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DETERMINANTS OF INFLATION IN EUROPE – A DYNAMIC PANEL ANALYSIS

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Abstract

This article offers an empirical analysis of determinants of inflation in 28 European economies that belonged to the transition group of countries in the end of the last century. We rely on dynamic panel methodology and find that economic and structural variables, including economic openness, unemployment, real wages, institutional effects, as well as external factors, such as prices of food and oil, determine the short-run inflationary dynamics in these countries. The obtained results also indicate that inflation rate is autoregressive in the observed period (2005-2015), confirming that contemporaneous inflation rate is determined by the entire history of these determinants. Our further investigation reveals long- term effects of the majority of these variables on price dynamics. Interestingly, distinction between the current EU and transition countries in the model does not lead to different conclusions.

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Introduction

The causes of inflationary dynamics to great extent determine the choice of instruments of economic policy aiming to promote economic growth and development, thus inflation remains in the focus of contemporary macroeconomic stabilization policies. Many authors point out the importance and role of price stability emphasizing that optimum economic development implies a monetary balance, but there is also economic and structural balance, alluding to a wider macroeconomic stability (Burton & Fischer, 1997; Snowdon & Vane, 2005; Blanchard, 2005; Stojanov, 2008). Therefore, the outcome of stabilization policies is largely attributed to the synergy and dynamics within the relation - institutional mechanisms - short-term fluctuations of supply and demand - domestic (controlled) and external (uncontrolled) influences.

The concept of stable prices and determinants of price movements are important for European economies striving to chart the course toward the EU[3] or for countries that are indeed EU member states, which means the related obligation of price stability and nominal convergence in rates of inflation. This phenomenon and preoccupation are still not studied sufficiently as shown in the empirical literature. In that regard, the focus of this paper is on 28 European economies that conducted transition reforms in the 1990s and for which we investigate the main determinants of inflation in the short and in the long run. To explore this research question, we rely on macroeconomic data over the period 2005-2015, and dynamic panel analysis that is a suitable methodology for endogenous modelling of short and long run determination.

The environment of transition countries is commonly associated with unstable economic and political conditions where both external influences of prices of energy sources or raw materials and local socio-political and economic conditions, such as fiscal and monetary imbalance and level of market liberalization, often act in mutual dependence on inflation dynamics. Therefore, the analysis starts with a review of empirical literature relevant for this investigation (Section 2). In Section 3 we discuss challenges in choosing relevant methodology of estimation and empirical specification as there are neither comprehensive nor precise guidelines in the literature. Section 4 presents an empirical analysis of determinants of inflation through dynamic panel models, as well as a statistical and economic interpretation of the obtained results and theirand their stability. The final section (Section 5) discusses the key results of the research and findings of the empirical analysis.

[3] The 17 countries from this group are EU member states (11 countries) or part of a group of Western Balkan countries (6 countries from the sample) aspiring to EU membership. The remaining parts of the sample are the countries of the Commonwealth of Independent States (CIS).

Determinans of inflation in empirical research

There is a general consensus that the type of connection between inflation and other macroeconomic variables is affected by their dynamic relations which characterize the global economies, including those in transition. Our approach to the analysis of this both specific and heterogeneous group of transition countries is to investigate relevant determinants of inflation, which complicates the analysis and presents a methodological challenge. Although the transition countries have been treated as a separate/distinctive group, they are not at the same level of institutional and economic development, they have not built identical market structures, and they are neither politically nor economically homogenous, which makes this analysis more challenging. Our discussion of the existing literature is organized to underpin our empirical analysis.

The existing empirical literature identifies the whole range of determinants of inflation, but at the same time is rather consistent in finding some conventional influences on price changes. For example, Coorey, Mecagni and Offerdal (1996), Cottarelli, Griffiths and Moghadam (1998) and Begovic (2014) report that inflation in transition economies is determined by money supply fluctuations, while Mahabadi and Kiaee (2015) identify money growth, GDP and oil prices as important inflation predictors for the panel sample of countries. Alfaro (2005), Mafi-Kreft and Kreft (2006) and Tasci, Esener and Darici (2009) find a significant positive relationship between inflation and openness implying that openness does not restrict growth of prices. Interestingly, the inverse relationship was empiricaly confirmed by Romer (1993), Terra (1998), Catao and Terrones (2005), Aisen and Veiga (2006) and Lin (2010).

The existing transition literature recognizes fiscal influences as an important inflation predictor, which is reported by Cottarelli et al., (1998), Inoue (2005), Staehr (2010), while papers that analyze a wider group of countries (e.g. Catao & Terrones, 2005; Lin & Chu, 2013) also identify fiscal deficits as the main inflationary impulse in countries characterized with high inflation rates.

Many authors emphasize the role of institutions on influencing inflation variability and recognize nondiscretionary or fixed exchange regimes as an efficient mechanism or external anchor in controlling inflation (Inoue, 2005; Alfaro, 2005; Mafi-Kreft & Kreft, 2006; De Grauwe &

Schnabl, 2008). Other contributors, as Staehr (2010), Agayev (2012) and Sek, Teo and Wong (2015) find the role of exchange rate an important inflation determinant. Central bank independence is identified as an important institutional factor that influences inflation stability and nominal price convergence criteria as noted by Bogoev, Petrevski and Sergi (2012), Posso and Tawadros (2013), Begovic (2014) and Garriga (2016). Besides central monetary authority, Hammermann and Flanagan (2007) emphasise the role of liberalization of economies as a key factor in reducing inflation in CIS countries. Transition related factors, namely price liberalization, is one of the main inflation determinants in EU emerging economies, according to Zoli (2009), besides significant impact of external commodity prices shocks (Furceri, Loungani, Simon, & Wachter, 2016). Likewise Aisen and Veiga (2006), Catao and Terrones (2005) and Staehr (2010) point out the role of external factors on inflation dynamics, primarily the role of oil prices, while Cunado and Perez de Gracia (2005) confirm a short-term nonlinear or asymmetric effect of oil price changes on inflation (Sek et al., 2015; Choi, Furceri, Loungani, Mishra & Poplawski-Ribeiro, 2018). Political stability also remains an important institutional variable affecting inflation in countries with high inflation rates in transition (Aisen & Veiga, 2006) or developed countries (Telatar, Telatar, Cavusoglu & Tosun, 2010). The role of the labour market or business cycle position, proxied by unemployment rate is recognized by Staehr (2010) and Kalimeris (2011) as relevant inflationary determinants, while Agayev (2012) and Deniz, Tekce and Yilmaz (2016) point out the wage - inflation relationship. Similarly, Blanchard and Gali (2007) and Blinder and Rudd (2008) discuss how growing wage flexibility reduces persistence and pass through of the effect of external shocks on domestic inflation.

In most empirical studies which investigate inflationary dynamics, the dependent variable has been defined as a percentage change in inflation rate (% of CPI change compared with the previous year), including here Coorey et al. (1996); Catao and Terrones (2006); Staehr (2010); Agayev (2012); Begovic (2014); Sek et al. (2015); Mahabadi and Kiaee (2015); Deniz et al. (2016); Cardoso and Vieira (2016); Choi et al. (2018), or current inflation rate presented by CPI (Alfaro, 2005; Inoue, 2005; Cunado & Perez de Gracia, 2005; Aisen & Veiga, 2006; De Grauwe & Schnabl, 2008; Tasci et al., 2009; Kwon, McFarlane & Robinson, 2009; Kalimeris, 2011; Posso & Tawadros, 2013). Rarely, it is percentage of GDP deflator change (Alfaro, 2005; Lin, 2010) or real money value depreciation rate (Mafi-Kreft & Kreft, 2006; Hammermann and Flanagan, 2007; Chrigui, Boujelbene & Mhamdi, 2011; Bogoev et al., 2012). There is a consensual approach in the literature to use the dependent variable in logarithms (*logINF*), which motivated our empirical strategy. However, the challenge in choosing the type of the dependent variable is partially guided by the data characteristics. Namely, in our sample we have some observations where inflation has a negative value caused by a significant deflation period in some countries. Such a situation limits the possibility for logarithmic transformation of the data and it is necessary to adapt the variable.[4] The logarithmic form of the dependent variable is welcomed as it reduces outliers and takes into consideration non-linearities (Catao & Terrones, 2005). Thus, we use logarithm of the dependent variable after we transform the dependent variable in a way that the inflation rate change is increased by 100 (e.g. following Ghosh, Ostry & Qureshi, 2014 who use reciprocal transformation or Lin & Chu, 2013). This modification has tackled the problem of negative values in the dependent variable. Accordingly, the impact of the dependent variable is interpreted as the elasticity (Box & Cox, 1964).[5]

The first independent variable that we look at is the growth of real GDP (*lnGDPG*). This variable is measuring overall progress of an economic system, and it is the main indication of development.[6] Almost all studies that investigate determinants of inflation include this variable in the group of regressors (although different transformation of the variable are used in different studies, including mainly GDPpc level, but also % of GDPpc change or GDP level or even GDP gap). We rely on *lnGDPG* like in the studies by Mafi-Kreft and Kreft (2006); Kwon et al. (2009); De Grauwe and Schnabl (2008); Staehr (2010); Begovic (2014) and Deniz et al. (2016). In our verification procedure we also use an alternative form of this variable, which is income growth per capita (GDPpcg). This is used in the studies such as those by Aisen and Veiga (2006); Tasci et al. (2009) and Lin and Chu (2013).

