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External Monetary Shocks to Central and Eastern European Countries

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Abstract

Few countries are part of the European Union but on the verge of the Euro-zone. This study aims at identifying the amplitude of the direct ECB monetary policy impact, that is the so-called international monetary spillovers, in Central and Eastern European countries (CEECs). The use of a panel-VAR method allows to deal with the small time span and endogeneity. We found that CEECs tend to significantly come close in monetary terms to the ECB standards. We focus on the exchange rate regime as a vector to justify different reactions. The exchange rate regime plays a small significant role looking at prices but no role when the focus is put on real variables such as GDP or price. Adopting an anchored strategy responds before all to institutional issues. The monetary credibility is the result of macroeconomic reforms implemented during the last 25 years.

Keywords

Monetary policy, International spillovers, Euro-zone integration, Panel VAR.

JEL Codes

C23, E52, F42.

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1 Introduction

Since the first EU integration process concerning the Central and Eastern European Countries (CEECs), in 2004, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovenia and Slovakia already joined the EMU, the latter one being Lithuania in January 2015. The six remaining countries, on the verge of the Euro-area, are Bulgaria, Croatia, Czech Republic, Hungary, Poland and Romania. Two of them, Poland and Romania, the biggest, are particularly of interest as they both represent strong economic issues, demographic and migration challenges (Poland and Romania together represent a 15% demographic increase for the EMU).
Over the last quarter-century, Poland and Romania have had a 6.4% per year average annual growth rate, while the European Monetary Union (EMU) poorly reached 3.3% per year; this last point reveals the high economic potential of the CEECs. While joining the EU, CEECs engaged in the middle term to fulfil EMU economic requirements.
However, being part of the EMU should not be a leitmotiv. The Euro, as a currency, must be perceived as a step, part of the transition and the growth process. Policies should focus on developing solid and coherent macroeconomic structures.
Many ways exist for the CEECs to join the EMU such that efficient political choices differ and are heterogeneous. From a monetary perspective, Bulgaria and Croatia decided to stay close to the ECB development; both gave up totally or partially their monetary independence by adopting respectively a currency board and a crawling peg regime. Since 2001, Hungary opts for a crawling peg regime but with huge bands ($+/-15\%$). Poland, in 1998, opted, like Romania and Czech Republic, for an inflation targeting (IT) strategy. Inflation targeting, as a tool of monetary policy, is one of the main determinants allowing to maintain price stability while allowing for a framework to the domestic demand, encouraging exports and controlling for credit boom. Referring to the trilemma literature from Mundell-Fleming, a country must choose two options between the three-following: free capital movement, fixed exchange rate and independent monetary policy. By choosing IT, i.e. independent monetary policy, Poland engaged in a flexible exchange rate regime as free capital movement is a *sine qua non* condition to join the EU.
The development of the EMU is surrounded by a single monetary policy. Such a framework considers an efficient integration, once countries heterogeneity does not hold problems, to drive the monetary policy. This is possible thanks to coherent domestic policy mix. Countries, members of the EU and on the verge of the EMU, have a particular status and so need a specific attention. Indeed, while they are not part of the EMU, they suffer from

the ECB decisions. We expect macroeconomic policies to directly and significantly affect real variables in these countries. Even for countries which give up their monetary autonomy (Bulgaria and Croatia), CEEC's entered a complex process of integration closely linked to macroeconomic constraints. On the one hand, monetary challenges handle with price stabilization (i.e. control of the inflation rate) and exchange rate issues. On another hand, budgetary rules impose a public deficit under 3 percent of the GDP and a level of indebtedness not higher than 60 percent of the GDP. In this binding framework, are intertwined structural reforms and development programs, implemented to fully integrate the worldwide market economy.

Up to now, ECB policy do not explicitly consider the specific characteristics of the CEECs as they are not yet part of the EMU. The goal of this paper is to deal with the ECB monetary policy impacts on CEECs. Three points may explain such impacts. First, concerning fixed exchange rate regime, countries directly "import" the ECB monetary policy. Second, countries with a more flexible exchange rate regime, suffer from the terms of trade variation induced by the ECB shock. Third, domestic monetary policy is hampered by euroisation, inducing for instance a weaker interest rate channel (Stojanović and Stojanović, 2016; Velickovski, 2013).

The literature concerning the monetary policy is not new neither from a European point of view (Dornbusch et al., 1998; Mihov and Scott, 2001; Angeloni et al., 2005; Jarocinski, 2010) nor concerning international spillovers (Calvo et al., 1993; Canova and Ciccarelli, 2009; Maćkowiak, 2007). Nevertheless, little has been done concerning the international monetary spillovers inside the European Union and even less looking at the middle term persistence of monetary shocks. The most recent monetary literature mainly focuses on monetary spillovers to the financial sector (Bruno and Shin, 2015; Barroso et al., 2016) or adopt the usual country-by-country perspective (Babecká Kucharčuková et al., 2016).

