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DISTINCTIVE CHARACTERISTICS OF THE CAUSALITY BETWEEN THE PPI AND CPI: EVIDENCE FROM ROMANIA

*   **Abstract.** This paper examines the causal relationship between the producer price index (PPI) and consumer price index (CPI) in Romania. The Granger full sample test shows unidirectional causality from PPI to CPI. The parameter stability test shows instability in the short run and the result is inappropriate for estimation due to the presence of structural changes. The Sub-sample rolling window test is used to address the time-varying, and it provides bi-directional causality at different sub-sample. The finding does not support the neoclassical profit-maximizing model, which states that PPI is not a single factor of fluctuation in CPI for Romania. It indicates the bidirectional relationship between the PPI and CPI, suggests that both these price indices play a significant role. The study implies policy-wise that PPI is a major factor in the price stability and should have been included in inflation targeting policy to curb the inflation in Romania.*
*   ***Keyword:*** *Consumer Price Index, Producer Price Index, Rolling Window, Time-varying Causality, Bootstrap.*

JEL Classification: C32, E31

1. Introduction

The relationship between the price indices is necessary to measure the inflation and the economic development. These price indices are sensitive to the various measures taken by the government to control the price stability. The institutional architecture of the EU in respect to monetary policy is shaped at the

level of the Central European Bank, Central European Bank System and Eurosystem; however there are other institutions who have not only exclusive competences, among which we can mention the ECOFIN Council, the Court of Auditors, the European Parliament and the European Commission. Nevertheless, an adequate institutional framework for the monetary policy staff involves the existence at the level of each country of an independent central bank who has the fundamental objective of ensuring and maintaining price stability. Regarding Romania, the National Bank of Romania (NBR) has the key mission to implement the monetary policy and the exchange rate policy. Starting from August 2005 NBR has adopted a new monetary policy strategy in order to fulfil its fundamental objective, i.e. *direct inflation targeting* for price stability maintenance. Inflation targeting objective involves an adequate framework for decision-makers, which implies relevant measurement of inflation for monetary policy decisions. For the central banks, which are implementing the inflation-targeting regime, core inflation indicators based on the exclusion of certain components are considered.

The price stability in the economy is perceived from the formation and transformation of the relationship of the two price indices, consumer and producer price, (Caporale *et al*., 2002). It helps in measuring the purchasing power of the currency in an economy and considers vital indicators to measure the current and future inflation. Providing an assessment tool of an economic condition which helps in a precise measure of an economy's overall price level, as well as its real output. The monetary policy derives their direction from the relationship between the consumer price index (CPI) and producer price index (PPI) as it has a key role in the calculation of producer and consumer inflation. Both has role in the calculation of real interest and in establishing social protection measures, considering short-lived shocks, such as the adjustments in administered prices, taxes cut, adverse weather conditions or oil market shocks. In order to separate the effects of such shocks, inflation is decomposed into a transitory component, namely non-core inflation and a permanent one, namely core inflation. Similar to the majority of central banks in Europe, The National Bank of Romania establish core inflation by using the exclusion method, i.e. CORE1 and CORE 2. Thie first method remove administered prices from headline inflation, while the second one, apart from excluding administered prices, is considering stripping out volatile prices (for fresh fruit and vegetables, eggs, fuels). The relationship is important for

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monetary authorities to measure the increase and predict the price instability (Tiwari *et al*., 2013). Inflation mainly depends on demand-pull inflation exercised when it grows beyond the potential level of the NDP (National domestic product) and / or cost-push inflation, being influenced by the relative elasticity of incomes, prices and interest rate. The authorities may have in better position to decide the future course of action related the inflation targeting in the economy and measure the national income The relationship between the PPI and CPI may serve an instrument to avoid the price instability and minimise the uncertainty to enhance the possibility of accurate decision making for the future (Tiwari *et al*., 2013). It may reveal better knowledge to the policymaker to forecast inflation, manage and accomplish the inflation target in the economy.

