.2 Currency Area Theories

In the following sections we present theories that are fundamental for the analysis of the optimal exchange rate regimes in small open economies exposed to various shocks, and we present alternative paths of the transition to the common currency—the theory of Optimum Currency Areas (OCA) and the boom–bust cycle theory. Further, two more approaches are discussed—the approach by Lahiri et al. (2006) and the euroisation dodge. In Figure 8.1 the coexistence of the theories is illustrated.[54] The original Optimum Currency Area theory of Mundell (1961), with its assumption that the exchange rate adjusts to asymmetric shocks in the economy is presented. This approach is often reviewed in the literature, including also a number of analyses for the CEECs (see for instance the overview by Mahlberg and Kronberger, 2003). According to this view, the accession to the EMU is advisable if the business cycles between EMU accession countries and the EMU or individual EMU countries are well synchronised.

Another strand of literature, the so-called boom–bust cycle theory, states that flexible exchange rates might amplify shocks. This approach follows a very different line of argument to the standard literature on OCAs (Mundell I). In fact the exchange rate can be seen as a transmitter (and even source) of shocks, rather than a shock absorber

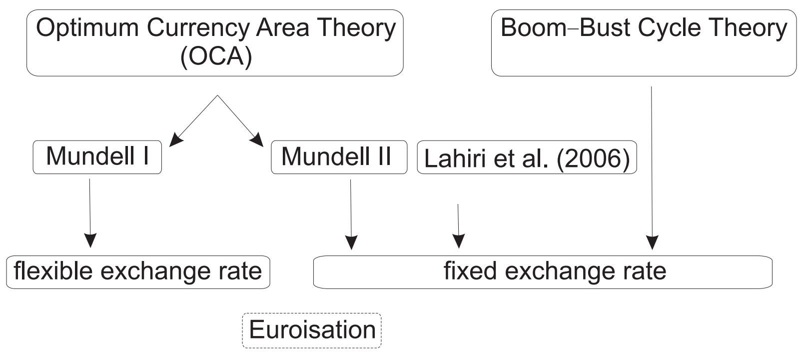
[52] See, among others, Honkapohja and Westermann (2009); Agénor and Aizenman (2008); Weyerstrass and Neck (2008) for a detailed analysis of the pros and cons of the common currency, also in the discussion of the euro launch in Slovenia.

[53] Honkapohja and Westermann (2009) emphasise the positive correlation between the size of a country and exchange rate flexibility. The population of the three Baltic economies was less than 7 million in January 2010. Also, Bulgaria's share of the population of the total EU27 population (about 500 million) is currently only 1.5 per cent.

[54] The behavioural equilibrium exchange rate (BEER) concept could be considered (Melecký, 2005), but this is not an aim of this study.

(Farrant and Peersman, 2006). Following this argument, the abandonment of flexible exchange rates seems less costly in terms of macroeconomic stability.

Figure 8.1: Exchange Rate Strategies to Cushion Shocks



Source: author's illustration.

Mundell (1973a,b) argued in his later work in favour of less flexible exchange rates and a closer integration of capital markets. This aspect is picked up again by Lahiri et al. (2006), who show that in the case of imperfect capital markets fixed exchange rates should be favoured to cushion real shocks. Finally, we point to the euroisation methodology. While an overview on all theories is presented, we focus on the boom–bust approach that is less familiar, but which marks the framework for the following empirical analyses.

8.2.1 Optimum Currency Areas Theory: Mundell I versus Mundell II

For the analysis of the choice of an exchange rate regime, the seminal works of Mundell (1961) and McKinnon (1963) on the optimum currency area (OCA) theory have become popular. According to this theory, a cost-benefit analysis should be undertaken for the choice of the currency regime and, hence, the attractiveness of a monetary union. They developed several criteria—like labour mobility, wage flexibility, and trade openness—to assess whether countries form an optimum currency area. Kenen (1969) emphasised that the complementarity of the countries is a necessary criterion; the diversification of the production structures helps the adjustment to shocks. In the course of time, the "New classical Synthesis" led to changes and different assumptions in the OCA theory (Mundell, 1973a,b; McKinnon, 2004) by considering the exchange rate as a source of a shock in a neoclassical framework. Following the theory of Frankel and Rose (1998), a common currency increases trade and reduces asynchronous shocks.[55] The OCA theory that evolved over the last 50 years also includes empirical approaches, estimating the costs, benefits, and the effects of the financial integration and trade deepening. The empirical analyses of OCAs, and in particular of the EMU, focus on real asymmetric shocks affecting the member countries. Of particular interest is the convergence of business cycles between several non-euro Member States and euro Member States, as well as the euro area as whole. The synchronisation of business cycles—typically proxied by either GDP or industrial production—as well as the similarity of economic shocks is a necessary condition for a common currency, as well as for a common monetary policy. Finally the "Maastricht approach" that is based on the Maastricht criteria is actually used for the establishment of the monetary union (Verde, 2009).

Mahlberg and Kronberger (2003) present an overview of OCA studies related to the CEECs, which analyse synchronisation between business cycles using pairwise correlation and VAR models. The authors find no clear-cut evidence that the countries are prepared for joining the EMU. More recently, various analyses, for instance Darvas and Szapáry (2008) and Fidrmuc and Korhonen (2006) show that most of the accession countries already have a high degree of synchronisation with the EMU, both with GDP and with industrial production.[56] Participation at the EMU will foster intra-industry trade and increase the correlation between business cycles. Real exchange rate volatility can be used to analyse possible sources of business cycle linkages between countries (Buch and Döpke, 2000).[57] However, one major critique of these analyses is that they often use bivariate statistical methods, like correlation measures, instead of analysing the OCA in a multi-country framework. Further, Beine et al. (2000) emphasise the distinction between short and long-run dynamics. While for the analysis of long-run trends between a set of countries cointegration tests are performed to document the process of convergence, short-run comovements are necessary indicators of the sustainability of the monetary union. Other methods suggested are for instance dynamic correlation and cohesion measures (Eickmeier and Breitung, 2006).

The traditional optimum currency area framework of Robert Mundell (Mundell, 1961) (hereafter *Mundell I*) that is based on the assumption of sticky prices and perfect

55 See Frankel and Rose (1998) for the relationship between international trade patterns and international business cycle correlations, which are both assumed to be endogenous.

56 See Raguseo and Sebo (2008) for an OCA analysis of the suitability of the Slovak Republic for euro adoption.

57 If exogenous shocks are the main cause of production fluctuations, this is reflected in changes in real exchange rates. The authors find that exchange rate volatility proxied by the standard deviation is greater vis-à-vis the US dollar than the one with the Deutsche mark.

capital mobility, suggests the flexibility of the exchange rate in the case of asymmetric business cycles to smooth asymmetric shocks across countries. Both Monetarists and Keynesians use this model.[58] However in his work, Mundell contradicts his former recommendations and abandons the assumption of stationary expectations. In his later work (Mundell, 1973a,b), he formulated an alternative theory, where he suggests fixed exchange rates to cushion the fluctuations in cases of nominal shocks to the small open economy through portfolio diversification and reserve pooling. This is dubbed in the literature as *Mundell II*. In this theory it is assumed that the exchange rate might become a source of asymmetric shocks rather being a shock absorber, especially with high capital mobility.[59] Mundell II (Mundell, 1973a,b) argues that in the case of nominal shocks to a small open economy, stable exchange rates seem to be appropriate to cushion the fluctuations. According to Mundell I, the foreign exchange market is efficient if exchange rates are flexible; in Mundell II the international capital (financial) market is efficient if exchange rates are fixed (McKinnon, 2004).

8.2.2 The Lahiri et al. (2006) Approach

The literature suggests that the optimal choice of the exchange rate regime depends on the type of shock that hits the economy, either a real or a monetary shock. Lahiri et al. (2006, 2007) emphasise that especially for emerging markets, asset-market frictions are as important as goods market frictions and that the assumption of perfect capital mobility in the Mundell world is inaccurate.[60] Thus the type of distortion (goods-market friction versus asset-market friction) determines the optimal choice of the exchange rate.

Table 8.3 indicates that in the case of goods-market frictions, a flexible exchange rate is optimal if the shock stems from the real side. Due to sticky prices, the adjustment of relative prices is only possible through changes in the exchange rate. Hence, the maintenance of independent currencies is justified in a Mundell–Fleming world by the

58 For Monetarists (for instance Milton Friedman), domestic monetary independence is favoured to hedge the domestic price level, while Keynesians suggest a flexible exchange rate for the stabilisation of fluctuations in domestic output, and for the support of counter-cyclical policies (McKinnon, 2004).

59 For an overview of the opposing theories (Mundell I versus Mundell II) see, among others, McKinnon (2004).

60 The literature uses various definitions of shocks. For example, it differentiates between real and nominal shocks (Farrant and Peersman, 2006), between supply and demand shocks (Fidrmuc and Korhonen, 2006; Darvas and Szapáry, 2008), real and monetary shocks (Lahiri et al., 2006, 2007; Llaudes, 2007) and domestic and foreign productivity shocks (Kolasa and Lombardo, 2010).

fact that exchange rate adjustments can absorb temporary macroeconomic asymmetries (real shocks) between two countries. In contrast, if shocks are of a monetary nature, a fixed exchange rate is suggested to adjust real money balances.[61] However, in the case of capital market frictions, for instance asset market segmentation, it is appropriate to fix the exchange rate; in the case of a real shock, flexible exchange rates are optimal in the case of a monetary shock (Lahiri et al., 2007). In a world with flexible prices and asset-market frictions the exchange rate evaluation of the Mundell world can be turned around (see Table 8.3, right column). In addition, a study by Faia (2010) shows—in the presence of credit market frictions—that the stabilising character of flexible exchange rate regimes, in particular in the case of foreign shocks, is enhanced compared to the case of a fixed exchange rate regime.

Table 8.3: Optimal Exchange Rate Regimes

	Good market friction	Asset market friction
Real shock	Flexible	Fixed
Monetary shock	Fixed	Flexible

Source: Lahiri et al. (2006).

While flexible exchange rates are Pareto optimal as well as socially optimal in a world with stationary expectations (Céspedes et al., 2004), the stability function of the exchange rate disappears in a world with non-stationary expectations. The exchange rate itself is very volatile and is an independent source of shocks. Hence, taking account of all the theoretical (and previous empirical) findings in the literature, it seems that in the case of a real shock and capital market frictions, in the CEECs a fixed exchange rate is optimal to cushion this shock. The exchange rate choice is strengthened by assuming non-stationary expectations. These ideas are picked up in the boom–bust cycle approach which is presented in Section 8.2.3.

8.2.3 The Boom–Bust Cycle Approach

Taking up the argument of capital market imperfections in emerging markets, as mentioned for instance by Lahiri et al. (2006, 2007), boom–bust cycle theory can be used to provide a more established framework for the reasons for joining a currency union. Similarly, Agénor and Aizenman (2008) focus on the effect of capital market

[61] The adjustment of real money balances is conducted by the adjustment of nominal money balances, which occurs endogenously by fixing the exchange rate (Lahiri et al., 2006).

imperfections on the welfare gains of the joining the monetary union.[62] However, so far little empirical research has been conducted on credit market imperfections in connection with the design and functioning of OCAs (Agénor and Aizenman, 2008). Some papers analyse the importance of domestic capital markets to provide consumption insurance in general (for instance, Ching and Devereux, 2003; Leblebicioğlu, 2009). Céspedes et al. (2004) analyse whether flexible exchange rates provide damping if financial markets are imperfect and liabilities are denominated in foreign currency. However, similar analyses of the economies in Central and Eastern Europe in a boom–bust framework are rare (Martin et al., 2007; Eichengreen and Steiner, 2008).

The boom–bust model of Schneider and Tornell (2004) captures the theoretical arguments of boom–bust episodes that were observed in middle-income countries. This theory is mainly based on the differences in corporate finance in a two-sector economy. On the one hand a nontradable (N-) sector—the sector that produces nontradable goods—and on the other hand a tradable (T-) sector that produces tradable goods. Kolasa and Lombardo (2010) show that in the presence of nontradable goods in an economy, monetary unions are optimal to cushion foreign productivity shocks.[63] The assumptions of the model are as follows:

- Imperfect capital markets: The investment possibilities of the N-sector depend on its cash flow; borrowing constraints arise for the N-sector firms that cannot revert to external financing and mainly depend on internal sources or domestic bank credit. In contrast, the T-sector firms can borrow abroad and can circumvent this obstacle.
- Currency mismatch and balance sheet effect: The N-sector firms can overcome the credit restrictions by borrowing in foreign currency (from domestic banks or the subsidiaries of foreign banks), while their income is denominated in domestic currency. In the case where the exchange rate—interpreted as the relative price of tradable and nontradable goods—appreciates, the debt value decreases and will boost further borrowing.[64] Céspedes et al. (2004) argue that in the case of a high share of foreign-currency-denominated debt, exchange rate fluctuations impair the balance sheets of firms and trigger their balance sheet effects.

62 The authors analyse whether monitoring costs and the degree of competition in banking affect the welfare gains.

63 See Kolasa and Lombardo (2010) for an analysis of the gains of a monetary union relative to the cooperative equilibrium compared to those other regimes (PPI–targeting, CPI–targeting, Taylor rules) in the presence of a nontradable sector.

64 The relative price is defined as $p = p_T/p_N = 1/e$, where p_T is the price of the tradable goods and p_N the price of the nontradable goods. e is the real exchange rate.

- Bail–out guarantees: In the case of systemic risk bail–out plans are taken by the government. This implies that the debt of the N-sector firms that cannot be hedged will be repaid by the government in the case of a depreciation of the currency due to a systemic shock.

- Contract enforceability problems: External borrowing constraints are increased by enforcement problems such as corruption and a weak judicature.

- Asymmetric sectoral comovements: The productivity in the T-sector is higher compared with the N-sector (Balassa–Samuelson effect). This leads to higher wages growth in the T-sector. Finally, the wage adjustment process leads to an increase in the N-sector's wages. However, productivity in the N-sector will not increase to this extent, so that the prices in the N-sector will increase more than in the T-sector.[65] In the case of a real devaluation, the demand for domestic goods increases and in turn raises the output of the N-sector (Céspedes et al., 2004).

Typically, boom–bust episodes in middle-income countries began with an excessive lending boom and a sharp appreciation of the real exchange rate. In a sudden crisis, the real depreciation of the currency goes along with the widespread defaults of the private sector on foreign debt. The sectoral differences during these episodes are analysed extensively by Schneider and Tornell (2004); Tornell and Westermann (2002, 2005), who show that the N-sector that produces nontradable goods grows faster than T-sector—that produces tradable goods—during a boom and falls harder during the crisis. The recovery takes longer afterwards. The aim is not to deal with the theoretical modelling of the argument, as shown, for instance in Schneider and Tornell (2004); Céspedes et al. (2004); Guajardo (2008), and Rancière et al. (2010). Rather, we conduct a comprehensive empirical analysis in the boom–bust cycle framework based on this literature, and on the arguments of Lahiri et al. (2006) and Agénor and Aizenman (2008) that assume that access to capital markets in developing countries is imperfect or not possible at all.

In the following chapters we analyse the key features of the boom–bust cycle model and document existing capital market imperfections in the CEECs, which are typical for emerging markets that have experienced boom–bust cycles. In the literature, (for instance, Guajardo, 2008; Tornell and Westermann, 2002; Tornell et al., 2003) various stylised facts have been presented for emerging economies:

65 The consequence of a rise in the relative prices of nontradable goods and the Balassa–Samuelson effect is the appreciation of the real exchange rate.

- Excessive credit growth in the boom period (Bakker and Gulde, 2010) (see Section 9.1).
- While the T-sector can revert to various sources of financing, the N-sector mainly depends on bank credit. The domestic banks and affiliates of foreign banks borrow abroad and mainly in foreign currency. Hence, asymmetric financing determines the credit constraints at the firm level. Typically, access to international financial markets and credit markets is volatile. Small firms, which can also be proxied by nontradable-sector firms, have often limited or even no access (external borrowing constraint) (see Section 9.2).[66]
- Weak enforceability of contacts and asymmetric information abate the risky credit demand but also amplify the credit constraints for the borrowers (Rancière et al., 2010), because the lenders guard against the default risk (see Section 9.3).
- If the firms (and households) denominate a large amount of their liabilities in foreign currency but have income and assets in domestic currency, a mismatch of currency is a major problem. This is especially so for small open economies characterised by exchange rate risk and hedging possibilities (see Section 9.4).
- Implicit bail–out guarantees which are provided by the government affect positively the amount of foreign-currency debt and affect negatively the incentives to hedge risk. Hence, the firms' (households') incentives to take risks will increase.[67]
- Assume that the sectors of an economy produce either tradable (T-sector) or nontradable (N-sector) goods. In the boom the growth in the N-sector is larger than the growth in the T-sector. This in turn affects the synchronisation of sectoral cycles and has an impact on the real effective change rate (see Chapter 10).

Having stated the facts, we aim to show in the next chapter that CEECs are likely to experience a boom–bust cycle, or to be precise, as far as recent data allow us to show, they experienced a typical boom–bust cycle. Different research approaches are applied to provide a comprehensive validation of the results. Finally, the results are used to argue that the early adoption of the common currency, will reduce or remove the fluctuations generated by real shocks.

[66] For a discussion of the role of credit market imperfections for the transmission of shocks see for instance Faia (2010).

[67] In the current crisis bail–outs are taken in form of supporting the pegs (Rancière et al., 2010).

8.2.4 Euroisation

The overview of the exchange rate arrangements and recent developments presented in Section 8.1 has already emphasised that the role of the euro as the nominal anchor in the CEECs is increasing. From a theoretical point of view, the new EU countries can choose between two alternative possibilities in adopting the euro. On the one hand they can officially euroise bilaterally by joining the European Monetary Union (EMU) or a currency board. Otherwise it could be unilateral, without joining the EMU (for the time being). This alternative is called euroisation. While Mundell (1961) differentiates between fixed and flexible exchange rates he does not consider euroisation/dollarisation, which is also an important mechanism that does not constitute an exchange rate system, rather it implies a link to a currency area (see, among others, Chang and Velasco, 2002; Winkler et al., 2004). Euroisation as well as swissfrancisation and dollarisation have become very familiar, especially for the CEECs.

The definition of euroisation is ambiguous, and we must differentiate between full and partial euroisation. The former can be seen as an alternative approach to joining the EMU by adopting unilaterally the euro as legal tender. Then the national currency is abolished without fixing an irrevocable conversion rate between the euro and the national currency. Further, the national monetary policy is waived. For some countries that are currently not members of the EU—but are potential candiates—the euro has become a nominal anchor, for instance in Montenegro and Kosovo, where the euro is used as de facto currency already. The second terminology is used for an increasing level of foreign-currency debt (and deposits). To refer to euroisation as currency substitution is more common. While for the CEECs euroisation is obviously the case, and the literature typically uses the term dollarisation. Hence, the terms euroisation and dollarisation are used interchangeably in this thesis.[68]

The first type of euroisation is officially excluded from the policy option for the new EU Member States. The ECB and European Commission refuse to accept this concept because it contravenes the theoretical economic framework and its stages towards euro adoption (convergence process) (see ECB, 2003; Winkler et al., 2004; Honkapohja and Westermann, 2009). In the literature, several arguments in favour of unilateral adoption of the euro, such as fostering macroeconomic stability, lower risk premia, and the elimination of transactions are discussed in detail. Also, the costs such as the loss of adjustment mechanism or the loss of seignorage are emphasised (see, among

68 This is due to the large body of literature on the dollarisation debate in Latin America.

others, Chang and Velasco, 2002; Belke et al., 2003; Winkler et al., 2004). Chang and Velasco (2002) present a theoretical framework in which euroisation may intensify the possibility of a financial crisis. For the reasons for euroisation see, among others, Ize and Powell (2005).

The second type of euroisation raises the question of to what degree the countries are already (un)officially euroised (or dollarised). Besides the geographical proximity to the EU implying, in particular, stronger trade and financial linkages, the institutional anchor of prospective EMU membership supports the role of the euro as the preferred currency for asset substitution, as the annual reviews by the European Central Bank show (ECB, 2008b, 2009).[69] The ECB (2008b, 2009) shows that the euro has broadened its stable role in foreign exchange markets, as 37 per cent of all foreign exchange transactions in 2007 were nominated in euro and this even increased to 41 per cent by the end of 2008. The euro's share in exports and imports invoiced in euro exceeds 50 per cent. The increasing amount of euroisation raises the susceptibility of the private sector. A high level of *euro reserves* held by the central banks is observed in the CEECs. Some of the countries (for instance Latvia) have started to reduce their stock of euro reserves.[70] This can be explained by the fact that becoming a member of the euro area will automatically change euro-denominated reserves to domestic assets. However, while the currency composition of debt is a significant determinant of the currency composition of foreign exchange reserves, this issue is not addressed in this study.[71] The unofficial dimension can be determined by the level of foreign currency which is used by individuals and firms for transactions (*currency substitution*) or asset investments (*asset substitution*) (see, for instance, Feige and Dean, 2002). The value of foreign cash in circulation is typically unknown, because it is not only determined by the vague net shipments of euro banknotes by euro area monetary financial institutions (MFIs), but also by outflows via non-MFI channels (ECB, 2008b). The OeNB EuroSurvey, a semi-annual survey conducted for the first time in 2007 by the national bank of Austria, provides among others, information on the amounts and composition of foreign-currency holdings in six of the CEECs (Dvorsky et al., 2008).[72] While the share of euro exceeds the other currencies, it varies considerably across the

69 See ECB (2010) for a recent analysis of factors which might be explain asset and liability substitution.

70 By the end of 2008, the share of euro in total foreign exchange reserves was in Bulgaria 92.4%, in Latvia 61.9% and in Lithuania 100% (ECB, 2009) for instance. Recent figures for some countries suggest that the share remained stable.

71 See Beck et al. (2008) for an analysis of the relationship between reserves and foreign debt.

72 Survey data are available for Bulgaria, the Czech Republic, Hungary, Poland, Romania, and Slovakia.

surveyed countries. Given that the actual extent of euroisation in transition countries is either not identified or not reliable, it is common in the literature (see Feige and Dean, 2002; Rosenberg and Tirpák, 2008) to use the loans and deposits denominated in foreign currencies as proxies for the degree of euroisation (dollarisation). This is analysed in more detail in Section 9.4.1.2. In this context, Kolasa and Lombardo (2010) also show that foreign-currency debt influences the optimal monetary policy.[73]

[73] The presence of financial frictions favours countries according to their DSGE estimation towards a monetary union.

9 Stylised Facts of Credit Market Imperfections

9.1 Excessive Credit Growth

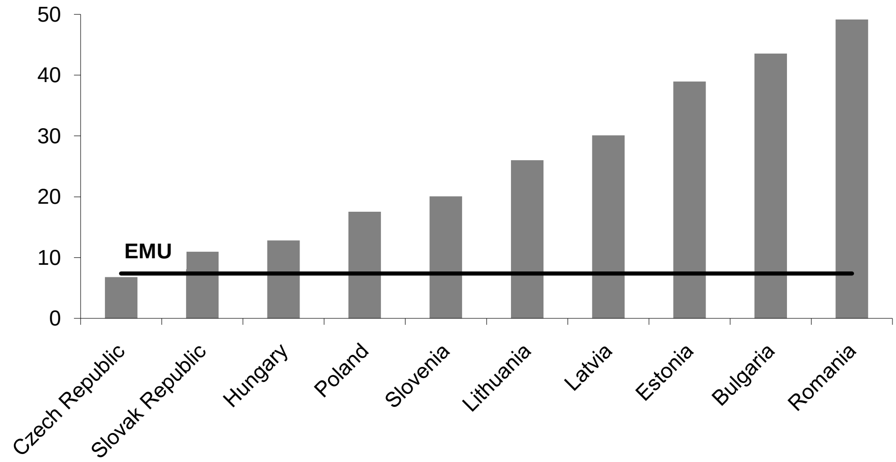
Brisk and rapid credit growth particularly in the private sector has been a key feature of the development of the CEEC economies, especially in the period of financial deepening which occurred from the second half of the 1990s. While the literature (Manzocchi, 1997; Gardó and Martin, 2010) argues that external financing promotes the catching-up process, and was very welcome at the beginning of the catching-up period, the large and rapid credit growth of more than 20 percent for most of the CEECs, has recently started to cause concern over its negative impact on reliability (see, among others, Maechler et al., 2007; Bakker and Gulde, 2010).

Figure 9.1 illustrates the average domestic credit growth over the period 1995–2008.[74] It is obvious that the credit growth in most of the CEECs is well above the EMU average at around 7.4 per cent.[75] However, the speed and the extent of credit growth in real terms differ from country to country. The figure shows that the countries considered can be divided into three groups. In the new accession countries, Romania and Bulgaria, the annual average credit growth rate exceeds 40 per cent, while the Baltic states reach an average credit growth rate of around 30 per cent. The remaining CEEC countries have more moderate credit growth rates which are similar to those experienced by the EMU countries in the boom period (6 to 20 per cent on average).

[74] According to the IMF, the "change in domestic credit equals the sum of changes in claims on the central government (net), on state and local governments, on non-financial public corporations, on other financial corporations, on private non-financial corporations, on households and non-profit organisations". The crisis year 2008 had a negative influence on credit growth. However, considering the averages for the years up to 2007 does not change the figures significantly.

[75] Calculation is based on IFS data (IMF, 2009b) for the period 1998–2008.

Figure 9.1: Annual Average Credit Growth



Note: Mean of annual domestic credit growth is calculated over the period 1995–2008.
Source: IFS (IMF, 2009b), and author's calculations.

Interestingly, lending is particularly strong in the countries that have a currency board for the euro (see among others Backé and Wójcik, 2008). This issue is discussed in more detail in Section 9.4.1.2.

Focusing on the last few years, domestic credit growth has accelerated in the Baltic economies as well as in Bulgaria and in Romania, exceeding 70 per cent in 2007. For Hungary, credit growth is slower at less than 20 per cent, and for the Czech Republic and the Slovak Republic the rates were negative for several years prior to 2003. Poland diverged after 2000 from the pattern of the other CEECs through its subdued credit growth until 2005. Since then, credit increased considerably. Despite the peak in credit growth in 2007 in all other countries, followed by a significant decline, a growth rate of 40 per cent was observed in Poland in 2008.[76] Differentiating between credit to households and firms, Eichengreen and Steiner (2008) find that credit to households trended upward in recent years in Poland, while credit growth to firms has been lower.

A similar pattern is observed when expressing the credit expansions as a ratio of GDP (see Figure 9.2).[77] Within the last seven years, Estonia and Latvia have increased their credit-to-GDP ratios from about 20 per cent to more than 80 per cent.[78] Very

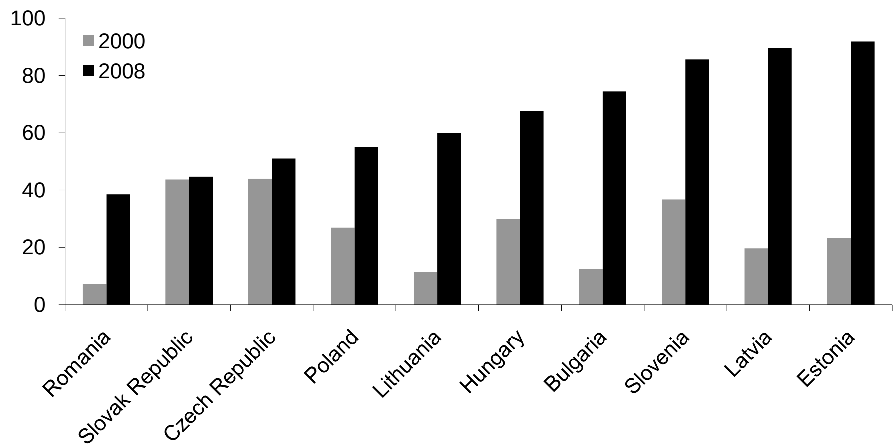
[76] See Eichengreen and Steiner (2008) for an analysis of the excessive credit growth in Poland and the danger of a boom–bust cycle in the run-up to euro adoption.

[77] The ratio is calculated according to the following formula: $\frac{0.5 \cdot \left[\frac{\text{Credit}_t}{\text{P\_e}_t} + \frac{\text{Credit}_{t-1}}{\text{P\_e}_{t-1}}\right]}{\frac{\text{GDP}_t}{\text{P\_a}_t}}$, where P_e is the CPI at the end of period and P_a the average CPI of period t or $t-1$.

[78] In Estonia and Latvia, the credit-to-GDP ratio exceeded 90 per cent of GDP by the end of 2007.

substantial increases have also been observed in Romania, Hungary, Lithuania, Bulgaria, and Slovenia. For the Czech Republic and the Slovak Republic, the increase was minor—the ratio was decreasing by the end of 2007. While in the euro area debt in relation to GDP has increased, the credit-to-GDP ratios in the CEEC are lower than the EMU average (Task Force of the Monetary Policy Committee of the ESCB, 2007; Beck et al., 2000).[79] However, the increasing credit-to-GDP ratios also indicate faster growth of the nontradable sector compared to the tradable sector (see Section 10.3.3), which is either promoted by the easing of credit constraints for the N-sector or by the excessive borrowing in foreign currency.

Figure 9.2: Domestic Credit to GDP



Note: Ratio of total outstanding bank credit to private sector (including households and enterprises) to GDP, at the end of the year.
Source: EBRD (2009) survey of central banks, IFS (IMF, 2009b), and the author's calculations.

The excessive credit growth has been supported on the one hand by the increasing activities of international banks—indirect capital flows through cross-border loans—and on the other hand through substantial funding from abroad, that is direct capital inflows via FDI (Manzocchi, 1997; Maechler and Ong, 2009).[80] The high credit demand causes liquidity constraints that cannot be tackled by domestic bank credits. Therefore alternative sources are relevant to keep up with credit growth (Maechler and Ong, 2009; Gardó and Martin, 2010): First, a source for local banks that issue credit in local currency, are *cross-border claims by foreign banks*, typically denominated in foreign currency. Second, for large, creditworthy firms which have access to finance

[79] The Task Force of the Monetary Policy Committee of the ESCB (2007) shows that the ratio of debt to total liabilities decreased in most euro area countries.

[80] The authors compile a data set on bank claims in Central and Eastern Europe using data from various sources, for instance the BIS and the IMF.

abroad, *direct cross-border borrowing* is possible. Third, *foreign-currency loans* from foreign parent banks can be accessed through their local affiliates. While the second and third ones are few and difficult to measure, the banks' exposure can be pictured (incompletely) through the consolidated banking statistic provided by the Bank of International Settlements (BIS) (see Section 9.4.3.2).

Borrowing in foreign currency is an important issue in tackling the current credit expansion and to overcome credit constraints (see Section 9.2.1). In contrast, we can observe that the credit expansion has been particularly strong in economies with a high share of foreign-currency liabilities (see Section 9.4.1.2). Average credit growth rates in Latvia—the country with the highest share of foreign-currency-denominated liabilities (81%)—exceeded 50 per cent prior to the financial crisis.

Finally, an analysis by the Task Force of the Monetary Policy Committee of the ESCB (2007) shows that the financial lending of the new Member States is different compared to the euro area.[81] The main outcomes are that the share of total loans in total liabilities tends to be lower in the CEECs, while they have a higher share of cross-border loans (bank and inter-company loans) in total loans.[82] Further, the ratio of liabilities and (net) financial assets to GDP is typically below the euro area average.

So far we have investigated data at the country level. However, before proceeding with our empirical analysis we stress that credit and (or) debt can be separated in other ways starting with a differentiation, for instance, between the types of borrowers: the private (households, firms) versus the public sector. Government debt is also a major challenge for these countries—as we have seen through the debt-to-GDP numbers in Section 8.1—and our focus will be on the private sector, and in particular on non-financial corporations. The type of lender—national banks, other firms, international capital markets—and the majority of loans—short-term, long-term—are important. We argue that it is sufficient to concentrate on bank–firm lending, because both domestic banks as well as local subsidiaries of foreign banks will lend to other firms that might hand on the credit. Finally, the denomination of the debt (domestic credit versus foreign currency debt) is very important. Therefore we deal with this category separately in Section 9.4.1.2.

81 The comparison of 10 CEECs by the Task Force of the Monetary Policy Committee of the ESCB (2007) is based on national data that are only available for different years, where the most recent full-year data available (2003–05) are used. Task Force of the Monetary Policy Committee of the ESCB (2007) define the total debt level as the sum of loans, debt securities, and insurance technical reserves.

82 This indicates a significant degree of international financial integration of the non-financial corporations (Task Force of the Monetary Policy Committee of the ESCB, 2007).

9.2 Financial Asymmetries

In this section, we aim to document the financial asymmetries across sectors using a firm-level survey database that examines the business environment of firms, including responses on their perceptions of financial constraints. With a particular focus on the transition countries, the Business Environment and Enterprise Performance Survey (BEEPS) was conducted as a joint initiative of the European Bank for Reconstruction and Development (EBRD) and the World Bank in 1999–2000. Respondents were from 26 countries of Eastern Europe and Central Asia.[83] Since the first round in 1999, several BEEPSs have been conducted in 2002, 2005, and 2009. However, the number of firms and the number of countries included in the surveys have been increased and the questions are more detailed. For instance, they differ between a core, manufacturing, and service-sector questionnaire.

Based on particular firm characteristics, which are given in the survey—size, export share, and the sectoral classification—this section considers credit market imperfections from a micro level and focuses on the credit constraints of the firms. Aside from the direct assessment of the finance obstacle, the credit constraints might also be observable directly in micro-data if small, non-export, or nontradable sector firms denominate their debt in foreign currency to overcome credit constraints.

We conduct the main analysis for the CEECs in Section 9.2.1.1 using 2005 survey data. Additionally, a summary of the results for an analysis of the World Business Environment Survey (WBES) is presented in Section 9.2.1.2 and the results of an additional BEEPS conducted in 2004 for selected euro area countries are in Section 9.2.2. Finally, for comparison, we also provide the results based on the latest survey conducted in 2009 (see Section 9.2.3). The advantage of using both surveys is that on the one hand our results will not be distorted by an overall credit squeeze and the recession period that overtakes the whole area, but on the other this allows us to make a rough comparison of both results, although a strict comparison among the different surveys is limited. The main problems result from the fact that the interviewed firms are not the same, and the number of firms differs substantially. The questions are

[83] Note that there are different types of firm surveys provided by the World Bank Group, not focusing just on transition countries. “Enterprise surveys” and “Doing Business” are examples. These surveys ask similar questions to the “Business Environment and Enterprise Performance Survey”.

not identical, as they vary in the question itself and in the response possibilities, and questions may be replaced or omitted.[84]

9.2.1 Financial Constraints in the CEECs

9.2.1.1 The BEEPS Survey

The Enterprise Survey is based on simple random sampling comprising 3900 interviewed firms in 10 countries in Central and Eastern Europe.[85] While Poland, with 975 firms, has the largest number of observations, Latvia and Lithuania are, with only 205 firms, the most narrowly represented. The classification of firms is possible according to several criteria, for instance their size, location, and exporting. Preferring the size criterion, measured by the number of full-time employees, firms are allocated to small and medium enterprises or businesses (SME, referred to as small firms thereafter) or large firms. Only 346 firms in the total sample are large.[86] Among all countries, Slovenia has the largest share of large firms (12.6 %); by way in contrast, in Poland only 7.1 per cent of those interviewed are large ones.

Table 9.1: Size Distributions of Firms

	total firms	non-export	export
no.	3900	2752	1148
small	3554	73 %	27 %
large	346	41 %	59 %

Note: Small (and medium) firms are characterised by two to 249 full-time employees, while large firms have 250 to 9999 full-time workers. Firms with more than 10,000 employees are excluded from the survey. Export firms include both direct and indirect exporters.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculations.

Table 9.1 shows the relationship between size and export options. Over the whole panel we can identify 73 per cent of the small firms as non-export firms, while 59 per

[84] To overcome this problem the World Bank recently published an unbalanced panel including data for 2002, 2005, and 2009. See Drechsel (2010) and Rancière et al. (2010) for analyses of this new data set.

[85] For a detailed description of the survey including the interview procedure and country-specific information on the sampling, see Synovate Research (2005).

[86] SMB have from two to 249 full-time employees, while large firms have from 250 to 9999 full-time workers. Firms with more than 10,000 employees are not included in the survey. Several studies differ between small and medium-sized firms (see Schiffer and Weder, 2001; Volz, 2008). The denomination "small" is where firms have fewer than 49 employees.

Table 9.2: Sector Distributions of Firms

	no.	construction	hotels	manufacturing	mining	real estate	transport	wholesale
total	2840	8.6 %	6.1 %	42.2 %	0.4 %	11.5 %	7.1 %	24.1 %
small	2612	8.7 %	6.4 %	41.1 %	0.4 %	11.8 %	6.7 %	24.9 %
large	228	7.5 %	3.1 %	54.8 %	0.4 %	7.9 %	11.4 %	14.9 %

Note: The industries are identified if the firms report operating wholly in one industry. Small (and medium) firms are characterised by two to 249 full-time employees, while large firms have 250 to 9999 full-time workers. Firms with more than 10,000 employees are excluded from the survey.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculations.

cent of large firms are export firms.[87] Also, at the country level, it can be verified that the share of non-exporting firms in the SMEs is always higher than the share of non-exporting firms in the large firms (see Table B.1 in the appendix). This result confirms the findings of Tornell and Westermann (2003) for Middle-Income Countries (MICs). Large firms are typically export firms while SMEs produce for national sales. However, for a few countries—the Czech Republic, Latvia, and Poland—the share of large firms that are non-exporters is higher than the share of export firms.

Table 9.2 reports the sector affiliations of the interviewed firms that can be clearly identified. The prevailing sector for the whole panel is manufacturing with 42 per cent, while for large firms this sector dominates with almost 55 per cent. Given the classification of the sectors in the survey, we group manufacturing and mining in the tradable sector and construction, transport, wholesale, real estate, and hotels to the N-sector aggregate.[88] We find that 57 per cent of the firms operate in the N-sector with 43 per cent in the T-sector. The majority of the small firms belong to the N-sector (59%) while the sectoral affiliation of large firms is predominantly the T-sector.[89] For Hungary and Romania, this finding cannot be confirmed.

The survey provides information on the obstacles the firms face in their business environment (see Figure B.1 in the appendix). Almost 40 per cent of the firms indicate major obstacles due to tax rates, followed by uncertainty about regulatory policies (28%), and macroeconomic instability (26%). The share of firms facing barriers in running their business due to financial costs and access to finance is as well above

[87] We denominate "export" for both direct and indirect export possibilities, the latter is where firms export through a distributor.

[88] This classification is in line with Rancière et al. (2010). Firms that operate in the sector named 'others' or which cannot be identified as operating wholly in one industry are excluded from our analysis. Hence, our sample is reduced to 2840 out of 3900 firms for the sectoral analysis.

[89] See Tornell and Westermann (2003) for a distribution of SME and large firms to the N- and T-sector in Middle-Income Countries (MICs).

20 per cent. Notwithstanding that the other difficulties are highly relevant, they are outside the scope of our analysis here. Therefore, in what follows, we mainly concentrate on the financial structure and constraints.

In the survey the firms are asked about their main sources of finance, which might differ for the finance for working capital and the finance for new investments (see Table 9.3).[90] While almost 65 per cent of financial sources are based on internal capital resources, the largest part of external finance originates from local private commercial banks. For new investment this share is more than 10 per cent. In addition, equity and trade credits play a significant part in the financing of working capital and leasing arrangements for new investments. A separate analysis for small and large firms indicates that trade credits are more pronounced for large firms. Not surprisingly, large firms' borrowings from both local as well as foreign banks are larger, and the internal finance sources are smaller than the equivalent sources for SME are. Additionally, SME resort more to family loans than large firms do. The different financing structure for large enterprises does not necessarily imply that they are less constrained. Rather, the constraints might cause them to choose other financing sources.

Table 9.3: Percentage Share of Financing Sources

	Working capital			New investments		
	total	large	small	total	large	small
Internal funds or retained earnings	67.6	57.1	68.6	64.4	56.7	65.2
Equity (i.e. issue new shares)	5.7	4.4	5.8	4.8	4.9	4.8
Borrowing from local private commercial banks	7.8	14.2	7.2	10.7	14.5	10.3
Borrowing from foreign banks	1.0	2.4	0.9	1.5	3.3	1.3
Borrowing from state-owned banks, including state development bank	1.9	2.4	1.9	2.6	3.3	2.5
Loans from family/friends	3.3	0.9	3.5	2.5	0.1	2.8
Money lenders or other informal sources (other than family/friends)	0.7	0.3	0.8	0.7	0.2	0.8
Trade credit from suppliers	5.1	8.1	4.8	1.5	2.1	1.5
Trade credit from customers	1.5	2.3	1.4	0.7	0.4	0.7
Credit cards	0.5	0.3	0.5	0.3	0.1	0.3
Leasing arrangement	2.1	1.9	2.1	6.6	7.5	6.5
Government (other than state-owned banks)	1.1	3.0	0.9	1.1	3.5	0.9
Other	1.7	2.6	1.6	2.5	3.5	2.4

Note: The average percentage of the various financing sources for working capital and for new fixed investment is given.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculations.

90 Working capital is associated with inventories, accounts receivable, or cash; new investments are defined by new land, buildings, machinery, or equipment (see World Bank and EBRD, 2005).

Financial Constraint Analysis

The BEEPS also interviews firms about their financing restrictions, where the general financing constraint is the key variable for the following analysis. Because some countries did not answer the questions on their financial conditions, our sample is narrowed down to 3722 firms.[91] Based on the firms' response possibilities, assessing the constraint$_i$ in a range from 1 to 4 (that is 1 = no obstacles, 2 = minor obstacles, 3 = moderate obstacles, and 4 = major obstacles) we find that for our set of countries the mean value of the accessing constraint is 2.29. This indicates that the access to finance is still restricted (see Volz, 2008, for similar findings).[92] Not surprisingly the average for small constrained firms is higher (2.33) than for large firms (1.92).

Table 9.4: Constrained Firms

	total firms	small and medium firms	large firms	non-export firms	export firms
Number of firms	3722	3391	331	2622	1100
Percentage share of constrained firms	20.8	21.6	12.1	21.6	18.8
Percentage share of constrained firms in:					
Bulgaria	16.3	16.9	10.7	16.5	15.5
Czech Republic	17.6	18.8	3.7	18.3	15.7
Estonia	6.3	5.9	9.5	7.1	4.6
Hungary	25.0	26.0	12.8	24.5	25.7
Latvia	4.1	4.0	5.0	4.3	3.8
Lithuania	8.8	8.7	9.1	7.8	10.5
Poland	34.8	35.3	27.5	34.7	35.0
Romania	20.2	21.6	8.5	21.6	15.8
Slovak Republic	11.9	12.4	7.7	13.6	8.1
Slovenia	9.6	10.5	3.6	13.2	5.8

Note: Firms are identified as constrained if they assess their access to finance as a "major obstacle" in running their business.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculations.

Table 9.4 indicates that 20.8 per cent of all firms in the panel consider access to finance as a major obstacle in running their business.[93] The percentage value varies across the types of firms. Small firms and non-export firms are affected even more by the

[91] 178 firms did not assess their financial constraints, indicated by question 54a in the survey, that is "Access to financing (e.g., collateral required or financing not available from banks)".

[92] Compared to the BEEPS from 2002, where the average value for the obstacles in access to finance is 2.34 (for 2311 firms), the access to finance has improved slightly in these countries. A similar finding is reached by Volz (2008), who compares in his analysis responses from the BEEPSs in 2002 and 2005 for 26 transition countries and finds a decrease from 2.33 to 2.26.

[93] Firms that answer the question "access to financing" with "don't know" or which did not respond to this question at all are excluded from the analysis. Finally, 3722 firms evaluated the conditions of their access to finance.

financial constraint (21.6%).[94] The shares of constrained large and export firms are substantially lower (12.1% and 18.8%, respectively). Table 9.4 details the assessment of the financial constraint for each country. We find that the share of Baltic and Slovenian firms that are constrained is less than 10 per cent, while for the small firms, up to 35 per cent of the Polish and 26 per cent of the Hungarian firms respectively assess access to finance as a major obstacle.

