Producer Price Index and Consumer Price Index: Causality in Central and Eastern European Countries

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Abstract

This article uses the bootstrap panel Granger causality to analyse the link between the Producer Price Index (PPI) and Consumer Price Index (CPI) in ten Central and Eastern European (CEE) countries. The result of cross-sectional dependency and slope homogeneity shows that PPI and CPI vary in different countries. However, the result indicates that PPI influences CPI in the sense of Granger causality in five CEE countries; namely, Latvia, Lithuania, Romania, Slovakia and Slovenia. The findings support the moderate inflation model in the significant countries, which explain that PPI is a primary contributing factor of CPI. On the other hand, CPI has a significant impact on the PPI only in Hungary. The results are useful for policy makers of these countries to formulate inflation targeting policies with greater attention towards the PPI.

Keyword: *Consumer Price Index, Producer Price Index, rolling window, time--varying causality, bootstrap*

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Introduction

Inflation is one of the most important macroeconomic variables, measuring the growth rate of consumer prices. High inflation has strong repercussions on all segments of an economy in the form of high-interest rates, reduction in

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investment and influences both labour market and living standards of people (Holub, 2000; Alexová, 2012). Broad-spectrum inflation is to be seen as a cost for businesses and households which results in the reduction of welfare and creating uncertainty in outputs (Friedman, 1977; Ball, 1992; Daniela, Mihail-Ioan and Sorina, 2014). On the other hand, price stability is essential for economic growth and efficiency as well as other macroeconomic goals (Christoffersen, Slok and Wescott, 2001), improving employment, financial stability and reducing the risk premium. Thus, the most important role of any monetary policy is long-term price stability to minimize the adverse consequences of aggregate price movements and uncertainty on the economic decision (Becsi, 1994). The debate on the association between the Producer price index (PPI) and Consumer price index (CPI) draws considerable attention as both have a profound impact on the monetary policy (Dorestani and Arjomand, 2006; Hakimipoor, Alipour and Akbaryan, 2016). The joint effect of the PPI and CPI in an economy helps in measuring the gross domestic product and actual inflation (Yu, 2016). A precise prediction is achieved by examining the relationship between PPI and CPI. It is argued that any increase in the PPI is reflected in the CPI and could have a sizable effect on long-term economic growth. As such, inflation forecasting is imperative to make informed decisions. Given the consequences of inflation on the economic, social and political sectors, the challenge is to encourage saving, investment and boost up the economic growth (Debelle et al., 1998). The relationship between price indices gives the information about inflation and economic development, helping governments devise the various policies (Gao, An and Zhong, 2013). Different economic policies revolve around controlling inflation, and government officials use price trends to evaluate financial performance (Webb and Willemse, 1989; Preda, Dragoi, and Constantinescu, 2015). It reveals better knowledge to the policymakers to forecast inflation, manage and accomplish the inflation target in the economy (Mihailov, Rumler and Scharler, 2011).

In the past decades, Central and Eastern Europe (CEE) countries recorded an active and significant economic development (Holub, 2000), registering during this transition period an average economic growth of 5% (Dombi, 2013). The Baltic States and Romania even had an average of 10% economic growth. However, at the same time, the biggest challenge to these countries was the substitution of the controlled price system from communism with price liberalisation (Fischer and Sahay, 2000). In the early 90s, these countries witnessed the problem of high inflation, and major economic policies were initiated to control it (Viorica et al., 2014). Structural reforms in the price and trade liberalisation, as well as currency devaluation, caused an increase in the inflation rate (Tiits et al.,

2008). During the transition period, CEE countries have adopted various approaches to managing inflation (Viorica et al., 2014), inflation targeting policies being different among these countries; the responses of the Czech Republic, Hungary and Poland were quicker as compared to the remaining the economies. Between 1998 and 2000, the external demand and falling oil prices subsequently the Asian crisis in 1997 and the Russian crisis of 1998 had declined the CPI (Stoica and Damian, 2013). However, the inflation in Bulgaria and Romania continued due to slow execution of structural reforms. Bulgaria achieved single digit inflation in 2000. On the other hand, Romania managed to lower inflation rates under the level of 10% only by 2005. During 2005 to 2007, Latvia, Lithuania, Slovenia and Bulgaria witnessed rising inflation rates while prices in the Czech Republic, Hungary, Poland and Slovakia remained under control as a result of successful execution of inflation targeting.

In Latvia Lithuania and Estonia, inflation consistently increased until the global financial crisis in 2008 occurred and the lowest inflation was observed. At the start of 2008, PPI witnessed a substantial increase by an average of 8%. Inflation increased due to the economic expansion of CEE countries and global commodity prices. However, the global financial crisis in 2008 had an adverse influence on economic growth causing the collapse of the global commodity prices inflation rates to drop. It strongly affected industrial production which led the decline of the PPI (Popescu, 2014).

The second half of 2008 was characterised by marked disinflation driven by a decrease in the global energy market and of food prices, as well as a decline in consumer demand and easing the tension in the labour market. The declining trend continued in 2009; the CPI in the whole region dropped to 2.1% and the annual inflation in the Czech Republic and Slovakia fell below zero. Nevertheless, the process of disinflation reversed in November 2011, the main reason behind it being the rising prices of energy and food as well as currency depreciation. Most of these small and open economies were also vulnerable to the Eurozone debt crisis in 2012 and shocks were felt in Romania, Bulgaria, Poland and the Baltic states (Sobják, 2013). All low time inflation in CEE countries was recorded in 2013 mainly due to the absence of high demand, and declining energy and food prices. Economic recovery continued in most CEE countries, and the disinflation pressure disappeared as rising commodity prices influenced the CPI. In 2015, the process of disinflation reversed in CEE countries, and the CPI rose again due to an increase in global commodity prices. The favourable economic condition was complemented by the fall in inflation which occurred in most countries mainly due to the supply side factors. The drop in inflation rates had a positive influence on competitiveness by lowering export prices as well as

domestic demand. A better knowledge of the leading factors of inflation in CEE countries is useful for households and businesses to anticipate and minimise its negative impact (Staehr, 2009).

The primary determinants of inflation in most of these countries are supply side and external factors. The changes in the cost of production lead to an increase in the price paid by the consumer indicating cost-push inflation. The supply-side inputs price causes the price of intermediate and final goods to change and is finally passed on to the CPI. On the other side, the demand for primary goods depends on expected future prices of consumer goods. The various reforms and structural changes, the accession to EU, the financial crisis in 2008 and Eurozone debt crisis in 2011 have a significant impact the supply and demand side factors which ultimately affect the CPI and PPI in the CEE.

This article contributes to the existing literature in two ways: first, it gives a new dimension to the relationship between the PPI and CPI as compared to previous research. Since the existing literature lacks panel studies to CEE countries, this paper is the first to examine the causality between the PPI and CPI in this region. The empirical results show that PPI causes the CPI in five of the studied CEE countries and those results are line with the moderate inflation model, which states that PPI is the leading indicator of CPI. On the other hand, CPI is a significant indicator of PPI only in Hungary.

