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Is there any Relationship between Producer Price Index and Consumer Price Index in Slovakia? A Bootstrap Rolling Approach[1]

Chi-Wei SU – Khalid KHAN** – Oana-Ramona LOBONŢ*** – Hao-Chang SUNG*****

Abstract

This study examines the causal link between the producer price index (PPI) and the consumer price index (CPI) in Slovakia. We use the bootstrap Granger full sample causality, and the sub-sample rolling window approach and results indicate the unidirectional causality running from the PPI to the CPI. By taking the structural changes into consideration, the full sample causal relationship is unstable and such results are misappropriated. Further, we use a time-varying rolling window approach to revisit the dynamic causal relationship between the PPI and the CPI. It indicates the existence of bi-directional causality between the two series in several sub-samples and the result supports the neoclassical profit-maximizing model, which shows that PPI plays a key role in the CPI in the Slovakia. We find that the PPI has a more contributing role to the CPI so the central bank can minimise the inflation by taking certain predictive measures to keep the input prices under control. The central bank should consider the reliable response of the prices at an aggregated and disaggregated level of production in the formulation of inflation targeting.

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

JEL Classification: C32, E31

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Introduction

The link between the Producer Price Index (PPI) and the Consumer Price Index (CPI) has attracted great attention (Dorestani and Arjomand, 2006). Price indices are considered the most important indicators to measure the economic condition (Hakimipoor, Alipour and Akbaryan, 2016). Both of these price indices have a great importance as they have a profound impact on shaping the monetary policy (Tiwari, Mutascu and Andries, 2012). They are also a useful input indicator to adjust the price, wages and a large quantity of economic information. Monetary policy is a key instrument in an economy for controlling the price level. Rising inflation will have an adverse impact on the purchasing power of various sections of society which in turn will influence their economic wellbeing (Rao and Bukhari, 2011). The relationship between the PPI and the CPI is critical for constructing the national income as well as the product account measures (Cecchetti, Kohler and Upperet, 2009). The PPI is highly discussed as a leading indicator to predict the future inflation. The changes in the cost of production often lead to an increase in the price paid by the consumer and it is used to forecast inflation (Akcay, 2011). The PPI Granger causes the CPI to indicate the cost-push inflation, which is the first stage of the production chain (Tiwari, Mutascu and Andries, 2012). It is, therefore, obvious from the supply side that any changes in the input price for the producer price may change the price of the intermediate and final goods, which are ultimately passed to the CPI (Clark, 1995). Meanwhile, according to the demand side approach, the demand for primary goods depends on expected future prices of consumer goods (Caporale, Katsimi and Pittist, 2002). The PPI shock passes through the production chain to the CPI (Tiwari, Mutascu and Andries, 2012). The relationship between the PPI and the CPI may serve as an instrument to avoid the price instability and minimise uncertainty to enhance the possibility of accurate decision making for the future (Tiwari, Mutascu and Andries, 2013). The relationship may reveal better knowledge for the policymaker to forecast inflation, manage and accomplish the inflation target in the economy (Mihailov, Rumler and Scharler, 2011).

Slovakia has achieved the highest economic growth, of 10.4%, among the European Union (EU) members in 2007. The massive domestic and export growth drive the economic development (Rucinska, Urge and Rucinsky, 2010. A sharp decline in the CPI has been observed for the first time in 2004. At the same time, PPI’s growth was slower than CPI’s. The CPI was at its lowest level in 2006 and the main reason behind that are the various subsidies provided by the government to achieve the accession criteria. However, the global financial crisis severely affected the economy, the GDP decreasing to 5.4% from 10.7%. As the global crisis has slowed down, the economic growth of the Eurozone economies has a far-reaching impact on Slovakia. The Eurozone countries were its main trading partners, and 86% of export was being aimed at the European Union (Sedliacikova, 2010). After adopting the Euro currency, the economy has experienced a short-term recession in 2009, the sharp declines in the foreign demand crashing the industrial production. In 2008 the CPI reached an average level of 4.6%, and it has been influenced by growth in energy and food prices, which increased due to the global oil price hike. The Eurozone crisis broke out at the end of 2009 and Slovakia passed through the second bottom during 2012 – 2013. The crisis has caused a decline in the Eurozone economies and a reduction in the demand for products. The supply side of the economy responded by a low PPI. Slovakia achieved the highest growth rate in 2015; domestic demand and investment driving it's economic growth. In the case of the PPI driving the CPI, in Slovakia, it has had a strong ramification for future price stability. Given this objective, we study the relationship between the PPI and the CPI in Slovakia and the results indicate that the PPI has a significant contribution to shaping and formulating the CPI. It is consistent with the neoclassical profit-maximizing model, which shows that PPI has a major role in the CPI in Slovakia and suggests that future inflation may be predicted and cured if proper measures are taken to control the varying input price of the PPI.

