

Inflation Uncertainty, Output Growth Uncertainty and Macroeconomic Performance: Comparing Alternative Exchange Rate Regimes in Eastern Europe

Muhammad Khan¹ and Nikolay Nenovsky²

Summary: In the late 90's, after severe financial and economic crisis, accompanied by inflation and exchange rate instability, Eastern Europe emerged into two groups of countries with radically contrasting monetary regimes (Currency Boards and Inflation targeting). The task of our study is to compare econometrically the performance of these two regimes in terms of the relationship between inflation, output growth, nominal and real uncertainties from 2000 till now. In other words, we test the hypothesis of non-neutrality of monetary and exchange rate regimes with respect to these connections. In a whole, the empirical results do not allow us to judge which monetary regime is more appropriate and reasonable to assume. EU enlargement is one of the possible explanations for the numbing of the differences and the lack of coherence between the two regimes in terms of inflation, growth and their uncertainties.

JEL codes: C22; C51; C52; E0

Key words: inflation, inflation uncertainty, real uncertainty, monetary regimes, Eastern Europe

¹ Laboratoire d'Economie d'Orléans (LEO), Université d'Orléans. Rue de Blois BP : 6739. 45067 Orléans Cedex 2 (France). E.mail: khann.muhammad@gmail.com

² Le STUDIUM, Université d'Orléans. 9 rue Saint-Pierre Lentin, 45041 Orléans Cedex 2 (France). E.mail: nenovsky@gmail.com.

Introduction:

In the late 90's, after severe financial and economic crisis, accompanied by inflation and exchange rate instability, Eastern Europe emerged into two groups of countries with radically contrasting monetary regimes. The first group was formed by the countries with Currency boards and strongly fixed exchange rate regimes (Estonia, Lithuania, Bulgaria and partly Latvia) and the second one was composed of Inflation targeting countries (Poland, Czech Republic, Hungary and later Romania). The reasons behind these choices were complex. One of leading arguments was the belief about the ability of two regimes to provide low inflation and to anchor inflationary expectations. This was viewed as a prerequisite for successful nominal and real convergence towards the EU integration and as a whole for sustainable economic growth. Over time, and especially with the launching of accession process and subsequently the EU membership, the differences in achievement and performance of both groups began to be increasingly subtle and unsystematic. This, in turn, undermined the importance of choosing one or another monetary regime and gave reasons to believe that the hypothesis of neutrality of the monetary regime can not be rejected.

The task of the present study is to compare econometrically the performance of these two regimes in terms of the relationship between inflation, inflation uncertainty, nominal and real uncertainty from 2000 till now. In other words, we test the hypothesis of non-neutrality of monetary and exchange rate regimes with respect to these connections. The article is constructed in three sections. The first section presents the theoretical foundations of the study, especially the main characteristics of both monetary regimes as well as the major theoretical relationships between nominal and real uncertainty. In the second section we set out and discuss empirical results. In the last section we conclude.

Theoretical framework:

As already pointed out the choice of both polar regimes - Currency boards and Inflation targeting was dictated primarily by the necessity to curb inflation, to fix inflation expectations and to accelerate growth. In this line of reasoning credibility of the monetary regime, and its ability to establish discipline were the leading motives behind the choice of individual countries. Monetary regime is the primary institutional anchor that is systemic in nature, not only to inflation but also to the overall developments of the economy.

There is little doubt that both monetary regimes, namely Currency Board and Inflation targeting are very contrasting in their mechanics. The aim of Currency board is to import credibility and discipline from abroad by legally fixing exchange rate to the leading foreign currency and by means of full monetary base coverage with liquid foreign reserves. The monetary policy is eliminated because the balance sheet of central bank contains no domestic assets. The Central bank cannot perform open market operations, although some elements of monetary policy are available through the manipulation of reserve requirements and banking regulation. Currency Board relies on an automatic link between balance of payments and money supply, real exchange rate and interest rates are supposed to quickly address all imbalances. Balance sheet separation of the Treasury from the Central bank, obligates the government to pursue conservative fiscal policy, and as a rule to maintain fiscal surpluses and low public debt. Proponents of Currency board consider that it produces high levels of discipline and credibility.

Likewise, Inflation targeting pursues the same objectives (high credibility and discipline), but with others, and above all internal to the country mechanisms. These are clearly defined inflation target, transparency, as well as active conduct of monetary policy. It relies on good knowledge of the economic model and transmission mechanisms. Central bank's communication with the public and its position as being accountable for attaining its inflation objectives reduces uncertainty in the markets. In purely theoretical terms Inflation targeting requires fully floating exchange rate³. Supporters consider this monetary regime appropriate to combine the power of enhancing the level of fiscal discipline and credibility without eliminating the possibility for discretionary reaction in shocks.

Focusing on our sample countries we can say that Currency Board regimes are generally small and highly open peripherals economies pursuing quick integration into the monetary system of the developed European countries. For example, Currency boards in Estonia (1992) and Lithuania (1994), were introduced at the beginning of transition, the main objective explicitly was to break the influence of Russia and the Russian economy. Bulgaria, in turn, introduced Currency board in mid 1997 after deep financial and monetary crisis, period of hyperinflation and sharp devaluation of national currency⁴. Here the main task was to break with years of inflation, monetary instability and lack of structural reforms. In this sense, the choice of the Currency Board in Bulgaria can also be seen as a decisive geostrategic integration into the European monetary zone. Turning to the three countries with Inflation targeting (Poland, Czech Republic and Hungary, and to some extent Romania)⁵, we see that they have the characteristics of Central European countries, they have some traditions in an economic and monetary policy prior to period of communism, and clear aspirations for independent and equal cooperation with leading European economies. Poland, the Czech Republic and Hungary began the transition with a fixed rate (to varying degrees) and progressively gained knowledge and experience in implementing monetary policy. These are countries that put much effort in building macroeconomic models serving the base for the later implementation of Inflation targeting regime. The case of Romania is somewhat peculiar. Romania has a number of characteristics similar both to Central European countries as well to Bulgaria that explains oscillations and late implementation of inflation targeting.