While the previous descriptive analysis already revealed financing asymmetries across sectors, we confirm these results through a comprehensive regression analysis. Based on a probit model, the probability can be calculated as

$$p = \text{Prob}\left(\text{constraint} = 1 \mid \mathbf{x}\right) = \Phi\left(\mathbf{x}'\boldsymbol{\beta}\right) = \int_{-\infty}^{(\mathbf{x}'\boldsymbol{\beta})} \phi(z)dz,$$

and on a logit model as

$$p = \text{Prob}\left(\text{constraint} = 1 \mid \mathbf{x}\right) = \Lambda\left(\mathbf{x}'\boldsymbol{\beta}\right) = e^{(\mathbf{x}'\boldsymbol{\beta})} / \left(1 + e^{\mathbf{x}'\boldsymbol{\beta}}\right),$$

where $\mathbf{x}$ is the vector of explanatory variables and $\boldsymbol{\beta}$ the vector with the corresponding coefficients. While in a linear probability model the interpretation of the coefficients corresponds to the individual effect, due to the nonlinearity of the functions we must compute the marginal effects of each variable as a function of that coefficient. In the probit this is $\partial p/\partial x_j = \phi\left(\mathbf{x}'\boldsymbol{\beta}\right)\beta_j$ and in the logit model as $\partial p/\partial x_j = \Lambda\left(\mathbf{x}'\boldsymbol{\beta}\right)\left(1 - \Lambda\left(\mathbf{x}'\boldsymbol{\beta}\right)\right)\beta_j$.

Based on a dummy variable indicating "major obstacles", we estimate the following binary regression to assess the existence of asymmetric financing across the sectors:[95]

$$\text{constraint}_i = c + \beta \cdot F_i + \sum_{n=1}^{9} \gamma_n \cdot D_n + \varepsilon_t \qquad \text{with} \quad i = 1, ..., 3722, \qquad (9.1)$$

where constraint$_i$ indicates, whether firm i considers the access to finance to be a major obstacle for running its business (constraint=1) or not (constraint=0).[96] For robustness checks, various models for several sectoral classifications F_i are estimated,

94 Besides Cabral and Mata (2003) find that the skewness of the size distribution can be explained to some extent by financial constraints.

95 Summarising "moderate and major obstacles" does not change the results significantly.

96 $\text{Prob}\left(\text{constraint} = 1 \mid \mathbf{x}\right) = F\left(\mathbf{x}, \boldsymbol{\beta}\right); \text{Prob}\left(\text{constraint} = 0 \mid \mathbf{x}\right) = 1 - F\left(\mathbf{x}, \boldsymbol{\beta}\right)$, where $\mathbf{x}$ is the vector that contains the factors that might explain the constraint and $\boldsymbol{\beta}$ the vector of parameters that reflect the impact of changes in $\mathbf{x}$ on the probability of the constraint.

including non-export firms, small firms, and different nontradables firms. As well as the constant c and the error term ε_t, we include country dummies as recommended by Schiffer and Weder (2001).[97]

While the dependent variable is ranked in a natural (ordinal) order in the BEEPS database we further run regressions using both simple and ordered binary models (see Tornell and Westermann, 2002; Schiffer and Weder, 2001).[98]

At first, for simple binary estimation, the results for both probit and logit regressions are presented in Table 9.5. Generally the coefficients—the impact of a regressor on Prob (constraint=1), of the probit and the logit estimation—are quantitatively similar, although the probit coefficients are systematically smaller compared with those given by the logit regression.[99] However, while the coefficients are difficult to interpret, at least the sign of the coefficient corresponds to the sign of the effect of a change and the significance can be evaluated ("signs-and-significance approach"). For probit and logit estimations the magnitude and sign of the coefficients of the explanatory variables are identical, while the statistical significance is also comparable. For our discrete explanatory variable F_i, the effect of change, the marginal effect, can be determined by the calculation of the implied probabilities for the two outcomes, $F_i = 0$ or $F_i = 1$, while all other explanatory variables are considered as fixed.[100] The marginal effect (ME) for the binary independent variable F_i would be ME $=$ Prob $\left[\text{constraint} = 1 \mid \bar{\mathbf{x}}_{(F)}, F = 1\right]$ − Prob $\left[\text{constraint} = 1 \mid \bar{\mathbf{x}}_{(F)}, F = 0\right]$, where $\bar{\mathbf{x}}_{(F)}$ is the mean of all other variables in the model.

Table 9.5 (columns 1–2, 5–6) reveals that the results differ with the selection of the firm criteria (F). Although the coefficient is positive—indicating that the restrictions are serious business for both the non-export as well as the small firms—significance is negligible for the first. However, testing the null hypothesis that the coefficients

97 Country dummies capture country-specific effects that determine the level of the constraint within each country and which affect all firms in the country similarly. Hence, we do not search for external factors, such as macroeconomic and institutional environment, financial deepening, or the role of state-owned banks, which are the same for all firms in a country (see Volz, 2008). However, note that for brevity the results for the country dummies and the constant are not reported in the following tables.

98 For the ordered binary model, the $\text{constraint}_i = \begin{cases} 1 & \text{if} \quad \text{constraint}_i^* \leq \gamma_1 \\ 2 & \text{if} \quad \gamma_1 \leq \text{constraint}_i^* \leq \gamma_2 \\ 3 & \text{if} \quad \gamma_2 \leq \text{constraint}_i^* \leq \gamma_3 \\ 4 & \text{if} \quad \gamma_3 \leq \text{constraint}_i^* \end{cases}$.

99 This is due to the shape of the underlying normal and logistic distribution functions, that is, with heavier tails for the latter.

100 Marginal effects can be computed for instance by evaluating the marginal effects for each firm and then calculating the sample average of the individual marginal effects (average marginal effect). For more details on this, see, among others, Greene (2008); Verbeek (2008).

Table 9.5: Financial Asymmetries I

"General constraint financing"	Probit (1)	Logit (2)	Probit (3)	Logit (4)	Probit (5)	Logit (6)	Probit (7)	Logit (8)
estimation results								
non-export	0.063	0.102	0.048	0.075				
	[0.053]	[0.094]	[0.054]	[0.095]				
small					0.356 ***	0.645 ***	0.375 ***	0.666 ***
					[0.095]	[0.177]	[0.103]	[0.188]
non gov			-0.087	-0.140			-0.161	-0.263
			[0.097]	[0.170]			[0.099]	[0.173]
age			-0.003	-0.004			-0.001	-0.002
			[0.001]	[0.002]			[0.001]	[0.002]
McFadden R^2	0.066	0.066	0.067	0.067	0.069	0.069	0.070	0.070
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
obs	3722	3722	3716	3716	3722	3722	3716	3716
marginal effects								
non-export	0.016	0.016	0.013	0.016				
small					0.084 ***	0.086 ***	0.088 ***	0.088 ***
non gov			-0.024	-0.022			-0.045 *	-0.043 *
age			-0.001	-0.001			0.000	0.000

Note: Probit and logit regression results are shown, both excluding and including control variables. *,** ,*** indicate significance at the 10%, 5% or 1% levels. Standard errors are given in parentheses. The lower part shows the average marginal effects of the variables, keeping all other things equal.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005), and the author's calculations.

are simultaneously equal to zero, the p-value of the likelihood ratio (LR) statistic indicates that together all regressors (including country dummies and a constant) have a significant impact. The McFadden R^2 used to evaluate the fit of the models is quite low. This is in line with the usual values for the McFadden R^2 in binary models.[101] In our case, this might result from the fact that the fitted log-likelihood is similar to the log-likelihood in the intercept-only model, and that the majority of the slope coefficients are close to zero. However, this measure should not be overrated for the evaluation of binary models. Overall, the estimated model correctly predicts 79.2 per cent of the observations. A major drawback of the 'standard' probit procedure is that often normality is implicitly assumed, without specific testing. Wilde (2008) highlights that in particular the standard maximum likelihood estimator of probit models is biased for non-normal disturbances. Following the simple representation of the Bera–Jarque–Lee test (Bera et al., 1984) by Wilde (2008), we checked whether the assumption of normality is a valid assumption. Applying the proposed test procedure for probit regressions we cannot reject the null hypothesis of normality.[102]

101 Using the fitted log-likelihood $(L_N(\hat{\beta}))$ and the value of the log-likelihood in the intercept-only model $(L_N(\bar{y}))$ the McFadden $R^2 = 1 - L_N(\hat{\beta})/L_N(\bar{y})$. Note, that the p-value of the LR-statistic and the McFadden R^2 are only given for completeness, but are not discussed for the following tables. Further, other goodness-of-fit measures are considered, like calculating the correct and incorrect classifications.

102 Based on the Stata command provided by P. Bönisch (Wilde, 2008), we checked the null of normality for robustness in all the probit models estimated, however the results are not shown in the tables.

To improve on interpretation, the corresponding average marginal effects are computed following the approach in Bartus (2005), and are given in the lower part of Table 9.5.[103] The results show that the signs as well as the significance of the explanatory variables conform to those for the coefficient. The values indicate that while assuming other things equal, the difference in the constraint between small and large firms is around 8 per cent (see Table 9.5, columns 5–6).

Comparing the simple probit and the ordered probit estimation results we find that the general differences are minor (see Tables 9.5 and B.2 in the appendix).[104] Again, we find evidence that the small firms are more likely to be constrained. Similarly to the binary models, a drawback of the ordered probit and logit estimations is that the results cannot be interpreted directly. Only the signs of the coefficients give a rough indication of the signs of the marginal effects. However, there are several reasons not to do so.[105] We recalculated the marginal effects of a firm on the major constraint. The values for a marginal effect of the firm on the major constraint are similar to those given by the binary model. However, neither the R^2 nor the likelihood statistic are comparable because the dependent variable is either binary or has four outcomes. While it is often argued that the ordered models yield more efficient estimates than the binary ones—they use more detailed information on the level of the constraint—we limit the following analysis to simple binary regression, as the robustness analysis has shown that the slope coefficients are similar.

To make the results of the above regression more robust, further control variables are taken into account in the baseline scenario. The composition of the sample according to size, export, and sector is as described earlier. Table 9.6 shows the average age of the firms and the average of the government share. With regard to the firms' establishment, the mean age of all firms is 16 years, whereas small firms are on average younger (14 years) than are large firms (34 years).[106] The age has a "double effect"

[103] Bartus (2005) recommends the calculation of average marginal effects instead of marginal effects at fixed values of the independent variables (for example mean marginal effects), particularly if dummies are used as regressors. See, Bartus (2005) for a comparison between average marginal effects and mean marginal effects.

[104] The only eye-catching discrepancy is that the use of control variables inverts the sign of the coefficient for non-export firms; the coefficient for the dummy for private firms is positive and that for the age variable is negative and significant.

[105] The major reason not to interpret the coefficients of the model is that an effect of a change in F_i results in a shift of the distribution slightly to the right, while the positions of the cut-off points remain the same. This is critical for the medium category, which first becomes larger then smaller with a change of the firm outcome. For the interpretation of these models, see, among others, Greene (2008); Liao (2000).

[106] Firms that started their operations in 2002, 2003, and 2004 are excluded from the initial survey.

(Cabral and Mata, 2003)—being a proxy both for labor market experience and the existence of liquidity constraints.[107] Of all interviewed firms 8.1 per cent are owned (at least partly) by the government. It is obvious that the government plays a major role in large firms (31 per cent) while around 6 per cent of the SMEs have at least some government ownership. The share of government ownership for all interviewed firms that are owned by the government was still 87 per cent in 2005. In small and non-export firms that are owned by the government, the share is even larger amounting to over 90 per cent.[108] However, we do not distinguish between private domestic and private foreign-owned firms as stressed by Kolasa et al. (2010), because only 216 out of 3722 firms (5.8%) were wholly owned by foreigners.[109]

Finally, the last row in Table 9.6 indicates that the firms that state major financial constraints (which will be key in the following) operate in business on average for 16 years; around 8 per cent of them are owned by the government.[110]

Table 9.6: Description of the Control Variables

	age	governmental ownership	government share
all firms	16.2	8.1%	86.9%
small firms	14.4	5.9%	89.5%
large firms	34.3	30.8%	81.8%
non-export firms	14.3	7.7%	90.3%
export firms	20.6	9.0%	79.9%
constrained firms	15.6	7.5%	91.8%

Note: The mean value for all control variables is given. The age (in years) is calculated referring to the year 2005.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculations.

Taking into account whether the government has a stake in the firm (proxied by the dummy non-gov=0) and the year of the firm's establishment (represented by age) changes equation (9.1) as follows:

[107] See Chavis et al. (2010) for an analysis of the relationship between the firms' age and financial constraints based on the WBES. They find that on the one hand younger firms use less formal finance and rely more on informal financing. On the other hand they face higher obstacles in the access to finance.

[108] The average age—as well as average government ownership—for firms that are small and are non-exporters is similar to that of small firms and differs only in decimal places.

[109] Kolasa et al. (2010) highlight the role of foreign ownership for the case of Polish firms during the financial crisis. The authors confirm that being foreign-owned helps firms to overcome credit constraints and that the crisis has affected these firms less. That is, foreign ownership has weakened the decrease in sales.

[110] Note that 11.5 per cent of 104 firms which are listed on the stock exchanges state major obstacles in their access to finance; 57 firms that are listed are SMEs and 14 per cent of them are constrained.

$$\text{constraint}_i = c + \beta \cdot F_i + \alpha_1 \cdot \text{non-gov}_i + \alpha_2 \cdot \text{age}_i + \sum_{n=1}^{9} \gamma_n \cdot D_n + \varepsilon_t, \qquad \text{with} \quad i = 1, ..., 3722 \tag{9.2}$$

We expect that the constraints will be major for small and non-export firms, for government-owned firms, and for younger firms.[111] The results of regression (9.2) are shown in Table 9.5 (columns 3–4 and 7–8). The impact of adding these control variables on the size of the coefficients is marginal and does not alter the sign of F_i. Hence, robust to the previous results, we find that firm size has a significant negative impact on the financial constraint, indicating that the large firms have fewer constraints in access to credit, and vice versa. This finding is similar to studies by Tornell and Westermann (2003); Beck et al. (2005); Beck and Demirgüç-Kunt (2006); Beck et al. (2008). We find no evidence of significant differences between non-export and export firms. Despite the coefficients being insignificant for private ownership and the firms' age, the signs give hints that the finance obstacle is more severe for younger firms, that is for a recent establishment, and for government-owned firms. This result is in line with findings by Schiffer and Weder (2001).[112] Again, to improve the interpretation, we calculate the marginal effects of the explanatory variables on the constraint. We find that the average marginal effect for small firms is 9 per cent. The change to small=1 is statistically significant. Further, the non-government dummy is significant at the 10% level, with a marginal effect of about -5 per cent.

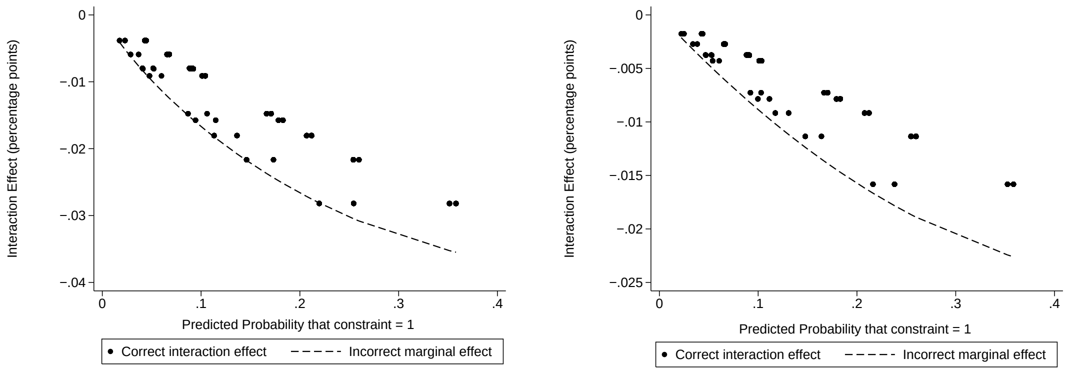
In addition, we run further regressions adding dummy variables that interact small, non-export firms, and private firms (considered individually above), to see whether they have effects on the constraint (see Table 9.7 for probit estimation results).[113] Similarly to the previous analysis, using the "sign-n-significance" interpretation is very common although not very sophisticated and perhaps even spurious (Ozer-Balli and Sorensen, 2010). We find that the coefficient for the interaction term between non-export and small firms is negative and insignificant (column 3), positive and significant for small and private (column 5), and positive and insignificant for non-export and

[111] In equation (9.2) the firm's foundation year is included for "age". Further, we do not distinguish whether the private firm is domestic or foreign-owned.

[112] The authors find that government participation is negatively significant for other obstacles like taxes and regulations, or corruption.

[113] See, for instance Ozer-Balli and Sorensen (2010) for the need to include the 'main terms' when considering the interaction effect. Analysing only the interaction terms may lead to spurious significant results that are due to left-out-variable bias. Multicollinearity occurs if the variables are highly correlated.

Figure 9.3: Interaction Effects



(a) Probit **(b) Logit**

Note: Interaction effects for small and non-export firms are shown as a function of the predicted probability. Calculation is based on the procedure proposed by Norton et al. (2004). The corresponding z-statistics are statistically significant.

private (column 7). With the dummy variables the direct effects have a conditional interpretation. Accordingly, the marginal effect of a change in both variables is different to the marginal effect of a change in the interaction term. The lower part of Table 9.7 shows the marginal effect of the individual variables and the interaction effects.[114] Following Ai and Norton (2003) and Norton et al. (2004), the magnitude of the effect can be calculated by the cross-partial derivative—or difference, in the case of discrete regressors—of the expected value of the dependent variable (that is the constraint dummy). Further, the significance of the interaction term cannot be deduced from the z-statistic of the binary regression, but must be based on the estimated cross-partial derivative.[115] Taking this into account, Figure 9.3 indicates that the sign of the coefficient for the interaction dummy is robust and negative, although the magnitude of the interaction effect varies by observation. Interestingly, although the interaction coefficient is itself not statistically significant, the interaction effect is significant for most observations. For the other interactions the effects are shown in Figure B.2 in the appendix. The interaction between (a) small and private firms is positive and overall significant; and (b) the interaction term between non-export and private firm is positive although its significance varies. In Table 9.7 the corresponding average marginal effects are given; however as the figures have shown, they are an approximation and the correct interaction effects vary widely. Adding the aforementioned control variable age

114 The effects are calculated with the `margeff,inteff,inteff3` commands in Stata.

115 The authors provide the corresponding Stata commands to determine the correct interaction effect. For details of the calculation, see Norton et al. (2004).

has no significant impact on the results. Considering the interaction of three dummy variables (included alongside with their pairwise interaction and the individual dummy variables), we find that none of the coefficients turn out to be significant. However, the slope coefficient indicating the marginal effect of the private dummy is negative and significant (column 10). [116] Finally, the control variable age indicates a significant impact on the constraint.

To summarise our findings, non-export and small firms are more likely to be constrained; private firms have significantly fewer obstacles. For small firms, the marginal effect is about 10 per cent—small firms are more constrained than large firms are. Further, we can conclude that the difference between non-export and export firms is not statistically significant. Except in the triple dummy regression (column 9–10), the firms' age seems to have no impact in either estimation. Again, the differences between probit and logit estimation results are minor (see Table B.3 in the appendix for logit estimation results).

[116] See Cornelißen and Sonderhof (2009) for partial effects in binary models with a triple dummy variable interaction term.

Table 9.7: Financial Asymmetries II

	"General constraint financing"									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
estimation results										
non-export	0.026	0.017	0.113	0.069			0.036	0.002	0.265	0.259
	[0.054]	[0.055]	[0.186]	[0.190]			[0.187]	[0.188]	[0.302]	[0.302]
small	0.348 ***	0.371 ***	0.392 ***	0.396 ***	0.006	-0.014			0.251	0.236
	[0.097]	[0.104]	[0.133]	[0.138]	[0.181]	[0.182]			[0.315]	[0.314]
non gov		-0.159		-0.155	-0.557 ***	-0.587 ***	-0.044	0.123	-0.319	-0.347
		[0.099]		[0.100]	[0.191]	[0.194]	[0.163]	[0.170]	[0.279]	[0.280]
non-export × small			-0.095	-0.057					-0.381	-0.390
			[0.194]	[0.197]					[0.387]	[0.386]
non gov × small					0.562 ***	0.563 ***			0.219	0.209
					[0.220]	[0.221]			[0.351]	[0.350]
non-export × non gov							0.030	0.050	-0.519	-0.536
							[0.196]	[0.196]	[0.407]	[0.407]
non-export × small × non gov									0.660	0.687
									[0.477]	[0.477]
age		0.001		0.001		-0.001				-0.001 ***
		[0.001]		[0.001]		[0.002]		-0.003		[0.002]
McFadden R^2	0.069	0.070	0.069	0.070	0.071	0.072	0.066	0.066	0.072	0.072
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
obs	3722	3716	3722	3716	3722	3716	3722	3716	3722	3722
marginal effects										
non-export	0.007	0.005	0.030 *	0.018			0.010	0.001	-0.002	-0.004
small	0.083 ***	0.087 ***	0.092 **	0.092 **	0.002	-0.004			0.125	0.123
non gov		-0.044		-0.043	-0.170 ***	-0.180 ***	-0.012	-0.034	-0.017 ***	-0.025 ***
non-export × small			-0.026 *	-0.025 *					0.035	0.037
non gov × small					0.126 **	0.126 **			0.023	0.026
non-export × non gov							0.008	0.013		
non-export × small × non gov									0.137	0.141

Note: Probit regression results are shown, both excluding and including control variables. *,**,*** indicate significance at 10%, 5% or 1% levels. Standard errors are given in parentheses. Marginal effects and interaction effects are shown in the lower part of the table.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005), and the author's calculations.

The previous results have shown that there are no significant differences between non-export and export firms; we use the sector classification given in the survey to analyse which sector is the most constrained.[117] In particular, different nontradable sectors that are expected to be more constrained are considered (see Table B.4 in the appendix). The results indicate that the outcome depends on the different proxies used for the N-sector; this is obvious both for the coefficients that are tabulated and for the marginal effects. We observe that the point estimate for the dummy variable for firms in the construction and transportation sector is positive, but insignificant however (regressions 1–4). When interacting this dummy with the dummy "small" (regressions 5–8) and "non gov" (regressions 9–12), the coefficient becomes statistically significant. The hotels and restaurants' dummy has a negative sign (although it is again insignificant), which does not alter when interacting with the "small" and "non gov" dummies. Finally, the wholesale and real estate sectors display large negative coefficients. These results are statistically significant. Apparently these two sectors also experience fewer obstacles in access to finance. This "sign-n-significance" finding can be confirmed by calculating the marginal effects and the interaction effects. The marginal effect is significant and negative for both the wholesale and real-estate sectors; that is, these sectors are less constrained than the other sectors are.

Overall our results suggest that some, but not all, potentially nontradables sectors appear to be more credit-constrained than the other sectors are. In this aspect, our findings for Eastern Europe do not fully confirm those reported for emerging markets in Tornell and Westermann (2005) (also for a Worldbank Survey analysis). A possible explanation could be that the survey used for our study was taken in 2005, which constitutes in many countries the peak of a lending boom compared to previous years.[118] Hence, the nontradable sector firms were not substantially disadvantaged with respect to tradable sector firms that were more likely also to have access to international capital markets. The directive on services and the posting of workers allows the provision of cross-border services and hence the free movement of workers.[119] So called "posted workers" can be employed in one EU Member State but are sent out on a temporary basis in another Member State to carry out their work abroad. For instance, an employee in the construction sector, which is historically assigned to the N-sector, can work abroad. This on the one hand increases competition within this

117 Again, a sector is identified if the firm operates wholly in this sector.

118 See, among others, Brzoza-Brzezina (2005); Coricelli et al. (2006).

119 See Directive 2006/123/EC of the European Parliament for the directive on services, and Directive 96/71/EC as well as 2008/C 85/01 for the posting of workers in the framework of the provision of services.

sector, but on the other it distorts the typical (historical) pattern between the N- and the T-sector.

To summarise our firm-level analysis, we can confirm that SMEs are more constrained than large firms are. However, we do not find evidence for a statistically significant difference between export and non-export firms. Our analysis confirms the findings of previous studies that the firm's foundation year (age) has a positive (negative) impact on the financial constraint (see, among others, Schiffer and Weder, 2001; Tornell and Westermann, 2005, for the analysis of a previous World Bank Survey).

Our analysis does not assess whether the firms have applied for credit at all or whether the firms do not have a need for credit. Therefore, to complete the deficiency between the demand and supply side effects we make further use of the survey. Interestingly, half of the 3722 firms in the sample that assess their financial constraints indicate that they currently have no loans. This is mainly because they did not apply for a loan (for 93% of these firms), rather than that their application was rejected (5%).[120] Further, 95 per cent of the firms that did not apply are small ones. These firms indicate that an absent demand for credit is the case for roughly 70 per cent of them having no need for loans; their internal funds are sufficient to run their business. This is in line with the pecking-order theory that states that internal financing is preferred by firms (Myers, 1984).[121] High interest rates and collateral requirements are less likely to be the reason.

9.2.1.2 The World Business Environment Survey (WBES)

This section aims to show how robust the results are compared to other (and earlier) studies. Starting with a comparatively small panel of firms in Eastern Europe (1239 firms), the World Business Environment Survey (WBES) was conducted the for first time by the World Bank in 2000 (World Bank Group, 2000).[122] Following the approach presented in the previous section, we distinguish in particular between small and large firms, and again, we find evidence that small firms in CEECs are more constrained. In over 34 per cent of small firms, access to finance is a major obstacle (see Table

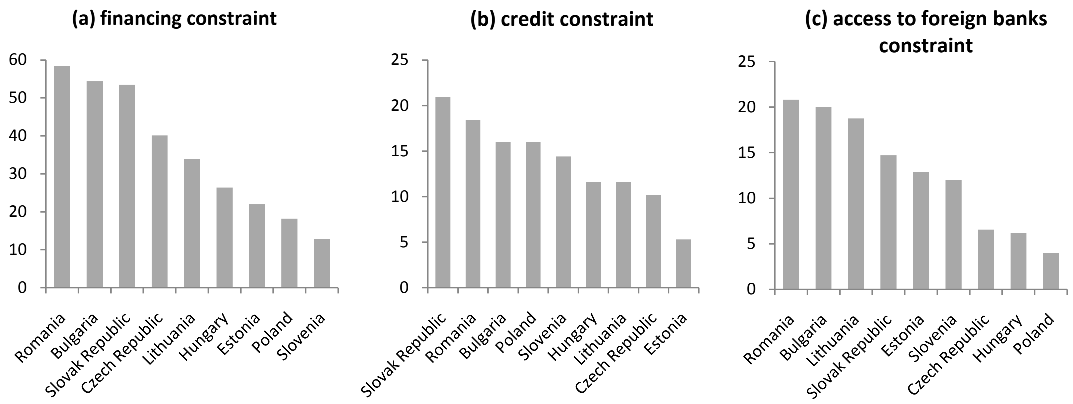
120 Note that for some firms the application for a loan was still pending.

121 However, many studies, for instance by Berger et al. (1998) have shown that, in particular, younger firms are heavily financed by external debt from financial institutions.

122 The WBES includes in total more than 9200 firms in over 80 countries, comprising both industrialised as well as developing ones. For our set of CEECs, the average number of interviewed firms in each country is 135. Poland leads with 225 and Lithuania has the least with 112. Latvia is not included in the survey.

B.5 in the appendix). This number can be understood by seeing in the distribution of the number of constrained firms that 93 per cent are small ones. Additionally, firms were asked more detailed questions on their financial constraint, that is, in addition to assessing their general constraint in finance, they further evaluate their access to credit, as well as their access to foreign banks. Again for small firms these constraints are more severe: 15 per cent of the firms experienced a major obstacle in their access to credit and 12 per cent in their access to foreign banks.[123] The constraints remain relatively severe for most countries. Figure 9.4 shows that the share of firms with major financial constraints exceeds 50 per cent in Bulgaria and Romania. For these two countries the other constraints considered are assessed as very critical. In particular, small firms benefit the most from a reduction of corruption (Beck et al., 2005). Similar to the regression results of the BEEPS in 2005, in Section 9.2.1.1, we find that SMEs are more likely to experience major obstacles to finance than are large firms (see also Beck et al., 2005). The advantage of this survey compared to the BEEPS of 2005 is that the question on financial obstacles includes the impact on both operations and growth. This allows us to analyse the linkages between financial constraints and firms' growth. It has been discussed by Coluzzi et al. (2009) and Buch and Döpke (2008).[124]

Figure 9.4: Firms with Major Constraints in Financing (WBES)



Note: The percentage of firms identifying access to finance as a major constraint. ("How problematic are these different financing issues for the operation and growth of your business?").
Source: World Business Environment Survey (World Bank Group, 2000) and the author's calculations.

123 The variables used are the following: 'general constraint—financing (gcf)', 'finance constraint—credit (crd)', 'finance constraint—access to foreign banks (acfk)'. For large firms the share of firms with major constraints is 26 per cent for access to finance, 6 per cent for access to credit, and 9 per cent for access to foreign banks, respectively.

124 The link between financial constraint and firms' growth has been recently discussed by Coluzzi et al. (2009) for selected euro area countries, and by Buch and Döpke (2008) analysing the linkage between output growth, volatility, and credit market imperfections for German firms.

9.2.2 Financial Constraints in the Euro Area

A BEEPS benchmark survey was conducted in 2004–2005 for seven non-transition countries.[125] For the euro area, this survey comprises 3355 firms in Germany, Greece, Ireland, Spain, and Portugal. Following the same procedure as described in Section 9.2.1.1, our sample is reduced to 3295 firms that assessed their financial constraints. The financial constraint is less severe for the selected euro area countries, where only 13.6 per cent of the firms indicate major obstacles in their access to finance (see Table 9.8). Similar to the CEECs, the obstacles are more severe for SMEs (14.3%) and for non-export firms (13.9%). For the countries considered, only Irish firms indicated fewer obstacles in their access to finance. Interestingly, the Irish firms that are more constrained are either large ones or exporters.[126]

Table 9.8: Constrained Firms in the Euro Area

	total firms	small and medium firms	large firms	non-export firms	export firms
Number of firms	3722	3391	331	2622	1100
Percentage share of constrained firms	13.6	14.3	6.7	13.9	12.2
Percentage share of constrained firms in:					
Germany	15.0	16.3	3.3	15.7	11.3
Greece	14.8	15.8	6.0	15.6	11.7
Ireland	7.4	7.3	8.6	6.0	10.1
Portugal	15.4	14.2	13.5	15.5	15.2
Spain	13.3	13.9	7.1	12.9	14.5

Note: Firms are identified as constrained if they respond to consider the access to credit to be a "major obstacle" in running their business.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2004) and the author's calculations.

To verify the findings given in this descriptive analysis we rerun the binary estimations. Table 9.9 shows the outcome for the probit regressions for the European non-transition countries. If the firm's size is small or medium, their access to finance is significantly constrained. Adding control variables, such as a dummy variable for privately owned or the formation year is significant, and it does not affect the finance constraints for small

125 Other than for euro area countries, surveys are conducted in South Korea and Vietnam.

126 The finding may be influenced by the fact that the share of large firms is only 7 per cent (the average value is 9.6%) and the share of export firms at 33.6 per cent exceeds the average value of 21 per cent.

firms; it does alter the sign of the coefficient for non-exporters.[127] Calculating the marginal effects indicates a significant difference between small and large firms. For non-exporters, there is a statistically insignificant difference compared with export firms. Compared to the firms in the CEECs, the Western European firms are slightly older (19.8 years) and fewer than 3 per cent are owned (at least partly) by the government. Both control variables turn out to be significant in the regression.

Table 9.9: Financial Asymmetries in the Euro Area

"General constraint financing"

	(1)	(2)	(3)	(4)	(5)	(6)
estimation results						
non-export	0.035	-0.027			-0.049	-0.0781
	[0.069]	[0.072]			[0.073]	[0.074]
small			0.447 ***	0.329 ***	0.466 ***	0.3548 ***
			[0.112]	[0.117]	[0.116]	[0.261]
non gov		0.803 ***		0.719 ***		0.716 ***
		[0.259]		[0.261]		[0.099]
age		-0.006 ***		-0.005 ***		-0.005 ***
		[0.002]		[0.002]		[0.002]
McFadden R^2	0.009	0.019	0.0156	0.022	0.016	0.022
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000
obs	3295	3292	3295	3292	3295	3292
marginal effects						
non-export	0.008	-0.006			-0.011	-0.017
small			0.078 ***	0.060 **	0.080 ***	0.064 **
non gov		0.109 **		0.102 *		0.102 *
age		0.001 ***		0.001 ***		0.001 ***

Note: Probit regression results are shown, both excluding and including control variables. *,**,*** indicate significance at the 10%, 5% or 1% levels. Standard errors are given in parentheses.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2004), and the author's calculations.

The results show that the financial constraints—in particular for small firms—in a cross-section of euro area countries are not significantly different from those in the CEECs. In contrast, the obstacle of access to finance is more severe for private firms, which might be explained by the small share of firms owned by the government.

This result can be confirmed with data from the 2005–2006 Flash Eurobarometer surveys conducted by the European Commission and the ECB for SMEs. (European Commission, 2006).[128] For policy-making this category of firms is of particular interest because 99 per cent of the firms in the European Union are small or medium-sized.

[127] The survey was conducted in 2005 for Spain and Ireland, while for the other countries the implementation period was 2004. Therefore, we add an additional year for these countries. However, that implies only minor changes in the regression results.

[128] For the euro area countries the survey was conducted in 2005, followed by interviews in the new Member States in 2006.

In addition, loans are the most important source of debt finance for non-financial corporations.[129] According to an analysis of the BACH (Bank for the Accounts of Companies Harmonised) database by the Task Force of the Monetary Policy Committee of the ESCB (2007),[130] the finance structures of firms in the euro area are relatively homogeneous. Remaining differences in bank lending across countries can be attributed to institutional and legal frameworks. The differences in the sectoral financial structure can be attributed to the degree of capital intensity that is inherent in the sectoral activity. Typically, less capital-intensive sectors such as construction or trade can be characterised in particular by short-term liabilities. A comparison between the CEECs and the EMU shows that the empirical evidence that SMEs in the euro area have more financial constraints is mixed prior to the crisis (Task Force of the Monetary Policy Committee of the ESCB, 2007). Finally, to identify the recent financial drawbacks, a new wave was conducted both for EMU and non-EMU, and EU Member States in 2009 (European Commission, 2009a,b). In addition, since 2009, the European Central Bank assesses every six months the difficulties that SMEs face in accessing finance (ECB, 2009).[131] These survey outputs confirm that SMEs face more severe financing obstacles than large firms.

9.2.3 Financial Constraints in the Crisis Period

While the main analysis discusses the financial constraints in the boom period, this section investigates briefly the recent survey by the World Bank and EBRD (2009) and the Financial Crisis Survey by the World Bank Group (2009).[132] A more detailed analysis of both surveys with a special focus on the financial crisis is provided in Drechsel (2010).[133] While the survey includes more countries compared to the previous ones, one major drawback is that the main classification for important characteristics

129 In the euro area, loans are on average 96 per cent (in 2005) of the source of finance (Task Force of the Monetary Policy Committee of the ESCB, 2007).

130 Firms in Belgium, Germany, Spain, France, Italy, the Netherlands, Austria, Finland, and Portugal are included.

131 Financial conditions in four EMU Member States, namely France, Germany, Italy, and Spain, and seven other euro area countries are considered.

132 Our analysis refers to the BEEPS data set provided by the World Bank and EBRD in October 2009. Recently, on April 30 2010, the World Bank and EBRD provided an update of this survey. For Poland and the Slovak Republic the weighting structure has changed.

133 Recently, Rancière et al. (2010) provide an analysis of the link between currency mismatch and growth, however the authors make use of the 2005 BEEPS and additionally run panel estimations including the new survey data.

has changed.[134] For instance, small and medium-sized firms comprise firms with five to 100 employees (before it was up to 250). No distinction is made between the financing of working capital and investment. Further, as the survey no longer asks about the currency denomination of the loans, this firm-level survey does not now provide information on whether the decomposition of loans might have an impact on the constraint, or might help to overcome credit constraints.[135] Similarly, foreign borrowing sources are not specified that might be used as a proxy. Based on a similar analysis presented in Section 9.2.1.1, we can recognise first that the share of constrained firms differs only marginally from the numbers before the crisis (see Table 9.4).[136] In both surveys, 21 per cent of the firms indicated major (and severe) constraints in their access to credit. Only for large firms (18.1%) is there a slight increase; for the other criteria the numbers differ only in decimal places. At the country level the evidence is mixed. For two countries, namely Poland and Hungary, the share of constrained firms decreases (see Figure 9.5).[137] For Latvia, Lithuania, and Romania the constraints are more severe. Moreover, following Kolasa et al. (2010), for robustness we distinguish between foreign and domestically owned firms. We cannot confirm for BEEPS 2009, that foreign-owned firms are less constrained than domestically owned ones; a share of foreign-owned firms indicates major and severe constraints of 11.9 per cent.

Finally, rerunning the probit regressions, we find that in the crisis period access to finance is a significant major, or even severe, obstacle for small firms (see Table 9.10). For non-export firms finding a major obstacle is not statistically significant. Finally, evidence that nontradable sector firms are more likely to be constrained is mixed. The N-sectors aggregate indicates fewer obstacles.[138] Considering the corresponding marginal effects, no statistical difference between non-exporters and exporters, small and large firms, or N- and T-sector firms can be found. However, the pattern is different if we consider a broader classification where major and severe obstacles are summarised. For this case, we find a significant difference between small and large firms, with a slight difference in major obstacles for small firms (Drechsel, 2010).

[134] See World Bank and EBRD (2009) for comparison reports of the 2005 and 2009 surveys on a individual country level.

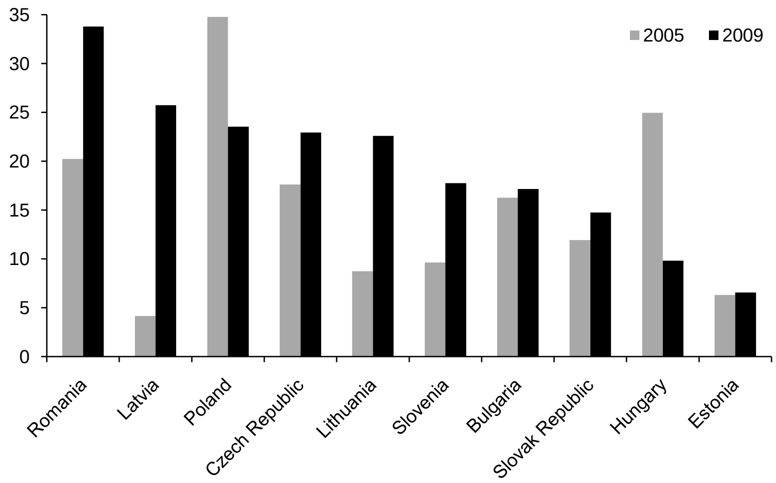
[135] This problem is caught by another survey by the World Bank Group (2009).

[136] The sample includes 3033 firms in the 10 countries, which are analysed throughout this study. Besides "major", in the recent survey the firms can asses their obstacles as "severe" as well. Considering only the severe cases reduces the number of firms considerably. For consistency with the prior survey—where the worst case is "major"—we summarise the firms which indicated major or severe obstacles.

[137] However, this result might be distorted by the fact that the number of firms for these two countries in the old survey is nearly twice the number in the new survey.

[138] The N-sector comprises the categories 'services' and 'other' in the BEEPS.

Figure 9.5: Chances in Financing Constraints



Note: The percentage of firms identifying access to finance as a major obstacle (BEEPS, 2005) and as a major or severe obstacle (BEEPS, 2009).
Source: Business Environment and Enterprise Performance Surveys (World Bank and EBRD, 2005, 2009) and the author's calculations.

While the core BEEPS 2009 is somewhat meagre regarding the firms' financing situation, as well as the currency denomination of loans, a recent enterprise survey by the World Bank, the Financial Crisis Survey (World Bank Group, 2009) fills this gap. It documents, among other things, the changes in financing for the firms. However, this survey covers only 1172 firms in five countries: Bulgaria, Hungary, Latvia, Lithuania, and Romania.[139] Similar to the BEEPS, the firms can be classified according to their size: 70 per cent are small and medium-sized firms; their non-export characteristic is 74%; and their sector affiliation is 61 per cent operating in the nontradable sector. In particular, the firms are asked about the main effects of the financial crisis on their business, including sales, employment, and finance. Ninety per cent of the firms in the sample indicate that they were affected by the crisis. Figure 9.6 shows the main effects of the financial crisis that the firms identify. Compared to the huge drop in the demand effect (over 70%), the percentage of firms that identify "reduced access to credit" as the main effect is quite low.[140] This might be explained by the fact that their access to credit was already severe before the crisis. Further, the main effects differ across countries and sectors.[141]

[139] An additional survey was conducted in Turkey.
[140] Based on 1040 firms answering this question, the shares of firms identifying decreased access to credit as a major effect of the crisis are: in Bulgaria (6.3%), Hungary (1.1%), Latvia (2.9%), Lithuania (6.8%), and Romania (5.4%).
[141] See ECB (2010b) for a recent analysis of both the impact of the financial crisis on the CEECs and the underlying macroeconomic imbalances.

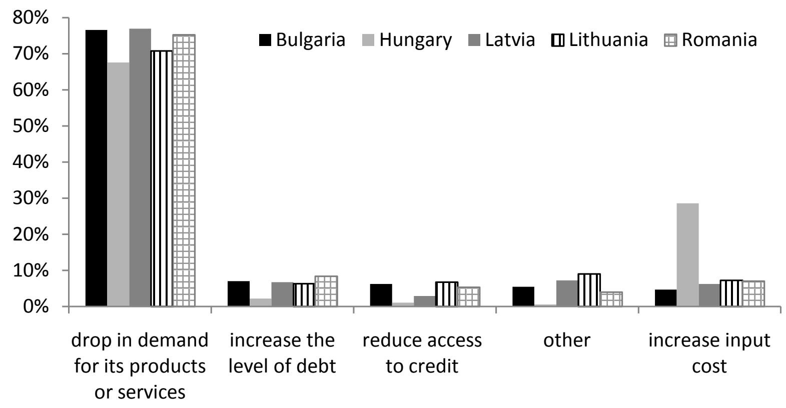
Table 9.10: Financial Asymmetries

	"General constraint financing"					
	(1)	(2)	(3)	(4)	(5)	(6)
estimation results						
non-export	0.074	0.077				
	[0.082]	[0.087]				
small			0.113 **	0.140 *		
			[0.059]	[0.064]		
N-sector					-0.027	-0.038
					[0.055]	[0.058]
non gov		-0.080		-0.114		-0.084
		[0.216]		[0.216]		[0.216]
age		-0.001		0.000		-0.001
		[0.002]		[0.002]		[0.002]
McFadden R^2	0.042	0.043	0.043	0.045	0.041	0.043
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000
obs	3033	2784	3033	2784	3033	2784
marginal effects						
non-export	0.020	0.019				
small			0.030 *	0.033 *		
N-sector		-0.010			-0.007	-0.008
non gov		-0.010		-0.020		-0.011
age		0.000		0.000		0.000

Note: Probit regression results are shown, both excluding and including control variables. The constraint dummy variable comprises major and severe obstacles. *,** ,*** indicate significance at the 10%, 5% or 1% levels. Standard errors are given in parentheses.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2009), and the author's calculations.

To summarise this section, we have shown that the financial obstacles, in particular the access to finance, were more severe for small than for large firms, while there is no significant difference between non-exporters and exporters with respect to their financial obstacles. However, the origin of the financial asymmetries are outside the scope of this thesis (see, among others, Hyytinen and Vaananen, 2006).

Figure 9.6: Effects of the Financial Crisis



Note: "What has been the main effect of the financial crisis on this establishment." (question e2). Only firms are included that answer this question.
Source: Financial Crisis Survey (World Bank Group, 2009) and the author's calculations.

9.3 Contract Enforceability

A further component of the boom–bust cycle model is weak contract enforceability. Aside from the external financing constraints presented in Section 9.2, credit constraints at the firm level can arise from moral hazard or from enforcement problems (Guajardo, 2008).[142] Weak contract enforceability entails that the banks might insure against default risk, and hence impose higher credit constraints. While the accession to the EU implies that the new EU countries have to make their corporate governance regulation conform to the EU norms, in fact the reality looks different. In general, corruption can be defined as the misuse of entrusted power for private gain (Transparency International, 2010; Svensson, 2005) and reflects the failure of legal, economic, and (or) political authorities. Political corruption—the abuse of government power for personal benefits, like vote-buying in an election—might also be a critical issue in the CEECs (see Wei, 1999). Schiffer and Weder (2001) and Beck et al. (2005) show that government ownership has influence over the extent of the obstacles to running their business. They find that firms that are either partly or fully controlled by a government might be less exposed to corruption than private firms are. Nevertheless we narrow our analysis to the corruption in the private sector.