[4] Logarithmic computation of inflation rate is not an adequate choice when the inflation rates measured by index of consumer prices are extremely low since this may result in inappropriate weighting factor for the countries with extremely low inflation rate.

[5] Cox (2005) points out that the transformations of a variable that are in percentages should be applied if it is consistent with the scientific view of the behavior of variables (in this case most research uses the inflation rate log as a dependent variable) because replacing a variable with an appropriate variable function changes the shape of data distribution, and essentially corrects the nonlinearity of the relationship between the observed variables. A common practice is the transformation in the form x / 100-x, for x <0 or x / 100 + x, for x> 0, but such reciprocal transformations complicate the interpretation of the relationship between variables. https://fmwww.bc.edu/repec/bocode/t/transint.html

[6] Autors Efendic and Pugh (2015) emphasize that the movement of GDP per capita is directly related to the process of institutional reform while Romer (1993) points out that GDPpc serves as a general measure of development.

The role of monetary policy is inevitably included as a determinant of inflation and it is mainly observed through the patterns of monetary aggregate M2 (M2 refers to broad money growth rate). The importance and connection between money and prices have been also pointed out by numerous theoretical movements, in the first place by the Classical Economy. The Classical Economy points out that the movement of nominal variables and common level of prices depend on the money policy. Later, the role of money is not denied by Keynes either while Monetarism is further focused on the international dimension of money through the concept of endogenous money. This doctrine stresses unanticipated changes in money flows which, through global integration of economies, imports, role of exchange rate, openness and liberalization of the market are transferred to the absolute level of prices in domestic context. Thus, we include in the model a variable denoted as *MSG*[7] (growth rate of monetary aggregate M2), which is important from the aspect of analysing the control of monetary policy over coordination of money. The most widely used form of this variable in the literature is the growth of monetary aggregate M2 [8] (Inoue, 2005; Begovic, 2014; Mahabadi & Kiaee, 2015; Deniz et al., 2016; Cardoso & Vieira, 2016), monetary aggregate M1 (Ghanem, 2012; Globan Arcabic & Soric, 2016), M1/ GDP (Catao & Terrones, 2015), including also M3 (Agayev, 2012). [9]

We follow the transition literature which consistently takes into account different institutional effects on inflation (e.g. Hammermann & Flanagan, 2007; Staehr, 2010; Agayev, 2012; Bogoev et al. 2012), and it typically includes percentage of real exchange rate change, choice of exchange rate regime, central bank independence and political stability. Fluctuations of exchange rate caused by local supply and demand shocks depend on the level up to which the shock effect is transferred through exchange rate to macroeconomic environment and inflation, and this primarily depends on the structural characteristics of economies. It is expected that, in terms of fixed exchange rates, the local shocks, especially the monetary ones, become overemphasized due to rigidity of the rate leading to more intensive effects of the initial shock. Therefore, in the analysis we include the exchange rate variable (*EXRGreer* - change in real exchange rate) although there is a heterogeneity of approaches to this determinant in the empirical literature. The diversity exists in different approximations of the variable used, including: index of nominal exchange rate (Tasci et al., 2009; Globan et al., 2016), index of real effective rate (Sek et al., 2015; Deniz et al., 2016) or changes in movement of nominal and real rate alternatively (Staehr 2010; Mohanty & Klau, 2001). We additionally observe the impact of exchange rate regime classification to the movement of prices (variable *PFW* – policy framework), which is an approach widely justified in the literature (e.g. Alfaro, 2005; Bleaney & Francisco, 2007; Ghosh, 2014; Wu & Wu, 2018). The classifications of exchange rate regime are numerous while the most often used are: IMF de jure and de facto classification of exchange rate regime, classification by Shambaugh (2004), Levy-Yeyati and Sturzenegger (2005; 2016), Reinhart and Rogoff (2004) and Ilzetski, Reinhart and Rogoff (2019). However, in this research we rely on IMF de facto classification as from 1998 the IMF has been preparing the annual reports on actual regimes of exchange rates, which we found to be a comprehensive dataset. Following Ghosh (2014), we have created a *dummy* variable to capture this effect.

The variable *CBI* (central bank independence) is probably the main institutional variable in analysing the inflation phenomenon. The existing literature identifies importance of the Central Bank independence to the change of general prices in transition countries, but also in other economies (e.g. Loungani & Sheets, 1997; Maliszewski, 2000; Berger, de Haan & Eijffinger, 2000; Cukierman, Miller & Neyapti, 2002; Ćorić & Cvrlje, 2009; Lin, 2009; Klomp & de Haan, 2010; Brumm, 2011; Bogoev et.al., 2012; Bodea & Hicks, 2015a; Garriga, 2016; Radovic, Radonjic & Djuraskovic, 2018). From a theoretical perspective, development of the New classic economy theory stresses the role of institutions and credibility of monetary authority as the factors of price level determination. Among many available measures of the CB independence, we use the Cukierman, Webb and Neyapti (1992) index, which is also the most widely applied measure of CB independence in the literature and the best available indicator for our sample. Many other indices such as those used by Bade and Parkin (1988), Eijffinger and Schaling (1993), Alesina (1998), Grilli, Masciandaro and Tabellini (1991), due to their structure, can be considered sub-types of the Cukierman index. According to the empirical literature, special attention should be given to the problem of endogeneity, which we do not ignore in our research. We include a lag variable CBI to tackle this challenge, which is an approach applied in studies by Cukierman et al. (2002), Maliszewski (2000), Begovic (2014) and Brumm (2011).

[7] The role of money and its effect on price movements is stressed in the Classical theory and modern variants of quantitative theory of money and prices.

[8] Due to heterogeneity of the countries of the group being the subject of the analysis and accessibility of data, we chose the analysis of monetary aggregate M2.

[9] According to data availability, it combines the data for M2, M3 and M4 for different countries.

[10] Data source Garriga (2016).

An additional institutional variable that we observe - political stability (*POLS*), has been also identified as one of the main determinants of inflation in many empirical studies (e.g. Aisen & Veiga, 2006; Alesina, Ardagna & Trebbi, 2006; Hammermann & Flanagan, 2007; Calderon & Schmidt- Hebbel, 2008; Telatar et al., 2010; Piplica, 2011; Choi et al., 2018). Different indices and data are used to measure these institutions, mostly the indicators developed in political and economic literature, including examples such as Aisen and Veiga (2006), Calderon and Schmidt-Hebbel (2008), Efendic (2010), Efendic and Pugh (2015), Efendic and Ledeneva (2020). These studies are based on indices such as the Index of economic freedom (Heritage Foundation), the Index of corruption perception - Transparency International (Piplica, 2011), the Structural and Institutional Change Indicators -and EBRD, the Governance Indicators – WB. It is worth mentioning that a good number of other economic studies use survey data to measure institutions in transition (e.g. Efendic, Pugh & Adnett, 2011; Rebmann, Efendic & Mickiewicz, 2017; Williams & Efendic, 2019). In this study we will use indices published by the World Bank (World Governance Indicators). For the purpose of checking the stability of results, two additional indices will be used or the measures of political stability (index of political stability from the database of the Heritage Foundation[11] and the index of political stability of the Fraser Institute, like in Choi et al. 2018). We include in the model also structural variables used as an approximation of institutional performance of a country, namely: *EBRDI2* (aggregated institutional indicator of development in transition)[12] and *FB* (fiscal balance as % of GDP). From a theoretical aspect, the argument for including the political variables in the analysis of inflation determinants we also find in development of the New political economy theory that stresses the synergy of politics and economy. The political systems and the institutions characterizing them have been identified as the main determinants of macroeconomic policies outcome.

