The Causal Relationship between Producer Price Index and Consumer Price Index: Empirical Evidence from Selected European Countries

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Abstract

The purpose of this study is to examine the causal relationship between Producer Price Index and Consumer Price Index for the five selected European countries, using seasonally adjusted monthly data from August 1995 to December 2007. Toda and Yamamoto causality test (1995) are employed to investigate causality. The results indicate that there is a unidirectional causality between producer price index and consumer price index, running from producer price index to consumer price index in Finland and France and bidirectional causality between two indices in Germany. In the case of the Netherlands and Sweden, no significant causality is detected.

Keywords: Producer Price Index, Consumer Price Index, Cointegration, Toda and Yamamoto Causality Test

1. Introduction

The Consumer Price Index (CPI) simply can be defined as a measure of average prices for a basket of goods commonly purchased by consumers. CPI is used for determining whether general prices are higher, lower or stable over time, calculating annual rate of inflation, and converting nominal values to real. The Producer Price Index (PPI) measures the average prices for a basket of inputs commonly purchased by producers. The PPI has two main functions: (1) to provide price indices for use in the deflation of gross domestic product data, and (2) to provide a general measure of inflation. Economists have argued that the PPI can be a useful indicator of future consumer inflation, as changes in prices paid by producers (changes in costs) often precede changes in prices paid by consumers. In the past, PPI is often called “Wholesale Price Index” (WPI). WPI focuses on the prices of traded goods and services between corporations, rather than goods and services bought by consumers.

What is the causal relationship between PPI and CPI? Do producer prices cause consumer prices or consumer prices cause producer prices? There are two basic approaches about PPI and CPI causality relationship, namely supply side and demand side in literature.

According to supply side approach, PPI and CPI are connected by production chain. Advocates of supply side approach claimed that crude materials serve as inputs to the production of intermediate goods, which in turn serve as inputs to the production of final goods. Changes in prices of crude materials should pass through to prices of intermediate and final goods and ultimately to consumer prices (Clark, 1995, p.26). Therefore, changes in PPI lead or cause CPI. PPI and CPI connection is summarized by Rogers (1998, p.53) as follows.

Producer prices for crude materials $\uparrow$ $\rightarrow$ Prices for intermediate products $\uparrow$ $\rightarrow$ Producer prices for finished goods $\uparrow$ $\rightarrow$ Consumer prices $\uparrow$

According to demand side approach ‘demand for final goods and services determines the demand for inputs between competing uses’. Thus, ‘the cost of production reflects the opportunity cost of resources and intermediate goods, which in turn reflects demand for the final goods and services’ (Caporale, Katsimi and Pittis, 2002, p.705). Consequently, consumer prices can affect producer prices. Cushing and McGarvey (1990) assumed that demand for primary goods depends on expected future prices of consumer goods. This assumption implies that current demand and past expectations of current demand determine consumer price and expected future demand determines producer price. Changes in the demand for final goods have an impact on input prices, therefore CPI leads to PPI.

The causality between PPI and CPI remains a controversial issue in empirical findings. There are three different empirical evidences about PPI and CPI nexus, namely one way, two-way and no causality in literature.

The purpose of this study is to investigate causality between PPI and CPI for the five (Germany, France, Netherlands, Sweden, Finland) European countries which has low level of inflation. According to Eurostat, the average inflation rate for these countries for the period of 1995-2007 is less than %2. Contrary to the previous studies that examined PPI and CPI causality for developing countries and countries that have high level of inflation, this study investigates PPI and CPI causality for European countries that has low level of inflation. With the above in mind, the rest of the study is organized as follows. Section II reviews the literature. Section III describes empirical methodology and the description of data. Section IV presents empirical results. The last section concludes the study.

2. Previous Research

There are numerous studies examining the directions of causality between PPI and CPI in many countries over periods of time.

Colclough and Lange (1982) investigated direction of causality between PPI and CPI by using Sims and Granger causality tests and they found that causality runs from consumer prices to producer prices in the USA. Jones (1986) provided evidence of bidirectional causality between PPI and CPI in the United States.

Blomberg and Harris (1995) analyzed the short-and long-run relationships between PPI and CPI, by employing several VAR specifications for USA. They find that PPI does not have a significant predictive content for the future pattern of the CPI especially starting in the mid 1980s.

Clark (1995) examined relationships between PPI and CPI, by using VAR forecasting models, over the period 1959:Q2-1994:Q4 in USA. His analysis reveals that changes in PPI do not systematically help predict CPI changes. In other words pass-through effect between PPI and CPI is weak.