Romania economy was the fastest growing economy in the EU with a highest economic growth of 7 percent during 2000-2008. The massive inflow of foreign investment and export were the primary instrument of such a high growth. However, the transition period reforms in the political, economic and financial sectors cause high price volatility (Tiwari *et al.*, 2103). The Romanian government initiated numerous policies with the sole objective of achieving the macroeconomic stability and lowering inflation (Topcu *et al*., 2012). The inflation decreased from 154.4% in 1997 to 3.2% in 2012. The process of disinflation continued until the outbreak of the global crisis and recorded a 7.1% decrease of the GDP in 2009. The whole region around the Romania faced the supply side shocks, which have also affected its economy. The global crisis has a devastating impact on the consumption, construction, and industrial production of the Romanian economy. The major sub-component of the PPI has declined due to the reduction in the domestic and external demand. While the inflation witness a rising trend during the global crisis. In 2009, the GDP continued to contract, and Romania signed a bailout package €20 billion with the International Monetary Fund (IMF) to balance the recession. Even if, following the 2008 global financial crisis, Romania experienced a robust credit boom, in 2011 succeed to implement economic policies against the backdrop of challenging global environment to achieve the economic stabilization. But, the disinflation started again and inflation touched all-time low in 2013. The CPI in Romania is more sensitive to the supply-side shock, and PPI causes a substantial growth in the inflation. The inflationary phenomenon may have strong repercussion for the price stability and future monetary policy. Significant progress has made in

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inflation targeting, but so far the inflation was only considered as a demand-driven phenomenon. However, it is realized that inflation targeting is sufficiently achieved by considering the supply side economy (Tiwari *et al.*, 2013). In 2015, Romania had one of the highest growth in the European Union (EU) regarding domestic demand with low inflation and a negative value for the annual CPI inflation rate. One of the most important effects for the Romanian economy in 2013-2016 periods was the effect of VAT rate. Starting from September 1, 2013, the reduction of VAT from 24% to 9% at certain bakery products, has established the entrance of CORE2 annual basic inflation adjusted, in negative territory. Even nowadays it manifests through discreet inflationist pressures generated by this reduction of VAT on food and drinks, starting from June 2016

In the previous literature, extensive research has been done to examine the relationship between the CPI and PPI**.** Caporale *et al.* (2002) reveal that in France and Germany PPI Granger cause the CPI and Japan, Italy, United Kingdom and the U.S. have bi-directional causality. In Canada, no causal link was found. Akdi *et al.* (2006) examine the relationship between the CPI and PPI and find a short term significant relationship between PPI and CPI. Shahbaz *et al*. (2009) find the long-term relationship between the CPI and PPI. Ulke and Ergun (2014) state that PPI and CPI have long run association, also find the unidirectional causality from CPI to PPI. Tiwari *et al*, (2012) conclude that CPI is a leading indicator of PPI at an intermediate level and have a significant impact on the medium-term macroeconomic policies. Tiwari *et al.* (2014) find the bidirectional relationship between the PPI and CPI. However, the CPI is leading indicator in short-run whereas in the long-run PPI cause the CPI.

The previous literature finds the evidence of a relationship between the CPI and PPI in Romania. Fratostiteanu (2010) examine the relationship between the CPI and various macroeconomic variables and find a significant relationship between the two price indices. Tiwari *et al.* (2013) analysis the relationship between the PPI and CPI through continuous wavelet analysis and find the cyclical effects. Rajcaniova and Pokrivcak (2013) and find the long relationship PPI and CPI. Vilcu (2015) finds no connection between PPI and CPI in the long term in Romania. Pintilescu (2016) find the strong evidence of a relationship between the producer price and inflation. It is evident from the previous work that these studies only consider the relationship over the full sample of the review time and ignore

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the structural changes which occur over the period, led the test result meaningless for estimation.

This study investigates the impact of the PPI on the CPI in Romania with a distinctive characteristic of including the time variation property of the time series data. Since the transition period, Romania economy experienced crisis and economic reforms which led structural changes in the CPI. The accession to EU in 2007, the global financial crisis in 2008 and Eurozone sovereign debt crisis in 2011 caused the structural changes in the PPI and CPI in Romania. Such structural changes are the main reason of instability between the two series at various sub-samples (Balcilar *et al.*, 2010). This research paper is first effort to examine causality between the PPI and CPI in Romania, as the previous work fall short of including the time varying characteristic. To address this problem, we used the bootstrap subsample rolling window test to reconsider the relationship between the PPI and CPI in Romania. The conventional methods of correlation and Granger causality have the disadvantage that it failed to investigate the casualty relationship at the sub-sample period and ignore to include structural changes in the time series. It implies that study examining the causality between two-time series data may have the problem of instability due to the structural changes (Balcilar *et al.*, 2010). To overcome the drawbacks of the conventional methods a rolling window sub-sample Granger causality test based on modified bootstrap estimation. We also employ the rolling sub-sample with fixed-size window to find the causality. These methods have the advantage to identify the structural changes occurred due to various external shocks and give a more accurate result at sub-sample periods. We test the relationship between the PPI and CPI by employing the rolling window with fixed size and including the time-varying. The result indicates both positive and negative bidirectional causality between the PPI and CPI in various sub-samples. The result does not support the neoclassical profit maximizing**;** the CPI dependent on the PPI and changes in the PPI will bring significant changes in CPI. It is clear that PPI and CPI have bidirectional causality, indicate that both PPI and CPI have influenced each other. It makes a contribution as PPI is the vital element of the predicting the inflation in Romania, any future policy formulation in the absence of PPI would be inappropriate to control the inflation. To limit, the negative repercussion of the PPI in the future inflation the authorities should have all information of the PPI at every stage of production.