The popular structural approach to inflation stresses the structure of economy or structural instability as the base source of inflation variability in a group of transition countries. Therefore, the structural imbalances in the context of transition countries can be observed through the factors of labour market, including the structure and qualification of labour, wage differences in sectors, structure productivity, exchange rate and, finally, competitiveness. These conventional inflation determinants are furthermore in a direct relation with the level of economy openness and terms of trade that, along with the role of exchange rate, considerably define the character of local prices. Wage movements and terms on the labour market are often under influence of exogenous shocks, and they are transferred directly through the international flows of goods, services and capital, i.e. the scope and structure of trade. Both variables have been the subject of analysis in numerous studies of inflation. While the unemployment rate is a standard variable of labour market performance (e.g. Cottarelli et al., 1998; Staehr, 2010; Kalimeris, 2011), there is a considerable heterogeneity in using the variable wage (real growth of wages) starting from use of nominal wages growth or unit costs of labour (e.g. Coorey et al., 1996; Mohanty & Klau, 2001), indexation level and wages centralization (e.g. Cottarelli et al., 1998), differences in labour productivity in sector of production and services (e.g. Staehr, 2010), rate of average gross wage change (e.g. Agayev, 2012), minimum real wages (e.g. Deniz et al., 2016) and the wages in production (e.g. Telatar et al., 2010). In our research we analyse how the change of real wages influence price movement based on economic theory which suggests that real wage growth above productivity level eventually leads to higher prices.[13] The importance of this determinant of inflation has been also stressed by numerous theoretical approaches. For example, Keynes emphasizes that besides money, the components of aggregate demand present the key factor for stimulating the economy and also points out the role of real factors in determining price levels. According to this theory, price instability is corrected through the real economy effect, mainly unemployment and wages.

Most transition countries have been externally indebted and a great part of their obligations is related to financing the fiscal sector or fiscal consumption, which makes them sensitive to external developments.[14] This makes the role of openness to trade (variable *OPEN*[15]) important for our investigation as well, including the terms of trade, liberalization, competition, reforms and movements of payments balance (presented by variable *TOT* - terms of trade, in our model)[16], for directions of movement and convergence of prices and income in this group of countries. These factors actually indicate the

[11] 4 years of missing data for Serbia and Montenegro (2005-2008).
[12] The index has been used as a measure of institutional impact in most studies dealing with transition countries (Cottarelli et al., 1998; Falcetti, Lysenko & Sanfey, 2006; Eicher-Schreiber, 2010; Begovic, 2014; Efendic & Pugh, 2015).
[13] It is considered that in the long-term real wages are determined by productivity Bidder (2015). Similarly, Boranova et al. (2019) analyse nominal wage growth adjusted for trend productivity.
[14] The New neoclassic synthesis binds the final price effect within national frames to the aspect of dynamic equilibrium and importance of coordinated implementation of fiscal and monetary policy measures.
[15] (Romer, 1993; Lane, 1997; Alfaro, 2005; Hammermann & Flanagan, 2007; Lin & Chu, 2010).
[16] e.g. Hammermann and Flanagan (2007) and Begovic (2014).

importance of synchronized implementation of the reforming process and stabilization policies, especially within the fiscal sector (adaptability of fiscal sector to shocks) in order to avoid accumulation of foreign debt in the environment of unstable finance systems, free movement of capital and uncertainty accompanied with the environment of transition economies.

As the generally increasing population generates additional pressure to an economic system, the role of changes in food prices is becoming more important and it is transferred to the local economy via import prices. Equally important is the effect of oil prices being the input in production of many goods including food, as well and they have been determined primarily by exogenous developments. Therefore, these factors can be observed as the variables that cover supply side or the external factor having impact on local inflation (variables *lnOIL* – oil prices and *lnFOODchangepos* – change of food prices). This is a special category of variables and their influence considerably depends on capability and reactions of monetary policy, as well as the transmission channels of monetary signals to the economy. Furthermore, the prices of energy have been often the subject of administrative controls, and food prices under the influence of many trading restrictions, which can be the source of pressure on the price movement in local frames. These determinants of price movement have also been recognized by the Equilibrium business cycles theory emphasizing that the price dynamics presents the mechanism of adjustment to real economic developments caused exactly by the shocks of supply (changes of energy prices, technological progress, labour prices and changes of productivity). Food prices have been the subject of analysis in many studies investigating the global dimension of inflation (e.g. Mohanty & Klau, 2001; Ciccarelli & Mojon, 2010; Staehr, 2010; Parker, 2017). Our choice of variable follows the methodology by Staehr (2010). The role and importance of oil price impact on inflation have been investigated by many authors (e.g. Hamilton, 2009; Chou & Tseng, 2011; Ghanem, 2012; Lin & Chu, 2013; Sek et al., 2015; Bala & Chin, 2018; Sussman & Zohar, 2018). The role of oil prices for a specific transition group of countries was analysed by Staehr (2010), Globan et al. (2016) for Croatia, while Choi et al. (2018) include five Western Balkan countries or 18 transition countries. Mahabadi and Kiaee (2015) analyse all countries from the World Bank data base. Most of them agree that the choice of variable is especially important, i.e. its approximation, in order to measure the possible effect on inflation, particularly having in mind the fact that the retail prices of energy are considerably different from country to country. We chose the linear form of variable following the majority of authors from this literature (e.g. Cunado & Perez de Gracia, 2005; Masso & Staehr, 2005; Lin & Chu, 2013).

In the end, we include the lagged dependent variable in the analysis since theoretical arguments indicate that economic processes and developments have been characterized by the "random walk" (Baum, 2006), therefore the current movement of macroeconomic variables has been often determined by historical influences (Efendic & Pugh, 2015). Many authors emphasize that the effect of persistence, that follows the economic processes, being presented by the lag dependent variable, need to be considered in case we want to estimate properly the impact of the remaining group of regressors to the dependent variable (Bond, 2002: 1; Greene, 2008: 469). Our intention is to observe the historical impact or dynamics of adjusting during time (Baltagi, 2008) in order to analyse the efficacy of monetary policy that can be observed through the role of inflationary inertia and it can be also treated as the structural characteristics of an economy. And simply, a dynamic panel model assumes including of the lagged dependent variable and time dummies to satisfy its properties.

Modelling inflation– estimation and interpretation of the results

The existing literature reports a number of methodologies used to analyse determinants of inflation, including: time series approach based on VAR models by Brada and Kutan (1999), Payne (2002); the structural VAR model by Jankov, Krznar, Kunovac and Lang (2008), Krznar and Kunovac (2010), Jovancevic, Arcabic and Globan (2012), Dumicic, Palic and Sprajacek (2015), Globan et al. (2016), the Bayesian VAR by Jovičić and Kunovac (2017), the model of Philips curve by Krznar (2011) and Basarac (2010), Lendvai (2005), Borio and Filardo (2007), Gerlach, Giovannini, Tille and Vinals (2008), Ihrig, Kamin, Lindner and Marquez (2010), Eickmeier and Pijnenburg (2013) and Auer, Borio and Filardo (2017).

Among the studies preferring the dynamic panel model in the analysis of inflation determinants, it is possible to identify Cottarelli et al. (1998), Aisen and Veiga (2006), Kwon et al. (2008), Calderon and Schmidt-Hebbel (2008), De Grauwe and Schnabl (2008), Staehr (2010), Telatar et al. (2010), Agayev (2012), Begovic (2014), Deniz et al. (2016); Cardoso and Vieira (2016). The static panel models have been assessed by Inoue (2005), Mafi-Kreft and Kreft (2006), Hammerman and Flanagan (2007), Calderon and Schmidt-Hebbel (2008), Tasci et al. (2009), Lin (2010), Chrigui, Boujelbene and Mhamdi (2011), Bogoev

et al. (2012), Ghanem (2012) and Garriga (2016).[17]

As our research aim is to distinguish between short-term and long-term determination of inflation, thus, dynamic panel model modelling is a suitable method of estimation (Baltagi, 2008). This is particularly important if we know that institutional changes most often have long-term effects (Acemoglu et al. 2002; Acemoglu & Johnson, 2003; Efendic & Pugh, 2015), and it is the impact we also want to investigate. Furthermore, Bond (2002) emphasizes that dynamic relations in analysing the base process can be decisive for proper and consistent estimations of parameters of the observed independent variables. Specific characteristics of the sample covering 28 countries over the period of 11 years, or the situation when T < N, is an important argument for choosing a dynamic panel model (Greene, 2008). The dynamic panel model is also a good method of estimation when potential endogeneity is considered, which is the case in our model (Greene, 2008). The dynamic panel model offers the possibility of generating internal instruments (external are typically difficult to find), so the treatment of potential endogeneity is comprehensive and the estimations more consistent (Roodman, 2006, 2007; Baum, 2006).

To conclude, we rely on a dynamic model - GMM estimation (Generalized method of moments), System GMM type (SGMM) established by Arrelano and Bover (1995) and Blundell and Bond (1998). The SGMM model is useful for estimations in small samples (Baltagi, 2008) and it results in more precise and more effective estimations; it does not require normality and tolerates heteroscedasticity in the data (Baltagi, 2008). Furthermore, in situations of imbalanced panel models, the gaps and the lack of data are best tackled in the SGMM, and it covers the fixed effects or heterogeneity between the units of measurement (Roodman, 2007)[18] avoiding the dynamic bias (Nickell, 1981). Simply, this method of estimation fits our research focus, sample and the data very well.