Turning to the theory, the multi-dimensional relationship between inflation, output growth as well as their uncertainties has been widely discussed in the literature.⁶ Since a complete set of hypotheses is large, the empirical studies separately cover several aspects of this nexus. To begin with the inflation and nominal uncertainty relationship, Friedman's (1977) rule assumes a positive association between these two variables. Turning to the empirical literature, it mainly supports the Friedman's view of positive inflation effects on nominal uncertainty. As the survey results of Golob (1994) show that 17 out of 21 studies find a positive impact of inflation on nominal uncertainty.⁷ Nevertheless, an alternative strand of literature argues that high inflation increases the cost of uncertainty and hence forces the agents to invest more time in predicting future prices (Frohman et al., 1981). Higher cost of ignorance, in terms of wealth

³ In practice the small and open economies such as in Eastern Europe still monitor and intervene on the foreign exchange market.

⁴ Latvia carried out a similar policy of a fixed exchange rate, it is not the subject of our reflections notably because it does not represent Currency board in its pure form.

⁵ Poland decided to move to inflation targeting in 1998 and introduce it in 2000, Hungary also passed in mid-2000, as well as Czech Republic - in 1997. Romania introduced this scheme in 2005.

⁶ See Fountas and Karanasos (2007) for a brief survey of literature on all these aspects.

⁷ See also Hess and Moris (1996) and Grier and Grier (2006), among others, for positive relationship between these two variables.

and income loss, necessitates better information about these variables and hence high inflation becomes more predictable.

Concerning the feedback effect from uncertainty to inflation; two opposing sets of hypotheses have been forwarded by the literature. According to the first view that has been advanced by Cukierman and Meltzer (1986), higher uncertainty augments inflation by raising the short run benefits of inflation uncertainty. Notwithstanding the aversion of a long run higher inflation, policy maker seeks short run objectives of higher output from inflation surprises. This increases optimal inflation level in an economy. This positive relationship, which is known as 'Cukierman-Meltzer hypothesis' after the notation used by Grier and Perry (1998); is also supported by many empirical studies (see also Fountas et al, 2004). In sharp contrast to this view, Holland (1995) argues that central banks work for stability objectives, the so-called 'stabilizing Fed hypothesis'. As soon as uncertainty increases after inflation, central bank reacts by contracting money supply to avoid the welfare loss due to uncertainty; making this inflation and nominal uncertainty relationship negative. This hypothesis has been further complemented by empirical studies of Grier and Perry (2000) and Grier et al (2004) etc. Finally, some mixed evidence based on country specific and time specific results are also documented by Caporale and Kontonikas (2009) among others.

Regarding the inflation effects on real growth variability, literature usually complements the signalling extraction model of Lucas (1973). In this environment, inflation obscures the signalling channel of production and hence inhibits the output growth. Producers increase their production as an immediate response of price changes but as soon as they come to know the overall price change, they reverse back these decisions causing higher output growth variability due to inflation.

Likewise, inflation uncertainty also directly impacts output growth and its volatility. Nominal uncertainty influences growth through different channels; i.e through its effect on the long-term real interest rate, real wage, tax revenues, long-term investment plans of consumers and investors etc. Since the effects on all these channels are different and interdependent on the other policy organs, literature does not provide any precise and overwhelming evidence regarding the effect of uncertainty on output growth or its volatility. Pindyck (1991) substantiates an adverse effect of uncertainty on growth that appears through investment channel. Taylor (1979), on the other hand, assumes an inverse relationship between real and nominal uncertainties in the presence of real world rigidities. To illustrate, if supply shock hits the economy and real wages are rigid downward, real output fluctuations can only be avoided at the cost of higher nominal uncertainty. These results have been empirically supported by Cecchetti and Krause (2001), among others.

Finally, the relation between real growth volatility and growth has also been widely treated in the literature with (again) contradictory findings. First, according to Devereux's (1989) model, higher growth uncertainty, results lower degree of indexation. This further makes it easier for the policy maker to use inflation surprises as a tool for higher output objectives. This all ends up with high average inflation and lower growth. Second, according to Black (1987), uncertainty increases the degree of specialization in an economy and hence yields more growth. His work on business cycle fluctuations elaborate that higher degree of specialization in an economy will result a positive real growth and volatility nexus (see Fountas and Karanasos (2007) and references therein for empirical support on this view).

Regarding the selected sample of the present study, the new EU member states, we could point out again that all abovementioned theoretical links between inflation, growth and their uncertainties are carried out within the two fundamentally different monetary regimes (Currency Board and Inflation targeting), each of which strives to achieve both nominal and real stability as well as their predictability. Monetary regime by itself is an essential institutional environment which lays down the basic features of the whole set of behavioral relationships (Maurer, 2006).