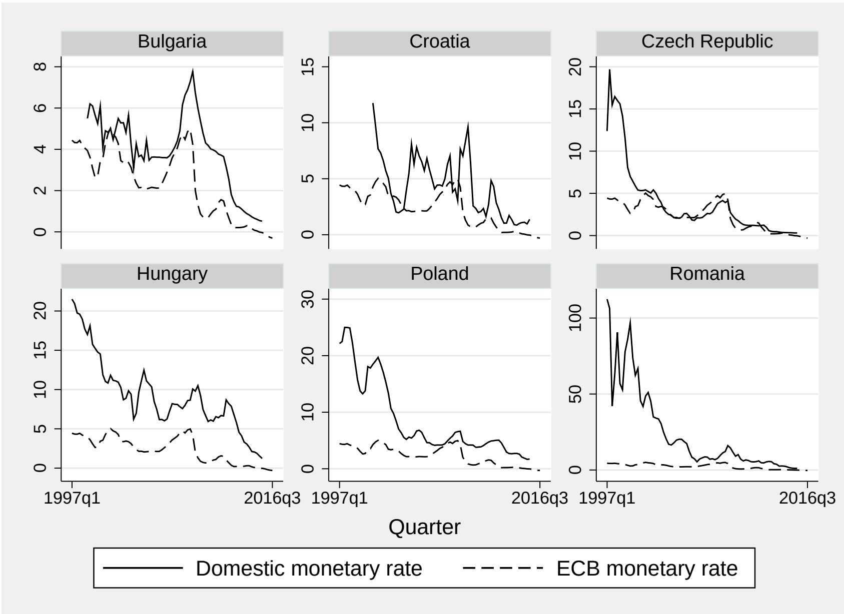
Our paper provides more than an up-to-date analysis of the existing literature. Indeed, here is proposed not to study each country but a block of country through a panel-VAR; the main goal is to determine to what extend CEECs react to the ECB monetary policy both in the short run thanks to impulse response function but also in the middle term through the forecasted error variance decomposition. We focus on the CEECs, given their common characteristics (historical background, political changes, demographic trends, GDP growth rates)and split our panel according to their exchange rate regime. We consider two groups of countries, those which already joined the EMU (plus Bulgaria and Croatia) and those still on the verge (which have preferred a flexible exchange rate regime). We also try to understand whether the six last CEECs out of the Euro-zone highlight an increase of

their interdependence with the ECB during the last decade. We compare their evolution with their peers.
Our results do not highlight huge differences in terms of monetary spillovers when the distinction is made between the two exchange rate regime strategies. EU but not yet EMU members are found to react to ECB shocks but these reactions are of small magnitude. Not surprisingly, the ECB rate is more accurate to explain the volatility in the domestic variables of pegged regimes compared to floating economies. The results corroborates the monetary efficiency after the first decade of the transition. The specific choice of an 'anchored' regime does not lead to stronger results but confirm the efficient strategies of the different countries, given their own characteristics. A specific focus at the end-of-period provides information about new perspectives, that have been emerging since the political and economic European turmoil.
The section 2 of this paper gives some stylized facts. The section 3 proposes a review of the existing literature. The section 4 explains the econometrical approach and the data; then, the rest of the paper is divided in two sections; the section 5 describes the main results and the section 6 concludes.

2 Stylized facts

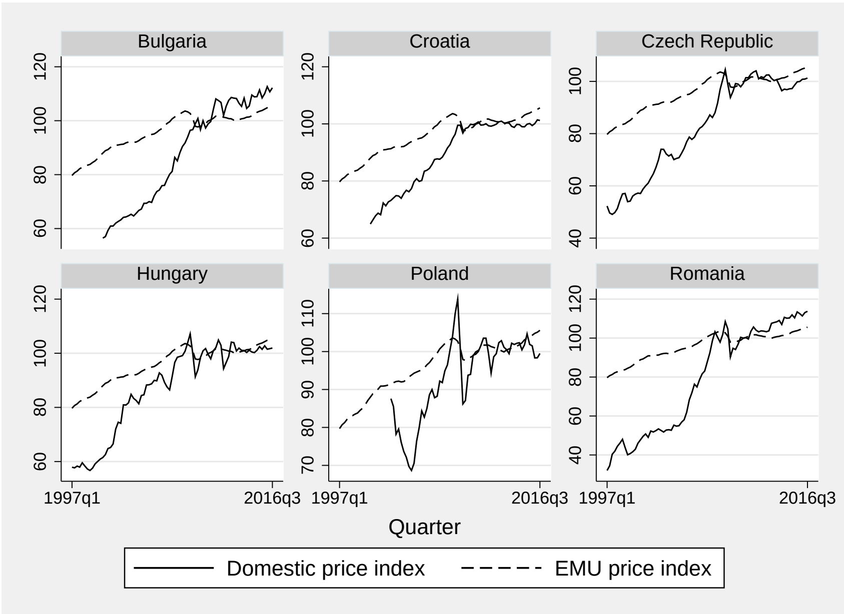
Figure (1) highlights the gap decline between the different domestic money market rates compared to the ECB one. Such facts may be the result of prominent structural reforms, implemented by the CEECs during their transition process, leading to an increase of trust and credibility. Indeed, restoring the monetary institution credibility was one of the main first targets for the CEECs, in order to justify and implement hereafter the budgetary reforms and their long term investment programs. It also reflects the CEECs ambition to join as quickly as possible the monetary union. The changes in the domestic rates are particularly impressive concerning Romania as the volatility sharply decreased. In less than fifteen years, the BNR (National Bank of Romania) succeeded in driving an efficient monetary policy in terms of volatility in the domestic rate.
The second variable concerning the monetary policy is the price index evolution. The six challenging countries display good results, concerning their inflation rate evolution. Indeed, one institutional challenge, following the liberalization during the nineties, was to fight the high volatility on prices, which was inducing too many uncertainty to enter coherent structural reforms.
Figure (2) represents each CEECs price index evolution compared to the

Figure 1: 3-month money market interest rates



EMU one. For most countries, we conclude of a price increase more in line with the Euro-area trend among the end of the period. Indeed, the trends are widely smoothed. However, we should bare in mind economic circumstances. Cheap imports from China, low food and oil prices are part of the improvement. Also, domestic reforms, such as changes in VAT rates, as the ones observed in Romania in 2013, 2015 and even more recently, in January 2016, must be considered. These changes helped a lot, in decreasing inflation and do not have to lead to spurious analysis.
The evolution of the GDP index is smoother in the EMU (figure 3). The impact of the economic crisis is more pronounced in the CEECs, particularly in Croatia, the index falls from 110 in 2008 to 97 in 2013. Czech Republic, Hungary and Romania suffered a break in the series at the beginning of the crisis but quickly returned to their increasing trend. Poland, as the EMU, do not exhibit such a break in the GDP index, only a non-persistent slowdown. Despite a less important decline of the Bulgaria GDP index, this last one appears to be long lasting.