[17] Staehr (2010) and Deniz et al. (2016) report the basic results of the test procedure. However, a serious problem in their research is that conclusions are derived based on the small total number of observations, which reflect the efficiency of estimates (Roodman, 2007). In this regard, a pragmatic solution, according to the recommendation (Roodman, 2006 and 2007), is to report on key choices of econometric specification, especially the number of instruments (due to complex estimation syntax of the model), estimation technique, and extensive statistical diagnostics (specification test results).

[18] In dynamic panel models the standard error is composed of two components namely fixed effects and the idiosyncratic error component.

The initial general specification of the dynamic panel model is the following:

$$\ln INFpos_{it} = \alpha_i + \beta \cdot \ln INFpos_{it-1} + \delta \cdot X_{it} \cdot + \lambda \cdot T_t + u_{it}$$

The dependent variable in model u_{it} (1) is the logarithm of inflation rate change presented by $lnINFpos_{it}$ (the variable is transformed for the pur- X_{it} pose of logarithmic computation as clarified previ- ously) while (l.$lnINFpos_{it-1}$) presents the first lag of dependent variable, and δ the error including all unobserved impacts on inflation. The index „ it „ presents the countries „i“ in time „t“. is 1 x k vector k of control variables identified as important determinants of inflation discussed in the previous section. Finally,„ “presents k x 1 vector of parameters to be estimated while „T“presents the vector of time dummy variables included into the analysis.[19] The detailed specification of the final dynamic panel model is in the following developed form[20]:

$\ln INFpos_{i,t} = \alpha_0 + \alpha_1 l.\ln INFpos_{i,t-1} + \alpha_2 \ln GDPGi_{,t} + \alpha_3 MSG_{i,t} + \alpha_4 OPEN_{i,t} + \alpha_5 UNEMPL_{i,t} + \alpha_6 WAGE_{i,t} + \alpha_7 EXRGreer_{i,t} + \alpha_8 EBRDI2_{i,t} + \alpha_9 \ln OIL_{i,t} + \alpha_{10} \ln FOODchangepos_{i,t} + \alpha_{11} EUdummy + \varepsilon_{i,t}$

Before estimating our dynamic model, as an initial empirical check we examine the coefficients of correlation for the variables in the model. We estimate the Pearson coefficient of correlation[21] for all variables used in regression and find that there is no possible problem of high correlation between the variables (all correlation coefficients are below the level of 0.7).

In our modelling strategy we treat lagged effect of inflation as predetermined, i.e. endogenous variables instrumented with lagged levels and differences. All other regressors are treated as “instrumented by themselves” (i.e., in the conventional manner for IV estimation. The sample has 28 groups, i.e. countries, and the model is estimated by using 31 instruments. We estimate Specification 2 by using SGGM method and report obtained results in Table 1.

[19] A detailed overview of variables and their respective forms is presented in the Appendix 1.

[20] In relation to the initial model, the specification of model does not include variables: CBI - independence of central bank, TOT - terms of trade, FB - fiscal balance and PFW - choice of exchange rate regime (the mentioned variables have not been statistically significant in any specification of dynamic panel model).

[21] The absolute value of the Pearson coefficient is the measure of intensity of the linear relation between the regressor and dependent variable, i.e. the sign and intensity of relation between the regressors.

Table 1: Base model – SGMM dynamic panel- one step robust estimate

The dependent variable is a logarithm of change in inflation rate –CPI measured (lnINFpos)			
Variables (*SHORT EXPLANATION OF VARIABLE*)	**Coefficients**	**t- statistic**	**p-value**
Constant (*INTERCPET TERM*)	2.148	1.53	0.137
l.lnINFpos (*LAGGED DEPENDENT VARIABLE, 1st LAGG*)	**0.442**	**2.09**	**0.046**
lnGDPG *(LOGARITHM OF REAL GDP GROWTH -%)*	-0.038	-0.49	0.631
MSG *(GROWTH OF MONETARY AGGREGATE M2 - %)*	0.001	0.77	0.447
OPEN *(OPENESS IN %GDP)*	**0.001**	**1.74**	**0.094**
UNEMPL *(UNEMPLOYMENT RATE -%)*	**-0.001**	**-1.88**	**0.071**
WAGE *(REAL WAGES GROWTH RATE- %)*	**-0.001**	**-3.18**	**0.004**
EXRGreer *(REAL EXCHANGE RATE-% OF CHANGE)*	0.001	0.41	0.686
EBRDI2 (*EBRD INDICATOR OF PROGRESS IN TRANSITION REFORM)*	**-0.126**	**-1.85**	**0.075**
lnOIL *(LOGARITHM OF OIL PRICES)*	**0.003**	**2.62**	**0.014**
lnFOODchangepos *(FOOD PRICE INDEX-% OF CHANGE)*	**0.150**	**3.38**	**0.002**
EU (dummy variable for EU membership)	-0.004	-0.59	0.562
Set of time dummy variables included			
t_2006	0.018	1.32	0.199
t_2007	0.015	1.11	0.276
t_2008	**0.062**	**7.43**	**0.000**
t_2009	-0.012	-0.91	0.369
t_2010	0.005	0.66	0.517
t_2011	**0.030**	**6.91**	**0.000**
t_2012	0.006	0.65	0.520
t_2013	0.001	0.09	0.932
Model diagnostics			
Number of observations			**243**
Number of groups (i.e. countries)/Number of instruments			**28/31**
F- test of joint significance *H_0: Independent variables are jointly equal to zero*			F(19, 27) = 123.32 **Prob > F = 0,00**
Arellano-Bond test for AR(1) in first differences *H_0: There is no first-order serial correlation in residuals*			z = -2.11 **Pr > z = 0.035**
Arellano-Bond test for AR(2) in first differences *H_0: There is no second-order serial correlation in residuals*			z = -0.39 **Pr > z = 0.696**
Sargan test of overidentifying restrictions			chi2(11) = 18.55 **Prob > chi2 = 0.070**

Hansen J-test of overidentifying restrictions *H_0: Model specification is correct and all overidentifying restrictions (all overidentified instruments) are correct (exogenous)*	chi2(11) = 9.21 **Prob > chi2 = 0.602**
Difference-in-Hansen tests of exogeneity of GMM instrument subsets: Hansen test excluding SGMM instruments (i.e. the differenced instruments) *H_0: GMM differenced- instruments are exogenous*	chi2(5) = 6.70 **Prob > chi2 = 0.244**
Difference-in-Hansen tests of exogeneity of GMM instrument subsets: *H_0: system-GMM instruments are exogenous and they increase Hansen J-test*	chi2(6) = 2.51 **Prob > chi2 = 0.868**

Source: Author's calculations using STATA 12

The obtained statistical diagnostics suggest that all relevant tests for SGMM type of modelling are appropriate (more discussion available in Roodman, 2009), which means that we can focus on interpretation of the obtained results. The estimated model indicates that the inflation rate is auto-regressive in the observed period and that the inflation rate from the previous period (*l.lnINFpos L1*) is a significant determinant of the current inflation rate. The intensity of the estimated effect of inflationary inertia (0.442) and statistical significance of the lag dependent variable (at conventional 5% level) suggest that the current inflation level presents the reflection of historical effect of the inflation determination processes in transition.

Among other independent variables, the following show statistically significant effects: *OPEN* - openness, *EBRDI2* – index of progress in transition, *UNEMPL* – unemployment rate, *WAGE* – growth of real wages, *lnOIL* – oil prices and *lnFOODchangepos* – change of food prices. The economic interpretation of short-term impact of these variables is as follows:

1) Change of food price by 1% upward leads to increase of inflation rate of 0.15%, on average, holding all other factors constant *(i.e. Ceteris paribus,* this interpretation applies to all estimated coefficients but will not be repeated again*).* The resulting effect has been estimated on the highest level of statistical significance.

2) Increase of oil prices by 1% leads to rise of inflation rate by 0.03%. This indicates that the effect of increase in oil prices on inflation is not that strong.

3) If openness of economy increases by 1% of GDP, this leads to increase of inflation by 0.01%; this effect is statistically significant at 10%.

4) Increase of unemployment by 1% leads to decrease of inflation rate by 0.001%. The coefficient is statistically significant at 10% and in line with the short-run Philips curve relation.

5) An increase in actual wages by 1% is associated with lower inflation rate by 0.01%. This effect is statistically significant at the highest level.

6) Institutional improvement in transition measured by the *EBRDI2* index by 1% (the index is normalized and it ranges from 0 to 1) is associated with lower inflation by 0.13% and this effect is statistically significant at 10%.

