International Review of Accounting, Banking and Finance

Vol 8, No. 1, Spring, 2016, Pages 14-31

IRABF

Why are there always inconsistent answers to the relation between the PPI and CPI? Re-examination using Panel Data Analysis

Chih-Ping Yu[a]

a. *Department of Marketing Management, Central Taiwan University of Science and Technology, Taichung City 40601, Taiwan, R.O.C.*

Abstract: To explore why empirical research on the relation between the PPI and CPI has always generated inconsistent answers, this research uses the Panel Data Analysis method and the Dumitrescu-Hurlin Panel Causality Tests to re-examine the causal relationship between the Producer Price Index (PPI) and the Consumer Price Index (CPI). Thus, by comparing the monthly data from January 1999 to August 2015 of the ASEAN countries and the G7 countries, we empirically prove the existence of a causal relationship between PPI and CPI in national industrial development patterns and regional economies. In addition, an advanced inference on the interaction in the aforementioned countries is performed using the industrial development pattern within the same industry. The empirical results demonstrate that the PPI of the ASEAN countries shows a significant one-way impact on CPI, while a two-way causality relationship exists between the PPI and CPI in the G7 countries. Considering national effects, a very significant two-way causality relationship exists between the PPI and the CPI of both the G7 countries and the ASEAN countries, fully supporting the contention that the innovative inferences proposed in this study are different from the existing literature.

Keywords: Producer Price Index, Consumer Price Index, Panel Data Analysis, Panel Granger Causality Test, G7, ASEAN

JEL classification: C33; E31

1. Introduction

What is the causality relationship between the "Producer Price Index (PPI)" and "Consumer Price Index (CPI)"? Are producer prices affecting consumer prices? Are consumer prices the leading indicator of producer prices instead? Since the 1980s, there has been a considerable amount of empirical research using different countries as study subjects, taking samples from different time periods or even using different research methods, with a sole purpose of addressing the above questions. This study, however, presented the following bold rebuttal after a detailed review of all the existing related literature: Does the answer simply vary from country to country, depending on the country's primary development, the regional economic patterns the countries belong to, or even the roles the countries play in the supply chain? Furthermore, we used Panel Data Analysis that has never been employed in previous related research to verify our innovative inference step by step.

The simple definition of the "Consumer Price Index" is the average price of a basket of goods purchased by consumers. It is often used to determine the general price level and price stability—and to calculate the yearly inflation rates or to calculate real value. On the other hand, the Producer Price Index is the average price a producer pays for the raw materials (a basket of inputs) needed to produce the basket of goods that consumers purchase. In addition to measuring inflation just as CPI does, PPI can be used as the price index deflator for the gross domestic product (GDP). Many economists advocate using PPI as the leading indicator of consumer inflation in the future as rising raw material prices lead to increased production costs, which are finally reflected in the price paid by consumers.

Certainly, both the CPI and PPI are crucial variables that measure the inflation and the actual GDP of a country, and the mutual impact between the two variables is of particular importance. Therefore, many studies since the early days have been devoted to finding the ultimate relation between the CPI and PPI. However, we found that the theoretic basis of existing studies may not be comprehensive enough or may no longer fit for the current trend of the international industrial and economic development. Therefore, incorrect inference was made or incorrect research direction was followed. Therefore, this study would raise questions, formulate hypotheses, and finally verify these hypotheses empirically, with the hope of providing correct guidance to the direction of subsequent research and its basis of inference regarding the relation between the CPI and PPI.

This study collected both existing theories and empirical research and documented analyses of relationships between producer prices and consumer prices based on the theories and empirical results, which can be divided into the two directions of "demand-pull" and "cost-push". Advocates of the “cost-push" theory argue that changes in producer prices throughout the production chain have a spillover effect that affects the final price consumers pay, i.e., empirical studies should exhibit the result that PPI leads to CPI due to the Granger Causality Relationship. Information related to producer prices possesses excellent predictive power in determining consumer prices; trends in producer price also contribute to the magnitude of change and impact level of the “cost-push” direction acknowledged by the central bank, thus improving the central bank’s effectiveness in consumer price inflation forecasting.