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The paper is organized as follow. Section 2 gives the theoretical framework. Section 3 explains the methodology. Section 4 consists of data. Section 5 reports the results. Section 6 concludes the study.

2. NEOCLASSICAL PROFIT MAXIMIZING MODEL

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

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

where P_p is the production price, m is the price of markup; AC is the average cost of the production and η is price elasticity of demand. The markup price is influenced by the fluctuation of the market price and price elasticity of demand assesses such fluctuations. 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.

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

where Y^{ed} is expected demand and Y^* is normal output. The cost of production consists of both labor and cost of capital. The normal or average cost is used to base in the model price setting. On the normal cost assumption, an average cost is measuring changes in the ratio of labor productivity to nominal wages rate, any cyclical demand variation between the actual unemployment rate and the equilibrium rate, rates of capacity utilization and external supply shocks (Burda and Wyplosz, 1993).

The price equation is further modified by Layard and Nickell, including expected competitor price

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

where P^p is production relative to expected prices, w is nominal wages inclusive

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of employers' labor taxes, $P（e）$ is expected price and　$Y（*）（αL）$ is the normal labor productivity. Consumer price is directly related to the producer price:

$$P^c = f(P^p, t^i, P^m) \qquad (4)$$

where t^i is indirect taxes and P^m import prices on consumption goods. The consumer price is dependent upon the producer price, indirect taxes and import price for the consumption goods. The consumer price is directly related to these inputs prices increase (decrease) may cause the same increase (decrease) in the consumer price. The production of final goods in each period uses primary products produced in lagged period as inputs that any disturbance on the supply side may affect the producer price and consumer prices for the upcoming period (Shahbaz *et al.*, 2009). The PPI is an important factor in CPI and may influence the inflation in Romania so the central bank may devise the monetary policy for inflation targeting keeping in view both PPI and CPI. Given the significant role played by the PPI in the CPI, the NBR inflation targeting strategy may be more successful if PPI is properly managed and predicted.

3. Methodology

In the case of violation of stationary of the standard causality, an asymptotic distribution does not hold. The estimation of the *VAR* model is difficult in the absence of standard asymptotic distribution Toda and Phillips (1994). Toda and Yamamoto (1995) come up with modified Wald test to find the asymptotic distribution using the augmented VAR model. Monte Carlo simulation reveals that the modified Wald test does not support the exact size in small and medium size (Shukur and Mantolos, 1997a). The residual-based bootstrap (RB) method solves the size and power issue. Numerous studies established the better performance of *RB* method over the standard asymptotic distribution irrespective of cointegration or not (Shukur and Mantalos, 2000; Balcilar *et al.*, 2010). In this regard, the most important work of Shukur and Mantalos (2000) established that the *RB* based modified-*LR* statistic 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 Romania.

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

$$x_t = \phi_0 + \phi_1 x_{t-1} + \ldots\ldots\ldots + \phi_p x_{t-p} + \varepsilon_t, \quad t = 1, 2, \ldots\ldots, T \qquad (5)$$

where $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t})'$ represents a zero mean, white noise process and its covariance

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matrix Σ The Schwarz Information Criteria (*SIC*) provides the optimal lag length.

By equation (5) $\quad x_t = (x_{1t}, x_{2t})'$ are divided into two sub-vectors, x_{1t} and x_{2t}.

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

where x_{1t} indicates PPI and x_{2t} represent CPI. The latter variable in the analysis portion denotes (CPI). $\phi_{ij}(L) = \sum_{k=1}^{p+1} \phi_{ij,k} L^k$, $i, j = 1, 2$ 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, $\phi_{12,k} = 0$ for $k = 1, 2, \ldots, p$. In the same way, the null hypothesis of Granger causality of CPI on the PPI is tested by imposing the restriction, $\phi_{21,k} = 0$ for $k = 1, 2, \ldots, p$.