The previous effects are obtained as the short-run influences in the model. To calculate the longer effect of these variables we use the following formula:

$$longX = \frac{\lambda}{1-\beta};$$

where "$longX$" denotes the "λ" long-term effect of changes in the chosen regressor is the estimated coefficient of variable in our dynamic panel model; and "β" is the estimated coefficient on the lagged depenent variable.

The long-run coefficient suggests that only one determinant from our list, namely, *FOODchangepos*- change of food prices is not statistically significant, while all other determinants are important in the long run as well. However, if we look at the magnitude of these effects, it is indicative that their effect is rather small. Simply said, unemployment, openness, price of oil, real growth of wages and EBRDI2- as a measure of institutional and structural progress are important for inflation in the long run, but their economic effect is not that strong. However, we have obtained an unexpected negative sign for the variable WAGE, which means that the growth of actual wages influences the reduction of inflation. An inverse relationship was also identified by Deniz, Tekce and Yilmaz (2016) for a group of industrialized countries where real wage growth is usually accompanied by productivity growth. However, theoretically explained wage rigidity, namely lags in the wage adjustment mechanism, can be a possible explanation as to why wage growth does not simultaneously affect inflation rate growth. Wages lag

Table 2: Determinants of inflation in the long-run

Dependent variable lnINFpos						
Independent variables	**Coefficients**	**Standard error**	**T**	**P>|t|**	**[95% Interval]**	
lrWAGE	-0.002	0.001	-1.71	0.099	-0.005	0.001
lrlnFOODchangepos	0.270	0.173	1.56	0.130	-0.084	0.626
lrlnOIL	0.005	0.002	2.35	0.026	0.001	0.010
lrOPEN	0.001	0.001	1.93	0.065	-0.001	0.001
lrUNEMPL	-0.002	0.001	-4.53	0.000	-0.003	-0.001
lrEBRDI2	-0.226	0.053	-4.26	0.000	-0.335	-0.117

Source: Author's calculations using STATA 12

behind prices and therefore passively and unexpectedly influence the character of the inflation process leading to asymmetric price responses. The lag dependent variable in our final specification indicates strong inertia in the inflation rate that can be attributed to slowly adapting or backward looking expectations. Similarly, Masso and Staehr (2005) emphasize the role of the backward looking mechanism as a potential source of rigidity and observe that current wages follow past inflation due to strong inertia. Coorey et al. (1996) further point to the extremely important role of inflation inertia in countries with moderate inflation levels while Aisen and Veiga (2006), Hammermann and Flanagan (2007) and Agayev (2012) for Eastern European countries have also identified the strong effect of inflation inertia on price dynamics. Our results are also consistent with empirical findings of Coorey et al. (1996), Borio and Filardo (2007), Agayev (2012) and Deniz, Tekce and Yilmaz (2016) who recognize wages or unit labor costs as a key inflation determinant. The role of unemployment as an inflation determinant and proxy for cyclical position or indication of labor market flexibility was recognized by Staehr (2010) and Kalimeris (2011).

The results of our research also point to the conclusion that dynamics of inflation in this group of countries is significantly determined by the geographical and institutional characteristics of the group, especially the foreign trade environment and role of external factors. Egert (2007) reached a similar conclusion for small and open economies. Although worrying, the influence of external supply side factors can also be partly explained by pronounced inertia as a key structural characteristic of an economy. These results would therefore be misinterpreted in such way that the individual characteristics of economies do not play significant role in price setting behaviour. In this regard, we conclude that sensitivity to global, regional and other external influences can be partly attributed to the characteristics of the trade sector, inability to influence trade conditions, market power and liberalization of trade flows as well as to specific effects of institutional mechanisms and the role of structural features, namely the labour market as factors of global economic transmission.

The obtained results also indicate that relative price variability or rise of commodity prices, namely food and oil prices, usually creates inflationary pressure in these countries. We have identified the importance of both, short- and long-term effects of oil prices on inflation dynamics while food prices proved to be a short-term inflation predictor and to have stronger but short-lived impact. Masso and Staehr (2005) come to the same conclusion. A systematic effect of oil prices on production, transport, wages and prices was also recognized by Aziz and Dahalan (2015) and Bala and Chin (2018), who emphasized the nonlinear impact of changes in oil prices on inflation as well as Sek, Teo, and Wong (2015) who highlighted the significant role of external shocks on inflation trends in countries characterized by financial instability. The long-term effect of oil prices on inflation was also identified by Chou and Tseng (2011) and Mahabadi and Kiaee (2015). Our findings are supported by the arguments of LeBlanc and Chinn (2004) who indicate that European inflation is more reactive to changes in oil prices and Cunado and Perez de Gracia (2005) who point to the negative effects of oil price shocks on capital and labor productivity, which usually leads to lower real wages. Aisen and Veiga (2006) have also recognized the role of oil

[22] This usually means a costly disinflation process and adjustments through relative price changes and consequently weak economic recovery.

[23] Bronfenbrenner and Holzman (1963) point out that wage growth does not necessarily lead to price growth since higher wages can be paid out from profits resulting from previous demand growth and therefore point out that there is a lag in wage movement that leads to smaller or slower price increases. There is also a "classical dichotomy argument" that separates movement of nominal variables from the real side of the economy.

prices as well as the effect of institutional factors and trade openness on inflation. A significant role of openness for developing countries, namely a positive relationship which is in line with our results was also identified by Tasci, Esener and Darici (2009), Ghanem (2010) for 17 MENA countries, Alfaro (2005) after heterogeneity control, and Mafi-Kreft and Kreft (2006). Therefore, our results suggest that openess does not eficiently reduce inflation and usually leads to negative trade effects. This kind of relationship can be partially attributed to the structural characteristics of these economies, which limit potential of monetary and fiscal policy to control inflation and lead to permanent differences in inflation variability.

Sensitivity analysis

As part of our sensitivity analysis we have expanded our specification with a number of other variables that can be identified in the literature as relevant, including *LAND*- territory area, *POPG*- population growth, *AGR*- share of agriculture in GDP, CURRENT- current account balance in % of GDP, *GOVEXP*- government expenditure, DOMCRED – domestic credit to private sector in % of GDP and INFINV – Inverse Hyperbolic Sine transformation form of the dependent variable. However, neither of these new models proved to provide a better model in terms of its statistical properties, which lead us to conclude that our preferred specification is a better choice.

Being specifically concerned about the potential problem of endogeneity in the model of related independent variables, we have estimated a number of models changing this assumption. Namely, the variables GDPG – real GDP growth, *M2* - growth of money supply, *EXRGreer* – growth of actual exchange rate and *WAGE* – growth of real wages, CBI-central bank independence have been also treated as endogenous, using internally generated instruments (we have instrumented these variables with their lag levels). This procedure was first applied independently for each variable. As our final step, we have estimated the chosen model equation treating these variables jointly as potentially endogenous. Our results remain consistent leading to the conclusion that possible omitted endogeneity is not an issue. Variables from the final model specification remained statistically significant, and statistical properties of relevant testing procedures (AR1, AR2, Sargan, and Hansen test statistic) were mostly satisfactory. Interestingly, endogeneity testing procedure points to the MSG variable – growth of money supply, as a nadditional possible inflation predictor in several estimated equations. This proves our thesis that observed countries import external conditions through institutional framework and highlights the role of the balance of payment account. However, even with the minimum number of lags these models have more instruments than groups due to small sample properties and we conclude that the statistical diagnostics of these models is not appropriate for SGMM, primarily due to the large number of weak instruments. Thus, our final specification is robust to the checks explained above.

One of the compiling explanations points out that limited access to external financing sources implies greater dependence on inflation tax. In the presence of inflation inertia and exchange rate shocks the potential accommodating fiscal policies are followed by money creation and changes (shrinking) in the inflation tax base. As an additional robustness check, we have included the variable DOMCRED (domestic credit to private sector to GDP ratio) in the final specification and our results remain mostly unchanged. The variable has the expected sign (-) meaning that countries with a more developed financial market are less prone to incur seigniorage based revenues. Variable EBRDI2, which was significant at 10%, was no longer significant and variable OIL becomes insignificant. Statistical properties of this model remain satisfactory and statistical diagnostics stable.

As our final checking procedure, we created an additional variable INFINV to account for negative inflation values. Model specification using Inverse Hyperbolic Sine transformation form of the dependent variable does not lead to different results/conclusions. All variables except the variable OPEN (proxy for trade openness) remain significant but statistical properties of the model are worsened, since the Sargan test rejects H_0 of instrument validity, while AR1, AR2, and Hansen diagnostics remain satisfactory. Thus, we believe that our preferred model is the one which should be reported.

