Sources of Asymmetric Shocks

Skořepa, Michal; Komárek, Luboš
2013

WORKING PAPER SERIES 12

Michal Skořepa, Luboš Komárek:

Sources of Asymmetric Shocks: The Exchange Rate or Other Culprits?

2013

CZECH NATIONAL BANK

WORKING PAPER SERIES

Sources of Asymmetric Shocks: The Exchange Rate or Other Culprits?

Michal Skořepa
Luboš Komárek

12/2013

CNB WORKING PAPER SERIES

Reviewed by: Agnieszka Stążka-Gawrysiak (Narodowy Bank Polski)
Evžen Kočenda (CERGE-EI)
František Brázdik (Czech National Bank)

Project Coordinator: Michal Franta

Sources of Asymmetric Shocks: The Exchange Rate or Other Culprits?

Michal Skořepa and Luboš Komárek*

Abstract

We analyze and quantify the determinants of asymmetric shocks showing up in the form of medium-term real exchange rate (RER) changes. First, we discuss sources of asymmetric shocks causing exchange rate variability and the role of the RER as a shock generator. Second, we use data for 21 advanced and late-transition economies to gauge the extent to which medium-term bilateral real exchange rate variability can be explained by various fundamental factors. Using Bayesian model averaging, we find that out of 22 factors under consideration, four types of dissimilarities within a given pair of economies are likely to be included in the true model: dissimilarities as regards (i) financial development, (ii) per capita income growth, (iii) central bank independence, and (iv) the structure of the economy. A regression based on these four factors indicates that these factors explain about one third of the behavior of the three-year RER variability for the whole sample and almost half of the behavior of the three-year RER variability for the RERs involving specifically the euro. The remaining part of the total variability represents an estimate of the influence of the exchange rate market itself (together with the influence of fundamental price level or nominal exchange rate determinants not captured by the regressors used).

Abstrakt

V této práci zkoumáme a kvantifikujeme příčiny asymetrických šoků projevujících se jako střednědobé změny reálného měnového kurzu (RER). Nejprve rozebíráme zdroje asymetrických šoků způsobujících variabilitu RER a diskutujeme roli RER coby veličiny, která vytváří šoky. Poté na základě dat pro skupinu 21 vyspělých ekonomik a ekonomik v pozdní fázi přechodu k tržní ekonomice odhadujeme, do jaké míry lze střednědobou variabilitu bilaterálního RER vysvětlit různými fundamentálními faktory. Za použití bayesovského průměrování modelů zjišťujeme, že z dvaceti dvou zvažovaných faktorů je u čtyř druhů odlišností v rámci daného páru ekonomik pravděpodobné, že jsou součástí skutečného modelu, a to sice u odlišností v oblasti (i) finančního rozvoje, (ii) růstu důchodu na hlavu, (iii) nezávislosti centrální banky a (iv) struktury ekonomiky. Regrese založená na těchto čtyřech faktorech indikuje, že tyto faktory vysvětlují zhruba třetinu chování tříleté variability RER pro celý vzorek a téměř polovinu pro reálné kurzy, kde jednou z měn je euro. V rámci logiky našeho přístupu platí, že zbylá část celkové variability představuje odhad vlivu samotného trhu s cizími měnami (společně s vlivem fundamentálních determinant cenových hladin a nominálního kurzu nezachycených použitými regresory).

JEL Codes: E52, E62, F31.

Keywords: Asymmetric shocks, Bayesian model averaging, OCA, real exchange rate.

---

*Michal Skořepa, Senior Economist, Financial Stability Department and Advisor to the Czech National Bank's Bank Board, Czech National Bank, e-mail: michal.skorepa@cnb.cz. Luboš Komárek, Director of the External Economic Relations Division, Czech National Bank, e-mail: lubos.komarek@cnb.cz.
This work was supported by Czech National Bank Research Project No. A2/2012. We thank Oxana Babecká Kucharčuková, František Brázdik, Michal Franta, Marek Rusnák, Kateřina Šmídková (all CNB), Agnieszka Stążka-Gawrysiak (Narodowy Bank Polski), Evžen Kočenda (CERGE-EI) and Roman Horváth (Charles University) for their valuable comments and suggestions. All errors and omissions remain entirely the fault of the authors. The views expressed in this paper are those of the authors and not necessarily those of the Czech National Bank.

Nontechnical Summary

The real exchange rate is one of the most important price indicators in the economy. Real exchange rate changes – which we take as reflections of “asymmetric shocks” hitting the economies involved – influence most consumers and producers. Both policymakers and market participants have a strong interest in understanding which factors influence the real exchange rate dynamics. The literature on the determinants of the real exchange rate, and the sources of its variability, is abundant. From the theoretical viewpoint, everything that affects the nominal exchange rate and the ratio of foreign to domestic prices is bound to influence the real exchange rate. Non-trend changes in exchange rates may induce hard-to-predict movements in relative prices in the economy. Understanding the main factors behind this variability, that is, the main sources of asymmetric shocks, has thus been one of the biggest challenges for international economics, in particular because exchange rate stability (possibly around a trend) is among the main factors that promote total investment, price stability, and stable economic growth.

In order to analyze the determinants of real exchange rate variability, we have taken the following empirical approach. Firstly, we use an appropriate way of measuring the exchange rate variability, namely, the mean absolute change, where the variability is equal to the mean of the absolute values of individual exchange rate changes. This measure, unlike the simple standard deviation of exchange rate changes used in most of the relevant literature, is able to capture a trend as a special type of variability.

Secondly, we try to identify potential sources of real exchange rate variability, that is, of asymmetric shocks from four main areas: (i) the overall economic structure, (ii) the pace of economic development, (iii) labor market policies and institutions, and (iv) other policies and institutions (fiscal, monetary, product market, financial sector, etc.). We use data for 21 advanced and late-transition economies covering the ten-year period 1999–2008. Hence, the sample starts with the birth of the euro and ends before the data become contaminated by the financial crisis. Using a Bayesian approach, we find that the true model is likely to contain four types of dissimilarities between two economies: dissimilarities as regards (a) financial development, (b) per capita income growth, (c) central bank independence, and (d) the structure of the economy. In the sample as a whole, such factors explain about one third of the behavior of the medium-term real exchange rate variability, i.e., the rest is an estimate of the influence of non-fundamental factors (together with the influence of fundamental price level or nominal exchange rate determinants not captured by the regressors used). Concerning real exchange rates involving specifically the euro, we can explain about half of the behavior of the medium-term real exchange rate variability.

1. Introduction

Asymmetric shocks can create serious problems for policymakers during the process of setting an optimal macroeconomic policy for a given economy. In this context, a crucial aspect is whether monetary policy in that economy applies a floating or fixed exchange rate. The textbook model (Fleming, 1962; Mundell, 1962; De Grauwe, 2009) implies that the nominal exchange rate is able to at least partly shield the domestic economy from many types of asymmetric – nominal as well as real – shocks (foreign monetary policy shocks, productivity shocks, changes in the terms of trade, etc.). More specifically, the nominal exchange rate changes in value so as to reduce the impact of those shocks on domestic output and employment. If the exchange rate does provide this partial shield, then it works as an "absorber" of asymmetric shocks. Empirical support for this view is provided, for example, by Stockman (1983). According to this view, a fixed exchange rate regime may seem inferior because it implies that the protection provided by the nominal exchange rate is lost.

In reality, however, the nominal exchange rate itself may be frequently and sizably misaligned (Obstfeld, 1985; Mussa, 1986; Buiter, 2000) – in other words, it may be a strong generator of asymmetric shocks, reflecting pressures originating in financial markets rather than in the real economy. In that case, a fixed nominal exchange rate regime may be superior, relying on other variables in the economy to fully bear the burden of adjustment to asymmetric shocks.[1] This second, non-exchange rate channel of potential adjustment consists of variables such as labor and capital flows, prices, wages, and fiscal redistribution.

The decision on whether a fix or a float is preferable in terms of macroeconomic shock elimination should depend on the relative size and frequency of shocks generated within the exchange rate channel of adjustment versus the non-exchange rate one. Determination of the relative size and frequency of these two types of shocks is largely an empirical issue. MacDonald (1998) formulates this issue as a question on the direction of causality between the variability of the nominal exchange rate (NER) and that of the real exchange rate (RER):[2] a float is better if changes in the RER mostly cause changes in the NER, while a fix is better in the opposite case.

Given the significant implications that the choice of the exchange rate regime has, it is no wonder that a lot of researchers have tried to assess empirically, for various economies and time periods, the extent to which the NER is a shock generator. For example, a popular approach is to use VAR-based decomposition techniques (Blanchard and Quah, 1989) to decompose the movements of the RER observed over time into essentially two segments, corresponding to nominal (financial markets, exchange rate) shocks and all other shocks (e.g., Lastrapes, 1992; Clarida and Gali, 1994).

This paper tries to shed some light on the same fundamental question, i.e., to what extent the exchange rate is itself a shock generator (and thus how strong is the case for an exchange rate peg), but from a somewhat different angle. It looks at the extent to which differences in medium-term RER variability, properly measured to capture trends, across various currency pairs can be explained by

[1] On a theoretical level, Devereux (2004) suggests that if the economy is not fully integrated into international financial markets, then a fix may actually dominate a shock-absorbing float in terms of overall welfare.

[2] $RER = NER*P*/P$, where *RER* is the real exchange rate, *NER* is the nominal exchange rate in the sense of the price of one unit of foreign currency, $P*$ is the foreign price index, and P is the domestic price index.

fundamental factors. The potentially relevant factors are represented here by 22 variables for a sample of 210 currency pairs formed by 21 advanced and late-transition economies. The part of the behavior of our measure of RER variability – as a measure of the overall incidence of asymmetric shocks – that remains unexplained by our regression can be viewed as an estimate of the impact on RER variability of shocks coming from the foreign exchange market itself (together with asymmetric shocks due to fundamentals not captured by the regressors used). Obviously, this question is especially important for central banks of small open inflation-targeting economies. We find that out of our set of 22 fundamentals, four seem likely to be a part of the true model of RER variability determination, namely, dissimilarities as regards (a) financial development, (b) per capita income growth, (c) central bank independence, and (d) the structure of the economy. In the sample as a whole, these four determinants are able to explain about one third of the behavior of our measure of RER variability; among those currency pairs where the euro is one of the currencies, the four fundamentals explain about one half of the behavior of our measure of RER variability.

The paper is organized as follows. Section 2 is a short survey of factors influencing the RER and its variability. Sections 3 and 4 explain the empirical methodology and data used in our analysis. In Section 5 we provide empirical results from Bayesian model averaging (BMA) and follow-up OLS estimations. Section 6 applies the estimates to explain RER variability. Section 7 concludes.

2. Variability of the Real Exchange Rate

2.1 Sources of Asymmetric Shocks Causing Exchange Rate Variability

As regards the time horizon, the determinants of the RER and its variability can be categorized in the following way. In the short run (less than one year), movements in the RER are determined by changes in the NER. This means that the correlation between the nominal and real exchange rates is very high in the short run (Meltzer, 1993). In the medium run (between one and three years) the RER is determined chiefly by two sets of factors: those associated with the balance of payments (real interest rates, which determine developments on the financial account; the current account position, which determines net foreign assets; and aggregate labor productivity), and by "real shocks" to the economy (significant technological changes, significant changes in the terms of trade, and significant changes in state finances, for example, rises or falls in expenditure on arms or infrastructure investment).[3] In the long run, the RERs between advanced economies can be more or less constant. This is evidenced by the exchange rates of advanced market economies, where time series stretching back more than a century can be compiled. This type of stationarity is admittedly not the norm for all the exchange rates of advanced market economies, but it does suggest that RERs return to equilibrium in the very long run. The ability of an economy to absorb asymmetric real shocks can be observed from the movements of the RER. In the presence of nominal rigidities and imperfectly integrated markets the role of macroeconomic policies is important to respond promptly to asymmetric real shocks and thus influence the variability of the RER. Monetary policy affects the exchange rate primarily in the following ways: (i) through the chosen exchange rate regime (a scale running from an exchange rate peg through to a free float); (ii) through the chosen monetary policy scheme (exchange rate targeting, money targeting or inflation targeting); and (iii) through foreign exchange intervention strategy (only relevant in countries that do not apply a currency board arrangement) which is

[3] Other factors that affect small open economies' exchange rates include, for example, the exchange rates of reserve currencies, market expectations, risk premia, and ratings.

motivated to change a NER that is out of line with economic fundamentals and which involves the "classic" attempt to smooth out excessive exchange rate volatility, which creates exchange rate "bubbles."

The influence of fiscal policy on the exchange rate in developing (transition) economies depends primarily on: (i) fiscal and monetary policy co-ordination (persistent fiscal expansion should result in nominal and real depreciation of the exchange rate); (ii) the way in which privatization payments are dealt with (including "conversion agreements" between the central bank and the government on the gradual release of privatization proceeds, these being a large source of income to the state budget); (iii) the level and growth rate of the budget deficit and state debt (this, together with growth in public debt, leads to increased foreign exchange risk and growth in the risk premium, which, in turn, brings about higher domestic interest rates). From the general perspective, it is also important to note that successful operation of a pegged exchange rate in the longer run is incompatible with a deficit fiscal policy that causes excessive growth in domestic demand.