Figure 2: Price index

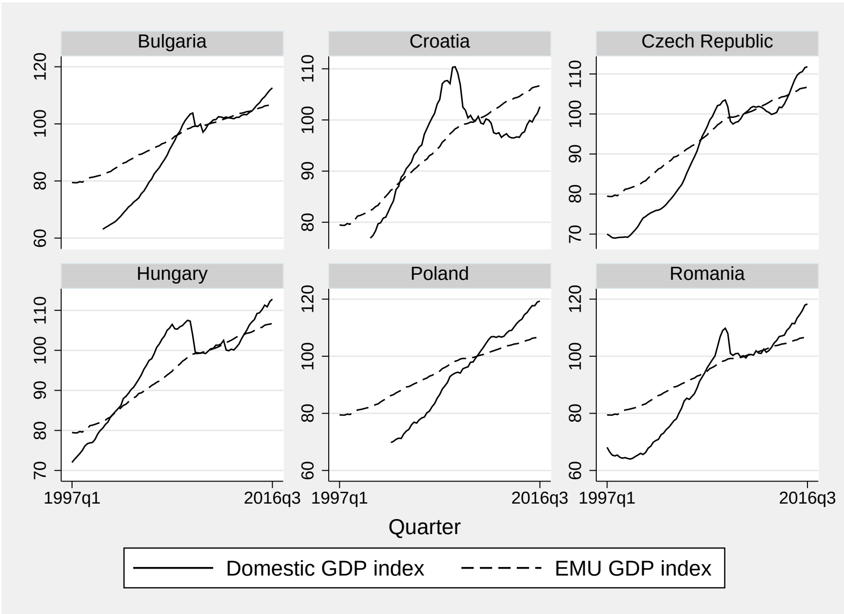


3 Literature

Thanks to models, like those developed by Mundell (1961), Fleming (1962) and Dornbusch (1976), expansionary monetary policy, through a drop in the main interest rate, leads to an increase of output as it favours investment (the price of capital declines). The MFD approach considers a recession abroad after a domestic monetary expansion. In case of an economic union like the EU, conditioned by the Maastricht criteria and the monetary middle term EMU accession, we expect a positive correlation in the CEECs to ECB decision, as a result of increased inter-dependence and the presence of a common market.

Clarida et al. (2002), based on a two-countries sticky price intertemporal model, highlighted the necessity, for small open economies to integrate, in their Taylor rules, the monetary policy shocks of developed economies; indeed those shocks directly affect their economic conditions, through the so called 'international monetary spillovers'. This 'new keynesian model' is in line with the arguments developed by Obstfeld and Rogoff (1996) [ch.10] and Walsh (2010) [ch.9]. Referring to Walsh (2010): *'The spillover effect of the output gap on inflation in the other country gives rise, in general, to gains from policy coordination'*. According to them, coordination leads to a welfare

Figure 3: GDP index



increase. This follows the idea that the output increase, in a given country, stimulates the domestic demand for foreign goods. The common market is expected to increase this effect

Kim (2001) studied the impact of a USA monetary shock on different OECD countries. A VAR model, with real GDP, a GDP deflator, a price index and the Federal funds rate, allows to understand endogenous phenomena. An expansionary monetary policy induces an economic boom elsewhere; the increase of exports and imports is possible through the world capital market channel. In our European perspective, the common market and the free capital movement inside the union, represent the perfect empirical situation that correspond to Kim (2001) conclusion.

Maćkowiak (2007) goes further in concluding that when the 'US sneeze, emerging countries catch a cold'. He implemented a country by country VAR model, focusing on reactions to Fed shock in Latin America and Asian countries. If Kim (2001) was not able to find any conclusive results, Maćkowiak (2007) explains that emerging countries, contrary to OECD countries, are more vulnerable to external shocks, such that impacts are easier to quantify. A recent IMF report from Osorio and Vesperoni (2015) gives details about the ECB policy impact on the financial sector, stronger in CEECs compared to other regions. These conclusions respond to Brada and Kutan (2001), who suggest to strengthen the financial sector, to obtain more coordination with the ECB policy.

Anzuini and Levy (2007) analysed the monetary policy in the CEECs. In order to join the EMU, countries have to highlight an overall similar reaction given their national banks strategies; the challenge is to enter an economic and monetary union while different business cycles persist. They implemented a country by country VAR model on Czech Republic, Hungary and Poland using measures of the industrial production, the consumer price, the interest rate, monetary aggregate and the exchange rate. They found some similar co-movement in the different economies.

But in the case of the CEECs, the monetary analysis cannot be separated from the euroisation issue. A more or less high degree of euroisation is a symptom justifying a direct impact from the ECB money market rates to real GDP or inflation in the CEECs. This explains the huge interest, for transition economies, to find the right equilibrium between macroeconomic policies control and institutional credibility. One way to deal with it, is to stay close to another currency to enjoy its stability, like the fixed exchange rate regime. In this case, the ECB monetary policy is imported from the EMU, political authorities concentrate on the budgetary policy.

Economies, like Scandinavians countries considered this strategy. As they are small open economies, the exchange rate channel of the monetary policy is important to determine the level of prices and production. The money market rate is not strong enough to draw by itself the orientation of the monetary policy. Moreover, the smaller the economy, the more efficient is the fixed regime, as the part of imported goods in the price index measure increases. Such a peg strategy, in this case, comes close to the price stability purpose.

Another way, while the monetary policy is kept autonomous, is to allow part of assets and loans to be denominated in Euro. This provides a higher security and a stronger stability to attract investors. But it hampers the transmission channel of the domestic monetary policy. Euroisation process is mainly used in case of high and unmanageable inflation (Brown et al., 2015). Once institutional credibility is restored, the authorities try to get back their influence on monetary policy. During the last decade, Broda and Yeyati (2006) and **?** noted some hysteresis of the euroisation, mainly from the demand side and so difficulties for central banks to recover their power.