The results of the study show mainly, that price stability is possible in CEE countries, as long as all implement well-established and coordinated monetary policies. Inflation can be mitigated if the PPI is taken into account in the formulation of economic policies. Second, the previous studies have no evidence of cross-sectional and heterogeneity slope. Thus, our study is an addition to the existing literature that the suggested Kónya (2006) model consider both cross--sectional dependence, as well as heterogeneity slope and results, indicates that interrelationship varies across CEE countries. The results of the bootstrap panel Granger causality for Latvia, Lithuania, Romania, Slovakia and Slovenia indicates that PPI has an important contribution in the CPI. The outcome of these five countries is consistent with moderate inflation model which describes how CPI variations caused in the sense of Granger causality by variations of the PPI. On the other hand, only in Hungary, the PPI is influenced by the CPI in the sense of Granger causality. The results are useful for policy makers of these countries to formulate inflation targeting policies with greater attention towards the Producer price index.

The structure of this study includes Part 1 reviews the literature. Part 2 explains the moderate inflation model. Part 3 describes the methodology. Part 4 reports the data and empirical analysis. Last Part mentions conclusion.

1. Literature Review

Several studies show the relationship between the PPI and CPI. Caporale, Katsimi and Pittis (2002) examine the causal link between the PPI and CPI using the Toda and Yamamoto (1995) method and find that PPI leads the CPI. Akdi, Berument and Cilasun (2006) conclude that PPI and CPI move together only in the short run. Ghazali, Yee and Muhammad (2008) find the long-term relationship as well as the unidirectional causality running from PPI to CPI. Shahbaz, Awan and Nasir (2012) find that PPI and CPI has a long-term association and their results also indicate that PPI plays a greater role in the formation of CPI. Akcay (2011) examines the correlation between the two indices and his finding indicates that price changes in the PPI are reflected in the CPI in long-term. Alemu (2012) shows a link between the two indices on both short and long-terms, in the sense that the CPI is more sensitive towards changes in the PPI concerning the direction and magnitude of the variation as well. Martinez, Caicedo, and Tique (2013) use the coincident profile method to explore the link between the PPI and CPI concluding that PPI plays a significant role in the CPI. Liu (2014) studies the price transmission mechanism and results reveal that the relationship is not stable between the PPI and CPI. Ulke and Ergun (2014) show that CPI is the leading indicator of the price changes in the long-term and it increases due to excess demand. Hakimipoor, Alipour and Akbaryan (2016) analyse the co-movement of the two indices and conclude no long-term relationship. Yu (2016) examines the relationship between the PPI and CPI in G7 and ASEAN countries and indicates that the latter have unidirectional causality from PPI to CPI while the same relationship is bidirectional in G7 countries. Tiwari (2012) investigates the PPI and CPI linkage in Australia, and the result demonstrates that PPI has a significant impact on the CPI at the intermediate level. Tiwari et al. (2014) examine the relationship between the PPI and CPI in Mexico and result indicate bidirectional causality in both short and long-term.

We find some studies related to CEE countries concerning the causal relationship between PPI and CPI. Holub (2000) finds that producer prices have a significant impact on a few elements of the price basket of the consumer price in the Czech Republic. Brada, King and Kutan (2000) find that the cost of goods influences CPI. Andersson, Masuch and Schiffbauer (2009) examine the determining factor of inflation and conclude that administered prices have a significant impact on price stability. Stavrev (2009) investigates the underlying driving force of inflation in transition economies and finds that supply-side factors in the form of administered price adjustments and indirect taxes play a vital role in inflation. Staehr (2009) finds the long-term impact of different supply-side factors on the CPI in CEE countries. Tiwari, Mutascu and Andries (2013) examine the link

between the PPI and CPI in Romania and find high cyclical effects between the PPI and CPI.

Rajcaniova and Pokrivcak (2013) show the linkage between the PPI and CPI for Slovakia by using the threshold co-integration and find no long-term relationship. Vilcu (2015) investigates the relationship between the PPI and CPI in Romania and results indicate that there is no connection. Su et al. (2016) find the bidirectional causality relationship between the PPI and CPI in Slovakia. Khan et al. (2017) find the unidirectional causality between the PPI and CPI in Romania.

It is obvious that previous literature lacks the studies about the interaction relationship between the PPI and CPI in CEE countries. The comparative analysis of the results from panel causality and Toda-Yamamoto (1995) methods shows that the selection of statistical technique is vital in causality study (Nazlioglu, Lebe, and Kayhan, 2011). Furthermore, Granger (2003) argues the likelihood of having the co-integration at the aggregate level but not at the individual level and vice versa. This study elucidates the causality link between the PPI and CPI in CEE countries employing the bootstrap panel Granger causality method taking into account cross-sectional dependencies. Cross section aggregation is the result several micro-variables combining to reach the macro variable and results on the basis of such collection is misappropriated; conventional methods of panel analysis fail to consider the cross-sectional properties and the problem of low power. To solve the problem of low power and to improve results, we employ the bootstrap panel Granger causality test which allows for cross-sectional information, also indicating that most of the previous research has used asymptotic methods in estimating and testing parameters (Chunchachinda et al., 1997) However, the problem of low power arises in the case of the non-normal probability distribution. The bootstrap gives more stable parameter assessment as related to other approaches (Hacker and Hatemi-J, 2006). This study offers new evidence about the causality between the PPI and the CPI in CEE countries

The bootstrap panel Granger causality test has the advantage. First, it examines the causal link between each panel member separately as it assumes heterogeneity of the panel which provides additional information about the particular group members. Second, it does not need to test the unit root and co-integration test, as various such tests may cause results to be contradicting. Third, it can find whether there is unidirectional Granger causality, bidirectional Granger causality or no Granger causality of as many as a panel member (Rault and Afonso, 2009; Mhadhbi, 2014). Our finding indicates bidirectional causality between the PPI and CPI. The PPI has Granger cause the CPI in the five countries and vice versa in only Hungary. The results support the moderate inflation model which states that PPI is the main contributing component of the CPI.

2. The Moderate Inflation Model

The moderate inflation model is the basis of this paper, and it is used to explain the relationship of price indices, wages and prices (Pujol and Griffiths, 1996). According to the supply side approach, the production chain links both PPI and CPI (Clark, 1995). It argues that raw materials are used as inputs in the manufacturing of intermediates goods. The PPI is the markup on the unit variable cost and is equivalent to the sum of wage and cost of intermediate inputs, divided by output (Pujol and Griffiths, 1996).

$$P_p = (1+\mu)\left[\frac{P_{ic}+W_g}{Y}\right] \tag{1}$$

where

P_p – PPI,
μ – markup,
P_{ic} – cost of the intermediate goods,
W_g – the wage,
Y – output.

According to Pujol and Griffiths (1996), the exchange rate also has a crucial contribution in PPI in transition economies. The exchange rate appreciation has a direct impact on the prices of intermediate goods while foreign competition has an impact on the markup of domestic firms. Equation (1) is formulated in the reduced form as follows:

$$P_P = f(W_g, e_x, o_t) \tag{2}$$

where

e_x – exchange rate,
o_t – output.

Any fluctuation in the prices of the raw materials should reflect in the price of intermediate and final foods and finally pass through to consumer goods (Clark, 1995). The CPI is the weighted average of the PPI and import prices. Further, the equation incorporates wages as important factors on the basis that consumer price is influenced by labour cost and retailers (Pujol and Griffiths, 1996). The CPI equals to the following.

$$C_P = f(P_p, W_g, e_x) \tag{3}$$

where

C_p – CPI.