In addition to fiscal-policy and labor-market flexibility, the ability of an economy to absorb asymmetric shocks is affected by the strength and stability of its financial sector. The real-convergence process is strongly influenced among other things by the existence of a strong financial sector capable, on the basis of market signals, of allocating savings into productive investments. In the event of rapid capital flows, the basic condition for sustainable economic growth is a strong financial sector. This is evidenced, for example, by the financial crises of the 1990s, most notably the Asian crisis in 1997. One can make the generalization, however, that changes in exchange rates have been triggers or at least strong catalysts in most financial crises (banking crises, debt crises, and currency crises), for instance in Sweden (1992), the ERM (1992), Russia (1998), and Argentina (2001–2002).

Our approach to explaining RER variability is inspired by the optimal currency area (OCA) hypothesis of Mundell (1961), which investigates exchange rate variability in both nominal and real terms. Mundell isolated the key economic factors that make two regions or countries a part of a common currency area. These factors include trade interdependence, size and degree of openness, and degree of commonality in economic shocks. Like previous studies (e.g., Bayoumi and Eichengreen, 1998; Hausmann et al., 2001; Larrain and Tavares, 2000; Engel and Rose, 2000, 2001; Gross and Hobza, 2003; Horváth and Kučerová, 2005), we use similar explanatory variables in modeling bilateral RER variability across countries. Bayoumi and Eichengreen (1998) analyze exchange rate volatilities and find that asymmetries in output time series have a positive influence on currency market pressures in nominal and real terms. Larrain and Tavares (2000) analyze the determinants of RER variability across regions and time. They show that greater asymmetry in output shocks or export patterns and lower levels of bilateral trade are associated with larger fluctuations in RERs. Horváth and Kučerová (2005) find that OCA criteria also largely explain RER variability. Engel and Rose (2001) compare empirical properties of RERs inside and outside currency unions and find that the standard deviation of exchange rate changes can be explained by a highly significant negative coefficient of a currency union dummy.

Our essential question on the sources of asymmetric shocks causing RER changes is related to the question of whether or not the two economies form an optimum currency area. Broadly speaking, the more intensive is the RER variability due to shocks originating outside the exchange rate market itself, the more suspicion there might be that the two economies do not form an OCA. Therefore, even though our paper is not focused primarily on the question of whether or not any two economies form an OCA, our starting point is the approach of Bayoumi and Eichengreen (1997a, 1997b, 1998).

In these three papers, Bayoumi and Eichengreen suggested a novel way of measuring the extent to which the bilateral exchange rate between two economies participates in their adjustment to asymmetric shocks. For two industrialized economies, the RER can be expected to have a roughly constant medium- to long-term equilibrium level: this is the well-known (constant) purchasing power parity hypothesis. However, due to the factors that distinguish the two economies from an OCA and that generate asymmetric shocks for the two economies, the equilibrium path may in fact undergo transitory or permanent changes, bringing about a tendency for the observed RER to change as well. The more differences a given pair of economies features in various such factors or "OCA indicators," the larger is the expected variability in the bilateral RER.

In statistical terms, a less OCA-like pair of economies will correspond to a larger expected standard deviation of changes in the level of the RER. The cross-section regressions that Bayoumi and Eichengreen and most of their followers (Bénassy-Quéré and Lahréche-Révil, 2000; Cincibuch and Vávra, 2001; Horváth and Komárek, 2002; Horváth, 2005; Partisiwi and Achsani, 2010) ran had the following general form:

$$SD(E_{ij}) = \alpha + \boldsymbol{\beta X}_{ij} + \varepsilon_{ij}, \qquad (1)$$

where $SD(E_{ij})$ stands for the standard deviation of changes in the bilateral (nominal or real) exchange rate between the currencies of economies i and j over the whole time period under study and $\boldsymbol{X}_{ij}$ is a vector of variables, each of these being an average value, over the whole time period under study, of one OCA indicator as measured for economies i and j. Each observation in this regression refers to one pair of economies, so that if there are n economies, the cross-section regression will work with $n(n-1)/2$ observations.

2.2 Is the Exchange Rate a Shock Generator or a Shock Absorber?

The traditional view of the exchange rate as a shock absorber has been challenged by a number of studies. While some studies within the VAR-based research stream support the view that the NER is a shock absorber, others come to the opposite conclusion; the specific conclusion depends on the assumptions and details of the method used and on the particular sample under study. For example, within a single study (Clarida and Gali, 1994), the variances in the RERs against the U.S. dollar of both the Japanese yen and the German mark are explained to a significant extent by NER shock-like disturbances, while the variances in the RERs against the U.S. dollar of the British pound and the Canadian dollar are mostly due to other types of shocks.

One of the few recognizable messages from the VAR-based research is that the RERs of developed economies tend to reflect real economy developments, so that the NER is a shock absorber, while for the RERs of developing economies or emerging markets the picture is less clear-cut (Borghis and Kuijs, 2004; Kontolemis and Ross, 2005; Stazka, 2006).

Audzei and Brázdik (2012) analyze the relations between the exchange rate and other macroeconomic variables within the VAR framework using the sign restriction technique. The results of variance decomposition of the exchange rate do not allow the authors to reject a shock-absorbing role of the exchange rate for the Czech economy. To assess the robustness of the results, they also examine the relation between monetary policy and exchange rate volatility and conclude that the shock-absorbing nature of the exchange rate prevails over the shock-generating one.

Besides the VAR decomposition method, various authors have tried to answer – directly or indirectly – the general question of whether the NER is a shock generator or shock absorber using various other approaches. For example, Chinn and Wei (2013) look at the extent to which the RER persistence can be explained by the exchange rate regime for a sample of more than 170 countries over the 1971–2005 period. Their conclusion is that there is no significant relationship. This can be taken as an indication that the NER (when not pegged) is not a source of additional disturbances to the RER. The same conclusion comes out of studies that focus specifically on the NER variability implications of the adoption of inflation targeting (De Gregorio et al., 2005; Edwards, 2006).

Maliszewska and Maliszewski (2006), building on Ghosh et al. (2002), regress output growth and volatility of output growth on an exchange rate regime dummy and a number of control variables, using data on 144 economies over the 1940–2001 period. They find that the exchange rate regime has no significant impact on output growth, while a de jure fix goes hand in hand with higher output volatility than a de jure float; for the Reinhart-Rogoff natural classification, however, this output volatility result is reversed. Again, these findings can be interpreted in terms of whether or not the NER (when not pegged) is a source of additional disturbances to the RER. Maurel and Schnabl (2011), using data for 45 economies in the 1990s and 2000s, find that economies with a fix tend to grow faster. Several other approaches to the basic absorber-generator question are discussed in MacDonald (1998).

3. Empirical Methodology

Technically speaking, our empirical methodology will be similar to that of the OCA index stream of studies mentioned in Section 2: we will regress, in a cross-sectional manner, values of RER variability for a number of currency pairs on a selection of OCA indicators pertaining to these currency pairs. But while the focus of the above research has been on whether various pairs of economies form an OCA or not, we are interested in a related but distinct issue: the extent to which asymmetric shocks (as reflected in medium-term bilateral RER variability) are non-fundamental, i.e., come from the foreign exchange market itself and make the NER a separate source of (non-fundamental) asymmetric shocks. To address this issue properly, we need to make the following choices:

(1) what type of exchange rate we will use as the underlying economic concept,

(2) what measure of variability of the exchange rate selected in step (1) we will use,

(3) what OCA indicators we will use to explain the exchange rate variability obtained in steps (1) and (2).

3.1 Selecting the Appropriate Type of Exchange Rate

The type of exchange rate used to construct our dependent variable should be chosen so as to best capture the asymmetric changes in welfare that any asymmetric shock ultimately leads to. The simplest choice is the bilateral NER (e.g., Bayoumi and Eichengreen, 1997b). This choice makes sense if we assume that all asymmetric shocks are reflected primarily in the bilateral NER – for example, if we assume that a rise in world demand for economy A's (but not economy B's) output gets reflected primarily in a nominal appreciation of A's currency vis-à-vis that of B.

In reality, the welfare implications of asymmetric shocks may also, in the medium term, be reflected in the bilateral inflation differential. Whether the shock will affect the NER or the inflation differential more depends on the various wage and price rigidities in the two economies and on whether the two economies' monetary policies are closer to inflation targeting or exchange rate targeting. Indeed, several authors construct their exchange rate variability measure on the basis of "exchange rate pressure" which contains, apart from the actual exchange rate, what we might call the "shadow" exchange rate. The latter is a collection of policy variables that document the short-term policy activity aimed at making the implications of asymmetric shocks end up reflected more in the NER or in the inflation differential via changes in aggregate demand and thus domestic economic activity.

Horvath (2005), for instance, operationalizes the shadow exchange rate as the differential in the volume of official exchange rate interventions and in the level of short-term interest rates. The idea is that if an adverse asymmetric shock hits one of the two economies and monetary policy in one of them is based on exchange rate targeting, the monetary policy authority will fight the ensuing devaluation pressures on its currency by intervening (without sterilization) in the foreign exchange market in support of the currency or by increasing the policy interest rate. These steps are likely to slow domestic economic growth and thus inflation, so that the devaluation pressure is transformed into a negative gap between domestic and foreign inflation.

Unfortunately, construction of the OCA index variable in the form of exchange rate pressure faces a data availability problem as regards, specifically, foreign exchange interventions. Their extent can be measured as the change in the stock of official foreign exchange holdings. However, given that only unsterilized interventions are generally believed to have a material impact on the exchange rate, we should assess interventions via the change in the monetary base. But monetary base data seem to be unavailable for a number of economies in our sample (as described later).

One way to tackle this problem is to use a proxy for the monetary base, such as currency in circulation (e.g., Skorepa, 2011); needless to say, however, this proxy may be far from perfect. We will follow a rather different route here: in constructing the OCA index variable, we will look at the RER (Bayoumi and Eichengreen, 1997b; Horváth and Kučerová, 2005) and, in addition, we will focus on changes in this variable over three years, that is, a time period significantly longer than the usual one year. This allows the leanings of the monetary policy authorities (and the extent of the rigidities) in the two economies to be largely ignored, as they determine the distribution of RER changes into NER changes and the inflation differential but do not influence the size of the RER changes as such.

3.2 Measuring Variability of the Exchange Rate

Most of the OCA index literature measures exchange rate variability simply as the standard deviation of the exchange rate changes within the time period under study. However, as Skorepa (2011) points out, when exchange rates in the sample feature trends, this simple approach is not adequate. The reason is that the standard deviation will not capture the trends. To take a hypothetical extreme example of a pure trend (i.e., regular equal-sized exchange rate changes in the same direction) with no variability around it, the exchange rate clearly is variable in the sense that it keeps changing value, but the standard deviation of the changes will be zero.

In Section 4 we will document that many economy pairs in our sample do feature sizeable trends. Therefore, an alternative way of measuring exchange rate variability is called for – one which will capture trends as well. We opt for the mean absolute change (along the lines of Skorepa, 2013), where the variability is equal to the mean of the absolute values of the individual changes.

The core of our empirical methodology is thus the following regression:

$$MAC(R^{\tau}_{ij}) = \alpha + \boldsymbol{\beta} X_{ij} + \varepsilon_{ij}, \qquad (2)$$

where $MAC(\cdot)$ stands for the mean of the absolute values of its argument; R^{τ}_{ij} is the rate of change in the RER in a given period t relative to period $t\text{-}\tau$ (as mentioned earlier, we will focus on $\tau = 3$) between the currencies of economies i and j; and X_{ij} is a vector of relevant OCA indicators, to whose selection we turn now.[4, 5]

3.3 Identifying Potential Culprits

It seems intuitively appealing to assume that two economies are more likely to be hit by a (fundamental) asymmetric shock the more they differ. In this study we will try to capture, in particular, the RER impact of dissimilarities in at least one indicator within each of these four areas:

(1) the overall economic structure,

(2) the pace of economic development,[6]

(3) labor market policies and institutions,

(4) other policies and institutions (fiscal, monetary, product market, financial sector, etc.).[7]

The key role that institutions and policies tend to play in economic development (e.g., North, 1990) may lead us to suspect that indicators in categories (3) and (4) matter for the RER evolution to the extent that they influence economic development, which is already captured in category (2). In reality, the various imperfections that beset the measurement of economic development lead us to think that, provided we are careful about the issue of multicollinearity, the indicators in categories

[4] Later on, when we report the results of our regressions, $MAC(R^{\tau}_{ij})$ will be referred to as *MACRERτ*, e.g., *MACRER3* for τ=3.

[5] Technically speaking, it would be possible to approach the present topic using panel regression. We will, however, stick with most of the previous literature in using the cross-section regression taking averages of the individual variables over the whole sample period. The reasons are fundamental (assessment of the relationship between ER variability and selected explanatory variables seems more likely to be robust when done over the medium term than in a year-to-year fashion) as well as technical (far from all of the variables we will use are available for each and every year of the sample period).

[6] To describe a dissimilarity in this pace, we will talk about "convergence" even in cases where the dissimilarity is such that it produces divergence (i.e., negative convergence).