4 Econometrical approach

A huge number of contemporaneous studies look at international monetary spillovers in their different forms and found an increasing role of the financial sector to explain interdependences (?Chen et al., 2016; Fratzscher et al., 2016; Rey, 2015). Focus on the CEECs is not new, especially thanks to the EMU development (Prettner and Prettner, 2014; Feldkircher, 2015; Moder, 2017).
Nevertheless, studying countries one by one, like Babecká Kucharčuková et al. (2016), has strong limitations due to the small time span of consistent data particularly concerning CEECs. To bypass the usual time series limitation, a panel approach has been preferred. The VAR specification, i.e. a dynamic panel model, using a LSDV[1] estimator, provides a powerful identification scheme to deal with both fixed effects issue and endogeneity (Bun and Kiviet, 2006).
The panel approach is widely used in empirical economic literature. Indeed, it allows a higher degree of freedom such that econometrical results appear to be more robust. The limitation of the panel is the homogeneity hypothesis. Despite different observed behaviours in the CEECs, in terms of policy choices, we consider our panel to fulfil the homogeneity hypothesis. Indeed, the CEECs have a similar historical and political background, during the cold-war period.
In the decade following the end of the communism supremacy, the different strategies, adopted by the CEECs government, do not hamper the homogeneity of the panel. As they entered the EU at the beginning of the XXI century, the CEECs had huge constraints before the accession in terms of political strategies (democracy, stability) and economical perspectives (competition, market economy). Moreover, the CEECs are *de facto* compelled to respect the Maastricht criteria as they also engaged the EMU accession process. The budgetary rules (ratio of public indebtedness, level of deficit) allow us to state a 'common' budgetary framework.
Moreover, the panel approach is more interesting, regarding the ECB decision process. The Euro-area is under a single monetary policy. This bar the ECB from implementing country specific decisions. Considering a group of countries allows us to disentangle whether the overall effect is consistent.

[1]LSDV: Least Square Dummy Variable

4.1 Econometric methodology

Up to now, the literature concerning monetary policy transmission and its spillovers is abundant. The commonly empirical approach is the use of a country by country VAR specification. This approach has been generalized by Sims (1980) and Engle and Granger (1987). Even though, those specifications are useful, it only provides statistical results; strong economic foundations may justify them (Stock and Watson, 2001). For Kim and Roubini (2000), VAR model alleviates the price puzzle sometimes found in the empirical international monetary spillovers literature (that is an increase of prices following a monetary contraction which is counter-intuitive according to the monetary policy theory).

The panel-VAR approach is particularly interesting as it overcomes usual econometric limitations. As recall Canova and Ciccarelli (2013), it captures the interdependencies both at a static or dynamic level. It is a useful tool to give some good interpretation of macroeconomic impacts of the monetary policy without modelling the global economy. As our panel exhibits a medium temporal dimension and a relatively small number of countries (6 to 12 countries), the panel with fixed effect specification (LSDV) is the most appropriated (Bun and Kiviet, 2006) and found to be consistent (Nickell, 1997).

The present model is a k variables panel VAR specification at order q with fixed effects:

$$Y_{it} = Y_{i(t-1)}\Gamma_1 + Y_{i(t-2)}\Gamma_2 + ... + Y_{i(t-q)}\Gamma_{q-1} + \omega_i + \varepsilon_{it} \tag{1}$$

where

$$i \in \{1, 2, ..., N\} \ \& \ t \in \{1, 2, ..., T_i\}$$

In equation (1), Y_{it} is a $(1 \times k)$ dimension vector containing all the dependent variables. The right side of the equation includes an individual fixed effects vector and a vector of idiosyncratic errors, respectively denominated as ω_i and ε_{it}. The different $(k \times k)$ dimension Γ matrices represent the parameters of the model to be estimated. Given the usual econometric hypothesis, the error term is supposed to behave in the following way: $E[\varepsilon_{it}] = 0, \ E[\varepsilon_{it}\varepsilon'_{it}] = \sigma, \ E[\varepsilon_{it}\varepsilon'_{ir}] = 0 \ \forall \ r < t$ The equation (1) in its reduce form:

$$Y_{it} = \Gamma(L)Y_{it} + \omega_i + \varepsilon_{it} \tag{2}$$

where $\Gamma(L)$ is a matrix polynomial of the lag operator; whereas the other elements remain unchanged. A crucial restriction is imposed in applying the VAR procedure under a panel database. The underlined structure is assumed to be the same for each cross-sectional unit. Fixed effects, introduced as ω_i

in the model, bypass this unrealistic assumption on parameters, thanks to the introduction of heterogeneity. Unfortunately, the problem is not entirely solved. The lags of the dependent variables induce regressors to be correlated with those fixed effects such that eliminating the fixed-effects through mean-differencing creates biased coefficients. The 'Helmert procedure' as the one described by Love and Zicchino (2006) solves the inconsistency by using forward mean-differencing. Only the mean of future observations is used to transform the variables. In a formal way, variables are transformed as follow:

$$\tilde{y}_{it}^{p} = \sqrt{\frac{T_i - t}{T_i - t + 1}} \left(y_{it}^{p} - \frac{1}{T_i - t} \sum_{r=t+1}^{T_i} y_{ir} \right) \tag{3}$$