Over recent years several types of corruption measures have been developed, such as the International Country Risk Guide's corruption indicator provided by the Political Risk Services, or the Corruption Perception Index provided by Transparency International, or the Worldwide Governance Indicators (WGI) of the World Bank (Kaufmann et al., 2009) using a broader definition of corruption.[143]

In the following section present selected corruption indicators and finally make use of the 2005 BEEPS for an assessment of corruption at the firm level.

9.3.1 Corruption Measures

The Corruption Perceptions Index (CPI) by Transparency International (2010) is a composite index that draws on multiple expert opinion surveys. In Table 9.11 the most recent index is given together with a country's ranking compared to the other

[142] According to Guajardo (2008) enforceability problems as well as the risk of default cause the external borrowing constraint.

[143] See, for instance, Svensson (2005); Desai (2003); Smarzynska and Wei (2000); Wei and Shleifer (2000).

179 countries included in the 2009 index, and the score of the perceived level of public-sector corruption in a range from 0—with the highest levels of corruption—to 10—with the lowest levels of corruption. The confidence range of the scoring indicates that the reliability of the CPI scores is given within a margin of at least 90% confidence. Finally the number of surveys used (out of 13) to determine the score are indicated in the last column. The CPI is based on eight independent surveys in CEECs.[144]

The figures in Table 9.11 indicate that corruption remains a serious challenge, with scores below 7 (out of 10). Bulgaria and Romania have the lowest score with 3.8, while Estonia and Slovenia reach the highest score among the CEECs with 6.6.[145] Comparing the annual Corruption Perceptions Index scores with the previous years' scores might lead to the conclusion that corruption perception in the Czech Republic, Latvia, Slovakia, and Slovenia has significantly improved over the last year; it does not change for Romania. However, Transparency International (2010) has stressed that a comparison of CPI over time is not advisable; rather, individual surveys should be investigated. Based on their detailed analysis Transparency International (2010), show that the score improved in Poland and deteriorated in Slovakia. Efforts on an anti-corruption campaign in Bulgaria were promoted by the new government from 2009, and included reforms in the customs and border police services. In Romania the efforts on anti-corruption are decreasing, and characterised by a lack of strategic coordination of legislative and institutional anti-corruption measures.[146] In spite of the corruption perception in the Czech Republic improving, it is one of the few signatories that have not yet ratified the United Nations Convention against Corruption.[147]

Another indicator that measures corruption is the Control of Corruption given in the set of Worldwide Governance Indicators (WGI) by the World Bank (Kaufmann et al., 2009).[148] Since 2002 the perception of corruption has been analysed annually in 208

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[144] The surveys used are the Bertelsmann Transformation Index from the Bertelsmann Foundation; Country Risk Service and Country Forecast from the Economist Intelligence Unit (EIU); Nations in Transit from Freedom House; Global Risk Service from IHS Global Insight; World Competitiveness Report from the Institute for Management Development; and the Global Competitiveness Report from the World Economic Forum for the years 2008 and 2009.

[145] For comparison, Germany has rank 14, with a CPI score of 8 (range 7.7 to 8.3) and is based on six different surveys. However, there are also EMU countries, such as Greece (score = 3.8) or Portugal (score = 5.3), that are similar to Bulgaria and Romania.

[146] Even being a member of the EU appears to reduce pressure for anti-corruption reforms (see Transparency International, 2010).

[147] The United Nations Convention against Corruption came into force in December 2005 and was signed by 140 countries.

[148] The WGI measures six dimensions of governance: Voice and Accountability, Political Stability and Absence of Violence and Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption.

Table 9.11: Corruption Perceptions Index

Country	Rank	CPI Score	Confidence Range	Surveys Used
Bulgaria	71	3.8	3.2 - 4.5	8
Czech Republic	52	4.9	4.3 - 5.6	8
Estonia	27	6.6	6.1 - 6.9	8
Hungary	46	5.1	4.6 - 5.7	8
Latvia	56	4.5	4.1 - 4.9	6
Lithuania	52	4.9	4.4 - 5.4	8
Poland	49	5.0	4.5 - 5.5	8
Romania	71	3.8	3.2 - 4.3	8
Slovakia	56	4.5	4.1 - 4.9	8
Slovenia	27	6.6	6.3 - 6.9	8

Note: Data refer to 2009.
Source: Transparency International (2010).

countries based on a variety of other surveys—they partially match the surveys used by Transparency International (2010). This corruption index is a weighted index based on 13 to 16 sources for the CEECs.[149] The data sources that are highly correlated with each other receive a greater weight in the index, because this signals more reliability in measuring corruption. Table 9.12 indicates the latest scores of the Control of Corruption measure. First, the percentile rank that ranges between 0 (low) and 100 (high) reports the countries' scores compared to all countries included in the WGI database. Further, the governance score that is ranked on a scale between -2.5 (worse governance) and +2.5 (better governance) is given. These scores are the lowest, and are negative, for Bulgaria and Romania, and highest (for the CEECs) in Slovenia and Estonia with about 0.95. While Kaufmann et al. (2009) stress taking into account the standard errors when comparing these scores, Table 9.12 shows that these are relatively similar for the CEECs. It is useful to consider the range instead of focusing just on the scores. In their comparison analysis, Kaufmann et al. (2009) find that Estonia is the only country in the CEECs with a significant increase in the corruption estimates since 1998, which is a substantial improvement in the control of corruption.

[149] The main sources are Business Enterprise Environment Survey, Business Environment Risk Intelligence Business Risk Service, Bertelsmann Transformation Index, Global Insight Global Risk Service, Economist Intelligence Unit, Freedom House, Cerberus Corporate Intelligence Gray Area, Transparency International Global Corruption Barometer, World Economic Forum Global Competitiveness Survey, Global Integrity Index, Gallup World Poll, Institutional Profiles Database, World Bank Country Policy and Institutional Assessments, Political Risk Services International Country Risk Guide, Institute for Management and Development World Competitiveness Yearbook, Global Insight Business Conditions and Risk Indicators.

Table 9.12: Control of Corruption

Country	Percentile Rank	Governance Score	Surveys Used
Bulgaria	52.2	-0.17	16
Czech Republic	66.7	0.37	15
Estonia	79.2	0.94	14
Hungary	72.5	0.55	16
Latvia	64.7	0.29	13
Lithuania	63.3	0.18	16
Poland	67.6	0.38	16
Romania	57.0	-0.06	16
Slovakia	68.6	0.43	13
Slovenia	79.7	0.95	13

Note: Data refer to 2008. The percentile rank ranges between 0 (low) and 100 (high), while governance is ranked on a scale between -2.5 and +2.5 (better governance).
Source: Kaufmann et al. (2009).

9.3.2 A Corruption Analysis

While the previous section presented several composite corruption measures, this section aims to analyse the particular survey used therein. Analysing the WBES survey, Beck et al. (2005) find that corruption obstacles resulting from less-developed both financial and legal systems imply lower firm growth rates. The authors confirm the findings of Schiffer and Weder (2001) that government-owned firms are subject to lower corruption and that small firms face higher corruption obstacles.

Using data from the 2005 BEEPS, already detailed and investigated in the previous sections, we try to assess—based on a cardinal measures of corruption—how problematic corruption is for firms in CEECs in running their business. First, Figure B.1 in the appendix indicates that corruption is among the 10 major obstacles for firms, and the share of firms that assess corruption as the biggest obstacle to running their business is only marginally smaller than the share of firms that assess 'access to finance' as the major obstacle. However, bribes have high transaction costs that are uncertain. Moreover, the ranking differs across countries.

Second, for 42 per cent of the 3542 (out of 3900) firms in our sample that answer this question corruption is not an obstacle for their business. The share of firms with major obstacles due to corruption is on average 16 per cent.[150] However the share of firms with a major obstacle due to corruption ranges from 3 per cent of the firms in Estonia and Slovenia to 30 per cent in Romania, where corruption seems to be a more problematic issue for the firms. In Bulgaria and the Czech Republic the share of firms

[150] The firms can answer the question: "How problematic is corruption for the operation and growth of your business?" (Q54q) on a scale from 1 (no obstacle) to 4 (major obstacle). None of the considered firms answered "don't know".

with major obstacles caused by corruption is, at 20 per cent, relatively high. Table 9.13 indicates that corruption is a major problem for small firms compared with large firms, while the differences between non-export firms and export firms are minor.

Table 9.13: Corruption Obstacles

		total firms	small and medium firms	large firms	non-export firms	export firms
2005	no. of firms	3542	3225	317	2495	1047
	firms with major corruption obstacles	16.2%	16.8%	10.4%	16.5%	15.7%
2009	no. of firms	1919	1345	574	1697	222
	firms with major corruption obstacles	40.0%	42.5%	34.2%	40.7%	35.1%

Note: The share of firms that assess corruption as a major obstacle for running their business is given.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005, 2009) and the author's calculations.

Compared with the most recent BEEPS, which we already presented in Section 9.2.3, the impact of corruption seems to have deteriorated, as 40 per cent of all 1919 firms that answered this question indicated major or severe obstacles related to corruption. In the ranking of all potential obstacles, the share of firms that indicated corruption as the major obstacle slightly increased.

To sum up, we have seen that corruption is a prevailing problem for firms in the CEEC. While the corruption perception increased, the governance of it has improved within the convergence period (Kaufmann et al., 2009). However, the latest figures—taking into account the recent crisis—indicate that corruption has worsened. Despite all that, the survey-based indices are highly correlated (Wei, 1999; Svensson, 2005); we must emphasise that the indices used are subjective measures and that perceptions might be different from the reality (Wei, 1999).[151] In general, an improvement to the legal environment promotes the external (formal) financing and, hence, reduces the financing constraints.[152]

[151] Kaufmann et al. (2009) distinguish between *de jure* notion of laws 'on the books' and *de facto* reality.

[152] See Chavis et al. (2010) for the relationship between the firms' age and the business environment (for instance legal and financial obstacles).

9.4 Currency Mismatch—The Role of Foreign Debt

While welcomed at the beginning of the transition period for financing the catching-up process, the large increase of credit in recent years has started to raise concerns about the creditworthiness of the CEECs. Because the large credit growth has been boosted by increasing foreign debt, in particular caused by the cross-border banking of banks and firms (Rosenberg and Tirpák, 2008), this is a key issue in this section. First, we present an overview of why foreign debt is favoured and what implications arise from large amounts of unhedged foreign debt. We illustrate the resulting currency mismatch problem (Section 9.4.1). The remaining parts of this section analyse the overall external debt in the CEECs (Section 9.4.2), the foreign exposure of the banking sector based on the BIS-statistics (Section 9.4.3), and finally we investigate foreign-currency mismatches at the firm level by making use of the 2005 BEEPS provided by the World Bank and EBRD (2005) (Section 9.4.4).

9.4.1 The Role of Foreign Debt

It must be emphasised that the terminology 'foreign debt' is not clearly defined in the literature. It is used either for the external debt or for the debt that is denominated in foreign currency. Often too the term "euroisation" is used for the degree of debt denominated in foreign currency.[153] One must distinguish between the types of borrowers who have exposure in foreign currency. Besides the government, the private sector—banks, firms, and households—can borrow abroad, or at least can borrow in foreign currency.

The incentive to hold and issue foreign debt results from different motives and is increased by several factors (see, among others, ECB, 2008b; Rosenberg and Tirpák, 2008; Luca and Petrova, 2008). Two arguments are familiar—the "natural hedge" hypothesis and the "original sin" hypothesis. According to the "natural hedge" hypothesis, the firms balance their revenues in foreign currency with foreign-currency debt. Especially for non-financial corporations, openness increases the hedging opportunities with foreign debt.[154] The "original sin" hypothesis originates from financial market

[153] See Rainer and Haiss (2010) for an overview of empirical studies on credit euroisation of the non-financial sector.
[154] Rosenberg and Tirpák (2008) show that exports plus imports are a useful proxy for openness.

constraints on emerging-market borrowers who try to broaden their investment base to be independent from limited domestic currency markets.[155] This literature goes back to Eichengreen and Hausmann (1999), Eichengreen et al. (2007), and Hausmann and Panizza (2003). According to the latter, the analysis of original sin can be partitioned into an international component and a domestic component. The first one measures whether a country is able to borrow in its own currency abroad, while the second one describes the inability to borrow long-term on domestic markets in local currency.

Opportunistic reasons support foreign-currency borrowing. That is, lower interest rates abroad lower the costs of reimbursement for the borrower.[156] An increasing share of foreign banks, and hence growing competition, implies lower borrowing costs both for households and firms (Eichengreen and Steiner, 2008). According to Rancière et al. (2010) the interest rate differential was the key driver for the high share of foreign-currency debt in recent years. This is linked to the fact that the interest rate does not include a premium capturing the currency mismatch risk. Hence financing in foreign currency is cheaper than in local currency. Despite a large decrease of nominal interest rates in the CEECs in the years prior to the recent crisis, the interest rates for foreign-currency loans were on average even lower (Eichengreen and Steiner, 2008). Figure 9.7 shows that only for the Czech Republic is the domestic lending rate lower than the foreign lending rate. For all other countries, a lower foreign interest rate seems to favour foreign-currency lending.[157] However, in contrast to Rosenberg and Tirpák (2008) who show that a higher interest rate differential leads to higher euroisation—that is a larger share of foreign-currency debt—we document in the following sections that a larger differential between the interest rates is not necessarily reflected in higher foreign-currency borrowing. It might be explained instead by the credibility of the exchange rate regime (Jeanne, 2003; Rosenberg and Tirpák, 2008).

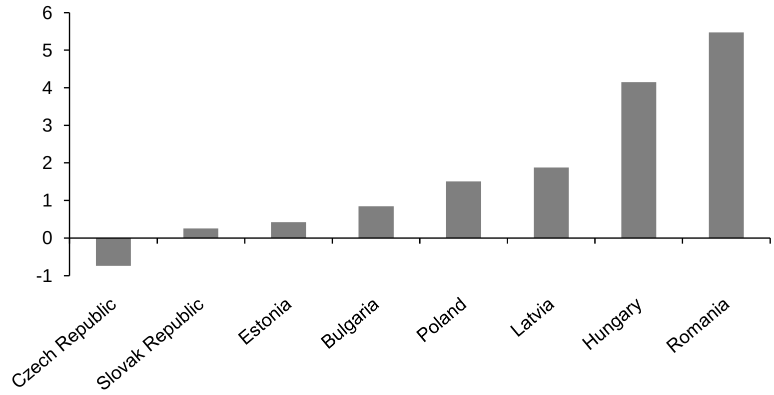
In the case of a currency board regime, only a small interest rate differential may involve a change in lending, while in a floating regime a larger difference is necessary to induce a similar shift in lending. This distinction between fixed versus flexible exchange

155 Foreign capital borrowed in international capital markets is typically denominated in foreign currency. That is, debtors cannot borrow in their own currencies.

156 This is the case if the uncovered interest parity does not hold; that is, that a difference between the interest rates of two countries cannot be adjusted either by depreciation or appreciation of the currency.

157 Average interest rate differences between the national 3-month interbank rates and the 3-month EURIBOR rate for the period 2005–07 are similar. For Estonia, the average difference has increased by 20 percentage points. However, the data are not adjusted for expected depreciation, which leads to different results compared to those in Rancière et al. (2010). They find that Hungary is the only country with a negative interest rate differential.

Figure 9.7: Interest Rate Differentials



Note: The average interest rate differences between the national 3-month interbank rates and the 3-month EURIBOR rate are shown for the period 2005–08.
Source: Datastream, national central banks and the author's calculations.

rate regimes is also considered by Backé and Wójcik (2008), who find that countries with a currency board regime—where the exchange rate risk is smaller—tend to have larger shares of foreign debt. The empirical analysis by Arteta (2005) shows that a flexible exchange rate exacerbates rather than ameliorates the currency mismatches of banks.[158] Hence, the variability of the exchange rate seems to be negatively correlated with foreign borrowing. An expected depreciation of the exchange rate results in higher expected borrowing costs and hence reduces the demand for foreign-currency debt.[159] Figure 9.8 shows that there is a slightly negative relationship between exchange rate volatility and the share of foreign-currency liabilities.[160]

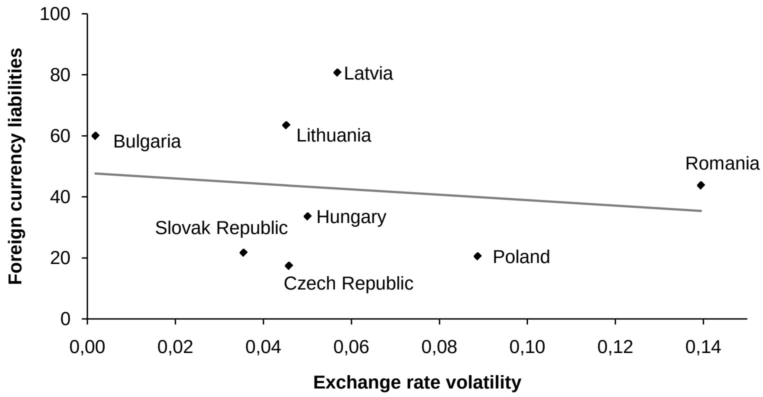
Finally, forthcoming euro adoption also contributes to a higher amount of foreign borrowing in euros with the anticipation that the exchange rate risk will vanish (Yeyati, 2006). Already participation in the EU and in the ERM II have resulted in an increasing foreign-currency debt (Rosenberg and Tirpák, 2008). This is due to better access to

158 Note that Arteta (2005) ignores the natural hedging of the firms. His assumption is that only the banks' credit supply affects the level of foreign debt.

159 In contrast, the study by Honig (2009) shows that the exchange rate regime does not promote euroisation directly; rather, the quality of the government has a significant negative effect on euroisation.

160 However, in a panel regression Rosenberg and Tirpák (2008) find that the coefficient of exchange rate volatility is rather small and not statistically significant. We can confirm the negative relationship—pictured in Figure 9.8—with an OLS estimation, where
foreign liabilities$= -47.8 - 88.6\cdot$ exchange rate volatility.

Figure 9.8: Exchange Rate Volatility and Foreign-currency Liabilities



Note: The share of liabilities that is denominated in foreign currency (Indicator I24 of the Data Report Tables of Financial Soundness Indicators, 2008) is shown with the average exchange rate volatility, calculated as the standard deviation of quarterly percentage changes of the exchange rate vis-à-vis the euro, compared to the previous year, over the period 2000–08.
Source: Eurostat (2009), Financial Soundness Indicators 2008 (IMF, 2009a) and the author's calculations.

foreign funds (financial liberalisation), natural hedging opportunities (trade openness), and the confidence of the private sector in exchange rate stability.[161]

Even the size of the countries might have an impact on foreign borrowing (Hausmann and Panizza, 2003). The smaller the countries, the more prone they are to borrow abroad. However, Rosenberg and Tirpák (2008) shows that the size strongly interacts with other determinants of foreign borrowing and recommend the exclusion of this indicator from empirical analyses.[162] Another aspect concerns the borrowing focus on neighbouring countries. Finally the size of the loans as well as their maturity militate in favour of foreign-currency borrowing (Brown et al., 2008).

While, the major reasons for foreign borrowing are summarised above, and the costs and benefits of euroisation or dollarisation—such as lower interest rates and an increase in trade versus the challenges to monetary policies—have been widely discussed in the literature, (see, among others, Rochon and Seccareccia, 2003) we aim instead to document in the following sections the currency mismatches in the CEECs.

161 Determining trade openness by the ratio of exports plus imports to GDP, the analysis by Rosenberg and Tirpák (2008) shows that this is only the case for non-financial corporations and not for households.

162 The size can be proxied for instance by GDP compared with the EU average or by population measures.

9.4.1.1 Models of Foreign Debt

The terminology 'currency mismatch' is defined ambiguously in the literature. In general, currency mismatch originates if there are differences in currencies in which assets and liabilities are denominated on the balance sheet of the private and the public sector and the economy as a whole (Eichengreen et al., 2007). More precisely, currency mismatch can be defined by the sensitivity of net worth to changes in the exchange rate (see, for instance, Goldstein and Turner, 2004).

There is no consensus, on how currency mismatch and the degree of foreign-currency-denominated debt (hereafter also foreign debt) should be measured (Hausmann and Panizza, 2003; Goldstein and Turner, 2004; Eichengreen et al., 2007; Rancière et al., 2010). Typical measures are, for instance, to compare the net national debt to the net exports of a country, or to calculate the ratio of foreign-currency-denominated liabilities to foreign-currency-denominated assets of the banking sector. The advantage of these measures is that the currency mismatch can be easily calculated by using available data. However, major drawbacks are that it is either not possible to separate between sectors or that the degree of currency mismatch is fudged by the fact that banks with a high amount of foreign-currency debt tend to lend in foreign currency (Rancière et al., 2010). In this case, in spite of the currency mismatch being small, the banks are exposed to exchange rate risk through credit risk if their debtors cannot hedge the exchange rate risk. Therefore Rancière et al. (2010) present a new measure calculating the foreign-currency-denominated net unhedged liabilities to total bank assets.[163]

Various studies (see, among others, Blank and Buch, 2007; Guajardo, 2008; Luca and Petrova, 2008) try to picture the differences between banks and firms in foreign borrowing. Few studies take into account the households' side (Schneider and Tornell, 2004; Pellényi and Bilek, 2009; Beer et al., 2010). The main ideas of the firm models are that the investment of the firms is financed either with net worth and (or) external credit.[164] Typically, this borrowing increases consumption and investment in the same period, but has to be repaid in the second period. Taking into account various types of risk preferences, for a risk-neutral firm the choices of debt in the local currency or in a foreign currency are equivalent. The model by Luca and Petrova (2008) assumes that all firms in the economy are identical, but in contrast to the common assumption,

[163] Total foreign-currency lending is adjusted by subtracting the foreign-currency lending to unhedged households and firms from the banks' assets.

[164] External credit comprises both domestic and international sources.

it is assumed that banks and firms are risk-averse. They can borrow either in domestic or in foreign currency to finance their production costs. Bank credit is the only source of external finance for the firms that were considered exporters of at least a small share of their output, and that accordingly, receive foreign-currency revenues.[165] The models by Berrospide (2008) and Luca and Petrova (2008) show that firms have access to domestic and international bank markets and can borrow from local banks in domestic currency or in foreign currency from foreign banks. However, according to the boom–bust cycle theory, firms have limited access to international capital markets (external borrowing constraint) and financing opportunities between the tradable and the nontradable sector are asymmetrical. While the T-sector firms can borrow abroad directly, both with better access to financial markets and by financing with, for instance trade-credits from customers, the N-sector firms can only rely on financing by national banks. These may pass the risk of their incurred foreign debt to the firms.

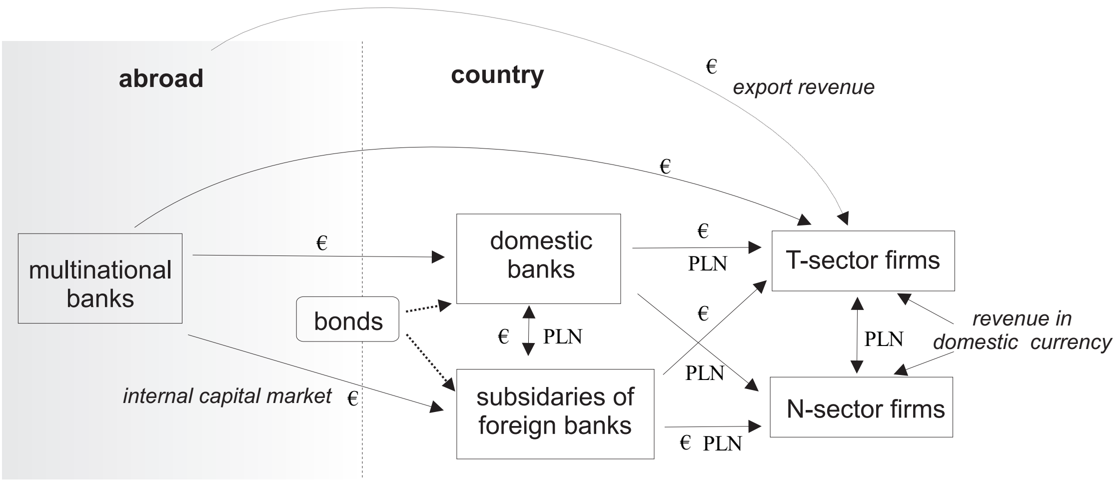
9.4.1.2 Currency Mismatch

As pointed out in Schneider and Tornell (2004) and Tornell and Westermann (2005), a high degree of foreign-currency liabilities can lead to balance sheet effects in the aggregate, when firms, particularly in the nontradable sector, have revenues in domestic currency, while their debt is denominated in foreign currency, and they have only limited access to the hedging instruments (Diev and Pouvelle, 2008). This phenomenon is often referred to as "currency mismatch". In many emerging markets that were characterised by a substantial degree of currency mismatch, a real appreciation has reduced the value of the debt—denominated in foreign currency—and has allowed firms to borrow more and more. In the case of a sudden real currency depreciation the debt amount of the N-sector firms increases significantly and might cause the banking system to crash, hence the resulting lending booms might end in a joint banking and currency crisis. Large imbalances of foreign debt between sectors can amplify the spillovers of financial crisis (Luca and Petrova, 2008).

Figure 9.9 shows the channels where currency mismatch can originate. On the one hand, it occurs on the banks balance sheets—with liabilities in foreign currency (proxied by €) and assets in domestic currency (proxied by PLN). The banks can borrow either abroad or in the case of subsidiaries of a foreign bank via internal capital markets, but usually their assets are in domestic currency. The banks are then exposed to the

[165] Assuming correlation between changes in the exchange rate and domestic prices, they consider the same optimisation for non-exporting firms, which only sell domestically.

Figure 9.9: Currency Mismatch



Note: € indicates lending in foreign currency and PLN lending in domestic currency.
Source: author's illustration.

exchange rate risk themselves. However, the currency mismatch in the banking sector is limited, as foreign-currency assets (essentially foreign-currency loans) are almost compensated for by foreign-currency liabilities (essentially foreign-currency deposits) at least to the extent needed to comply with regulatory requirements.

On the other hand, the banks can pass the currency risk to firms (households) by issuing foreign-currency loans or foreign-currency-linked loans.[166] For firms, the currency mismatch might be different. At least for tradable-sector firms and exporters that have revenues in foreign currency, the risk emerging from currency mismatch can be hedged.[167] However, the majority of the debtors do not have income in foreign currency that they could use to hedge the risk, in particular small firms, non-exporters, and nontradable-sector firms are subject to currency risk. If these firms cannot repay their loans, *de facto* currency mismatch arises at the firm level. In the case where the firms themselves are not able to hedge, the currency risk is only displaced between banks and the non-financial corporate sector (Luca and Petrova, 2008). Thus, the banks are indirectly exposed to the risk, while the banks' degree of currency mismatch itself is small. Currency mismatch among households might be large, in particular if the

[166] See, among others, Goldstein and Turner (2004) for a presentation of the overall foreign-currency balance sheet of an economy, taking the public sector, for instance, with net international reserves on the asset side, and foreign-currency-linked domestic debt and external foreign-currency debt on the liability side into account.

[167] Even firms that might have access to international trade and finance can be affected if their exports decrease due to declining foreign demand, or if they borrow directly abroad (Rancière et al., 2010).

households cannot hedge the currency risk with income in foreign currency. However, this is outside the scope of this analysis.[168]

Based on this view, the "dual role" of currency mismatch is evident: on the one hand foreign-currency borrowing augments the financial sources and facilitates the financing in particular for small and younger firms. This contributes to increasing growth, but on the other hand involves increasing exposure to systemic risk (see Rancière et al., 2010).[169]

Banks and non-banks (households and firms) can issue debt in national or foreign currencies. While country-specific data for external debt are available from the Bank of International Settlements and the Joint External Debt Hub statistics, sources for firm- and household-specific data are scarce.[170] The problem is that the firms are not obliged to account for foreign-currency-denominated debt. Some of the larger firms have noted in the appendix of their annual balance sheets which amount of their debt is denominated in foreign currency. However, the specification of the currency is rare. While the bulk of the literature analyses the determinants of the currency composition of firms and banks and the consequences of foreign debt (Yeyati, 2006), the empirical evidence on currency risk at the bank level and firm level is scarce (Luca and Petrova, 2008).[171] Measures proposed in the literature are, for instance, to compare the net debt of a country with net exports, or to consider the ratio between the foreign-currency-denominated liabilities to the assets of the banking sector (see, among others, Rancière et al., 2010). The ratio of foreign debt to total debt (Berrospide, 2008) can be considered. While an example of a firm-level analysis of currency mismatches is presented in Section 9.4.4, the following sections investigate currency mismatch at the aggregate level (Section 9.4.2).

[168] See Beer et al. (2010) for an Austrian household analysis of the so-called "carry trade", that is the household's borrowing in a low-yielding currency and investment in a high-yielding currency; and Pellényi and Bilek (2009) for the foreign-currency borrowing in Hungarian households.

[169] Using a firm-level analysis, Rancière et al. (2010) find that currency mismatch helps to overcome firms' credit constraints by improving the borrowing conditions and increasing firms' growth. Based on an aggregate bank-level analysis, they find that in tranquil times currency mismatch is linked with higher growth, but more problems arise during crisis periods.

[170] External debts are financial obligations to a creditor who is not a resident of the debtor's country (IMF, 2008).

[171] For a discussion of foreign-currency liabilities and their implications for macroeconomic stability in Eastern Europe, see also Yeyati (2006).

9.4.2 Currency Mismatch at the Macro Level

In recent years, the analysis of currency and maturity mismatches in sectoral balance sheets is one of the IMF's measures for the surveillance of emerging markets. The balance sheet approach is used to identify debt-related vulnerabilities. While consolidated balance sheets are considered by the BIS, sectoral balance sheets—government, financial, non-financial, external—can provide additional information.[172] However, the indirect channel between financial and external sectors should not be neglected.

For an analysis of the aggregate currency mismatch or foreign debt, the Joint External Debt Hub (JEDH), developed by the BIS, IMF, OECD, and the World Bank (BIS-IMF-OECD-World Bank, 2010), differentiates between types of debtors, financial instruments, time spreads, and currencies. While the gross external debt comprises the total outstanding amount of liabilities that are owed to non-residents by residents of an economy (IMF, 2003), the international debt covers securities in all (foreign) currencies issued to residents and non-residents in an economy.[173] The absolute figures measured in US dollars indicate that the share is comparatively minor for the Baltic economies, while for Poland and Hungary the external debt was five times larger by the end of 2008. Similarly, Figure 9.10 reveals that the ratio of external debt to GDP differs among countries.[174] In the Czech Republic and Poland the ratio is less than 50 per cent, which is evidence of their preference for domestic currency; it reaches dimensions of over 140 per cent in Hungary. A high proportion of foreign-currency debt is also observable in Latvia and Estonia (see also Rosenberg and Tirpák, 2008). These differences are also observable when looking at the ratio of external debt to domestic credit. In the Czech Republic and Poland the amount of external debt is lower than domestic credit, with a ratio of 66 per cent and 76 per cent respectively.[175] The highest ratio is reached for Hungary with 174 per cent in 2008.

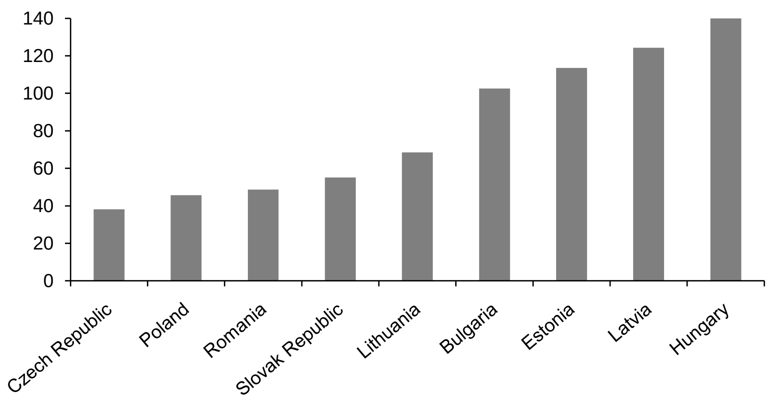
172 The balance sheet of external financial assets and liabilities is named international investment positions in the official balance of payments statistics and is broken down to four sectors. Figure B.4 in the appendix shows the direct linkages between the sectoral balance sheets.

173 The (IMF, 2003, p. 7) defines gross external debt as "the outstanding amount of those actual current, and not contingent, liabilities that require payment(s) of principal and (or) interest by the debtor at some point(s) in the future and that are owed to non-residents by residents of an economy."

174 Manzocchi (1997) shows that aside from the debt-to-GDP ratio, the debt-to-export ratio can be used as an alternative measure of country-specific sustainability of the stock of foreign debt.

175 Author's calculation based on IFS data (IMF, 2009b).

Figure 9.10: External Debt



Note: Ratio of external debt to GDP is given in per cent for 2008.
Source: Joint External Debt Hub (BIS-IMF-OECD-World Bank, 2010) and IFS (IMF, 2009b).

The sectoral breakdown in Figure 9.11 gives an overview of the sectoral external debt relative to total external debt by the end of 2008. Clearly the banking sector and the 'other sectors' are the sectors that are the most exposed to foreign debt.[176]

According to the IMF (2003), foreign-currency debt can be defined as debt that is payable in currency other than the domestic one.[177] For economies with significant gross foreign-currency external debt, detailed information is provided in the JEDH. For the countries considered in this thesis, only for Bulgaria, Hungary, and Romania does the JEDH split the gross external debt position into foreign currency and domestic currency. Most recent data referring to 2009Q4 indicate that the share of foreign-currency debt to total external debt is 96.8 per cent for Bulgaria, 85.5 per cent for Hungary, and 88.3 per cent for Romania.

9.4.3 Currency Mismatch at the Bank Level

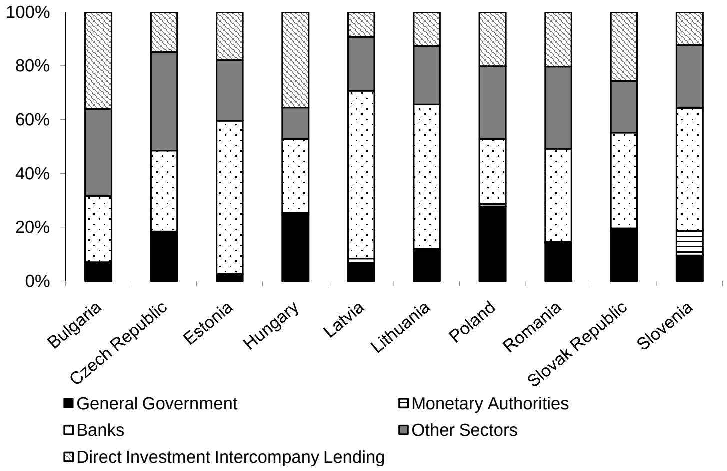
9.4.3.1 Share of Foreign Banks

While the cross-border lending measured of the BIS reporting banks has already been analysed in the previous section, we must stress that the level of foreign debt is also

[176] Interestingly, for Hungary, the country with the largest debt-to-GDP ratio, the shares of these two sectors are comparatively small.

[177] This also includes sub-categories of foreign debt such as the debt that is payable in a foreign currency, but with the amounts to be paid linked to a domestic currency (domestic-currency-linked debt), and the debt that is payable is in domestic currency but with the amounts to be paid linked to a foreign currency (foreign-currency-linked debt)(IMF, 2003).

Figure 9.11: External Debt by Sectors



Note: External debt by sectors is given. Data are based on 2008 Q4 in US dollars.
Source: Joint External Debt Hub (BIS-IMF-OECD-World Bank, 2010).

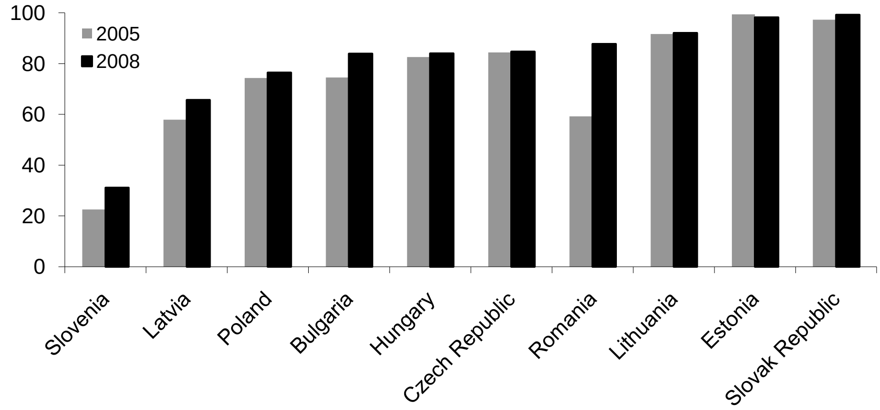
influenced and facilitated by the level of foreign-owned banks (parent banks), which bolster the banking system stability (see Rosenberg and Tirpák, 2008; IRC expert group on financial stability challenges in candidate countries, 2008; Paulhart et al., 2009). First, the number of foreign-owned banks in a country gives rough evidence of the impact of foreign-currency lending and borrowing.[178] Slovenia has the lowest share of foreign banks and, respectively, a low asset share of foreign banks. In Latvia and Lithuania about half of the banks are foreign-owned. Estonia is extremely different, with a share of foreign banks of almost 90 per cent. For the Czech Republic, Poland, and Romania the number of foreign banks is quite large, with shares above 80 per cent in 2008.

Second, Figure 9.12 gives more precise evidence on the foreign banks' influence and shows a common measure of financial integration. Measured by the asset share, almost all assets of the banking sector are foreign-owned in Estonia and the Slovak Republic. Similarly, foreign banks in Lithuania held more than 90 per cent of the banking sector's assets at the end of 2008, which clearly shows that foreign-owned banks dominate.[179] On the contrary, the share of foreign banks' assets in Slovenia is slight at 30 per cent. Empirical analyses show that the impact of foreign banks on the level of foreign-currency differs across countries and sample periods. For a smaller set of countries Paulhart

178 Based on EBRD (2009) data available from 1996 onwards, the share is simply calculated as the ratio of foreign-owned banks to total banks in the country.

179 While the asset share of foreign banks has increased on average by 40 per cent since 2000, the changes from 2007 to 2008 are minor. Estonia is the only country where the asset share decreased marginally by 6 percentage points in 2008.

Figure 9.12: Market Share of Foreign Banks



Note: The market share of foreign banks is shown measured by the asset share of foreign-owned banks to total banking sector assets (in per cent).
Source: EBRD (2009) and the author's calculations.

et al. (2009), for instance, find evidence that the asset share of foreign banks is not significantly correlated with foreign-currency lending.

9.4.3.2 BIS Data

Based on the components of total bank claims, we can proxy the currency mismatch in the countries' balance sheets and the level of foreign-currency debt to the private sector. Figure B.3 in the appendix indicates the general structure of total bank claims provided by the BIS (BIS, 2010), that is the liability positions of resident banks vis-à-vis non-residents. Total foreign claims (A+B+C) are based on international claims (A+B) and local claims in local currency (C). The local claims of local affiliates of foreign banks in foreign currency (C) are the difference between all local claims of the affiliates of foreign banks (B+C) and the local claims of affiliates of foreign banks in local currency (B) (Maechler and Ong, 2009).[180]

Table 9.14 presents the share of foreign bank claims on the public and private sectors in the percentage of total foreign bank claims at December 2008. The claims on the public sector are the highest in the Slovak Republic (32%) and Poland (29%), and the lowest in Estonia (3%). These figures remain similar to the previous year, while they increased prior to 2007 (Maechler and Ong, 2009; BIS, 2010). The average of foreign bank claims on the private sector is quite high (82%). The increase over recent years

[180] Local affiliates of foreign banks includes foreign subsidiaries and branches.

is mainly related to the increasing claims on the non-bank sector, with a share of 63 per cent of total foreign claims.[181]

Table 9.14: Sectoral Structure of Total Foreign Claims

	Private			Public
	Non-bank	Bank	Total	
Bulgaria	78.3	11.2	89.5	10.5
Czech Republic	69.8	9.5	79.3	20.7
Estonia	69.6	27.8	97.4	2.6
Hungary	55.5	16.0	71.4	28.6
Latvia	67.9	23.8	91.8	8.2
Lithuania	61.7	19.6	81.2	18.8
Poland	58.2	13.1	71.3	28.7
Romania	67.4	16.3	83.8	16.2
Slovakia	47.6	20.6	68.2	31.8
Slovenia	62.0	27.1	89.2	10.8

Note: Foreign bank claims on private and public sectors in per cent of total foreign bank claims by December 2008.
Source: Bank of International Settlements (BIS, 2010) and the author's calculations.

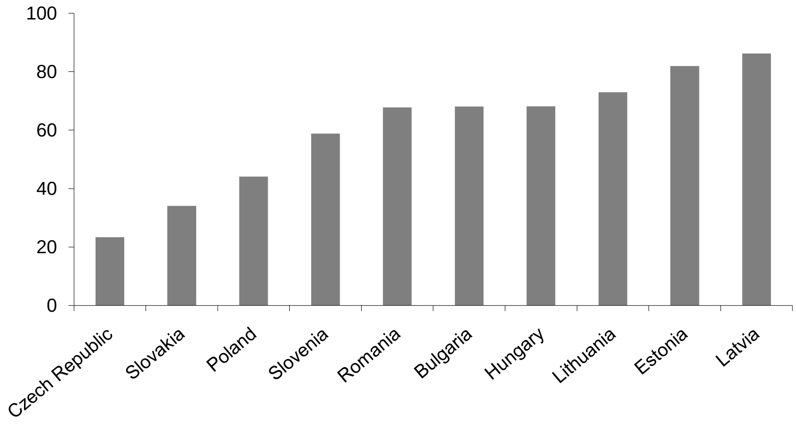
In particular, the borrowing of the non-bank private sector is increasingly dependent on foreign banks.[182] These claims are more often denominated in foreign currency, especially in the Baltic countries with more cross-border lending and more lending from local affiliates of foreign banks. Figure 9.13 indicates that the share ranges from 23 per cent in the Czech Republic to 86 per cent in Latvia.[183] Blank and Buch (2007) find a positive relationship between banks' cross-border activities and trade.[184] In their long-run regressions Blank and Buch (2007) find that the explanatory power of the model for assets and liabilities vis-à-vis non-banks is much higher than for assets and liabilities vis-à-vis banks.

However, the overall asset-to-GDP ratio indicates that the total size of the CEECs' banking sector is low compared with a ratio of almost 300 per cent for the euro area.[185]

Interestingly the claims as well as liabilities of the banks reporting to the BIS remained stable at the beginning of the financial turmoil. However, in the course of the crisis

181 The share of foreign bank claims on the non-bank sector in claims to the private sector is 78%.
182 Despite that, domestic banks have a cost advantage in their market relative to foreign banks (Agénor and Aizenman, 2008).
183 For the Czech Republic, Lithuania, and the Slovak Republic, Maechler and Ong (2009) find that borrowing in local currency by foreign affiliates is increasing.
184 The link between imports and liabilities is positive, while the link between exports and assets can be either positive or negative. Exceptions are international financial centres, where Blank and Buch (2007) find negative links.
185 This figure refers to the end of 2006 (see the IRC expert group on financial stability challenges in candidate countries, 2008).

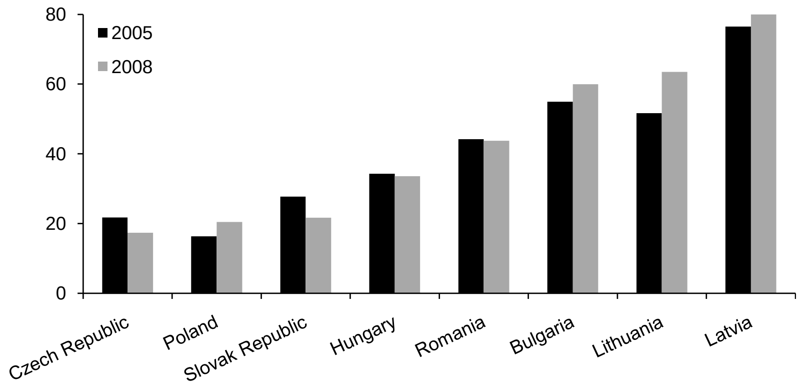
Figure 9.13: Bank Claims in Foreign-currency



Note: The share of international claims, that are cross–border claims and local claims in foreign-currency, to total claims is given in per cent.
Source: Bank of International Settlements (BIS, 2010) and the author's calculations.

the parent banks have withdrawn liquidity from their foreign markets to tackle their domestic liquidity needs.