Caporale et al. (2002) looked at the relationship between PPI and CPI using Toda and Yamamoto approach (1995) for G7 countries for the period January 1976 to April 1999, by estimating bi-variate and five-variate VAR systems. In this study, the authors firstly estimated bi-variate VAR system. Results of bi-variate VAR system suggest that causality is unidirectional running from PPI to CPI in France and Germany, and causality is bidirectional in Italy, Japan, the United Kingdom and the United States. In Canada no causality found at all. The authors secondly estimated five-variate VAR system. Results of five-variate VAR system indicate that causality is unidirectional running from PPI to CPI for all countries.

Akdi, Berument and Cilasun, (2006) studied long – and short – run relationships between Wholesale Price Index (WPI) and Consumer Price Index (CPI) using monthly data for the period 1987:01 to 2004:08 in Turkey. Their findings suggest that Engle and Granger (1987) and Johansen (1988) conventional tests give mixed results. They also, employed periodogram method to test whether there is a cointegrating relationship between two indices. Results of periodogram method suggest that there is no cointegration between PPI and CPI in Turkey. Moreover, they found a short- run relationship between WPI and CPI in Turkey.

Ghazali, Yee and Muhammed (2008) examined the relationship between PPI and CPI using monthly data from January 1986 to April 2007 in Malaysia. The authors employed both Engle-Granger Vector Error Correction Model (VECM) and Toda and Yamamoto no-causality test. Results of both approach reveals a unidirectional causality running from PPI to CPI in Malaysia.

Liping, Gang and Jiani (2008) analyzed the relationship between PPI and CPI using monthly data for China. The authors found a unidirectional causality between two indices that is running from CPI to PPI in China.

Shahbaz, Awan and Nasir (2009) investigated the relationship between PPI and CPI using monthly data for Pakistan. The authors employed ARDL bounds testing and Johanson cointegration approach to determine the long run relationship between PPI and CPI. The authors also used Toda and Yamamato approach (1995) to determine causality between PPI and CPI. Their results have verified the existence of long run relationship between producer and consumer prices. They also found that there is bidirectional causality but it is stronger from producer to consumer prices.

Sidaoui, Capistrán, Chiquiar, and Ramos-Francia (2010) examined the relationship between PPI and CPI using monthly data for Mexico. The authors employed Engle-Granger Vector Error Correction Model (VECM) to determine short run and long causality between PPI and CPI. They found that Granger causality is from the PPI to the CPI in the long run but in the short run there is no causality between PPI and CPI.

3. Data and Empirical Methodology

This study uses monthly PPI and CPI data over the period August 1995 to December 2007, for the selected European countries. Both PPI and CPI data is obtained from the OECD Statistics. PPI and CPI series are seasonally adjusted by using Seat / Tramo method, and transformed into natural logarithm scale prior to analysis.

One of the features of Vector Autoregression (VAR) model is that they permit us to test the direction of causality. In order to assess the causality between PPI and CPI, Toda and Yamamoto no-causality test is utilized.

Toda and Yamamoto method is chosen due (as noted by Shirazi and Abdul Manap, 2005, p. 478) to following reasons: a) the standard Granger (1969) causality test for inferring leads and lags among integrated variables is likely to give spurious regression results and F-test becomes invalid unless the variables are cointegrated, b) the error correction model (Engle and Granger 1987) and the VAR error correction model (Johansen and Juselius 1990) as alternatives for testing of non causality between time series are cumbersome, c) Toda and Phillips (1993) claimed that the Granger causality tests in ECMs still contain the possibility of incorrect inference and suffer from nuisance parameter dependency asymptotically in some cases.

Toda and Yamamoto (1995) procedure has an advantage in that it does not require whether the series are I(0), I(1), I(2) or whether the series are cointegrated (see Caporale and Pittis, 1999). Toda and Yamamoto procedure can be applied even when there is no integration or stability, and when rank conditions are not satisfied 'so long as the order of integration of the process does not exceed the true lag length of the model' (Toda and Yamamoto, 1995, p.225). Unlike the conventional Granger causality test, the Toda and Yamamoto (1995) approach fits a standard vector auto-regression on levels of the variables not on the first difference of the variables.