[7] In principle, we should add also indicators of the tendency of the market for a given currency pair to produce shocks. In that way, the contribution of NER itself to the total RER variability would be captured explicitly in our regressions and would not have to be ascribed to the residual (as we do below). Alas, we know of no publicly available indicator which would, in this sense, characterize each of the markets for the currency pairs that will feature in our regressions.

(2)–(4) can all appear side by side in the same regression, as they are alternative imperfect measures of a similar economic concept.

Many asymmetric shocks due to the dissimilarities measured by the indicators in categories (1)–(4) may be at least partly mitigated by mechanisms of risk sharing between the two economies whereby originally asymmetric shocks are turned less asymmetric and more symmetric. Therefore, in order to obtain a measure of the "net" asymmetric shocks, we need to include in our regressions a fifth category of independent variables – those that will capture these risk-sharing mechanisms.[8]

Obviously, the question is which available statistical data are acceptable as real-life proxies for the above economic concepts of dissimilarities and risk-sharing mechanisms. The choices that we make – given the data constraints – are as follows:

(1) the overall economic structure will be proxied by the structure of GDP, the structure of exports to the rest of the world, and the structure of employment;

(2) the pace of economic development will be proxied by the growth of per capita income;

(3) labor market policies and institutions will be proxied by a number of indicators related to international migration, minimum advance notice period, minimum severance pay, unemployment, replacement ratio for the unemployed, wage bargaining coordination, etc.;

(4) other policies and institutions will be proxied by fiscal surpluses, monetary policy independence and transparency, financial development, etc.;[9]

(5) risk sharing will be proxied by mutual trade links (more intensive trade links imply that a larger share of any shock hitting only one of the two economies is transmitted to the other economy).

In total, we will work with 22 independent variables, all but one (mutual trade links) being of the dissimilarity type. All the variables are listed in Table A1 in the Appendix together with some explanatory notes. Importantly, all dissimilarities are expected to be positively correlated with RER variability, while for mutual trade links the regression coefficient is, conversely, expected to be negative.

Within category (4) above, we also include among the regressors policy variables such as fiscal surpluses and monetary policy independence and transparency which can be viewed as "exchange rate-sensitive" in the sense that they might be expected to react relatively flexibly to exchange rate developments (especially unusual ones). The inclusion of such policies may raise concerns about endogeneity: the values of policy-related independent variables may potentially be influenced by the RER variability that we take as the dependent variable. To deal with this issue, we take values of the policy-related variables lagged by three years. Similar endogeneity concerns lead us to use lagged

[8] De Grauwe (2009) is a popular survey of all OCA indicators – not only sources of asymmetric shocks and risk-sharing mechanisms, but also various rigidities characterizing the two economies, which we do not include in our regressions for the reasons discussed in Section 3.1.

[9] To be absolutely clear about the logic here, it should be noted that, for example, central bank independence appears in this list not in the sense that a higher level of central bank independence would in itself be likely to cause more (or less) RER volatility. Instead, the idea is that a larger difference, between the two economies, in the level of central bank independence is likely to cause more RER variability. For example, if two economies are hit by the same shock, the respective two central banks, enjoying different degrees of independence, may react differently, so that the remaining stages of the process of the shock unfolding become asymmetric.

values for mutual trade links as well. Here we essentially assume that the RER variability effects of the factors to which we apply this three-year time lag are not limited to the short-term only.

To sum up, our general methodology differs from that employed in the research stream initiated by Bayoumi and Eichengreen (1997a, 1997b, 1998) in its different focus (we focus on sources of medium-term RER changes rather than the OCA judgment), in allowing for income convergence (as in Skorepa, 2013), and in using a set X_{ij} of explanatory variables augmented by a number of indicators related to dissimilarities between the two economies in their domestic institutions and policies. Having obtained estimates of α and β, we can calculate $MAC(E^{\tau}_{ij})^{e}$, that is, the fitted (fundamentally explained) value of medium-term RER variability for each currency pair. Assuming away the possibility of sizable non-fundamental changes in the inflation differential, the residual, $MAC(E^{\tau}_{ij})$ - $MAC(E^{\tau}_{ij})^{e}$, is then the non-fundamental part of the overall behavior of the RER variability, or the part due to the exchange rate market itself (together with the influence of fundamental price level or nominal exchange rate determinants not captured by the regressors used).

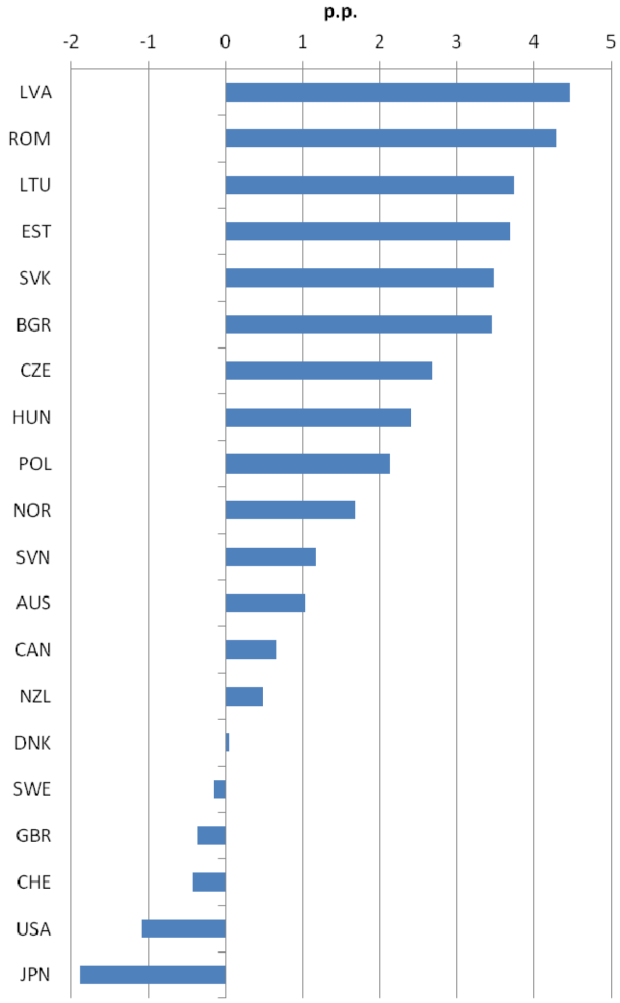
4. The Sample

Our sample consists of the following 21 economies (abbreviations are provided in parentheses): Australia (AUS), Bulgaria (BGR), Canada (CAN), the Czech Republic (CZE), Denmark (DNK), Estonia (EST), the euro area, Hungary (HUN), Japan (JPN), Latvia (LVA), Lithuania (LTU), New Zealand (NZL), Norway (NOR), Poland (POL), Romania (ROM), Slovakia (SVK), Slovenia (SVN), Sweden (SWE), Switzerland (CHE), the United Kingdom (GBR), and the United States (USA). Our individual observations will actually be pairs of economies; the sample implies 21*(21-1)/2 = 210 observations (pairs of economies).[10]

The sample purposely blends advanced and selected late-transition economies. The point of working with such a sample is to strike a balance between two considerations: on one hand, we need heterogeneity to be able to assess the exchange rate impact of differences among economies (heterogeneity specifically as regards income convergence is illustrated by Figure 1, taking the euro area as the reference economy); on the other hand, we need to focus on market economies (where the role of government is not so strong as to make interpretation of our results too complicated). In selecting the economies to be included, we were also limited by data availability.

[10] We will actually work with 209 observations, since some data are missing for the Latvia–New Zealand pair.

Figure 1: Average Yearly Growth of GDP per Capita Based on PPP in Current International Dollars, Excess (in p.p.) Over the Euro Area, 1999–2008



The sample covers the ten-year period 1999–2008 (with the exceptions described below). It starts with the birth of the euro so that we can include in the sample all euro area economies (as a whole) without the need to deal with the thorny issue of linking pre-euro national data and euro area-wide data. And the sample ends in 2008, the last year for which the data we use are relatively uncontaminated by the financial crisis, which erupted in full only with the fall of Lehman Brothers in September of that year.

5. Estimation

5.1 Identifying the Preferred Specification

Given that we intend to explain our left-hand-side variable with a fairly high number of independent variables, the issue of multicollinearity should be dealt with first. The literature suggests, in general, that multicollinearity is a worry if the variance inflation factor (VIF) is above 10 for at least some of the variables. In our case, however, the VIF values are well below this threshold for each explanatory variable. Multicollinearity thus does not seem to be a problem.

Even so, there is substantial uncertainty as regards the correct specification. For example, since some of the variables represent similar economic concepts, perhaps not all of them should appear in the regression. Also, many of the variables are "soft data," such as those derived at least partly from subjective assessments of respondents within surveys; perhaps such variables are rather noisy and thus not very useful in explaining the behavior of the RER. All these specification uncertainties lead us to opt for the Bayesian model averaging (BMA) technique (Hoeting et al., 1999). This technique should point out the variables most likely to belong to the specification that seems true given our data set.

The BMA literature offers multiple options as regards the priors on both parameters and models (for details, see Moral-Benito, 2012). Among these options we will focus primarily on the "unit information prior," or UIP, for parameters and on the "random prior" for models; the use of several other popular priors is discussed in Section 5.2. To economize on computation time, we use the Markov chain Monte Carlo routine (Madigan and York, 1995; Eicher et al., 2011); we set the number of draws to 4 million, of which the first 2 million are thrown away as burn-ins. The estimation is executed using the R package BMS (Zeugner, 2011).

Each BMA estimation generates a number of interesting statistics. As regards the basic issue of specification selection, the most important indicator is the posterior inclusion probability (PIP): a PIP value above or below 0.5 indicates that the variable at hand is more likely to be present in or absent from the true model, respectively. In our case, since we have a very clear ex ante idea about the proper signs of the regressors' coefficients, the signs that we obtain will be another indicator guiding us toward the most likely model.

Indeed, in an initial BMA estimation of regression (2) taking *MACRER3* as the dependent variable, using all the 22 variables listed in Table A1 in the Appendix and taking the three-year lagged values of the flexible-policy variables (*BBS*, *CBI*, *CBT*) and of the trade-link variable (*TIN*), two of the variables for which PIP > 0.5, namely, *LEG* and *BUR*, turn out to have a negative coefficient (see Table A2 in the Appendix). In contrast, ex ante considerations clearly suggest for these two regressors – just like all the other dissimilarity-type regressors – a positive sign: there seems no reason why, when the two economies in question are more different (as regards *LEG* or *BUR* or any other parameter), the variability of these two economies' RER should fall. Therefore, we think that the negative sign in the regression results should override the implication of PIP > 0.5. That is, the two variables are in fact unlikely to take part in the true model (regression results for the specification which does include these two variables are presented in the Appendix, Table A6, column A).

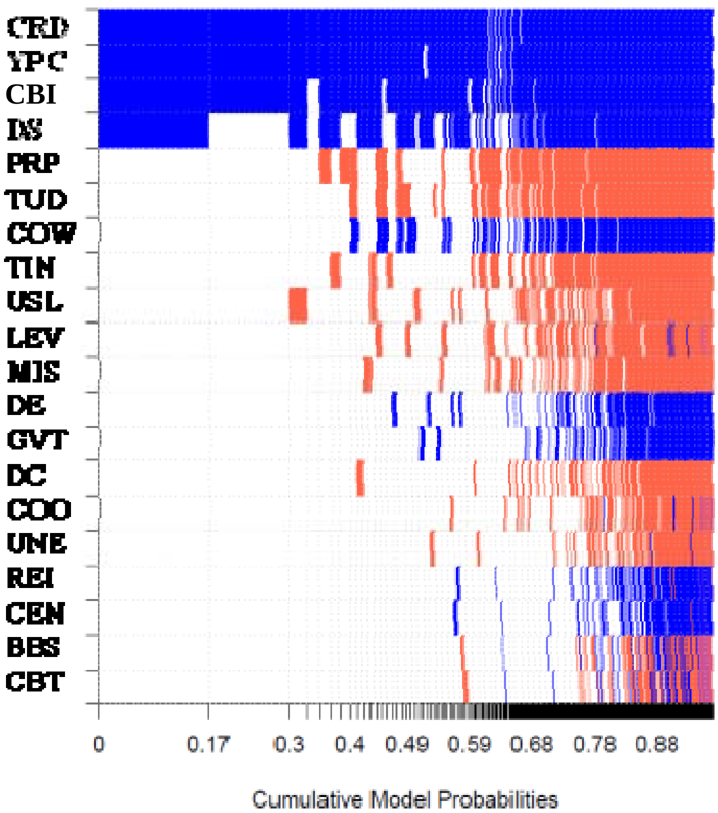
After dropping *LEG* and *BUR*, our BMA estimation leads to the result on which we will base our preferred specification in this study. This result is summarized in Table 1. Figure 2 presents the 5,000 possible models with the highest posterior probability of being correct in the BMA estimation, ordered by that probability; the PIP for any given variable is the sum of the probabilities of all models in which that variable is included.