3.1 Parameter stability test

It is assumed that the parameter of *VAR* model in full sample Granger causality remains constant but due to structural changes the assumption of parameter constancy does not hold. The results are no longer valid, and the causal link becomes unstable (Balcilar *et al*, 2010). The recent literature offers evidence that the parameter instability is a major problem. We use short-term parameter stability tests to overcome this issue. Put forward by Andrews (1993), the *Sup-F, Mean-F* and *Exp-F* tests to explore short run parameter constancy. Parameter stability of overall VAR system investigated by using the L_c test proposed by Nyblom (1989) calculated from the sequence of *LR* statistics aiming to evaluate parameter constancy and address structural change problem. These tests display the non-standard asymptotic distribution. Andrews (1993) calculate critical values and *p*-values by the parametric bootstrap procedure. A Monte Carlo simulation with 10000 samples from a VAR model with the constant parameter is used to obtain the critical and *p*-values. As according to Andrew (1993) these tests are trimmed 15 percent from both sides of the sample. This trimming specifies (0.15, 0.85) fraction of the sample to be evaluated by these tests. On the L_c tests, they are computed in the current paper for equations and VAR system separately.

3.2 Sub-sample Rolling Window Causality Test

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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 used to resolve the structural problem. The absence of stationary in the entire period and detection of instability in different sample periods justifies using rolling window estimate. The rolling window is based on the fixed size rolling sequentially from beginning to the end of the full sample (Balcilar *et al*., 2010). A fixed rolling window with *l* observation of full size is transformed into a sequence of *T-l* sub-samples, that is, τ-*l*+1, τ-*l*, ..., T for τ= *l*, *l*+1, ..., T. Then each sub-sample causality is determined by the *RB* based modified-*LR* causality test. The bootstrap *p*-values of observed *LR*-statistic rolling through T-*l* sub-samples provide variation and magnitude of the relationship between PPI and CPI in Romania. The causality of PPI on CPI is equal to the average of the entire bootstrap estimates and presented by formula, $N_b^{-1} \sum_{k-1}^{p} \hat{\phi}_{21k}^{*}$, where N_b refers the number of bootstrap repetitions. Similarly, $N_b^{-1} \sum_{k-1}^{p} \hat{\phi}_{12k}^{*}$ is the formula which displays the impact of CPI on PPI. Both $\hat{\phi}_{21,k}^{*}$ and $\hat{\phi}_{12,k}^{*}$ are bootstrap estimates from the VAR models in Equation (6). The 90-percent confidence intervals are also computed, where the lower and upper limits equal 5th and 95th quantiles of each of the $\hat{\phi}_{21,k}^{*}$ and $\hat{\phi}_{12,k}^{*}$ respectively (Balcilar *et al*., 2010).

The accuracy of the estimated parameter and representativeness of the model over the sub-sample periods are the two conditions of the rolling window estimation. The window size makes the precise estimation. 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 an equilibrium between the accuracy and representativeness. These are no particular rule in the selection of the rolling window size estimation (Balcilar *et al*., 2010). Pesaran and Timmerman (2005) use the root mean square error to calculate the window size under structural change and establish that optimal window size depends upon on the persistence and size of the break. As per Monte Carlo simulations, they suggest the minimum 20 window size with the frequent breaks. Given balance between accuracy and representativeness, we select a window size of 24 [1]months (this excludes the observations required for

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[1] 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-,

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lags and hence is the actual number of observations in the VAR)

4. Data

We obtain the PPI and CPI monthly observation 1998:01 to 2016:03 from the
Organization for Economic Co-operation and Development (OECD). We take the
natural log of the data to address the problem of heteroscedasticity. The PPI is the
average price of good and services at the first level of production, and the CPI is
measured from the consumer perspective, defined as the change in the price of the
good and services by the consumer over the time. Romania followed different
policy framework during the transition period to control inflation. It adopted the
broad money targeting, high-powered money targeting and then inflation targeting
with the ultimate objective to bring the inflation to a single digit. The period of
study is relevant in many perspectives, numerous economic development, and the
crisis occurred. At the start of our study, the Romania economy was already passing
through a hard time as its economy shrank for consecutive two years. All the
economic indicators were showing the downward trend. The Russian crisis has also
started in 1998, which has a negative implication for the Romanian economy. The
CPI declined as a result of the supply shock in the form of oil and fuel prices.
Romania joined the European Union in 2007; membership brought numerous
challenges to economic and financial sectors. The year 2015 records a series of
conjectural factors, basically negative weather conditions and bird flu, who have
generated the restriction of the offer and a series of mutations in the structure of the
demand. In 2007, as a follow-up of the modifications adopted by the monetary
authority in Romania and following the structure directed by the European Central
Bank and the European System of Accounts- have caused changes in the structure
of monetary aggregates M1, M2 and M3. The most significant correction was in the
structure of narrow money (payment instruments) and broad money (store of value
instruments.