Figure 9.14: Foreign-currency-denominated Liabilities



Note: The figure shows the share of liabilities that is denominated in foreign currency (Indicator I24 of the Data Report Tables of Financial Soundness Indicators, 2008). The values for Hungary are taken from the Bank Regulation and Supervision Database (2007).[186]
Source: Financial Soundness Indicators of the IMF (2009a) and Bank Regulation and Supervision Database 2007 provided by Barth et al. (2008).

Analysing liability substitution, Figure 9.14 reveals two interesting facts on the foreign-currency liabilities. First, when comparing the share of foreign-currency liabilities

[186] The response to question 7.8: "What percentage of the commercial banking system's liabilities is foreign-currency denominated?" of part 7 (Liquidity & Diversification Requirements) of the 2007 Bank Regulation and Supervision Database is used.

to total liabilities of the banking sector there are striking differences between the countries.[187] Bulgaria, Lithuania, and Latvia, countries where the exchange rate risk is low relative to their exchange rate arrangements, have shares of foreign-currency liabilities of more than 50 per cent. In contrast, the Czech Republic and Poland have rather low shares of less than 20 per cent, values that are typical for countries in the EMU.[188] These are substantial amounts and are close to the values typically observed in Latin America and East Asia during the 1990s, where currency crises have triggered the widespread banking crisis. Second, comparing the most recent data (year 2008) with the Financial Soundness Indicators of 2005, there are two countries—the Czech Republic and the Slovak Republic—where the share has decreased. While for Hungary and Romania the share remains relatively robust, the share has increased in Bulgaria, Lithuania, and Latvia. While the euro dominates in foreign-currency loans and deposits in most of the countries, the Swiss franc is favoured in Hungary (Pisani-Ferry and Posen, 2010).

To prevent having large currency mismatches on their balance sheets, which is required by the regulatory framework, banks borrow in foreign currencies to increase their loans denominated in foreign currency. Figure 9.15 indicates a positive relationship between asset euroisation and liabilities euroisation, and that for most of the countries the share of foreign-currency assets is slightly higher than the share of foreign-currency liabilities.[189] This implies that the currency risk is passed to the private sector; only in Bulgaria and the Slovak Republic the foreign-currency liabilities were larger than the foreign-currency loans. However, the difference between the share of foreign-currency loans and the share foreign-currency liabilities is minor. Only for Romania and Poland do we find a discrepancy of about 14 per cent. Over this time the euroisation process has been asymmetric between loans and deposits—while the foreign-currency deposits remained stable over time, the foreign-currency credits have increased (see Rosenberg and Tirpák, 2008).

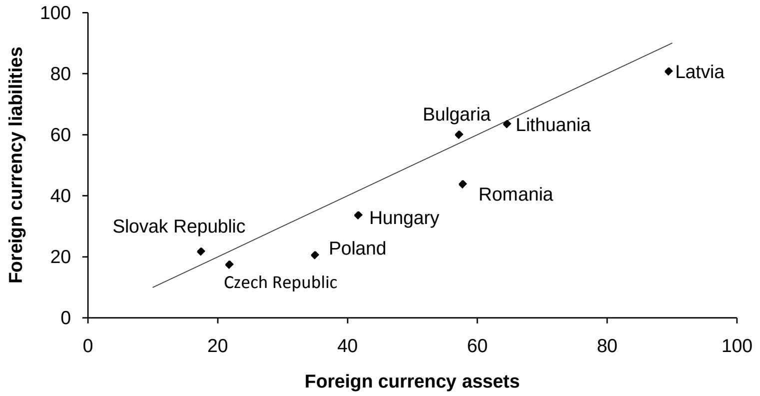
187 No data are available in the FSI (2008) database on foreign loans and liabilities for Slovenia, Hungary, and Estonia. For Hungary, data from the Bank Regulation and Supervision Database 2007 provided by Barth et al. (2008) are used to fill this gap.

188 The share of foreign-currency liabilities to total liabilities in the EMU average is roughly 17.5 per cent. This value is calculated using available Financial Soundness Indicators for 2008 for Austria, Germany, Greece, Luxembourg, the Netherlands, Portugal, and Spain, provided by the IMF (2009a).

189 This comparison is inexact, because both indicators are related to the total share of liabilities and loans respectively. But under the assumption that the banks' balance sheet is balanced, this relationship can be used for the argument.

190 The response to question 7.7: "What percent of the commercial banking system's assets is foreign-currency denominated?" and to question 7.8: "What percent of the commercial banking

Figure 9.15: Banks Currency Mismatch



Note: The figure shows the share of loans and the share of liabilities that are denominated in foreign currency (Indicators I23 and I24 of the Data Report Tables of Financial Soundness Indicators, 2008). The values for Hungary and Slovenia are taken from the Bank Regulation and Supervision Database (2007).[190]
Source: Financial Soundness Indicators of the IMF (2009a) and Bank Regulation and Supervision Database 2007 provided by Barth et al. (2008).

The share of euro in total loans including domestic liabilities refers more closely to the use of foreign currencies and liability substitution in general. Figure 9.16a indicates that the euro dominates in loans in the Baltic economies. On average, the CEECs denominate 38 per cent of their loans in euro.[191] The share of the euro in total foreign-currency loans provides an indication of the role of the euro in liability substitution compared with other currencies. Figure 9.16b shows that while the share of the euro in foreign-currency loans is above 80 per cent for most of the countries, Poland and Hungary deviate with a share of the euro of less than 25 per cent.[192]

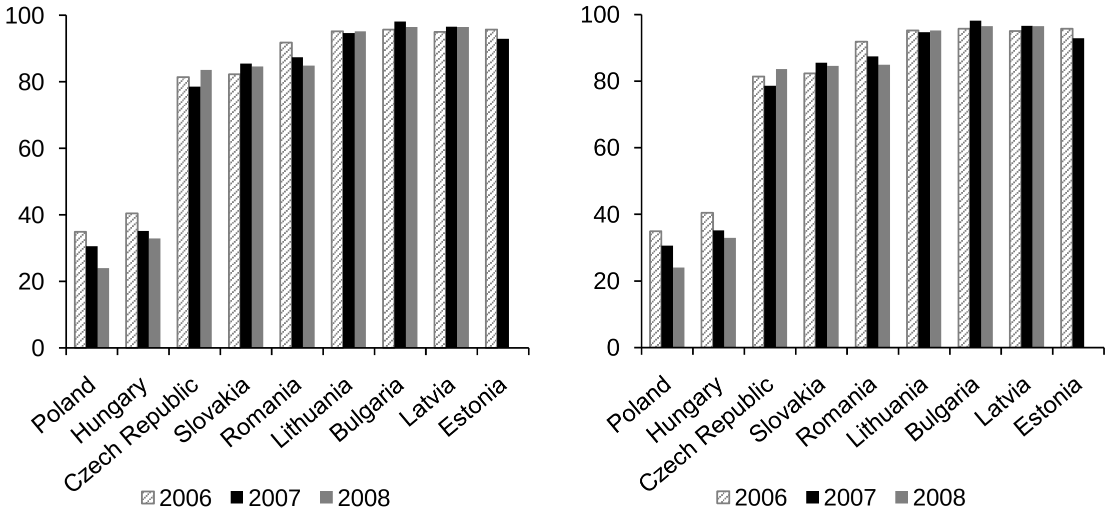
Tornell et al. (2003) stress that a simple comparison of foreign-currency-denominated assets and liabilities is incorrect and at most is a vague proxy, as these indicators represent only a subset of the total balance sheet. This measure is not sufficient if the banks are strongly exposed to the N-sector. The impact of banks' currency mismatch depends positively on the banks' risk aversion and negatively on the number of identical banks (Luca and Petrova, 2008).

system's liabilities is foreign-currency denominated?" of part 7 (Liquidity & Diversification Requirements) of the 2007 Bank Regulation and Supervision Database are used.

191 This is in line with the results of Luca and Petrova (2008), who find for transition economies that on average 39 per cent of total loans are foreign-currency loans. Data refers to 2008, because latest data is not yet available for all countries (ECB, 2010).

192 The Swiss franc clearly dominates in the foreign-currency loans (Brzoza-Brzezina et al., 2010; Eichengreen and Steiner, 2008). However, the euro exchange rates and Swiss Franc exchange rates as well as the two interest rates are closely correlated.

Figure 9.16: Share of euro in Loans



(a) As a Percentage of Total Loans **(b) As a Percentage of Foreign-currency Loans**

Note: No data are available for Estonia in 2008.
Source: ECB (2008b, 2009).

9.4.4 Currency Mismatch at the Firm Level

The choice of the foreign-currency-denominated debt provides an insight to firms' risk approach. Typically firms are faced with several risks arising from exchange rate exposure:[193] General *market risk* emerges from changes in financial conditions and exchange rates. A high share of foreign liabilities increases the *exchange rate risk* (*translation risk*).[194] *Economic risk*, reflecting the uncertainty about future cash flows, along with the *transaction risk*, that is, the risk of variations of the value of committed future cash flows, and the *rollover risk*, that is, the risk associated with the refinancing of debt, arise from foreign-currency borrowing.[195] Finally, the *insolvency risk* is not fully covered by the risk premia on foreign debt, because bail-out guarantees granted by the government are decreasing the systemic risk.

193 See, among others, Döhring (2008); IRC expert group on financial stability challenges in candidate countries (2008).

194 As proposed by Diev and Pouvelle (2008), the ratio of differences between foreign-currency-denominated loans and deposits to GDP can be used for the assessment of exchange rate risk. Referring to the firm level, the risk of variations of the value of assets and liabilities denominated in foreign currency is also referred to as *translation risk*.

195 Rollover risk is large if the foreign debt is of a short-term nature.

Brzoza-Brzezina et al. (2010) show that for the CEECs private sector, domestic and foreign- currency loans are close substitutes. Attempts to assess the currency mismatch at the firm level are given by Bodnar (2009). In her analysis of the exchange rate exposure of Hungarian enterprises she finds that firms are more likely to have foreign-currency debt if the firm is older, operates in manufacturing industry, or has a higher share of export revenues. This is in line with empirical studies for other countries, for instance, by Gelos (2003) on Mexican firm-level data, who shows that export firms borrow more abroad (in foreign currency). This confirms the theory based on a "natural hedge". The analysis by Kedia and Mozumdar (2003) on US firm-level data shows that firms which issue foreign debt have larger sales and total assets. Kolasa et al. (2010) point out that in the case of financial frictions and high shares of foreign-currency debt, balance sheet effects might be a major problem. The authors show that the welfare gain with a fixed exchange rate regime is higher under these conditions.

In the following section we analyse the foreign debt in CEECs, with the focus on borrowing in foreign currency and in particular the difference between the N-sector and T-sector. However, neither portfolio investment in foreign currency nor foreign-currency reserves are considered directly.[196] Traditional foreign exchange markets (swaps, forwards) as well as the sustainability of foreign debt (see Manzocchi, 1997) are also omitted from the analysis.

A Currency Mismatch Analysis

In this section we use the 2005 BEEPS—already presented in more detail in Section 9.2.1—to provide information on the currency denomination of the firms' loans (see Rancière et al., 2010; Brown et al., 2008).[197] This analysis provides evidence of the role of foreign-currency debt that is investigated theoretically in the previous sections. Table 9.15 indicates that the majority of loans are denominated in domestic currency.[198] Thirty per cent of large firms and exporters have loans denominated in foreign currency. For small firms and non-exporters this share is slightly lower (around 20%). This share can be interpreted as the share of unhedged foreign-currency borrowing.

196 For portfolio investment in foreign currency see, for instance, the Coordinated Portfolio Investment Survey (CPIS) conducted annually since 2001 by the IMF.

197 This analysis is based on the 1689 firms that state whether their most recent loan was denominated in local or foreign currency. This results from the fact that not all firms have applied for loans. Further, we assume that this loan reflects the denomination preferences of the firms debt (Rancière et al., 2010). The currency is not specified and we assume that the euro is the dominant currency.

198 This refers to the firms' answers to question Q.46f of the BEEPS (2005): "Was the loan denominated in local or foreign currency?"

Table 9.15: Currency Denomination of Loans

	local	foreign
all firms	77.0	23.0
small firms	78.7	21.3
large firms	66.2	33.8
non-export firms	81.7	18.3
export firms	69.7	30.3
constrained firms	79.8	20.2

Note: The currency decomposition of the most recent loan is given in per cent.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculations.

These descriptive results can be confirmed with a binary regression. The currency mismatch CM in firm i is proxied by a dummy variable that is 0 if the most recent loan was in local currency and is 1 otherwise.[199]

$$CM_i = c + F_i + \text{constraint}_i + \sum_{n=1}^{9} D_n + \varepsilon_t, \qquad \text{with } i = 1, ...1689 \qquad (9.3)$$

where F_i is the firm specification, that is, size and (non-)export, and constraint$_i$ indicates whether the firm faces major obstacles in access to finance (see also Section 9.2). D_n is a country dummy.[200]

Table 9.16: Currency Mismatch

	(1)	(2)	(3)	(4)	(5)
non-export	-0.441 ***			-0.521	
	[0.071]			[0.080]	
small		-0.389 ***			-0.407 ***
		[0.097]			[0.105]
constraint			-0.038	-0.257	-0.130
			[0.089]	[0.145]	[0.255]
non-export × constraint				0.405 **	
				[0.179]	
small × constraint					0.125
					[0.270]
Mc Fadden R^2	0.080	0.068	0.059	0.083	0.068
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000
obs	1689	1689	1689	1689	1689

Note: Probit estimation results are shown for the currency denomination of the loans. *,**,*** indicate significance at 10%, 5% or 1% levels. Standard errors are given in parenthesis.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculations.

199 Similarly, Rancière et al. (2010) apply a logit model to estimate currency mismatch by firms' characteristics, firms' age, past sales, and country dummies. The associated probability is labelled as "propensity score".

200 Industry-specific dummies are not considered, as suggested by Rancière et al. (2010).

Table 9.16 indicates that the firm characteristic—that is being a small firm or a non-export firm—has a negative impact on the denomination of their loans in foreign currency. Hence, these firms are more likely to borrow in domestic currency. However, interacting these characteristics with the dummy variable for constrained firms changes the sign of the coefficient. Table 9.16, columns 3–4, indicate for non-export firms that this coefficient is positive and significant. For the nontradable sector no clear conclusion is reached. We find a positive coefficient for constrained firms in almost all sectors, suggesting that in these sectors the foreign-currency-denominated loans are more relevant. Only for the hotel sector the coefficient is negative. However, the significance is negligible. We partly confirm the theory that currency mismatch helps to overcome financial constraints in the non-export sector. For small firms and N-sector firms our results do not support the statement significantly. A more detailed analysis using the BEEPS to determine the currency mismatch can be found in Rancière et al. (2010). They find that currency mismatch relaxes the constraint for small firms and firms operating in the nontradable sector.[201] However, a major problem of this analysis is that it is not obvious whether the requested loan and the granted loan are denominated in the same currency.

Finally, the World Bank's Financial Crisis Survey (2009), which we already used in Section 9.2.3, can be used to assess the foreign-currency risk during the crisis. The firms are asked to state their share of foreign-currency liabilities, and the results indicate that half of the firms in the sample borrow abroad, that is, in foreign currency (see Table 9.17).[202] Latvian firms are more likely to borrow in other currencies than in Latvian Lats (63%). Similarly, the share of firms in Hungary that borrow in foreign currency is 57 per cent. Also for Romania and Lithuania the share of firms with foreign-currency loans is well above 40 per cent and reaches almost 30 per cent in Bulgaria. For all firms, the share of liabilities that is not denominated in domestic currency ranges between 17 per cent for Bulgaria and 41 per cent for Latvia.[203] The findings are similar for small firms that represent over 70 per cent of the firms in our sample. For large firms, the share of firms with foreign-currency loans is extremely large, amounting to up to 98 per cent in Lithuania. The share of foreign-currency loans in total liabilities ranges in a narrow band between 30 and 40 per cent, both for

201 The analysis by Rancière et al. (2010) is different to our analysis, as it follows a propensity score matching procedure.

202 This refers to question d8 of the World Bank Group (2009): "What percentage of the total level of liabilities (debt) of this establishment is denominated in foreign currency?".

203 Considering only firms that indicate a share of foreign-currency liabilities greater than zero, we find that the average share of foreign-currency liabilities to total liabilities for the five countries is around 62 per cent.

small and large firms. Only for Bulgarian firms is the share of non-Lev-denominated liabilities lower (17%).

Table 9.17: Firms with Foreign-currency Liabilities

	Total sample	small firms	large firms	non-export firms	export firms
Total	48.8%	41.7%	76.6%	40.6%	67.4%
Bulgaria	28.6%	24.1%	47.4%	27.0%	33.3%
Hungary	56.8%	50.0%	66.7%	36.0%	84.2%
Latvia	63.0%	57.1%	73.7%	55.8%	75.9%
Lithuania	44.7%	38.5%	97.7%	34.3%	70.5%
Romania	48.3%	40.7%	76.5%	43.3%	63.3%

Note: The share of firms that indicate that they have loans in foreign currency is given.
Source: Financial Crisis Survey (World Bank Group, 2009) and the author's calculations.

As noted above, firms are faced with foreign-currency risk if they cannot hedge the exchange rate fluctuations by income in domestic currency. Therefore, we consider the share of non-export and export firms that borrow in foreign currency. Our findings indicate that export firms are more likely to demand foreign-currency loans. At the country level, we find that the share of Hungarian exporters that borrow in foreign currency is the largest with 84 per cent, followed by the Latvian exporters (75%). The latter even denominate almost the half of their liabilities in foreign currency. While the analysis has shown that the shares of firms that borrow in foreign currency are higher for large and export firms, there is clear evidence also that the small or non-export firms have a comparatively high share of loans in foreign currency (with more than 40%). Moreover, the recent crisis has shown that currency mismatch is highly correlated with a sharper drop in GDP (see Rancière et al., 2010).[204]

[204] See Rancière et al. (2010) for a correlation analysis between the nontradable to tradable output ratio and currency mismatch.

9.5 Exchange Rate Fluctuations

The real effective exchange rate (REER) can be used as a competitive measure; it is defined as the ratio of domestic prices of nontradable goods relative to the prices of tradable goods. A rise in the relative price of nontradable goods corresponds to an appreciation of the real exchange (spending effect).[205]

According to the BIS (Klau and Fung, 2006) the effective exchange rate is calculated as a geometric weighted average of bilateral exchange rates based on a 'double-weighting' procedure.[206] For the calculation of real values, the nominal effective exchange rate is adjusted by relative consumer prices. While for instance the weights used in the IMF's calculation of REERs are fixed (1999–01), the weights used by the BIS are time-varying and are currently based on the trade structure for 2005–07. Figure 9.17 illustrates an increase—a trend to appreciation—of the real effective exchange rate (REER) prior to the financial crisis. Given the real convergence process towards the euro area average this is not surprising.

After the failure of Lehman Brothers in September 2008 most of the REERs depreciated sharply and it was pronounced in Poland and Hungary. Since the beginning of 2009 the REER appreciated again.[207] In contrast, the downward pressure of the REER turned out to be less pronounced in Bulgaria.

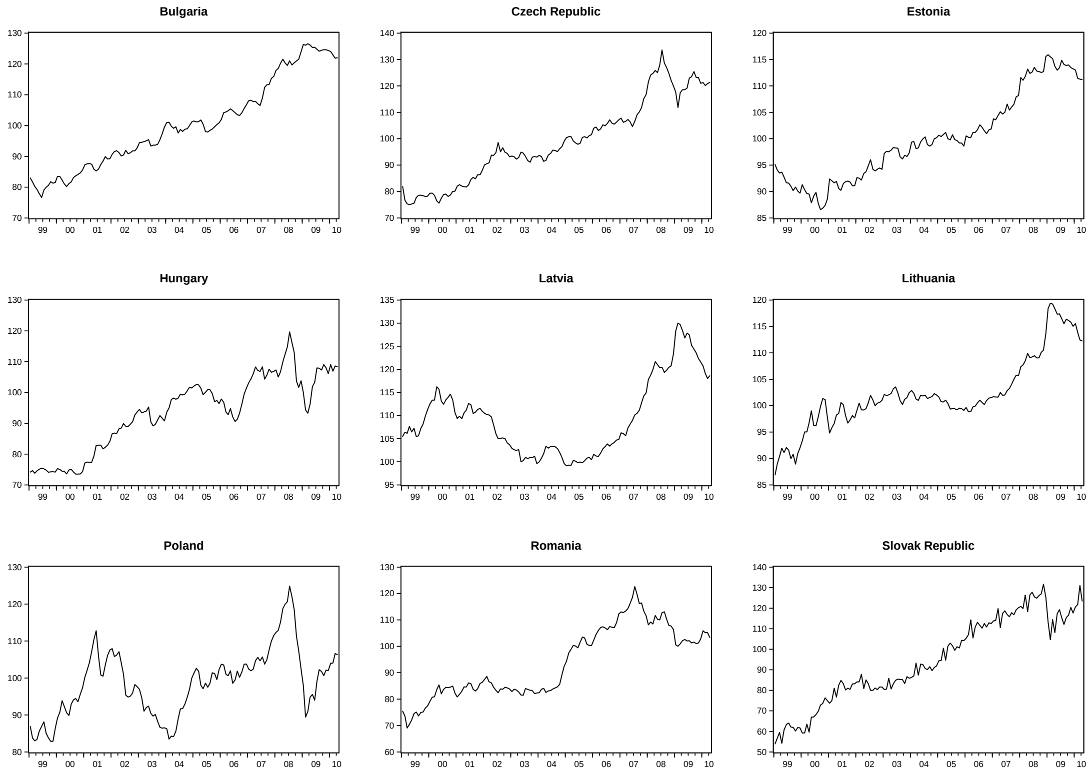
The results of different REER calculations should be interpreted with considerable caution due to different weighting procedures, reference years, and the number of trading partners included in the calculation by national and international sources. For robustness, we have therefore calculated the relative price between nontradable and tradable goods by the inverse of the real exchange rate. The latter is based on the nominal exchange rate between the individual countries and the euro area, and both domestic and foreign consumer prices. The results are close to the ones given by the REERs.

[205] See Bakardzhieva et al. (2010) for a recent analysis of the impact of capital inflows on the REER. The authors find that FDI and foreign debt (proxied by other net investments in the financial account as a percentage of GDP) have an insignificant, negative impact on the REER in the CEECs.

[206] See Klau and Fung (2006) for a detailed description of the BIS methodology to calculate effective exchange rates.

[207] To overcome the crisis and to restore sound growth, the IMF approved a Stand-By Arrangement in November 2008 for Hungary, and a Flexible Credit Line for Poland in May 2009.

Figure 9.17: Real Effective Exchange Rate



Note: Effective exchanges rate indices are the ratio of an index of the monthly average of the currency to a geometric average of the exchange rates of selected countries and the euro area (2000 = 100). Relative consumer prices are used as deflators to give real values. An increase of the index indicates an appreciation of the national currency.
Source: BIS (BIS, 2010).

10 Sectoral Comovement

Business cycle analyses are very common, and in particular the output comovements among countries are extensively discussed, but analyses of the sectoral (dis-)aggregated data are comparatively rare.[208] Comovements across sectors have been analysed earlier with respect to several research questions (for example, employment) and for different countries.[209] So far, no study focused on a sectoral analysis for the CEECs. Thereby the sectoral comovement gives useful information for the overall development of these countries by defining the characteristic of the business cycle (Hornstein, 2000). This chapter analyses common time-series properties (*common features*) in the sectoral business cycles of several Central and Eastern European EU countries. As before, the 10 considered countries are Bulgaria, the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovakia and Slovenia. Our analysis tests for long-term and short-term comovements between the tradable sector (T) and the nontradable sector (N) within each country. Since the fundamentals of the common feature analysis have been proposed by Engle and Kozicki (1993), the bulk of the common feature literature is still increasing, as Urga's (2007) overview on the variety of common features has shown. In the following we deal with common stochastic trends (Engle and Granger, 1987), serial correlation common features (SCCF) (Vahid and Engle, 1993), and polynomial serial correlation common features (PSCCF) (Cubadda and Hecq, 2001; Ericsson, 1993), as well as codependence (Cubadda, 1999a).

The remainder of this chapter is as follows: In Section 10.1, the classification in the N-sector and the T-sector are described and individual time-series characteristics in

[208] Earlier common features analyses with regard to the CEECs focus on the synchronisation of business cycles between the CEECs and the EU and Germany, respectively. Real and financial integration of the acceding countries are considered, testing correlation, cointegration, and common autocorrelation features (Buch and Döpke, 2000); but none of these studies considers sectoral comovements.

[209] See, among others, Long and Plosser (1987); Engle and Issler (1995); Caporale (1997); Hornstein (2000); Cubadda et al. (2002); Harvey and Mills (2002); Cheung and Westermann (2003) and Raddatz (2008).

sectoral data are analysed. Section 10.2 investigates common features in the sectoral time series and presents the results. Section 10.3 gives a comparison of the sectoral behaviour in selected euro area countries. In addition, we present some extensions of our analysis in Section 10.4, including the results for seasonally adjusted data; we use only two industries instead of an aggregation of sectors and the outcomes for the whole sample that comprise the crisis period. Finally, the implication of our results for the participation in the EMU are summarised in Section 11.

10.1 Preliminary Analysis

After a brief description of the sectoral data, the following sections aim to determine the individual time-series features of the sectoral data. Above all the distinction between stationary and non-stationary series is important for the following study. Further we analyse the process structure, and finally the correlation between the N-sector and the T-sector provides the first evidence on the relationship between the two sectors.

10.1.1 Data Description

The dataset employed comprises the gross value added data of the NACE aggregates at chain-linked volume (reference year 2000) in national currency and is provided by Eurostat.[210] While in the main part of the analysis seasonally unadjusted data covering the period between 1995QI and 2008QI (labelled "pre-crisis" hereafter) are used, we analyse seasonally adjusted data (Section 10.4.1) and the total sample period (1995QI and 2009QII) as well (see Section 10.4.3).[211] The pre-crisis sample comprises approximately 53 raw observations for each series in quarterly data.[212] We neglect further data transformation, for example, taking the logarithm, to avoid unnecessary distortions in our results (Corradi and Swanson, 2006).[213]

210 The data are provided by Eurostat in the tables "namq nace06 k". Other industry variables, such as employment or capital services (Hornstein, 2000), are not analysed here. While Cubadda et al. (2002) propose to analyse output instead of gross value added data to include the shock propagation mechanism that is induced by the input-output structure of the economy, we do not take into account intermediate consumption.

211 CensusX12 seasonal adjustment procedure is applied.

212 Two of the analysed countries have a smaller sample. For the Czech Republic the sample covers only data starting in 1996Q1 and for Romania in 2000Q1.

213 While it is common in the economic literature to use logged data, actual data are analysed in the following, as Corradi and Swanson (2006) showed that the results of unit root tests are severely biased and common feature tests may suffer power problems.

Table 10.1: Sector Classification

	T-sector		N-sector
[A]	agriculture, hunting, and forestry	[F]	construction
[B]	fishing	[G]	wholesale and retail trade
[C]	mining and quarrying	[H]	hotels and restaurants
[D]	manufacturing	[I]	transport, storage, and communication
[E]	electricity, gas, and water supply	[J]	financial intermediation
		[K]	real estate, renting, and business activities

Note: The NACE classification (rev.1.1) is given in parenthesis.
Source: Goldstein and Officer (1979); Eurostat (2008).

With a distinction between sectors which produce tradable goods (T) and sectors which produce nontradable goods (N) we can take into account the different reaction to exchange rate variation or different foreign financial lending possibilities. The sectoral data series are aggregated for the N-sector and the T-sector of each country. Following Goldstein and Officer (1979) we chose the classification given in Table 10.1. In contrast to these authors, who allocate the agriculture, mining, and manufacturing sector to the tradable sector, and simply define the N-sector as 'all other industries' from which the gross valued added originates, we skip the government sector and social sectors (education, health, and social work, and so on), as they are hardly affected by exchange rate fluctuations.[214] In addition, we have studied the bivariate case, where the T-sector is determined only by manufacturing and the N-sector by construction, as often used in literature (see Section 10.4.2). However, this classification is censorious for the countries under investigation due to the excessive construction boom in the CEECs, in particular in the Baltic states (Égert and Martin, 2008).

214 The sectors are classified by the NACE classification (Nomenclature générale des activités économiques dans les Communautés Européennes). This classification scheme is applied in the European Union since 1970 and is revised in 2002 (NACE, rev.1.1). While a new revision (NACE, rev.2) was implemented on January 1st, 2008, Eurostat still use the former data classification in its database in the transition period until 2011 (Eurostat, 2008). Please note, that the countries are no longer obliged to publish individual sectoral data, hence only aggregated data are published by Eurostat. Accordingly, the tradable sector is defined by agriculture, hunting, forestry, and fishing (A_B) and total industry (excluding construction) (C_D_E), while the nontradable sector is defined by construction (F), wholesale and retail trade; hotels and restaurants; transport, storage, and communication (G_H_I) and financial intermediation; real estate, renting, and business activities (J_K). The sectors public administration and defence; compulsory social security (L); education (M); health and social work (N); social and personal service activities (O) and activities of households (P) are omitted.

The total gross value added is the sum of the individual sectors. Hence, we simply sum up the corresponding sectors according to Table 10.1, to the N-sector and the T-sector respectively.[215]

The output data plotted in Figure C.1 in Appendix C show an upward trend both for the nontradable sector as well as the tradable sector. The graphs of their first differences of gross value added data, calculated as year-on-year growth rates are shown in Figure C.2. The sectoral growth rates display completely different volatilities and no clear pattern is obvious—whether the growth rate of the T-sector or the N-sector is higher. A more detailed analysis of sectoral volatility, presented in Section 10.3.3, will shed some light on the differences between sectoral cycles in CEECs and in EMU countries. Notwithstanding that this graphical analysis already delivers some insights into the sectoral characteristics in the CEECs, we further analyse empirically the trend behaviour and the stationarity of time series, respectively.

10.1.2 Unit Root Tests

One key characteristic of the data is the order of integration, denoted by $y \sim I(d)$. Stationarity of the time series is given, if the stochastic process, that is, the time series, has a constant mean and variance, being finite over time, and the covariance between two time periods depends only on the lag between the two periods and not the time at which the covariance is computed. Besides this weak (covariance) stationary process, strict stationarity is fulfilled if all moments of the probability distribution function are invariant over time.[216] In the case that one of the first two conditions is not fulfilled the series might have a unit root, that is, the process is I(1). In this section we apply two standard methodologies to test the degree of integration: the Augmented Dickey–Fuller (ADF) test in Fuller (1976); Dickey and Fuller (1979) and the HEGY test in Hylleberg et al. (1990).

215 Using volume data for the analysis, no weighting scheme is necessary, as it is suggested by Hornstein (2000) for the aggregation of the growth rates. Nevertheless, we analyse the share of the industries in total gross value added in Section 10.3.3.

216 $E(y_t) = E(y_{t-p}) = \mu$, $Var(y_t) = E\left[(y_{t-p} - \mu)^2\right] = \sigma^2$ and $E\left[(y_t - \mu)(y_{t-s} - \mu)\right] = \gamma_s \quad \forall t, s.$

10.1.2.1 ADF Test

Although, there are various methods for testing non-stationarity or stationarity (see, among others, Phillips and Perron, 1988; Kwiatkowski et al., 1992)[217], we apply the common Augmented Dickey–Fuller (ADF) test (Fuller, 1976; Dickey and Fuller, 1979) with the following equation to test the null hypothesis of the non-stationarity:

$$\Delta y_t = \mu + \gamma t + \alpha y_{t-1} + \sum_{p=1}^{p^*} \beta_p \Delta y_{t-p} + \epsilon_t \ , \tag{10.1}$$

where Δy denotes the sectoral growth rate at time t and ϵ_t the error term. The lag structure p^* is selected by the Schwarz criterion (SIC) with a maximal lag length of $p = 8$.[218] We allow for an intercept μ and a deterministic trend t. If the time trend is not significant we rerun the ADF test using intercept only. The null hypothesis of non-stationarity $(a = 0)$ is rejected if $|\alpha| > 0$. The critical values given in MacKinnon (1996) are used, taking into account the finite sample properties, and the lag order.[219]

Table 10.2 reports the ADF test results for the pre-crisis period. The gross value added data display the expected pattern: we cannot reject the null hypothesis of non-stationarity for the level data. Regarding the growth rates, the ADF test fails for most of the countries and we can reject the null of a unit root for the series under investigation, at least at the 10% significance level. Hence, a unit root (stochastic trend) is found for the raw indices, indicating that the data are difference stationary, that is, I(1). This condition prompts the question of whether or not these trends are common across sectors. The only outliers are the N-sector growth in Estonia where we find a sharp downturn after 2006Q3, and the N-sector in Romania with a reduced

217 For robustness the Phillips-Perron (PP) approach is pursued as well, using a non-parametric correction for serial correlation in the error term instead of adding lagged values as regressors. However, because the results do not differ significantly from those of the ADF test, we do not tabulate them.

218 In some cases the optimal lag length is determined by a "general-to-specific" approach (Hall, 1994), where we start at the a priori chosen upper bound (p=8) and drop the last lagged regressor if it is not significant (t-test) and the residual is white noise.

219 The calculation of a response surface equation has already been proposed earlier by Cheung and Lai (1995), who define the finite-sample critical values as $CV_{N,k} = \tau_0 + \sum_i^2 \tau_i (1/T)^i + \sum_j^2 \phi_j [(k-1)/T]^j + \epsilon_{N,k}$, where T is the effective number of observation defined as the difference between the total number of observations N and the lag k. For $k = 1$ the critical values differ only marginally from those given in MacKinnon (1991). Cheung and Lai (1995) show that the critical values approach most rapidly to those in MacKinnon (1991) for the test with no constant or trend; the critical values given in MacKinnon (1996) are those that are commonly used.

Table 10.2: Unit Root Test Results

Null Hypothesis: series has a unit root

	N-sector				T-sector			
	Level		First Differences		Level		First Differences	
Bulgaria	1.21	[4]	-3.25 **a)	[0]	-0.76	[4]	-3.19 **	[0]
Czech Republic	2.95	[7]	-3.03 **	[0]	0.86	[4]	-2.60 *	[0]
Estonia	-1.49	[4]	-1.65	[0]	1.32	[1]	-6.74 ***	[3]
Hungary	-0.20	[4]	-3.00 **	[0]	-0.62	[4]	-3.18 **	[1]
Latvia	2.16	[4]	-4.58 ***	[0]	0.24	[6]	-3.52 **	[0]
Lithuania	2.07	[4]	-2.86 *	[0]	1.17	[4]	-4.11 ***	[0]
Poland	1.61	[5]	-2.68 *	[1]	1.87	[3]	-3.71 ***	[0]
Romania	9.61	[3]	-1.64	[2]	-1.63	[5]	-3.69 **	[1]
Slovak Republic	0.96	[4]	-4.01 ***	[0]	4.06	[3]	-4.81 ***	[0]
Slovenia	1.54	[8]	-2.83 *a)	[3]	1.72	[7]	-3.52 **	[1]

Note: The table reports the ADF test statistics for the level and first differences of the nontradables sector (N) and the tradables sector (T) based on an estimation without a trend. The lag parameters selected by the Schwarz information criterion (with a maximum lag of 8) are given in parenthesis. The probability for the stated t-statistics is given by the MacKinnon (1996) one-sided p-values. *,**, *** indicate significance at the 10%, 5% and 1% levels. a) indicates that the lag length is selected manually by the "general-to-specific" method (Hall, 1994).

data sample.[220] Including a trend in the ADF test has little impact on the results.[221] We find no evidence for trend stationarity in the first differences. As the evidence for unit roots is influenced by the optimal lag length, we also test the optimal lag length according to Akaike criteria (AIC) and can confirm the results above, and even reject the null more often.

10.1.2.2 HEGY Test

Another problem that should not be neglected is that the sectors might feature unit roots at various seasons (see for example, Hylleberg et al., 1990). While seasonal dummies or seasonal adjustment take the seasonal component into account (see Section 10.4.1), Lee (1992) argues that the analysis of adjusted data yields a mistaken inference on the economic relationship.[222] Furthermore, important information is lost, especially if the seasonal fluctuations are the source of the cyclical pattern. Another critical aspect in using seasonally adjusted data is that seasonal drifts over time might be

[220] For the sample period from 1996Q1 to 2007Q3 the ADF test for the Estonian N-sector growth rates indicates that the null hypothesis can be rejected.

[221] While the results for ADF tests without a trend are given in Table 10.2, we find evidence for trend-stationary data for the N-sector in Hungary and the T-sector in Bulgaria, Hungary, Romania, and Slovenia.

[222] In the case of a deterministic seasonal pattern it is important to remove the seasonality by including seasonal dummies in the regression (Wolters and Hassler, 2006).

possible and may have an impact on the results, that is, a shock lasts forever and may permanently change the seasonal pattern. Therefore original data should be considered as being a seasonally integrated process (of order 1) that has seasonal unit roots at frequencies $\theta = \left\{0, \frac{1}{2}, \left[\frac{1}{4}, \frac{3}{4}\right]\right\}$, where θ is given as the share

of a total circle of 2π.[223]

The polynomial $(1 - L^4)$ can be rewritten as

$$(1 - L^4) = (1 - L)(1 + L)(1 - iL)(1 + iL) = (1 - L)(1 + L)(1 + L^2)$$

which implies that our quarterly processes might have four possible roots, 1,-1 and the complex roots $\pm i$, corresponding to a zero frequency root (quarterly cycle), a two-period (biannual) cycle and one cycle per year.

Following the basic ordinary least squares estimation proposed by Hylleberg et al. (1990) (thereafter the HEGY approach), the sectoral growth rate is estimated by

$$\Delta_4 y_t = \sum_{i=1}^{4} \Pi_i y_{i,t-i} + \epsilon_t, \tag{10.2}$$

with

$$\begin{aligned} y_{1,t-1} &= (1 + L + L^2 + L^3) y_{t-1} \\ y_{2,t-1} &= (1 - L + L^2 - L^3) y_{t-1} \\ y_{3,t-1} &= (1 - L^2) y_{t-1} \\ y_{4,t-1} &= y_{3,t-2}, \end{aligned}$$

where L is the lag operator. We estimate an extended version of equation (10.2) including either an intercept c, deterministic seasonal dummies D_i, and a deterministic trend t or all:

$$\Delta_4 y_t = c + \sum_{i=1}^{4} \Pi_i y_{i,t-i} + \sum_{i=1}^{3} \beta_i D_i + \gamma t + \Delta_4 y_{t-p} + \epsilon_t \tag{10.3}$$

[223] Hylleberg et al. (1990) emphasise that for the analysis of the seasonal factors, a distinction between a purely deterministic seasonal process, a stationary seasonal process, and integrated seasonal processes are necessary. In the first case the series is simply a constant value that is given by the mean and the seasonal factors. The second case refers to a series that is generated by an autoregressive process. And the third case is evident, if the series has a seasonal unit root in its AR representation.

where $\Delta_4 y_{t-p}$ are additional lags. t-tests are d for the null hypothesis of seasonal integration $\Pi_1 = 0$ (unit root at zero frequency) and for $\Pi_2 = 0$ (unit root at semi-annual frequency).[224] Finally a joint F-statistic is calculated for $\Pi_3 = 0$ and $\Pi_4 = 0$, with the null hypothesis of a unit root at seasonal frequency.[225] Note that these hypotheses are not alternatives and have to be analysed individually. The natural alternative hypothesis for these three hypotheses is stationarity, that is, $\pi \neq 0, \pi_{1/2} \neq 0, \pi_{1/4} \neq 0$.

The results based on an optimal lag length selected by the SIC criteria can be found in Table 10.3. At first, seasonal unit root tests including only an intercept and lags (see Table 10.3(a)) indicate that the Czech Republic is the only country where neither the N-sector nor the T-sector has a seasonal unit root. For regression (10.3), including an intercept, seasonal dummies, and a trend, we find that the null hypothesis of a unit root at zero (π) and semi-annual frequency $(\pi_{1/2})$ cannot be rejected (see Table 10.3). In addition, the column for $(\pi_{1/4})$ shows that there is evidence for seasonal unit roots in some countries. These are the countries where the null cannot be rejected. However, the null can be rejected more often at annual frequency, especially in the T-sector. The first differences of a seasonal unit root process are not stationary. Therefore, we deal with both seasonal and non-seasonal differences to analyse sectoral gross value added data.

10.1.3 Time Series Process

In general for an appropriate analysis the identification and the implementation of the adequate process of the stationary data is important. In particular for our common cycle analysis the correct AR(p) specification reveals a feature that might be common. However, this will be discussed more detailed in Section 10.2.2. Following the Box and Jenkins (1976) approach three steps are therefore necessary: identification, estimation and diagnostic checking. We determine the appropriate AR(p) process of each sectoral growth rate by investigating the sample empirical autocorrelation as well as sample partial autocorrelation (identification stage). Stability of the model and significance of parameters are checked at the estimation stage. Whenever this stage is disappointing, we start anew to specify the process. With diagnostic checking, that is, analysing the uncorrelated nature of the residuals, we finish the commonly used approach. If the calculated Q-statistics exceed the critical value of χ^2, we reject the null that

224 Critical values are tabulated in Fuller (1976).
225 Critical values are tabulated in Hylleberg et al. (1990).

Table 10.3: Seasonal Unit Root Test Results

Null Hypothesis: series has a seasonal unit root

	(a) with intercept			(b) with intercept, dummies and trend		
N-sector	π	$\pi_{1/2}$	$\pi_{1/4}$	π	$\pi_{1/2}$	$\pi_{1/4}$
Bulgaria	3.16	0.36	2.60 *	-1.20	-0.75	0.25
Czech Republic	2.10	0.90	3.12 **	-0.04	-0.30	0.99
Estonia	-1.49	0.23	0.56	-2.91	-2.13	0.63
Hungary	-0.20	3.03	2.96 *	-2.59	-0.23	0.48
Latvia	2.16	0.26	3.07 **	-0.71	-1.36	0.35
Lithuania	2.07	0.34	1.61	0.26	-0.83	0.32
Poland	1.61	-0.34	0.66	-2.38	-1.97	6.12 *
Romania	9.61	1.88	10.40	0.75	0.59	5.68 *
Slovak Republic	0.96	-1.70	1.65	-0.27	-3.43	6.30 *
Slovenia	1.54	-0.63	0.72	0.30	-2.16	6.66 **
T-sector						
Bulgaria	-0.18	-0.50	0.45	-4.23	-2.80	3.63
Czech Republic	0.86	-2.42	2.77 *	-1.59	-3.66	7.48 **
Estonia	0.94	0.59	11.50 **	-2.21	-1.87	25.59 **
Hungary	-0.62	-0.70	0.21	-3.08	-1.43	2.43
Lithuania	1.17	-0.73	0.32	-1.18	-2.91	11.06 **
Latvia	0.31	-1.04	0.28	-2.59	-3.10	20.50 **
Poland	1.87	-3.18	0.24	-0.03	-4.28	1.05
Romania	-1.63	-0.07	0.09	-3.38	-4.80	6.58 **
Slovak Republic	4.06	-2.85	1.03	0.69	-3.62	1.46
Slovenia	-0.03	0.17	0.95	-2.34	-2.98	2.17

Note: The Table shows the HEGY test statistics for the nontradables sector (N) and tradables sector (T). The lag parameters are selected by the Schwarz information criterion. Tests conducted include either: (a) intercept, or (b) intercept, seasonal dummies, and a trend variable. The critical values for the stated t-statistics for π and $\pi_{1/2}$, and F-statistic for $\pi_{1/4}$ are given by Fuller (1976) and Hylleberg et al. (1990). * indicates significance at the 10% and ** at the 5% levels.

autocorrelation is not different from zero $(r_k = 0)$.[226] Further, we apply of Akaike (AIC) and Schwarz (SIC) information criteria in the first stage to confirm the results. However, errors could originate from inappropriate process determination. Typically parsimony leads to inaccurate coefficient estimates, while dissipation increases the confidence interval.

Another procedure is based on the estimation of $y_t = \mu + \sum_{i=1}^{p} \alpha_i y_{t-1} + \varepsilon_t$, where the initial lag length is set to p=8. For defining the optimal lag structure of the autoregressive representation of the process, we estimate different AR representations and select the specification with the smallest number of AR terms under the condition that the residual ε_t is not autocorrelated and hence the Q-statistics are insignificant. Table 10.4(a) shows the results of the Box–Jenkins analysis. The lag structure for the N-sector is either AR(1) or AR(2). Obviously, the T-sector allows more lags, ranging

226 The common Ljung and Box (1978) Q-statistic is calculated as $Q = T(t+2)\sum_{k=1}^{s} r_k^2/(T-k)$, where T is the sample size and s the number of degrees of freedom. The Q-statistic is asymptotically χ^2 distributed.