Table 1: BMA (UIP Random) Estimation of Specification (2), LEG and BUR Dropped

Variable	PIP	Posterior mean	Posterior SD
FIN	**0.990**	**0.592**	**0.157**
YPC	**0.967**	**1.187**	**0.394**
CBI	**0.912**	**0.116**	**0.051**
DS	**0.595**	**0.101**	**0.096**
PRP	0.313	-0.031	0.052
TUD	0.282	0.000	0.001
COW	0.275	0.000	0.001
TIN	0.186	0.000	0.000
USL	0.142	-0.011	0.032
LEV	0.123	-0.002	0.007
MIS	0.114	-0.017	0.056
DE	0.092	0.006	0.025
GVT	0.077	0.004	0.019
DC	0.072	-0.002	0.007
COO	0.046	0.000	0.002
UNE	0.041	-0.004	0.037
REI	0.036	0.000	0.008
CEN	0.035	0.001	0.010
BBS	0.034	0.004	0.054
CBT	0.033	0.000	0.000
Dependent variable	*MACRER3*		
Draws	4,000,000		
Burn-ins	2,000,000		
No. models visited	1,024,780		
Model space	1,048,576		

Note: PIP stands for posterior inclusion probability. Variables with PIP > 0.5 are printed in bold.

Figure 2: Model Inclusion Based on the Best 5,000 Models



We see that there are four variables with PIP > 0.5, but now all four have the expected sign. This group contains three "culprits" which echo earlier research (e.g., Skorepa, 2011). First there is *DS*, which represents dissimilarity in the structure of the two economies. Structural dissimilarity was emphasized by Bayoumi and Eichengreen (1997b), but as regards usefulness in explaining RER variability, their specific measure, focused on the structure of exports (represented in our regression approximately by *DC*), is overshadowed in our results by *DS*. The second variable with PIP > 0.5 which has already appeared in earlier research is *YPC*, or income convergence; its relevance for explaining RER variability was pointed out by Skorepa (2013). The third familiar variable is *FIN*, or degree of financial development. This variable mixes data such as the share of bank deposits held in privately owned banks, the share of foreign banks in the banking sector assets, and the extent to which interest rates are determined by the market (for details, see Gwartney et al., 2012).[11] While measured in various ways, a financial development or deepness variable has appeared in numerous previous studies of exchange rate variability (Bayoumi and Eichengreen, 1998; Horváth, 2005).

The only "culprit" which has not appeared prominently in previous studies of exchange rate variability is *CBI*, or central bank independence. This could be due to the fact that systematic empirical research on central bank independence has gained in popularity relatively recently.

In sum, the set of four variables which our BMA regression reveals to play a significant role in determining RER variability is not dramatically surprising. What is perhaps more surprising is the broad range of variables that turn out not to play such a role: all the dissimilarities in labor market functioning, in migration intensity, in central bank transparency, in fiscal discipline, etc. come out with PIP < 0.5, just as trade links do. To some extent, this could be due to statistical reasons: even if multicollinearity is not high, there is nevertheless some degree of correlation between many of the explanatory variables, which may push the PIP for some of them below the 0.5 mark. Another possible explanation was already hinted at above: noise in the measurement of at least some of the variables (cf. Kaufmann and Kraay, 2007; Snodgrass, 2008) may reduce their ability to explain RER variability. Yet another possibility is that some of the variables are related to RER variability in a more complex way.[12] Exploration of this possibility is one possible way of extending our research in the future. It may also be pointed out that the absence of a clear effect of some of the labor market variables is in line with existing relevant research (such as Arpaia and Mourre, 2005; Chor and Freeman, 2005; Howell et al., 2007; Kennedy and Sløk, 2005) finding no clear macroeconomic effects of some of the key labor market institutions and policies.

As was explained, BMA estimation pointed to:

$$MACRER3 = \alpha + \beta_1 FIN_{ij} + \beta_2 YPC_{ij} + \beta_3 CBI_{ij} + \beta_4 DS_{ij} + \varepsilon_{ij} \qquad (3)$$

as the specification that is most likely to be true. Therefore, we can now assume that the results of standard OLS estimation of (3) will be a more reliable basis for further inference than if we looked at the initial set of all 22 variables listed in Table A1 and hand-picked several of them based on intuition alone.

[11] Gwartney et al. (2012) formally label this variable as Credit Market Regulations. Given its actual content, however, we think a label such as Financial Development would be more appropriate.

[12] For example, as regards labor market variables, Calmfors and Driffill (1988) suggest that trade unions are most likely to internalize the macroeconomic consequences of their wage claims (and thus generate fewer asymmetric wage shocks) in the case of medium-level coordination of wage bargaining.

The results of the OLS estimation of (3) are shown in Table 2. We present and will use the results of robust estimation, since the Breusch-Pagan/Cook-Weisberg test gives a clear signal of heteroskedasticity. Not very surprisingly, all four regressors are highly statistically significant and have the expected sign. The value of R-squared implies that our model is able to explain about one third of the behavior of the three-year RER variability within our sample.

Table 2: OLS Estimation of Specification (3)

	Coefficient
FIN	0.528***
	0.127
YPC	1.149***
	0.335
CBI	0.139***
	0.039
DS	0.172***
	0.058
constant	0.006
	0.014
Dependent variable	*MACRER3*
Observations	210
R-squared	0.34

Note: *** significant at the 1% level. Robust standard errors are reported below the estimates.

As soon as we present the results of the BMA procedure, an important caveat must be emphasized. Even if they are intuitively fairly acceptable and in line with previous research, these results (and thus also the subsequent calculations and considerations that we make based on them) should be viewed as very preliminary and in need of checking with more sophisticated econometric methods once they become available. First, given how all the variables entering the BMA are constructed, the distribution of the error term does not necessarily approach the normal distribution (not even asymptotically). Second, the data may be subject to significant spatial autocorrelation. Both these problems may introduce biases into the inferences made within OLS, including the OLS regressions performed within the BMA. We return to these issues in the next subsection.

5.2 Sensitivity Analysis

We perform a number of sensitivity checks. The first two concern the specific priors used in the BMA estimation procedure and the time period over which we measure the RER variability. The remaining exercises focus on the issues of dealing with the dependent variable's non-normality, spatial autocorrelation, and the potential influence of certain economies having been in transition or certain RERs being subject to a fixed (nominal) exchange rate regime.

As regards the BMA estimation procedure, above we used the random prior and the UIP prior for the models and the coefficients, respectively. It turns out that using alternative priors for the coefficients, namely, the BRIC, HQ, or RIC priors as suggested by Zeugner (2011), makes almost no difference to the results (see Table A3 in the Appendix).

Refocusing now on the model prior, we found that moving from the random prior to the uniform one increased the number of variables ending up with PIP > 0.5 from four to seven (see Table A4 in the Appendix). This is only natural given that the uniform prior gives each variable a 50% prior probability of being included and thus implicitly assigns a relatively higher weight to models closer to the average possible number of explanatory variables: in our case this average is eleven, which is much higher than four, the number of regressors in our preferred specification. However, ignoring those variables which have the non-intuitive sign (*TUD* and *PRP*), we are left with the same four variables as in the preferred specification, and just one new variable (*COW*). The similarity of the results under the uniform prior to those under the random one provide us with some comfort; in any case, given the unsubstantiated prior advantage that the uniform prior gives to medium-sized models, we think that a more agnostic and thus more conservative option is to stick with the random prior results (regression results for the specification which includes *COW* and which includes *COW*, *TUD*, and *PRP* are presented in the Appendix, Table A6, columns B and C, respectively).

As for the time period over which the RER variability is being measured, for reasons explained earlier our preferred specification works with a three-year period. Making this period shorter or longer by one year does not change the results substantively, as is documented by Table A5 in the Appendix. The only appreciable effect (after dropping *LEG* and/or *BUR* due again to their non-intuitive signs) is that for the two-year period, *DS* falls below the PIP = 0.5 line, while for the four-year period, on the contrary, this variable's PIP rises closer to 1. Taken together, we can discern a fairly plausible message: the longer the term over which we measure the RER variability, the more we can be sure that dissimilarity in the structures of the two economies plays a role in that variability.

The potential problem of spatial autocorrelation was pointed out above. Statistical software which would marry BMA and spatial autocorrelation does not seem to be available yet. So, we address this issue at least by augmenting specification (3) with spatial weights and estimating the resulting specification using the spatial autocorrelation model. In this model, a new right-hand-side variable is included whose value is a weighted average of the values of the dependent variable in all the other observations (volatility in all the other currency pairs). The coefficient on this new independent variable is usually termed the "spatial lag." It measures the importance of mutual spatial proximity between observations for the value of the dependent variable.

The results of this regression are presented in the Appendix, Table A6, column D. As we would expect, the spatial lag (*rho*) is positive: if *MACRER3* is high, say, for the USD/EUR pair, then it is likely to be high for all other currency pairs featuring USD or EUR. It should be noted that the results may be sensitive to the way the spatial weights are constructed. We take the contiguity approach, where the spatial weight has value 1 if the two observations (currency pairs) involved are spatial "neighbors," that is, if they share a currency; if they share no currency, the weight is 0. A more gradualist approach might be taken where the weights would be higher if the two currency pairs both included currencies that were "similar" as regards tendency to RER variability (e.g., sharing the same regional ER pressures), but this would raise non-trivial questions about the appropriate definition of such similarity and would take us beyond the focus of this paper.[13]

Another problem touched upon earlier is potential non-normality of the distribution of the error term in our regressions. To see the extent to which the regression results change if we modify the construction of the left-hand-side variable such that it is allowed to take negative values (as one way

[13] Regardless of the approach taken to the construction of the weights, it will always be difficult to use spatial regression results to answer our basic question about the degree to which fundamentals explain RER variability. The reason is that the traditional, easy-to-interpret R-squared measure of goodness of fit is not appropriate in the spatial context (Anselin, 1992).

to possibly make the distribution of that variable more normal), we re-run specification (3) with the dependent variable being the logarithm of *MACRER3*. The results, shown in the Appendix, Table A6, column E, indicate that this modification alone does not bring a dramatic change to the results compared to the preferred specification.[14]

The last two sensitivity checks look at how the results change if we take into account, by augmenting specification (3) with appropriate dummies, two more potential factors: whether one of the two economies in a given pair was a transition economy, and whether the bilateral NER was subject to a fixed exchange rate regime. More specifically, the *trn1* dummy is equal to 1 if one of the two economies in the pair was in transition; the *trn2* dummy is equal to 1 if both were in transition; the *fix1* dummy is equal to 1 if one of the two economies in the pair pegged its NER to an economy other than the other one in the pair; the *fix2* dummy is equal to 1 if one of the two economies in the pair applied a peg to its NER with the other one in the pair. A transition character was assumed for Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. An exchange rate peg was assumed for Bulgaria, Denmark, Estonia, Latvia, and Lithuania.[15]

The results of these two checks, performed separately and together, respectively, are reported in the last three columns of Table A6 in the Appendix. The pattern of statistical significance of the dummies is quite clear: peg dummies play a significant role, while transition dummies do not, especially when present in the regression side by side with the peg ones. Given the overlap of the group of transition economies and the group of exchange rate fixers, this finding is not entirely surprising.

Comparing the results in the last three columns of Table A6 with those for the preferred specification (3), the sign, size, and degree of statistical significance of the four key culprits identified in the preferred specification do not change appreciably; a mild exception is *DS*, whose coefficient falls and whose statistical significance weakens after peg dummies are introduced. Also, the presence of these dummies somewhat improves the overall fit.

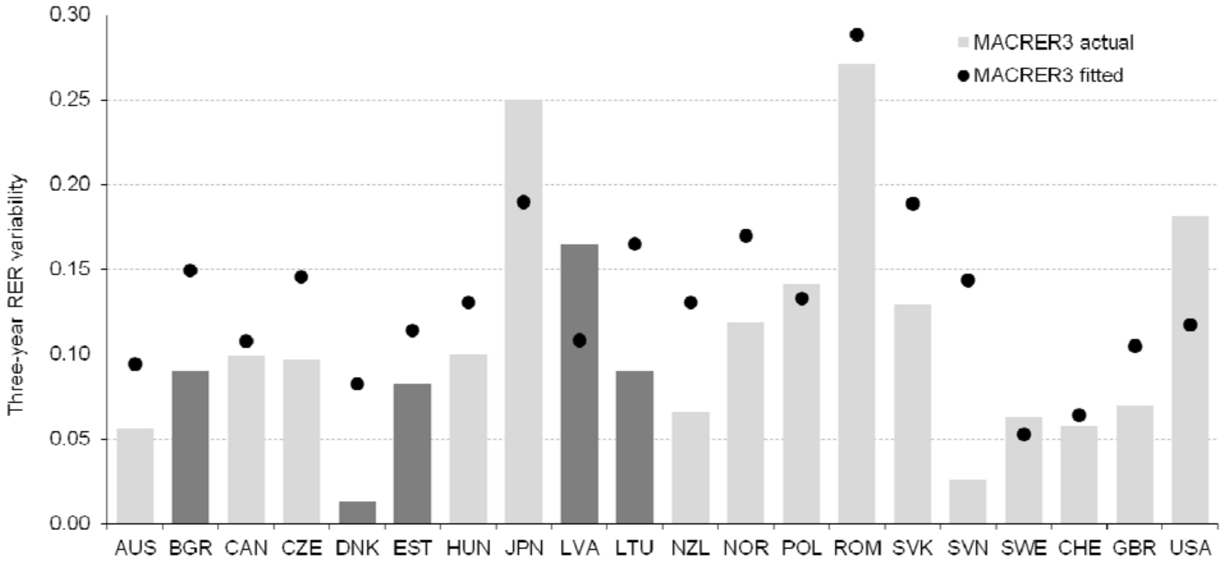
6. Explaining the Real Exchange Rate Variability

Having estimated specification (3), we are now ready to take a closer look at the main determinants of the three-year RER variability for individual pairs of economies. To narrow down the number of economy pairs being discussed, we will focus on RERs vis-à-vis the euro, that is, we will focus on pairs in which one of the two economies is the euro area (but the coefficients and residuals that we will use are those implied by the estimation of (3) for the whole sample). With 21 economies in the sample, this implies focusing on 20 real exchange rates; we will call these the "euro real exchange rates." The extent to which we are able to explain the three-year RER variability of the euro real exchange rates is illustrated by Figure 3.