Although the SGMM model does not require checking of stationarity, in general we applied a strategy according to which all the variables entering the model may be treated as stationary (presented as % of change or the share of GDP) which reduces the risk of false correlation of variables. We have also estimated the final model without time dummies. The Hansen test of that model was not appropriate, and this confirms that the universal time related shocks must be controlled and that the final model is a better choice of interpretation.

Conclusion

This paper investigates determinants of inflation in 28 European economies by using dynamic panel modelling. The empirical investigation includes relevant determinants of inflation and distinguishes between their short and long run effects, which is the main contribution of this study. The obtained results of this analysis identify the important role of structural variables for inflation, such as

unemployment rate and growth of real wages, including both, the short-term and long-run general price dynamics. The research results also confirm a long-term effect of institutional indicators, which is not identified in the short run. Among external factors being controlled in the research, we identify dominance of the supply side shocks, such as changes of food and energy prices. The energy prices have a significant long-term effect on inflation while the influence of food prices is limited only to the short-term. The effect of relative price variability is amplified by existing specific structural features and market rigidities and usually results in strong inflation inertia due to inoperational policy mechanisms. In such circumstances, short-term changes result in long-term effects. To overcome negative terms of trade shocks and external influences our results further critically point to institutional mechanisms and the role of prudent monetary and fiscal policies as a way of insulating economies from asymmetric shock impacts. The results additionally indicate the impact of time related shocks on inflation in transition countries. Accordingly, we can conclude that the combined effect of supply side shocks and demand side shocks determine price oscillations of transition economies. Interestingly, the results do not differ between the EU and non-EU European countries in our focus. Inflationary experiences may serve as a proper benchmark which points to underlying causes that lead to similarities or differences in economic outcomes of countries. Therefore, for European countries, the character of inflationary dynamics is recognized as a key convergence and stabilization indicator. Stability of the results has been confirmed by carrying out standard checking procedures including additional model specifications and different assumptions regarding endogeneity of the variables used in the modelling procedures.

Appendix 1: List of variables in the research

Variable	Label	Description of variable	Source	Note
Inflation	LnINF	Logarithm of inflation rate change (annual % change in CPI)	WEO	Since 26 observations have negative values in order to apply logarithmic computation we transformed the dependent variable in a way that inflation rate change had been increased by the constant value 100
Real GDP growth	LnGDPG	Annual growth rate based on market prices, expressed in constant local currency (annual % change)	WDI	LnGDPG is logarithmic transformation of variable GDPG
Growth rate of monetary aggregate- M2	MSG	Broad money supply growth which is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveller's checks; and other securities such as certificates of deposit and commercial paper (annual % change)	WDI	Data for 5 countries: Estonia, Latvia, Lithuania, Slovakia and Slovenia are from national central bank statistics while the data source for Turkmenistan and Uzbekistan is the Asian Development Bank. The exceptions are data for 2015 for Lithuania –source IMF country report 2019-article IV consultation , and data for Slovenia for 2005, 2006 and 2007 –source EBRD report)

Openness	OPEN	The sum of exports and imports of goods and services measured as a share of gross domestic product (% of GDP)	WDI	
Fiscal balance/GDP	FB	Fiscal balance in % of GDP	WEO	
Terms of trade	TOT	Ratio of the export unit value index to the import unit value index (base year 2000)	WDI	Data source for Serbia and Montenegro is AMECO database (2010=100)
Unemployment rate	UNEMPL	Unemployment rate (%)	ILO estimate	
Real wage growth	WAGE	Mean real monthly wages of employees (annual growth rate-%)	ILO estimate	Data for Albania, Montenegro, Romania, Georgia, Kirgizstan and Moldova for 2015 are from Global Wage Report ILO 2018/2019. Data for Hungary for 2007 is from national statistical office, data for Montenegro for 2005 and 2006 are from Annual Central Bank Report while the data for Turkmenistan for 2006 and 2007 are calculated as average value based on ILO Wage Report 2008. Source data for Uzbekistan is WB Report "Growth and Job Creation in Uzbekistan: An In-depth Diagnostic", 2018
Political stability	POLS	Political stability measured by index of control of corruption which has value from -2,5 to 2,5	World governance indicators	
Exchange rate	EXRGreer	Annual average of national currency (% change of real exchange rate –previous year)	Bruegel	
Exchange rate regime	PFW	Dummy variable for IMF De facto classification of exchange rate regimes (fixed –value 2;intermediary-value 1 and floating-value 0)	IMF (AREAR annual report)	Ghosh (2014)
Central bank independence	CBI	Cukierman index of central bank independence	Garriga (2016)	According to author suggestion index value for 2012 is assigned for the following period 2013-2015

EBRD index of structural and institutional reforms	EBRDI2	The EBRD index of structural and institutional reforms, published annually, includes the following areas: Governance and enterprise restructuring; Price liberalization; Trade and foreign exchange system; Competition policy; Banking reform and interest rate liberalization; Securities markets and nonbank financial institutions; Large-scale privatization; Small-scale privatization. Since the EBRD indices range from 1 to 4 + (where 4 + is approximation of an advanced market economy) we have linearized the scores, assigning the value of 0.33 to a '+' indicator (following Efendic and Pugh 2015). Hence, all indices are divided by 4.33 in order to get the rank from 0 to 1, where 1 is the maximum value of the index.	EBRD	Available for all countries in sample except for Czech Republic for 2008-2015 as it is considered to have completed its transition in 2007. Index is transformed according to Efendic and Pugh (2015)
Oil prices	lnOIL	Oil price expressed in local currency (Real oil price - Brent crude oil in US$ converted in local currencies using the average market exchange rates against US $ and deflated by CPI)	WB Pink Sheet, FAO, WB	LnOIL is logarithmic transformation of variable
Food prices	lnFOOD-changepos	% change in food CPI	FAO	Data source for Uzbekistan 2005-2015, Mongolia 2005 and Armenia 2005-2009 - Asian Development Bank. Data source for 2005 and 2006 for Albania - UN statistics. Data for 2005-2012 for Moldova – source National Statistic office. Data for Serbia for 2005 and 2006-source National statistical office
EU membership	EU	Dummy variable for EU members	Author calculation	
Domestic credit to private sector*	DOMCRED	Domestic credit to private sector as % of GDP	WDI	Missing data for Uzbekistan (2005-2015) and data for Latvia and Lithuania (2005-2009)

Inflation*	INFINV	Inverse Hyperbolic Sine transformation form of dependent variable, Pence (2006)	Author calculation	
WB group*	WB	Dummy variable for countries in Western Balkan region	Author calculation	
CIS group *	CIS	Dummy variable for countries in CIS region	Author calculation	
General government expenditures *	GOVEXP	General government final consumption expenditure (% of GDP)	WDI	
Current account balance *	CURRENT	Current account balance (% GDP) presents sum of net export of goods and services, net primary and secondary income	WDI	Data for Turkmenistan and Uzbekistan - source Asian Development Bank, Data for 2006 for Serbia and Montenegro are from Quarterly report of European Commission 2011 for candidate and potential candidate countries, while data for 2005 are from EBRD 2008 transition report
Share of agriculture *	AGR	Agriculture, forestry, and fishing, value added (% of GDP)	WDI	Data for Armenia for 2005-2011 -source FAO
Population growth *	POPG	Population growth (annual %) – Population is based on de facto definition of population which includes all residents no matter of legal status or nationality.	WDI	LnPOPG is logarithmic transformation of variable
Territory area *	LAND	Territory area (sq. Km) – the total territory of the country, excluding the area under inland water zones, national claims for the continental belt and exclusive economic zones. In most cases, the definition of inland water zones includes major rivers and lakes.	WDI	LnLAND is logarithmic transformation of variable
Growth of real GDP per capita*	GDPpcg	Annual growth rate of BDP per capita (%) based on constant local currency in US$	WDI	LnGDPpcg is logarithmic transformation of variable

Index of Economic Freedom*	POLSHFI	The Index covers 12 freedoms (property rights, judicial effectiveness, government integrity, tax burden, government spending, fiscal health, business freedom, labour freedom, monetary freedom, trade freedom, investment freedom and financial freedom). Maximum score is 100 and minimum 0.	Heritage foundation	
Index of Economic Freedom*	POLSFIW	The Index covers 5 areas (size of government, legal system and property rights, sound money, freedom to trade and regulation)	Fraser Institute	
Nominal or real exchange rate index*	EXR/EXRr	Nominal/Real exchange rate index	Bruegel	

Source: Author Note: marks additional variables used for stability analysis of the chosen model.*