Numerous studies have analysed the relationship between the PPI and the CPI. Caporale, Katsimi, and Pittist (2002) examine the relationship between the PPI and CPI in G7 countries using the Toda and Yamamoto. They find the unidirectional causality running from the PPI to the CPI in France and Germany, whereas Japan, Italy, the United Kingdom and the United States have bidirectional causality. In Canada, no causal link was found. Ghazali, Yee and Muhammad (2009) study the causal relationship between the CPI and the PPI for Malaysia by using the Johansen co integration tests and Toda-Yamamoto. The empirical result indicates the long-term association and the unidirectional causality from the PPI to the CPI. Shahbaz, Tiwari and Tahir (2009) find the long-term relationship as well as the existence of bidirectional causality. The PPI has strong implication on the CPI in small economies. Gang, Liping and Jiani (2009) find that CPI has a significant impact on PPI in China. Sidaoui, Capistrán, Chiquiar (2009) examine the effect of PPI on CPI in Mexico using the Granger causality and find that PPI significantly improves the forecasts of CPI in the long-run. Akcay (2011) investigates the relationship between PPI and CPI by employing Toda and Yamamoto test.

The results indicate the unidirectional causality in Finland and France, running from PPI to CPI; Germany shows bidirectional causality whereas Sweden and the Netherlands have no causality. Tiwari, Mutascu and Andries (2012) analyses the association between the PPI and the CPI for Australia by employing the Johansen and Juselius maximum likelihood method. The result finds that CPI is the leading indicator of PPI in Australia. Martinez, Caicedo and Tique (2013) explore the causal link between the CPI and the PPI using the coincident profile method and result shows that PPI has significant impact on CPI. Ulke and Ergun (2014) use the Johansen's co-integration tests to evaluate the relationship between the CPI and PPI. The empirical result confirms the long-term relationship and unidirectional causality running from CPI to PPI. Tiwari, Suresh, Arouri and Teulon (2014) find bidirectional Granger causality between the PPI and CPI. However, CPI has a significant short-term impact on the PPI and PPI Granger cause in the long-run. Rajcaniova and Pokrivcak (2013) explore the association between the PPI and CPI by using the threshold co-integration method and result find no long-term relationship between the PPI and the CPI.

The current study contributes to the specialised contemporary literature by including the time variation property of time series. The full sample causal link may face structural changes which cause the results to be inappropriate (Balcilar, Ozdemir and Arslanturk, 2010). To overcome the problem of structural changes, we use the bootstrap rolling window approach to study the causality between the PPI and the CPI in Slovakia The conventional methods of causality cannot identify the relationship between the full-sample and sub-sample as well as lacking in power to detect the time variation. The bootstrap rolling window provides an alternative approach to identifying the relationship between the full-sample and sub-sample by taking into account the time variation. The result of the bootstrap rolling window shows the bi-directional causality between the PPI and CPI. It is consistent with the neoclassical profit maximising model which indicates that the PPI has a significant role in the CPI in Slovakia and suggests that future inflation may be predicted and cured if proper measures are taken to control the varying input price of PPI.

This study is organised as follows: Section 1 explains the relevant theoretical model; Section 2 presents the methodology, followed by section 3 which describes the corresponding data, moving to the empirical in Section 4 and concluding.

1. Neoclassical Profit Maximizing Model

In this study, we use the neoclassical profit-maximizing framework with imperfect competition proposed by Layard and Nickell (1985; 1986) and Nickell (1988). In the model, firms' price is equivalent to a markup on the marginal cost of production represented by average or unit costs (Burda and Wyplosz, 1993).

$$P_p = m*AC \qquad m = \frac{1}{1-\frac{1}{\eta}} > 0; \qquad m' \geq 0 \tag{1}$$

where

Pp – the production price,

m – the price of markup,

AC – the average cost of the production,

η – price elasticity of demand.

The markup price is influenced by the volatility of the market to price change, measured by price elasticity of demand. As expected, that demand situation in the short term has a significant impact on the markup price *m*, which is equivalent to the ratio of expected demand and normal output (Nickell, 1988).

$$m = m\ (\frac{Y^{ed}}{Y^{*}}) \tag{2}$$

where

Y^{ed} – expected demand,

Y^{*} – normal output.

The cost of production consists of both labour and cost of capital. The normal average cost is used as a base in the model price setting. An average cost of productivity may be specified in terms of (1) change in nominal wage rate to productivity (2) cyclical demand pressures such as deviations in actual unemployment rates from the equilibrium rate of unemployment, rates of capacity utilization, (3) external supply shocks (Burda and Wyplosz, 1993).

Layard and Nickell further modified this price equation and included expected competitor price

$$\frac{P^{p}}{w} = h\ (\frac{P^{P}}{P^{e}})\ m\ (\frac{Y^{ed}}{Y^{*}})\ g\ (\frac{Y^{*}}{\alpha L}) \tag{3}$$

where

P^{p} – production relative to expected prices,

w – nominal wages including employers' labour taxes,

P^{e} – expected price,

$\frac{Y^{*}}{\alpha L}$ – the normal labour productivity.