The global financial crisis in 2008 prompted price the price volatility and the
first significant fluctuation was observed around the international financial crisis of
2008. The world financial crisis has an impact on the decreasing commodity price,

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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.

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economic activity contracted, which further reduced demand at both external and internal level. The NBR reports show that during the year 2009, the prices for tobacco products have contributed to more than a third of the annual growth of consumer prices, as a follow-up of the successive increases in excise duties. An upward trend of inflation has been marked starting with July 2010, as a result of the effects caused by the increase in the standard rate of VAT by 5% and by the acceleration of growth rhythms of prices for fuels, based on the international increase of fuels quota.

The year 2011 records an influence of disinflation nature at the level of all components of the adjusted CORE2 index although one can notice the impact of the growth in rate at natural gases for industrial producers upon the costs of production of certain processed food products; however, the incidence on consumer prices has been reduced. The high oil and input prices have caused to increase the PPI, the process of disinflation stop, and inflation started to rise again. The next point of which we see, the fluctuation is the last quarter of 2012. During this time, Romania economy was affected by the Euro area crisis. The economic growth declined, and Romania touches all time low inflation in 2012. The Romania CPI shows more fluctuations as compared to PPI especially during 2008 and 2012. The relevant time periods have witnessed the global and Eurozone crisis which exerted pressure on the PPI while inflation was stable. Annual inflation attenuation took place in the context of volatile food prices correction, of the downtrend in the international prices of crude oil and currency appreciation against the Euro. The year 2013 has brought a significant change, namely the extension of the reduced VAT rate to all food products, except spirits, where 2016 brings the same changes. According to a report by the NBR at the end of 2013, annual CPI inflation rate has reached a historic low (1.55%), got down to the lower limit of the variation band of ± 1 percentage point of the 2.5% target, recording the lowest value in the fourth quarter of the past 24 years. After following a general downward trend in 2014, the annual CPI inflation rate was kept below the variation band of the inflation target by June 2015.

All these events have contributed a significant shift to economic growth, which has synchronization with both PPI and CPI. These developments over the study period motivate to study the causal relationship between the CPI and PPI in Romania

5. Empirical results

We test the stationary of the variables by using Augmented Dickey-Fuller test (ADF test, 1981), Phillips-Perron test (PP test, 1988) and Kwiatkowski Phillips Schmidt Shin (*KPSS* test, 1992). The unit root test shows that variables are stationary at levels. This stationary demonstrates that variables have I(0) relationship between CPI and PPI. The Schwarz Information Criterion (SIC) select lag 2 for the equations. **Table 1** shows full sample Granger causality test results. According to the bootstrap *p*-values, PPI does Granger cause the consumer price index CPI at 10% significance level. The result shows unidirectional causality running from PPI to CPI.

Table 1. Full sample Granger causality test in Romania

Tests	H0: *PPI* does not Granger cause CPI		H0: *CPI* does not Granger cause *PPI*	
	Statistics	*p* values	Statistics	*p*-values
Bootstrap-*LR* Test	17.388***	0.000	0.0816	0.7700

Notes: *** denotes significance at the 1 percent level.

The next step we explore the parameter stability over the whole period in our samples. As it is described, that full sample test, is unreliable and misleading, due to the structural changes (Balcilar *et al*., 2010). We check the parameter constancy to reach out the structural changes in the sample of PPI and CPI in Romania. These structural changes may create disturbance in the causal link between the two data series of PPI and CPI for Romania. To address this problem, we use the *Sup-F, Mean-F and Exp-F* tests put forward as an output of Andrews (1993) work, in order 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) is also used to test all parameters in the overall VAR system. **Table 2**, reports the results of the entire above test. The null hypothesis of *Sup-F* test parameter constancy against the one time sharp and the result show shifts in PPI equation and VAR at 1% and 5% level respectively. The *Mean-F and Exp-F* test the null hypothesis of the martingale process against the gradual evolution of parameter and result reveals that PPI equation evolves gradually at 1% significance level. **Table 2** also reports the parameter constancy

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test results for the CPI equation. The *Sup-F* shows that a one-time shift exists in CPI equation and VAR system at 1% and 5% level respectively. However, the *Mean-F and Exp-F* test indicate CPI evolves gradually with time at 5% significance level. The result of the PPI, CPI, and VAR system confirms that system changes gradually with time. The L_c test statistics indicates that parameter follows the random walk process in the overall model. The empirical results of the entire above test validate the existence of parameter instability in the short run.