Finally, we briefly summarize the literature on how specific exchange rate affects the macroeconomic performance of an economy. Theoretically, the possibilities of both flexible exchange rate and fixed exchange rate to bring stability and enhance growth have been advanced and supported by the empirical literature. Alternatively, a third possibility of exchange rate neutrality has also been advanced in the previous studies. First, regarding optimality of flexible exchange rate, Friedman (1953) argues that flexible exchange rate can smooth the adjustment of real shocks even in the presence of nominal rigidities. Moreover, ER flexibility reduces the chances of speculative attacks against currency. Empirical evidence to this view can be found from the studies of Broda (2001), Ghosh et al. (1997) and Rogoff et al (2003), among others. Second, on the optimality of fixed exchange rate, it is argued that it reduces market uncertainty, ensures credibility and fiscal discipline of the Government. Some theoretical and empirical support to these arguments has been substantiated by Rose (2004) and Thom and Walsh (2002), among others. Lastly, the proponents of ‘exchange rate neutrality’ believe that macroeconomic fundamentals take time to change while exchange rate moves fluently; hence ER regime does not influence economic stability or growth. Moreover, intuitively, volatility of macroeconomic variables is not systematically different in both regimes. Flood and Rose (1995) provide some theoretical support on the independence between macroeconomic variables and any particular ER regime. Baxter and Stockman (1989) and Obstfeld and Rogoff (1995) bring further empirical support, using the panel data.

Empirical analyses and interpretations:

3.1) Methodology

Here we briefly discuss our selected exponential GARCH (E-GARCH) model that has been actualized to estimate the stochastic component of real and nominal uncertainties for our new EU members. This specific functional form has an advantage of taking into account the asymmetry in the inflation and uncertainty relationship and hence provides a better way to test the Friedman’s view. Since according to Friedman, higher inflation exerts larger uncertainty, using a symmetric variance of the error term (the standard GARCH models) as measure of uncertainty is a poor approach to test this hypothesis (see Brunner and Hess, 1993 for more details). Following the traditional notations, let π_t and y_t represent the inflation and the output growth, respectively and define the residual vector ε_t as $\varepsilon_t = (\varepsilon_{\pi_t} \varepsilon_{y_t})'$. A more specific form of the bivariate VAR (p) model can be described as;

$$\pi_t = a_0 + \sum_{i=1}^p a_i \pi_{t-i} + \sum_{i=1}^p \rho_i y_{t-i} + \eta_i i_{t-1} + \tau Oil_{t-1} + \varepsilon_{\pi_t}, \quad (1)$$

$$y_t = b_0 + \sum_{i=1}^p b_i y_{t-i} + \sum_{i=1}^p \delta_i \pi_{t-i} + \lambda y_{EU(t-1)} + \varepsilon_{y_t}, \quad (2)$$

Here ‘ i ’ represents a change in the nominal interest rate. For the Currency Board economies we have used interest rate of European central bank (ECB). Here is one of the main difference between the both monetary regimes, in the case of Currency Boards because of the lack of own policy rate, and because of the mechanics of the regime, the ECB policy rate directly

shape home market interest rate. ‘Oil’ in the first equation shows oil price changes as exogenous variable and ‘ y_{EU} ’ represents European Union Industrial Production Index (IPI); to incorporate the effect of regional shocks on the domestic output. Our volatility estimates are based on the vector autoregressive (VAR) models and the specific number of lags is selected using Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC). Since E-GARCH specification models the logarithm of the conditional variance, it does not impose non-negativity constraint on the coefficients. Uncertainty in both variables is captured in the following way:

$$h_{\pi t} = \alpha_0 + \alpha_1 h_{\pi,t-1} + \beta \left| \frac{\varepsilon_{t-1}}{h_{t-1}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \quad (3)$$

$$h_{y_t} = \alpha_0 + \alpha_1 h_{y,t-1} + \beta \left| \frac{\varepsilon_{t-1}}{h_{t-1}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \quad (4)$$

Here parameter ‘ γ ’ estimates the asymmetry in the relationship. When ‘ γ ’ is positive then positive inflation change causes more uncertainty than the negative one of the same magnitude. Our next step estimation consists of the Granger causality tests to see the exact direction of effects between real and nominal variables as well as their uncertainties.

Data:

To test all these set of hypotheses, we use monthly data of six Eastern European economies over the period of 2000-01 to 2011-07, using International Financial Statistics (IFS, 2011). The selected sample includes three currency board economies; Bulgaria, Estonia, and Lithuania, and three inflation targeting countries Czech Republic, Romania, and Poland. For these economies, inflation is represented by the annualized monthly difference of the logarithm of the consumer price index [$\pi_t = \log(CPI_t / CPI_{t-1}) \times 1200$] and real output growth is also measured accordingly [$y_t = \log(IPI_t / IPI_{t-1}) \times 1200$]. Our stationarity tests indicate that all the variables are non-stationary at their level and stationary at first difference, hence we use first difference of all variables in the analysis⁸. Summary statistics of both these variables are given in Table 1.

Table 1
Data Description

	Inflation (π)			Industrial Production Growth (y)		
	Mean	Standard Deviation	JB Normality	Mean	Standard Deviation	JB Normality
Bulgaria	5.73	3.34	4.98 ^c	4.17	9.92	50.69 ^a
Estonia	4.14	2.85	2.42	5.78	14.08	75.29 ^a
Lithuania	3.01	3.33	17.08 ^a	5.83	11.23	11.22 ^a
Czech Rep.	2.46	1.83	13.34 ^a	4.33	8.98	83.08 ^a
Poland	2.85	1.58	3.14	5.63	6.75	14.56 ^a
Romania	11.21	7.71	53.13 ^a	3.81	5.82	47.81 ^a

Note: Here ‘a’, ‘b’, and ‘c’ shows 1%, 5% and 10% level of significance.