Table 10.4: AR(p) Representations

	(a) Pre-crisis sample		(b) Total sample	
	N-sector	T-sector	N-sector	T-sector
Bulgaria	1	2	1	2
Czech Republic	1	4	1	4
Estonia	1	6	1	4
Hungary	1	1	1	2
Latvia	1	2	1	2
Lithuania	1	1	1	1
Poland	1	1	1	1
Romania	1	1	1	2
Slovak Republic	2	2	1	1
Slovenia	2	2	2	1

Note: The table reports the AR(p) structure for the gross value added growth rate in the nontradables sector (N) and in the tradables sector (T) for (a) the pre-crisis period (1995Q1-2008Q1) and (b) the whole sample period (1995Q1-2009Q2).

from AR(1) to AR(6). In Hungary, Lithuania, Poland, and Romania, the sectoral data follow an AR(1) process, which suggests that we are more likely to find a common cycle between the N-sector and the T-sector. Compared with the total sample period (see Table 10.4(b)), the optimal specified AR(p) stays relatively robust especially for the N-sector.[227] However, the number of countries where the sectors might have similar cycles decreases to two pairs, which was anticipated, because in the crisis the sectors react more asynchronously to shocks. Finally, Figure C.3 in Appendix C shows the autocorrelation function for the N-sector and the T-sector, in each country. With regard to our following analysis, a common reaction to a shock (common cycle) would require collinearity of the autocorrelation functions. Obviously, the T-sector reacts faster to a shock than the N-sector does, with the exception of the Czech Republic and the Slovak Republic, where the T-sector reacts more slowly.

10.1.4 Correlation Analysis

For the analysis of contemporaneous movements of country-specific sectoral gross value added data we refer to the Pearson correlation coefficient.[228] Table 10.5 shows that the correlation coefficients for the growth rates are low. For Estonia and Lithuania correlation between the two sectors is about 0.5. A pro-cyclical movement (positive correlation) between the N-sector and the T-sector is found for the Baltics, Poland,

227 See Section 10.4.3 for a detailed analysis of the total sample period.

228 $\rho_{N,T} = \frac{cov(N,T)}{\sigma_N \sigma_T} = \frac{\sum_{i=1}^{I}(N_i - \bar{N})(T_i - \bar{T})}{\sigma_N \sigma_T}$, where N is the N-sector and T is the T-sector, for the analysed sample size I. Note that if the time series are non-stationary, the correlation coefficient depends on the sample size, converging to zero for small samples.

and Bulgaria. All the remaining countries show counter-cyclical movements between the sectors.

Table 10.5: Pair-wise Correlation between the N-sector and the T-sector

	(a) Pre-crisis	(b) Sa	(c) Total	(d) Two
Bulgaria	0.03	0.04	0.06	0.15
Czech Republic	-0.15	-0.14	0.06	-0.12
Estonia	0.48	0.48	0.79	0.38
Hungary	-0.25	-0.26	0.26	0.24
Latvia	0.21	0.21	0.57	0.42
Lithuania	0.50	0.52	0.76	0.38
Poland	0.31	0.34	0.27	0.46
Romania	-0.46	-0.44	0.14	-
Slovak Republic	-0.13	-0.14	-0.13	-0.09
Slovenia	-0.03	-0.03	0.55	-0.06

Note: The table shows the pair-wise correlation between the N-sector and the T-sector growth rates within each country. For the (a) the pre-crisis period, (b) seasonally adjusted data, (c) the total sample period including the crisis, and (d) the correlation between construction and manufacturing. Individual data for the manufacturing sector in Romania are not available.

We further consider cross correlation, which allows leads or lags between the two sectors (see Figure C.4). Lagging the T-sector the correlation coefficient increases in most countries; only in the Baltics the correlation coefficient is decreasing over time. Only for Poland a lag structure has no impact on the correlation results. Thus a lead–lag structure between the sectors should not be neglected.[229]

However, the results give only a general intuition whether the sectors move together in a pro- or contra cyclical way and whether there is a lead or lag in the reaction; they do not provide information whether such comovement between the sectors is based on common shocks or on common cyclical behaviour (Engle and Kozicki, 1993; Buch and Döpke, 2000). Van Riet et al. (2004) point out that despite the absence of any correlation across sector-specific shocks, individual sectors can display a common pattern if sectoral comovements are strong enough.

10.2 Common Features

This section analyses various *common features* (cofeatures) in the sectoral gross value added data. The literature on common features originates in the seminal work of Engle and Granger (1987) and Engle and Kozicki (1993), showing that evidence for cofeatures

229 Lagging the N-sector leads to similar findings.

can be drawn from the behaviour of an appropriate linear combination of these series. Following Engle and Kozicki (1993), common features can be removed by this linear combination, for example, a linear combination of two or more non-stationary series might be stationary. The recent overview by Urga (2007) points out the growing variety of common time-series features, for example, common stochastic trends (Engle and Granger, 1987; Engle and Kozicki, 1993), common serial correlation (Vahid and Engle, 1993), codependence (Vahid and Engle, 1997), common structural breaks (Hendry and Massmann, 2007), or common seasonality (Hylleberg et al., 1990; Engle and Hylleberg, 1996; Cubadda, 1999a). For all these theories a common factor is the key. Cointegration, for instance, is the result of a common factor that generates the common trend between the analysed series; common cycles are the result of a common factor that generates transitional dynamics between the analysed series. Applied to the sectoral analysis, the common feature axioms can be described as follows (Engle and Kozicki, 1993; Vahid and Engle, 1997):

- If the N-sector has (does not have) the feature, then αN also have (does not have) the feature for any $\alpha \neq 0$. Likewise if the T-sector has (does not have) the feature, then αT also have (does not have) the feature for any $\alpha \neq 0$.
- If both the N-sector and the T-sector do not have the feature, then any linear combination of the N-sector and the T-sector will not have the feature.
- If the N-sector has the feature and the T-sector does not have the feature (or vice versa), then any non-trivial linear combination of the N-sector and the T-sector will have the feature.

Finally, a feature of those series is common if a non-zero linear combination of the series exists that does not have the feature (Engle and Kozicki, 1993). However, the existence of the feature in both sectors does not necessarily imply that a linear combination of both sectors will not have the feature.

For a comprehensive analysis of common features, especially regarding the reaction to common shocks, a distinction between long-run and short-run comovements is necessary.[230] Economic growth theories examine long-run properties while business cycle theories analyse cyclical movements of the time series. For testing long-run relationships we apply the cointegration method and for short-run relationships a

[230] While for the analysis of sectoral cycles only a short-run analysis is necessary, we have to start with analysing long-run relationships that have to be taken into account by a correction term in the common cycles analysis.

common serial correlation test is recommended. Due to linear independence of cointegration and cofeature vectors, the sum of the cointegration space and cofeature space could equal the number of dependent variables.

For sectoral distinction, Engle and Issler (1995) emphasise the importance of the productivity process for sectoral outputs to share common trends and, in addition, the importance of the production function for sectoral outputs to have common cycles. Lucke (1998) demonstrates that there is cointegration between sectoral outputs if and only if there is cointegration between productivity shocks. Otherwise sectoral outputs are not cointegrated if and only if all productivity shocks are independent random walks.

As analysed in the literature (see, among others, Issler and Vahid, 2001), the impact of permanent and transitory shocks is ambiguous, that is, both demand and supply shocks can be either permanent or transitory.[231] According to Engle and Issler (1995) manufacturing and retail trade, for instance, are more influenced by transitory shocks. We neglect this fact here and focus only on long-run and short-run comovements between the sectors. In the following we briefly summarise selected common feature methods and present the results of our sectoral analysis.

10.2.1 Common Trends

Many methodologies for testing cointegration have been proposed in the literature since the seminal work of Engle and Granger (1987) and are applied to various topics, frequencies, and so on. The intuition of cointegration is that a linear combination of two I(d) variables is of lower order of integration, for instance while two (or more) series are I(1), the deviation from the long-run equilibrium is stationary, that is, I(0). In this case, the two variables have a common stochastic trend. A stationary linear combination $\alpha' y_t$ of non-stationary sectoral time series N_t and T_t with the cointegration vector $(1 \quad \alpha)$ can be found so that $y_t = N_t - \alpha T_t$. However, for all methods it is necessary to affirm that each individual series has a unit root (stochastic trend), because the concept of cointegration implies that the growth rate of each series is a zero mean, purely non-deterministic, stationary, stochastic process and the levels to which they belong are I(1) as mentioned above.

[231] For instance, for output and investment transitory shocks are the most important source of their variation, while for consumption permanent shocks are the most important souce (Issler and Vahid, 2001).

We present common methods to test for common long-run trends and apply them in the sectoral framework (see, among others, Cheung and Westermann, 2003; Engle and Issler, 1995), namely the cointegration approach proposed by Engle and Granger (1987) and Johansen (1988), as well as the seasonal cointegration approach by Hylleberg et al. (1990).

10.2.1.1 Engle–Granger Test

After pre-testing whether both sectoral variables have a unit root (see Section 10.1.2), we estimate the long-run relationship between the two sectors. In this section, we use the two-step least square estimation proposed by Engle and Granger (1987) for the bivariate case to estimate the parameters of the co-integrating vector $(1 \quad \alpha)$ between the N-sector(N) and the T-sector(T):

$$N_t = c + \alpha_1 \cdot T_t + \varepsilon_t. \tag{10.4}$$

For robustness, equation (10.4) can be considered the other way around, as $T_t = c + \alpha_2 \cdot N_t + \varepsilon_t$. However, the different possibilities of normalisation imply that the values of α will change. The so called "cointegration regression", which tries to fit the long run, provides a very good approximation to the true co-integrating vector, because it is seeking vectors which minimise the residual variance and therefore is most likely stationary (see Granger, 1986; Engle and Granger, 1987).[232] Significance of the cointegrating coefficients is tested with t-tests.[233] Further, the authors have recommended an ADF test for the estimation residual ε_t to test whether the variables are cointegrated:[234]

$$\Delta\hat{\varepsilon}_t = a_1\hat{\varepsilon}_{t-1} + u_t. \tag{10.5}$$

An intercept is not necessary, as $\hat{\varepsilon}_t$ is the residual from a regression with a constant mean (10.4). However, the critical values used are slightly different to those of the standard ADF test to correct the bias towards finding cointegration (Engle and Yoo,

[232] The pioneer work is already given in Granger (1981) by discussing integration of variables and introducing cointegration as a "special case".

[233] Note, that the t-test is only appropriate, if the error term is serially uncorrelated. See, Phillips and Hansen (1990) for an appropriate correction of t-statistic.

[234] In addition, Granger (1986) has suggested using the Durbin–Watson statistic (DW) of cointegration regression to test whether DW is significantly greater than zero. Further, an alternative residual-based test for cointegration has been proposed by Phillips and Ouliaris (1990).

1987).[235] MacKinnon (1991, 1996) provides a computation of the critical values for small sample sizes.

Table 10.6: Engle-Granger Cointegration Test Results

Null Hypothesis: series has a unit root (no cointegration)

	(a)				(b)			
	α_1		t-statistic		α_2		t-statistic	
Bulgaria	1.14	***	-0.39		0.38	***	-2.75	***
	[0.18]				[0.06]			
Czech Republic	0.88	***	-2.86	***	0.87	***	-1.01	
	[0.07]				[0.07]			
Estonia	2.49	***	-2.87	***	0.39	***	-2.81	***
	[0.06]				[0.01]			
Hungary	1.41	***	-3.55	***	0.64	***	-3.24	***
	[0.06]				[0.03]			
Latvia	5.55	***	-3.20	***	0.17	***	-3.51	***
	[0.23]				[0.01]			
Lithuania	1.85	***	-0.43		0.49	***	-1.32	
	[0.08]				[0.02]			
Poland	1.54	***	-1.94	*	0.55	***	-1.53	
	[0.09]				[0.03]			
Romania	0.80	***	-0.68		0.54	***	-0.94	
	[0.17]				[0.11]			
Slovak Republic	0.42	***	-2.08	**	1.53	***	-0.75	
	[0.04]				[0.16]			
Slovenia	1.56	***	-1.80	*	0.59	***	-2.19	**
	[0.06]				[0.02]			

Note: The table reports the coefficients α_1, α_2 of the bivariate cointegration regression (a) $N_t = c + \alpha_1 \cdot T_t + \varepsilon_t$ and (b) $T_t = c + \alpha_2 \cdot N_t + \varepsilon_t$ with the standard deviation given in parenthesis. The corresponding t-statistic results are stated with *** for the 1% significance level. Furthermore the t-statistic of the ADF test for ε_t is reported, where *,**,*** indicate significance at the 10%, 5% and 1% level according to finite sample critical values by MacKinnon (1996).

Table 10.6 indicates that the null hypothesis of finding no common trend cannot be rejected for the Lithuanian and Romanian sectors. There is a no evidence of a long-run relationship between the two sectors in these countries. However, the null is clearly rejected for the sectors in Estonia, Hungary, Latvia, and Slovenia. Hence, we can conclude that the gross value added data in these countries are cointegrated and the sectors have a common long-run trend.

The results of the cointegration test are important for model specification for short-run relationships. If there is no evidence of common long-run trends, short-run relationships can be analysed immediately. For the series which indicate cointegration relationships, the specification of an error correction (EC) term is necessary, with $EC = 1 \cdot T - \alpha \cdot N$, where $(1 \quad \alpha)$ is the cointegration vector. This error correction term is used in the following analysis.

[235] The residuals are generated by a process that tries to minimise them (see equation 10.4).

While the Engle-Granger procedure gives a simple intuition on the long-run relationship between the two sectors and can easily be conducted, it is standard in the literature to use more sophisticated models. This is mainly due to two obvious pitfalls: first, the analysed error term is not the actual one, but the estimated one. According to the estimation above, the residual variance is minimised, which tends towards finding a stationary error term. Any error in the first step (equation(10.4)) results in incorrect findings in the second step (unit root test for the residual). Second, especially for small samples, the results on cointegration vary with the choice of the selected variable for normalisation. In Table 10.6 this problem is obvious for Bulgaria, the Czech Republic, Poland, and Slovakia.

Some authors (see, among others, Gonzalo and Lee, 2000) recommend the application of the Engle and Granger (1987) cointegration test because of a strong dependence of the results from the estimated VAR, in particular from the selected lag order, as we will show in the next section.[236]

10.2.1.2 Johansen Test

For the analysis of common stochastic trends and hence long-run comovements, we further apply the proposed maximum likelihood approach by Johansen (1988, 1991). While this broader concept is common for the multivariate case, we use it for our bivariate sector case. To find a cointegration relationship in the data vector (x_t), a linear combination (Z_t) of them must be I(0), that is, the equilibrium error has to be stationary. The cointegrating equation is $Z_t = \alpha' x_t$, where α is a $(n \times r)$ cointegrating matrix with full column rank r, whose columns are called cointegrating vectors. The $(n \times 1)$ matrix x_t covers the $n = 2$ sectors. Generally $0 \leq r < n$ cointegrating relationships are possible for a system of n variables and thus $n - r$ common trends. For two sectors, finding one cointegrating relationship $(r = 1)$ implies finding one common trend.

To implement Johansen's cointegration test we estimate a vector autoregressive (VAR) model, describing sectoral data that are integrated of order 1. We consider a bivariate VAR including the N-sector and the T-sector, with an optimal lag choice of p, which allows for dynamic feedback between the individual sectors. Usual information criteria, namely Schwarz (SIC) and Akaike (AIC), are used to select the optimal time lags of p

[236] However, considering the VAR has the advantage that all variables are treated as jointly endogenous and residuals from the VAR are not serially correlated.

periods to make residuals white noise.[237] The considered finite order VAR(p) can be described as:

$$x_t = \mu + A_1 x_{t-1} + A_2 x_{t-2} + ... + A_p x_{t-p} + \varepsilon_t \tag{10.6}$$

where $x_t = (N \quad T)'$ denotes the vector of the two sectors at period t and A_j are (2×2) coefficient matrices.[238] The ε_t assigns the (2×1) vector of white noise with zero mean. We allow for a constant term μ in the VAR (see Johansen, 1994).[239]

As already indicated in the previous section, the results for cointegration are important for model specification of short-run relationships. Different from the error correction term above we have to specify a vector-error-correction model (VECM), using the past error as an exogenous variable to determine the dynamic behaviour of the endogenous variable. This term shows the deviation from the long-run trend. Defining $A(L) = -(I - \sum_{j=1}^{p} A_j)$ and $A_j = -(\sum_{j=j+1}^{p} A_j)$ the VAR in levels (equation (10.6)) can be rewritten in first differences as

$$\Delta x_t = \mu - A(1)x_{t-1} + \sum_{j=1}^{p-1} A_j \Delta x_{t-p+1} + \varepsilon_t, \tag{10.7}$$

where A(1) will be a zero matrix in the case of no cointegration. However, in the case of cointegration the VECM presentation is as follows:[240]

$$\Delta x_t = \mu - \sum_{j=1}^{p-1} A_j \Delta x_{t-p+1} + \beta z_{t-1} + \varepsilon_t, \tag{10.8}$$

where the error-correction term is defined as $z_{t-1} = \alpha' x_t - 1$. The Johansen procedure looks at the number of non-zero canonical correlations between the first differences (Δx_t) and the lagged levels (x_{t-1}) with the rank of A(1) being the cointegration rank r. Rewriting $A(1) = z_{t-1} = \alpha' x_{t-1}$ allows us to define the columns of α as cointegrating

237 The analysis confirms the findings of previous studies that the cointegration results are very sensitive to the lag length, with AIC postulating mostly a more abundant optimal lag order than SIC. Cheung and Lai (1993) find that an underestimation of the true lag length has significant impact on the size of the LR statistic.

238 Equation (10.6) can be written as $A(L)\, x_t = \varepsilon_t$.

239 For robustness, different assumptions about the parameters, that is, the intercept and trend are tested.

240 Note that $A_0 = I$. Furthermore, the presence of common cycles allows us to rewrite the VECM as a Reduced Rank Regression model. This is detailed in Section 10.2.2.1.

vectors (Engle and Granger, 1987). The coefficient vector β indicates the speed of adjustment of Δx_t to its long-run equilibrium.

Based on the eigenvalues λ_i and the assumption that ϵ_t is Gaussian white noise, the Trace statistic is calculated to test the null hypothesis that the number of cointegrating vectors is less than or equal to r, versus a general alternative with

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} ln(1 - \hat{\lambda}_i).$$

In addition, the Maximum Eigenvalue statistic is used to test the null hypothesis of r cointegration relationships versus $r + 1$ with

$$\lambda_{max}(r, r+1) = -Tln(1 - \hat{\lambda}_{r+1}).$$

The asymptotic critical values for the both test statistics are given by Osterwald-Lenum (1992).

Table 10.7 summarises the cointegration results based on the Johansen procedure. The null of $r = 0$ is tested against the alternative $r > 0$ with the Trace statistic and the null of $r = 0$ is tested against the alternative $r = 1$ with the Maximum Eigenvalue statistic.[241] Using an optimal lag structure according to the (a) SIC and (b) AIC, the λ_{trace} is such that the null is rejected for the Czech Republic, Romania, and the Slovak Republic. Using the Maximum Eigenvalue statistic it can be confirmed that the null is rejected for the Czech Republic and Romania. The results are robust when using lags selected by the Akaike criterion (see Table 10.7b). Hence, we find evidence for cointegration between the N-sector and the T-sector in these countries. However, for the majority of the CEECs we cannot reject the null, which is evidence that there is no cointegration relationship between the sectors.[242]

Compared to the results given by the Engle-Granger methodology (see Table 10.6), the findings cannot be completely confirmed. This is not surprising regarding the pitfalls of the Engle-Granger procedure mentioned in the previous section. Some of the distortion in the results based on the small sample size might be offset by using the critical values proposed by Cheung and Lai (1993). The authors suggest using critical values that are based on a scaling factor (SF), which is applied to the asymptotic critical values of Osterwald-Lenum (1992):

[241] Consequently $H_0 : r \leq= 1$ is tested against $H_1 : r > 1$ and $H_0 : r = 1$ is tested against $H_1 : r = 2$.

[242] Note that this might be explained by the low power of the cointegration test in small samples.

Table 10.7: Johansen Cointegration Test Results

Null Hypothesis: no cointegration

	(a) SIC						(b) AIC					
		λ_{trace}		λ_{max}				λ_{trace}		λ_{max}		
Bulgaria	r=0	9.99		5.48		[5]	r=0	9.99		5.48		[5]
	r=1	4.51		4.51			r=1	4.51		4.51		
Czech Republic	r=0	34.00	**+	25.07	**+	[6]	r=0	34.00	**+	25.07	**+	[6]
	r=1	8.92		8.92			r=1	8.92		8.92		
Estonia	r=0	16.15		11.00		[5]	r=0	11.11		6.20		[6]
	r=1	5.16		5.16			r=1	4.91		4.91		
Hungary	r=0	16.84		9.84		[5]	r=0	29.02	**	16.46	**	[7]
	r=1	7.00		7.00			r=1	12.56	**	12.56	**	
Latvia	r=0	16.26		12.54		[5]	r=0	16.26		12.54		[5]
	r=1	3.73		3.73			r=1	3.73		3.73		
Lithuania	r=0	17.62		13.39		[5]	r=0	17.62		13.39		[5]
	r=1	4.23		4.23			r=1	4.23		4.23		
Poland	r=0	13.00		10.37		[5]	r=0	13.46		9.34		[7]
	r=1	2.63		2.63			r=1	4.12		4.12		
Romania	r=0	31.62	**	25.59	**+	[5]	r=0	26.90	**	23.43	**	[8]
	r=1	6.03		6.03			r=1	3.47		3.47		
Slovak Republic	r=0	20.05	**	15.43		[5]	r=0	20.05	**	15.43		[5]
	r=1	4.62		4.62			r=1	4.62		4.62		
Slovenia	r=0	15.33		8.84		[5]	r=0	17.04		9.54		[6]
	r=1	6.49		6.49			r=1	7.50		7.50		

Note: Trace and Maximum Eigenvalue statistics for the bivariate Johansen cointegration test are reported. Panel (a) refers to a lag order based on SIC while the lag structure in panel (b) is determined by AIC (both with a maximum lag of 8) which is given in parenthesis. We assume that the data have no deterministic trend but the cointegrating equations have intercepts. ** indicates rejection of the null hypothesis with a significance at the 5% level according to asymptotic critical values by Osterwald-Lenum (1992). In addition, + reports significance at the 5% level according to the finite sample critical values by Cheung and Lai (1993).

$$SF = \frac{T}{T - n \cdot p} \;, \tag{10.9}$$

where T denotes the sample size, n the number of variables $(n = 2)$, and p the number of lags. The application of the scaling factor influences the rejection of the cointegration relationship. Only for the Czech Republic do we find that the null hypothesis $r = 0$ can be rejected.[243] Hence, taking into account the small sample properties, we find no long-run relationship between the N-sector and the T-sector for all CEECs, with the exception of the Czech Republic.

The previous analyses show that we find only weak evidence for cointegration between the N-sector and the T-sector in the CEECs. The results indicate that cointegration does not necessarily imply high correlation. Regarding, for instance, the N-sector

243 Using the SIC to determine the lag length, the Maximum Eigenvalue statistic gives evidence that we further can reject the null for Romania.

and the T-sector in the Czech Republic, we find evidence for cointegration but the correlation is comparatively low (see Table 10.5).

10.2.1.3 Seasonal Cointegration

While already discussed in the unit root context, the analysis of seasonality is also important for the cointegration analysis. This analysis is often neglected in the literature, and we will focus in this section on whether or not the sectors are cointegrated at some frequency. The pioneering work on cointegration at various frequencies is provided by Hylleberg et al. (1990) (HEGY), and Lee (1992) and is developed further by Lee and Siklos (1997) and Cubadda (1999a), assuming that the series share common stochastic seasonal factors. According to the authors, an innovation has only a temporary effect on the seasonal behaviour of the linear combination but a permanent impact on the seasonal factors of the series.

Again, we are considering the frequencies $\theta = \left\{0, \frac{1}{2}, \frac{1}{4}\right\}$. In the case that the series does not have seasonal unit roots at some frequency, seasonal cointegration does not exist at this frequency. In the case of unit roots at various frequencies, the two-step procedure proposed by Engle and Granger (1987) is inappropriate for testing seasonal cointegration, as the coefficient may not be consistently estimated in the presence of seasonal unit roots. Hylleberg et al. (1990) propose the calculation of first differences for both series to remove a zero-frequency unit root, and estimate

$$\Delta N_t = \sum_{j=0}^{s-2} \alpha_j \Delta T_{t-j} + \epsilon, \tag{10.10}$$

where s=4 for our quarterly data. Then a seasonal unit root test is applied to the residual ϵ. However, this concept requires prior information on whether there is evidence or not for seasonal unit roots to filter out the seasonal unit root components. Another strand of seasonal cointegration literature goes back to Lee (1992), who proposed a maximum likelihood estimation. This methodology does not require prior information on seasonal unit roots.

Similar to the cointegration procedure above we specify an appropriate VAR model, that can be rewritten in the form of a Seasonal Error Correction Model (SECM) in the case that the series are cointegrated at some frequency as

$$\Delta x_t = \Pi_1 x_{1,t-1} + \Pi_2 x_{2,t-1} + \Pi_3 x_{3,t-1} + \Pi_4 x_{3,t} + A_1 \Delta x_{t-1} + ... + A_{p-4} \Delta x_{t-p+4} + \epsilon_t \tag{10.11}$$

with

$$x_{1,t-1} = (1 + L + L^2 + L^3) x_{t-1}$$
$$x_{2,t-1} = (1 - L + L^2 - L^3) x_{t-1}$$
$$x_{3,t-1} = (L - L^3) x_{t-1}.$$

The coefficient matrices of Π_i might have information on the long-run relationship between the components of the vector x_t, and hence information on whether the series are cointegrated at some frequencies. With a rank between $0 < r < n$, there might exist a linear combination $\Pi_k = \gamma_k \alpha_k'$ that does not have a unit root at the corresponding frequency, with γ_k being the matrix of the short-run coefficients and α_k' the vector of stationary cointegration relationships. The null hypothesis of seasonal cointegration, $rank(\Pi_k) \leq r$, is tested with the Trace statistic.[244]

If the linear combination $\alpha_1' x_{1t}$ has unit roots at seasonal frequencies but not at zero frequency then the series are cointegrated at zero frequency with cointegrating vector α_1.[245] If there are unit roots at -1, and $\alpha_2' x_{2t}$ will not have a unit root at -1, we find that the series are cointegrated at frequency $\pi = \frac{1}{2}$ with the cointegrating vector α_2.[246] If there are unit roots at frequency $\frac{1}{4}$ and $\alpha_3' x_{3t}$ will not have a unit root at $\frac{1}{4}$, the series are cointegrated with the cointegrating vector α_3.[247] Zero frequency can be found between seasonally adjusted series, while seasonal integration occurs between differenced series. Following Perron and Campbell (1993) and Cubadda (1999a), we use an intercept, a linear trend, as well as seasonal dummies for the regression. This methodology allows for 'stochastic' cointegration at the considered frequencies.[248]

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244 Accordingly H_1 can be formulated as $rank(\Pi_k) > r$.

245 With the assumption that $\Pi_2 = \Pi_3 = \Pi_4 = 0$ this is similar to the Johansen approach.

246 In the following we label the frequency as π. Hence Π_1 corresponds to a frequency $\pi = 0$, Π_2 corresponds to $\pi = \frac{1}{2}$ and Π_3 corresponds to $\pi = \frac{1}{4}$.

247 To be precise it is a polynomial vector $\alpha_3 + \alpha_4 L$.

248 Perron and Campbell (1993) distinguish between a 'stochastic' cointegration and a 'deterministic' cointegration. They show that 'stochastic' cointegration is a necessary condition that a cointegration relationship has an error correction representation.

Table 10.8: LR Test for Seasonal Cointegration

Null Hypothesis: no seasonal cointegration

		$\pi = 0$	$\pi = 1/2$	$\pi = 1/4$
Bulgaria	r=0	25.10	12.40	35.51 **
	$r \leq 1$	10.26	0.39	1.24
Czech Republic	r=0	33.02 **	26.47 **	11.71
	$r \leq 1$	1.85	0.08	3.22
Estonia	r=0	11.20	8.71	18.44
	$r \leq 1$	0.67	2.31	0.28
Hungary	r=0	10.79	8.65	6.40
	$r \leq 1$	0.52	1.72	1.76
Latvia	r=0	13.04	13.95	13.51
	$r \leq 1$	0.80	1.55	0.01
Lithuania	r=0	12.81	11.16	13.78
	$r \leq 1$	0.00	1.98	0.00
Poland	r=0	17.07	20.93	22.09
	$r \leq 1$	1.41	8.21	6.33
Romania	r=0	17.57	17.92	21.22
	$r \leq 1$	1.16	2.85	2.16
Slovak Republic	r=0	19.46	18.86	14.51
	$r \leq 1$	3.24	5.23	0.04
Slovenia	r=0	8.01	16.57	26.98
	$r \leq 1$	1.28	1.72	1.03

Note: The Trace statistic for the cointegration test at frequency 0, $\frac{1}{2}$ and $\frac{1}{4}$ is reported (Lee, 1992). ** indicates rejection of the null hypothesis with significance at the 5% level according to finite sample critical values by Lee and Siklos (1995). We allow for an intercept, deterministic trends, and seasonal dummies.

The order of the seasonal error correction model (SECM) is defined by $p - 4$, where p is the optimal lag length of the VAR. Using the finite sample critical values of Lee and Siklos (1995), the results are given in Table 10.8 for all frequencies. Using the Lee's approach we can confirm the results given in the previous section, that is, we can reject the null of no cointegration at zero frequency for the Czech Republic.[249] We find evidence for seasonal cointegration between the sectors at frequency $\pi = \frac{1}{2}$ in the Czech Republic and at frequency $\pi = \frac{1}{4}$ in Bulgaria. For the other countries the null hypothesis ($r = 0$) cannot be rejected, the reasoning being that these sectors are not cointegrated at any frequency.[250]

249 Note that the Trace statistic differs from the results in Table 10.7, because we allow in this analysis for intercept and trend in the VAR. The results for zero frequency are only given for completeness and comparability with the other frequencies.

250 Note that the results for $\pi = 0$ given in Table 10.8 are based on an intercept, deterministic trends, and seasonal dummies in the equation, while the results of the Johansen procedure are just based on a constant term.

10.2.2 Common Cycles

This section analyses the degree of asymmetry between the two sectors by investigating whether the non-stationary components of the data share common elements, that is, sectoral cycles. While the correlation analysis presented in Section 10.1.4 already gives an intuition on the comovement between the sectors, such an analysis cannot distinguish between common shocks and common cyclical behaviour (Buch and Döpke, 2000). Using an econometrically and technically more advanced approach like the common cycle methodology, we can separately investigate the common cyclical behaviour. This is even more relevant for the OCA approach suggested by Beine et al. (2000) to assess the sustainability of a monetary union. The idea is similar to the common trend analysis, as we are looking for a common feature in each sector. But now we are analysing whether the same autocorrelation order in the N-sector and the T-sector can be eliminated by a linear combination which has no correlation with the past.

Following Long and Plosser (1987), comovements among economic activities depend on comovements across sectors as well as persistence of sector-specific shocks. Despite different amplitudes, the sectors follow a common cycle if the phase is the same across them (Engle and Issler, 1995). If there are common dynamics between the T-sector and the N-sector, they share a *serial correlation common feature* (SCCF). Due to the sector-specific input of labour and capital, as well as the nature of the shocks affecting the economy, the sectors might react with a different dynamic to innovations, in particular with varying adjustment speeds. In this case they share a *polynomial serial correlation common feature* (PSCCF) or codependence.[251] The two common approaches to test for common cycles are canonical correlation and regression techniques based on GMM estimators.

Taking into account that cointegration neither prevents nor implies common cycles, it is possible to find a short-run common feature although long-run comovement does not hold and vice versa. In the analysis of the short-run comovements, the long-run relationships are captured by an error term. Therefore it is necessary, that in the case of cointegration an error-correction model (ECM) has to be specified.[252] Referring to the results of the previous section, common features can be directly analysed by investigating the growth rates of the N-sector and the T-sector for the majority of

[251] Vahid and Engle (1997) define the SCCF as a strong form of codependence because the linear combination of both sectors annihilates any serial correlation.

[252] That is well known as the Engle–Granger representation theorem. The theorem states that error correction and cointegration are equivalent representations for any set of I(1) variables.

countries. For the countries where the results show evidence of cointegration between the sector, that is, the Czech Republic, Romania, and Slovakia, an additional lagged error-correction term is specified in the set of instruments. In what follows we are analysing both synchronised cycles and non-synchronous cycles.

10.2.2.1 Serial Correlation Common Feature

In addition, and for the extension of common trend analysis, Engle and Kozicki (1993) as well as Vahid and Engle (1993) have recommended a serial correlation common feature test (SCCF).[253] They show that the same linear combination that eliminates serial correlation in differences of data will also eliminate common cycles in levels if the trend is defined as a random walk. The SCCF implies the existence of a linear combination of series ($\tilde{\alpha}'\Delta x_t$), which is not correlated with the lagged values Δx_t and, hence, is an innovation. This linear combination removes the autocorrelation that actuates on the short-run dynamics of Δx_t. If the linear combination yields a white noise process, then the cycle is said to be synchronous. The impulse responses of the sectors are collinear. Generally $s = n - 1$ independent cofeature combinations for a system of n variables are possible, where s is the number of zero canonical correlations. This implies $n - s$ corresponding common dynamic factors (strong form reduced-rank structure).

In the case of r cointegrating vectors, at most $n - r$ cofeature vectors s are possible to eliminate the common cycles.[254] Vahid and Engle (1993) show that the trend-cycle decomposition can easily be obtained, as the sum of linear independent cointegration and cofeature vectors accords to the dimension of the system. Information of a completely specified VECM is not necessary for this decomposition, as the VECM can be rewritten as a restricted reduced-rank regression (see, among others, Vahid and Engle, 1993; Schleicher and Barillas, 2005)

$$\Delta x_t = \begin{bmatrix} -\alpha^{*\prime} \\ I_{n-s} \end{bmatrix} \sum_{j=1}^{p-1} A_j \Delta x_{t-p} + \beta^* z_{t-1} + \epsilon_t. \qquad (10.12)$$

253 This is a strong form of codependence and corresponds to the Tiao and Tsay (1989) test with a scalar component model (SCM) (0,0).

254 If there is cointegration and hence an lagged error term is included, we refer to a weak form reduced rank structure (Hecq et al., 2000). In this case the number of possible cofeature vectors s may be greater than $n - r$ but smaller or equal to $n - 1$ and the $n - s$ common dynamic factors consist of linear combinations of lagged first differences only.

Regression-based Procedures
Engle and Kozicki (1993) recommended SCCF approach tests for concurrent common feature and, hence, synchronous cycles only. Following their regression methodology to test on common features, two steps are necessary:

The first step requires a check on whether both series exhibit the feature individually, that is, whether the AR(p) structure is the same for both sectors. Hence, at first, sectoral gross value added data are analysed for serial correlation. Autocorrelation and Box Pierce test statistics are considered.[255] The test of whether the sectoral series is an innovation relative to its own past over the time is performed through the null hypothesis of no autocorrelation. The results have already been presented in Section 10.1.3. The results in Table 10.4 indicate that the same feature is evident in six countries. However, for the sake of completeness we test for common cycles in all countries.[256]

In the second step, two-stage least square (TSLS) equations are estimated, where at the first stage one sector is regressed on a set of instruments, including lagged values of both sectors and a constant.[257] Hence the problem of endogeneity is taken into account. Following Vahid and Engle (1993), we include the lagged error correction term (EC) for the cases of cointegration.[258]

The standardisation of the coefficient of ΔN_t to one yields the following equation:

$$\Delta N_t = c + \sum \delta \Delta T_{t-p} + \beta EC_{t-1} + \epsilon_t, \tag{10.13}$$

where $(1 \quad \delta)$ is the common feature vector. The second stage is the regression of the estimated residuals $\hat{\epsilon}_t$ on the set of instruments:

$$\hat{\epsilon}_t = \beta + \sum \mu \Delta N_{t-p} + \sum \eta \Delta T_{t-p} + \beta EC_{t-1} + u_t$$

255 Uncorrelated residuals and information criteria of Schwarz and Akaike assess the stability of the model as well as the significance of the parameters. Errors can originate from inappropriate process determination, induced either by omitting necessary lags or by over-fitting.

256 For the cases where the process in the N-sector and the T-sector are not equal, the higher AR(p) process is selected, if the residuals are not autocorrelated.

257 $W(p) = \left(\Delta x'_{t-1}, ..., \Delta x'_{t-p}, EC_{t-1}\right)$.

258 Vahid and Engle (1997) suggest the inclusion also of lags of the EC term.

Testing the null hypothesis of a common serial correlation feature, the test statistic is χ^2 distributed with the number of instruments as degrees of freedom. If the F-statistic of the TSLS is significant we can reject the null of a SCCF and, hence, a common cycle is evident if the common feature coefficient is significant.

Table 10.9: Common Cycle and PSSCF Results

Null Hypothesis: common feature at lag p

		lag p			
		0	1	2	3
Bulgaria	F-statistic	7.74 **	22.72	14.39	7.67
	Common cycle coefficient	-0.46	0.29	0.47 **	0.54 **
Czech Republic	F-statistic	8.37 **	14.11	10.74	7.38
	Common cycle coefficient	-0.12	0.05	0.16	0.24 **
Estonia	F-statistic	3.28 **	4.00	4.81	5.10
	Common cycle coefficient	0.34 **	0.28 **	0.20 **	0.12
Hungary	F-statistic	3.37 **	18.56	11.23	8.49
	Common cycle coefficient	-0.18 **	-0.07	0.00	0.06
Latvia	F-statistic	1.14	5.42	3.53	2.49
	Common cycle coefficient	-0.20	0.03	-0.13	0.00
Lithuania	F-statistic	1.53	20.70	9.97	8.04
	Common cycle coefficient	0.63 **	0.34 **	0.27 **	0.28 **
Poland	F-statistic	3.94 **	5.34	4.36	3.83
	Common cycle coefficient	0.11	0.15	0.20 **	0.15
Romania	F-statistic	0.90 **	6.07	3.48	4.95
	Common cycle coefficient	-0.14	-0.26 **	-0.16	-0.14
Slovak Republic	F-statistic	2.07	6.50	5.65	4.42
	Common cycle coefficient	0.23	0.16	0.02	0.09
Slovenia	F-statistic	6.83 **	8.67	8.63	6.78
	Common cycle coefficient	-0.12	-0.11	-0.11	-0.08

Note: The F-statistic of the TSLS estimation and the common feature coefficient are reported. The optimal lag length is determined by SIC. ** indicates significance at the 5% level.

The results of the two-stage common cycle test are reported in Table 10.9 (lag p=0). Only for Lithuania the null hypothesis cannot be rejected, which gives evidence of a common cycle between the T-sector and the N-sector. For the other countries, the gross value added data of the N-sector and T-sector follow individual features in sectoral cyclical movements. Although regressions from the N-sector on the T-sector, and vice versa, yield a different normalisation, depending on whether the N-sector or the T-sector is chosen to have a coefficient of unity, the main test results are not influenced. To circumvent the normalisation problem the limited maximum likelihood (LIML) estimator is suggested (see, among others, Vahid and Engle, 1997). In addition, the dimension of the cofeature space can be deduced from the number of statistically non-significant canonical correlations.[259]

[259] Cofeature vectors are identified as canonical covariates that correspond to insignificant canonical correlations (see Vahid and Engle, 1997).

Canonical correlation analysis
Based on the methodology in Tiao and Tsay (1989), the number of zero canonical correlations and, hence, the number of linearly independent common cycle vectors can be determined.[260] The null hypothesis of this test is that the dimension of the common feature space is at least s. In other words, we test that there were s scalar components of type SCM$(0, p)$ implying s zero canonical correlation between the first differences and the set of instruments. This corresponds to at most $n - s$ common cycles. Accordingly, for our two-sector case $(n = 2)$, there is evidence of one common cycle if $s = 1$. The χ^2-distributed test statistic with $s(np + r + s - n)$ degrees of freedom for codependence order $q = 0$ is

$$C(p, s) = -(T - p - 1) \sum_{j=1}^{s} ln(1 - \hat{\lambda}_j^2), \qquad j = 1, 2 \qquad (10.14)$$

with $\hat{\lambda}_j^2$ being the j^{th} smallest squared canonical correlation between the first differences (Δx_t) and the set of instruments (that is, lagged differences, and in the case of cointegration the lagged EC-term). p is the order of the (S)ECM, and r the number of cointegrating vectors.[261]

The results are reported in the first column of Table 10.10 (codep=0). Using the SCM(0,p) approach, we find that the null hypothesis of finding s zero canonical correlations between the first differences and the set of instruments can be clearly rejected for all countries. Hence, the dynamics of the sectoral response to a shock are different and there will be no common cycle.

GMM analysis
This finding can also be confirmed using the optimal GMM test proposed by Cubadda (1999a) (see Table 10.11 (codep=0)). The results for codependence of order $q = 0$ give inference on common synchronised cycles. While the GMM methodology will be explained in detail in the context of codependence of order $q > 0$ in the next section, we find that the null hypothesis of codependence of order $q = 0$ is rejected for all countries, with the exception of Romania, and the Slovak Republic. However, for these

[260] This methodology is mainly proposed for a multivariate analysis. See also Vahid and Engle (1997).

[261] To be precise, the p is the order of the VECM. The lag order is the same as the one used in the cointegration tests. For details on the relationship between cointegration and SCCF/ codependence, see, among others, Vahid and Engle (1997); Schleicher (2007). Considering seasonal cointegration, the lag order is accordingly adjusted.

Table 10.10: Codependence Tiao–Tsay Test Results

Null Hypothesis: codependence of order q

		q=0		q=1		q=2		q=3	
Bulgaria	s=1	47.05	**	7.30	**	5.59		0.24	
	s=2	123.94	**	21.34	**	14.98	**	8.15	
Czech Republic	s=1	57.59	**	23.37	**	17.31	**	19.58	**
	s=2	183.01	**	41.05	**	27.24	**	26.48	**
Estonia	s=1	20.53	**	2.31	**	0.01		1.51	
	s=2	76.53	**	10.89	**	3.48		9.01	
Hungary	s=1	23.28	**	3.60		0.34		0.32	
	s=2	57.09	**	11.05	**	3.35		3.98	
Latvia	s=1	21.23	**	1.32		1.06		3.34	
	s=2	71.60	**	12.54	**	9.42	**	0.02	**
Lithuania	s=1	6.24	**	2.83		0.00		0.10	
	s=2	73.93	**	16.13	**	8.38		6.33	
Poland	s=1	9.10	**	0.58		0.25		0.35	
	s=2	32.63	**	12.47	**	8.47		8.95	
Romania	s=1	10.34	**	0.00		3.23		6.41	**
	s=2	26.42	**	3.93		9.04		19.29	**
Slovak Republic	s=1	5.06	**	0.77		0.21		0.85	
	s=2	55.46	**	11.23		6.95		5.48	
Slovenia	s=1	21.63	**	1.61		0.89		5.51	**
	s=2	67.53	**	17.27	**	9.79	**	10.42	**

Note: The Tiao–Tsay test statistic is shown. ** indicates significance at the 5% level.

two countries the common feature coefficient is not significant. Hence, using the GMM approach, we find no evidence that the sectors have synchronised cycles.

Table 10.11: Optimal GMM Test Results

Null Hypothesis: codependence of order q

	q=0		q=1		q=2	q=3	
Bulgaria	6.47	**	2.75		5.51	5.01	
Czech Republic	21.63	**	3.34		3.34	0.04	
Estonia	21.63	**	3.34		0.07	0.04	
Hungary	17.58	**	5.73	**	0.47	0.76	
Latvia	7.89	**	0.18		0.44	0.04	
Lithuania	5.66	**	2.11		0.06	0.22	
Poland	9.89	**	0.45		0.05	0.05	
Romania	0.03		0.04		0.03	5.55	**
Slovak Republic	0.98		0.00		0.28	0.62	
Slovenia	22.82	**	10.19	**	2.91	2.22	

Note: The χ^2 test statistic is reported. ** indicates significance at the 5% level.

The test whether piecewise serial correlation common feature within some regimes exists (Hecq, 2009) is neglected to due the small size of the sample.