Consumer price is directly related to the producer price:

$$P^{c} = f(P^{p}, t^{i}, P^{m}) \tag{4}$$

where

t^{i} – indirect taxes,

P^{m} – import prices on consumption goods.

The consumer price is dependent on the producer price, indirect taxes and import price for the consumption goods (Moolman and Toit, 2004). The production of final goods in each period uses intermediates goods produced in lagged period as inputs and any disturbance on the supply side may affect the producer price and consumer prices for the upcoming period (Shahbaz, Tiwari and Tahir, 2009).

2. Methodology

The Granger causality statistic is based on the assumption that underlying time series are stationary and may not have standard asymptotic distribution when the stationary assumption does not hold. The estimation of the VAR model (Vector autoregressive model) is difficult in the absence of standard asymptotic distribution (Sims, Stock and Watson, 1990) and Toda and Phillips (1993; 1994). Toda and Yamamoto (1995) come up with modified Wald test to find the asymptotic distribution using the augmented VAR 1(1) variables. Shukur and Mantalos (1997a) use Monte Carlo simulation to examine the power and size properties of the modified Wald test and explore that it lacks in the correct dimension in small and medium size. Shukur and Mantalos (1997b) state that the residual-based bootstrap (RB) method solves the size and power issue. Numerous studies have established a better performance of *RB* method over the standard asymptotic distribution irrespective of co-integration or not (Mantalos and Shukur, 1998; Shukur and Mantalos, 2000; Mantalos, 2000; Hacker and Hatemi-J, 2006; Balcilar, Ozdemir and Arslanturk, 2010). In this regard, the most important work of Shukur and Mantalos (2000) established that *LR* test with small sample size gives better power. This paper uses the *RB* based modified-*LR* statistic to find the causality between PPI and CPI in the Slovakia.

The bivariate VAR (*p*) need to calculate *RB* based modified-*LR* causality test as follow.

$$x_t = \varphi_0 + \varphi_1 x_{t-1} + \ldots + \varphi_p x_{t-p} + \varepsilon_t\,,\ t = 1,\ 2,\ \ldots,\ T \tag{5}$$

where $\varepsilon_t = (\varepsilon_{1t},\ \varepsilon_{2t})'$ is a white noise process with zero mean and covariance matrix $\sum$. The Schwarz Information Criteria (*SIC*) provides the optimal lag length. On the basis of equation (5) $x_t = (x_{1t},\ x_{2t})'$ are divided into two subvectors, x_{1t} and x_{2t}.

$$\begin{bmatrix} PPI_{1t} \\ CPI_{2t} \end{bmatrix} = \begin{bmatrix} \varphi_{10} \\ \varphi_{20} \end{bmatrix} + \begin{bmatrix} \varphi_{11}(L)\varphi_{12}(L) \\ \varphi_{21}(L)\varphi_{22}(L) \end{bmatrix} \begin{bmatrix} PPI_{1t} \\ CPI_{2t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{6}$$

where

x_{1t} – indicates PPI,

x_{2t} – represent CPI.

The latter variable in the analysis portion denotes CPI. $\varphi_{ij}(L)=\sum_{k=1}^{p+1}\varphi_{ij,k}L^k$ $i,\ j=1,\ 2$ and L is the lag operator defined as $L^k x_t = x_{t-k}$.

Equation (6) test Granger causality of the PPI on CPI with imposing the restriction, $\varphi_{12,k}=0$ for $k=1,\ 2,\ ...,\ p$. In the same manner, the null hypothesis of Granger causality of CPI on the PPI is tested by imposing the restriction, $\varphi_{21,k}=0$ for $k=1,\ 2,\ ...,\ p$.

2.1. Parameter Stability Test

The full sample Granger causality test assumes that parameters of the underlying VAR model remain constant over time but due to the presence of structural changes assumption of parameter constancy does not hold. The results are no longer valid, and the causal link becomes unstable (Balcilar, Ozdemir and Arslanturk, 2010). The recent literature offers evidence that the parameter instability is a major problem (Granger, 1969). We use short-term parameter stability tests to overcome this issue. Andrews (1993) and Andrews and Ploberger (1994) developed *Sup-F*, *Mean-F* and *Exp-F* tests to explore short run parameter constancy. The L_c test proposed by (Nyblom, 1989; Hanson 2002) examines the overall parameter stability in the VAR system. These tests are calculated from the sequence of *LR* statistics aiming to evaluate parameter constancy and address the structural change problem. These tests display the non-standard asymptotic distribution. Andrews (1993) and Andrews and Ploberger (1994) calculate critical values and *p*-values by the parametric bootstrap procedure. A Monte Carlo simulation with 10,000 samples from a VAR model with the constant parameter is used to obtain the critical and p-values. According to Andrew (1993), these tests are trimmed 15% from both sides of the sample. This trimming specifies (0.15; 0.85) fraction of the sample to be evaluated by this tests. With respect to the L_c tests, they are computed in the current paper for equations and VAR system separately.