One prominent difference between inflation targeting and the currency board economies is the standard deviation of y and π which is higher for the Currency Board economies than for the

⁸ We use Augmented Dickey Fuller (ADF) and Phillips-Peron (PP) tests for stationarity. The results are available on demand.

Inflation targeting countries. Since Inflation targeting regime explicitly focuses on the price stability, it reduces real uncertainty more efficiently than the Currency Board based monetary regime. Once nominal exchange rate is fixed under Currency Board, the uncertainty move to other variables especially price level. The case of Romania is distinctive. The inflation volatility is higher, because of a whole unstable economic and political climate.

3.3) Empirical Results:

In order to apply our selected AR (p) - E-GARCH (1, 1) model we need to have the estimates of real and nominal uncertainty that are free from autocorrelation but contain heteroscedasticity; to justify the manipulation of this econometric technique. To do this, we ran AR (12) model and obtained the following results for the residuals.⁹

Table 2

Preliminary tests on the residuals

	Bulgaria	Estonia	Lithuania	Czech Rp.	Poland	Romania
Inflation						
Q ₁₂	5.56	4.46	4.45	4.72	12.05	6.01
Q ₁ ²	5.26 ^a	0.01	0.23	7.35 ^a	7.43 ^a	0.07
Q ₁₂ ²	10.32	4.46	8.48	9.58	17.45	19.66 ^c
Output						
Q ₁₂	7.32	4.82	9.11	8.25	6.91	11.33
Q ₁ ²	4.01 ^b	0.33	4.45 ^b	5.74 ^a	1.39	3.17 ^c
Q ₁₂ ²	10.68	26.71 ^a	10.43	31.12 ^a	25.12 ^a	23.77 ^a

Notes: Q₁₂ is the 12th-order Ljung-Box test for standardized autocorrelation. Q₁² and Q₁₂² are tests for ARCH effects using squared residuals. 'a', 'b' and 'c' show 1%, 5% and 10% level of significance, respectively.

Our residual diagnostics (presented in Table 2) show no sign of remaining autocorrelation for both inflation and output growth series. However the LM style ARCH tests show conditional heteroscedasticity in all cases except for two inflation series (Estonia and Lithuania). Although our square residuals are not so compelling in few cases, the results were, however, significant on some other lags; not mentioned here. Hence we use our AR (p) - E-GARCH (1, 1) test for both inflation and output series and the results are presented in Table (3).

Here we present the results of inflation equations (1) and (3) for all countries. Most of the autoregressive coefficients are significant in almost all countries, showing strong influence of previous inflation to determine prices today. On our selected covariates, changes in previous period output amplify the level of inflation today. Effect of interest rate changes is different; it augments inflation when domestic interest rate increases (i.e in case of Czech Republic) and decreases inflation when ECB interest rate goes up (i.e in Bulgaria). One interpretation can be that higher interest rate in the ECB can result capital flight from this Currency Board based economy which further lowers reserve money, money supply and as a result inflation in this small open economy. However this systematically different effect is significant only in these two countries. Oil price increases lower the inflation in all cases where their impact turns out to be significant.

Turning to our volatility results, GARCH impact is significant in all cases where our first step residual tests have identified the presence of heteroscedasticity in the inflation process. The most interesting results come from our asymmetric parameter 'γ' (its sign is positive in all

⁹ Our AR (12) specification is based on the minimum values of AIC and SIC under alternative lags for all countries.

significant cases). When $\gamma > 0$, this substantiates the Friedman and Ball effect regarding the impact of inflation volatility on its level. Higher inflation is indeed more volatile and hence more costly in terms of its impact on relative prices and output growth in an economy. Since welfare cost of inflation increases at its higher levels, price stability becomes an optimal choice for these economies; irrespective of the differences in the monetary policy regimes in these countries. These are the cases of Bulgaria, Lithuania, Czech Republic and Romania. When $\gamma < 0$, meaning that higher inflation is negatively related with inflation volatility, as in the case of Estonia and Poland, the results seem intuitive. Estonian Currency Board is extremely credible, has a long successful history, and this is probably the reason of the negative correlation, and its difference with the other two Currency Boards countries. Bulgarian Currency Board was introduced after deep crisis, in Lithuania there were always hesitations about the commitment to this monetary regime. Concerning the Polish case experts share the view that Central bank has established good reputation and this in some respect is confirmed by negative sign of γ .