Table 2. Parameter Stability test

Test	PPI Equation		CPI Equation		*VAR* System	
	Statistics	**Bootstrap**	**Statistics**	**Bootstrap**	**Statistics**	**Bootstrap**
Sup-F	23.723***	0.000	26.556***	0.000	38.109**	0.024
Mean-F	6.787***	0.030	10.147**	0.002	18.303**	0.044
Exp-F	7.542***	0.003	9.204**	0.001	14.215*	0.058
L_c^b					2.190**	0.038

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

Given the above results from the parameter stability test, we confirm that the data series has the problem of structural changes which led the estimation meaningless and unreliable. Our purpose is to achieve the results which take into account the structural changes over the whole sample period. We use the RB bootstrap-based modified-*LR* causality approach to examine the causality between the PPI and CPI in Romania. The rolling window has an advantage over the conventional methods of finding causality by including the time-varying property across the different sub-samples. The RB bootstrap-based modified-*LR* test the null hypothesis that PPI does not Granger causes the CPI and vice versa. Based on the Equation (6) the *p*-values of the LR-statistics are specified by using the rolling subsample data including 24-months observation.

In the subsample bootstrap rolling window, we test that PPI does not Granger cause the CPI. **Figure 1** indicates the results for sub-sample Granger causality test. According to the bootstrap *p*-values, the PPI Granger cause CPI at 10 percent significance level in the following sub-samples 2001:09-2001:12; 2003:08-2004:02; 2006:04-2006:08; 2008:08-2008:12, and 2011:09-2013:10. It shows that PPI has a

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significant impact on CPI in the sub-samples. **Figure 2** reports the magnitude of the relationship between the PPI and CPI. In 2001:09-2001:11 the PPI had a positive impact on CPI when Romania achieved the highest economic growth in the EU accession countries and favourable developments in industry and agriculture. The rapid growth and expansion caused the inflationary pressure (Dedu and Dumitrescu, 2009). According to the NBR, the PPI rise due to the energy sectors, oil and natural gas and in the mining sectors. In the subsample of 2003:08-2003:10 the PPI has a positive influence on CPI. The economic growth continued along the disinflation and control over the budget deficit. In the last quarter of 2003, the Romania trading partner economic growth slowed down which caused the reduction of demand for Romania products, and domestic demand replaced the export as a main driver of the economic growth. The PPI in manufacturing went up which lead the CPI, and the process of disinflation stopped. The NBR started the inflation targeting strategy in 2005 to control the inflation (Tiwari *et al.*, 2013). The PPI has a positive influence on CPI in the subsample of 2006:04-2006:08, when the main components of the PPI increased and at the same time the CPI was at the lowest level. Romania economy expanded after the macroeconomic stability due to economic reforms; the rapid expansion exerted inflationary pressure (Dedu and Dumitrescu, 2009). The authorities pursued the economic policies for accession to the EU and joined the in 2007. The accession to the EU has given trade liberalization to Romania and boosted the economic growth. The producer prices for industrial goods and agricultural products increased resulting the generation of inflationary pressures. The accession to EU caused the CPI to increase in 2007 due to the significant increase in the utility prices. During this period, the PPI has a leading significant factor of CPI (Tiwari *et al.*, 2013). In the sub-sample 2008: 08-2008:11, PPI has a positive impact on the CPI. The supply side factors declined, and the PPI witnessed a declining trend in the domestic market due to the favourable input prices for intermediate goods and energy products, whereas the agricultural prices remained unchanged during this time. In 2010:09-2010, PPI has a positive impact on CPI. This is the time when the economic recovery from the global crisis has started at domestic and external level. The major sub-components of PPI increased due to the rise in the oil, food prices and administered price which pass-through to CPI. As a medium-term inflation targeting policy, central bank initiated to broaden the monetary condition to protect from the second round indirect taxes. In the