[14] Two other remedies one might consider assume that the left-hand-side variable is truncated or censored. Alas, neither of these two assumptions would be an appropriate representation of reality, since the construction of *MACRER3* involves neither losing any observations (as with truncation), nor losing the true values of some of the observations (as with censoring).

[15] The basis here is the IMF de facto classification of exchange rate regimes (see the appendices of IMF Annual Reports in the relevant years). Up to 2004 the Latvian currency was pegged to the SDR, where the weight of the euro was about 40%; the currency was pegged to the euro only as from 2005 (i.e., for the last four years of our sample period). Nevertheless, for simplicity, in the regressions we take the currency as a peg to the euro.

Figure 3: Actual and Fitted Values of the Three-Year RER Variability of the Euro Real Exchange Rates, Based on Estimation of (3)



Source: Authors' computations.

Note: Darker bars correspond to cases where some form of de facto fixed exchange rate regime was applied to the nominal exchange rate over (most of) the period 1999–2008.

The five out of the 20 euro real exchange rates whose nominal counterparts were managed during (most of) our sample period within some sort of fixed exchange rate regime (see the previous section) are shown in Figure 3 with darker bars. Not surprisingly, for these particular rates, the fitted values of the RER variability tend to be higher than the actual ones, i.e., the residual tends to be negative.[16] In other words, when measuring RER variability, even the focus on three-year periods is probably not enough to ensure that the RER behavior will be completely free of monetary policy choices.

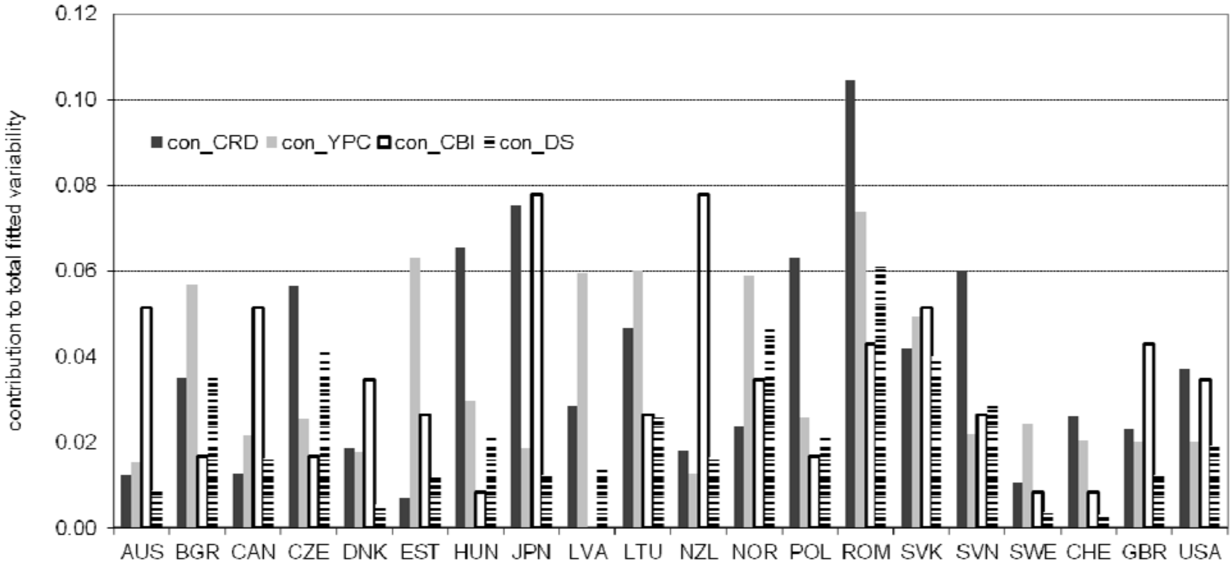
As a matter of fact, negative residuals are prevalent in the euro exchange rate group more generally: the residual is positive for five exchange rates only (those against the currencies of Japan, Latvia, Poland, Sweden, and the USA) and the fitted value is, on average for all the euro exchange rates, about 24% lower than the actual one. This may give the impression of a poor fit of the model as regards euro exchange rates. In fact, however, the analogue of the R-squared (namely, 1-RSS/TSS) is 0.47 within the group of euro exchange rates, which is substantially more than the 0.34 reported in Table 2 for the sample as a whole. In other words, our model fit is considerably better for observations in which the euro is involved than for the sample as a whole. In economic terms, the predominantly negative residuals for the euro exchange rates give a fairly intuitive indication that non-fundamental (exchange rate market-generated) shocks are relatively weak and/or infrequent in markets involving the euro compared to the other exchange rate markets in our sample.

Moving now to the more specific question of the relative strength of the key "culprits" in determining the three-year RER variability, the main findings for the euro real exchange rates are summarized in Figure 4.

---

[16] The exception is Latvia, whose currency, however, was pegged strictly to the euro for the last four years of the sample period only.

Figure 4: Components of the Fitted Value of the Three-Year Variability of the Euro Real Exchange Rates, Based on Estimation of (3)



Source: Authors' computations.
Note: For the sake of simplicity, the contribution of the constant is not shown as it is very small.

The figure indicates that even within the group of euro real exchange rates, the composition of the contributions from the four factors under study differs perceptibly, depending on which particular exchange rate we look at. For example, differences from the euro area as regards *FIN* and *DS*, or financial development and structure of the economy, during the sample period had a strong impact for the three-year variability of the euro real exchange rate vis-à-vis the Czech koruna but almost none for that vis-à-vis the Swedish krona.

Despite all these differences, however, the average contribution of the four culprits across the euro area exchange rates is fairly even: it lies between roughly 0.033 and 0.038 for *FIN* (financial development), *YPC* (income convergence), and *CBI* (central bank independence), and is about 0.22 for *DS* (structure of the economy). It is thus not true that the explanation of the RER variability caused by these four culprits is driven primarily by just one or two of them.

7. Conclusion

In this paper we try to shed some light on the extent to which asymmetric shocks, as reflected in real exchange rate variability, are due to fundamental factors versus pressures from the exchange rate market itself. In order to be able to largely abstract from the influence of rigidities and macroeconomic policies, we strive to explain the behavior of the real exchange rate in the medium term, namely, three years. Our list of explanatory variables has 22 items: one of them is mutual trade links (which should dampen any existing asymmetric shocks), while the rest are dissimilarities between the two economies under consideration. We take a sample of 21 advanced and late-transition economies in the period 1999–2008 and use the Bayesian model averaging technique to identify the specification that is most likely to be true. We also briefly discuss the issue of possible non-normality and spatial autocorrelation of the data.

Our empirical findings can be summarized as follows. The true model determining the medium-term real exchange rate variability is most likely to contain four types of dissimilarities within a given pair of economies: dissimilarities as regards (1) financial development, (2) per capita income growth, (3) central bank independence, and (4) the structure of the economy.

These four factors explain about one third of the behavior of the three-year RER variability for the whole sample and almost half of the behavior of the three-year RER variability for the 20 real exchange rates involving specifically the euro. In the logic of our approach, then, about two thirds of the behavior of the medium-term RER variability in the whole sample is an estimate of the influence of non-fundamental factors (together with the influence of relevant fundamentals not captured by the regressors used), that is, of the exchange rate market itself. Specifically for real exchange rates involving the euro, the split between fundamental and non-fundamental (or fundamental but omitted) factors is about even.

References

ANSELIN, L. (1992): "SpaceStat Tutorial: A Workbook for Using SpaceStat in the Analysis of Spatial Data." Mimeo, University of Illinois, Urbana-Champaign.

ARNONE, M., B. J. LAURENS, J.-F. SEGALOTTO, AND M. SOMMER (2007): "Central Bank Autonomy: Lessons from Global Trends." IMF WP 07/88.

ARPAIA, A. AND G. MOURRE (2005): "Labour Market Institutions and Labour Market Performance: A Survey of the Literature." European Economy – Economic Papers 238, Directorate General Economic and Monetary Affairs (DG ECFIN), European Commission.

AUDZEI, V. AND F. BRÁZDIK (2012): "Monetary Policy and Exchange Rate Dynamics: The Exchange Rate as a Shock Absorber." CNB WP 9/2012.

BAYOUMI, T. AND B. EICHENGREEN (1997A): "Ever Closer to Heaven? An Optimum-Currency-Area Index for European Countries." *European Economic Review* 41, pp. 761–770.

BAYOUMI, T. AND B. EICHENGREEN (1997B): "Optimum Currency Areas and Exchange Rate Volatility: Theory and Evidence Compared." In Cohen, B. J. (ed.): *International Trade and Finance New Frontiers for Research: Essays in Honor of Peter Kenen*. Cambridge University Press.

BAYOUMI, T. AND B. EICHENGREEN (1998): "Exchange Rate Volatility and Intervention: Implications of the Theory of Optimum Currency Areas." *Journal of International Economics* 45(2), pp. 191–209.

BÉNASSY-QUÉRÉ, A. AND A. LAHRÉCHE-RÉVIL (2000): "The Euro as a Monetary Anchor in the CEECs." *Open Economies Review* 11, pp. 303–321.

BLANCHARD, O. J. AND D. QUAH (1989): "The Dynamic Effects of Aggregate Demand and Supply Disturbances." *American Economic Review* 79(4), pp. 655–673.

BORGHIJS, A. AND L. KUIJS (2004): "Exchange Rates in Central Europe: A Blessing or a Curse?" IMF WP 2/04.

BUITER, W. (2000): "Optimal Currency Areas: Scottish Economic Society/Royal Bank of Scotland Annual Lecture 1999." *Scottish Journal of Political Economy* 47(3), pp. 213–249.

CALMFORS, L. AND J. DRIFFILL (1988): "Bargaining Structure, Corporatism and Macroeconomic Performance." *Economic Policy* 6, pp. 13–61.

CHINN, M. AND S.-J. WEI (2013): "A Faith-Based Initiative Meets the Evidence: Does a Flexible Exchange Rate Regime Really Facilitate Current Account Adjustment?" *Review of Economics and Statistics* 95(1), pp. 168–184.

CHOR, D. AND R. FREEMAN (2005): "The 2004 Global Labor Survey: Workplace Institutions and Practices Around the World." NBER WP 11598.

CINCIBUCH, M. AND D. VAVRA (2001): “Toward the European Monetary Union: A Need for Exchange Rate Flexibility?” *Eastern European Economics* 39(6), pp. 23–64.

CLARIDA, R. AND J. GALI (1994): “Sources of Real Exchange Rate Fluctuations: How Important Are Nominal Shocks?” NBER WP 4658.

DE GRAUWE, P. (2009): *Economics of Monetary Integration*. 8th ed. Oxford University Press.

DE GREGORIO, J., A. TOKMAN, AND R. VALDÉS (2005): “Flexible Exchange Rate with Inflation Targeting in Chile: Experience and Issues.” Inter-American Development Bank Research Department Working Papers, 4427.

DEVEREUX, M. B. (2004): “Should the Exchange Rate Be a Shock Absorber?” *Journal of International Economics* 62, pp. 359–377.

DINCER, N. N. AND B. EICHENGREEN (2007): “Central Bank Transparency: Where, Why, and With What Effects?” NBER WP 13003.

EDWARDS, S. (2006): “The Relationship between Exchange Rates and Inflation Targeting Revisited.” NBER WP 12163.

EICHER, T. S., C. PAPAGEORGIOU, AND A. E. RAFTERY (2011): “Default Priors and Predictive Performance in Bayesian Model Averaging, With Application to Growth Determinants.” *Journal of Applied Econometrics* 26, pp. 30-55.

ENGEL, C. AND A. K. ROSE (2000): “Currency Unions and International Integration.” NBER WP 7872.

FLEMING, M. (1962): “Domestic Financial Policies under Fixed and under Floating Exchange Rates.” *International Monetary Fund Staff Papers* 9, pp. 369–379.

GHOSH, A., A.-M. GULDE, AND H. WOLF (2002): *Exchange Rate Regimes: Choices and Consequences*. Cambridge, MA, MIT Press.

GROSS, D. AND A. HOBZA (2003): “Exchange Rate Variability as an OCA Criterion: Are the Candidates Ripe for Euro?” International Center for Economic Growth, San Francisco, Working Paper 23.

GWARTNEY, J., J. HALL, AND R. LAWSON (2012): “Economic Freedom of the World: 2012 Report.” Fraser Institute.

HAUSMANN, R., U. PANIZZA, AND E. STEIN (2001): “Why Do Countries Float the Way They Float?” *Journal of Development Economics* 66, pp. 387–414.