2.2. Sub-sample Rolling Window Causality Test

The different methods are used to avoid the structural changes in the full sample data which result in the pre-test bias. The rolling-window sub-samples Granger causality test based on the modified bootstrap estimation is used to resolve the structural problem. The absence of stationarity in the entire period and detection of instability in different sample periods justify using rolling window estimation. The rolling window is based on the fixed size rolling sequentially from the beginning to the end of the full sample (Balcilar, Ozdemir and Arslanturk, 2010). A fixed rolling window with l observation of full size is transformed into a sequence of $T - l$ sub-samples, that is, $\tau - l + 1, \tau - l, ..., T$ for $\tau = l, l + 1, ..., T$. Then, each subsample's causality is determined on the basis of the *RB* based modified-*LR* causality test. The bootstrap *p*-values of the observed LR-statistic rolling through *T-l* sub-samples provide the variation and magnitude of the relationship between PPI and CPI in Slovakia. The causality of PPI on CPI is equal to the average of the entire bootstrap estimates and is presented by formula, $N_b^{-1}\sum_{k-1}^{p}\hat{\varphi}_{21,k}^{*}$, where N_b refers the number of bootstrap repetitions. Similarly, $N_b^{-1}\sum_{k-1}^{p}\hat{\varphi}_{12,k}^{*}$ is the formula displaying the impact of CPI on the PPI. Both $\hat{\varphi}_{21,k}^{*}$ and $\hat{\varphi}_{12,k}^{*}$ are bootstrap estimates from the VAR models in Equation (6). The 90% confidence intervals are also computed, where the lower and upper limits are equal to the 5th and 95th quantiles of each of the $\hat{\varphi}_{21,k}^{*}$ and $\hat{\varphi}_{12,k}^{*}$ respectively (Balcilar, Ozdemir and Arslanturk, 2010).

The rolling window estimation has two contradictory objectives such as accuracy of the parameter estimates and the representativeness of the model over the sub-sample period. The precise estimation is made based on the window size. The accuracy is achieved with a large window size, but in the presence of heterogeneity, it reduces representativeness.

However, the small window size may have a lack of accuracy and improvement in the representation. Thus, we must select the appropriate window size to represent between the accuracy and representativeness. There are no specific criteria for the selection of window size in rolling window estimation (Balcilar, Ozdemir and Arslanturk, 2010). Pesaran and Timmerman (2005) use the root mean square error to calculate the window size under structural change and establish that the optimal window size depends on the persistence and size of the break. Monte Carlo simulations suggest the minimum of 20 for the window size with frequent breaks. Considering the balance between accuracy and representativeness, we select a window size of 24 months[2] (this excludes the observations required for lags and hence is the actual number of observations in the VAR).

[2] Though an interpretation for the selection of 24-month window size has been mentioned earlier, we still implemented different bootstrap rolling-window causality tests using 20-, 30-, 36-month window size and estimated the magnitude of the effect of PPI on *CPI* and that of *CPI* on *PPI*. The results are proved much similar to those from the causality test based on 24-month window size, which further indicates that the results based on 24-month window size are robust.

3. Data

The study is undertaken to examine the causal link between the PPI and the CPI from 1998:01 to 2016:01. The data is taken from the Organization for Economic Co-operation and Development (OECD). We transform the data into natural logarithms to avoid the issue of heteroscedasticity. This period is important from a research point of view as it witnesses some particular economic developments and events. Slovakia has initiated a thorough reform process to achieve macroeconomic stability as well as some market-oriented structural reforms. It passed through a transition process from being a centrally controlled economy to a becoming a free market economy. During this period, Slovakia passed through a high level of economic growth rate. However, the global financial crisis in 2008 has had adverse consequences on the economy. The first major fluctuation in the PPI was observed in 2008:09 and it has reached the highest point. At the same time, the CPI shows a stable position. The low domestic and foreign demands have put pressure on the production to decline. Slovakia faced a short recession, which has an adverse impact on the CPI and introduced the Euro on the 1st of January 2009. The PPI dropped sharply in 2009:05 as the global crisis had started to emerge on both domestic and international level. At the end of 2009, the Eurozone debt crisis broke out which had a significant impact on Slovakia. By joining the Eurozone, Slovakia has lost its independent monetary policy and competitive price edge. It participated in the rescue aid program to rescue Greece, Portugal, Ireland, Spain, and Cyprus. The economic growth has declined, and the unemployment rate has risen sharply. During 2009 – 2011, Slovakia CPI inflation was at a low level due to the weak economic activity (Li, 2016). The next period in which we observe the PPI witnessing a sharp upward trend was in 2012:10. The economic recovery had started both on a global level, as well as in Slovakia. During this period the PPI has been led by the energy price and the rising food price. However, CPI shows a stable position during the time. We conclude by pointing out that the PPI is more volatile compared to the CPI, especially around the period of the global and European debt crisis and the direction of movement is not same at all times.