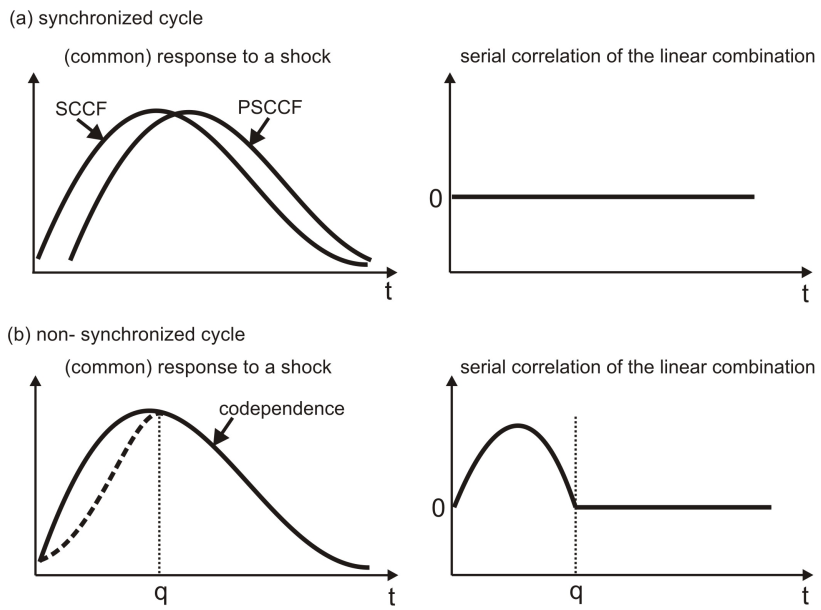
10.2.2.2 Non-synchronised Common Cycles

Although the test on common synchronised sectoral cycles between the N-sector and the T-sector has been rejected for most of the countries, it is crucial not to interpret the SCCF as sole indicator for comovement between the sectors, as there is a possibility of heterogeneity in sectoral adjustment to shocks with different speeds (phase-shifts) (Cubadda, 1999b; Schleicher and Barillas, 2005). This can be ascribed, for example, to different adjustment costs, institutional arrangements, or labour market rigidities. As indicated in the preliminary analysis (see Section 10.1.4), the cross-correlation results show for some countries increasing correlation taking time lags into consideration. Accordingly, it is helpful to analyse both and the non-synchronised cycles (see, among others, Harding and Pagan, 2006). In the literature different modifications for non-contemporaneous common cyclical movements have been presented. For instance the concept of codependence by Vahid and Engle (1997), the analysis of weak form common features by Hecq et al. (2000), and the test on polynomial serial correlation common features (PSCCF) by Cubadda and Hecq (2001).[262] However, the use of the terminology is ambiguous. In a recent paper by Trenkler and Weber (2009) the concept of codependence is even applied to I(1) series.

Figure 10.1 illustrates the differences between the various methodologies presented. At first the sectoral response functions are shown at the left-hand side for the cases of (a) SCCF, PSCCF (upper panel) as well as (b) codependence of order(q). While in panel (a) the short-run dynamics are similar across sectors for the case of SCCF and similarly with a permanent reaction lag for the case of PSCCF (that is, shift of the graph to the right), panel (b) indicates that the sectoral dynamics are different (dash versus line) up to period q. Hence, for the latter, the impulse responses of the N-sector and the T-sector are allowed to be linearly independent up to the period q but are collinear beyond q. Second, looking at the right-hand side of Figure 10.1, the corresponding autocorrelation function of the linear combination is shown. In panel (a) it is shown that the linear combination has no correlation with its own past, while in panel (b) serial correlation of the linear combination is different to zero up to q.

[262] Cubadda (2007) presents a comparison between SCCF and the weak form of SCCF, as well as PSCCF and the weak form of PSCCF.

Figure 10.1: Sectoral Short-run Dynamics



Note: The sectoral response functions are shown at the left-hand side. The right-hand side shows whether the corresponding serial correlation of the linear combination is different to zero.
Source: author's illustration.

10.2.2.3 Codependence

The concept of codependence was introduced by Gourieroux and Peaucelle (1989) within a stationary framework with the general idea that a common response to a shock does not occur in the same period but with a delay of some periods.[263] Despite the first responses to a shock might be different, the reaction functions of the N-sector and the T-sector are collinear beyond a certain period of time (q), that is, the variables are linear dependent after a certain time (q).[264] Hence, the sectors might share a common cycle after q periods, despite them having different responses to a shock until the qth period.

Canonical Correlation Analysis

For the analysis of non-synchronous cycles various approaches have been presented, where the key procedures are either based on canonical correlation or GMM estima-

[263] For the authors, codependence is given if, for a linear combination, adjustments are faster than for the analysed stationary series. The authors are testing for codependence in the context of purchasing power parity, modelling the vector process in a moving-average representation.

[264] The case of $q = 0$ corresponds to the SCCF test presented above, see equation (10.14). Hence, the test on codependence weakens the SCCF test described above.

tors.[265] At first we apply the codependence test proposed by Tiao and Tsay (1989), which is based on hidden scalar components of order (0, j). The dimension of the VAR system and the existence of a cointegration relationship restrict the number of possible cofeature combinations as well as the codependence order (Schleicher, 2007).

The test statistic for the null hypothesis of at least s codependence vectors, with s being the number of zero canonical correlation, after q periods is given by

$$C(q,p,s) = -(T-p-q-4)\sum_{j=1}^{s} ln\left((1-\frac{\hat{\lambda}_j^2(q)}{d_j(q)})\right), \qquad s=1,2. \qquad (10.15)$$

with $\hat{\lambda}_j^2(q)$ being the j^{th} smallest squared canonical correlation between the first differences, (Δx_t) and the set of instruments, $d_j(q)$ is a factorisation of the sample autocorrelation, p is the order of the SECM, and r, the number of cointegrating vectors.[266] The test intuition is that the linear combinations $(\hat{\alpha}' y_t)$ and $(\hat{\gamma}' W_{p,t})$ have a non-zero cross correlation up to q periods but zero cross correlation beyond the q+1 period.

The elements of Δx_t are codependent of order q, denoted by CD(q), if there exists a $n \times s$ full-rank matrix $\tilde{a}$ such that $\tilde{a}' C_j \neq 0$ if $j = q$ and $\tilde{a}' C_j = 0$ if $j > q$. The subspace spanned by the matrix $\tilde{a}$ is the codependence space and its dimension, s, is the codependence rank.

If codependence is present for $s = 1$ then codependence emerges also for a codependence rank $s > 1$.[267] Hence, the test procedure starts for $s = 1$. As there is not an upper bound of the codependence order q, we follow the approach by Cubadda (1999a) and start the test at $q = 3$ and decrease the codependence order if the null is not rejected until the smallest order of codependence where the null is rejected (or $q = 0$).[268] Vahid and Engle (1997) indicate the weakness of the codependence method,

265 Other common approaches are based on maximum likelihood or information criteria (Vahid and Issler, 2002; Schleicher, 2007).

266 $W(q,p) = \left(\Delta x'_{t-p-1}, ..., \Delta x'_{t-p-q}, EC_{t-1}\right)$ and $d_j(q) = 1 + 2\sum_{v=1}^{q} \hat{\rho}_v(\hat{\alpha}' x_t)\hat{\rho}_v(\hat{\gamma}' W_{t-q-1})$ with $\hat{\rho}_v$ being the sample autocorrelation at lag v. α and γ are the canonical variates corresponding to $\lambda_j^2(q)$. For $q = 0$, that is, when testing a SCM(0,0), $d_j(q) = 1$, which corresponds to the SCCF test above.

267 Based on the null hypothesis $H_0 : q \geq j$, if we cannot reject an SCM$(0, q_1)$, any SCM$(0, q_2)$, with $q_2 > q_1$ will not be rejected either (Schleicher and Barillas, 2005).

268 Note that the codependence order differs for first differences and cycles, as a codependence order of q for $q \geq 1$ among first differences implies that the BN cycles are codependent of order $q - 1$ (Vahid and Engle, 1997; Cubadda, 1999a; Trenkler and Weber, 2009).

because it produces a consistent, but non-optimal estimate. However, they further show that the results are good for small sample sizes.

Table 10.10 shows the results for codependence up to order 3 based on the SCM approach of Tiao and Tsay (1989). The null of $s = 2$ codependence vectors is clearly rejected for the Czech Republic for all codependence orders, indicating that there are no non-synchronised cycles at all. The null hypothesis for one common feature vector $(s = 1)$ cannot be rejected, while the hypothesis $s = 2$ is rejected for Bulgaria for codependence of order 2. Hence the Bulgarian sectors share one common cycle after two periods. The hypothesis of one co-feature vector $s = 1$ is rejected, but the null of $s = 2$ cannot be rejected for Hungary, Latvia, Lithuania, Poland, the Slovak Republic, and Slovenia. Hence, there exists a linear combination of the sectors that displays no significant serial correlation after one period.

GMM analysis

It is often argued, that the results based on the Tiao and Tsay (1989) procedure are very sensitive to the specification of the entire estimation system. Hence we apply in addition an optimal GMM test suggested by Vahid and Engle (1997) and Cubadda (1999a), that can be seen as a generalisation of the Tiao–Tsay test.[269] The idea behind the Generalised Method of Moments (GMM) approach is to minimise the distance $Q_t(\beta) = g(\beta)'Wg(\beta)$, where W is the weighting matrix that satisfies certain conditions, for example, to be positive semi-definite for finite sample size.[270]

Especially in small samples the GMM estimator yields a good performance and compared to the ML estimator, the GMM estimator is robust to over-parameterisation issues (Cubadda, 1999a). The results of this test are reported in Table 10.11. For all countries the null hypothesis cannot be rejected for a codependence order of 1, with the exceptions of Hungary and Slovenia, where codependence of order 1 is rejected.

269 Cubadda (1999a) finds that the results for codependence based on GMM estimates are similar to the results based on the TSLS approach. Therefore we skip the TSLS analysis for codependence orders $q > 0$.

270 For a general overview on the generalised method of moments (GMM) see Hall (2005). For details of the link between the test based on canonical correlation and the GMM test, see Vahid and Engle (1997). The GMM estimator is based on the population moment condition, that is, there exists a parameter vector $\beta_0 \in \Theta$ such that the population moment condition holds: $E[f(v_t, \theta_0] = 0$, with v_t being the vector of observed variables. The GMM estimator is given by $\hat{\beta} = (X'_{4,2}WP_TW'X_{4,2})^{-1}(X'_{4,2}WP_TW'X_{4,1})$, where P_T is a positive semi-definite symmetric matrix which converges in probability to a positive definite symmetric matrix of constants P (Cubadda, 1999a; Hall, 2005). Finally using $\gamma(j) = E(u_t u_{t-j})$, $p^* = plim(T^{-1}[\gamma(0)\sum_{t=h+4}^{T-q-1} w_t w_t' + \sum_{j=1}^{q}\gamma(j)\sum_{t=h+4+j}^{T-q-1}(w_t w_{t-j}' + w_{t-j}w_t')])^{-1}$ is the best choice to yield the most efficient GMM estimator.

However, for the remaining countries, there is evidence of a common cycle after one period, but the corresponding codependence vectors are not significantly different to zero. Only for Bulgaria and Lithuania, where the χ^2 test statistic is not significant, do we find a significant codependence vector.[271] This implies that we can confirm the inference on a common non-synchronised cycle between the sectors in these countries, and that their response to a shock is similar one period after the shock has occurred.

10.2.2.4 PSCCF

Finally, we apply an approach proposed by Ericsson (1993) as a comment to the SCCF methodology by Engle and Kozicki (1993), which we refer to as Polynomial Serial Correlation Common Feature (PSCCF).[272] Ericsson (1993) emphasises that the inference whether there is a common cycle for the series depends on the relative lag between the series.[273] Hence, we propose here to allow for leads or lags l in the growth rates, so that the proposed first step in the procedure (see equation (10.2.2.1)) will change to

$$\Delta N_t = c + \delta \Delta T_{t-l} + \sum \mu \Delta N_{t-p} + \sum \eta \Delta T_{t-l-p} + \epsilon_t, \tag{10.16}$$

where $(1 \quad \delta)$ is the common feature vector.[274] The second stage is the regression of the estimated residuals $\hat{\epsilon}_t$ on the set of instruments:

$$\hat{\epsilon}_t = \beta + \sum \mu \Delta N_{t-p} + \sum \eta \Delta T_{t-l-p} + \sum \eta \Delta u_t.$$

Allowing for lead/lags in the series, we find that the cofeature coefficient is non-significant for most of the countries (see Table 10.9, lag=1,2,3). Only for Estonia, Lithuania, and Romania the coefficient is significant if we allow a one-period lag between the sectors. Furthermore, for these countries we cannot reject the null of a common cycle taking into account lags between the N-sector and the T-sector. Non-contemporaneous cycles are found for Bulgaria and Poland at codependence of

[271] The optimal GMM estimate of the codependence vector is for Bulgaria $(1 \quad 1.01)$ and for Lithuania $(1 \quad -0.91)$.

[272] Note, that the PSCCF discussed by Cubadda and Hecq (2001) and Cubadda (2007) differs from the methodology presented here, as the former consider a lag of one period only.

[273] Taking into account phase-shifts, Cubadda (1999b) shows that finding a SCCF does not imply the absence of leading-lagging behaviour between the series.

[274] As already shown in equation (10.2.2.1), we include the lagged error correction term in the list of instruments in the case of cointegration between the sectors.

order 2, and for the Czech Republic at order 3. Despite finding that a contemporaneous cycle in our common cycle analysis is rare, it its obvious that including lags alters these results. However, for Hungary, Latvia, the Slovak Republic, and Slovenia, we find neither common contemporaneous cycles nor non-contemporaneous cycles between the sectors.

To summarise, our analysis of common trends and common cycles in the N-sector and the T-sector in the CEECs has shown, that we only find evidence for a few common trends and even fewer common cycles. However, common cycles after a certain reaction time to shocks are more likely.

Finally, some limitations regarding the accuracy of the estimation must be mentioned (Lucke, 1995). VAR estimation results are unduly suitable with growing dimension of the system. In the case of a distinction between weak and strong cofeatures, cointegration vectors and common cycle vectors do not sum up to the dimension of the system. Different lag lengths as well as structural breaks can distort the results. Moreover, our sample size is possibly too small to cover a complete cycle. Several distortions, for example, seasonal adjustment or linear transformations must be considered for the validity of the SCCF (Urga, 2007). The inference of common trends as well as common cycles are conditional on the number of lags. Hence, it is very important to select the order of the system and adhere to it throughout the whole analysis (Vahid and Engle, 1997). Despite not finding a common cycle, finding seasonality as a common factor is critical. Therefore we further analyse seasonally adjusted data separately (see Section 10.4.1).

10.3 A Comparison with the Euro Area

While the focus of this part is on the CEECs, the aim of this section is to provide evidence on whether the sectoral pattern in the EMU is different compared to the sectoral structure in the CEECs. The estimation procedure is similar to the analysis of the sectoral cofeatures in the CEECs in the previous section; hence we limit this section to a description of the findings for the euro area countries.

10.3.1 Sectoral Data in the EMU

For the sectoral analysis of Western European countries, we select the EMU aggregate and highlight some major countries, namely France, Germany, and Italy. Aggregate data for a changing EMU composition are available; we have chosen the EMU12 aggregate to maintain a clear distinction between the "old" and "new" EMU members.[275] In the following section, extended analyses that include the results for the seasonal unadjusted data and a pre-crisis sample are also performed for Western European countries.

The aggregated gross value data provided by Eurostat are plotted for the N-sector and the T-sector in Figure C.5 in Appendix C.[276] In addition, the graphs of the sectoral growth rates are shown in Figure C.6 in Appendix C. The eye-catching pattern regarding the non-stationarity of the levels data and the stationary course of the growth rates are confirmed by (seasonal) unit root tests. The results reported in Table C.1(b) in Appendix C indicate that we find a unit root for all investigated countries at zero frequency. In addition, we find evidence for a unit root at a semi-annual frequency. Seasonal unit roots at frequency $\frac{1}{4}$ are rare. However, the results for the growth rates indicate stationarity (see the last column in Table C.1).[277] In addition, the preliminary analysis for the euro area countries shows that the N-sector can be best described by an AR(1) process, while the T-sector can be better expressed by an AR(4) process. For France, both the N-sector and T-sector are best described by an AR(1) process.[278] Figure C.7 in Appendix C displays the autocorrelation function for the N-sector and the

275 The EMU12 aggregated gross value added provided by Eurostat is based on national data from Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

276 Again, we use Table "namq nace06 k", that is, chain-linked volumes in national currency, with reference year 2000. The classification of the N-sector and the T-sector is identical to those given in section 10.1.1.

277 For the N-sector in the euro area (12) the null hypothesis can not be rejected.

278 The Box and Jenkins (1976) approach is used for the selection of the optimal AR process.

T-sector. In all countries considered, the T-sector reacts to a shock with a significant margin compared to the N-sector.

Table 10.12: Pair-wise Correlation between the N-sector and the T-sector

	(a) Pre-crisis	(b) Sa	(c) Total	(d) Two
Euro Area (12)	0.75	0.76	0.90	0.48
France	0.58	0.58	0.79	0.17
Germany	0.34	0.34	0.65	0.35
Italy	0.56	0.56	0.79	0.18

Note: The table shows the pair-wise correlation between the N-sector and the T-sector growth rates. For the (a) the pre-crisis period, (b) seasonal adjusted data, (c) the total sample period including the crisis and (d) the correlation between construction and manufacturing.

The correlation analysis in Table 10.12(a) already gives a hint on the comovement between the sectors. The correlation coefficient between the sectors mostly exceeds 0.5 and is higher compared with the correlation between the sectors in the CEECs (see Table 10.5). In addition, the results for cross correlation, given in Figure C.8 in Appendix C show that correlation declines considerably over time, a pattern that is also observed for the Baltic sectors.

10.3.2 Sectoral Comovements in the EMU

First, long-run comovements are analysed. The results based on the Engle-Granger TSLS procedure and the Johansen test indicate that we can reject the null hypothesis only for Germany (see Table C.2 in Appendix C). We find a common trend between the sectors in Germany. This result is consistent, applying the Cheung and Lai (1993) scaling factor for small samples. The test results of the seasonal cointegration test proposed by Lee (1992) indicate a common trend between the two sectors in Germany at both seasonal frequencies and, in addition, for the euro area at annual frequency ($\pi = \frac{1}{4}$) (see Table 10.13).[279]

The weak evidence of cointegration does not imply that there are no common cycles between the sectors in Western Europe. Similarly to the analysis for the CEECs, we start investigating serial correlation in common features. The column for lag=0 in Table 10.14 indicates that the F-statistic is significant, which implies that the null

[279] Note that the results for $\pi = 0$ given in Table 10.13 are based on an intercept, deterministic trends and seasonal dummies in the equation, while the results of the Johansen procedure are based on only a constant term.

Table 10.13: LR Test for Seasonal Cointegration (EMU)

Null Hypothesis: no seasonal cointegration

		$\pi = 0$	$\pi = 1/2$	$\pi = 1/4$
Euro Area (12)	r=0	9.06	17.97	29.31 *
	r=1	0.00	2.33	3.70
France	r=0	5.00	10.27	18.74
	r=1	0.01	1.10	7.65
Germany	r=0	12.28	25.10 *	29.88 *
	r=1	0.08	4.40	12.02
Italy	r=0	4.74	21.36	21.68
	r=1	0.06	4.69	5.66

Note: The Trace Statistic for the cointegration test at frequency 0, $\frac{1}{2}$ and $\frac{1}{4}$ is reported (Lee, 1992). ** indicates rejection of the null hypothesis with significance at the 5% level according to finite sample critical values in Lee and Siklos (1995). We allow for an intercept, deterministic trends, and seasonal dummies. The lag order of the SECM is given by the SIC.

of a contemporaneous common cycle is rejected for all Western European countries. However, if we allow for lags of up to three periods between the N-sector and the T-sector (Ericsson, 1993), the results reported in the remaining columns of Table 10.14 reveal that we cannot reject the null of a PSCCF for the euro area, France, and Italy at least at lag=1 or lag=2. Further, the common cycle coefficients are statistically significant. Finally, for a lag of three periods we also find a common cycle for Germany. Hence, lagged common cycles exist in Western Europe.

Table 10.14: Common Cycle and PSSCF Results (EMU)

Null Hypothesis: common feature

		lag p			
		0	1	2	3
Euro Area (12)	F-statistic	6.21 **	8.18	9.36	9.80
	Common cycle coefficient	0.43 **	0.31 **	0.25 **	0.19 **
France	F-statistic	15.33 **	35.59	23.33	19.24
	Common cycle coefficient	0.36 **	0.33 **	0.27 ***	0.19
Germany	F-statistic	4.23 **	6.01	5.18	3.97
	Common cycle coefficient	0.10	0.12	0.11	0.15 **
Italy	F-statistic	6.36 **	7.64	8.31	9.36
	Common cycle coefficient	0.41 **	0.33 **	0.26 **	0.17

Note: The F-statistic of the TSLS estimation and the common feature coefficient are reported. The optimal lag length is determined by SIC. ** indicates significance at the 5% level.

Another possibility is that the sectors might react similarly to shocks after a certain point in time. With regard to Table 10.15, the results for common synchronous cycles (that is, codependence order $q = 0$) are in line with the findings using the SCCF approach above; hence no evidence for common cycles is given. For the euro area and Italy the results suggest a co-dependence relationship between the sectors of order one. Using the optimal GMM test (Vahid and Engle, 1997; Cubadda, 1999a) the result of finding codepence of order one for the euro area is confirmed (see Table 10.16). While the χ^2 test statistic cannot be neglected for the other countries and for higher codependence orders, none of the GMM estimations yield a significant coefficient. Hence, non-synchronous sectoral cycles in Western Europe are rare.

Table 10.15: Codependence Tiao–Tsay Test Results (EMU)

Null Hypothesis: codependence of order q

		q=0		q=1		q=2		q=3	
Euro Area (12)	s=1	26.59	**	1.16		9.49	**	1.90	
	s=2	94.26	**	14.35	**	16.94	**	11.27	
France	s=1	32.55	**	6.25	**	1.83		0.14	
	s=2	114.44	**	19.71	**	7.04		2.18	
Germany	s=1	31.65	**	2.89		5.43		0.57	
	s=2	85.61	**	12.29		24.32	**	6.76	
Italy	s=1	11.68	**	2.73		0.44		0.20	
	s=2	59.91	**	13.75	**	8.48		9.37	**

Note: The Tiao–Tsay test statistic is reported. ** indicates significance at the 5% level.

Table 10.16: Optimal GMM Test Results (EMU)

Null Hypothesis: codependence of order q

	q=0		q=1		q=2		q=3
Euro Area (12)	26.16	**	1.54		7.59	**	2.07
France	31.62	**	5.20	**	0.00		1.44
Germany	24.82	**	5.15		4.69		1.58
Italy	15.78	**	12.24	**	0.59		0.22

Note: The χ^2 test statistic is reported. ** indicates significance at the 5% level.

10.3.3 Sectoral Differences among CEECs and EMU countries

In Table 10.17 we summarise the large number of results detailed in the previous sections. To avoid confusion from too many details through merging all analysed statistics in one table, we chose a very simple codification, where "+" indicates that the feature is present and (or) common. While we find some evidence for common trends between the sectors for both the CEECs and the EMU countries, evidence for a contemporaneous common cycle is rare. Only for the Lithuanian sectors is evidence found with the SCCF regression test. However, allowing time lags in the cycle for Eastern and Western Europe evidence of non-synchronous common cycles (PSCCF) increases. Taking into account different reaction speeds of the sectors, the Tiao–Tsay test indicates codependence of order one, that is, a common dynamic after one period after a shock has occurred. Interestingly, common features revealed by the GMM test are rare.

Table 10.17: Comparison of Sectoral Comovements

		Bulgaria	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovak Republic	Slovenia	Euro Area (12)	France	Germany	Italy
same AR(p)					+		+	+	+	+	+		+		
Common Trends															
Johansen			+						+	+			+	+	
Seasonal Cointegration	π		+												
	$\pi_{1/2}$		+												+
	$\pi_{1/4}$	+											+		+
Common Cycles															
SCCF	0						+								
PSCFF	1			+			+		+			+	+		+
	2	+		+			+	+				+	+		+
	3	+	+				+					+		+	
Tiao Tsay	0														
	1				+	+	+	+			+	+			+
	2	+				+					+			+	
	3					+									+
GMM	0														
	1	+					+								
	2											+			
	3														

Note: + indicates that the feature is common to both sectors.

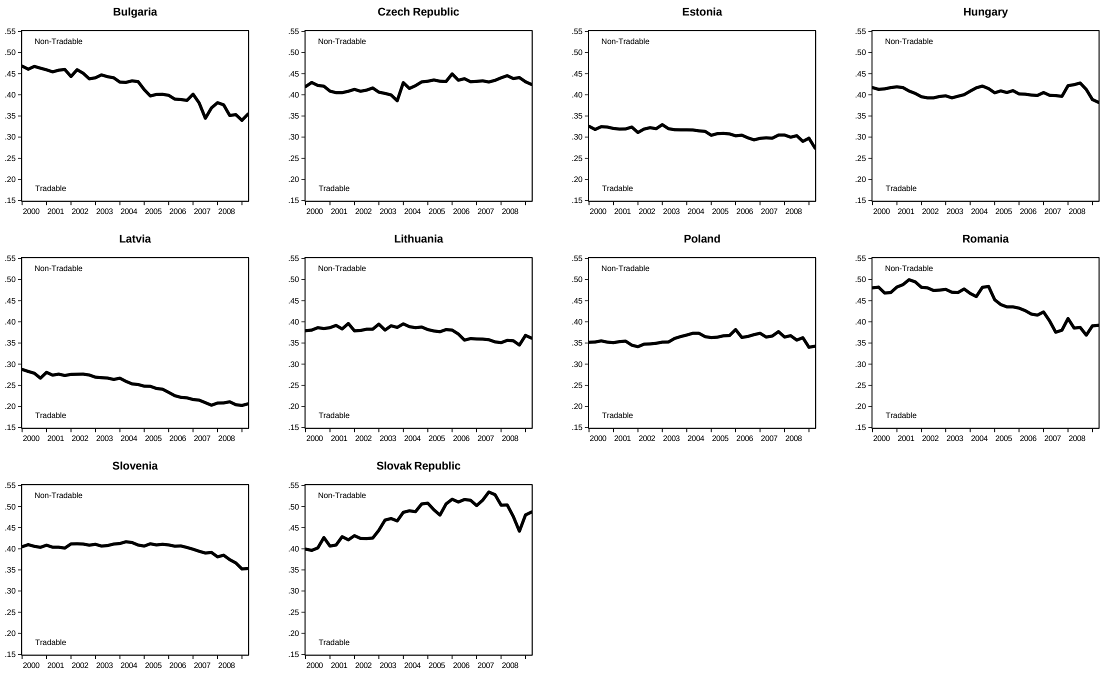
However, while common sectoral cycles between the N-sector and the T-sector cannot clearly be identified, the analysis of sectoral volatility will shed some light on the differences between the CEEC and EMU countries.[280] As a first pass, Figures 10.2 and 10.3 show that the composition of sectors in total gross value added data in the CEECs is more volatile than in Western Europe, where the relative share of sectors in total output is quite stable over time or shifts from the T-sector to the N-sector. Only for two exceptions, the Czech Republic and the Slovak Republic, is the share of the T-sector increasing until 2007.

While the N-sector is less volatile than the T-sector is, both in Eastern Europe as well as in Western Europe, Table 10.18 indicates that the standard deviation of the growth rates is always higher in the CEECs. For the individual sectors, the highest

[280] Note, that we do not aim to compare each sector in the CEECs to the corresponding sector in Western Europe; rather, we focus on the sectoral differences within each country, and compare the national sectoral differences among the countries.

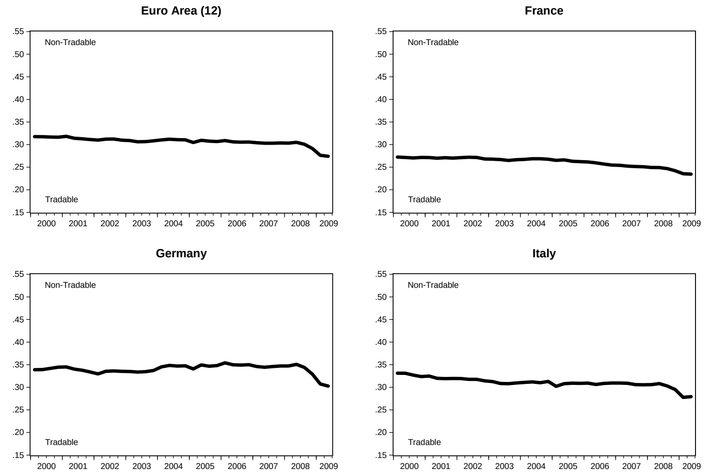
volatility is observed in the agricultural sector (A_B) and in construction (F), while industrial production, and wholesale and retail trade rank among the sectors with quite low volatility.

Figure 10.2: Shares of Different Sectors in Total Gross Value Added in the CEECs



Note: The share of the (non-)tradables sector in total gross value added is shown. The percentage is based on the chain-linked volume (reference year 2000) of NACE aggregates in national currency and is seasonally adjusted. The sectors are defined by the NACE-classification: The tradables sector: agriculture, hunting, forestry, and fishing (A_B), total industry (excluding construction) (C_D_E), and the nontradables sector: construction (F), wholesale and retail trade; hotels and restaurants; transport, storage, and communication (G_H_I) and financial intermediation; real estate, renting, and business activities (J_K).
Source: Eurostat (2009), and the author's calculations.

Figure 10.3: Shares of Different Sectors in Total Gross Value Added in the EMU



Note: as for Figure 10.2.
Source: Eurostat (2009), and the author's calculations.

Table 10.18: Sectoral Volatility

	sector						
	N	T	A_B	C_D_E	F	G_H_I	J_K
Bulgaria	0.0914	0.0763	0.1459	0.1055	0.2003	0.0932	0.1213
Czech Republic	0.0377	0.0631	0.1450	0.0694	0.1049	0.0450	0.0558
Estonia	0.0366	0.0639	0.1376	0.0647	0.1254	0.0457	0.0399
Hungary	0.0204	0.0394	0.1899	0.0379	0.0879	0.0224	0.0345
Latvia	0.0499	0.0727	0.0775	0.0831	0.1478	0.0541	0.0726
Lithuania	0.0440	0.0536	0.0951	0.0539	0.1398	0.0444	0.0294
Poland	0.0272	0.0421	0.0892	0.0487	0.0963	0.0293	0.0511
Romania	0.0361	0.0562	0.1381	0.0204	0.1040	0.0415	0.0519
Slovak Republic	0.0722	0.0753	0.1315	0.0830	0.2328	0.0973	0.1198
Slovenia	0.0270	0.0309	0.0967	0.0320	0.0955	0.0231	0.0340
mean	0.0442	0.0573	0.1247	0.0599	0.1335	0.0496	0.0610
Euro Area (12)	0.0109	0.0206	0.0506	0.0212	0.0228	0.0137	0.0108
France	0.0140	0.0190	0.0874	0.0194	0.0320	0.0195	0.0137
Germany	0.0154	0.0312	0.1045	0.0312	0.0477	0.0178	0.0182
Italy	0.0143	0.0236	0.0584	0.0230	0.0260	0.0212	0.0149
mean	0.0177	0.0290	0.0849	0.0306	0.0505	0.0219	0.0245

Note: The standard deviation of the sectoral growth rate is reported for each sector for the pre-crisis period. Mean indicates the average standard deviation over the set of countries for each sector. The sectors are defined by the NACE-classification: The tradables sector (T) :agriculture, hunting, forestry, and fishing (A_B), total industry (excluding construction) (C_D_E), and the nontradables sector (N): construction (F), wholesale and retail trade; hotels and restaurants; transport, storage, and communication (G_H_I) and financial intermediation; real estate, renting, and business activities (J_K).

10.4 Extended Analysis

In this section we present results based on seasonally adjusted data and for the whole sample period. Furthermore, two selected sectors—manufacturing and construction—are analysed and compared with the aggregate N-sector and T-sector results; the tables present the results for both the CEECs and the EMU countries.

10.4.1 Analysis of Seasonally Adjusted Data

While the use of seasonally adjusted data for business cycles analysis is favoured in the literature and empirical work, many studies show that the use of seasonally adjusted data yields, on the one hand, different results compared to raw data (see, among others, Ghysels et al., 1993; Cubadda, 1999a). On the other hand, this results in a loss of useful information, especially if variations are due to seasonal fluctuations. Despite the timing and that the direction of the seasonal effects is expected to some extent, we cannot evaluate the magnitude of the effects of the factors causing seasonality in the sectors (Lee and Siklos, 1997). Beine et al. (2000) point out that common feature results of seasonally adjusted data are meaningless because the adjustment procedure induces both size and power distortions.

The advantages of seasonally adjusted data are in particular for graphical analysis purposes and to present an input for business cycle analysis; their use facilitates the comparison of long-term and short-term movements between sectors and countries (Eurostat, 2009a). Following the recommendation of Eurostat (2009b) for seasonal adjustment in the EU, we apply the commonly used Census X-12 method to eliminate the seasonal pattern in the sectoral gross value added data for all countries.[281] For the euro area aggregate we use the direct method, that is, the unadjusted aggregate value is seasonally adjusted by the Census X-12 approach.[282]

The unit root test results for seasonally adjusted data presented in Table C.4 in Appendix C are similar to the results for unadjusted data at zero frequency.[283] However, that there might be unit roots and various seasonal frequencies has been already shown in Section 10.1.2.1. The correlation coefficients differ only marginally from the results of the unadjusted data (see Table 10.5, column (b)); again we find evidence for a counter-cyclical pattern for the Czech Republic, Hungary, Romania, the Slovak Republic, and Slovenia. Using seasonally adjusted data has no significant effect on the correlation coefficients for Western Europe; they are still higher than those in the CEECs are. Looking to changes in the process structure, we find that seasonally adjusted data follow a somewhat higher AR(p) order for both sectors (see Table C.5(a) in Appendix C). Only for Hungary, Poland, and France, can we identify the same AR(p) process for both sectors. The number of countries in which the AR(p) process for the T-sector is higher than the one for the N-sector increases.

[281] Note that in the EU two types of seasonal adjustment are used: most of the Eastern European countries apply the model-based TRAMO/SEATS procedure, while most of the Western European Countries are using the moving average based method Census X-11 Arima method. For both methods upgrades are available, for example, the Census X-12-ARIMA, which is a seasonal adjustment software produced and maintained by the United States Census Bureau. For a country-specific overview see Table C.3 and Eurostat (2009a,b) for details.

[282] Eurostat (2009b) uses the indirect approach to seasonally adjust the quarterly European aggregates, that is, national accounts data are primarily adjusted at national level and are aggregated thereafter. Accordingly this is a mix of both adjustment methods and different adjustment effects (for example, working days).

[283] This confirms the findings in Ghysels et al. (1993) that seasonal deterministic dummies capture much of the seasonal variation, but adjustment procedures have no impact on the existence of seasonal unit roots. According to the authors, the assumption of no seasonal unit root implies a misspecification of the time series.

Table 10.19: Johansen Cointegration Test Results (sa)

Null Hypothesis: no cointegration

	(a) SIC				(b) AIC			
		λ_{trace}	λ_{max}			λ_{trace}	λ_{max}	
Bulgaria	r=0	32.75 *+	29.01 *+	[1]	r=0	29.93 *	21.64 *	[8]
	r=1	3.75	3.75		r=1	8.29	8.29	
Czech Republic	r=0	38.75 *+	31.59 *+	[1]	r=0	38.75 *+	31.59 *+	[1]
	r=1	7.15	7.15		r=1	7.15	7.15	
Estonia	r=0	18.09	11.89	[1]	r=0	18.09	11.89	[1]
	r=1	6.23	6.23		r=1	6.23	6.23	
Hungary	r=0	41.78 *+	34.05 *+	[1]	r=0	41.78 *+	34.05 *+	[1]
	r=1	7.74	7.74		r=1	7.74	7.74	
Latvia	r=0	27.32 *+	21.38 *+	[1]	r=0	17.75	14.34	[4]
	r=1	5.94	5.94		r=1	3.42	3.42	
Lithuania	r=0	30.38 *+	24.93 *+	[1]	r=0	30.38 *+	24.93 *+	[1]
	r=1	5.45	5.45		r=1	5.445	5.45	
Poland	r=0	45.34 *+	39.5 *+	[1]	r=0	22.50 *	15.69 *	[8]
	r=1	5.80	5.80		r=1	6.81	6.81	
Romania	r=0	29.55 *+	22.42 *+	[3]	r=0	29.55 *+	22.42 *+	[3]
	r=1	7.13	7.13		r=1	7.13	7.13	
Slovak Republic	r=0	21.82 *+	14.26	[1]	r=0	14.93	12.78	[8]
	r=1	7.55	7.55		r=1	2.15	2.15	
Slovenia	r=0	43.16 *+	40.62 *+	[1]	r=0	24.46 *+	21.36 *+	[2]
	r=1	2.5	2.55		r=1	3.10	3.10	
Euro Area (12)	r=0	31.57 *+	23.46 *+	[1]	r=0	31.57 *+	23.46 *+	[1]
	r=1	8.11	8.11		r=1	8.11	8.11	
France	r=0	25.99 *+	17.86 *+	[1]	r=0	25.99 *+	17.86 *+	[1]
	r=1	8.13	8.13		r=1	8.13	8.13	
Germany	r=0	25.95 *+	19.47 *+	[1]	r=0	20.62 *	15.43	[2]
	r=1	6.49	6.49		r=1	5.19	5.19	
Italy	r=0	36.98 *+	30.95 *+	[1]	r=0	36.98 *+	30.95 *+	[1]
	r=1	6.03	6.03		r=1	6.03	6.03	

Note: Trace and Maximum Eigenvalue statistics for the bivariate Johansen cointegration test are reported. Panel (a) refers to a lag order based on SIC, while the lag structure in panel (b) is determined by AIC (both with a maximum lag of 8) and is given in parenthesis. We assume that the data have no deterministic trend but the cointegrating equations have intercepts. ** indicates rejection of the null hypothesis at the 5% significance level according to asymptotic critical values by Osterwald-Lenum (1992), $^{+}$ reports significance at the 5% level according to the finite sample critical values in Cheung and Lai (1993).

To avoid finding seasonality as a common feature, we apply the Johansen procedure to seasonally adjusted data allowing only an intercept. Table 10.19 indicates that the null hypothesis is rejected more often, which implies that we find more cointegration relationships in the seasonally adjusted data. Estonia is the only country where the null hypothesis cannot be rejected. This result is robust when using different criteria to determine the optimal lag length, and when applying the scaling factor proposed by Cheung and Lai (1993) to take into account the small sample properties.[284] For Latvia and the Slovak Republic there is weak evidence for a common sectoral trend if we follow the lag length selected by the Akaike criteria. Hence, the results correspond to the

[284] Using the Engle-Granger approach, we find a common sectoral trend for all countries, with the exception of France.

literature (see, among others, Lee and Siklos, 1997) showing that seasonal adjustment has on the one hand a large impact on the VAR analysis, and on the other tends to reject the null hypothesis of no cointegration more often. According to Lee and Siklos (1997), these cointegration relationships (at the zero frequency) in seasonally adjusted data often tend to be spurious.

Table 10.20: Common Cycle and PSSCF Results (sa)

Null Hypothesis: common feature

		lag p			
		0	1	2	3
Bulgaria	F-statistic	19.13 **	23.62	15.02	8.41
	Common cycle coefficient	0.14	0.30	0.48 **	0.57 **
Czech Republic	F-statistic	7.07 **	16.34	13.78	9.72
	Common cycle coefficient	0.24	0.05	0.16	0.25 **
Estonia	F-statistic	16.86 **	4.37	5.15	5.47
	Common cycle coefficient	0.34 **	0.28 **	0.20 **	0.12
Hungary	F-statistic	10.10 **	19.83	12.07	9.23
	Common cycle coefficient	-0.22 **	-0.08	0.00	0.06
Latvia	F-statistic	5.22 **	6.14	4.07	2.84
	Common cycle coefficient	0.01	0.03	-0.13	0.00
Lithuania	F-statistic	3.18 **	12.26	12.85	8.08
	Common cycle coefficient	0.89 **	0.40 **	0.30 **	0.28 **
Poland	F-statistic	5.04 **	6.68	6.00	4.37
	Common cycle coefficient	0.22	0.14	0.23 **	0.19 **
Romania	F-statistic	3.57 **	6.88	6.01	5.60
	Common cycle coefficient	-0.23	-0.26 **	-0.20	-0.17
Slovak Republic	F-statistic	0.91	4.80 **	4.53	3.86
	Common cycle coefficient	0.78 **	0.15	0.03	0.10
Slovenia	F-statistic	9.39 **	4.84	6.07	5.26
	Common cycle coefficient	-0.24	-0.10	-0.05	0.04
Euro Area (12)	F-statistic	5.20 **	9.89	10.99	11.92
	Common cycle coefficient	0.65 **	0.31 **	0.25 **	0.19 **
France	F-statistic	50.83 **	35.17	22.84	18.78
	Common cycle coefficient	0.42 **	0.33 **	0.28 **	0.20
Germany	F-statistic	11.82 **	6.49	5.56	4.26
	Common cycle coefficient	0.05	0.12	0.12	0.16 **
Italy	F-statistic	7.98 **	7.87	8.64	9.62
	Common cycle coefficient	0.61 **	0.33 **	0.26 **	0.17

Note: The F-statistic and the common feature coefficient of the TSLS estimation are reported. The optimal lag length is determined by SIC. ** indicates significance at the 5% level.

Typically, common cycle properties of seasonal differences of raw data series do not generally apply to first differences of seasonally adjusted series. Hence, Cubadda (1999a) recommends using raw data for common cycle analysis. Following the approach described in Section 10.2.2, we analyse SCCF, codependence, and PSSCF, adopting the wider process structure given in Table C.5 in Appendix C. The null hypothesis of a contemporaneous cycle (lag=0) is rejected for most of the countries (see Table 10.20). Only for the Slovak Republic do we find evidence for a common cycle in seasonally adjusted data.[285] Allowing a time lag between the N-sector and the T-sectors' reactions to a shock, the results are robust to the findings based on seasonally unadjusted data. Hence, lagged common cycles can be identified in most of the countries. In addition, the size of the coefficient using adjusted data differ only marginally from the results presented in Section 10.2.2.

Tables C.6 and C.7 in Appendix C, report the Tiao and Tsay (1989) and GMM tests; they confirm that evidence for common cycles in seasonally adjusted data is rare. Table C.6 indicates that the smallest order for which the null hypothesis of finding s zero canonical correlations between the first differences and the set of instruments is rejected is one for most of the CEECs, hence, the sectors share a common cycle after one period. The same is found for the French sectors. Using the GMM approach we can confirm a codependence relationship at order one for Lithuania.

To summarise this section, we find that the seasonal adjustment of the data increases the evidence for cointegration, but it does not affect the results of the common cycle analysis. However, it makes the cycles non-synchronous. Hence, our findings are in line with the literature that seasonal adjustment implies that we reject the null of no cointegration more often, and that we find more short-term relationships (Lee and Siklos, 1997; Cubadda, 1999a), but the results are not dwarfed by the seasonal effects of the data.

10.4.2 Comovements between Manufacturing and Construction

While the main analysis considers the aggregation of individual sectors to the N-sector and the T-sector, this section analyses the characteristics of two individual industries for robustness, namely manufacturing and construction. These two sectors are often used as proxies for the T-sector and the N-sector (see, among others, Llaudes, 2007).[286] Compared with the pair-wise correlation between the N-sector and the T-sector, the correlation coefficient between manufacturing and construction tends to be smaller for most of the countries, only for Bulgaria, Latvia, and Poland is the relationship

[285] For the Slovak Republic we already rejected the null in the seasonally unadjusted data above, however, the common cycle coefficient is not significant (see Table 10.9).

[286] Often services are used instead of construction, as the latter shows considerable volatility. However, due to the fact that the manufacturing and construction data are published individually by Eurostat (NACE sections D and F), we use the national time series instead of averaging again the multiple NACE sectors that are associated with services.

between the N-sector and the T-sector much stronger. For the euro area countries the variation is mixed; for Germany correlation remains stable, while for the other countries the coefficient decreases (see column (d) in Table 10.5 and Table 10.12). The AR(p) structure reported in Table C.5(b) in Appendix C diverges from the one that results for the sectors' aggregates. Only for Poland do we find the same process structure of AR(1) for both sectors. Interestingly, higher AR(p) processes are determined for the individual sector series. The (seasonal) unit root test results for construction and manufacturing remain stable with those of the N-sector and the T-sector, hence we cannot reject the null of unit root and zero and semi-annual frequency. The null hypothesis of a seasonal unit root is rejected for some countries, but less often compared to the N-sector and the T-sector. This can be confirmed using both an intercept, and also an intercept, seasonal dummies, and trend (see Table C.8 in Appendix C).