Appendix 2: Summary of selected empirical research

Study	Data and Sample	Dependent variable(s)	Controls	Technique
Coorey et al. (1996)	1991/92- IIIq1995 quarterly data for 21 transition economies (only Albania from group of Western Balkan –WB countries)	Inflation rate (quarterly change %)	Growth rate of broad money - contemporaneous and lag form **(+)**, unit labor cost growth or nominal wage growth - contemporaneous and lag form **(+)**, real exchange rate growth measured as the relative price of tradables to nontradables in lag form **(-)**, exchange rate regime **(-)**, relative price variability **(+/-)**, lag dependent variable **(+)**	OLS
Cottarelli, Griffiths and Moghadam (1998)	1993-1996 (annual data) 47 countries including 22 industrialized countries (OECD), 10 transition economies (Albania and North Macedonia from group of WB countries) and 15 FSU countries (CIS group)	Δ Log Inflation	Fiscal balance % of GDP **(+)**, Absence of government securities market **(+)**, Domestic debt/GDP **(-)**, Base money/GDP **(-)**, Current account deficit as % of GDP **(+)**, Unemployment rate **(-)**, Private sector share in GDP **(-)**, Relative price changes **(+)**, Subordination of Central bank independence **(+)**, Exchange rate regime **(-)**, Various EBRD transition indicators **(-/+)**, Openness measured as import ratio to GDP **(+)**, Index of economic freedom (Heritage foundation) and other structural factors influencing natural rate of unemployment -Degree of centralization of wage bargaining system **(+)**, Wage indexation **(+)**	Dynamic panel Arellano-Bond (1991)

Alfaro (2005)	1973-1998 (annual data) (130 developed and developing countries)	Log of Inflation measured by GDP deflator (log of average annual changes in GDP deflator), CPI inflation (for robustness check)	Openness measures (Import share in GDP **(-/+)** and Export share inGDP **(-/+)**, Log of real GDP per capita **(-)**, Growth of real GDP per capita -first difference of log of real per capita GDP in constant 1995 US dollars **(-)**, Fiscal deficit as % of GDP **(+)**, Public debt -central government debt in % GDP **(+)**, Exchange rate regime (IMF classification and Rogoff and Reinhart (2004) classification **(-)**	OLS and Panel analysis (FE - Fixed effects)
Inoue (2005)	1995-2003 20 transition countries (10 CEE countries and 10 FSU countries (from group of WB countries: Albania, Croatia and North Macedonia)	First difference of natural logarithm of inflation rate (CPI 1991=100 is derived from the change in annual average CPI)	Exchange rate regime and policy framework -dummy variables for inflation targeting and fixed exchange rate regime **(-)**, Government budget surplus in %GDP **(-)**, First difference of natural logarithm of broad money –M2 **(+)**, Indices of economic liberalization -subindicies and weighted average of EBRD transition indicators **(-)**, Central bank independence index according to Cukierman et al. 1992 **(-)** and lag dependent variable **(+)**	Panel analysis (FE -fixed effects and GLS-Generalized Least Squares)
Catao and Terrones (2005)	1960-2001 107countries	Inflation rate (annual percent change in CPI)	Narrow money M1/GDP **(-)**, Central government nominal deficit scaled by GDP or M1 **(+)**, General government deficit scaled by GDP or M1 **(+)**, Oil price inflation – average annual % change of US$ spot price **(+)**, Openness measured as import+export/GDP **(+)**, exchange rate regime **(-)**, Reinhart and Rogoff, (2004)	Panel analysis (MG and PMG estimator, Pesaran et al. 1999)
Cunado and Perez de Gracia (2005)	1975Q1-2002Q2 6 Asian countries	Inflation rate (CPI) GDP (real GDP or Index of Industrial Production as proxy)	-Oil prices measured as quarterly changes of real oil price –first difference transformation of oil price variables in log **(+)**: oil_t = ln oil_t − ln oil_{t-1} (oil_t-real oil price in US $ or expressed in local currency by means of market exchange rate -Oil prices measured as real oil price increases **(+)**: $\Delta oilt^+$= max(0,Δoilt) or -Oil prices expressed as net oil price increases –quarterly % change in real oil price levels from past 4 or 12 quarters **(+)**	GARCH model (cointegration and Granger causality test)

Aisen and Veiga (2006)	1960-1999 around 100 countries (data collected for 178 countries)	Inflation rate - CPI (logINF)	-Political variables as proxy for political instability and role of institution according to Beck et al. (2001), Database of Political Institutions, Freedom House and Polity IV dataset (Government crisis **(+)**, Cabinet changes in premier office **(+)**, Index of Economic freedom –not included in final model **(-)**, Polity scale –from autocratic to democratic **(-)** -Economic structural variables (Share of agriculture as %GDP (not included in final model),Openness **(-)** -Variables accounting economic performance and external shocks (Growth of real GDPpc **(-)**, Real effective overvaluation of the national currency **(-)**, Growth of oil prices % of annual change **(+)**, US Treasury Bill Rate as proxy for international interest rate **(+)**, lag dependent variable	Dynamic panel SGMM Blundell-Bond (1998)
Mafi-Kreft and Kreft (2006)	1995–2001 25 transition countries	- Rate of depreciation in real value of money according to Cukierman, Miller and Neyapti (2002) in order to eliminate variability in inflation rates among countries in sample)	Central bank independence index **(-)** according to Cukierman, Miller and Neyapti, (2002), Exchange rate flexibility index **(+)** according to Bubula and Otker-Robe, (2002), Dummy for hard peg, Dummy for countries at fast track to EMU **(-)**, Government fiscal balance as % GDP **(+)**, Real GDP growth rate **(-)**, Openness **(+)**, Share of value added of agriculture in GDP **(+)**	Panel analysis (FE)

Hammermann and Flanagan (2007)	1995-2004 19 transition countries (CIS West, CEEC countries – Baltic countries and Central Europe countries	Depreciation rate of money defined as: $d_{it}= \pi_{it}^{d}/1+ \pi_{it}^{d}$ where π_{it}^{d} presents inflation rate – CPI annual average	EBRD price liberalization index **(-)**,General government gross debt in % of GDP as measure of fiscal sustainability **(+)**, Competition policy - EBRD index **(+/-)**, Openness -EBRD trade and foreign exchange rate system **(-)**,Governance and enterprise restructuring -EBRD index, Flat tax dummy **(+)**, Share of agriculture in % of GDP (-), Current account in % of GDP **(+)**, Bank reform and interest rate liberalization **(+/-)**, Securities market and non-bank financial institutions **(+/-)**, Exchange rate vis-à-vis key currency, Interest rate, Weighted index of Central Bank Independence (-) according to Cukierman, Miller and Neyapti, (2002),Terms of trade in goods and services **(+)**, Change in the share of administered prices **(-)**, Government stability indicator - Database of Political Institutions **(-)**, Crop production index, EU dummy for accession **(+/-)**	Panel analysis (FE) following Cottarelli, Griffiths, and Moghadam (1998), Mafi-Kreft and Kreft (2006) and Aisen and Veiga (2006).
Kwon et al. (2008)	71 countries (13 major advanced countries, 10 other advanced countries and 48 developing countries) 1963-2004	Inflation rate (first difference of log CPI)	Money growth (+), Real GDP growth (-), Public debt growth (+), Public debt/BDP (+), Exchange rate regime flexibility according to Reinhart and Rogoff (2004) (+) and lag dependent variable (variables expressed as first differential and in log form)	Panel analysis (FE and GMM, and stability analysis MGE, FMOLS model)
Calderon, Schmidt- Hebbel (2008)	97 countries 1975-2005 (Bulgaria, Croatia, Hungary, Poland from group of transition countries)	Inflation rate (CPI inflation rate/(1+CPI inflation)	Overall government budget balance (surplus)/GDP **(-)**, Domestic credit to private sector/GDP **(+)**, GDPpc **(-)**, Trade openness **(+/-)**, dummy for IT **(-)**, Exchange rate regime, Reinhart and Rogoff, (2004) and IMF **(-)**, Capital openness dummy **(-)**, Chinn and Ito, (2002, 2005) , Democratic accountability , International country risk guide **(-),** International oil price average **(+)**, National output gap **(+/-)**,Foreign output gap **(-)**, External inflation **(+/-)**	Panel analysis (FE, RE, PMG, MG, GMM)