4. Empirical Result

In the first stage, we test the stationary of the underlying data series by the using Augmented Dickey-Fuller test (1981), Phillips-Perron test (see Phillips and Perron, 1988), and KPSS test proposed by Kwiatowski, Phillips, Schmidt and Shin (1992). The result shows that CPI and PPI are stationary at a level. The result confirms the I(0) relationship between the CPI and PPI so that we can use the full sample causality test between the CPI and PPI. The lag 2 is specified on the Schwarz Information Criterion (SIC). The results of the full sample Granger causality test are presented in Table 1. According to the bootstrap *p*-values, PPI does Granger cause the CPI at 10% significance levels, but CPI does not Granger cause PPI. It is evident from the bootstrap full sample causality test that PPI has a significant role in the Slovakia.

T a b l e 1

Full Sample Granger Causality Test in the Slovakia

Tests	**H0: *PPI* does not Granger cause *CPI***		**H0: *CPI* does not Granger cause *PPI***	
	Statistics	*p*-values	Statistics	*p*-values
Bootstrap *LR* Test	4.7838*	0.0900	0.6145	0.4900

Notes: * denotes significance at the 10% level.

Source: Own calculation in R program.

In general, a consensus has been developed stating that full sample has only one causal relationship and no structural changes in the whole sample period (Balcilar, Ozdemir and Arslanturk, 2010). The existence of such structural changes may cause a shift in the causal relationship between the PPI and the CPI in Slovakia. The causality relationship becomes unstable and unreliable to be used for estimation (Zeileis, Leisch, Kleiber and Hornik, 2005).

To address this issue of structural changes, we proceed with the parameter stability test to determine the existence of structural changes in the sample data. For this reason, we use the *Sup-F*, *Mean-F* and *Exp-F* tests developed by Andrews (1993) and Andrews and Ploberger (1994) to investigate the temporal stability of parameters in the above VAR models formed by the CPI and PPI. The L_c test of Nyblom (1989) and Hanson (2002) is also used here to test for all parameters in the overall VAR system.

The results are reported in Table 2. In both equations, the *Sup-F* is used to test the parameter constancy against a one-time sharp shift in parameter and results indicate that null hypothesis is rejected against a one-time sharp shift in parameter, predicting short run parameter instability at 5% significance level. *Mean-F* and *Exp-F* tests under the null hypothesis that parameter follows the martingale process against the possibility that parameter might evolve gradually. The result for the PPI equation indicates that the *Sup-F* test rejects the null hypothesis of parameter consistency against one time sharp shift. The *Mean-F* and *Exp-F* reject the null hypothesis of a martingale process and evolve gradually over the time. The *Sup-F* test rejects the null hypothesis of parameter consistency against one time sharp shift. The *Mean-F* and *Exp-F* reject the null hypothesis of a martingale process at 5% and 1% significance level and evolves gradually over the time. It shows significant evidence that parameter evolves gradually with time. The L_c statistics test proposed by Granger (1969), testing the null hypothesis-parameter constancy against the random walk, indicate parameter non-constancy in the overall VAR estimated model. The result of these tests provides an indication of short-run instability and estimation on the basis of these results is invalid.

Table 2

Parameter Stability Test

	PPI Equation		**CPI Equation**		**VAR (1) System**	
	statistics	bootstrap p-value	statistics	bootstrap p-value	statistics	bootstrap p-value
Sup-F	25.825***	0.000	17.990***	0.009	15.441**	0.021
Mean-F	3.439	0.307	6.071**	0.051	7.123	0.263
Exp-F	8.007***	0.002	5.295**	0.020	5.046	0.203
Lza					1.707**	0.046

Notes: We calculate p-values using 10,000 bootstrap repetitions.
** , *** denote significance at 5% and 1%, respectively.
A Hansen-Nyblom parameter stability test for all parameters in the VAR(1) jointly.

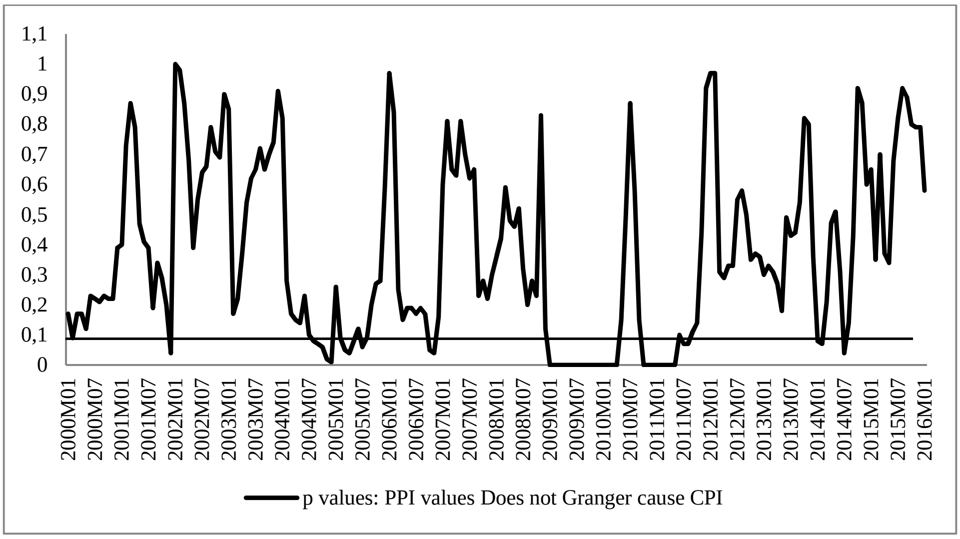
Source: Raw data from OECD statistics and calculated in R program.