Table (3)
Estimates of AR(p)-EGARCH(1,1) model of inflation

	Bulgaria	Estonia	Lithuania	Czech Rp	Poland	Romania
Intercept a_0	-0.025 ^a	0.001	-0.017 ^a	0.021 ^a	-0.005	0.006
a_1	0.228 ^a	0.227 ^a	0.105	-0.111 ^a	0.448 ^a	0.135 ^a
a_2	0.124			0.152 ^b	-0.255 ^a	
a_3		0.091	0.149 ^b			
a_4	-0.138 ^c				0.19 ^c	0.116 ^c
a_5					-0.407 ^a	
a_6	-0.199 ^a			-0.147 ^c	0.378 ^a	0.146 ^b
a_7			-0.106	0.053	0.378 ^a	-0.137 ^c
a_8			-0.098		0.233 ^b	
a_{10}	-0.128 ^c	0.093		-0.102 ^c	-0.272 ^a	-0.015
a_{11}		-0.106			0.388 ^a	
a_{12}	-0.038	0.012	0.246 ^a	0.282 ^a		0.008
$Y_{(t-1)}$	0.026 ^a	0.036	0.018 ^a	0.021 ^a	0.006	-0.005
i-rate _(t-1)	-0.0079 ^b	-0.004	-0.005	0.003 ^b	0.001	-0.0003
Oil _(t-1)		-0.0001 ^c		-0.0001 ^a	-8.5E-05 ^c	
α_0	-5.048 ^b	-4.55	-8.56	-16.971 ^a	21.435 ^a	-2.014 ^b
α_1	0.511 ^b	0.57	0.185	-0.519 ^a	-0.839 ^a	0.782 ^a
β	0.318	-0.19	-0.406 ^b	-0.661 ^b	-0.295	-0.52 ^a
γ	0.615 ^a	-0.17	0.128	0.523 ^a	-0.081	0.116 ^b
R^2	0.18	0.22	0.21	0.39	0.37	0.11
F-Statistics	1.84	2.12	2.11	3.78	3.58	0.88
Log Likelihood	397.96	558.61	459.09	440.25	514.06	464.52
Q_{12}	7.817	7.92	4.63	5.31	11.61	8.14
Q_1^2	0.01	0.04	0.41	0.01	0.65	0.19
Q_{12}^2	5.36	4.88	7.98	10.27	10.59	12.09

Notes: Q_{12} is the 12th-order Ljung-Box test for standardized autocorrelation. Q_4^2 and Q_{12}^2 are tests for ARCH effects using squared residuals. 'a', 'b' and 'c' show 1%, 5% and 10% level of significance, respectively.

In the next step, we want to see how different monetary policy regimes impact the output growth or its variability in these emerging markets (growth equation 2 and 4). Here again we obtain standard results for the relationship between growth variability and overall output growth. One notable outcome appears from the fact that in almost all economies (other than Estonia, probably because of its large trade share with Russia), regional shocks (in our

case EU) lower growth of these economies. Since EU is the largest trading partner of our selected economies, fluctuations in the industrial production of EU countries exert negative impact on the output growth of these economies. Parameter δ , that shows trade off between inflation and growth volatility, show negative value (except for Czech Republic) in accordance to dominant theories. Asymmetry in the output growth and its uncertainty is again positive, albeit, insignificant in most of the cases.

Table 4
Estimates of AR(p)-EGARCH(1,1) model of Output Growth

	Bulgaria	Estonia	Lithuania	Czech Rp	Poland	Romania
Intercept b_0	0.271 ^a	-0.005	0.664 ^a	1.159 ^a	0.624 ^a	1.154 ^a
b_1	0.133 ^b		0.281 ^a	0.118	0.225 ^c	0.026
b_2	0.324 ^a	-0.101	0.217 ^b	-0.022	0.196 ^b	-0.094 ^b
b_3	0.179 ^a	0.083		0.034	0.181 ^b	-0.061
b_4		0.084	-0.293 ^a	-0.063	-0.045	-0.021
b_5		0.377 ^a		-0.101	-0.081	-0.039
b_6					0.139 ^c	
b_7					-0.202 ^a	
b_8			-0.188 ^a	-0.141 ^c	-0.023	0.049
b_9			0.116 ^c	-0.161 ^c	-0.033	-0.318 ^a
b_{10}	-0.147 ^a			-0.356 ^a	-0.153 ^b	-0.149 ^a
b_{12}	0.631 ^a	0.028	0.187 ^a	0.512 ^a	0.599 ^a	0.431 ^a
Π_{t-1}	-0.325	-0.014	-0.721	1.442	-2.039 ^c	-0.761
$Y_{EU(t-1)}$		0.001 ^a	-0.007 ^a	-0.007 ^a	-0.001	-0.004 ^a
α_0	-2.728 ^a	-2.554 ^b	-2.573	-1.488	-1.844	-10.53 ^a
α_1	0.681 ^a	0.719 ^a	0.619 ^b	0.791 ^a	0.823 ^a	-0.421 ^b
β	0.812 ^a	0.367	0.459	0.178	0.734 ^b	1.11 ^a
γ	0.303	0.652 ^a	0.137	0.223	0.249	0.125
R^2	0.67	0.08	0.54	0.73	0.67	0.63
F-Statistics	14.59	0.874	10.22	14.11	8.52	9.56
Log	204.69	298.72	168.38	205.86	236.62	225.44
Likelihood						
Q_{12}	12.06	5.24	8.94	10.97	11.79	6.85
Q_1^2	0.66	0.11	0.38	1.46	0.48	0.11
Q_{12}^2	13.37	15.06	14.88	8.68	8.75	11.79

Notes: Q_{12} is the 12th-order Ljung-Box test for standardized autocorrelation. Q_4^2 and Q_{12}^2 are tests for ARCH effects using squared residuals. 'a', 'b' and 'c' show 1%, 5% and 10% level of significance, respectively.