It is evident from equation (3) that CPI is a function of the PPI and the input cost of intermediate goods (Caporale, Katsimi and Pittis, 2002). It depends on the PPI, and any fluctuation will cause changes in the CPI (Dutoit and Moolman, 2003).

3. Methodology

3.1. Cross-sectional Dependency Tests

Shock effects between different countries are estimated by employing the cross section test. The cross-sectional dependency is examined by use of the Lagrange multiplier test proposed by Breusch and Pagan (1980). The following model is the base of test statistics of the Lagrange test.

$$y_{it} = \kappa_i + \gamma_i x_{it} + \rho_{it} \text{ for } i = 1,\ 2,\ ...,\ N;\ t = 1,\ 2,\ ...,\ T \tag{4}$$

where

i – the cross-sectional dimension,
t – the time dimension,
x_{it} – the $k \times 1$ vector of explanatory variables.

Equation (4) allows the individual intercept (κ_i) and slope coefficient (γ) to vary across the countries. It tests the null hypothesis against the alternative hypothesis.

H_0: *Cov* (μ_{it} ,μ_{jt}) = 0, for all *t and* $i \neq j$

H_1: *Cov* (μ_{it}, μ_{jt}) $\neq 0$, for at least one pair of $i \neq j$

The Lagrange multiplier statistics recommended by Breusch and Pagan (1980) evaluate the null hypothesis against the alternative hypothesis, as follows:

$$LM = \mathrm{Y} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\nu}_{ij}^{\ 2} \tag{5}$$

where $\hat{\nu}_{ij}$ is the sample estimate of the pair-wise correlation of the residuals from the Ordinary Least Squares (OLS) estimation of equation (4) for each *i*. The Lagrange multiplier statistic manifests itself as an asymptotically distributed as chi-square variable with $N(N-1)/2$ degrees of freedom with relatively small *N* and large *Y*. The scaled version of the Lagrange multiplier test proposed by Pesaran (2004) is used to overcome the weakness:

$$CD_{lm} = \left(\frac{1}{N(N-1)} \right)^{1/2} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (Y\hat{\nu}_{ij}^{\ 2} - 1) \tag{6}$$

The null hypothesis states that when both *Y* and *N* are sufficiently large, this test statistics has a standard normal distribution. On the other hand, CD_{lm} is useful in case of large *Y* and *N*, but the possibility of misrepresentation is increased with small *Y* and large *N*. Although the above two tests have drawbacks, they are still useful to test the cross-sectional dependency with the large *N* and a small *Y*. Pesaran, Ullah and Yamagata (2008) further emphasize the advantages of CD_{lm} test that it will lose power only when the population average pairwise association are zero instead of non-zero. Pesaran, Ullah and Yamagata (2008) upgraded the LM test and put forward bias-adjusted test which employs the exact mean and variance of the LM statistics. Following the modified version of the *LM* test is reported:

$$LM_{adj} = \sqrt{\left(\frac{2Y}{N(N-1)}\right)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\nu}_{ij} \frac{(Y-k)\hat{\nu}_{ij}^{\ 2} - \omega_{Tij}}{\sqrt{\beta^2_{Tij}}} \tag{7}$$

where

ω_{Tij} – the exact mean,

β^2_{Tij} – represents the variance.

The null hypothesis states that LM_{adj} will meet the asymptotic distribution as standard normal criteria if the $N \to \infty$ follows the $Y \to \infty$.

3.2. Slope Homogeneity Tests

The identification of slope homogeneity or heterogeneity is the basic requirement of the panel causality test. Equation (4) is the source for the formulation of the null hypothesis of homogeneity against the alternative heterogeneity:

$H_0 : \phi_i = \phi$, for all *i*

$H_1 : \phi_i \neq \phi$, for a non-zero fraction of pair-wise slopes and $i \neq j$

The Wald principle is used in the conventional method to test the null hypothesis. Based on the slope homogeneity test the null hypothesis is $H_0 : \phi_1 = ... = \phi_N$. The Wald principal test is applicable in a situation where *Y* is large and *N* is relatively small as well as the explanatory variable are strictly exogenous and error variance are homoscedastic (Pesaran and Yamagata, 2008).

To confirm whether the slope coefficient is homogenous or heterogeneous, Swamy (1970) introduces the slope homogeneity test which is useful when *N* is fixed, *Y* is large and allow for cross-sectional heteroscedasticity (Pesaran and Yamagata, 2008). The test is formulated in the following form below:

$$S = \sum_{i=1}^{N} \left(\hat{\beta}_i - \hat{\beta}_{WFE} \right)' \frac{x_i' M_\tau x_i}{\hat{\sigma}_i^2} \left(\hat{\beta}_i - \hat{\beta}_{WFE} \right) \tag{8}$$

where

$\hat{\beta}_i$ – the pooled OLS estimator,

$\hat{\beta}_{WFE}$ – the weighted fixed-effect pooled estimator,

M_τ – an identity matrix and

$\hat{\sigma}_i^2$ – the estimator of σ_i^2 .

However, the Swamy test converts the asymptotic chi-square distribution with $k(N-1)$ degrees of freedom[1] when *N* is fixed and *Y* is relatively large. The standard format of Swamy test $\tilde{\Delta}$ is recommended by Pesaran and Yamagata (2008) to examine the slope homogeneity of the large panel. It can be used in the case when both *N* and *Y* are relatively large and does not take into account any restriction on the relative extension rate of *N* and *Y* if the error term is normally distributed.

$$\tilde{\Delta} \quad = \quad \sqrt{N} \left(\frac{N^{-1} \tilde{S} - k}{\sqrt{2K}} \right) \tag{9}$$

The standard Swamy test $\tilde{\Delta}$ is asymptotic standard normal distribution if the $(N, Y) \rightarrow \infty$, as long as $\sqrt{N / Y} \rightarrow \infty$. Furthermore, the adjusted $\tilde{\Delta}$ is useful in case of small sample.

$$\tilde{\Delta}_{adj} = \sqrt{N} \left(\frac{N^{-1} \tilde{S} - E(\tilde{y}_{it})}{\sqrt{var(\tilde{y}_{it})}} \right) \tag{10}$$

where the mean $E(\tilde{y}_{it}) = k$ and the variance $var(\tilde{y}_{it}) = 2k(Y - K - 1)/Y + 1$. If the null hypothesis of cross-sectional dependency and homogeneity is rejected, it implies that shock affects as well as heterogeneity occurs through the CEE countries. The result shows that panel causality test is suitable for the causal link investigation.

[1] The detail information about Swamy's test and its modification for the panel study when the N and Y are large can be found in Pesaran and Yamagata (2008). However, in our study N is small which is appropriate for using the Swamy's test.