The above tests conclude parameter instability due to the presence of structural changes, which violate the credibility of the causal relationship between CPI and PPI. To address the structural changes problem, we use the bootstrap rolling window approach. The rolling window has the advantage that it determines how the system evolved over time as well as detecting sub-sample instability in the system (Balcilar, Ozdemir and Arslanturk, 2010). We use RB bootstrap modified-LR causality to investigate the causal relationship between the PPI and the CPI. Null hypothesis tests that PPI does not Granger cause CPI and vice versa. The bootstrap p-values of LR statistics can be estimated from the VAR models in Equation (6) by using the rolling sub-sample data including 24-month observations. We also calculate the magnitude of the impact of PPI on CPI and vice versa.

Figure 1 reports the results of bootstrap rolling window causality test between the PPI and the CPI. According to the bootstrap p-values, the PPI does Granger cause the CPI at 10% significance level in the several subsample including 2004:07 – 2005:06, 2006:10 – 2006:12, 2008:12 – 2010:05, 2010:09 – 2011:09, 2014:02 – 2014:07. In these sub-samples, the PPI guides the direction of the CPI.

F i g u r e 1

Bootstrap p-values of Rolling Test Statistic Testing the Null Hypothesis that PPI does not Granger Cause CPI in the Slovakia

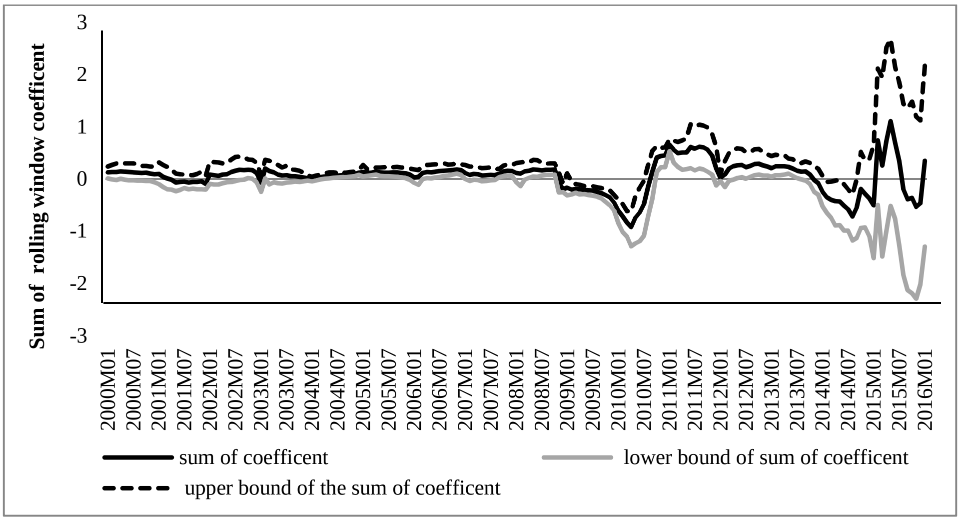


Source: Data are from Bootstrap rolling test statistic results and dotted in Eviews 8.0.

In Figure 2, the result of the bootstrap estimates of rolling window is reported. According to the coefficient value, PPI has both positive and negative significant impact on CPI in the several subsamples. In the sub-sample 2004:07 – 2005:06 PPI has a significant positive impact on the CPI. The ongoing reform and integration process created a favourable condition for strong economic growth. The price deregulation resulted in the increase of the supply side cost. This increasing trend was mainly caused by increased adjustment in the related price of energy prices and changes in indirect taxes. The PPI increased due to adjustment of value added tax, consumption taxes, and regulated prices for households, these adjustments increased the input prices. In sub-sample 2006:10 – 2006:12, the PPI has a positive impact on the CPI. In 2006 Slovakia achieved highest economic growth of 8.9% in OECD member countries and ranked third highest in the EU (Rucinska, Urge and Rucinsky, 2010). The low-level inflation started to rise again in 2006. The domestic demand declined by adjustment in excise taxes, and high energy prices. While in the sub-sample of 2008:12 – 2010:09, PPI has a negative influence on CPI. During 2008 – 2009 substantial decline observed in the industrial production and export due to global crisis (Dąborowski, 2009). In 2009, the industrial production declined which resulted in the foreign trade. All these developments contributed to declining the industrial production as an outcome of the lack of demand. During this time, Slovakia inflation declined continuously throughout 2009 and reached its lowest level, almost close to zero. In the sub-sample 2014:01 – 2014:08 PPI has a negative impact on the CPI. Inflation turned to negative values in early 2014, reflecting weak domestic demand, as well as falling food and energy prices. Inflation control is the top priority for the Slovakia in 2014. The inflation growth has almost stopped due to the reduction in the oil price and food prices.