Toda and Yamamoto approach requires estimation of an augmented VAR ($k+d_{max}$) model where k is the optimal lag length in the original VAR system, and d_{max} is the maximal order of integration of the variables in the VAR system. The Toda and Yamamoto Granger causality test employs a modified Wald (MWald) test for zero restrictions on the parameters of the original VAR (k) model. The coefficient of the last lagged d_{max} vectors is ignored in the VAR (k) model (see Caporale and Pittis, 1999; Rambaldi and Doran, 1996 and Zapata and Rambaldi, 1997). MWald test has an asymptotic χ^2 distribution when the augmented VAR ($k+d_{max}$) is estimated. According to Rambaldi and Doran (1996) MWald tests for testing Granger no-causality increases efficiency when Seemingly Unrelated Regression (SUR) models are employed in the estimation. Toda and Yamamoto Granger no-causality test is employed in this study by estimating the following bi-variate VAR system using the SUR method.

$$PPI_t = \alpha_0 + \sum_{i=1}^{k+d} \alpha_{1i}\, PPI_{t-i} + \sum_{j=1}^{k+d} \alpha_{2j}\, CPI_{t-j} + u_t \quad (1)$$

$$CPI_t = \beta_0 + \sum_{i=1}^{k+d} \beta_{1i}\, CPI_{t-i} + \sum_{j=1}^{k+d} \beta_{2j}\, PPI_{t-j} + v_t \quad (2)$$

PPI and CPI are logarithm of producer and consumer price index. The optimal lag order is k, d is the maximal order of integration of the variables in the system (d_{max}) and u_t and v_t are error terms that are assumed to be white noise. Each variable is regressed on each other variable lagged from one (1) to the $k+d_{max}$ lags in the SUR method, and the restriction that the lagged variables of interest are equal to zero is tested. From equation (1), "CPI does not Granger cause PPI" if $H_0 : \alpha_{2j} = 0$ against $H_1 : \alpha_{2j} \neq 0$, where $j \leq k$. Similarly, from equation (2), "PPI does not Granger cause CPI" if $H_0 : \beta_{2j} = 0$ against $H_1 : \beta_{2j} \neq 0$, where $j \leq k$.

4. Empirical Results

In the first stage of the empirical analysis, the Augmented Dickey-Fuller (ADF) unit root test is employed to test stationarity of the series. Results of unit root test are reported in Table 1. The results show that we can not reject the null hypothesis of unit roots for both variables in level forms. However, the null hypothesis is rejected when ADF unit root test is applied to the first differences of each variable. The first differences of the PPI and CPI are stationary indicating that these variables are integrated of order one, I (1).

Insert Table 1 Here

In the second stage of this study, Johansen and Juselius (1990) cointegration test is used to test the long run relationship of PPI and CPI series. As Engle and Granger (1987) pointed out, only variables with the same order of integration could be tested for cointegration. Since PPI and CPI series are integrated with the same order I (1) for all countries, cointegration test can be conducted.

Insert Table 2 Here

Table 2 provides, $\lambda - \text{Trace}$ and $\lambda - \max$ statistics. The null hypothesis of no cointegration (r=0) against the alternative of r ≤1 and r≤2 is tested. Both tests show that there is one cointegrating vector present between the variables, and it can be concluded that there is a long-run equilibrium relationship (linkage) present between PPI and CPI in Germany. Existence of a long - run relationship between two price indices in Germany means that existence of price stability in one index guarantees price stability in the other index in Germany. PPI and CPI series are not cointegrated in France, Sweden, Finland and Netherlands. Therefore, PPI and CPI do not closely move with each other in the long – run. This means that CPI can not be predicted by looking at PPI. Thus, the higher cost of production will not necessarily increase inflation rate in France, Sweden, Finland, and the Netherlands.

Insert Table 3 Here

Table 3 reports, the optimal lag length (k), VAR order ($k+d_{max}$), MWald statistics, p values and direction of causality for each country.

The null hypothesis "Granger no–causality from CPI to PPI" can be rejected, but he null hypothesis "Granger no–causality from PPI to CPI" can not be rejected for Finland and France. These results indicate that there is a unidirectional causality between PPI and CPI, and the direction of causality is from PPI to CPI in Finland and France. The supply side approach is therefore supported by the empirical evidence. The implication here is that policy makers can predict future inflation by using PPI in Finland and France. Both the null hypothesis "Granger no–causality from PPI to CPI" and the null hypothesis "Granger no–causality from CPI to PPI" can be rejected at the 5 percent level of significance for Germany. This indicates that there is bidirectional causality between PPI and CPI, in Germany. Both the supply side and demand side approaches are therefore supported by the empirical evidence for Germany. The implication here is that policy makers can predict future inflation by using PPI and CPI in Germany. In the case of the Netherlands and Sweden, there is no significant causality between PPI and CPI.

5. Conclusion

Numerous studies have investigated the causality between the producer price index and the consumer price index in economic literature. Some studies found unidirectional, some studies found bidirectional and some other studies found no causality between PPI and CPI at all.