HOETING, J. A., M. MADIGAN, A. E. RAFTERY, AND C. T. VOLINSKY (1999): “Bayesian Model Averaging: A Tutorial” (with Comments by M. Clyde, David Draper and E. I. George, and a Rejoinder by the Authors). *Statistical Science* 14(4), pp. 382–417.

HORVÁTH, R. (2005): "Exchange Rate Variability, Pressures and Optimum Currency Area Criteria: Lessons for the Central and Eastern European Countries." CNB WP 8/2005.

HORVÁTH, R. AND L. KOMÁREK (2002): "Theory of Optimum Currency Areas: A Framework on Discussion about Monetary Integration." *Finance a uver* 52(7–8), pp. 386–407 [in Czech].

HORVÁTH, R. AND Z. KUČEROVÁ (2005): "Real Exchange Rates and Optimum Currency Areas: Evidence from Developed Economies." *Czech Journal of Economics and Finance* 55(5–6), pp. 253–265.

HOWELL, D., D. BAKER, A. GLYN, AND J. SCHMITT (2007): "Are Protective Labour Market Institutions at the Root of Unemployment? A Critical Review of the Evidence." *Capitalism and Society* 2(1), pp. 1–71.

KAUFMANN, D. AND A. KRAAY (2007): "Governance Indicators: Where Are We, Where Should We Be Going?" World Bank Policy Research Working Paper, 4370.

KENNEDY, M. AND T. SLØK (2005): "Are Structural Reforms the Answer to Global Current Account Imbalances?" *OECD Economic Studies*, OECD Publishing, vol. 2005(2), pp. 47–73.

KONTOLEMIS, Z. G. AND K. ROSS (2005): "Exchange Rate Fluctuations in the New Member States of the European Union." Economics Working Paper Archive, series Macroeconomics, 0504015.

LARRAÍN, F. AND J. TAVARES (2003): "Regional Currencies versus Dollarization: Options for Asia and the Americas." *Journal of Policy Reform* 6(1), pp. 35–49.

LASTRAPES, W. D. (1992): "Sources of Fluctuations in Real and Nominal Exchange Rates." *Review of Economics and Statistics* 74(3), pp. 530–539.

MACDONALD, R. (1998): "What Do We Really Know about Real Exchange Rates?" Oesterreichische Nationalbank Working Paper No. 28.

MADIGAN, D. AND J. YORK (1995): "Bayesian Graphical Models for Discrete Data." *International Statistical Review* 63(2), pp. 215–235.

MALISZEWSKA, M. AND W. MALISZEWSKI (2006): *The Exchange Rate: Shock Generator or Shock Absorber?* In Dabrowski, M., Rostowski, J. (eds.): The Eastern Enlargement of the Eurozone. Springer.

MAUREL, M. AND G. SCHNABL (2011): "Keynesian and Austrian Perspectives on Crisis, Shock Adjustment, Exchange Rate Regime and (Long-Term) Growth." Documents de travail du Centre d'Economie de la Sorbonne, 2011/04.

MELTZER, A. (1993): "Real Exchange Rates: Some Evidence for the Postwar Years." In: Dimensions of Monetary Policy. Proceedings of the Seventeenth Annual Economic Policy Conference of the Fed of St. Louis, Federal Reserve Bank of St. Louis Review, March/April 1993.

MORAL-BENITO, E. (2012): "Model Averaging in Economics." Banco de Espana, Documentos de Trabajo, 1123.

MUNDELL, R. (1961): "A Theory of Optimum Currency Areas." *American Economic Review* 51, pp. 657–665.

MUNDELL, R. (1962): "The Appropriate Use of Monetary and Fiscal Policy for Internal and External Stability." *International Monetary Fund Staff Papers* 9(1), pp. 70–79.

MUSSA, M. (1986): "Nominal Exchange Rate Regimes and the Behaviour of Real Exchange Rates: Evidence and Implications." *Carnegie-Rochester Conference Series on Public Policy* 25, pp. 117–213.

NORTH, D. C. (1990): *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

OBSTFELD, M. (1985): "Floating Exchange Rates: Experience and Prospects." *Brookings Papers on Economic Activity* 2, pp. 369–450.

PARTISIWI, T. AND N. A. ACHSANI (2010): "Testing the Feasibility of ASEAN+3 Single Currency Comparing Optimum Currency Area and Clustering Approach." *International Research Journal of Finance and Economics* 37, pp. 79–84.

SKOREPA, M. (2011): "A Convergence-Sensitive Optimum-Currency-Area Index." Institute of Economic Studies Working Paper No. 23/2011, Faculty of Social Sciences, Charles University, Prague.

SKOREPA, M. (2013): "Troubles in the Euro Area Periphery: The View through the Lens of a Simple Convergence-Sensitive Optimum Currency Area Index." *Czech Journal of Economics and Finance* 63(2), pp. 129–151.

SNODGRASS, D. (2008): "Alternative Business Enabling Environment Rankings: A Review." USAID/Business Growth Initiative.

STAZKA, A. (2006): "Sources of Real Exchange Rate Fluctuations in Central and Eastern Europe: Temporary or Permanent?" CESifo Working Paper No. 1876.

STOCKMAN, A. C. (1983): "Real Exchange Rates under Alternative Nominal Exchange-Rate Systems." *Journal of International Money and Finance* 2(2), pp. 147–166.

ZEUGNER, S. (2011): "Bayesian Model Averaging with BMS." http://bms.zeugner.eu.

Appendix

Table A1: List of All Independent Variables

No.	Label	Description	Source	Use
1	*DS*	structure of GDP (agriculture, industry, services)	WDI	dissimilarity
2	*DC*	structure of exports (nine SITC categories)	ComTrade	dissimilarity
3	*DE*	structure of employment (agriculture, industry, services)	WDI	dissimilarity
4	*YPC*	growth rate of GDP per capita (current international dollars, PPP)	WDI	dissimilarity
5	*MIS*	international migrant stock as % of population	WDI	dissimilarity
6	*PRP*	regulatory restrictions on sale of real property	EFW	dissimilarity
7	*REI*	rigidity of employment index	WDI	dissimilarity
8	*UNE*	rate of unemployment	WDI	dissimilarity
9	*USL*	long-term unemployment as % of total unemployment	WDI	dissimilarity
10	*CEN*	wage bargaining: centralization	ICTWSS	dissimilarity
11	*COO*	wage bargaining: level of coordination	ICTWSS	dissimilarity
12	*COW*	wage bargaining: coverage	ICTWSS	dissimilarity
13	*LEV*	wage bargaining: dominant level	ICTWSS	dissimilarity
14	*TUD*	trade union density	ICTWSS	dissimilarity
15	*BBS*	general government structural budget balance	WEO	dissimilarity
16	*CBI*	central bank independence (at end of 2003)	Arnone	dissimilarity
17	*CBT*	central bank transparency	Dincer	dissimilarity
18	*GVT*	role of government enterprises and investment	EFW	dissimilarity
19	*LEG*	integrity of legal system	EFW	dissimilarity
20	*FIN*	financial development	EFW	dissimilarity
21	*BUR*	business regulations	EFW	dissimilarity
22	*TIN*	exports to other economy as % of GDP	DOTS	average

Abbreviations:

Arnone = Arnone et al. (2007), summary index (full index, overall); Arnone et al. actually label their index Central Bank Autonomy but we use Central Bank Independence to avoid confusion with autonomy in the sense of a non-fixed exchange rate regime in which the domestic monetary policy stance has some room to accommodate shocks rather than having to mimick the stance of the relevant foreign central bank(s).

ComTrade = United Nations' ComTrade database

Dincer = Dincer and Eichengreen (2009)

DOTS = International Monetary Fund's Direction of Trade Statistics database (via Datastream)

EFW = Fraser Institute's Economic Freedom of the World database (where our *FIN* is labeled Credit Market Regulations)

ICTWSS = Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts (Amsterdam Institute for Advanced Labour Studies, University of Amsterdam)

WDI = World Bank's World Development Indicators database (via Datastream and World Bank website)

WEO = International Monetary Fund's World Economic Outlook database (via Datastream)

Note: All variables also involve the authors' calculations. Construction of the variables follows.

Construction of the variables

$$DS_i = \frac{1}{T}\sum_{t=1}^{T}\sum_{s=1}^{3}\left|share_{jt}^{s} - share_{kt}^{s}\right| ,$$

where: i indexes all the pairs of economies in the sample,
t indexes all the years in the sample period ($T = 10$ for the period 1999–2008),
j and k are the two economies forming pair i,
$share^s$ is the share of a given economy's agricultural (divisions 1–5 of ISIC, rev. 3), industry (divisions 15–37 of ISIC, rev. 3), and service (divisions 50–99 of ISIC, rev. 3) output in that economy's total value added.

$$DC_i = \frac{1}{T}\sum_{t=1}^{T}\sum_{c=1}^{9}\left|share_{jt}^{c} - share_{kt}^{c}\right| ,$$

where: i, t, j, and k have the same meaning as in DS_i,
$share^c$ is the share of a given economy's exports within single-digit SITC category c in that economy's total merchandise exports.

$$DE_i = \frac{1}{T}\sum_{t=1}^{T}\sum_{s=1}^{3}\left|share_{jt}^{e} - share_{kt}^{e}\right| ,$$

where: i, t, j, and k have the same meaning as in DS_i,
$share^s$ is the share of a given economy's agricultural (divisions 1–5 of ISIC, rev. 3), industry (divisions 15–37 of ISIC, rev. 3), and service (divisions 50–99 of ISIC, rev. 3) sector in that economy's total employment.

$$YPC_i = \frac{1}{T}\sum_{t=1}^{T}\left|\Delta \log GDPpc_{jt} - \Delta \log GDPpc_{kt}\right| ,$$

where: i, t, j, and k have the same meaning as in DS_i,
$GDPpc$ is GDP per capita based on PPP in current international dollars.

$$TIN_i = \frac{1}{T}\sum_{t=1}^{T}(share_{jkt} + share_{kjt})/2 ,$$

where: i, t, j, and k have the same meaning as in DS_i,
$share_{lm}$ is the share of economy l's exports to economy m in economy l's GDP.

$$MIS_i = \frac{1}{T}\sum_{t=1}^{T}\left|MIS_{jt} - MIS_{kt}\right| ,$$

where: i, t, j, and k have the same meaning as in DS_i.
MIS is the international migrant stock as % of the population.

The value, for economies j and k, of each of the remaining independent variables is constructed from the respective values for j and k analogously to how MIS_i is constructed from MIS_{jt} and MIS_{kt}.

Table A2: BMA (UIP Random) Estimation of Specification (2), Using All 22 Regressors

	PIP	Post mean	Post SD
FIN	**0.999**	**0.699**	**0.153**
YPC	**0.980**	**1.429**	**0.448**
CBI	**0.950**	**0.121**	**0.043**
LEG	**0.682**	**-0.109**	**0.086**
BUR	**0.565**	**-0.160**	**0.161**
DE	0.448	0.048	0.061
DS	0.437	0.069	0.089
PRP	0.188	-0.014	0.033
TIN	0.114	0.000	0.000
COW	0.109	0.000	0.000
TUD	0.106	0.000	0.000
DC	0.072	-0.002	0.007
UNE	0.061	0.013	0.070
GVT	0.061	0.003	0.015
LEV	0.055	-0.001	0.003
MIS	0.046	-0.003	0.024
CBT	0.041	0.000	0.001
USL	0.041	-0.001	0.012
BBS	0.039	0.007	0.063
COO	0.037	0.000	0.001
REI	0.036	-0.001	0.008
CEN	0.033	0.001	0.009
Dependent variable	*MACRER3*		
Draws	4,000,000		
Burn-ins	2,000,000		
No. models visited	1,063,589		
Model space	4,194,304		

Note: Variables with PIP > 0.5 are printed in bold.

Table A3: BMA Estimation of Regression (2), Random Model Prior, LEG and BUR Dropped

Coefficient prior: BRIC		Coefficient prior: HQ		Coefficient prior: RIC	
Variable	PIP	Variable	PIP	Variable	PIP
FIN	**0.989**	***FIN***	**0.991**	***FIN***	**0.989**
YPC	**0.965**	***YPC***	**0.968**	***YPC***	**0.964**
CBI	**0.887**	***CBI***	**0.917**	***CBI***	**0.889**
DS	**0.503**	***DS***	**0.636**	***DS***	**0.506**
PRP	0.172	*PRP*	0.428	*PRP*	0.170
TUD	0.130	*TUD*	0.409	*TUD*	0.129
COW	0.124	*COW*	0.401	*COW*	0.124
TIN	0.097	*TIN*	0.265	*TIN*	0.097
USL	0.091	*LEV*	0.197	*USL*	0.093
DE	0.062	*MIS*	0.175	*DE*	0.062
MIS	0.052	*USL*	0.171	*MIS*	0.053
LEV	0.048	*DE*	0.115	*LEV*	0.049
GVT	0.039	*GVT*	0.114	*GVT*	0.039
DC	0.038	*DC*	0.104	*DC*	0.037
COO	0.023	*COO*	0.068	*COO*	0.023
UNE	0.023	*UNE*	0.057	*UNE*	0.023
BBS	0.019	*CEN*	0.051	*REI*	0.019
CEN	0.019	*REI*	0.051	*CEN*	0.019
REI	0.019	*BBS*	0.049	*BBS*	0.018
CBT	0.017	*CBT*	0.046	*CBT*	0.018

Note: Variables with PIP > 0.5 are printed in bold.