sub-sample 2011:09-2013:10, the PPI has a positive impact on the CPI when Romania achieved the stable economic growth. The main reason behind this robust growth rate was the industrial sector performance. The favourable industrial performance was mainly caused by the low price in the agricultural, energy price, administered price and the stable exchange rate. According to the NBR, CPI stood at the historically low level. The main reason behind this lowest CPI is the absence of pressure from producer price, energy prices and stable exchange rate. The relationship between the PPI and CPI inconsistent with the neoclassical profit-maximizing model, i.e., the CPI is dependent on the PPI, and any increase (decrease) will lead increase (decrease) in the CPI. However, the relationship between the PPI and CPI in Romania indicates a two-way Granger causality; both has a significant impact on each other in the formation and transformation in the Romania. The monetary authority cannot control or limit the inflation in Romania only including the CPI. Therefore, the purpose of the price stability can be better achieved when both the PPI and CPI are included in the future policy formulation.
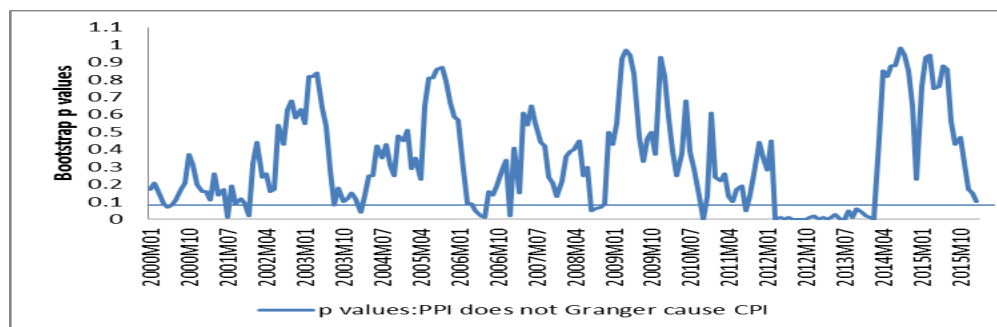

Figure 1: Bootstrap estimates of the sum of the rolling window coefficients for the impact of *PPI* on CPI in Romania
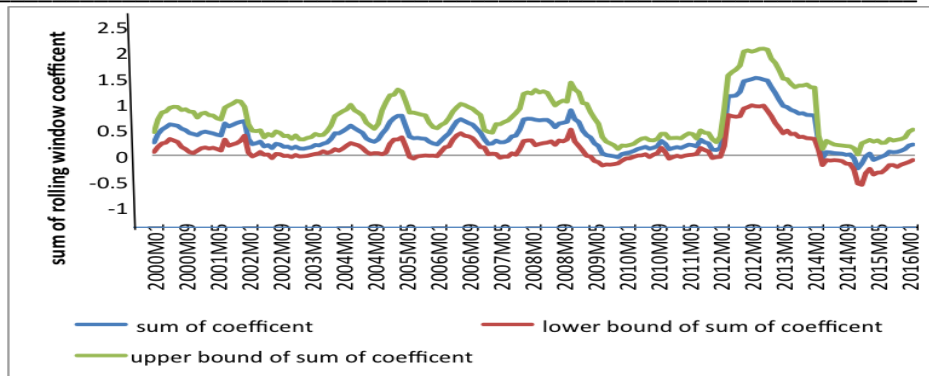
Figure 2: Bootstrap p-values of rolling test statistic testing the null that PPI does not Granger cause CPI in Romania

Figure 3 shows the bootstrap rolling window results. According to the *p*-values, the PPI does Granger cause the CPI at 10% significance level in the several sub-samples including, 2001:06-2001:08, 2008:09-2009:04; 2010:12-2011:12 and 2015:03-2015:06. In these sub-samples, the null hypothesis rejects at 10 percent. **Figure 4**, reports the results of the values of the extent of the impact of PPI on CPI. The CPI has a positive effect on PPI in 2001:06-2001:08. During the period the main goal of the economic program for economic growth and reduction in the inflation rate. For this purpose, the government initiated the disinflation in 2000 and 2001 the inflation targeting gained a pivotal role in the monetary policy strategy (Pintilescu *et al*., 2016). All these measures were taken to ease the inflation growth. While in sub-sample 2008:09-2009:04, CPI has a positive impact on PPI. The last quarter of 2008 appeared difficult for the Romania economy as the global crisis has started influence the economy. A sharp decline was observed in industrial output, reduction of the retail sales and slowdown of the economic growth. These developments at the external and domestic level caused the decrease in the demand for Romania products. According to NBR, the unit labour cost increased which cause an increase in the PPI. The prices of the intermediate goods are increased due to rise in the oil price and natural gases prices which exerted pressure on CPI to lead PPI. During 2010:12-2011:02 CPI have a positive impact on the PPI. During the period, the economic recovery from global financial crisis started at global and domestic level. In 2011 Romania experienced the Euro area and sovereign debt crisis which has slowed down the pace of growth. The global crude oil price, administered price and tensions on international agrifood markets pushed the CPI,