Finally, in order to know the exact nature of the relationship and the direction of effects between real and nominal variables, we ran Granger causality tests. Table 7 shows how real and nominal uncertainties affect real growth as well as inflation. Panel (A) supports Black's (1987) 'stabilizing Fed hypothesis' effect that nominal uncertainty reduces inflation by forcing the central bank to take anti-inflationary steps in the presence of high inflation; albeit the evidence is supported only for two countries' Lithuania and Poland. Panel (B) also shows an insignificant effect of inflation uncertainty on growth, for the four countries. However, for Bulgaria and Czech Republic it supports Dotse and Sarte (2000) by saying that inflation uncertainty, by increasing precautionary savings, enhances investment and growth. Panel (C) shows ambiguous effect of output growth uncertainty on inflation while panel (D) gives positive effect of real uncertainty on growth for the I.T countries and negative effect for the C.B economies.

Table 7

Bivariate Granger-causality tests from uncertainty about inflation and output growth to inflation and output growth

Optimal Lag	Bulgaria	Estonia	Lithuania	Czech Rp.	Poland	Romania
Panel (A) H_0 : Inflation uncertainty does not Granger-cause inflation						
4 lags	0.36	0.36	<u>2.83</u>^b (-)	1.67	<u>0.81</u>	0.89
8 lags	1.09	0.49	2.41 ^b (-)	1.68	0.93	1.66
12 lags	1.01	0.25	1.64 ^c (-)	1.32	2.04^b (-)	1.17
Panel (B) H_0 : Inflation uncertainty does not Granger-cause output growth						
4 lags	<u>0.44</u>	1.8	0.23	0.45	0.63	0.33
8 lags	2.06 ^b (+)	1.05	0.41	1.02	0.87	0.77
12 lags	1.44	1.38	0.52	<u>4.28</u>^a (+)	1.18	1.41
Panel (C) H_0 : Output Growth uncertainty does not Granger-cause inflation.						
4 lags	0.93	<u>2.64</u>^b (+)	<u>1.16</u>	<u>1.92</u>	0.66	1.51
8 lags	0.64	1.77 ^c (+)	1.35	1.85 ^b (+)	0.59	1.21
12 lags	0.39	1.33	1.77^c (-)	1.41	0.55	0.95
Panel (D) H_0 : Output growth uncertainty does not Granger-cause output growth						
4 lags	<u>2.72</u> ^b (+)	<u>2.73</u>^b (-)	1.54	<u>11.51</u> ^a (+)	<u>5.45</u> ^a (+)	3.74 ^a (+)
8 lags	2.28 ^b (+)	1.54	1.81 ^c (-)	4.57 ^a (+)	1.65	2.09 ^b (+)
12 lags	2.25 ^b (+)	1.43	1.09	2.31 ^b (+)	1.92 ^b (+)	<u>1.87</u>^b (+)

Notes: The numbers in the first column give the lag structure. Figures are F-statistics.

A (+) (-) indicates that the sum of the lagged coefficients of the causing variable is (positive) (negative).

'a', 'b' and 'c' show 1%, 5% and 10% level of significance, respectively. The **bold (underlined)** numbers indicate the optimal lag length chosen by AIC (SIC).

Our next step Granger Causality tests probe into direct bi-directional relationship between inflation and growth along with their uncertainties. In Panel (A), an overwhelming support has been advanced for the 'Phillips curve' relationship between inflation and growth. Nonetheless, in case of Romania; a relatively high inflation country, this relationship fades away. Panel (B) shows a very strong evidence of higher inflation to cause more growth for four out of six economies. This supports the famous Balassa-Samuelson effect for these emerging economies. Since productivity growth is high in these countries, the adverse effects of inflation are minimized in the developing economies.

Moreover, as most of our selected sample countries include the economies with overall low inflation, increasing inflation from this level does not exert any immediate loss of growth, rather it increases growth; due to lower degree of wage indexation in these markets. Nevertheless for high inflation countries like Romania, inflation definitely reduces growth. Panel (C) presents the effect of nominal uncertainty on the real uncertainty and Panel (D) vice versa. The results of both these investigations are positive but significant only in few cases. The results imply that each type of uncertainty causes the other.

Table 8
Bivariate Granger-causality tests between (i) inflation and output growth and (ii)
nominal and real uncertainty

Optimal Lag	Bulgaria	Estonia	Lithuania	Czech Rp.	Poland	Romania
Panel (A) H ₀ : Output growth does not Granger-cause inflation						
4 lags	<u>3.94^a</u> (+)	<u>1.97^c</u> (+)	<u>2.92^b</u> (+)	<u>6.06^a</u> (+)	3.59 ^a (+)	1.47
8 lags	4.28^a (+)	1.22	2.20 ^b (+)	5.83^a (+)	<u>4.07^a</u> (+)	0.99
12 lags	2.57 ^a (+)	1.41	2.11^b (+)	2.52 ^a (+)	2.49^a (+)	0.97
Panel (B) H ₀ : Inflation does not Granger-cause output growth						
4 lags	<u>0.48</u>	3.75^a (+)	0.85	<u>6.06^a</u> (+)	0.67	2.19 ^c (-)
8 lags	2.81 ^a (+)	2.36 ^b (+)	2.19 ^b (+)	5.83^a (+)	<u>4.84^a</u> (-)	1.79 ^c (-)
12 lags	1.61^c (+)	2.16 ^b (+)	1.07	2.52 ^a (+)	2.23^b (-)	1.62^c (-)
Panel (C) H ₀ : Inflation uncertainty does not Granger-cause output growth uncertainty						
4 lags	0.06	0.02	0.55	3.05 ^b (+)	1.16	1.75
8 lags	0.32	0.56	1.41	3.66 ^a (+)	0.93	1.11
12 lags	0.27	0.57	1.42	7.58^a (+)	0.97	0.32
Panel (D) H ₀ : Output growth uncertainty does not Granger-cause inflation uncertainty						
4 lags	0.24	1.52	<u>0.39</u>	0.82	1.42	0.25
8 lags	0.18	1.13	2.42^b (+)	0.58	1.98 ^c (+)	0.43
12 lags	0.28	1.28	1.78 ^b (+)	0.57	2.54 ^a (+)	0.89

Notes: The numbers in the first column give the lag structure. Figures are F-statistics.