The Johansen cointegration results reported in Table C.9 in Appendix C suggest that there is a common long-run trend between manufacturing and construction in Bulgaria, Latvia, the Slovak Republic, and France. In addition, the results for seasonal cointegration indicate that a common trend at zero frequency between the sectors in the Slovak Republic, and at semi-annual frequency in the Czech Republic, Latvia, the Slovak Republic, and Italy. Regarding the short-run comovements given in Table C.10 in Appendix C, the SCCF test (lag=0) indicates no common cycles between manufacturing and construction, either for the CEECs or for the Western European countries. However, allowing time lags between the sectoral reaction to shocks, the PSCCF test results (lag=1,2,3) indicate that the null hypothesis of a lagged common cycle between the countries cannot be rejected for Estonia, Lithuania, and Poland. At a lag of three periods the Latvian sectors also share a common cycle. There is no evidence for lagged common cycles between manufacturing and construction in Western Europe. Using the Tiao and Tsay (1989) test and the GMM test we can confirm that the null hypothesis of codependence at order zero, that is, finding a serial correlation common feature is rejected (see Tables C.11 and C.12 in Appendix C). For higher codependence orders, the Tiao–Tsay test shows that the sectors in all countries have similar reactions to a shock after one period, with the exception of Latvia and Lithuania. Also for the euro area we can confirm the previous results and do not find evidence for common, non-synchronised features. The GMM test confirms the findings of codependence of order one between the manufacturing and the construction sector in Estonia and Poland.

In contrast with the results for the N-sector and the T-sector, the findings in this section indicate that different sectors suggest different conclusions. However, the overall findings remain robust: while cointegration relationships between the N-sector and the T-sector exist, common cycles are rare. Only allowing leads and (or) lags causes few common lagged and common non-synchronous cycles.

10.4.3 Sectoral Distortions during the Crisis

While the principal analysis for the N-sector and the T-sector has concentrated on the pre-crisis period (1995Q1:2008Q1), this section considers whether our findings are robust for the overall sample period (1995Q1:2009Q2), that is, whether the crisis leaves its mark in distortions in the sectoral comovements. Hecq (2009) emphasise that the same shock might has different effects dependent on whether is occurs in normal time, expansions or recessions. He shows that the test-statistics are biased towards finding no co-movements in the case of different regimes in the sample period.

Over the total sample period, the sectors tend to correlate more strongly, which is not too surprising, as the crisis hits both sectors simultaneously, although to a different extent (see column (c) in Table 10.5). In addition, all comovement between the sectors is pro-cyclical, with the exception of the Slovak Republic. For the Western European countries, we find that the correlation coefficient increases considerably, for example, up to 0.9 for the euro area (see column (c) in Table 10.12).

The test for seasonal unit roots results in rejecting the null hypothesis for unit roots at annual frequency more (less) often in the N-sector (T-sector). For zero and semi-annual frequency the null cannot be rejected as is shown in Table C.13 in Appendix C. The AR(p) structure is similar to the pre-crisis period, however we found that more euro area countries have the same AR(p) process, while they tend to be different in the CEECs (see Table 10.4(b) in section 10.1.3).

The Johansen cointegration test results for the whole sample period differ from those in the pre-crisis period for the CEEC, but are robust for the Western European countries, that is, indicating a common trend in Germany (see Table C.14 in Appendix C). Strong evidence for cointegration is given for the sectors in Lithuania, and the Slovak Republic. In addition, seasonal cointegration at semi-annual frequency is found for Romania, Slovenia, and Germany. Table C.15 shows that the evidence for a common synchronised cycle in Lithuania is also robust if we take into account distortions caused by the crisis. While the pattern for PSCCF is somewhat different, it is obvious that (also) for a longer sample period the Hungarian and Slovak sectors do not share a contemporaneous or a lagged common cycle. Tables C.16 and C.17 in Appendix C confirm the outcome: there are few signs for common cycles. However, we can confirm codependence of order one for Hungary, Latvia, and Lithuania, the euro area, and Italy using the Tiao–Tsay test.[287] The GMM test mainly supports the previous results.

As expected, the crisis had a significant impact on our results. According to the latest data we find that for most of the countries the conclusions are very sample-sensitive. While the number of cointegration relationships remains almost constant, the countries in which the sectors feature a common long-run trend varies. But on the other hand the short-run comovements are less affected, as the SCCF and PSCCF outcomes show. The effect of sample size on the codependence test is likewise marginal. Finally, looking at sectoral volatility, the sectoral standard deviation is, as expected, higher for most of the countries compared to the pre-crisis period. The impact of the crisis seems less severe in the construction sector, where we do not find an increase in volatility.

[287] Note that for the three CEECs this finding is also present in seasonally adjusted data. In addition, we have shown that in the two-industry case, codependence of order one is given for Hungary.

11 Summary

Various empirical and theoretical studies have analysed whether and to what degree the business cycles in Central and Eastern Europe are well synchronised with the business cycle of the euro area, or with those of individual EMU countries, in particular prior to the accession of countries to the European Union. The EU enlargement also involves newcomers participating in the EMU in the future. Aside from the responsibility to fulfil the Maastricht criteria, the theory of optimum currency areas emphasises that the synchronisation of business cycles is a necessary condition for joining the common currency area. However, by a failure in one of the Maastricht criteria the CEECs can adjourn their EMU entry indefinitely.

Our analysis contributes to the literature on the EMU enlargement in an unconventional way. We consider the approach of Lahiri et al. (2006) and the boom–bust model of Schneider and Tornell (2004) for discussion on whether the CEECs should join the EMU in the near future. After stating the current exchange rate arrangements in the CEECs, we presented the alternative approach to thinking about the adoption of the euro in the new EU Member States. The empirical investigation of the stylised facts of the boom–bust framework is based on two main empirical analyses—credit market imperfections and sectoral comovements.

As a first contribution we investigated the existence of credit market imperfections, and documented that credit growth in the CEECs increased considerably in the years prior to the crisis, which was mainly driven by the private sector and the convergence process towards the Western European countries. However, according to the model, the financial opportunities across firms are rather different, and in particular for small and nontradable sector firms—restricted to domestic financial markets—access to finance is significantly constrained. By using different firm-level surveys conducted by the World Bank, we confirmed that in fact access to credit is quite different across firms, and that major obstacles exist for small firms. This result is robust across countries, sample periods, and different sectors of the economy. Control variables such as firms' formation year or government ownership show no significant impact on the firm's credit constraint.

Other challenges of the credit markets are weak contract enforceability and high corruption levels. Based on composite indices by Transparency International (2010) and Kaufmann et al. (2009) we document corruption scores for the CEECs. Moreover we confirm by analysing a firm-level survey by the World Bank that corruption is a problematic issue for firms in this region.

To avoid the financial credit squeeze and domestic obstacles, firms and banks borrow abroad. We documented major advantages and risks that arise from borrowing in foreign currency, and focused on the risk of currency mismatch on private-sector balance sheets. Based on macro data, we showed that in the banking sector the shares of foreign positions—both foreign liabilities and foreign assets—are quite high. Further, bank-level data give evidence that the banking sectors' balance sheet is almost balanced, which implies that the currency mismatch problem—and hence the exchange rate risk—is passed to the non-financial corporations (and households). The analysis of firm-level data confirmed that the share of foreign-currency-denominated debt is comparatively high. The boom–bust cycle theory emphasises that foreign borrowing will be amplified by an appreciation of the currency—that is the debt value will decrease—but it turns out to be a major problem if the exchange rate depreciates. This appreciation effect has been documented for most of the CEECs.

Prudential policy measures, such as the accumulation of foreign-exchange reserves or an adequate monetary and exchange rate policy might help to cushion the risks arising from currency mismatch and reduce foreign debt. However, their task is often limited owing to fixed exchange rate systems. Restrictive monetary policy leads to a decrease in domestic currency lending but simultaneously accelerates the demand for foreign-currency-denominated loans. Rancière et al. (2010) find that for countries with prudential measures in the domestic banking environment in the boom-period, the currency mismatch that results from direct borrowing is more pronounced. These measures contribute to the increase in foreign-currency borrowing. It must be emphasised that there is no adequate measure for currency mismatch that takes into account systemic risk—the currency mismatch cannot be estimated precisely. In contrast, fiscal policy measures might be useful to restrict credit growth in general.[288] Given the virtually complete foreign ownership of banks, intensive supervisory coordination with cross-border authorities remains the crucial way to manage foreign debt.

As a second contribution we investigated common long-run and short-run comovements in the sectoral time series of selected EU Member States that do not belong to the euro area. Gross value added data are tested for common trends and common cycles. While there is evidence for common long-run trends between the sectors in some countries, we cannot find contemporaneous common cycles, except for Lithuania. Evidence for non-synchronous cycles and codependent cycles is more pronounced. Accordingly our results are in line with previous empirical findings in the literature indicating that sectoral outputs share a relatively large number of common trends and a low number of common cycles.[289] The use of seasonally adjusted data increases the signals for long-run comovements, but has only a marginal impact on short-run contemporaneous movements.

Although we find evidence for codependence as well as lagged synchronised cycles, we must bear in mind that this analysis has been carried out by adopting the higher AR(p) process for the cases where the optimal lag structure of the sectors was different. Different lag-determination methods, estimation approaches, seasonal adjustment, sample sizes, and sector choices have significant impacts on the results. Accordingly, we should avoid drawing too strong a conclusion at the country level and instead gather information for a panel of countries—perhaps for the CEECs' region versus the euro area. Short samples of data imply lower power for the applied tests and do not take into account possible parameter shifts over time.

Through the distinctions between the T-sector and the N-sector we can follow the argument of the boom–bust cycle theory. We find that their sectoral reactions are quite different. This implies also that sectoral prices will be affected differently by exchange rate fluctuations, and hence can amplify asymmetries between the sectors. Accordingly, the existing credit market imperfections and the absence of evidence for common cycles are favourable for a rapid adoption of the euro—countries benefit from the stabilisation mechanism of the exchange rate. Individual sectoral cycles imply that the sectoral specialisation patterns have a negative impact on the overall harmonisation

288 Suggestions are given by the IRC expert group on financial stability challenges in candidate countries (2008) for the cases of Croatia, the former Yugoslav Republic of Macedonia, and Turkey.

289 For similar results on sectoral output, see for instance Engle and Issler (1995) for the United States; and Schleicher and Barillas (2005) for Canadian sectoral output.

of the business cycles between individual countries in Eastern Europe and the EMU, and (or) individual EMU countries (van Riet et al., 2004). Resources need to be shifted from the nontradable sector to the tradable sector to achieve balanced growth (ECB, 2010b).

Finally, we have seen that during the recent financial crisis credit market imperfections were even worse than prior to the crisis. GDP and credit growth dropped dramatically, mainly driven by a weakening of demand (from the main trading partners) and the cutback of liquidity (de-leveraging). That is, banks withdrew huge amounts from their affiliates in the CEECs. The credit constraints at the firm level do not deteriorate significantly. This is mainly attributed to the fact that small and non-export firms use mainly internal funding to run their businesses. Overall, credit demand decreased and hence the number of firms demanding credit face similar credit constraints. In contrast, the constrained credit supply by the banks might indicate that firms' credit demand is low. While financial obstacles vary across countries, they are more severe for those with significant currency mismatches. The depreciation of the national currencies and the balance-sheet effect weakened financial stability considerably.

As already emphasised, the improvement of cross-border financial supervision should be a major goal for the near future; banks should disclose the specific risk to borrowers, and eligibility criteria should be tightened further and local funding should be encouraged.

Appendix B:
Credit Market Imperfections

Table B.1: Size Distribution of Firms in Individual Countries

Bulgaria	Small firms	Large firms
number of total firms		
295	267	28
non-export sector	80%	39%
export sector	20%	61%

Czech Republic	Small firms	Large firms
number of total firms		
335	308	27
non-export sector	75%	52%
export sector	25%	48%

Estonia	Small firms	Large firms
number of total firms		
206	185	21
non-export sector	71%	48%
export sector	29%	52%

Hungary	Small firms	Large firms
number of total firms		
581	534	47
non-export sector	66%	28%
export sector	34%	72%

Latvia	Small firms	Large firms
number of total firms		
193	173	20
non-export sector	75%	60%
export sector	25%	40%

Lithuania	Small firms	Large firms
number of total firms		
160	149	11
non-export sector	66%	36%
export sector	34%	64%

Poland	Small firms	Large firms
number of total firms		
952	883	69
non-export sector	77%	51%
export sector	23%	49%

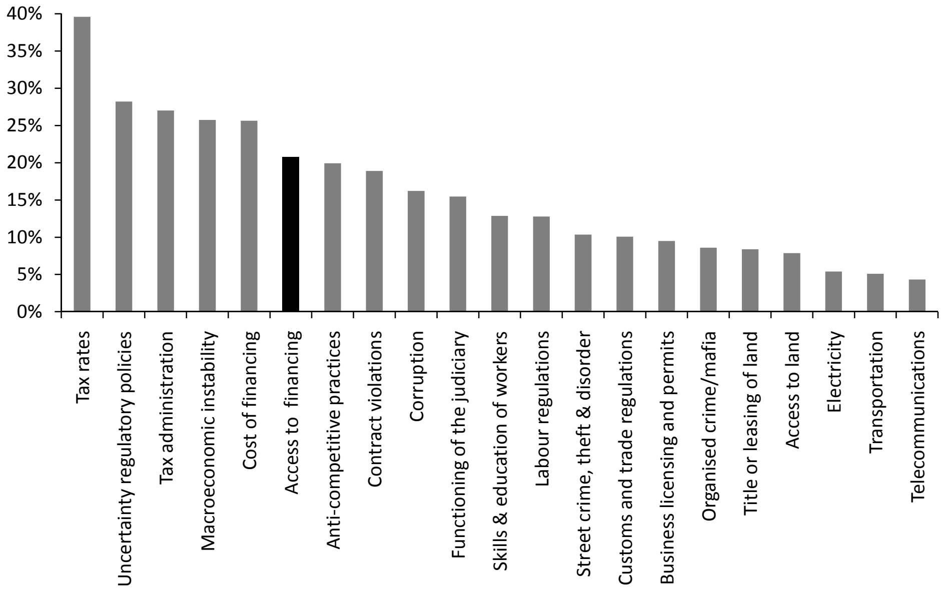
Romania	Small firms	Large firms
number of total firms		
583	524	59
non-export sector	80%	42%
export sector	20%	58%

Slovakia	Small firms	Large firms
number of total firms		
285	259	26
non-export sector	73%	38%
export sector	27%	62%

Slovenia	Small firms	Large firms
number of total firms		
218	190	28
non-export sector	57%	18%
export sector	43%	82%

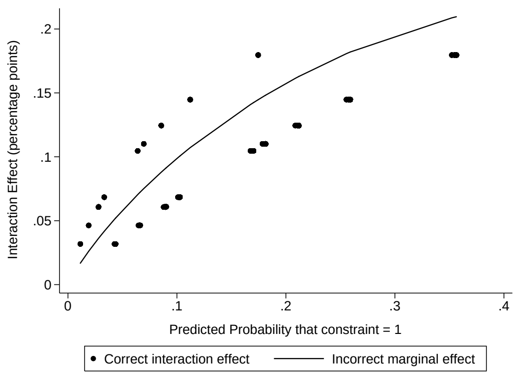
Note: Small (and medium) firms have two to 249 full-time employees, while large firms have 250 to 9999 full-time workers. Firms with more than 10,000 employees are excluded from the survey. Export firms include both direct and indirect exporters. The sample consists of firms that answered the question on financial constraints.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculation.

Figure B.1: Biggest Obstacles for Business

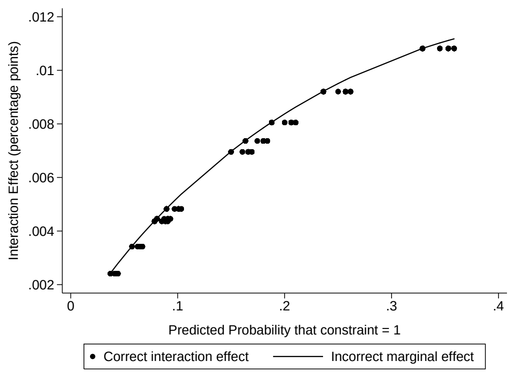


Note: The share of firms facing major obstacles in running their businesses due to a specific factor is shown. Each obstacle is considered separately.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005) and the author's calculation.

Figure B.2: Interaction Effects II



(a) Small × Private



(b) Non-export × Private

Note: Interaction effects for (a) small and private firms and (b) non-export and private firms are shown as a function of the predicted probability. Calculation is based on the procedure proposed by Norton et al. (2004).

Table B.2: Financial Asymmetries based on Ordered Probit Regressions

	"General constraint financing"							
	Ordered Probit (1)	Ordered Logit (2)	Ordered Probit (3)	Ordered Logit (4)	Ordered Probit (5)	Ordered Logit (6)	Ordered Probit (7)	Ordered Logit (8)
estimation results								
non-export	0.004	-0.002	-0.021	-0.046				
	[0.040]	[0.066]	[0.040]	[0.067]				
small					0.398 ***	0.679 ***	0.357 ***	0.605 ***
					[0.066]	[0.112]	[0.071]	[0.119]
non gov			0.089	0.188			0.029	0.095
			[0.073]	[0.123]			[0.074]	[0.125]
age			-0.004 ***	-0.006 ***			-0.002	-0.003
			[0.001]	[0.001]			[0.001]	[0.002]
McFadden R^2	0.046	0.046	0.048	0.048	0.050	0.050	0.051	0.051
p-value (LR-stat)	0.000	0.000	0	0	0.000	0.000	0.000	0.000
obs	3722	3722	3716	3716	3722	3722	3716	3716
marginal effects								
non-export	0.001	-0.000	-0.006	-0.007				
small					0.093 ***	0.093 ***	0.085 ***	0.082 ***
non gov			0.023	0.029			0.008	0.015
age			-0.001 ***	-0.001 ***			-0.001	-0.001

Note: Ordered probit and logit regression results are shown, both excluding and including control variables. *,**,*** indicate significance at the 10%, 5% or 1% level. Standard errors are given in parentheses. The lower part shows the average marginal effects of the variables, keeping all other things equal; the outcome of the binary is equal to 4, which indicates the major constraint.

Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005), and the author's calculations.

Table B.3: Financial Asymmetries III

"General constraint financing"

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
estimation results										
non-export	0.034	0.019	0.125	0.056			0.030	-0.030	0.382	0.372
	[0.096]	[0.096]	[0.347]	[0.352]			[0.331]	[0.334]	[0.537]	[0.538]
small	0.635 ***	0.661 ***	0.680 ***	0.679 ***	0.056	0.019			0.451	0.428
	[0.180]	[0.189]	[0.246]	[0.253]	[0.319]	[0.322]			[0.559]	[0.558]
non gov		-0.261		-0.259	-0.952 ***	-1.009 ***	-0.084	-0.222	-0.558	-0.611
		[0.174]		[0.175]	[0.351]	[0.356]	[0.289]	[0.301]	[0.506]	[0.509]
non-export × small			-0.098	-0.040					-0.603	-0.626
			[0.360]	[0.364]					[0.685]	[0.684]
non gov × small					0.955 ***	0.958 ***			0.366	0.341
					[0.401]	[0.401]			[0.630]	[0.630]
non-export × non gov							0.079	0.113	-0.927	-0.961
							[0.345]	[0.345]	[0.764]	[0.764]
non-export × small × non gov									1.188	1.245
									[0.880]	[0.882]
age		0.002		0.002		-0.002		-0.005		-0.003 ***
		[0.002]		[0.002]		[0.002]		[0.003]		[0.003]
Mc Fadden R^2	0.069	0.070	0.069	0.070	0.071	0.072	0.0657	0.0666	0.072	0.072
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
obs	3722	3716	3722	3716	3722	3716	3722	3716	3722	3722
marginal effects										
non-export	0.005	0.003	0.019	0.009	0.009		0.005	-0.005	-0.004	-0.006
small	0.085 ***	0.087 ***	0.090 **	0.089 **		0.003			0.120 ***	0.119 ***
non gov		-0.042		-0.042	-0.172 ***	-0.183 ***	-0.013	-0.036	-0.017	-0.027
non-export × small			-0.015	-0.006					0.037	0.039
non gov × small					0.121 *	0.121 *			0.025	0.029
non-export × non gov							0.012	0.017	0.123 **	0.126 ***
non-export × small × non gov									0.134	0.145

Note: Logit regression results are shown, both excluding and including control variables. *,**,*** indicate significance at 10%, 5% or 1% level. Standard errors are given in parenthesis. Marginal effects and interaction effects are shown at the lower part of the table.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005), and the author's calculations.

Table B.4: Sectoral Financial Asymmetries

"General constraint financing"

	Probit (1)	Logit (2)	Probit (3)	Logit (4)	Probit (5)	Logit (6)	Probit (7)	Logit (8)	Probit (9)	Logit (10)	Probit (11)	Logit (12)
N-sector (construction=100)	0.138	0.234	0.117	0.197	-0.086	-0.154	-0.099	-0.176	-0.585	-1.152	-0.603	-1.183
	[0.096]	[0.164]	[0.096]	[0.165]	[0.419]	[0.786]	[0.422]	[0.789]	[0.367]	[0.753]	[0.368]	[0.754]
N-sector × small					0.233	0.404	0.231	0.398				
					[0.431]	[0.804]	[0.433]	[0.806]				
N-sector × small × non gov									0.791 **	1.502 *	0.793 **	1.505 *
									[0.381]	[0.772]	[0.382]	[0.773]
small					0.342 ***	0.621 ***	0.362 ***	0.644 ***	0.367 ***	0.657 ***	0.346 ***	0.621 ***
					[0.098]	[0.182]	[0.105]	[0.193]	[0.101]	[0.185]	[0.104]	[0.189]
non gov			-0.091	-0.144			-0.161	-0.26	-0.163 *	-0.27	-0.193 *	-0.327 *
			[0.097]	[0.170]			[0.099]	[0.174]	[0.095]	[0.166]	[0.100]	[0.176]
age			-0.003 *	-0.005 *			-0.001	-0.002			-0.001	-0.003
			[0.001]	[0.002]			[0.001]	[0.002]			[0.001]	[0.002]
McFadden R^2	0.066	0.066	0.067	0.067	0.070	0.070	0.071	0.071	0.072	0.072	0.072	0.072
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
obs	3722	3722	3716	3716	3722	3722	3716	3716	3722	3722	3716	3716

	Probit (1)	Logit (2)	Probit (3)	Logit (4)	Probit (5)	Logit (6)	Probit (7)	Logit (8)	Probit (9)	Logit (10)	Probit (11)	Logit (12)
N-sector (transport=100)	0.157	0.274	0.153	0.268	0.422	0.747	0.384	0.685	0.045	0.062	0.058	0.085
	[0.106]	[0.182]	[0.106]	[0.183]	[0.313]	[0.554]	[0.320]	[0.564]	[0.269]	[0.489]	[0.270]	[0.490]
N-sector × small					-0.279	-0.496	-0.244	-0.44				
					[0.333]	[0.586]	[0.339]	[0.596]				
N-sector × small × non gov									0.144	0.267	0.129	0.238
									[0.293]	[0.528]	[0.294]	[0.529]
small					0.387 ***	0.701 ***	0.399 ***	0.713 ***	0.391 ***	0.694 ***	0.374 ***	0.662 ***
					[0.100]	[0.188]	[0.107]	[0.197]	[0.101]	[0.186]	[0.104]	[0.190]
non gov			-0.082	-0.130			-0.143	-0.232	-0.136	-0.217	-0.163	-0.267
			[0.097]	[0.170]			[0.100]	[0.176]	[0.096]	[0.169]	[0.101]	[0.178]
age			-0.003 *	-0.005 *			-0.001	-0.002			-0.001	-0.002
			[0.001]	[0.002]			[0.097]	[0.170]			[0.001]	[0.002]
McFadden R^2	0.066	0.066	0.067	0.067	0.070	0.070	0.071	0.071	0.070	0.070	0.071	0.071
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
obs	3722	3722	3716	3716	3722	3722	3716	3716	3722	3722	3716	3716

	Probit (1)	Logit (2)	Probit (3)	Logit (4)	Probit (5)	Logit (6)	Probit (7)	Logit (8)	Probit (9)	Logit (10)	Probit (11)	Logit (12)
N-sector (hotel=100)	-0.098	-0.185	-0.103	-0.193	0.116	0.178	0.093	0.172	-0.094	-0.181	-0.112	-0.202
	[0.130]	[0.241]	[0.131]	[0.241]	[0.619]	[1.132]	[0.630]	[1.131]	[0.454]	[0.811]	[0.455]	[0.809]
N-sector × small					-0.237	-0.399	-0.212	-0.391				
					[0.633]	[1.159]	[0.644]	[1.158]				
N-sector × small × non gov									-0.016	-0.022	0.002	-0.002
									[0.474]	[0.849]	[0.475]	[0.848]
small					0.363 ***	0.657 ***	0.381 ***	0.677 ***	0.397 ***	0.704 ***	0.376 ***	0.668 ***
					[0.096]	[0.179]	[0.104]	[0.190]	[0.100]	[0.184]	[0.103]	[0.188]
non gov			-0.091	-0.146			-0.16	-0.262	-0.13	-0.205	-0.16	-0.262
			[0.097]	[0.170]			[0.099]	[0.173]	[0.094]	[0.165]	[0.099]	[0.174]
age			-0.003 *	-0.005 *			-0.001	-0.002			-0.001	-0.002
			[0.001]	[0.002]			[0.001]	[0.002]			[0.001]	[0.002]
McFadden R^2	0.065	0.065	0.067	0.067	0.069	0.069	0.070	0.070	0.070	0.070	0.070	0.070
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
obs	3722	3722	3716	3716	3722	3722	3716	3716	3722	3722	3716	3716

Table B.4: Sectoral Financial Asymmetries (cont)

"General constraint financing"

	Probit (1)	Logit (2)	Probit (3)	Logit (4)	Probit (5)	Logit (6)	Probit (7)	Logit (8)	Probit (9)	Logit (10)	Probit (11)	Logit (12)
N-sector (wholesale=100)	-0.202 ***	-0.370 ***	-0.210 ***	-0.385 ***	-0.612	-1.136	-0.626	-1.159	-0.476 *	-0.844 *	-0.492 **	-0.872 *
	[0.067]	[0.122]	[0.068]	[0.122]	[0.371]	[0.757]	[0.373]	[0.758]	[0.245]	[0.460]	[0.245]	[0.460]
N-sector × small					0.413	0.775	0.427	0.797				
					[0.378]	[0.767]	[0.380]	[0.768]				
N-sector × small × non gov									0.289	0.502	0.302	0.525
									[0.255]	[0.477]	[0.255]	[0.477]
small					0.336 ***	0.604 ***	0.345 ***	0.608 ***	0.389 ***	0.687 ***	0.363 ***	0.639 ***
					[0.099]	[0.183]	[0.107]	[0.194]	[0.101]	[0.185]	[0.104]	[0.190]
non gov			-0.086	-0.142			-0.156	-0.258	-0.145	-0.232	-0.183 *	-0.303 *
			[0.097]	[0.169]			[0.099]	[0.173]	[0.096]	[0.168]	[0.101]	[0.178]
age			-0.003 *	-0.005 *			-0.002	-0.003			-0.002	-0.003
			[0.001]	[0.002]			[0.001]	[0.002]			[0.001]	[0.002]
McFadden R^2	0.068	0.068	0.069	0.069	0.072	0.072	0.073	0.073	0.073	0.073	0.073	0.073
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
obs	3722	3722	3716	3716	3722	3722	3716	3716	3722	3722	3716	3716

	Probit (1)	Logit (2)	Probit (3)	Logit (4)	Probit (5)	Logit (6)	Probit (7)	Logit (8)	Probit (9)	Logit (10)	Probit (11)	Logit (12)
N-sector (real estate=100)	-0.405 ***	-0.738 ***	-0.419 ***	-0.76 ***	-0.227	-0.306	-6.017	-22.74	-0.345	-0.484	-0.362	-0.518
	[0.109]	[0.208]	[0.109]	[0.208]	[0.249]	[0.450]	[24447]	[63318]	[0.263]	[0.472]	[0.263]	[0.472]
N-sector × small					-0.235	-0.556	5.595	21.98				
					[0.274]	[0.502]	[24447]	[63318]				
N-sector × small × non gov									-0.109	-0.366	-0.093	-0.334
									[0.288]	[0.524]	[0.288]	[0.525]
small					0.376 ***	0.68 ***	0.382 ***	0.672 ***	0.419 ***	0.738 ***	0.396 ***	0.698 ***
					[0.096]	[0.178]	[0.104]	[0.189]	[0.100]	[0.184]	[0.103]	[0.188]
non gov			-0.121	-0.196			-0.199 **	-0.327 *	-0.151	-0.227	-0.187 *	-0.294
			[0.097]	[0.171]			[0.100]	[0.175]	[0.098]	[0.172]	[0.104]	[0.182]
age			-0.003 *	-0.005 *			-0.002	-0.003			-0.002	-0.003
			[0.001]	[0.002]			[0.001]	[0.002]			[0.001]	[0.002]
McFadden R^2	0.069	0.069	0.071	0.070	0.074	0.074	0.075	0.075	0.074	0.074	0.075	0.075
p-value (LR-stat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
obs	3722	3722	3716	3716	3722	3722	3716	3716	3722	3722	3716	3716

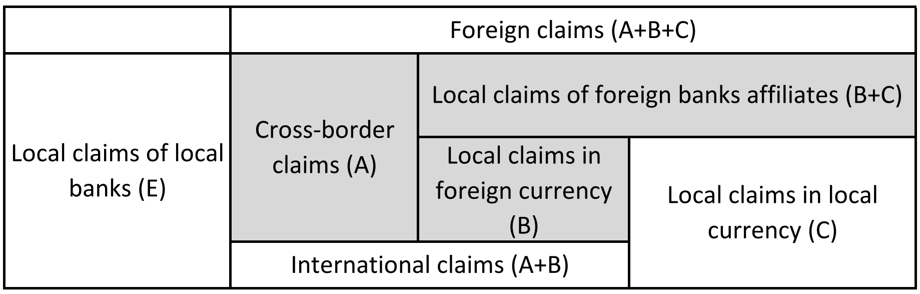
Note: The sector is clearly identified if the firm operates wholly in this sector. Probit and logit regression results are shown, both excluding and including control variables. *,**,*** indicate significance at the 10%, 5% or 1% level. Standard errors are given in parentheses. The lower part shows the average marginal effects of the variables, keeping all other things equal; the outcome of the binary is equal to 4, which indicates the major constraint.
Source: Business Environment and Enterprise Performance Survey (World Bank and EBRD, 2005), and the author's calculations.

Table B.5: Constrained Firms in WBES

	total firms	small and medium firms	large firms
no of total firms	1239	1129	110
General constraint financing	34.1%	34.9%	26.4%
Finance Constraint - access to credit	14.0%	14.7%	6.4%
Finance Constraint - access to foreign banks	12%	12.3%	9.1%

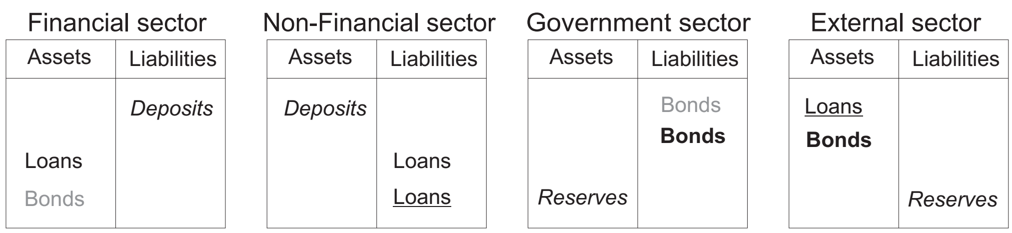
Note: The share of firms that indicate major obstacles in finance is shown.
Source: World Business Environment Survey (World Bank Group, 2000), and the author's calculations.

Figure B.3: Bank Claims on a Country



Note: The claims blocks marked in grey are available on an ultimate risk basis, while the other claims have to be derived from an immediate borrower basis and an ultimate risk basis.
Source: Bank of International Settlements (BIS, 2010).

Figure B.4: Linkages between Sectoral Balance Sheets

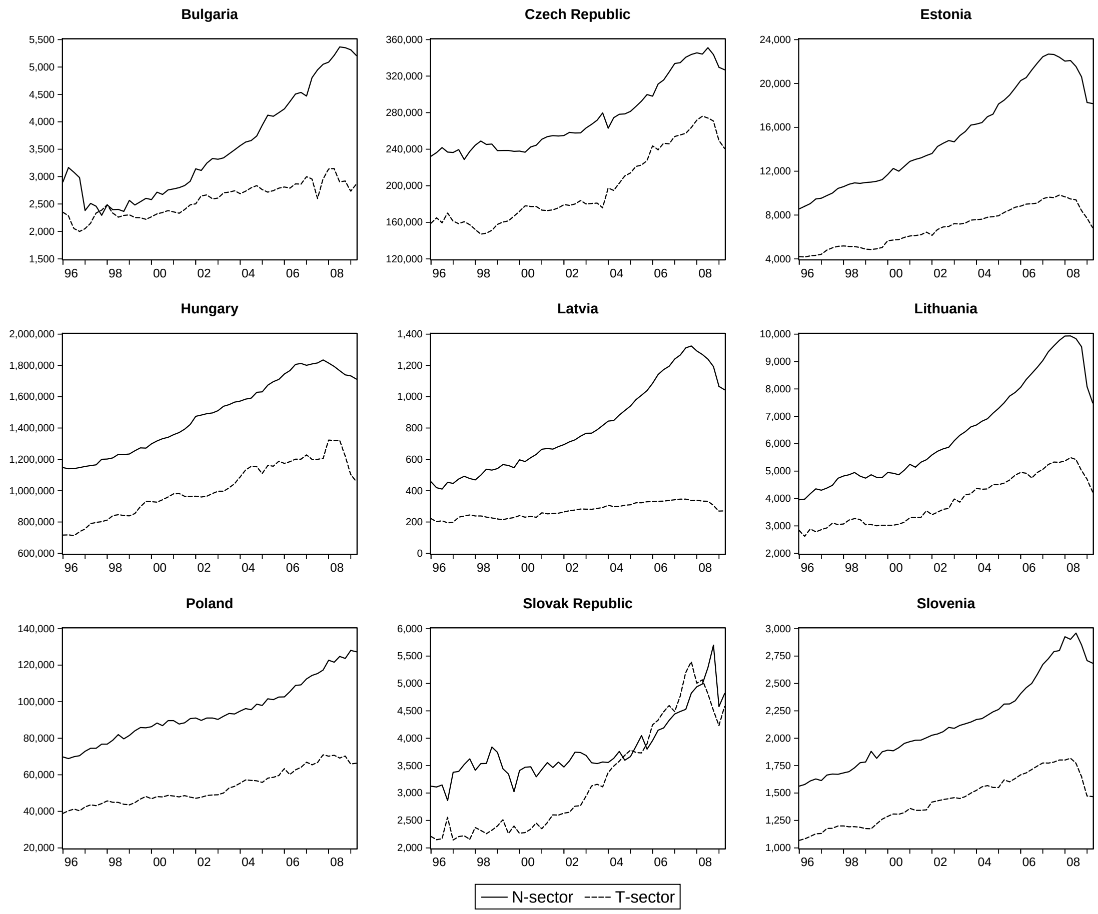


Source: see, among others, Rosenberg et al. (2005).

Appendix C:
Sectoral Comovement

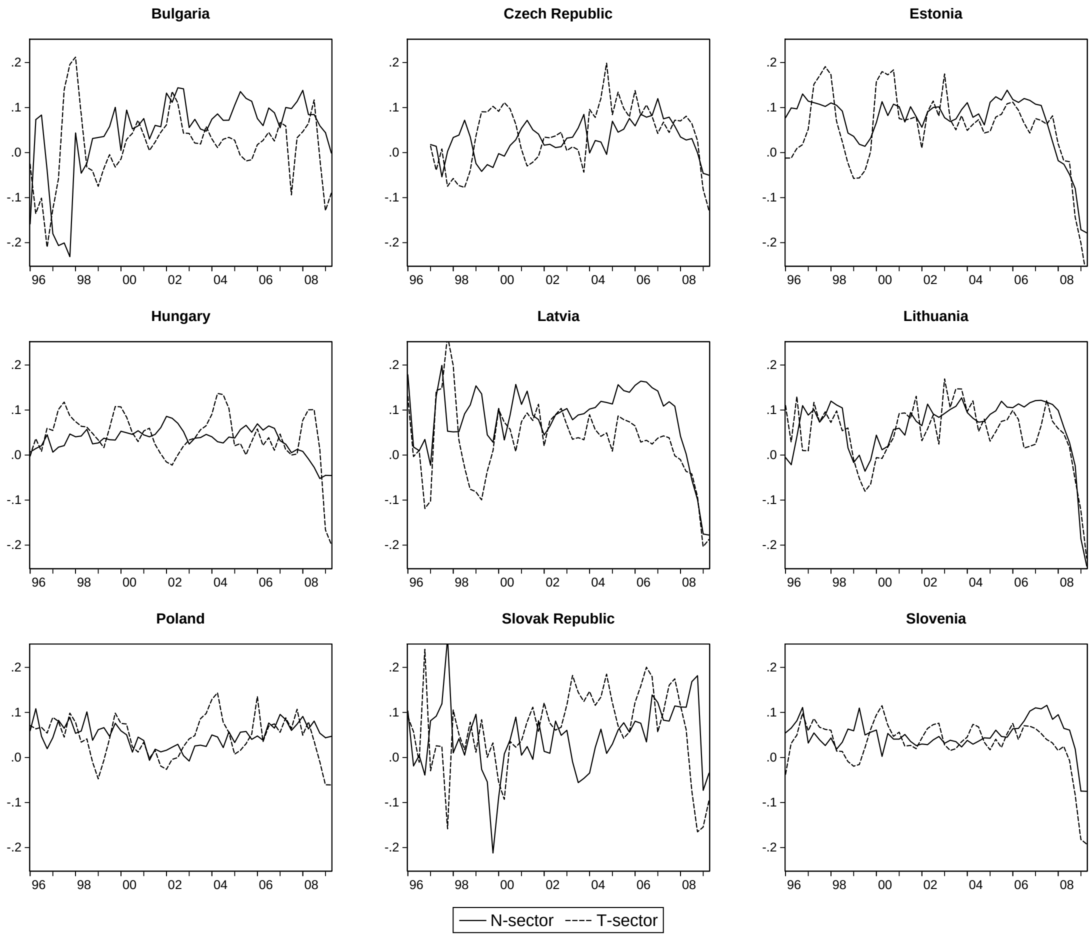
Results for the CEECs

Figure C.1: Gross Value Added Levels in the CEECs



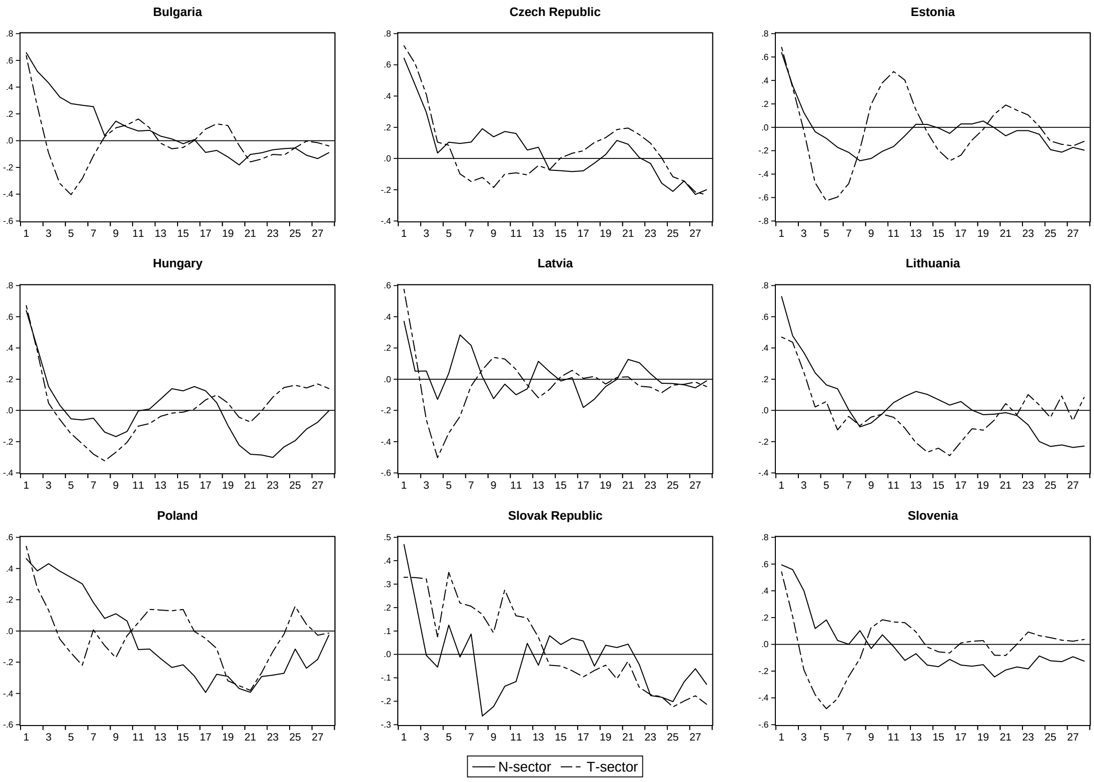
Note: Gross value added data for NACE aggregates in national currency and seasonally adjusted form are shown. The tradables (T) sector is defined by agriculture, hunting, forestry, and fishing (A_B), total industry (excluding construction) (C_D_E), and the nontradables (N) sector by construction (F), wholesale and retail trade; hotels and restaurants; transport, storage, and communication (G_H_I) and financial intermediation; real estate, renting, and business activities (J_K). Romanian data are not shown, as they are only available after 2000.
Source: Eurostat (2009) and the author's calculations.

Figure C.2: Sectoral Cycles in the CEECs



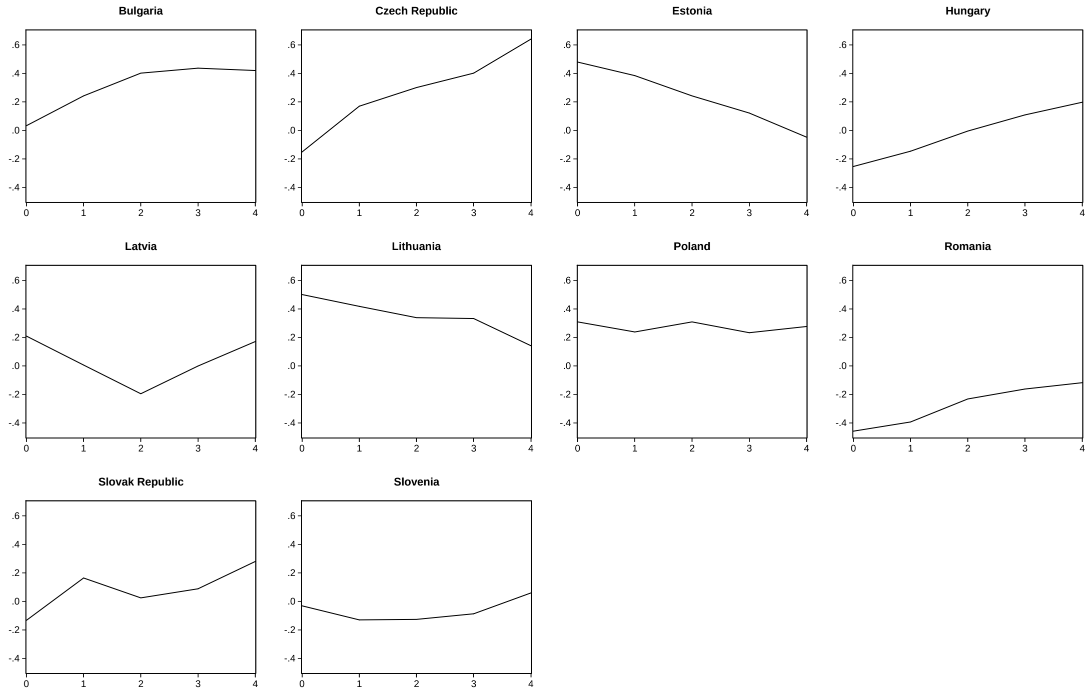
Note: Gross value added growth for NACE aggregates in national currency and seasonally data adjusted are shown. See the note to Figure C.1 for industry aggregations.
Source: Eurostat (2009) and the author's calculations.