3.3. Panel Causality Test

The Granger causality means that information of previous period of one time series (*X*) helps in forecasting another time series (*Y*) (Granger, 1969). If countries show cross-sectional dependency along with heterogeneity, the technique employed to test causality should consider these features. Some panel causality methods encourage the examination of such relationships (Kar, Nazlıoğlu and Ağır, 2011). In this regard, Kónya (2006) suggested the bootstrap panel method to examine the cross-sectional dependency and heterogeneity. This method identifies the causal link on the basis of the Seemingly Unrelated Regression (SUR) estimation of the set of equations and the Wald tests with country specific bootstrap critical values. The country related critical bootstrap values are useful as they give exemption from the stationary which means that variables are in the level form and independent of unit root and co-integration characteristics. The number of countries which have the Granger causality is also shown by imposing country-specific restrictions. The bootstrap panel causality approach can be expressed in the following form:

$$
\begin{aligned}
CPI_{1,t} &= \beta_{1,1} + \sum_{i=1}^{ly} \phi_{1,1,i} CPI_{1,t-i} + \sum_{i=1}^{lx_1} \lambda_{1,1,i} PPI_{1,t-i} + \delta_{1,1,t} \\
CPI_{2,t} &= \beta_{1,2} + \sum_{i=1}^{ly_1} \phi_{1,2,i} CPI_{2,t-i} + \sum_{i=1}^{lx_1} \lambda_{1,2,i} PPI_{2,t-i} + \delta_{1,2,t} \\
&\vdots \\
CPI_{N,t} &= \beta_{1,N} + \sum_{i=1}^{ly_1} \phi_{1,N,i} CPI_{N,t-i} + \sum_{i=1}^{lx_1} \lambda_{1,N,i} PPI_{N,t-i} + \delta_{1,N,t}
\end{aligned}
\tag{11}
$$

and

$$
\begin{aligned}
PPI_{1,t} &= \beta_{1,1} + \sum_{i=1}^{ly} \phi_{1,1,i} PPI_{1,t-i} + \sum_{i=1}^{lx_{21}} \lambda_{1,1,i} CPI_{1,t-i} + \delta_{1,1,t} \\
PPI_{2,t} &= \beta_{1,2} + \sum_{i=1}^{ly_2} \phi_{1,2,i} PPI_{2,t-i} + \sum_{i=1}^{lx_2} \lambda_{1,2,i} CPI_{2,t-i} + \delta_{1,2,t} \\
&\vdots \\
PPI_{N,t} &= \beta_{1,N} + \sum_{i=1}^{ly_1} \phi_{1,N,i} PPI_{N,t-i} + \sum_{i=1}^{lx_1} \lambda_{1,N,i} CPI_{N,t-i} + \delta_{1,N,t}
\end{aligned}
\tag{12}
$$

where *l* is the lag length. The Granger causality test with null hypothesis against the alternative hypothesis can be found in a country in four possible forms: (i) The uni-directional Granger causality will exist from PPI to CPI if not all $\lambda_{1,\mathrm{I}}$ are zero but all $\varphi_{,2,i}$ are zero. (ii) The unidirectional Granger causality from CPI to PPI will occur when all $\lambda_{1,\mathrm{I}}$ are zero but not all $\varphi_{2,i}$ are zero. (iii) The CPI and PPI will have a bi-directional Granger causality when neither λ_1, nor $\varphi_{2,i}$ is zero. (iv) The CPI and PPI will have no Granger causality when all $\lambda_{1,\mathrm{I}}$ and $\varphi_{2,i}$ all are zero. The lag structure is crucial; it may likely have an impact on the causality test results. In the case of the large panel, an equation and variable having the changeable lag structure will cause a considerable increase in the computational burden. This issue is solved by taking Kónya (2006) which allow maximal lags to vary through variables but to be the same across equations. We assume from 1 to 4 lags to calculate the system for each possible pair of ly_1, lx_1, ly_2 and lx_2 and then select the group that minimizes the Schwarz Bayesian Criterion.[2]

3.4. System Generalized Method of Moment Regression

To examine the relevant group effect of the macroeconomic variable and the endogeneity problem, we use the System Generalized Method of Moment Regression (SGMM), recommended by the Arellano and Bover (1995). It incorporates both first differences as well as appropriate lagged levels as instruments in the standard equation. We have the following two equations to investigate the group effect of various macroeconomic variables on both CPI and PPI.

$$PPI_{it} = \alpha_0 + \alpha_1 PPI_{i,t-1} + \alpha_2 CPI_{it} + \alpha_3 X_{it} + \varepsilon_{it} \tag{13}$$

where PPI_{it} denotes the initial *PPI*, $PPI_{i,t-1}$ is the lagged *PPI*, CPI_{it} is the consumer price index, X_{it} is other explanatory variables and instrumental variables.

$$CPI_{it} = \beta_0 + \beta_1 CPI_{i,t-1} + \beta_2 PPI_{i,t-1} + \beta_3 X_{it} + \gamma_t + \varepsilon_{it} \tag{14}$$

where CPI_{it} is the initial value of *CPI*, and $CPI_{i,t-1}$ is the lagged value of *CPI*. X_{it} represents that other variables that can effect the *CPI*. Moreover, γ_t symbolize the exogenous instruments while α_1 to α_5 are coefficient of different variables and instruments that can affect the regression.

[2] Kónya (2006) pointed out that this step is important, because causality test results may be mainly build upon the lag structure. Both large and small lags have drawbacks. The small lag selection indicates that some key variables are lost which will results in bias and cause an inappropriate conclusion. On the other hand, large lag shows the excess of observation which will increase the coefficient of the standard error of estimate, the result is not accurate.

4. Data and Empirical Results

The study investigates the Granger causality between the PPI and CPI for ten CEE countries include Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia and Slovakia, using monthly observation from 1998:01 to 2016:03. Data has been gathered from the International Financial Statistics (IFS) and the Organization for Economic Co-operation and Development (OECD). It is argued that CEE countries share resemblances in price dynamics due to the common market and political origins (Halka and Szafrański, 2015). During the studied period all these CEE countries joined the EU (Backe et al., 2003). In the early 90s, CEE countries introduced various reforms to replace a centrally controlled to a free market economy (Kutan and Yigit, 2004). The economic and structural reforms have achieved substantial results in reducing price instability and progressing towards disinflation (Backe et al., 2003). The Russian crisis in 1998 had a negative impact on CEE countries as Latvia and Lithuania entered a period of recession. However, at the end of 1999, these transition economies recovered at a tremendous pace most of them achieved high economic growth rates. By 2000, Bulgaria and Romania recorded the lowest price levels whereas Slovenia had the highest level (Gallego et al., 2010). The period 2000 to 2007 saw rapid economic growth across the region due to the favourable global environment and the EU enlargement process which targeted these countries. The process of accession also had affected the inflation in CEE countries. Between 2004 and 2008, Romania, Latvia and Bulgaria recorded the highest inflation due to domestic price pressure. However, CPI was still at an intermediate level in Hungary, the Czech Republic and Poland. At the same time, Bulgaria and Romania remained unsuccessful in reducing inflation rates due to foreign debt, which put pressure on the floating exchange rate regime and passed on to consumer prices. The stabilisation period was followed by the Global Financial crisis in 2008, which affected this region particularly influencing unemployment and economic growth rates. This influence was strongest in Romania, Bulgaria, Latvia and Lithuania (Forgo and Jevcak, 2015). In the wake of the decline of global energy and food prices both the CPI and PPI decreased. The Eurozone crisis also affected CEE countries by further reducing inflation rates due to the weak supply-side factors. In 2013, gradual recovery started and demand from the main trading partners improved. In January 2015 deflation occurred in all the CEE countries due to the reduction of global commodity prices and regulated prices. All these rapid external and internal changes motivate us to study the relationship between the CPI and PPI in CEE countries.