A (+) (-) indicates that the sum of the lagged coefficients of the causing variable is (positive) (negative).

'a', 'b' and 'c' show 1%, 5% and 10% level of significance, respectively. The **bold (underlined)** numbers indicate the optimal lag length chosen by AIC (SIC).

Finally, Table 9 explains how inflation and output growth affect macroeconomic instability under different monetary regimes. Again we could not figure out any systematic difference in the effects of inflation and output growth on macroeconomic instability between two regimes. Panel (A), for example, support the Friedman (1977) and Ball (1992) hypothesis in most of the countries, irrespective of their exchange rate regimes. In two countries, Estonia and Czech Republic, inflation lower inflation uncertainty supporting Ungar and Zilberfarb's (1993) view (explained before). The effect of inflation on real growth uncertainty is weak and ambiguous; insignificant in three cases, positive for Poland and Czech Republic and negative for Lithuania (at four lags only). Panel (C) shows the constructive effect of growth on nominal uncertainty, nevertheless, valid only for Bulgaria and Estonia. For these two currency board regimes, growth lowers nominal uncertainty, supporting 'Phillips curve' and Ungar and Zilberfarb (1993) hypotheses for these countries. Panel (D) shows a very strong positive impact of growth on its uncertainty. A theoretical as well as an empirical support of this result comes from Fountas et al (2002). According to them as output growth rises and an inflation pressure is created, the monetary authority responds by a monetary contraction which reduces average rate of inflation and inflationary uncertainty, and hence increases the real uncertainty (Fountas et al, 2002, p.295). Moreover, as explained by Loayza and Raddatz (2007) that in the developing countries with underdeveloped financial markets combined with trade openness,

terms of trade shocks make the higher growth more volatile. The implication of this final result to our exchange rate regimes is indeed important, since the source and the origin of fluctuations are mainly external for these countries, their domestic difference i.e flexible versus pegged regimes matter very little for stability. Of course the stability motive of both ER regimes is important but it is not the major factor that can bring systematic differences in the growth and uncertainty relationship between real and nominal variables across these countries.

Table 9

Bivariate Granger-causality tests from inflation and output growth to uncertainty about inflation and output growth

Optimal Lag	Bulgaria	Estonia	Lithuania	Czech Rp.	Poland	Romania
Panel (A) H_0 : Inflation does not Granger-cause inflation uncertainty						
4 lags	<u>29.41</u> ^a (+)	<u>43.62</u> ^a (-)	<u>18.76</u> ^a (+)	<u>9.89</u> ^a (-)	<u>4.68</u> ^a (+)	<u>11.07</u> ^a (+)
8 lags	12.15 ^a (+)	23.37 ^a (-)	8.66 ^a (+)	4.92 ^a (-)	2.53 ^b (+)	7.29 ^a (+)
12 lags	5.68 ^a (+)	17.57 ^a (-)	5.06 ^a (+)	4.54 ^a (-)	1.98 ^b (+)	4.49 ^a (+)
Panel (B) H_0 : Inflation does not Granger-cause output growth uncertainty						
4 lags	0.26	1.21	<u>2.65</u> ^b (-)	<u>1.21</u>	<u>1.26</u>	0.82
8 lags	0.84	0.76	1.11	2.32 ^b (+)	1.48	0.56
12 lags	0.92	0.86	0.78	2.48 ^a (+)	1.73 ^b (+)	0.61
Panel (C) H_0 : Output Growth does not Granger-cause inflation uncertainty						
4 lags	0.46	<u>3.42</u> ^a (-)	1.83	0.83	0.98	0.48
8 lags	<u>3.01</u> ^b (-)	2.23 ^a (-)	1.48	0.37	1.07	0.58
12 lags	1.52	1.92 ^b (-)	1.23	0.79	1.54	0.45
Panel (D) H_0 : Output growth does not Granger-cause output growth uncertainty						
4 lags	<u>12.03</u> ^a (+)	<u>20.69</u> ^a (+)	<u>13.81</u> ^a (+)	<u>9.94</u> ^a (+)	<u>5.34</u> ^a (+)	<u>2.66</u> ^b (+)
8 lags	5.71 ^a (+)	13.41 ^a (+)	8.15 ^a (+)	8.69 ^a (+)	2.48 ^b (+)	2.02 ^b (+)
12 lags	5.67 ^a (+)	7.65 ^a (+)	5.71 ^a (+)	8.16 ^a (+)	2.09 ^b (+)	1.51

Notes: The numbers in the first column give the lag structure. Figures are F-statistics.

A (+) (-) indicates that the sum of the lagged coefficients of the causing variable is (positive) (negative).

'a', 'b' and 'c' show 1%, 5% and 10% level of significance, respectively. The **bold (underlined)** numbers indicate the optimal lag length chosen by AIC (SIC).