As period differs for each country in the panel, T_i refers to the last available period for country 'i'. This procedure gives more weight to data close to the beginning of the period and no transformation is allowed on the last period as no future observation is available. The same transformation is applied on the error vector; indeed, given the assumptions of neither auto-correlation nor homoscedasticity, the procedure does not alter its characteristics. The following model is obtained:

$$\hat{Y}_{it} = \Gamma(L)\hat{Y}_{it} + \hat{\varepsilon}_{it} \tag{4}$$

This well-known procedure keeps the orthogonality between lagged regressors and the transformed variables; consistent lagged regressors are introduced as instruments. Instead of referring to the common use of Anderson and Hsiao (1982) and Arellano and Bover (1995) methods, estimating the model equation by equation, here the Holtz-Eakin et al. (1988) method is preferred; this last one is a system based approach. Indeed, it allows strong efficiency gains. To disentangle international spillovers, a first estimation with stationary variables is computed where the vector of endogenous variables is built as:

$$Y_{it} = \left(i_t^{ecb},\ fx_t,\ i_{it}^{dom},\ \Delta y_{it},\ \Delta p_{it} \right) \tag{5}$$

y refers to the real GDP index, p is the GDP deflator as a proxy of prices, i^{dom} is the real 3-month domestic money market rate, fx is the bilateral exchange rate Euro versus national currency and eventually i^{ecb} is the 3-month maturity EURo Interbank Offered Rate.

The key element in the use of VAR is the possibility to draw the impulse response function (IRF) and the variance decomposition of the error (FEVD). To do so, standard errors of the estimated coefficient are taken into account. The confidence interval set at 95 percent is computed thanks to 500 repetitions of the Monte Carlo simulation. To obtain the IRF, errors have to remain

orthogonal; that is a diagonal variance-covariance matrix. The Cholesky decomposition solves such a constraint. Indeed, the use of a specific ordering assumes the variable, in the first position, not to be contemporaneously impacted by the other variables in the model.
We consider the ECB rate as the most exogenous variable, as the NMS are not part of the ECB board. So the ECB rate is placed in first position. Then is introduced the bilateral exchange rate and the domestic interest rate. Here is supposed that national banks consider in their Taylor rule the ECB directions to draw their monetary policy. Therefore, the ECB rate may influence contemporarily the domestic rate but conversely is not true. This idea refers directly to Clarida et al. (2002). Finally, are added GDP measure and prices to obtain the impact on the the real economy.[2]

4.2 Data and preliminary investigation

To remain coherent with the existing literature and to draw comparison over time with previous studies, common used variables are introduced in this model. We use quarterly data[3] from 1995 to 2016 (depending on data availability) for twelve transition countries. Cyprus, Estonia, Latvia, Lithuania, Malta and Slovenia were chosen as they were EMU acceding countries not so far away. They were part of the Soviet block or exhibit the same economic background.[4] Hence, the homogeneity hypothesis of the panel may not be hurt. All the variables are downloaded from the Eurostat database (Eurostat, 2016). Table (1) summarizes each country characteristics. We use the real GDP at market prices, seasonally and calendar adjusted as a measure of output. The index considers chain linked volumes and equal 100 in 2010. For more convenience, it has been transformed in log-form. The impact on prices is captured through the GDP deflator as the implicit price for GDP (index 2010=100) also in log form(Kim, 2001; Gavin and Kemme, 2009).

[2]As no consensus exists concerning the causal ordering, we switched output and prices. No relevant changes are found such that we assume a good specification.

[3]To control for our results, the model has been implemented, using monthly data (with the Industrial Production Index and the HICP to consider respectively output and prices); results are in line with the quarterly specification.

[4]To draw an interesting comparison, we also wanted to study international monetary spillovers from the ECB to EU candidates. Unfortunately, lack of data do not allowed us to construct a robust and pertinent third group.

The 3-month Euribor[5][6] ECB rate and the 3-month domestic interest rate are used to consider, respectively the ECB and the domestic monetary policies (Minea and Rault, 2011).
Reynard (2007) justifies these choices as rates paid on deposits are rigid and change only when there is a persistent change in the interest rate on the market. Moreover, the 3-month interest rate fits particularly well to the Taylor rule and reflects the credit market stance.[7] Last we introduce the foreign exchange rate corresponding to the bilateral exchange rate Euro versus national currency.[8] The table (2) sums up the different variables previously introduced with their respective integration order.

4.3 Econometrical issues

The variables in the VAR model must be integrated of the same order. To control for it, the Im-Pesaran-Shin (IPS) test has been implemented (Im et al., 2003). This test has been preferred as it release the homogeneity hypothesis. Dealing with stationary variables is possible once output and prices are transformed in first difference[9]. The ECB rate, the domestic rate and the foreign exchange rate are kept in level but are de-trended using the Hodrick-Prescott filter.

[5]It has become a usual approach to include non-conventional measures of the monetary policy, especially when analyzing spillovers to the financial market as the policy rate is closed to zero (Aysan et al., 2015; Takats and Vela, 2014). A recent analysis from Ammer et al. (2016) mentions that spillovers between conventional and non-conventional policies are nearly the same; they are not introduced in this analysis.

[6]We use as a robustness check, the shadow rate, to indirectly count for unconventional policy and once again, overall results remain unchanged. The shadow rate follows the method of Wu and Xia (2016), data are available on Quandl website (www.quandl.com/data/SHADOWS/EUROPE-European-Central-Bank-Shadow-Rate)

[7]Different maturities are used as robustness checks. Results highlight almost the same behaviour, they are not presented here.

[8]As a robustness, we substitute the real effective exchange rate against the foreign exchange rate; results do not present a different conclusion.

[9]As both variables are in log-form, we obtain their growth rate which are stationary

Table 1: Countries characteristics

Country name	Data availability	Number of periods	EMU member	Exchange rate regime
Slovenia	1998q2 - 2006q4	35	2007	Pegged*
Cyprus	1999q1 - 2007q4	32	2008	Pegged*
Malta	2000q2 - 2008q1	28	2008	Pegged*
Estonia	1996q1 - 2010q4	56	2011	Pegged*
Latvia	1997q3 - 2013q4	61	2014	Pegged*
Lithuania	1999q1 - 2014q4	60	2015	Pegged*
Bulgaria	2000q1 - 2016q2	62	No	Currency board
Croatia	2000q2 - 2015q3	61	No	Soft peg
Czech Republic	1996q2 - 2015q3	77	No	Managed - IT**
Hungary	1995q2 - 2015q3	81	No	Floating - IT
Poland	2002q2 - 2015q3	50	No	Free floating - IT
Romania	1995q3 - 2015q3	80	No	Floating - IT

* Corresponds to the exchange rate regime before the EMU accession.