Figure C.3: Autocorrelation Functions of Sectoral Growth Rates in the CEECs



Note: Autocorrelation functions of sectoral growth rates are shown for up to 28 lags.

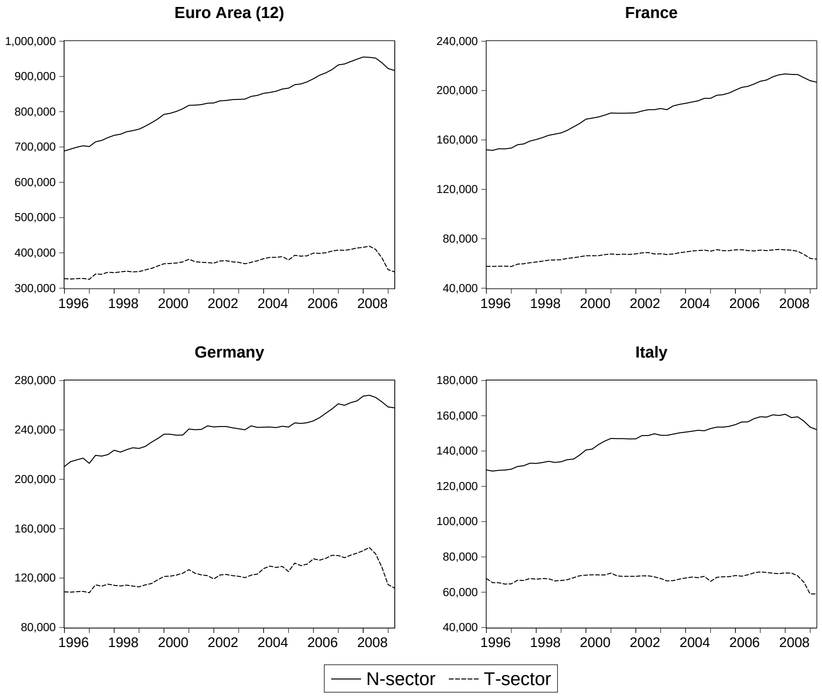
Figure C.4: Cross-correlation in the CEECs



Note: Cross-correlation coefficients between the N-sector and the T-sector are shown. The T-sector is lagged by (-i) periods, with i=0,...,4.

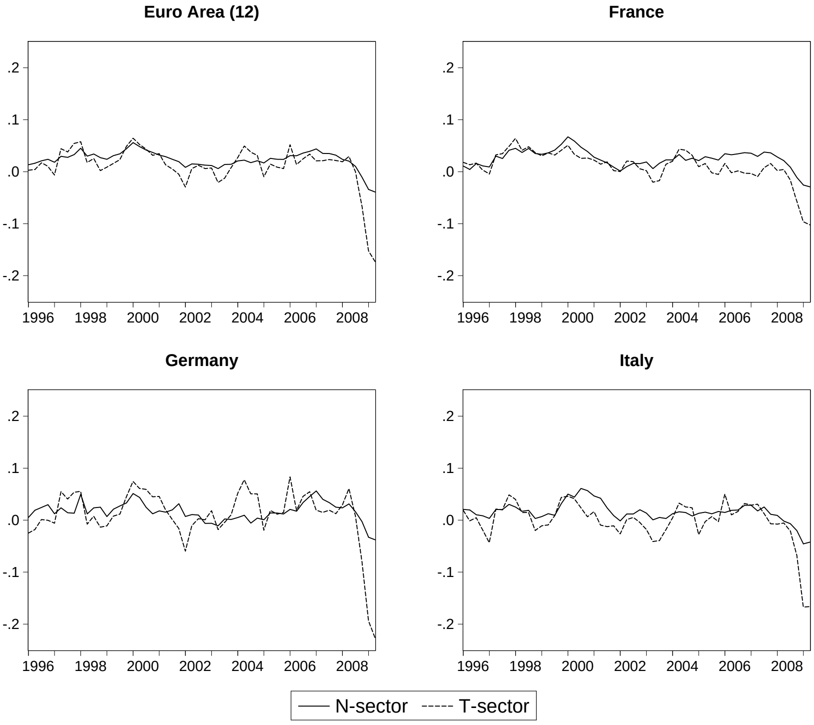
Results for the Euro Area

Figure C.5: Gross Value Added Levels in the EMU



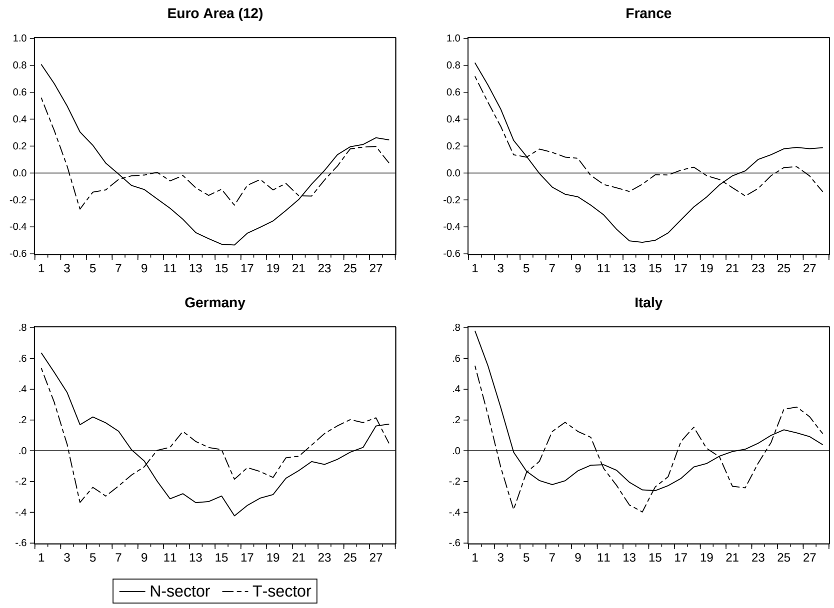
Note: Gross value added data for NACE aggregates in national currency and seasonally adjusted form are shown. See the note to Figure C.1 for industry aggregations.
Source: Eurostat (2009) and the author's calculations.

Figure C.6: Sectoral Cycles in the EMU



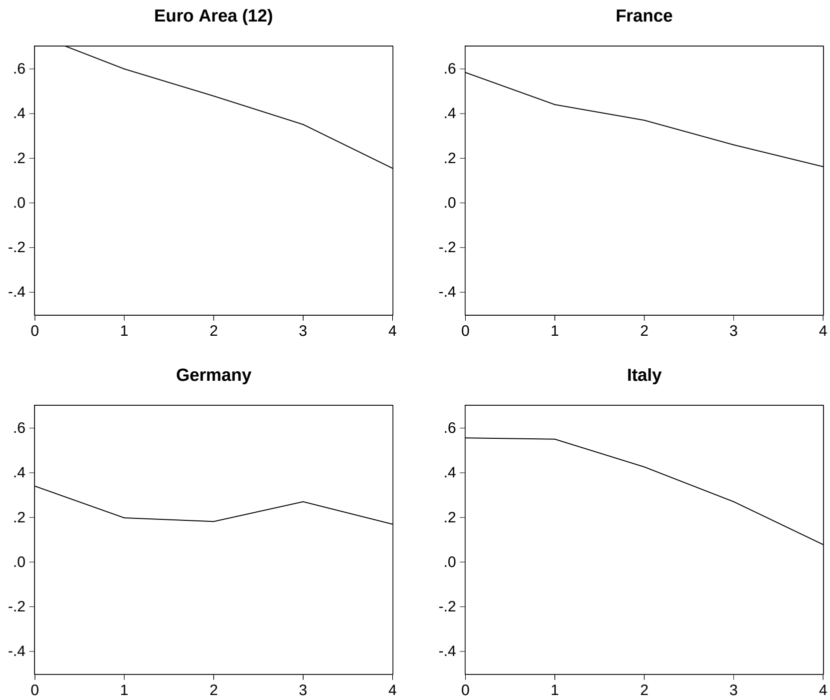
Note: Gross value added growth for NACE aggregates in national currency, seasonal adjusted form is shown. See the note to Figure C.1 for industry aggregations.

Figure C.7: Autocorrelation Functions of Sectoral Growth Rates in the EMU



Note: Autocorrelation functions of sectoral growth rates are shown.

Figure C.8: Cross-correlation in the EMU



Note: Cross-correlation between the N-sector and the T-sector is shown. The T-sector is lagged by (-i) periods, with i=0,...,4.

Table C.1: Seasonal Unit Root Test Results (EMU)

Null Hypothesis: series has a seasonal unit root

	Levels (a) with intercept			(b) with intercept, dummies and trend			Growth rates
N-sector	π	$\pi_{1/2}$	$\pi_{1/4}$	π	$\pi_{1/2}$	$\pi_{1/4}$	π
Euro Area (12)	-0.52	0.02	0.81	-2.59	-1.79	3.70	-2.32
France	-0.23	0.06	0.26	-1.92	-3.24	33.72 **	-3.04 **
Germany	-0.49	-1.65	0.63	-1.89	-1.79	7.46 **	-3.22 **
Italy	-0.75	0.11	0.05	-2.52	-2.11	4.34	-3.13 **
T-sector							
Euro Area (12)	-0.64	-0.51	0.76	-2.24	-3.54	22.39 **	-3.65 ***
France	-1.96	-0.79	0.06	-1.07	-2.09	5.81 *	-2.64 *
Germany	-0.10	-1.37	3.21 **	-2.54	-3.48	22.03 **	-3.85 ***
Italy	-2.64	-0.26	0.01	-2.01	-4.17	16.61 **	-4.66 ***

Note: The table shows the HEGY test statistics for the nontradables sector (N) and the tradables sector (T). The lag parameter is selected by the Schwarz information criterion. Tests including either intercept, or intercept, seasonal dummies and a trend variable. The critical values for the stated t-statistics for π and $\pi_{1/2}$ and F-statistic for $\pi_{1/4}$ are given in Fuller (1976) and Hylleberg et al. (1990). * indicates significance at 10% and ** at the 5% levels.

Table C.2: Johansen Cointegration Test Results (EMU)

Null Hypothesis: no cointegration

	(a) SIC				(b) AIC			
		λ_{trace}	λ_{max}			λ_{trace}	λ_{max}	
Euro Area (12)	r=0	14.32	9.65	[5]	r=0	14.32	9.65	[5]
	r=1	4.67	4.67		r=1	4.67	4.67	
France	r=0	18.00	13.27	[5]	r=0	23.10 **	17.52 **	[8]
	r=1	4.73	4.73		r=1	5.58	5.58	
Germany	r=0	30.81 **+	27.79 **+	[3]	r=0	14.84	11.50	[5]
	r=1	3.02	3.02		r=1	3.34	3.34	
Italy	r=0	17.76	13.31	[5]	r=0	17.76	13.31	[5]
	r=1	4.45	4.45		r=1	4.45	4.45	

Note: Trace and Maximum Eigenvalue statistic for the bivariate Johansen cointegration test are reported. Panel (a) refers to a lag order based on SIC while the lag structure in panel (b) is determined by AIC (both with a maximum lag of 8), which is given in parenthesis. We assume that the data have no deterministic trend but the cointegrating equations have intercepts. ** indicates rejection of the null hypothesis with significance at the 5% level according to the asymptotic critical values in Osterwald-Lenum (1992), + reports significance at the 5% level according to the finite sample critical values in Cheung and Lai (1993).

Results for the Extended Analysis

Table C.3: Seasonal Adjustment Methods for Quarterly National Accounts

country	method	working day correction
Bulgaria	no seasonal adjustment applied yet	-
Czech Republic	Tramo-Seats	Yes
Estonia	X12	No
Hungary	Tramo-Seats	Yes
Latvia	Tramo-Seats	No
Lithuania	Tramo-Seats	Yes
Poland	Tramo-Seats	Yes
Romania	no seasonal adjustment applied yet	-
Slovak Republic	Tramo-Seats	No
Slovenia	Tramo-Seats	Yes
Euro Area (12)	indirect method	-
France	X11	Yes
Germany	X12/ Berliner Verfahren	Yes
Italy	Tramo-Seats	Yes

Note: The Euro Area's "indirect method" is the aggregations of national data that are separately seasonally adjusted using different methodologies. However, in most of the countries there are attempts to harmonise or at least to update the seasonal adjustment procedure (see, among others, Fabre and Prost, 2009).
Source: Eurostat (2009b).

Table C.4: Unit Root Test Results (sa)

Null Hypothesis: series has a unit root

	N-sector						T-sector					
	Level		First Differences				Level		First Differences			
Bulgaria	1.68	[1]	-3.24	**a)	[0]		-0.38	[2]	-2.96	**	[0]
Czech Republic	1.54	[0]	-2.89	**a)	[0]		1.62	[0]	-3.81	**a)	[3]
Estonia	1.12	[0]	-3.48	***a)	[1]		0.83	[0]	-6.84	***	[3]
Hungary	0.92	[0]	-2.91	*	[0]		0.58	[0]	-3.18	**	[1]
Latvia	2.11	[0]	-4.50	***	[0]		-0.62	[0]	-5.12	***	[2]
Lithuania	4.95	[0]	-2.67	*	[0]		0.51	[0]	-3.85	***	[0]
Poland	1.07	[1]	-3.65	***	[0]		0.55	[0]	-3.24	**	[0]
Romania	4.90	[3]	-4.00	***	[0]		-1.36	[2]	-3.65	**	[1]
Slovak Republic	-0.39	[0]	-4.00	***	[0]		0.85	[0]	-4.72	***	[0]
Slovenia	3.81	[1]	-3.11	**a)	[0]		0.94	[0]	-4.71	***	[3]
Euro Area (12)	1.11	[0]	-2.69	***a)	[3]		-0.25	[0]	-3.65	***	[0]
France	1.09	[0]	-3.07	*a)	[3]		-1.75	[0]	-2.77	*a)	[3]
Germany	0.22	[0]	-3.18	**	[0]		0.18	[0]	-3.27	**	[4]
Italy	-0.32	[0]	-3.12	**	[2]		-1.78	[0]	-3.63	***a)	[0]

Note: The table shows the ADF test statistics for the levels and the first differences of nontradable sectors' aggregate (N) and tradable sectors' aggregate (T). The lag parameters are selected by the Schwarz information criterion (with a maximum lag of 8) and are given in parenthesis. $^{a)}$ indicates whether the lag length is selected by the general or specific method. The probability for the stated t-statistics is given in the MacKinnon (1996) one-sided p-values. *,**,*** indicates significance at 10%, 5% and 1% levels.

Table C.5: AR(p) Representations

	(a) sa		(b) two	
	N-sector	T-sector	construction	manufacturing
Bulgaria	1	2	1	2
Czech Republic	4	5	4	4
Estonia	1	6	4	4
Hungary	1	1	2	1
Latvia	1	2	1	5
Lithuania	1	2	1	4
Poland	1	1	1	1
Romania	1	2	–	–
Slovak Republic	3	2	2	2
Slovenia	4	3	1	3
Euro Area (12)	1	4	1	2
France	1	1	4	1
Germany	2	4	1	4
Italy	2	4	4	2

Note: The table reports the AR(p) structure for the gross value added growth rate in the nontradables sector (N) and in the tradables sector (T) for the pre-crisis period. Results for seasonally adjusted data (sa) and two individual sectors (two), for example, the construction and the manufacturing sector are shown.

Table C.6: Codependence: Tiao–Tsay Test Results (sa)

Null Hypothesis: codependence of order q

		q=0		q=1		q=2		q=3	
Bulgaria	s=1	42.21	**	3.67		13.15	**	4.67	
	s=2	117.79	**	15.33	**	22.56	**	13.45	
Czech Republic	s=1	46.17	**	2.56		30.97	**	2.77	
	s=2	143.23	**	17.17	**	39.85	**	8.73	
Estonia	s=1	51.10	**	2.67		6.41		0.81	
	s=2	122.77	**	11.72		57.96	**	6.47	
Hungary	k=1	25.16	**	3.63		0.31		0.38	
	k=2	68.34	**	12.53	**	4.02		3.16	
Latvia	s=1	4.95	**	0.60		3.89	**	2.81	
	s=2	81.78	**	10.36	**	16.44	**	8.00	
Lithuania	s=1	22.14	**	0.25		2.18		0.70	
	s=2	132.85	**	15.51	**	11.70		5.80	
Poland	s=1	33.58	**	4.01		24.46	**	1.68	
	s=2	83.87	**	12.74		40.02	**	11.98	
Romania	k=1	12.57	**	0.01		2.96		6.61	**
	k=2	56.27	**	9.55	**	9.49	**	12.84	**
Slovak Republic	k=1	49.04	**	21.91	**	21.33	**	16.59	
	k=2	139.55	**	37.50	**	36.60	**	25.81	
Slovenia	s=1	50.95	**	2.14		20.96	**	5.06	
	s=2	129.27	**	13.55	**	33.08	**	12.73	
Euro Area (12)	s=1	39.50	**	1.31		19.97	**	2.53	
	s=2	123.80	**	13.17		35.39	**	9.86	
France	s=1	58.49	**	5.48		17.96	**	1.02	
	s=2	160.51	**	18.76	**	26.51	**	3.37	
Germany	s=1	46.22	**	1.88		14.30	**	2.68	
	s=2	106.65	**	8.87		46.56	**	7.23	
Italy	s=1	38.79	**	2.16		40.88	**	0.60	
	s=2	113.13	**	12.20		64.98	**	14.36	

Note: The Tiao–Tsay test statistic is shown. ** indicates significance at the 5% level. While the lag length is selected by the SIC for most of the countries, the AIC is chosen for the Slovak Republic, Germany, and Italy.

Table C.7: Optimal GMM Test Results (sa)

Null Hypothesis: codependence of order q

	q=0		q=1		q=2		q=3	
Bulgaria	31.37	**	7.52	**	11.43	**	8.98	**
Czech Republic	27.87	**	5.96	**	6.17	**	2.66	
Estonia	30.11	**	3.87		15.21	**	1.24	
Hungary	21.94	**	7.23	**	0.48		0.73	
Latvia	2.09		0.03		0.83		0.32	
Lithuania	20.73	**	0.02		5.07		0.72	
Poland	25.52		5.96		19.29	**	9.51	**
Romania	0.92		0.03		0.01		0.28	
Slovak Republic	35.70	**	18.70	**	16.36		15.87	
Slovenia	35.78	**	8.80	**	21.16	**	3.41	
Euro Area (12)	33.80	**	1.81		19.46	**	2.48	
France	39.48	**	10.85	**	18.50	**	1.73	
Germany	32.21	**	4.78		22.50	**	2.69	
Italy	36.91	**	12.09	**	25.19	**	0.86	

Note: The χ^2 test statistic is reported. ** indicates significance at the 5% level. While the lag length is selected by the SIC for most of the countries, the AIC is chosen for the Slovak Republic, Germany, and Italy.

Table C.8: Seasonal Unit Root Test Results (two)

Null Hypothesis: series has a seasonal unit root

	(a) with intercept			(b) with intercept, dummies and trend		
construction	π	$\pi_{1/2}$	$\pi_{1/4}$	π	$\pi_{1/2}$	$\pi_{1/4}$
Bulgaria	4.76	-0.77	1.34	1.9	-2.12	0.81
Czech Republic	-1.99	-0.19	0.04	-2.69	-3.69	1.62
Estonia	0.9	-0.4	0.42	-0.97	-6.23	4.15
Hungary	-1.74	0.27	0.02	-0.25	-1.92	2.76
Latvia	2.84	0.35	4.19 **	-0.35	-0.93	0.11
Lithuania	-0.03	1.18	1.76	-0.97	-0.12	3.48
Poland	-1.21	0.7	0.56	-1.2	-1.61	2.89
Slovak Republic	-1.19	-2.57	1.25	-1.55	-2.86	5.91 *
Slovenia	2.78	-3.36	0.48	0.98	-3.22	8.33 **
Euro Area (12)	0.23	-0.95	2.61 *	-2.04	-2.66	3.53
France	0.36	-0.04	3.2 **	-3.72	-3.9	7.19 **
Germany	-0.73	-2.16	2.33 *	-0.99	-2.3	3.79
Italy	-1.41	0.12	4.47 **	-2.3	-5.07	12.55 **
manufacturing						
Bulgaria	0.90	-0.43	0.69	-0.90	-3.32	3.02
Czech Republic	2.21	-0.30	0.04	-0.54	-3.45	9.18 **
Estonia	2.22	0.90	0.24	-2.00	-1.08	5.7 *
Hungary	0.00	-0.70	0.05	-2.36	-1.63	4.19
Latvia	0.11	-0.53	0.44	-2.52	-1.21	2.73
Lithuania	1.52	-0.58	0.75	-1.35	-2.54	6.80 **
Poland	2.20	-4.25	1.71	-0.74	-2.15	0.99
Slovak Republic	5.63	-1.87	2.47 *	0.79	-2.74	0.19
Slovenia	2.00	-0.73	0.68	-2.03	-2.11	2.80
Euro Area (12)	-0.64	-0.96	1.92	-2.02	-3.60	19.95 **
France	-2.10	-0.91	0.28	-1.49	-2.19	5.88 *
Germany	-0.14	-1.51	3.26 **	-1.96	-3.37	20.14 **
Italy	-2.28	-0.52	0.61	-2.23	-3.37	18.46 **

Note: See the note to Table C.1.

Table C.9: Johansen Cointegration Test Results (two)

Null Hypothesis: no cointegration

	(a) SIC				(b) AIC			
		λ_{trace}	λ_{max}			λ_{trace}	λ_{max}	
Bulgaria	r=0	21.96 *	19.29 *	[4]	r=0	21.96 *	19.29 *	[4]
	r=1	2.67	2.67		r=1	2.67	2.67	
Czech Republic	r=0	11.97	7.57	[5]	r=0	18.46	15.95 *	[8]
	r=1	4.41	4.41		r=1	2.51	2.51	
Estonia	r=0	15.60	13.50	[6]	r=0	15.60	13.50	[6]
	r=1	2.10	2.10		r=1	2.10	2.10	
Hungary	r=0	17.49	14.95	[4]	r=0	19.97 *	17.23 *	[7]
	r=1	2.54	2.54		r=1	2.74	2.74	
Latvia	r=0	24.89 *+	19.80 *+	[4]	r=0	24.89 *+	19.80 *+	[4]
	r=1	5.09	5.09		r=1	5.09	5.09	
Lithuania	r=0	17.40	13.47	[5]	r=0	17.40	13.47	[5]
	r=1	3.92	3.92		r=1	3.92	3.92	
Poland	r=0	11.50	7.29	[5]	r=0	11.50	7.29	[5]
	r=1	4.21	4.21		r=1	4.21	4.21	
Slovak Republic	r=0	20.44 *	15.12	[4]	r=0	20.44 *	15.12	[4]
	r=1	5.33	5.33		r=1	5.33	5.33	
Slovenia	r=0	20.72 *	14.20	[4]	r=0	19.90	13.46	[5]
	r=1	6.52	6.52		r=1	6.44	6.44	
Euro Area (12)	r=0	14.97	9.26	[4]	r=0	21.34 *	14.50	[5]
	r=1	5.71	5.71		r=1	6.84	6.84	
France	r=0	32.71 *+	27.73 *+	[7]	r=0	42.35 *+	38.65 *+	[8]
	r=1	4.98	4.98		r=1	3.70	3.70	
Germany	r=0	14.01	12.04	[4]	r=0	16.64	14.25	[7]
	r=1	1.97	1.97		r=1	2.39	2.39	
Italy	r=0	16.48	10.16	[5]	r=0	10.43	6.92	[7]
	r=1	6.31	6.31		r=1	3.51	3.51	

Note: See the notes to Table C.2.

Table C.10: Common Cycle and PSSCF Results (two)

Null Hypothesis: common feature

		lag p			
		0	1	2	3
Bulgaria	F-statistic	3.28 **	8.08	6.95	5.26
	Common cycle coefficient	-0.15	0.14	0.19	0.20
Czech Republic	F-statistic	4.53 **	5.19	4.29	3.12
	Common cycle coefficient	-0.23	-0.13	0.06	0.33
Estonia	F-statistic	4.45 **	3.82	3.33	5.53
	Common cycle coefficient	1.04 **	1.17 **	1.19 **	0.80
Hungary	F-statistic	2.75 **	4.76	3.80	2.94
	Common cycle coefficient	0.07	0.13	-0.01	0.05
Latvia	F-statistic	4.89 **	2.54	1.86	2.55
	Common cycle coefficient	0.25	0.04	0.19	0.29
Lithuania	F-statistic	12.10 **	15.32	12.69	11.37
	Common cycle coefficient	1.20 **	0.92 **	0.88 **	0.78
Poland	F-statistic	3.72 **	10.31	3.93	4.54
	Common cycle coefficient	0.91 **	0.87 **	0.79 **	0.67
Slovak Republic	F-statistic	3.28 **	5.82	5.13	4.16
	Common cycle coefficient	-0.32	-0.21	-0.29	0.27
Slovenia	F-statistic	3.18 **	7.43 **	5.87	4.96
	Common cycle coefficient	0.20	-0.26	-0.50	-0.37
Euro Area (12)	F-statistic	1.38	3.95	3.17	2.14
	Common cycle coefficient	0.19	0.21	0.19	0.15
France	F-statistic	36.90 **	78.72	81.47	71.97
	Common cycle coefficient	0.13	0.12	0.17	0.27
Germany	F-statistic	1.00	1.53	1.23	1.09
	Common cycle coefficient	-0.01	0.06	-0.08	-0.14
Italy	F-statistic	4.78 **	5.58	4.75	5.25
	Common cycle coefficient	0.02	0.25	0.23	0.09

Note: The common feature coefficient and the F-statistic of the TSLS estimation are reported. The optimal lag length is determined by SIC. ** indicates significance at the 5% level either of the coefficient or the F-statistic.

Table C.11: Codependence Tiao–Tsay Test Results (two)

Null Hypothesis: codependence of order q

		q=0		q=1		q=2		q=3	
Bulgaria	s=1	13.04	**	0.71		1.55		4.87	**
	s=2	44.15	**	10.84	**	9.60	**	13.13	**
Czech Republic	s=1	19.98	**	3.95		1.10		3.21	
	s=2	71.15	**	17.43	**	11.07		11.82	
Estonia	s=1	21.60	**	4.45		6.65		2.44	
	s=2	89.12	**	19.52	**	14.80		11.12	
Hungary	s=1	17.64	**	6.41		4.69		4.05	
	s=2	64.17	**	22.02	**	11.71		9.65	
Latvia	s=1	25.56	**	2.60		3.41		1.57	
	s=2	70.84	**	10.01		12.27		13.22	**
Lithuania	s=1	22.86	**	8.79	**	7.94	**	2.15	
	s=2	81.78	**	19.75	**	14.33	**	8.11	
Poland	s=1	8.93	**	2.88		1.35		0.69	
	s=2	55.97	**	11.85	**	6.31		4.28	
Slovak Republic	s=1	26.17	**	2.91		0.69		4.30	**
	s=2	90.40	**	18.41	**	10.61	**	12.33	**
Slovenia	s=1	15.08	**	2.98		0.07		1.69	
	s=2	56.63	**	14.99	**	6.30		4.96	
Euro Area (12)	s=1	17.67	**	1.88		0.03		0.69	
	s=2	43.78	**	7.74		2.81		3.74	
France	s=1	32.20	**	13.20	**	7.19		4.09	
	s=2	180.74	**	32.94	**	19.28		12.38	
Germany	s=1	9.25	**	2.70		0.57		0.56	
	s=2	37.41	**	19.06		12.74		6.64	
Italy	s=1	32.33	**	3.74		1.63		0.34	
	s=2	68.33	**	11.63		6.57		3.67	

Note: The Tiao–Tsay test statistic is shown. ** indicates significance at the 5% level.

Table C.12: Optimal GMM Test Results (two)

Null Hypothesis: codependence of order q

	q=0		q=1		q=2		q=3	
Bulgaria	1.43		0.06		0.08		0.02	
Czech Republic	12.47	**	0.15		2.78		3.05	
Estonia	18.82	**	5.13		6.64		9.82	**
Hungary	12.49	**	6.10		7.92		7.17	
Latvia	8.50	**	0.49		1.45		2.70	
Lithuania	29.56	**	6.23	**	3.19		0.36	
Poland	4.69	**	1.08		0.19		0.00	
Slovak Republic	15.41	**	1.00		0.15		2.03	
Slovenia	17.28	**	4.72	**	0.00		0.23	
Euro Area (12)	9.84	**	0.47		0.79		0.14	
France	29.91	**	22.46	**	14.88	**	10.62	
Germany	8.83		3.54		0.77		0.82	
Italy	23.31	**	5.35		4.07		0.62	

Note: The χ^2 test statistic is reported. ** indicates significance at the 5% level.

Table C.13: Seasonal Unit Root Test Results (total)

Null Hypothesis: series has a seasonal unit root

	(a) with intercept			(b) with intercept, dummies and trend		
N-sector	π	$\pi_{1/2}$	$\pi_{1/4}$	π	$\pi_{1/2}$	$\pi_{1/4}$
Bulgaria	0.97	-0.43	3.74 **	-2.78	-1.23	2.25
Czech Republic	-0.69	0.28	0.17	-2.31	-1.64	0.83
Estonia	-3.74	1.17	1.97 **	-2.83	-0.45	0.2
Hungary	-1.94	1.75	0.79	-1.41	-1.5	2.26
Latvia	-2.94	0.62	1.77 *	-3.36	-1.02	0.48
Lithuania	-5.14	0.82	3.63 **	-3.14	-0.33	1.09
Poland	1.12	-0.56	0.48	-3.02	-1.44	6.3 *
Romania	-3.95	3.14 **	2.22	-4.13	0.04	2.09
Slovak Republic	1.64	-2.81	1.83 *	-0.3	-3	1.05
Slovenia	-0.94	-0.78	1.74	-4.9	-3.1	0.5
Euro Area (12)	-2.77	0.14	0.26	-2.61	-1.99	4.08
France	-2.4	-0.07	0.61	-1.89	-3.59	45.73 **
Germany	-2	-1.79	0.26	-1.82	-3.09	26.37 **
Italy	-1.85	0.15	0.04	-0.7	-2.71	6.08 *
T-sector						
Bulgaria	-0.6	-0.58	0.36	-4.3	-2.95	3.08
Czech Republic	-1.05	-2.55	2.86 *	-2.58	-4.06	12.42 **
Estonia	-2.43	-1.1	9.46 **	-0.82	-3.2	62.71 **
Hungary	-1.56	-0.73	0.19	-2.19	-2.22	2.74
Latvia	-1.26	-0.84	0.01	-0.81	-3.45	20.91 **
Lithuania	-1.83	-0.32	0.18	-1.31	-3.41	20.77 **
Poland	-0.62	-0.59	0.06	-2.06	-1.04	1.55
Romania	-1.89	-0.78	0.19	-2.64	-3.13	10.08 **
Slovak Republic	-0.81	-3.1	3.77 **	-2.31	-3.35	5.14
Slovenia	-2.56	0.51	1.9 *	-1.8	-2.47	1.68
Euro Area (12)	-2.08	-0.29	1.51	-1.2	-3.43	24.93 **
France	-1.49	-0.67	0.53	1.55	-3.12	18.67 **
Germany	-2.33	-1.1	3.26 **	-2.47	-3.62	30.32 **
Italy	-1.87	0.03	0.19	-1.67	-4.38	15.06 **

Note: See the note to Table C.1

Table C.14: Johansen Cointegration Test Results (total)

Null Hypothesis: no cointegration

	(a) SIC						(b) AIC					
		λ_{trace}		λ_{max}				λ_{trace}		λ_{max}		
Bulgaria	r=0	9.75		7.49		[5]	r=0	9.75		7.49		[5]
	r=1	2.26		2.26			r=1	2.26		2.26		
Czech Republic	r=0	37.73	*+	24.46	*+	[6]	r=0	37.73	*+	24.46	*+	[6]
	r=1	13.27	*+	13.27	*+		r=1	13.27	*+	13.27	*+	
Estonia	r=0	23.52	*	16.68	*	[5]	r=0	19.64		13.89		[6]
	r=1	6.84		6.84			r=1	5.75		5.75		
Hungary	r=0	18.85		9.72		[5]	r=0	18.85		9.72		[5]
	r=1	9.12		9.12			r=1	9.12		9.12		
Latvia	r=0	22.72	*	15.33		[5]	r=0	22.72	*	15.33		[5]
	r=1	7.38		7.38			r=1	7.38		7.38		
Lithuania	r=0	24.02	*	17.65	*	[5]	r=0	24.02	*	17.65	*	[5]
	r=1	6.37		6.37			r=1	6.37		6.37		
Poland	r=0	17.10		14.00		[5]	r=0	17.10		14.00		[5]
	r=1	3.10		3.10			r=1	3.10		3.10		
Romania	r=0	14.89		10.53		[8]	r=0	14.89		10.53		[8]
	r=1	4.37		4.37			r=1	4.37		4.37		
Slovak Republic	r=0	13.28		11.76		[5]	r=0	24.85	*	18.52	*	[8]
	r=1	1.53		1.53			r=1	6.34		6.34		
Slovenia	r=0	26.00	*	20.97	*+	[6]	r=0	26.00	*	20.97	*+	[6]
	r=1	5.03		5.03			r=1	5.03		5.03		
Euro Area (12)	r=0	14.32		9.65		[5]	r=0	14.32		9.65		[5]
	r=1	4.67		4.67			r=1	4.67		4.67		
France	r=0	18.00		13.27		[5]	r=0	23.10	*	17.52	*	[8]
	r=1	4.73		4.73			r=1	5.58		5.58		
Germany	r=0	30.81	*+	27.79	*+	[3]	r=0	14.84		11.50		[5]
	r=1	3.02		3.02			r=1	3.34		3.34		
Italy	r=0	17.76		13.31		[5]	r=0	17.76		13.31		[5]
	r=1	4.45		4.45			r=1	4.45		4.45		

Note: See the note to Table C.2.

Table C.15: Common Cycle and PSSCF Results (total)

Null Hypothesis: common feature

		lag p							
		0		1		2		3	
Bulgaria	F-statistic	8.85	**	24.43		15.62		10.13	
	Common cycle coefficient	-0.29		0.29	**	0.46	**	0.46	**
Czech Republic	F-statistic	6.67	**	14.19		14.19		10.86	
	Common cycle coefficient	0.09		0.11		0.15		0.21	**
Estonia	F-statistic	4.56	**	22.83		33.37		36.81	
	Common cycle coefficient	0.66	**	0.64	**	0.52	**	0.35	**
Hungary	F-statistic	12.51	**	47.68		34.99		27.47	
	Common cycle coefficient	0.16	**	0.03		-0.07		-0.02	
Latvia	F-statistic	8.53	**	19.03		18.81		17.85	
	Common cycle coefficient	0.50	**	0.41	**	0.18		0.23	
Lithuania	F-statistic	1.02		28.63		18.55		22.90	
	Common cycle coefficient	0.94	**	0.72	**	0.55	**	0.36	**
Poland	F-statistic	3.90	**	5.94		4.62		4.04	
	Common cycle coefficient	0.07		0.14		0.2	**	0.17	**
Romania	F-statistic	1.28		12.36		9.21		4.74	
	Common cycle coefficient	0.34		0.08		-0.19		-0.31	
Slovak Republic	F-statistic	2.52	**	9		5.63		4.21	
	Common cycle coefficient	0.10		0.16		0.14		0.2	
Slovenia	F-statistic	5.54	**	10.18		12.25		10.82	
	Common cycle coefficient	0.38	**	0.37	**	0.25		0.11	
Euro Area (12)	F-statistic	6.13	**	19.78		18.15		35.45	
	Common cycle coefficient	0.38	**	0.4	**	0.4	**	0.21	
France	F-statistic	16.81	**	31.3		25.88		29.47	
	Common cycle coefficient	0.48	**	0.47	**	0.47	**	0.35	**
Germany	F-statistic	7.29	**	4.86		6.99		7.30	
	Common cycle coefficient	0.20	**	0.22	**	0.19	**	0.11	
Italy	F-statistic	5.42	**	24.74		10.91		22.15	
	Common cycle coefficient	0.41	**	0.40	**	0.42	**	0.26	**

Note: See the note to Table C.10.

Table C.16: Codependence Tiao–Tsay Test Results (total)

Null Hypothesis: codependence of order q

		q=0		q=1		q=2		q=3	
Bulgaria	s=1	21.47	**	1.55		0.53		2.27	
	s=2	73.18	**	15.88	**	9.55	**	11.96	**
Czech Republic	s=1	31.98	**	14.48	**	5.23		4.06	
	s=2	135.42	**	35.04	**	23.68	**	25.50	**
Estonia	s=1	17.73	**	4.69	**	0.04		6.71	**
	s=2	141.02	**	25.11	**	9.79	**	11.35	**
Hungary	s=1	5.32	**	0.00		3.00		2.44	
	s=2	74.09	**	16.14	**	22.46	**	14.42	**
Latvia	s=1	26.82	**	2.55		0.05		0.03	
	s=2	123.04	**	19.55	**	9.18	**	10.15	**
Lithuania	s=1	6.97	**	3.36		0.48		1.21	
	s=2	113.41	**	27.81	**	16.73	**	9.80	
Poland	s=1	19.22	**	4.02	**	0.70		0.44	
	s=2	47.64	**	17.82	**	10.16	**	9.44	**
Romania	s=1	24.62	**	11.27		11.73		9.67	
	s=2	59.76	**	25.45		26.46		24.44	
Slovak Republic	s=1	15.22	**	2.39		0.58		0.25	
	s=2	76.85	**	14.66	**	7.04		5.88	
Slovenia	s=1	49.49	**	15.92	**	9.50		6.64	
	s=2	168.03	**	42.96	**	27.01	**	21.22	**
Euro Area (12)	s=1	34.72	**	3.44		0.74		0.58	
	s=2	124.45	**	18.46	**	6.14		7.77	
France	s=1	70.52	**	13.05	**	3.06		0.45	**
	s=2	156.89	**	26.62	**	7.80		2.80	
Germany	s=1	19.27	**	2.52		0.00		0.14	
	s=2	84.35	**	8.04	**	7.65		2.57	
Italy	s=1	19.12	**	2.56		0.02		0.12	
	s=2	97.63	**	17.32	**	6.27		4.26	

Note: The Tiao–Tsay test statistic is reported. ** indicates significance at 5% level.

Table C.17: Optimal GMM Test Results (total)

Null Hypothesis: codependence of order q

	q=0		q=1		q=2		q=3	
Bulgaria	19.38		6.60	**	0.09		0.05	
Czech Republic	24.39	**	17.27	**	9.61	**	6.25	
Estonia	15.40	**	5.12	**	0.00		5.69	**
Hungary	5.11	**	0.00		2.46		2.26	
Latvia	21.96	**	1.93		0.68		8.13	**
Lithuania	4.53		2.19		0.11		0.64	
Poland	14.35	**	9.87	**	5.66	**	0.24	
Romania	22.21	**	20.93	**	19.16	**	25.41	**
Slovak Republic	12.90	**	1.91		0.57		0.86	
Slovenia	26.30	**	15.34	**	12.50	**	7.17	
Euro Area (12)	24.81	**	2.19		2.98		1.88	
France	32.86	**	5.76	**	0.00		1.02	
Germany	17.68	**	2.25		0.01		0.15	
Italy	17.76	**	3.47		0.00		0.03	

Note: χ^2 test statistic is reported. ** indicates significance at the 5% level.

Conclusion

This thesis tackled two major macroeconomic challenges for the euro area and the EMU-acceding countries. Its findings are relevant for both theory and policymaking. The first contribution reflects important aspects of current research on forecasting euro area GDP; the second contribution is a discussion on euro adoption in Central and Eastern European economies in a boom–bust cycle framework.

Considering the forecasting of euro area GDP, we take into account the delay in release dates of the individual indicators. We deal with a broad range of forecast combination weights and their changes during a sequence of forecasting periods. Based on standard forecast performance measures, the results are presented for the nowcast and the forecast one quarter ahead. We confirm that forecast pooling improves the forecast performance. The crisis has shown how difficult events and growth rates are to predict and estimate. Recent studies have already presented some possibilities, such as structural break tests, and forecasting the ability of economies to tackle the financial crisis issue.

Prior to the financial crisis, the catching-up progress of the CEECs to the euro area was pronounced, as many studies have shown. The condition for sound functioning of the common monetary policy is that the countries that want to join the EMU must achieve a substantial degree of convergence to the euro area—first, they must fulfil the Maastricht criteria. Second, a substantial degree of economic flexibility is necessary so that a more limited range of economic policy instruments is sufficient for the countries to counteract economic problems.

The CEECs were hit by the financial crisis even more so than the EMU countries were, particularly those countries that cannot use the exchange rate to cushion shocks. For the euro area countries, the EMU provided a protective umbrella and an institutional anchor for its Member States against what may have resulted in an exchange rate crisis. In spite of the euro cushioning the effects of global shocks in the euro area, the increasing imbalances in these countries have not been eliminated through the common currency, which scrutinises the role of the common economic target criteria.

In the CEECs, national authorities as well as international organisations—for instance, the EU Commission, the ECB, and the IMF—provided significant support. On the one hand they undertook countercyclical monetary and fiscal policies and on the other hand they gave financial support to curb the impact of the financial crisis. Poland, for instance, managed to avoid the recession in 2009 by securing access to a one-year Flexible Credit Line arrangement from the IMF. Also, the government tried to keep access to international capital markets on favourable terms.[290]

In the light of the recent financial crisis, the risks of boom–bust cycles spread out. This study provides empirical evidence on financial market imperfections and sectoral asymmetries in the CEECs in the boom–bust cycle framework, and finds that countries with sounder fundamentals—for instance lower foreign debt—were generally less affected by the crisis. Accordingly, the boom–bust cycle approach is a sophisticated, supplementary approach to assess whether the countries should join the euro area. We can argue that euro adoption is even more pronounced because the common currency helps to cushion asymmetric reactions of the sectors, and hence prevents the increase of the differential between the nontradable and tradable sectors. While GDP growth has already begun to recover, responsible policies are necessary for sustainable long-run growth. The recovery will not be uniform across the sectors, in particular because of the obvious financial constraints in the N-sector.

The major challenge for these countries is to return to sustainable policies in the near future for the further convergence process to the EMU. As emphasised in 2009 by Gertrude Tumpel-Gugerell—member of the ECB executive board—policies to overcome the financial crisis, and the adoption of the euro in the CEECs are two different issues that should not be lumped together.[291] Focusing on the euro adoption process, the financial crisis seems to have had no impact, at least on the rules of adoption—that is, the economic criteria set by the Maastricht Treaty that the countries have to fulfil to join the EMU. However, the crisis did have an impact on the convergence process and this will move euro adoption further into the future. Accordingly, for the stabilisation

290 The authorities remain committed to very strong macroeconomic policies, as the approval of the IMF's Executive Board at July 2 2010 of an arrangement for Poland under the Flexible Credit Line indicates.

291 The stated arguments are based on the speech of Tumpel-Gugerell (2009) at the OeNB Conference on European Economic Integration—The Euro's Contribution to Economic Stability in CESEE—held in Vienna in November 2009.

of the economy and as the provision of an anchor for policymakers, a credible euro adoption strategy is important.

Policies should aim to improve the regulatory framework for financial markets both at the national and at supranational level to ensure economic and financial stability—in both the euro area and the CEECs. Policymakers should pay more attention to the supervision of excessive borrowing in foreign currency and should tackle this problem more critically. To address the imperfections, contract enforcement must be improved. Vulnerabilities in the CEECs have to be gauged more precisely to identify the main channels through which the countries were affected.

The Greek crisis at the beginning of 2010 stressed discussion on the sustainability of the euro area, and on efficient rules for the Member States as well as the accession states. There are good prospects for the adoption of the euro in Estonia in 2011, as announced by the European Commission in May 2010. This might also have positive effects on the other Baltic states and on overall confidence in the common currency. It stresses the importance of further surveillance of the effects for both the country concerned as well as for the whole euro area. We tried to incorporate the impact of the financial crisis in several parts of this thesis. It is obvious that more comprehensive research is necessary as new statistics are published. Finally, we must stress that at this time the achievement of the Maastricht criteria, and hence the macroeconomic challenges are even more difficult than they already were before the crisis.

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