De Grauwe and Schnabl (2008)	1994-2004 18 countries from (South) East and Central European countries (Serbia and Montenegro are excluded from group of Western Balkan countries due limited data availability)	Inflation rate - CPI GDP	Money supply growth **(+)**, Real GDP growth **(-)**, Dummy for fixed and intermediary regimes **(-)**, Exchange rate regime -IMF de facto classification –volatility against $ and euro **(+)** , Central bank independence - dummy and index according Cukierman et al. (2002), Capital inflows as % of GDP, Budget deficit as % of GDP, EMU CPI, Dummy for financial crisis **(-)**, real EU GDP growth **(+)**, IT dummy **(-)**	Panel analysis-GMM GLS
Staehr (2010)	1997-2007 10 CEE countries	Inflation rate – Annual percentage change in HICP	Import price % change **(+)**, Percentage change in nominal exchange rate index **(+)**, Exchange rate regime –dummy **(+)**, Government budget balance %GDP **(-)**, Government debt %GDP **(+)**, Government revenue % GDP **(+)**, Total tax revenue % of GDP **(+)**, Value added tax revenue % of GDP **(+)**, Difference in labor productivities in manufacturing and private sector % of change **(+)**, Overall labor productivity % change **(-)**, Gross fixed capital formation % of GDP **(+)** Openness **(+)**, Unemployment rate % **(-)**, Employment % change **(+)**, GDP % change **(+)**, Current account balance % of GDP **(-)**, Trade balance % GDP **(-)**, Gross labor earnings % GDP **(-)**, EBRD index of price liberalization -change **(-)**, EBRD index of forex and trade liberalization-change **(+)**, 3-month interest rate % **(+)**, Food and Energy price inflation % change **(+)**, EU dummy **(-)**, lag dependent variable	Panel analysis GMM
Tasci, Esener and Darici (2009)	1980-2006 11 developing countries	Inflation	Openness to foreign trade **(+)**, Nominal exchange rate **(+)**, Foreign direct investment **(+)**, GDPpc **(+)**	Panel analysis (FE, RE)
Lin (2010)	1970-2007 106 countries (annual data) and 2005-2008 49 countries (monthly data)	Inflation (change in inflation rate measured by GDP deflator and expressed as log (1+inflation $_{it}$)	Openness measured as share of import in % of GDP **(+/-)**,Growth rate of GDPpc **(+)**,Exchange rate regime **(-/+)** according to Reinhart and Rogoff, (2004)	Quantile regression and Least Square Fixed effects (FE)
Telatar et al. (2010)	1983-2002 39 countries	Inflation rate measured as annual growth rate of GDP implicit deflator	Growth rate of money **(+)**, Wages proxied by earnings in manufacturing **(+)**, Import price **(+)**, Change in interest rate **(+)**,Political stability **(-)**, International Country Risk Guide-PSR group, Political freedom -Gastil Index, Freedom House **(+)**	Panel analysis (GMM)

Kalimeris (2011)	Jan1997-April 2007 EU, SAD and Japan	Inflation HICP (monthly)	Oil price **(+)**,Unemployment **(-)** and Interest rates **(+/-)**	Panel analysis (Pooled Least Squares-FE)
Chrigui et al. (2011)	1971-2004 40 emerging and developing countries	Inflation rate D = P/(P + 1) where P represents inflation rate	Central bank independence measured by TOR index-turnover rate of governor **(+)**, GDP/capital **(-)**, Openness **(-)**, Debt % of GDP **(+)**, Credit to private sector %GDP **(-)**	Static panel (FE)
Agayev (2012)	1998-2008 23 transition economies (three countries from group of WB countries: Albania, Croatia and North Macedonia)	Inflation rate – CPI (% change)	Change in annual exchange rate of national currency expressed in US $ **(+)**, % change in average gross wages **(+)**, Growth rate in money supply -M2, M3 or M4 **(+/-)** and lag dependent variable	Panel analysis (FE, RE and mixed effects model)
Bogoev, Petrevski and Sergi (2012)	1990-2009 17 transition economies (Albania, BH, North Macedonia ,Serbia and Croatia from group of Western Balkan countries)	Inflation rate (transformed as rate of real depreciation of money $\pi_{it}/1+\pi_{it}$)	Central bank independence **(-)** measured as Cukierman index and GMT index according to Cukierman et al. (2002) and Maliszevski, (2000) respectively, Foreign inflation-EMU inflation rate **(+)**, Cumulative liberalization index **(-)**, Openness **(+)**, Output gap **(+/-)**, Budget deficit **(-)**, Exchange rate regime (-), IMF and Reinhart and Rogoff, (2004) classification	Panel analysis (FE)
Ghanem (2012)	1980-2007 17 MENA countries	Log of Inflation rate	Growth of real money -M1 **(+)**, Real GDP growth **(-)**, Exchange rate regime **(-)**, Openness **(+)**, Real oil price expressed in domestic currency **(-)**, lag dependent variable	OLS, FE and FGLS and GMM estimator
Lin and Chu (2013)	1960-2006 (annual data) 91 countries (24 OECD countries)	Inflation rate - CPI (% change defined as log 1+inflation/100)	Nominal central government deficit scaled by M1 or GDP **(+)**, growth rate of narrow money - M1**(-)**, Growth rate of real GDPpc **(-)**, Oil price inflation % change expressed in local currency **(+)**, Openness **(-)**, Exchange rate regime **(+)**, Reinhart and Rogoff, (2004), lag dependent variable	Dynamic panel (DPQR model and ARDL specification and difference GMM)
Posso and Tawadros (2013)	1987-1991 and 2002-2006 56 countries	Inflation (average annual inflation rate)	Openness **(+)**, Central bank independence index **(-)**, Cukierman et al. (1992), Central bank political transparency **(+)**, Crowe and Meade, (2008), Governor turnover rate **(+)**, Democracy score **(-/+)**, Marshall and Cole, (2011), Level of GDPpc **(+)**, Exchange rate flexibility **(+)**	Covariance structure analysis (First difference estimator)

Begovic (2014)	1998-2009 25 transition countries	Log Inflation (annual rate of CPI change)	Real GDP growth **(-)**, Growth of broad money-M2 in lag form **(+)** ,Fiscal balance/GDP **(+)**, Openness **(+)**, Terms of trade **(+)**, EBRD progress in transition indicator **(-)**, Central bank independence **(-)**,Cukierman et al. (1992), Fixed exchange rate regime (dummy) **(-)**, EU membership dummy **(+/-)**, Dummy for VAT introduction **(+)**, lag dependent variable	Static and dynamic panel analysis
Sek, Teo and Wong (2015)	1980-2010 20 countries	Inflation (annual rate of CPI change)	GDP in US$ **(+)** ,Real effective exchange rate **(+/-** in long term), PPI index for US **(+)**, World oil prices in $ per barrel **(+)**	Panel analysis, ARDL model-PMG estimator
Mahabadi and Kiaee (2015)	2008-2012 All countries from WB database	CPI inflation rate (log of annual % change) and inflation level expressed as ordinal inflation variable	Growth rate of money **(+)**, Change in currency value per US $ **(+)**, Change in private consumption level **(+)**, Change in government consumption level **(+)**, Change in gross capital formation **(-)**, % change in GDP level **(+)**, Oil price change per barrel **(+)**	Panel analysis (Random effects model, Ordinal logistic mixed effects model)
Garriga (2016)	1970-2012 182 countries	Inflation Unemployment GDP growth	Central bank independence **(-)**, Cukierman et al. (1992), lag dependent variable	Panel analysis (FE)
Deniz, Tekce and Yilmaz (2016)	2002-2012 (annual data) 40 countries of which 34 OECD countries	CPI inflation rate- (% change on the same period previous year)	Growth rate of broad money- M2 **(+)**, Real effective exchange rate index **(-)**, General government budget balance as % of GDP **(-/+)**, GDP growth rate **(+/-)**, Annual minimal real wages **(+/-)**, Output gap **(+/-)**, IT dummy **(+/-)** and lag dependent variable	Static and dynamic panel analysis (FE,RE, GMM)
Cardoso and Vieira (2016)	1990-2009 82 countries	CPI inflation rate (% change on the same period previous year)	Exchange rate regime dummy for intermediate and flexible regime **(+/-)**, Growth rate of broad money - M2 **(+)**, Gross government debt as % GDP **(+)**, Change in real effective exchange rate **(-)**, Real interest rate in % **(+/-)**, IT dummy **(+/-)**, Level of development dummy **(+/-)**, dummy for Currency crisis **(-/+)**, Crisis of capital flows **(+)**, Banking crisis **(-/+)**, Government debt crisis **(+)** and lag dependent variable	Panel analysis, system GMM

Choi et al. (2018)	1970-2015 annual data 72 advanced and developing economies (18 countries from group of transition countries) 2000-2015 monthly data	CPI inflation rate (% change on the same period previous year)	Global oil inflation **(+)**, Inflation targeting regime **(-)**, Energy intensity **(+)**, Primary energy production **(-)**, Labor market flexibility proxied by Index of Economic Freedom, Fraser institute **(-)**, Central bank governor turnover as measure of CB governance **(+)**, Crowe and Meade, (2007), Legal central bank independence index **(-)**, Crowe and Meade, (2007) and Dincer and Eichengreen ,(2014), Transport weight in CPI **(+)**, Energy subsidies **(-)**, Fuel import **(+)**, Net energy import **(+)**, Nominal exchange rate , lag dependent variable	Panel analysis (Impulse Response Function), GMM and VAR approach for robustness check Weighted Least squares

Source: Author

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