** IT refers to the Inflation Targeting strategy.

Table 2: Variables Summary

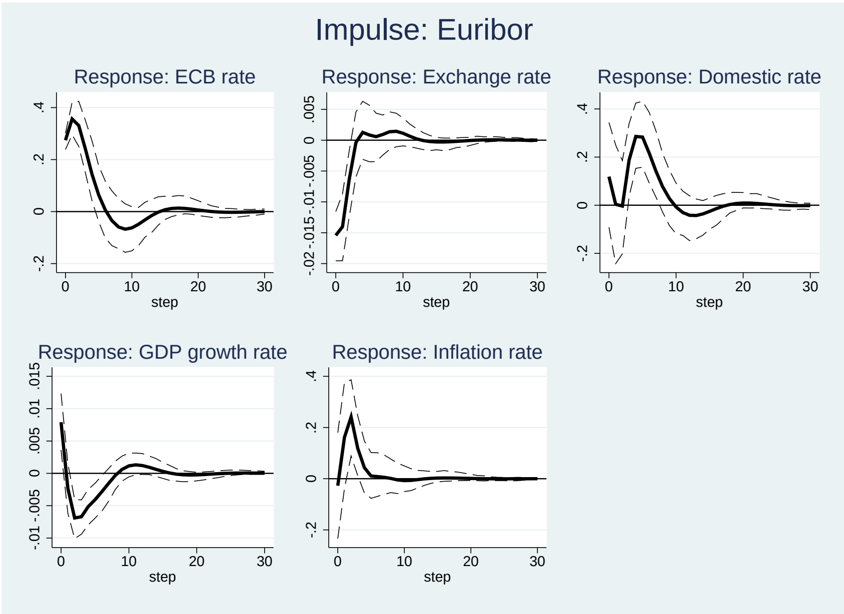
Variable	Description	Level of integration
Output	Real GDP index	I(1)
Prices	Implicit price for GDP index	I(1)
ECB rate	Euribor - 3-month maturity	I(0) de-trended
Domestic rate	3-month money market interest rate	I(0) de-trended
Exchange rate	Foreign exchange rate Euro /NC	I(0) de-trended

5 Results

5.1 The impulse response functions

In this section, we present the results of the different models. Figures transcript the impulse response up to thirty periods (7.5 years), of the four endogenous variables after the simulation of a positive shock on the ECB rate. The positive impulse corresponds to a monetary policy contraction. According to the theory, such a contraction may induce a decrease in both output and prices. The lag order has been chosen according to the minimization of the Hannan-Quinn criteria. Indeed, following Ivanov and Kilian (2005), the HQ criteria fits better when dealing with monthly and quarterly data.

Figure 4: Flexible regime countries



Note: The solid lines are the impulse response functions whereas, the dashed one represent the 95 percent confidence interval; Errors are generated with 500 repetitions of Monte Carlo.

Output and prices, in the model, correspond respectively to their growth rate. We present three main estimations, corresponding to countries under floating regime, countries pegged to the EMU and last a focus on floating economies after the economic 2008 breakdown.

The first estimation, figure (4), considers the panel of flexible exchange rate regime economies, namely Czech Republic, Hungary, Poland and Romania, on the overall period. We found the exchange rate to positively slightly react in the very short run while the interest rate also respond to the ECB monetary shock within a small delay from two to eleven quarters. However, both reactions, of little magnitude become not significant in the year following the shock. These first results corroborate some other empirical studies highlighting a significant, persistent and sufficiently wide effect to be taken into consideration (Clarida et al., 2002; Gavin and Kemme, 2009). The domestic rate increase is in line with expectations; the non-immediate response refers to institutional delays. Domestic national banks interpret the ECB rate change as permanent and consistent with some lags.

The GDP growth rate reacts positively in the short run. This counterintu-

itive positive impact on the GDP growth in case of a contractionary monetary policy is also found by Minea and Rault (2011) and can be interpreted as even more integrated economies in the EU. Agents anticipate a future increase in their domestic rates as their monetary policy goes close to the ECB one. This positive differential on interest rates favours the domestic one, in the very short run, inducing investment to increase and so the GDP. Then the output measure goes back to its long term trajectory.
We observe an almost not significant price puzzle at the begining of the period. This has been already found by Jarocinski (2010). The price puzzle quickly disappears. Different ways to deal with price puzzles are studied in the literature such as considering a different lag order or using another measure as a proxy for prices.[10] The overall reaction on prices growth rate may be explained by an 'aggressive' policy mix against inflation as previously mentioned (graph 2). Indeed, implemented policies, concerning the high prices volatility, have smoothed the impact of external monetary shocks. This may largely explain such a result.

The main goal of this paragraph is to compare the previous results with countries under a pegged regime. To do so we introduce in the specification the six countries already member of the EMU (only looking at the period before the Euro adoption) plus Bulgaria and Croatia. In this specification, according to the pegged status, we do not introduce the exchange rate in the VAR. The results, presenting the pegged regimes are available on appendix (A) figure (5). The positive impact on the domestic rate is twice as high as in the previous estimation, coherent with the 'import' of the ECB monetary policy. Results on the GDP and prices are in line with the previous estimation. We do not highlight a huge difference on real variables given the type of exchange rate regimes. Being pegged or in a flexible strategy is not an significantly vector to explain spillovers.