Figure 2

Bootstrap Estimates of the Sum of the Rolling Window Coefficients for the Impact of PPI on CPI in the Slovakia

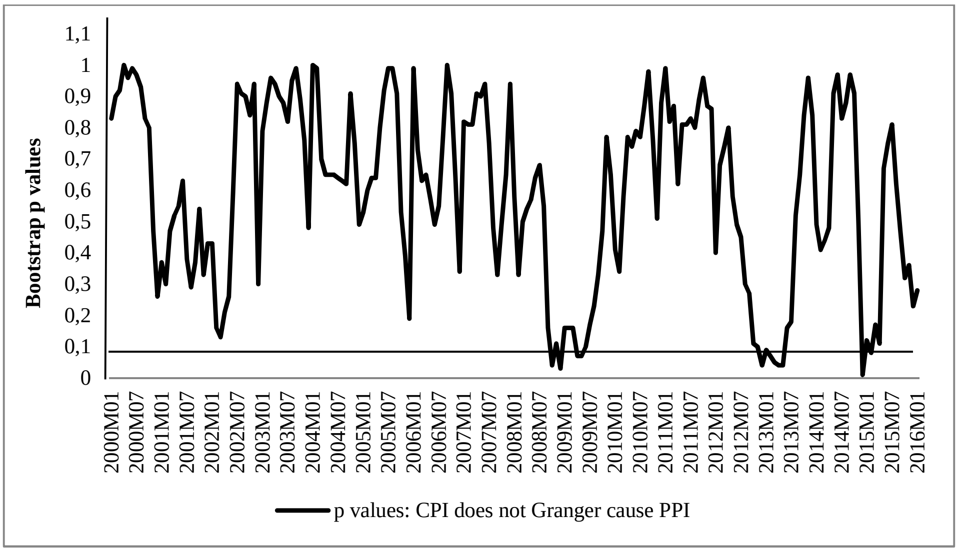


Source: Data are from bootstrap estimates of the sum of the rolling window results and dotted in Eviews 8.0.

Figure 3 reports the results of bootstrap rolling window causality test between the CPI and PPI. According to bootstrap p-values, the CPI does Granger cause the PPI at 10% significance level in the subsample including, 2008:10 – 2009:06, 2012:10 – 2013:06. In these subsamples, the CPI has a significant impact on the PPI. In these sub-samples, CPI plays a major role in the direction of PPI. Figure 4 reports bootstrap estimates of the sum of rolling window. These values of the coefficient show the magnitude of causality between CPI and PPI. The sub-sample 2008:11 – 2009:06 shows a significant positive impact of CPI on PPI when CPI witnesses a declining trend due to the industrial production. In a sub-sample of 2012 – 2013, the CPI has an adverse impact on the PPI. When the regulated prices, fuel prices and appreciation of currency caused the reduction in the CPI and led the PPI. The result of the bootstrap full sample causality and sub-sample rolling window indicates the instability of causal relationship between the PPI and the CPI in the Slovak Republic over different sub-sample periods. We find bi-directional causality between the PPI and CPI.

Figure 3

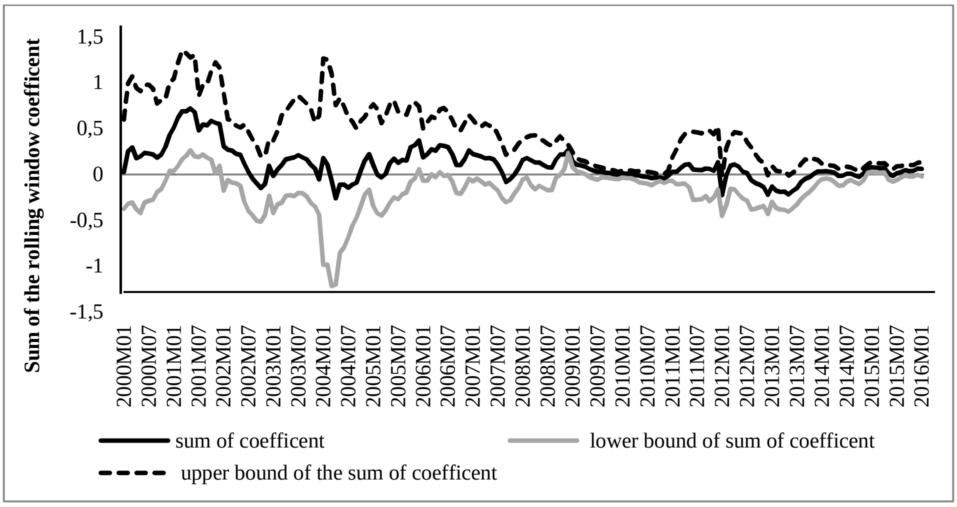
Bootstrap p-Values of Rolling Test Statistic Testing the Null that CPI does not Granger Cause PPI in the Slovakia



Source: Data are from Bootstrap rolling test statistic results and dotted in Eviews 8.0.