In this study, cointegration, and methodology of Granger no-causality test developed by Toda and Yamamoto are employed to empirically investigate causal link between PPI, and CPI for the selected five European countries, using seasonally adjusted monthly data. The cointegration test results of Johansen and Juselius (1990) indicate that two variables are cointegrated in Germany, but not cointegrated in France, Finland, Sweden and the Netherlands.

The results of Toda and Yamamoto no-causality test indicate a one-way causality between PPI and CPI in Finland and France. The direction of causality is from PPI to CPI in these countries. The results indicate that a price change recorded in a particular component of the PPI will eventually and directly be seen in the same component of the CPI in Finland and France. In the case of Germany there is a two-way causality between PPI and CPI and no significant causality detected in the Netherlands and Sweden.

The empirical result supports supply side approach for the case of Finland and France and supports both supply side and demand side approach for the case of Germany. In the case of the Netherlands and Sweden neither supply side nor demand side approach is supported.

This study provides mixed results on the direction of causality between CPI and PPI for the selected countries. This can be attributed to the model misspecification errors, omission of important variables and content of the baskets of producer and consumer price indices.

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Table 1. ADF Unit Root Tests

Country	Series	Level Constant & Trend	Critical Value	First Difference Constant	Critical Value	Integration Order I (d)
Sweden	PPI	-1.210 (4)	-3.441	-4.155* (4)	-2.881	I(1)
	CPI	-1.312 (4)	-3.441	-6.427* (4)	-2.881	I(1)
France	PPI	-0.574 (2)	-3.440	-5.076 * (2)	-2.881	I(1)
	CPI	-1.794 (1)	-3.440	-9.220* (1)	-2.881	I(1)
Germany	PPI	-1.858 (1)	-3.440	-5.905* (1)	-2.881	I(1)
	CPI	-1.686 (1)	-3.440	-9.008* (1)	-2.881	I(1)
Finland	PPI	-0.507 (4)	-3.440	-4.497 *(4)	-2.881	I(1)
	CPI	-1.285 (4)	-3.440	-6.731* (4)	-2.881	I(1)
Netherlands	PPI	-1.376 (1)	-3.440	-6.981 *(1)	-2.881	I(1)
	CPI	0.135 (3)	-3.441	-9.617* (3)	-2.881	I(1)

Notes: The numbers in parentheses indicates the selected lag order of the ADF model. Lags are chosen based on Akaike Information Criterion (AIC). * indicate significance at 5% levels.
EViews 5.0 was used for all computations.

Table 2. Johansen - Juselius likelihood cointegration tests between PPI and CPI

Country	Hypothesis	Alternative	Eigen -value	$\lambda - \text{Trace}$	$\lambda - \max$
Sweden	r=0	r=1	0.030	6.590	4.377
	r ≤1	r=2	0.015	2.213	2.213
France	r=0	r=1	0.058	8.451	8.450
	r ≤1	r=2	6.40E-06	0.000	0.000
Germany	r=0	r=1	0.103	17.263*	15.223*
	r ≤1	r=2	0.103	2.040	2.040
Finland	r=0	r=1	0.045	7.006	6.650
	r ≤1	r=2	0.002	0.355	0.355
Netherlands	r=0	r=1	0.040	6.539	5.830
	r ≤1	r=2	0.040	0.708	0.708

Notes: * indicate significance at 5% level and r denotes number of cointegrating vectors.
EViews 5.0 was used for all computations.

Table 3. Toda –Yamamoto No-Causality Test Results

Country	Null Hypothesis	Lag(k)	$k+d_{max}$	MWald Statistics	p-values	Direction of Causality
Sweden	PPI does not Granger Cause CPI	7	7+1=8	10.438	0.235	No causality
	CPI does not Granger Cause PPI			10.246	0.248	
France	PPI does not Granger Cause CPI	8	8+1=9	34.515***	0.000	PPI→ CPI
	CPI does not Granger Cause PPI			11.581	0.170	
Germany	PPI does not Granger Cause CPI	8	8+1=9	17.994**	0.021	PPI ↔ CPI
	CPI does not Granger Cause PPI			23.942***	0.002	
Finland	PPI does not Granger Cause CPI	4	4+1=5	10.068*	0.073	PPI → CPI
	CPI does not Granger Cause PPI			4.781	0.443	
Netherlands	PPI does not Granger Cause CPI	7	7+1=8	4.195	0.757	No causality
	CPI does not Granger Cause PPI			11.565	0.115	

Notes: The ($k+d_{max}$) denotes Var order. The lag length selection was based on Akaike information criterion. ***, ** and * denotes 1% , 5% and %10 significance level, respectively. EViews 5.0 was used for all computations.