Table A4: BMA (Uniform UIP) Estimation of Regression (2), LEG and BUR Dropped

Variable	PIP	Post mean
FIN	**0.995**	**0.605**
YPC	**0.969**	**1.110**
CBI	**0.920**	**0.109**
TUD	**0.724**	**-0.001**
COW	**0.714**	**0.001**
DS	**0.701**	**0.112**
PRP	**0.700**	**-0.075**
TIN	0.425	0.000
LEV	0.365	-0.007
MIS	0.299	-0.048
USL	0.220	-0.016
GVT	0.181	0.011
DE	0.158	0.009
DC	0.154	-0.003
COO	0.109	-0.001
UNE	0.082	-0.008
CEN	0.077	0.002
REI	0.075	-0.001
BBS	0.073	0.009
CBT	0.068	0.000

Note: Variables with PIP > 0.5 are printed in bold.

Table A5: BMA (Random UIP) Estimation of Regression (2), LEG and BUR Dropped

Dep. var.: MACRER2		Dep. var.: MACRER4	
Variable	PIP	Variable	PIP
CBI	**0.949**	***FIN***	**0.989**
FIN	**0.886**	***YPC***	**0.965**
YPC	**0.869**	***CBI***	**0.841**
DE	0.382	***DS***	**0.816**
BUR	0.345	*PRP*	0.249
TIN	0.232	*USL*	0.221
TUD	0.187	*TUD*	0.140
DS	0.179	*MIS*	0.119
COW	0.136	*COW*	0.116
PRP	0.118	*LEV*	0.100
GVT	0.089	*DC*	0.098
MIS	0.049	*TIN*	0.074
DC	0.046	*DE*	0.065
USL	0.045	*UNE*	0.052
UNE	0.040	*COO*	0.047
LEV	0.039	*GVT*	0.037
REI	0.029	*BBS*	0.036
CEN	0.028	*REI*	0.031
BBS	0.028	*CEN*	0.030
COO	0.027	*CBT*	0.030
CBT	0.026		

Note: Variables with PIP > 0.5 are printed in bold.

Table A6: Regression Results for Several Alternative Specifications

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
CRD	0.760***	0.530***	0.621***	0.283	3.486***	0.563***	0.485***	0.514***
	0.139	0.129	0.129	0.092	0.878	0.137	0.128	0.141
YPC	1.544***	1.156***	1.077***	1.103***	8.176***	1.276***	1.666***	1.793***
	0.351	0.338	0.328	0.249	2.385	0.369	0.370	0.398
CBI	0.132***	0.141***	0.113***	0.081	0.974***	0.128***	0.117***	0.116***
	0.037	0.039	0.039	0.027	0.262	0.040	0.038	0.039
DS	0.166***	0.170***	0.134**	0.127*	1.152***	0.169***	0.116**	0.116**
	0.056	0.058	0.056	0.042	0.366	0.058	0.055	0.055
LEG	-0.117**							
	0.046							
BUR	-0.198**							
	0.086							
COW		0.000	0.001***					
		0.000	0.000					
PRP			-0.101***					
			0.034					
TUD			-0.001***					
			0.000					
trn1						-0.015		-0.012
						0.013		0.014
trn2						-0.021*		-0.007
						0.012		0.013
fix1							-0.040***	-0.038***
							0.010	0.011
fix2							-0.023	-0.027
							0.025	0.028
rho				0.026***				
				0.001				
_cons	0.015	-0.001	0.022	-0.095***	-3.037***	0.013	0.021	0.021
	0.014	0.017	0.018	0.011	0.114	0.015	0.013	0.014
adj. R-squared	0.38	0.33	0.37	not available	0.27	0.33	0.39	0.39

Note: The dependent variable is *MACRER3* in all columns except column E, where it is ln(*MACRER3*); *** significant at 1%, ** at 5%, and * at 10% level of significance. Robust standard errors are reported below the estimates.

CNB WORKING PAPER SERIES

12/2013	Michal Skořepa Luboš Komárek	*Sources of asymmetric shocks: The exchange rate or other culprits?*
11/2013	Alexis Derviz	*Collateral composition, diversification risk, and systemically important merchant banks*
10/2013	Tomáš Konečný Oxana Babecká Kucharčuková	*Evaluating the links between the financial and real sectors in a small open economy: The case of the Czech Republic*
9/2013	Michal Franta	*The effect of non-linearity between credit conditions and economic activity on density forecasts*
8/2013	Jan Babecký Tomáš Havránek	*Structural reforms and economic growth: A meta-analysis*
7/2013	Michal Andrle Jan Brůha Serhat Solmaz	*Inflation and output comovement in the Euro Area: Love at second sight?*
6/2013	Marek Rusnák	*Nowcasting Czech GDP in real time*
5/2013	Tomáš Havránek Roman Horváth Petra Valičková	*Financial development and economic growth: A meta-analysis*
4/2013	Peter Tóth	*Currency shocks to export sales of importers: A heterogeneous firms model and Czech micro estimates*
3/2013	Aleš Bulíř Jaromír Hurník Kateřina Šmídková	*Inflation reports and models: How well do central banks really write?*
2/2013	František Brázdik	*Expected regime change: Transition toward nominal exchange rate stability*
1/2013	Adam Geršl Jitka Lešanovská	*Explaining the Czech interbank market risk premium*
15/2012	Róbert Ambriško Jan Babecký Jakub Ryšánek Vilém Valenta	*Assessing the impact of fiscal measures on the Czech economy*
14/2012	Václav Hausenblas Ivana Kubicová Jitka Lešanovská	*Contagion risk in the Czech financial system: A network analysis and simulation approach*
13/2012	Michal Franta	*Macroeconomic effects of fiscal policy in the Czech Republic: Evidence based on various identification approaches in a VAR framework*
12/2012	Konstantin Belyaev Aelita Belyaeva Tomáš Konečný Jakub Seidler Martin Vojtek	*Macroeconomic factors as drivers of LGD prediction: Empirical evidence from the Czech Republic*
11/2012	Adam Geršl Petr Jakubík Tomáš Konečný Jakub Seidler	*Dynamic stress testing: The framework for testing banking sector resilience used by the Czech National Bank*
10/2012	Tomáš Havránek Marek Rusnák	*Transmission lags of monetary policy: A meta-analysis*

9/2012	Volha Audzei František Brázdik	*Monetary policy and exchange rate dynamics: The exchange rate as a shock absorber*
8/2012	Alexis Derviz Jakub Seidler	*Coordination incentives in cross-border macroprudential regulation*
7/2012	Peter Claeys Bořek Vašíček	*Measuring sovereign bond spillover in Europe and the impact of rating news*
6/2012	Michal Franta Jan Libich Petr Stehlík	*Tracking monetary-fiscal interactions across time and space*
5/2012	Roman Horváth Jakub Seidler Laurent Weill	*Bank capital and liquidity creation: Granger causality evidence*
4/2012	Jaromír Baxa Miroslav Plašil Bořek Vašíček	*Changes in inflation dynamics under inflation targeting? Evidence from Central European countries*
3/2012	Soňa Benecká Tomáš Holub Narcisa Liliana Kadlčáková Ivana Kubicová	*Does central bank financial strength matter for inflation? An empirical analysis*
2/2012	Adam Geršl Petr Jakubík Dorota Kowalczyk Steven Ongena José-Luis Peydró Alcalde	*Monetary conditions and banks' behaviour in the Czech Republic*
1/2012	Jan Babecký Kamil Dybczak	*Real wage flexibility in the European Union: New evidence from the labour cost data*
15/2011	Jan Babecký Kamil Galuščák Lubomír Lízal	*Firm-level labour demand: Adjustment in good times and during the crisis*
14/2011	Vlastimil Čadek Helena Rottová Branislav Saxa	*Hedging behaviour of Czech exporting firms*
13/2011	Michal Franta Roman Horváth Marek Rusnák	*Evaluating changes in the monetary transmission mechanism in the Czech Republic*
12/2011	Jakub Ryšánek Jaromír Tonner Osvald Vašíček	*Monetary policy implications of financial frictions in the Czech Republic*
11/2011	Zlatuše Komárková Adam Geršl Luboš Komárek	*Models for stress testing Czech banks´ liquidity risk*
10/2011	Michal Franta Jozef Baruník Roman Horváth Kateřina Šmídková	*Are Bayesian fan charts useful for central banks? Uncertainty, forecasting, and financial stability stress tests*
9/2011	Kamil Galuščák Lubomír Lízal	*The impact of capital measurement error correction on firm-level production function estimation*

8/2011	Jan Babecký Tomáš Havránek Jakub Matějů Marek Rusnák Kateřina Šmídková Bořek Vašíček	*Early warning indicators of economic crises: Evidence from a panel of 40 developed countries*
7/2011	Tomáš Havránek Zuzana Iršová	*Determinants of horizontal spillovers from FDI: Evidence from a large meta-analysis*
6/2011	Roman Horváth Jakub Matějů	*How are inflation targets set?*
5/2011	Bořek Vašíček	*Is monetary policy in the new EU member states asymmetric?*
4/2011	Alexis Derviz	*Financial frictions, bubbles, and macroprudential policies*
3/2011	Jaromír Baxa Roman Horváth Bořek Vašíček	*Time-varying monetary-policy rules and financial stress: Does financial instability matter for monetary policy?*
2/2011	Marek Rusnák Tomáš Havránek Roman Horváth	*How to solve the price puzzle? A meta-analysis*
1/2011	Jan Babecký Aleš Bulíř Kateřina Šmídková	*Sustainable real exchange rates in the new EU member states: What did the Great Recession change?*
15/2010	Ke Pang Pierre L. Siklos	*Financial frictions and credit spreads*
14/2010	Filip Novotný Marie Raková	*Assessment of consensus forecasts accuracy: The Czech National Bank perspective*
13/2010	Jan Filáček Branislav Saxa	*Central bank forecasts as a coordination device*
12/2010	Kateřina Arnoštová David Havrlant Luboš Růžička Peter Tóth	*Short-term forecasting of Czech quarterly GDP using monthly indicators*
11/2010	Roman Horváth Kateřina Šmídková Jan Zápal	*Central banks´ voting records and future policy*
10/2010	Alena Bičáková Zuzana Prelcová Renata Pašaličová	*Who borrows and who may not repay?*
9/2010	Luboš Komárek Jan Babecký Zlatuše Komárková	*Financial integration at times of financial instability*
8/2010	Kamil Dybczak Peter Tóth David Voňka	*Effects of price shocks to consumer demand. Estimating the QUAIDS demand system on Czech Household Budget Survey data*
7/2010	Jan Babecký Philip Du Caju Theodora Kosma Martina Lawless Julián Messina Tairi Rõõm	*The margins of labour cost adjustment: Survey evidence from European firms*

6/2010	Tomáš Havránek Roman Horváth Jakub Matějů	*Do financial variables help predict macroeconomic environment? The case of the Czech Republic*
5/2010	Roman Horváth Luboš Komárek Filip Rozsypal	*Does money help predict inflation? An empirical assessment for Central Europe*
4/2010	Oxana Babecká Kucharčuková Jan Babecký Martin Raiser	*A gravity approach to modelling international trade in South-Eastern Europe and the Commonwealth of Independent States: The role of geography, policy and institutions*
3/2010	Tomáš Havránek Zuzana Iršová	*Which foreigners are worth wooing? A Meta-analysis of vertical spillovers from FDI*
2/2010	Jaromír Baxa Roman Horváth Bořek Vašíček	*How does monetary policy change? Evidence on inflation targeting countries*
1/2010	Adam Geršl Petr Jakubík	*Relationship lending in the Czech Republic*
15/2009	David N. DeJong Roman Liesenfeld Guilherme V. Moura Jean-Francois Richard Hariharan Dharmarajan	*Efficient likelihood evaluation of state-space representations*
14/2009	Charles W. Calomiris	*Banking crises and the rules of the game*
13/2009	Jakub Seidler Petr Jakubík	*The Merton approach to estimating loss given default: Application to the Czech Republic*
12/2009	Michal Hlaváček Luboš Komárek	*Housing price bubbles and their determinants in the Czech Republic and its regions*
11/2009	Kamil Dybczak Kamil Galuščák	*Changes in the Czech wage structure: Does immigration matter?*
10/2009	Jiří Böhm Petr Král Branislav Saxa	*Perception is always right: The CNB´s monetary policy in the media*
9/2009	Alexis Derviz Marie Raková	*Funding costs and loan pricing by multinational bank affiliates*
8/2009	Roman Horváth Anca Maria Podpiera	*Heterogeneity in bank pricing policies: The Czech evidence*
7/2009	David Kocourek Filip Pertold	*The impact of early retirement incentives on labour market participation: Evidence from a parametric change in the Czech Republic*
6/2009	Nauro F. Campos Roman Horváth	*Reform redux: Measurement, determinants and reversals*
5/2009	Kamil Galuščák Mary Keeney Daphne Nicolitsas Frank Smets Pawel Strzelecki Matija Vodopivec	*The determination of wages of newly hired employees: Survey evidence on internal versus external factors*
4/2009	Jan Babecký	*Downward nominal and real wage rigidity: Survey evidence from*