which exerted pressure on the intermediate goods prices of manufacturing and agricultural price. In the subsample, 2015:03-2015:06 CPI has a negative impact on PPI. When the CPI fell into negative territory due to a reduction in the Indirect taxes, low oil price, and low domestic agricultural price. In the context of the drop in the oil price and lower domestic demand the PPI also fell sharply. The overall result of the rolling window sub-sample causality reveals that PPI has a significant contribution in CPI and Granger causality running from PPI to CPI is strong than the CPI to PPI. It does not support the neoclassical profit-maximizing models which suggest that PPI will bring substantial changes in CPI. However, the empirical results indicate that both PPI and CPI cause each other in Romania, both have a contributing role in the each other fluctuation. The result contributes towards the policy makers that PPI is the essential component of the predicting the inflation in Romania, so any future policy formulation in the absence of PPI would be inappropriate to control the inflation. The negative impact can be minimised if the PPI is predicted and specified at each point of production.
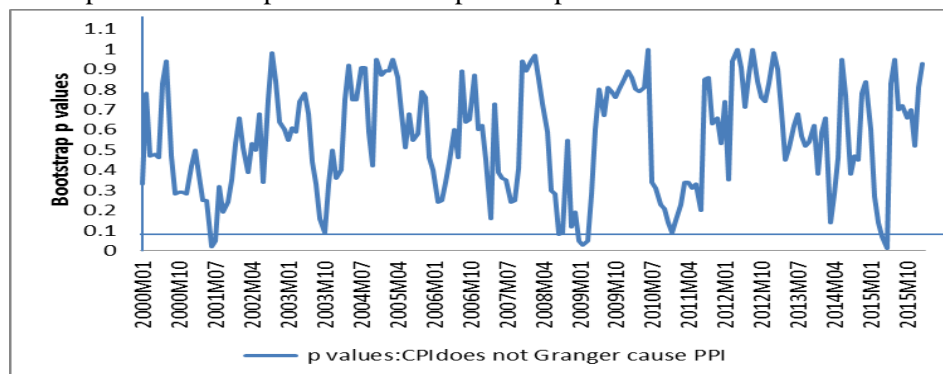

Figure 3: Bootstrap estimates of the sum of the rolling window coefficients for the impact of CPI on PPI in Romania
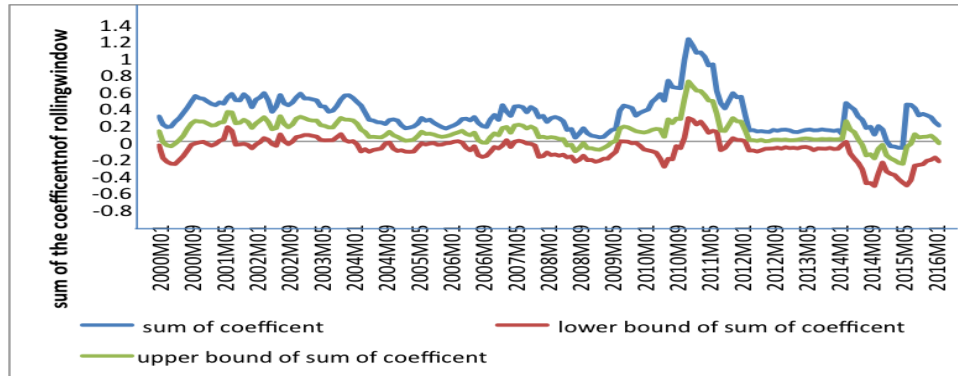
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Figure 4: Bootstrap p-values of rolling test statistic testing the null that CPI does not Granger cause PPI in Romania

6. Conclusion

The study investigates the causal relationship between the CPI and PPI for Romania by using the bootstrap rolling window approach. The full sample Granger causality test indicates one-sided causality from PPI to CPI. By including the structural changes, the parameter stability test shows instability and the result are misleading. A bootstrap subsample rolling window approach is used to address the structural problem, and the result indicates that both CPI and PPI have a significant impact on each other. They have both positive and negative relationship and indicate that PPI has a major contribution in CPI inflation in Romania. Considering that PPI inflation rate is more volatile and less persistent than the CPI inflation rate, PPI should be used as a short-term indicator of CPI inflationary trends in Romanian economy. Although, the results are inconsistent with the neoclassical profit-maximizing model; which state that CPI is dependent upon the PPI. The study has some policy implication. First, the PPI is leading factor in CPI so the National Bank of Romania may devise the single monetary policy, which includes PPI, as most relevant and leading indicator. The monetary authority will be in better position to achieve the price stability by the inclusion of both PPI and CPI in the monetary policy formulation. To guarantee sustainable economic growth is undeniable the necessity to maintain a prudent monetary policy to anchor inflation expectations firmly and conservation prospects of recovery in the annual rate of inflation in the established medium term limits. Second, the negative implication

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can be avoided or minimise if the authorities have information of PPI at every point of the production process in the economy.

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