The relationship between PPI and CPI has been discussed in influential literature, such as by Clark (1995), who suggested that raw materials are the input for intermediate goods, which are in turn the input for finished goods purchased by consumers. Therefore, price changes in raw materials lead to price changes in intermediate products and further in the final price of the finished goods consumers pay for. Thus, Clark (1995) reasoned that changes in PPI must lead to changes in CPI. Rogers (1998) also put forward the same argument, as clearly illustrated below:

Raw materials prices faced by producer’s ↑ → prices of intermediate goods ↑ → prices of final products faced by producer’s ↑ → consumer prices ↑

Advocates of the "demand-pull" theory believe that the producer’s price is generally the sum of overheads in the form of salary and wages, which depends on the consumption level of the labor suppliers themselves. Therefore, when consumer prices change, the labor suppliers adjust to meet their own consumer demand, which in turn changes their asking price for the labor they provide to the producers, ultimately leading to adjustments and changes in producers’ salary costs. As a result, empirical research supporting the “demand-pull” theory largely exhibits the result that the CPI trend can be used to explain change in PPI. Recent studies that focused on the demand standpoint, such as by Caporale, Katsimi and Pittis (2002), who believe that ultimate demand for finished goods or services determines the raw material inputs, while production cost reflects the opportunity cost of both the resource inputs and the intermediate goods. In other words, production cost reflects consumer demand for finished goods or services. As a result, Caporale, Katsimi and Pittis (2002) inferred that consumer prices impact producer prices. Early studies by Cushing and McGarvey (1990) proposed that demand for primary products depends on the assumption of the future speculative price of consumer goods expected. Inferences made for current demand as well as past speculation of current demand determine consumer price. The forecast of future demand determines producer price, and finally, changes in demand for finished goods or services affect the price of raw material inputs. Therefore, Cushing and McGarvey (1990) claim that CPI leads to PPI.

Those who advocate the "cost-push" theory stress that PPI changes surely lead to CPI changes, and advocates of "demand-pull" maintain that CPI leads to PPI. However, the bulk of the current related empirical research repeatedly examines only one country at a time as their research object or uses different time series analysis methods, all resulting in inconsistent inferences. The inconsistent inferences include the following: no correlation exists between CPI and PPI, PPI affects CPI, CPI leads to PPI, or there is a reciprocal causal relationship between CPI and PPI. Furthermore, in order to resolve the shortcomings in existing related literature, the direction of which was relatively monotonous, narrow, and problematic and provided no definitive theoretic inference basis, we attempted to adopt the novel Panel Data Analysis method using different data patterns and data processing methods to put forth the innovative theory that the causality relationship between PPI and CPI is indeed affected by the industrial development situation in a country and the impact from other countries that bear the same regional economic or development similarities, as supported by an empirical analysis using the panel data of the Association of Southeast Asian Nations (ASEAN) and the Group of Seven (G7).

In a departure from existing empirical research, the present study has not only drawn inferences from the long-term relationships between PPI and CPI of a single nation using its time series analysis results, we have also examined the panel data that was made up of the five emerging industrial nations that belong to the ASEAN, along with another set of panel data of the G7. The causal relationship analyzed in the present study was rather between PPI and CPI data of nations representing two different industrial development patterns; the possible impact among all nations on the same panel was also examined in the results.

With respect to the debate regarding the causal relationship between PPI and CPI, supporters of the “cost-driven” theory, such as Clark (1995) and Rogers (1998), whose claim that PPI (Granger cause) leads to CPI can be explained by the “cost-driven” principle, while those who support the "demand-pull” debate, such as Caporale, Katsimi and Pittis (2002) and Cushing and McGarvey (1990), maintain that empirical research results show that CPI causes PPI, as explained in the “demand-pull” principle. Based on an integration of the two principles, further inferences were made in this research. The causal relationship between a country’s PPI and CPI may depend on whether the country is of the “demand-pull” or “cost-driven” type. However, whether a country is “demand-pull” or “cost-driven” relates to its role in the industrial development, regional economies, and production supply chain, as well as its mutual influence among all countries. Therefore, the present study anticipates that the empirical panel results employed using both the ASEAN 5 and G7 would exhibit a causality relationship between PPI and CPI, and the two causality relationships would not be the same.