The last specification make the focus on the last years of the period from 2009 to 2015. During this period, the EBC policy is at the Zero Lower Bound (ZLB). As we are dealing with the 3-month money market rate, we suppose our variables still reflecting the ECB policy benchmark. Indeed, one of the main goal of the ECB is to promote growth through price stability.

[10]We tried different numbers of lags which were not able to get rid of the puzzle. As in our case, this puzzle is almost not significant we will not consider it as an issue.
Instead of using the implicit GDP deflator as commonly used, it is possible to introduce the HICP; but as in transition economies administrated prices are still of interest, core inflation does not lead to the same definition upon all countries such that the HICP index responses are hard to identify.

Unconventional measures of the monetary policy are captured by the variations in the interest rate curve. Promoting growth may be effective thanks to an increase of credit volume. Unconventional measures are profiled to this purpose such that we expect the interest rate curve on the monetary market to behave by the same way.
To make sure, our assumption is not erroneous, we also substitute the shadow rate to the ECB 3-month money market rate. The shadow rate refers to Wu and Xia (2016) who developed a measure for the monetary policy stance in order to study unconventional monetary policy's impact on the real economy. As results remain coherent comparing the 3-month and the shadow rates, we keep the first one to draw our comparison with the first estimation. According to the impulse-responses (figure 6), the impact of the ECB rate shock on the domestic rate is positive but small in the middle term (during the second year after the shock). The peak occurs after six periods and remains at low magnitude.
The GDP growth rate is negatively impacted by the ECB monetary contraction. This corroborates the rise of interdependences between EU economies and may be analysed as an encouraging statement in terms of business cycle integration. This last approach is a first step, to confirm the even more credible monetary policies in the CEECs, for international investors. Obviously, only 25 periods under study, do not allow to make robust inference. What is found here should be viewed as a possible new tendency that must be kept in mind and more deeply analysed during the integration process of the CEECs to the monetary union.

5.2 The variance decomposition

As IRFs provide information about the amplitude but not about the importance of the changes, we consider the forecast error variance decomposition (FEVD). It allows to identify how strongly a variable plays a role in the volatility of another one. We analyse the FEVD results, distinguishing the flexible from the pegged regimes.
The domestic monetary rate, at the beginning of the simulation, reflects the same behaviour in both specifications. Nevertheless, after a thirty period simulation, the domestic monetary rate is highly influenced by domestic prices (54% of the variance) in the flexible regime compared to the pegged countries (14%). This point is explained by the inflation targeting strategy which induce a strong focus on prices evolution in the aftermath of the transition. The monetary autonomy loss, in case of pegged regimes, explain the stronger influence of the ECB policy rate on the domestic monetary policy

Table 3: Forecasted error variance decomposition

	Periods ahead	i^{ECB}	fx	i^{DOM}	y	p
Domestic monetary rate						
Flexible regime	5	1	10	56	3	30
	30	8	10	46	6	27
Fixed regime	5	1	.	86	1	12
	30	22	.	60	8	9
Last years	5	0	6	58	0	36
	30	4	6	52	3	35
GDP						
Flexible regime	5	8	1	2	86	3
	30	22	6	7	60	5
Fixed regime	5	14	.	5	81	0
	30	28	.	9	63	0
Last years	5	0	8	0	84	8
	30	5	7	3	73	12
Prices						
Flexible regime	5	0	15	62	1	22
	30	5	13	51	5	26
Fixed regime	5	4	.	71	0	24
	30	10	.	62	5	23
Last years	5	0	2	65	0	33
	30	0	3	59	4	34

Numbers are expressed in percentage of the total variance;

Colums explain lines

(the country is said to 'import' the ECB monetary policy) while the GDP is less powerful (only 3% of the variance is explained by the GDP compared to 12% in flexible regimes) to drive the domestic policy.
The way, GDP variance is explained, is similar in both flexible and fixed regime; the domestic rate do not play a significant role (a marginal one in fixed regime) while the ECB rate explain a little bit more the volatility in GDP. This point suggests how important is the economic situation in the EMU for the CEECs and how monetary spillovers play a role in their economy. This can be explained through two channels. The first one is the well-known euroisation phenomenon. A higher level of euroisation hamper the domestic monetary policy as real variables such as GDP are directly impacted by the ECB policy through the relative price of capital. Indeed, in case of an increase of the ECB monetary rates, households tend to increase their savings denominated in Euro which is counter-productive at the domestic level as firms in the same situation tend to increase their investment in domestic currency as it become relatively more profitable to do so. Whatever the adopted exchange rate regime, the direct spillovers are consistent and of similar level.
The second channel is explained by the reaction of the EMU output. The ECB contraction implies changes in the EMU GDP; Given the common market framwork, it induces changes in the trade balance for the CEECs. To better understand this phenomenon, one may have a look at the share of CEECs exports devoted to Euro area member states. Data, available on Eurostat, reveal that in 2015, exports from Hungary Poland and Romania to the EMU represent respectively 55 percent, 45 percent and 55 percent of their total exports.[11]
From the price FEVD perspective, the results corroborates the inflation targeting hypothesis. Indeed, an almost absent role of the ECB rate in the flexible regime compared to the pegged countries is explained by the monetary autonomy. The monetary autonomy was justified by the inflation issue during the nineties.
According to our results, being pegged to the Euro is confirmed not to be the only 'one way' to integrate in the medium term the EMU. The choice of an anchored regime is, before all, in the case of the European Union, the result of a political choice. This strategy may be justified in the case of countries like Bulgaria and Croatia, the last two poorest economies, when they are facing huge institutional challenges. Our results, slightly different according to the exchange rate regime, are similar when the focus is made on real variables.

[11] ratio of: $\frac{exports\ devoted\ to\ euro\ zone}{total\ exports}$; available on Eurostat (2016).