The other variables in this study include Unemployment (UEM), exports of goods and services, household consumption (HC) expenditure, industrial

production (IP), interest rate (INT), government expenditure (GEXP), oil prices, import of goods and services (IMP), wages, exchange rate (EXR), money and quasi money (M2), current account balance (CA) foreign direct investment (FDI) and taxes on goods and services (TAX). We use the regulatory quality (RQ) and the control of corruption (CC), the financial crisis (FC) and accession (AC) to EU as exogenous variables. These variables have a significant role in the formulation of the inflation in the CEE countries.

We apply three-panel unit root of Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003) and Augmented Dickey-Fuller test (Dickey and Fuller, 1981) to determine the stationarity of the variables. It tests the null hypothesis of the unit root test and the results indicate that both PPI and CPI are significant at 1% and 5% significance level respectively. The null hypothesis of the unit root test is rejected, suggesting that both PPI and CPI are stationary. Thus, we proceed with the panel bootstrap Granger causality test.

T a b l e 1

Panel Unit Root Test

Variables	**Levin et al. (2002**		**Im, Pesaran and Shin (2003)**		**ADF-Fisher Chi Square**	
	t-statistics	*p*-values	*t*-statistics	*p*-values	*t*-statistics	*p*-values
PPI	–5.203***	000	–1.734**	0.041	31.693**	0.046
CPI	–7.281***	0.000	–1.895**	0.029	45.798***	0.000

Note: ** and *** indicate significance at the 1% level.

Source: Data from OECD statistics and calculated in Eviews.

The panel causality test needs a suitable estimator and both cross-sectional dependency and slope homogeneity test are mean to reach such an estimator. The underlying the above test is crucial as these countries may have a strong economic relationship.

Therefore, the first step of our study is to investigate the cross-sectional dependency and heterogeneity across these countries. For this purpose, four different type of test (LM, CD_{lm}, LM_{adj}) were carried out, and Table 2 illustrates the results. It shows that null hypothesis of no cross-sectional dependency is rejected at 1% significance level and confirms the suitability of SUR method over a country by country OLS estimation. They also find that shocks occurring in any one of the CEE countries may also spread to other member countries. The result of the slope homogeneity test is also illustrated in Table 2. According to the results, the null hypothesis is strongly rejected at 1% significance level, thus implying country-specific heterogeneity. The existence of heterogeneity reveals that Granger causality relationship between the variables may vary in these ten CEE countries. From the results of slope homogeneity test, we conclude that the panel

causality analysis is an appropriate technique to elucidate the link between the PPI and CPI in CEE countries.

T a b l e 2

Cross-sectional Dependency and Homogeneity Tests

	Test	PPI	CPI
Breusch and Pagan (1980)	*LM*	820.097***	854.573***
Pesaran (2004)	CD_{lm}	22.358***	24.793***
	CD	81.702***	85.336***
Pesaran and Yamagata (2008)	s	71.606***	121.237***
	Δ	148.253***	51.972***
Swamy (1970)	Δ*adj*	149.274***	52.331***

Note: *** indicates significance at the 0.01 level.

Source: Data from OECD statistics and calculated in Gauss.

The dependency and shock transmission in the CEE countries offers an indication of the suitability of the bootstrap panel Granger causality method. Table 3 reports the results and indicates that PPI does not influence the CPI in the sense of Granger causality is rejected at 1%, 5% and 10% significance respectively in Latvia, Lithuania, Romania, Slovenia and Slovakia. It implies that in these countries the PPI has a significant impact on CPI. The openness of these economies to neighbouring countries and the alignment process to the global economy contributed to the cost of production which had a considerable impact on the PPI price development. The impact of global commodity prices on the PPI was especially strong during the financial crisis of 2008. Falling commodity prices resulted in a weak domestic and external demand and caused a severe reduction of raw material prices (Hałka and Szafranski, 2015). Besides determining the PPI, energy prices (oil, gas and coal) also have a strong influence on the CPI (Hałka and Kotłowski, 2013).

T a b l e 3

PPI Does not Granger Cause CPI

Country			Bootstrap Critical Value		
	C	Wald Statistics	1%	5%	10%
Bulgaria	0.278	6.606	31.678	18.390	12.533
Czech Republic	–0.010	0.311	56.614	23.545	15.908
Estonia	0.163	2.793	32.542	18.357	10.684
Hungary	0.138	3.318	33.626	18.267	11.977
Latvia	0.172	17.747*	35.605	18.862	12.695
Lithuania	0.371	18.647**	32.031	17.492	12.573
Poland	0.092	0.859	49.437	24.180	14.754
Romania	0.014	40.066**	65.343	30.331	20.472
Slovenia	0.069	18.697*	35.965	18.805	11.421
Slovakia	0.167	34.299***	13.975	8.928	7.334

Note: ***, **, * indicate significance at the 0.01, 0.05 and 0.1 level, respectively. Bootstrap critical values are obtained from 10,000 replications.

Source: Data from OECD statistics and calculated in TSP.

The PPI in Latvia and Lithuania increased due to variations in import prices, and administrative prices, external factors such as oil prices having a greater impact as compared to the domestic unit labour cost. Similarly, the accession process to the advanced economies of the EU played an important role. The accession to the EU caused an increase in the administrative cost as a catching process which added to the cost of industrial production and finally passed on to the CPI. At the domestic level, the growth in the unit labour cost increased production costs, in turn, causing the CPI to rise (Benkovskis et al., 2009). These factors caused a considerable increase in manufacturing costs of domestic products and an increase in the CPI. Between 2003 and 2005, the slow economic growth and exchange rate depreciation caused an inflation rate increase in Latvia and Lithuania. The supply-side factors like import prices, rising labour costs, indirect taxes harmonisation with the EU system and regulated taxes were the main factors which increased the PPI. All these factors raised production costs and were transmitted to the CPI. In Slovenia, the higher input prices in the form of global oil prices increased both PPI and CPI. Slovenia adopted the Euro in 2007, which brought additional taxes to the existing prices (Imeri, 2014). The higher domestic and foreign demand pushed the CPI in Estonia.