Figure 4

Bootstrap Estimates of the Sum of the Rolling Window Coefficients for the Impact of CPI on PPI in the Slovakia



Source: Data are from bootstrap estimates of the sum of the rolling window results and dotted in Eviews 8.0.

Over the years, various economic events and financial crisis have led to structural changes, and the relationship between the PPI and CPI has not been stable. The most critical period in which, we find the significant association between the two price indices is 2004 – 2006, 2008 – 2009, 2012 – 2013. The result shows that PPI has a major role in the CPI in the Slovak Republic and suggest that future inflation may be predicted if the proper measures are taken to control PPI.

Conclusion

This study examines the causal relationship between the PPI and the CPI by using the full sample Granger causality test and sub-sample rolling window causality in Slovakia. The results of full sample Granger causality show unidirectional causality running from the PPI to the CPI. In the presence of structural changes, the parameter stability test indicates short-term instability. The result of bootstrap rolling window clearly shows Granger causality in several sub-samples. We find both positive and negative bidirectional causality. The PPI has a more positive impact on the CPI. Our result is consistent with the neoclassical profit-maximizing model that the PPI plays a significant role in the CPI. The study has a particular policy implication for the government. First, the PPI has a more contributing role to the CPI so the government can minimise inflation by taking certain predictive measures to keep the input prices in control. Secondly, the inflation is dependent on the various internal and external factors and central bank's inflation targeting must consider the accurate and credible response of prices at different stages of production.

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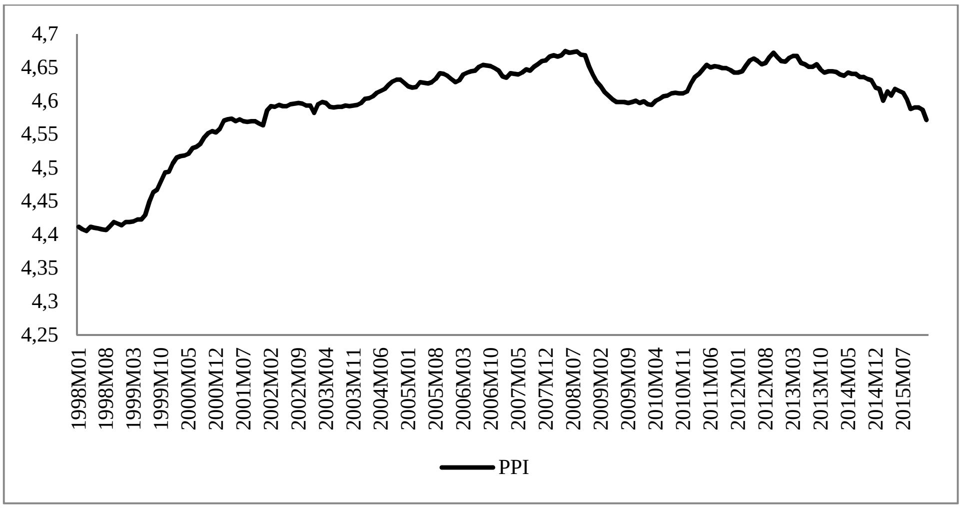
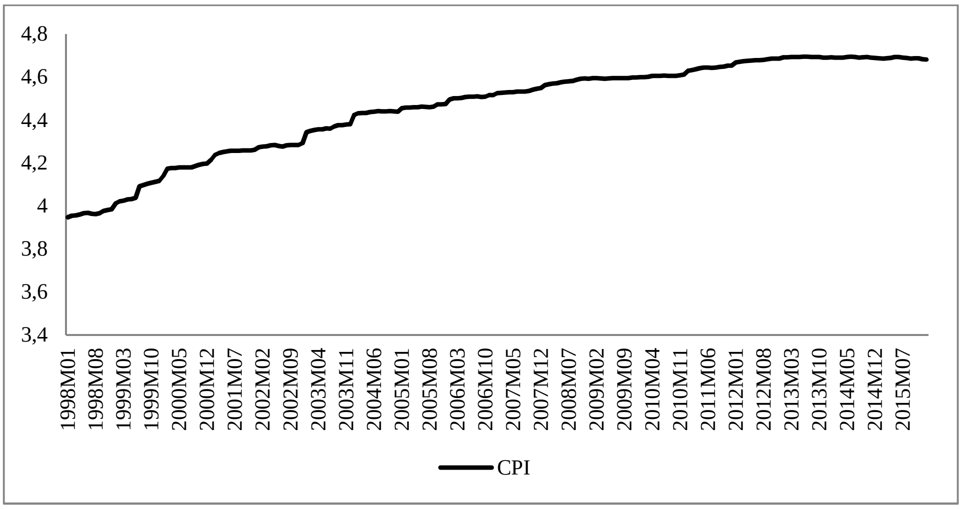
Appendix 1

Growth Rate of the PPI and CPI





Source: Based on the data from Organization for Economic Co-operation and Development (OECD).