It is interesting to look at variance reaction during the last decade as the economic crisis and the ZLB policy of the ECB may have had some impact on policy channels. Compared to the first estimation the ECB rate is less accurate to explain the GDP variance, while the role of domestic prices increase, reflecting the control put into inflation and price stability. In the same vein, prices are less sensitive to the exchange rate and relatively more explained by GDP growth.

6 Conclusion

This paper aims at highlighting the importance for emerging and transition open economies in Central and Eastern Europe, to integrate in their macroeconomic policies, the ECB monetary decisions. In the case of the single ECB monetary policy, a panel estimation with a VAR specification, gives rather better results. Moreover, panel estimation is an efficient way to deal with short time span.

To do so, we implemented different countries approach according to their exchange rate regime. The underlined goal was to disentangle whether the countries, still on the verge of the EMU perform as well as countries which already joined the monetary union (in a pegged framework). Our sub-panel of flexible economies considers Czech Republic, Hungary, Poland and Romania. We found a small positive reaction of the domestic rates in both situations. According to our impulse response functions, the impact on GDP and prices remains weak and almost not significant.

The results confirm that the different economies do have interactions with the EMU in monetary terms. The absence of significant impact on prices is not fully surprising as all the economies, included in the panel, hardly fought inflation over the all period. Moreover, the 'floating' economies entered an inflation targeting strategy which reinforce the absence of response of the inflation rate to ECB monetary shocks.

This point leads us to conclude that the CEECs developed credible monetary institutions and implemented efficient reforms and policies to allow for a sustainable growth under the constraint of the Maastricht criteria. The floating economies perform quite well given a small fluctuation of their exchange rate. Nevertheless, the loss of the monetary autonomy stems from macroeconomic issues. For instance, Bulgaria and Croatia wanted to get rid of high inflation and non-credible institutions.

The CEECs strongly focused on their inflation rate over the last twenty-five years. Now that inflation is more or less under control, it is time for these countries to switch through real objectives. As mentioned during this paper, those results are converging to the idea that countries tend to homogenize their monetary policy. This strengthens their economies and stimulates a better further integration to the monetary union. Nevertheless, EMU accession should not be a leitmotiv and the focus on the country development remains the primary goal of monetary institutions.

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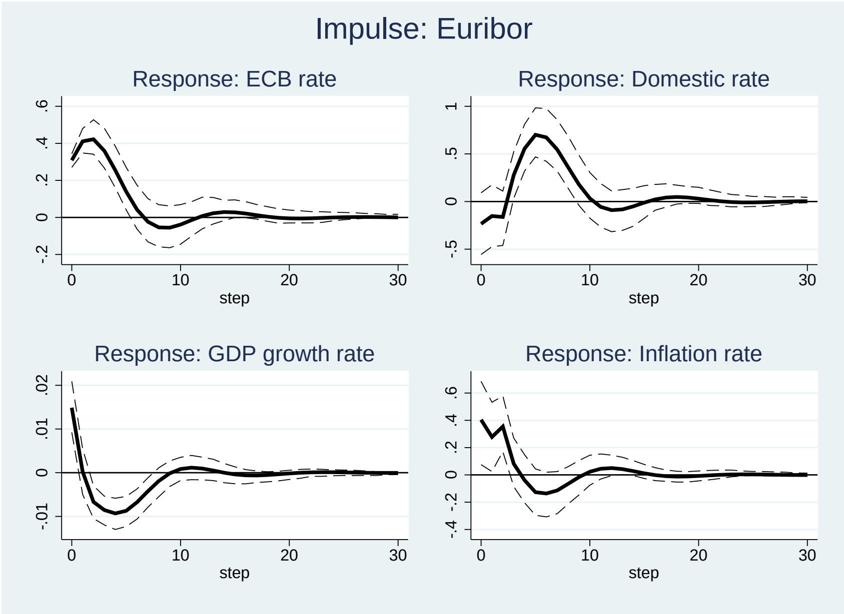
Appendices

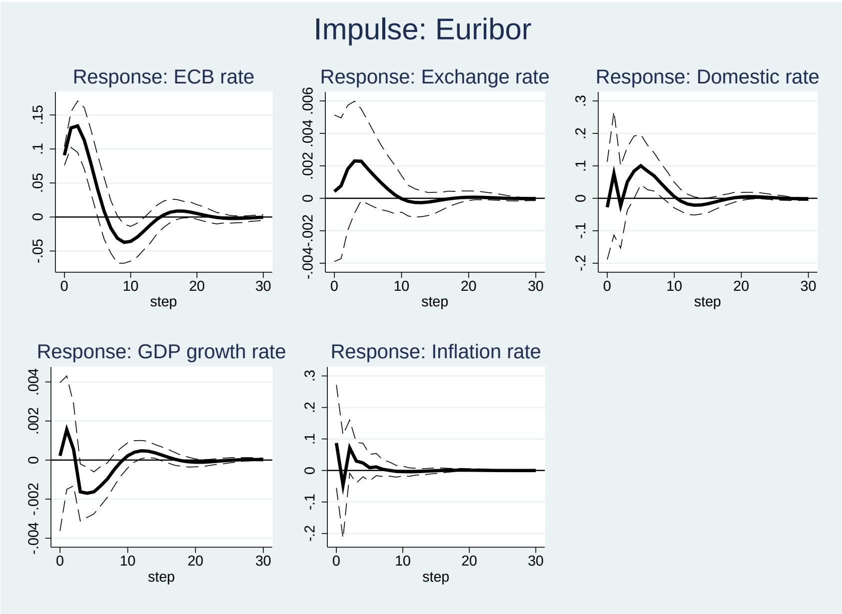
A IRFs

Figure 5: Pegged regime



Note: The solid lines are the impulse response functions whereas, the dashed one represent the 95 percent confidence interval; Errors are generated with 500 repetitions of Monte Carlo.

Figure 6: After the crisis



Note: The solid lines are the impulse response functions whereas, the dashed one represent the 95 percent confidence interval; Errors are generated with 500 repetitions of Monte Carlo.