In Slovakia, the reforms and EU integration process created a favourable situation which had a positive influence on economic growth. In 2004, the price deregulation resulted in the increase of the supply side costs. This increasing trend was mainly caused by an adjustment in energy prices and changes in indirect taxes. The PPI increased due to change of value-added tax, consumption taxes, and regulated prices for households; these changes increased input costs. Between 2008 and 2009 the PPI collapsed because of the low industrial production due to the financial crisis, while at the same time, the CPI fell to its lowest level in country history (Daborowski, 2011). The Eurozone debt crisis had also affected the PPI in Slovakia, as the crisis and falling energy prices had a negative impact on domestic demand. The reduction in the input costs of the PPI caused the CPI to fall in 2014 (Su et al., 2016). In Slovakia, 70% of changes in prices were due to the unit labour cost which increased the manufacturing price of domestic products. The Romanian economy expanded after the transition reforms, reaching a certain stability degree which exerted pressure on the inflation (Dedu and Dumitrescu, 2009). Romania's EU integration boosted domestic production, and industrial goods prices caused the PPI to rise (Falnita and Sipos, 2007). Other factors, mainly supply-side factors like the process of input goods, had a significant role in the formation of CPI. The findings from Latvia, Lithuania, Romania, Slovenia and Slovakia, are consistent with the moderate inflation model, which states that PPI is playing a pivotal role in the formation and fluctuation of the CPI. The results also imply that remaining countries the PPI does not influence the CPI in the

sense of Granger causality and that other contributing factors exist such as convergence of price and interest level to EU or cyclical and financial situations (Stavrev, 2009). The CPI is influenced in Bulgaria, Czech Republic, Estonia, Hungary and Poland by regional factors like exchange rate, commodity prices and unemployment. However, Bulgaria faced high inflation at the beginning of its transition period as a result of the short-term investment inflow. The inflow created substantial foreign assets and money supply which pushed the inflation to rise. At the domestic level, unemployment and household consumption contributed in the CPI. At the same time, other leading indicators include fiscal deficit and inconsistencies in the macroeconomic policy. However, in the second half of the transition period, the Currency Board Agreement (CBA) was introduced for the transformation of the economy has as primary objective price stability. In the second part of the transition period, the main influencing factors on inflation were structural reforms and the consequent price liberalisation. The EU accession and the exchange rate of the Czech Republic, Poland and Hungary, have contributed to CPI variations, as these countries' international trade is based on a major proportion on commercial relationships with other EU countries (Stoica and Damian, 2013). At the beginning of the transition period, Poland abolished the price control system and adopted the fixed exchange rate system (Horská, 2001). Exchange rate fluctuations reflected in the prices of imported commodities which further play a major role in the formation of CPI. Other factors include fiscal deficit which has caused the inflation to rise. In Estonia, the CPI is mainly driven by fundamental factors like the price and productivity convergence with EU. In 2004, Estonia changed in tax rates due to the EU accession which brought an increase in the CPI (Ehrlich, 2004). However, from 2009 onward the CPI is sensitive to the global commodity price. The CPI in these countries is also explained by some short-term factors either country or region specific. Country related factors include changes in the indirect tax system and price liberalisation. On the other hand, region related or common short-term factors including interest rate, higher productivity and openness have an influence on the CPI (Backe et al., 2003).

Table 4 reports how CPI affects the PPI in the sense of Granger causality only in Hungary while the remaining countries reveal no causal relationship. Prices of intermediate goods like food and energy and administrative prices caused an increase in the PPI of Hungary. It experienced a disinflation period before joining the EU (Krusper, 2012). The accession to the EU, which boosted the growth of the Hungarian economy, caused higher domestic and industrial activity which, in turn, resulted in the rise in the PPI. External factors like fluctuations in export, and oil prices as well currency depreciation against the Dollar caused an increase in import prices which ultimately raised the PPI in Hungary with the

domestic market playing a major role in price developments in this country (Alexová, 2012).

T a b l e 4

CPI Does not Granger Cause PPI

Country			Bootstrap Critical Value		
	C	Wald Statistics	1%	5%	10%
Bulgaria	0.237	4.692	69.771	36.737	22.043
Czech Republic	0.072	2.192	30.563	15.560	10.628
Estonia	0.118	2.520	47.361	24.935	18.438
Hungary	0.207	18.097*	51.586	24.469	16.032
Latvia	0.418	9.736	45.965	22.923	15.536
Lithuania	0.029	0.103	63.409	31.794	22.409
Poland	0.481	14.952	42.268	25.804	17.060
Romania	–0.472	4.020	65.335	33.722	22.544
Slovenia	–0.012	0.298	20.134	11.359	7.301
Slovakia	0.160	4.225	61.408	27.219	18.334

Note: * indicate significance at the 0.1 level. Bootstrap critical values are obtained from 10,000 replications.
Source: Data from OECD statistics and calculated in TSP.

For the remaining nine CEE countries, there are indications that the CPI has no impact on the PPI. The cause of this absence of Granger causality, that the domestic demand, different price levels and the convergence with EU, as well as the cyclical and financial condition at domestic level, explained the PPI (Stavrev, 2009). In these countries, the higher inflow of foreign direct investment (FDI) increased the industrial output which further enhances the cost of production and ultimately influenced the PPI (Michalíková and Galeotti, 2010). In Romania, the exchange rate, money and wage growth affected the PPI. A substantial fluctuation is observed in the PPI due to changes in the costs of intermediate good in Bulgaria, the Czech Republic, Poland and Romania. These price variations were more evident around the boom years and led the PPI to increase (Ifrim, 2015). The appreciation of exchange rate exerted upward pressure on the PPI in Slovenia, Romania and Czech Republic (Backe et al., 2003). In Romania, the global trend and the appreciation of Leu have had a significant contribution in the PPI (Ehrlich, 2004). During 2007 – 2010 the exchange rate causing the PPI in the Czech Republic due to massive capital inflow and appreciation of the Czech Koruna (CZK). The exchange rate in the period to observed an appreciation trend due to the favourable economic conditions along with the decreasing current account deficit and foreign short-term investment. In this period, due to greater imports and to the level of external demand, we noticed an increase in production costs at the domestic level, which translated into the dynamics of the PPI. The results are in line with work of Skořepa, Tomšík and Vlček (2016), who suggest that exchange rate cause the PPI.

The PPI increased in Romania during 2009 – 2011 due to an increase in the oil prices, food prices and the administrative prices. In 2012, Romania experienced the Euro area and sovereign debt crisis which has slowed down the growth. The global oil prices and administered prices exerted pressure on the intermediate goods of manufacturing and agricultural price which increased the PPI. During 2008 – 2009 the PPI in Slovakia witnessed a decreasing trend due to the industrial low production. However, during 2012 – 2013 the PPI increased as a result of the regulated prices, fuel prices and appreciation of currency led the PPI. While the CPI does not seem to play a meaningful role in the PPI, the exchange rate and the price convergence to EU are contributing factors of the PPI (Horvath and Kopernicka, 2008). In Latvia, the price determinants are administrative and labour costs (Bitans, Slakota and Tillers, 2001). In sum, the factors which are mainly responsible for changes in the PPI are wage growth and the adoption of additional taxes due to the EU accession. The remaining nine countries display that CPI does not Granger Cause the PPI which indicates that other factors than CPI drive the PPI. The PPI includes import prices which are more sensitive towards fluctuations in exchange rates, different price systems of these countries, money supply, foreign investment and additional taxes. All these factors have a considerable impact on raw material prices which further cause the fluctuation of the PPI. As all these countries are the main trading partner of the EU, the exchange rate fluctuation, taxes and external demand have a significant impact on the PPI.