Conclusion:

Our main result indicates that although inflation and output growth influences the macroeconomic instability of a country and vice versa, these effects nevertheless are not dependent upon a specific exchange rate regime followed by an economy. On the whole, the empirical results do not allow judging which monetary regime is more appropriate and is reasonable to assume, as Jeffrey Frankel has said few years ago that all is about the specific assessments and depends upon the concrete characteristics of each economy. Evidence of the importance of specific historic background in determining the effectiveness of any monetary regime is clear, for example, in case of Estonia, where Currency Board fits well into the

overall institutional setting and ideologically liberal climate. Or, Poland, where discretionary monetary policy is conducted by Central bank with a well established reputation.

But there is something else. The results of our study lead to consider the negotiation process, legal and normative convergence with the EU that occur after 2000, expectations dynamics of economic agents to the future EU integration, and subsequently EU membership itself, as major economic anchors, which largely absorbed the importance and specificity of internal anchors (monetary regime). EU enlargement is one of the possible explanations for numbing of the differences and the lack of distinction between the two regimes in terms of inflation, growth and their uncertainties.

References:

- Baxter, M., Stockman, A. (1989). "Business cycles and the exchange-rate regime". *Journal of Monetary Economics* Vol. 23 (3), pp 377–400.
- Black, F. (1987). "Business Cycles and Equilibrium", *Basil Blackwell, New York*.
- Broda, C. (2001). "Coping with terms-of-trade shocks: pegs versus floats". *American Economic Review, Papers and Proceedings* Vol. 91 (2), 376–380.
- Brunner, A.D., Hess, G., (1993). "Are higher levels of inflation less predictable? A state-dependent conditional heteroskedasticity approach." *Journal of Business and Economic Statistics*. 11 (2): 187–197.
- Caprole, G.M. and Kontonikas, A. (2009). "The Euro and inflation uncertainty in the European Monetary Union. *Journal of International Money and finance*. 28: 954-971.
- Cecchetti, S. and Krause, S. (2001). "Financial Structure, Macroeconomic Stability and Monetary Policy." *NBER Working Paper No. 8354*.
- Cukierman, A. and A. Meltzer (1986), "A theory of ambiguity, credibility, and inflation under discretion and asymmetric information." *Econometrica*, 54: 1099-1128.
- Devereux, M. (1989). "A positive theory of inflation and inflation variance." *Economic Inquiry*, 27: 105–116.
- Golob, J. (1994). "Does Inflation Uncertainty Increases with Inflation." *Federal Reserve Bank of Kansas City. Third Quarter*, pp. 28-38.
- Flood, R.P., Rose, A.K. (1995). "Fixing exchange rates: a virtual quest for fundamentals". *Journal of Monetary Economics* Vol. 36, pp 3–37.
- Fountas, S., Ioannidis, A., Karanasos, M. (2004). "Inflation, inflation uncertainty, and a common European monetary policy." *The Manchester School*. 72 (2): 221-242.
- Fountas, S. and Karanasos, M. (2007). "Inflation, output growth, and nominal and real uncertainty: Empirical evidence for the G7". *Journal of International Money and finance*. 26: 229-250.
- Friedman, M. (1953). "Discussion of the inflationary gap". *In Essays in positive Economics, Chicago: Univ Chicago Press, 1970*.
- Friedman, M. (1977). "Nobel Lecture, Inflation and Unemployment." *Journal of Political Economy*, 85: 451-72.
- Frohman, A ., Leroy L. O. and Thomas D. (1981). "Uncertainty Costs of High Inflation." *Voice of the Federal Reserve Bank of Dallas. July* pp.1-9
- Ghosh, A., Gulde, A.-M., Ostry, J., Wolf, H. (1997). Does the nominal exchange rate regime matter? *NBER Working Paper 5874*.
- Grier, K. and Perry, J.M. (1998). "On inflation and inflation uncertainty in the G-7 countries." *Journal of International Money and Finance*, 17: 671-689.

- Grier, K. and Perry, M. (2000). "The effects of real and nominal uncertainty on inflation and output growth: some GARCH-M evidence." *Journal of Applied Econometrics*. 15: 45-58.
- Grier, K., Henry, O. , Olekalns, N. and Shields, K. (2004). "The asymmetric effects of uncertainty on inflation and output growth." *Journal of Applied Econometrics*. Vol. 19 (5): 551-565
- Holland, S. (1995). "Inflation and uncertainty: tests for temporal ordering." *Journal of Money, Credit, and Banking*. 27 (3): 827-837
- Lucas, R.(1973), " Some international evidence on output inflation trade-offs." *American Economic Review*, 63: 326-334
- Maurer, B. (2006). "The Anthropology of Money." *The Annual Review of Anthropology*, 35: 15-36
- Obstfeld, M. and K. Rogoff. (1995). "Exchange Rate Dynamics Redux". *Journal Of Political Economy* vol 103, pp 624-660.
- Pindyck, R. (1991). "Irreversibility, uncertainty, and investment." *Journal of Economic Literature*. 29 (3): 1110-1148.
- Rogoff, S. R., Husain, A. M., Mody, A., Brooks, R. and Oomes, Neinke (2003). Evolution and performance of exchange rate regime. *IMF Working paper WP/03/243*.
- Rose, A., (2004). "A meta-analysis of the effect of common currencies on international trade". *NBER Working Paper No: 10373*.
- Taylor, John B, (1979). "Staggered Wage Setting in a Macro Model." *American Economic Review, American Economic Association*, 69(2): 108-113
- Thom, R., and Walsh, B. (2002). "The effects of a currency union on trade: lessons from the Irish experience". *European Economic Review*. 46 (6), 1111–1123.