	Philip Du Caju Theodora Kosma Martina Lawless Julián Messina Tairi Rõõm	*European firms*
3/2009	Jiri Podpiera Laurent Weill	*Measuring excessive risk-taking in banking*
2/2009	Michal Andrle Tibor Hlédik Ondra Kameník Jan Vlček	*Implementing the new structural model of the Czech National Bank*
1/2009	Kamil Dybczak Jan Babecký	*The impact of population ageing on the Czech economy*
14/2008	Gabriel Fagan Vitor Gaspar	*Macroeconomic adjustment to monetary union*
13/2008	Giuseppe Bertola Anna Lo Prete	*Openness, financial markets, and policies: Cross-country and dynamic patterns*
12/2008	Jan Babecký Kamil Dybczak Kamil Galuščák	*Survey on wage and price formation of Czech firms*
11/2008	Dana Hájková	*The measurement of capital services in the Czech Republic*
10/2008	Michal Franta	*Time aggregation bias in discrete time models of aggregate duration data*
9/2008	Petr Jakubík Christian Schmieder	*Stress testing credit risk: Is the Czech Republic different from Germany?*
8/2008	Sofia Bauducco Aleš Bulíř Martin Čihák	*Monetary policy rules with financial instability*
7/2008	Jan Brůha Jiří Podpiera	*The origins of global imbalances*
6/2008	Jiří Podpiera Marie Raková	*The price effects of an emerging retail market*
5/2008	Kamil Dybczak David Voňka Nico van der Windt	*The effect of oil price shocks on the Czech economy*
4/2008	Magdalena M. Borys Roman Horváth	*The effects of monetary policy in the Czech Republic: An empirical study*
3/2008	Martin Cincibuch Tomáš Holub Jaromír Hurník	*Central bank losses and economic convergence*
2/2008	Jiří Podpiera	*Policy rate decisions and unbiased parameter estimation in conventionally estimated monetary policy rules*
1/2008	Balázs Égert Doubravko Mihaljek	*Determinants of house prices in Central and Eastern Europe*
17/2007	Pedro Portugal	*U.S. unemployment duration: Has long become longer or short become shorter?*
16/2007	Yuliya Rychalovská	*Welfare-based optimal monetary policy in a two-sector small open economy*
15/2007	Juraj Antal	*The effects of anticipated future change in the monetary policy*

	František Brázdik	*regime*
14/2007	Aleš Bulíř Kateřina Šmídková Viktor Kotlán David Navrátil	*Inflation targeting and communication: Should the public read inflation reports or tea leaves?*
13/2007	Martin Cinncibuch Martina Horníková	*Measuring the financial markets' perception of EMU enlargement: The role of ambiguity aversion*
12/2007	Oxana Babetskaia-Kukharchuk	*Transmission of exchange rate shocks into domestic inflation: The case of the Czech Republic*
11/2007	Jan Filáček	*Why and how to assess inflation target fulfilment*
10/2007	Michal Franta Branislav Saxa Kateřina Šmídková	*Inflation persistence in new EU member states: Is it different than in the Euro area members?*
9/2007	Kamil Galuščák Jan Pavel	*Unemployment and inactivity traps in the Czech Republic: Incentive effects of policies*
8/2007	Adam Geršl Ieva Rubene Tina Zumer	*Foreign direct investment and productivity spillovers: Updated evidence from Central and Eastern Europe*
7/2007	Ian Babetskii Luboš Komárek Zlatuše Komárková	*Financial integration of stock markets among new EU member states and the euro area*
6/2007	Anca Pruteanu-Podpiera Laurent Weill Franziska Schobert	*Market power and efficiency in the Czech banking sector*
5/2007	Jiří Podpiera Laurent Weill	*Bad luck or bad management? Emerging banking market experience*
4/2007	Roman Horváth	*The time-varying policy neutral rate in real time: A predictor for future inflation?*
3/2007	Jan Brůha Jiří Podpiera Stanislav Polák	*The convergence of a transition economy: The case of the Czech Republic*
2/2007	Ian Babetskii Nauro F. Campos	*Does reform work? An econometric examination of the reform-growth puzzle*
1/2007	Ian Babetskii Fabrizio Coricelli Roman Horváth	*Measuring and explaining inflation persistence: Disaggregate evidence on the Czech Republic*
13/2006	Frederic S. Mishkin Klaus Schmidt-Hebbel	*Does inflation targeting make a difference?*
12/2006	Richard Disney Sarah Bridges John Gathergood	*Housing wealth and household indebtedness: Is there a household 'financial accelerator'?*
11/2006	Michel Juillard Ondřej Kameník Michael Kumhof Douglas Laxton	*Measures of potential output from an estimated DSGE model of the United States*
10/2006	Jiří Podpiera Marie Raková	*Degree of competition and export-production relative prices when the exchange rate changes: Evidence from a panel of Czech exporting companies*

9/2006	Alexis Derviz Jiří Podpiera	*Cross-border lending contagion in multinational banks*
8/2006	Aleš Bulíř Jaromír Hurník	*The Maastricht inflation criterion: "Saints" and "Sinners"*
7/2006	Alena Bičáková Jiří Slačálek Michal Slavík	*Fiscal implications of personal tax adjustments in the Czech Republic*
6/2006	Martin Fukač Adrian Pagan	*Issues in adopting DSGE models for use in the policy process*
5/2006	Martin Fukač	*New Keynesian model dynamics under heterogeneous expectations and adaptive learning*
4/2006	Kamil Dybczak Vladislav Flek Dana Hájková Jaromír Hurník	*Supply-side performance and structure in the Czech Republic (1995–2005)*
3/2006	Aleš Krejdl	*Fiscal sustainability – definition, indicators and assessment of Czech public finance sustainability*
2/2006	Kamil Dybczak	*Generational accounts in the Czech Republic*
1/2006	Ian Babetskii	*Aggregate wage flexibility in selected new EU member states*

14/2005	Stephen G. Cecchetti	*The brave new world of central banking: The policy challenges posed by asset price booms and busts*
13/2005	Robert F. Engle Jose Gonzalo Rangel	*The spline GARCH model for unconditional volatility and its global macroeconomic causes*
12/2005	Jaromír Beneš Tibor Hlédik Michael Kumhof David Vávra	*An economy in transition and DSGE: What the Czech national bank's new projection model needs*
11/2005	Marek Hlaváček Michael Koňák Josef Čada	*The application of structured feedforward neural networks to the modelling of daily series of currency in circulation*
10/2005	Ondřej Kameník	*Solving SDGE models: A new algorithm for the sylvester equation*
9/2005	Roman Šustek	*Plant-level nonconvexities and the monetary transmission mechanism*
8/2005	Roman Horváth	*Exchange rate variability, pressures and optimum currency area criteria: Implications for the central and eastern European countries*
7/2005	Balázs Égert Luboš Komárek	*Foreign exchange interventions and interest rate policy in the Czech Republic: Hand in glove?*
6/2005	Anca Podpiera Jiří Podpiera	*Deteriorating cost efficiency in commercial banks signals an increasing risk of failure*
5/2005	Luboš Komárek Martin Melecký	*The behavioural equilibrium exchange rate of the Czech koruna*
4/2005	Kateřina Arnoštová Jaromír Hurník	*The monetary transmission mechanism in the Czech Republic (evidence from VAR analysis)*
3/2005	Vladimír Benáček Jiří Podpiera Ladislav Prokop	*Determining factors of Czech foreign trade: A cross-section time series perspective*

2/2005	Kamil Galuščák Daniel Münich	*Structural and cyclical unemployment: What can we derive from the matching function?*
1/2005	Ivan Babouček Martin Jančar	*Effects of macroeconomic shocks to the quality of the aggregate loan portfolio*
10/2004	Aleš Bulíř Kateřina Šmídková	*Exchange rates in the new EU accession countries: What have we learned from the forerunners*
9/2004	Martin Cincibuch Jiří Podpiera	*Beyond Balassa-Samuelson: Real appreciation in tradables in transition countries*
8/2004	Jaromír Beneš David Vávra	*Eigenvalue decomposition of time series with application to the Czech business cycle*
7/2004	Vladislav Flek, ed.	*Anatomy of the Czech labour market: From over-employment to under-employment in ten years?*
6/2004	Narcisa Kadlčáková Joerg Keplinger	*Credit risk and bank lending in the Czech Republic*
5/2004	Petr Král	*Identification and measurement of relationships concerning inflow of FDI: The case of the Czech Republic*
4/2004	Jiří Podpiera	*Consumers, consumer prices and the Czech business cycle identification*
3/2004	Anca Pruteanu	*The role of banks in the Czech monetary policy transmission mechanism*
2/2004	Ian Babetskii	*EU enlargement and endogeneity of some OCA criteria: Evidence from the CEECs*
1/2004	Alexis Derviz Jiří Podpiera	*Predicting bank CAMELS and S&P ratings: The case of the Czech Republic*

CNB RESEARCH AND POLICY NOTES

2/2013	Jan Brůha Tibor Hlédik Tomáš Holub Jiří Polanský Jaromír Tonner	*Incorporating judgments and dealing with data uncertainty in forecasting at the Czech National Bank*
1/2013	Oxana Babecká Kucharčuková Michal Franta Dana Hájková Petr Král Ivana Kubicová Anca Podpiera Branislav Saxa	*What we know about monetary policy transmission in the Czech Republic: Collection of empirical results*
3/2012	Jan Frait Zlatuše Komárková	*Macroprudential policy and its instruments in a small EU economy*
2/2012	Zlatuše Komárková Marcela Gronychová	*Models for stress testing in the insurance sector*

1/2012	Róbert Ambriško Vítězslav Augusta Dana Hájková Petr Král Pavla Netušilová Milan Říkovský Pavel Soukup	*Fiscal discretion in the Czech Republic in 2001-2011: Has it been stabilizing?*
3/2011	František Brázdik Michal Hlaváček Aleš Maršál	*Survey of research on financial sector modelling within DSGE models: What central banks can learn from it*
2/2011	Adam Geršl Jakub Seidler	*Credit growth and capital buffers: Empirical evidence from Central and Eastern European countries*
1/2011	Jiří Böhm Jan Filáček Ivana Kubicová Romana Zamazalová	*Price-level targeting – A real alternative to inflation targeting?*
1/2008	Nicos Christodoulakis	*Ten years of EMU: Convergence, divergence and new policy priorities*
2/2007	Carl E. Walsh	*Inflation targeting and the role of real objectives*
1/2007	Vojtěch Benda Luboš Růžička	*Short-term forecasting methods based on the LEI approach: The case of the Czech Republic*
2/2006	Garry J. Schinasi	*Private finance and public policy*
1/2006	Ondřej Schneider	*The EU budget dispute – A blessing in disguise?*
5/2005	Jan Stráský	*Optimal forward-looking policy rules in the quarterly projection model of the Czech National Bank*
4/2005	Vít Bárta	*Fulfilment of the Maastricht inflation criterion by the Czech Republic: Potential costs and policy options*
3/2005	Helena Sůvová Eva Kozelková David Zeman Jaroslava Bauerová	*Eligibility of external credit assessment institutions*
2/2005	Martin Čihák Jaroslav Heřmánek	*Stress testing the Czech banking system: Where are we? Where are we going?*
1/2005	David Navrátil Viktor Kotlán	*The CNB's policy decisions – Are they priced in by the markets?*
4/2004	Aleš Bulíř	*External and fiscal sustainability of the Czech economy: A quick look through the IMF's night-vision goggles*
3/2004	Martin Čihák	*Designing stress tests for the Czech banking system*
2/2004	Martin Čihák	*Stress testing: A review of key concepts*
1/2004	Tomáš Holub	*Foreign exchange interventions under inflation targeting: The Czech experience*

CNB ECONOMIC RESEARCH BULLETIN	
November 2013	*Macroeconomic effects of fiscal policy*
April 2013	*Transmission of monetary policy*
November 2012	*Financial stability and monetary policy*
April 2012	*Macroeconomic forecasting: Methods, accuracy and coordination*
November 2011	*Macro-financial linkages: Theory and applications*
April 2011	*Monetary policy analysis in a central bank*
November 2010	*Wage adjustment in Europe*
May 2010	*Ten years of economic research in the CNB*
November 2009	*Financial and global stability issues*
May 2009	*Evaluation of the fulfilment of the CNB's inflation targets 1998–2007*
December 2008	*Inflation targeting and DSGE models*
April 2008	*Ten years of inflation targeting*
December 2007	*Fiscal policy and its sustainability*
August 2007	*Financial stability in a transforming economy*
November 2006	*ERM II and euro adoption*
August 2006	*Research priorities and central banks*
November 2005	*Financial stability*
May 2005	*Potential output*
October 2004	*Fiscal issues*
May 2004	*Inflation targeting*
December 2003	*Equilibrium exchange rate*

Czech National Bank
Economic Research Department
Na Příkopě 28, 115 03 Praha 1
Czech Republic
phone: +420 2 244 12 321
fax: +420 2 244 14 278
http://www.cnb.cz
e-mail: research@cnb.cz
ISSN 1803-7070