T a b l e 5

Consumer Price Index (CPI) and Producer Price Index (PPI) SGMM Results

	Part (a)	**Part (b)**
	CPI	PPI
PPI	0.214***	
CPI		0.291***
PPI (–1)		0.590***
CPI (–1)	0.733***	
OIL Price	0.011***	0.049**
M2	0.011	
INT		0.048***
IP		0.062**
IMP	–0.009	
EXG	0.001	0.0017
HC	0.044***	
GEXP	0.009**	
UEM	–0.117***	
WAGE	–0.026	0.048*
TAX	–0.006	0.121
RQ	–0.006*	–2.161
CC	1.151	–0.725
FC	1.079***	1.151
AC	0.348	1.237
C	7.634***	7.323*

Note: *, **, *** denote significance at 1, 5 and 10 %.

Source: Data from OECD statistics and calculated in STATA.

Table 5 part (a) reveals the finding of the group effect on CPI employing the SGMM method. According to the results, the PPI has a significant positive impact on the CPI in the CEE countries. The cost of the intermediate goods and production increased due to the alignment process as well as openness to the global and neighbouring economies which resulted in the rising PPI. The influence of global commodity prices on the PPI was especially high during the financial crisis of 2008. Falling commodity prices led to a weak domestic and external demand and caused a severe reduction in raw material costs (Hałka and Szafrański, 2015). At the domestic level, the growth in the unit labour cost increased production costs and led the CPI. The accession of these CEE countries also grown in the administrative cost as a catching process which further to the cost of industrial production and finally passed on to the CPI. The household consumption (HC) has a significant influence on the CPI and in line with the work of Manzoor et al. (2011) which states that CPI will increase when the HC increases. In the CEE countries, the results indicate that high CPI will cause to reduce the HC.

On the other hand, the unemployment (UEM) has a negative impact on the CPI which supports the Philips curve in the CEE countries, indicating that if the unemployment decreases the CPI will increase. The results support the idea of the Hałka and Szafrański (2015) who explore that unemployment is one of the determinants of inflation in CEE countries. In the start of the transition period, the unemployment rise as a result of the liquidation of the state-owned firms and transformation to the private ownership.

However during the transition period until the financial crisis in 2008, the unemployment rate decreased due to the economic stability. Whereas the CPI rose in the respective period subjected to the underlying economic activity across the CEE countries. The higher economic growth led the higher consumption and increased the inflation. During 2008 – 2009 the inflation decreased, and unemployment witnessed the upward trend due to the recession at the global and the domestic level. The oil prices have a substantial impact on the CPI. The changes in the oil prices influence the inflation directly through oil product purchased by the consumer and indirectly by adding in the cost of production. These transition economies energy consumption and the oil price has considerable effects on the CPI. The finding is unanimous with the Globan, Arčabić and Sorić (2016) who find that foreign supply shocks have a significant impact on the inflation in the transition economies. During the financial recession in 2008, the energy prices sharply declined which led the CPI in the CEE countries to decrease substantially. In 2013 the CEE countries witnessed the lowest inflation due to the low global energy prices.

Government expenditure (GEXP) leads the CPI in positive ways which mean that higher spending will cause to increase the CPI in the CEE countries. The GEXP transmitted through aggregate demand which enhances the consumption, investment and ultimately increases the CPI. In the case of the government borrows from banks the interest rate will rise and consumption, as well as the investment, will decrease which finally leads to decline the output. The CEE countries have a substantial portion of the public expenditure share of the GDP influenced the CPI. In 2005 most of the CEE countries, government spending increased and reached up to 50% of the GDP, such rising trend in the government expenditure resulted in the higher consumption, output and subsequently passed to the end consumer in the form of inflation (Magdalena, Logica and Zamfiroiu, 2015). The results are consistent with the work of Hammermann and Flanagan (2007), which reveal that government expenditure causes the inflation. The financial crisis in 2008 has a significant impact on the CPI in CEE countries, caused the reduction in the industrial production, falling GDP, export and investment. A falling inflation trend has been observed in the CEE during the financial crisis which was high in most of these countries before the crisis. The main reason behind the falling inflation in these countries is the reduction in the commodity prices, wages and weak domestic demand. Bulgaria, Estonia, Latvia and Lithuania have witnessed the highest and quickest drop in the inflation.

However, tax on the goods and service (TAX), import (IMP), the exchange rates and the accession to the EU has no significant impact on the CPI. In the governance indicator, the regulatory quality (RQ) has a major role in the formation of the CPI in the CEE countries. The various policies and regulation are essential to encourage the economic growth and achieving the sustainable price stability (Salahodjaev and Chepel, 2014). Thus, the information about the important factors of inflation is critical in the process of evaluation and predicting the future inflation. The result shows that RQ has a significant impact on the CPI, implies that increases in the number of regulation will decrease the inflation and vice versa in the CEE countries. The political stability, institution building and the protection of the investors promoted the economic growth which ultimately resulted in the low inflation. The previous CPI also contributes in the same way and has a significant role in the future Inflation. The higher preceding CPI causes the higher future CPI (Friedman, 1977). The lagged CPI has a positive and significant role in the following year CPI. We observe that previous years CPI follows the same trend in future and results consistent with the Liu (2014) which detects the impact of the lagged CPI on the CPI. The finding in the CEE also indicates the same pattern. During the period from 2000 – 2008, the CPI in these countries witnessed an upward trend which can be perceived by

the investors and businesses that higher inflation will follow the same pattern in the near future.

Table 5 part (b) reports the group effect of the macroeconomic variables on the PPI. The results show that CPI has a significant and influence on the PPI. Prices of intermediate goods like food, energy and administrative prices caused an increase in the PPI. The accession to the EU boosted the growth of the CEE economies created a higher domestic industrial activity which increased the PPI. The outcome describes that CPI has a critical role in PPI, implies that demand-side factors are a crucial part of the PPI. The higher demand at the domestic and the external level dominate the economic activity which resulted in the greater industrial production to meet the growing demand. Most of these small open economies of the CEE countries initiated the reforms process during the transition period and were dependent on the external demand for the industrial production; the higher production caused an increase in the cost of production and finally appears in the higher PPI. The wages have a notable effect on the PPI and consistent with the Keynesian theory of cost-push inflation describe that wages cause the inflation. The firms include the markup prices take into account the wage rate and in the cost of production increases as a result of higher wages which ultimately add to the consumer prices. The average wages in the CEE countries reveals the rising trend during the transition period and especially the early 2000s when an impressive economic growth recorded in the CEE countries which were the driver behind the rising wages. During the period the PPI also saw an upward trend and wages might be one the contributing element in the growing PPI because the wages are adding in the cost of production which passed to the PPI. However, the global financial crisis in 2008 has adverse consequences, and the overall economic growth slowed down. At the same period, the PPI also decreased as a direct upshot of the widespread uncertainty at the global level. The falling economic growth at the domestic level caused the reduction in the economic activity and contracted the labour market; the wages observed the downward trend. Although, after the crisis, the position in the labour market consolidated and wages started to improve mainly because of the recovery at the domestic and global level. The PPI starts rising again during this period, and cost of production in the form of higher wages might also contribute to the PPI in these countries.

The finding detects that interest rate has a positive impact on the PPI in the CEE countries. The interest rate shows a declining trend since the late 1990s especially during the financial crisis in 2008. In most of these CEE countries interest rate shows a downward pattern over the period. The outcomes in line with the Caporale, Katsimi and Pittis (2002) explain that interest rate affects the

PPI. The oil price and the PPI have a significant relationship, which is basic input to the industrial production and prices shocks increase the cost of production which resulted in the high PPI. In the CEE countries, the oil price shock has critical consequences on the domestic industrial production which pass on to the PPI. The declining trend was observed during the financial crisis in 2008 and Eurozone debt crisis. During the period the oil prices at the global level declined which caused considerable reduction inflation. At the same period, the CEE countries inflation was at the lowest level, and the primary driver behind this low inflation was the low energy prices at the global.

The result reveals that industrial production (IP) is also one of the elements which contribute in the PPI of the CEE countries. The higher IP may lead to the higher demand for the raw and intermediate goods which ultimately increase the cost of production in the PPI. It is consistent with the work of the Saritha et al. (2015) reveal that industrial production Granger causes the CPI. In the CEE countries, the IP witnessed rising trend until the financial crisis in 2008 and declined in the response of the overall slowed down of the macroeconomic situation at the global and domestic level. However, in 2010 the IP start rising in response to the recovery at the global and domestic level and the demand for the domestic product increased from the main trading countries. The higher IP correlates with the higher PPI while the Eurozone debt crisis has also resulted in the decrease of the industrial production and the PPI. The exchange rate, regulatory quality (RQ), control of corruption (CC), accession to the European Union (AC) has no significant impact on the PPI. The lagged value of the PPI causes the PPI, implies that previous producer prices have a significant role in the future PPI.

Conclusion

This paper elucidates the causality between the PPI and CPI in ten CEE countries, using the bootstrap panel Granger causality method, and covers the period from 1998:01 to 2016:03. The result of the cross-sectional dependency and slope homogeneity tests indicate that PPI and CPI vary across different countries. The finding of the bootstrap panel Granger causality for Latvia, Lithuania, Romania, Slovakia and Slovenia shows that PPI plays an important role in the CPI. The outcome of these five countries is consistent with moderate inflation model which describes how CPI variations caused in the sense of Granger causality by variations of the PPI. However, the remaining five countries do not indicate any causality from PPI to CPI; additional factors may cause the CPI to vary in these countries instead of the PPI. On the other hand, only in Hungary, the PPI is influenced by the CPI in the sense of Granger causality. Administrative prices

and prices of intermediate goods like food and energy caused an increase in the PPI of Hungary. In the remaining nine countries, results show that CPI has no impact on the PPI and indicates other determinants of the PPI like exchange rates, wage growth, the adoption of additional taxes due to accession to EU. The result of the SGMM indicates that PPI, HC, UEM, oil prices, RQ and the financial crisis (FC) cause the CPI. On the other hand, the CPI, wages, interest rate, oil prices and industrial production (IP) cause the PPI. The results are useful for future policy formulation as both CPI and PPI are vital contributors to price stability and macroeconomic policies like monetary and fiscal policies. The mutual relationship is influenced by various internal and external factors so to get precise and predicted inflation targeted policies by these economies need to have information at all stages of the value creation chain. In countries where the PPI has more significant implications as compared to the CPI, it can play a vital role in the macroeconomic policies. The objectives if these policies can be better achieved if these countries have accurate, credible information of PPI and give the incentive to control abnormal price fluctuations.

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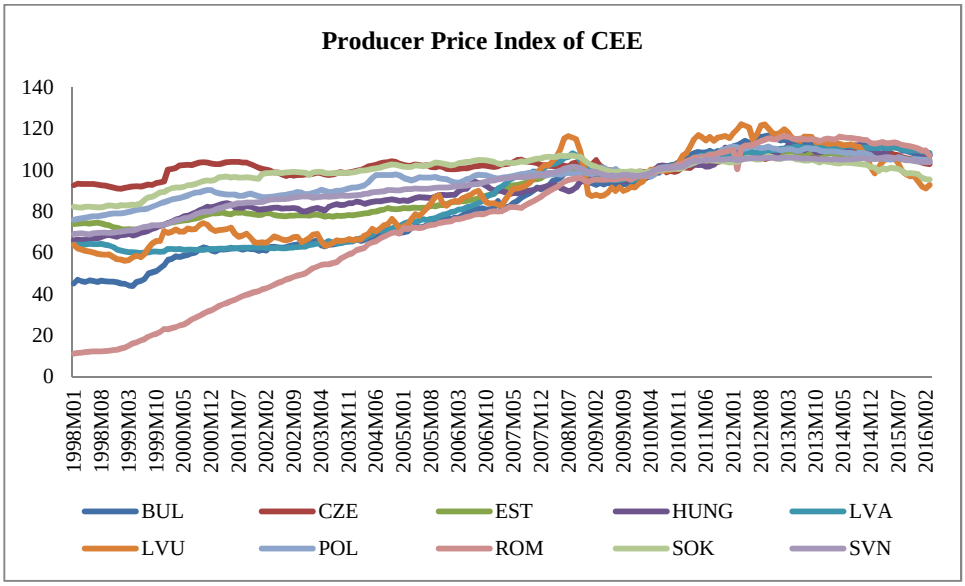
Appendix

Figure 1

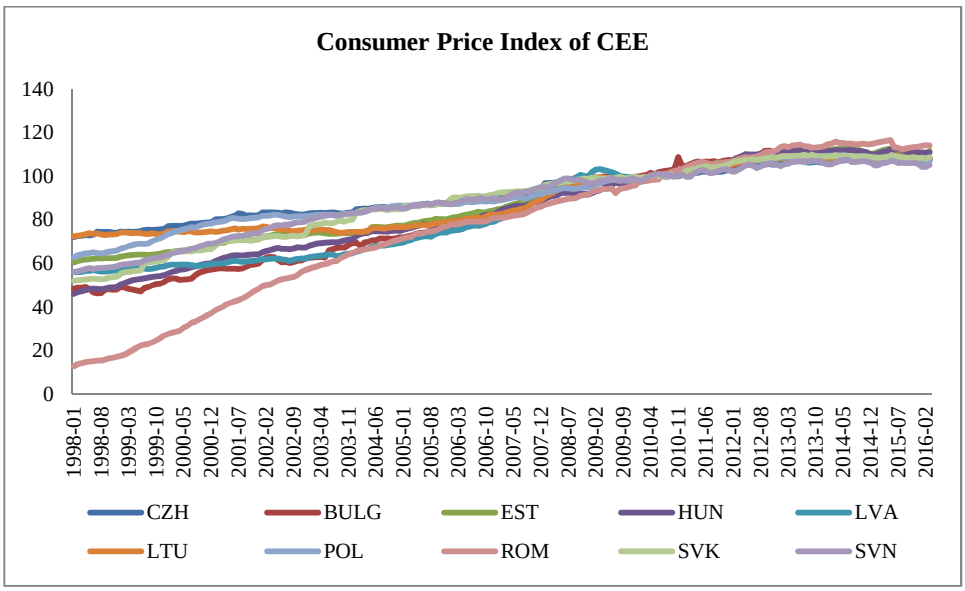
The PPI Trends in CEE



Source: Data from OECD statistics and calculated in Excel.

Figure 2

The CPI Trends in CEE



Source: Data from OECD statistics and calculated in Excel.