This section holistically examines the many empirical results and the principal developments that support the discussion of the causal relationship between PPI and CPI and advances the proposed research into innovative reasoning as well as the anticipated empirical results. Meanwhile, the next section will offer a more detailed and in-depth review of literature as well as discussion. The third section introduces our research in full, and the longitudinal analysis method is presented. The fourth section is a description of our empirical data source, coupled with a presentation of the original data characteristics. The fifth section explains in full detail the empirical results. The final section is for findings and conclusions.

2. Literature Review

There are many empirical studies that have, thus far, committed to testing in a particular country within a certain period of time the direction of causality between CPI and PPI. These studies attempt to clarify whether there exists any causal relationship between PPI and CPI, and if relevant, whether CPI affects PPI, or PPI affects CPI.

Colclough and Lange (1982) and Jones (1986) used samples in the U.S. Colclough and Lange (1982), through the Sims and Granger causality tests, confirmed how consumer price impacts producer price. However, Jones (1986) came up with different results, indicating that the causality relationship between CPI and PPI is bidirectional.

Using different VAR models to analyze the short- and long-run relationships between the CPI and PPI of the U.S. from 1970 to 1994, Blomberg and Harris (1995) found that PPI did not have any significant power to predict changes in CPI. That same year, Clark (1995) also used a VAR model to verify the relationship between PPI and CPI using a sample from the United States. The only difference is that Clark used the "VAR Forecasting Models" using a sample taken during the second quarter of1959 to the fourth quarter of 1994. The empirical results of Clark (1995) were that a change in PPI could not systematically predict changes in CPI; therefore, Clark inferred a weak pass-through effect between CPI and PPI.

Caporale et al, (2002), using a VAR systems approach developed by Toda and Yamamoto (1995), studied the relationship between CPI and PPI among the G7 countries from January 1976 to April 1999 and determined that both France and Germany show a unidirectional causality relationship of PPI toward CPI. For Italy, Japan, the UK, and the U.S., the CPI and PPI causal relationship is bidirectional. However, no significant causal relationship was found between CPI and PPI in Canada.

Akdi, Berument and Cilasun (2006) used the monthly data collected from January 1987 to August 2004to examine CPI and PPI's short-run and long-run relationships in Turkey. Empirical results show no cointegration relationship between CPI and PPI in the long run in Turkey, but a short-run relationship.

Ghazali, Yee and Muhammed (2008), using the Johansen Cointegration Method, discovered the existence of a long-term equilibrium relationship between CPI and PPI from 1986 to 2007 in Malaysia. The Engle Granger and Toda-Yamamoto causality tests found short-term unidirectional causality in PPI toward CPI.

Liping, Gang and Jiani's (2008) Granger Causality Test examined China's CPI and PPI, from January 2001 to August 2008, and showed a delayed reaction in the causal relationship for approximately one to three months in PPI subsequent to changes in CPI. In other words, a change in CPI was the cause leading to change in PPI. Therefore, Liping, Gang and Jiani (2008) reasoned that, compared to the supply-side factors, the demand-side factors were more crucial in terms of recent CPI inflation in China's economy.

Akcay (2011) used 5 months' worth of data from five European countries, covering August 1995 to December 2007. Using the Toda and Yamamoto Causality Test (1995), Akcay verified the causality between CPI and PPI, and the empirical results show that in Finland and France, PPI was the cause and CPI was the result in a unidirectional causality relationship. In Germany, CPI and PPI impact each other and exhibit a bidirectional causality relationship, while in the Netherlands and Sweden, no significant causal relationship was found.

To facilitate comparison, we have organized the aforementioned empirical results as shown in Table 1. As seen in Table 1, the results of many related research papers, including the earlier Colclough and Lange (1982) to the more recent Akcay (2011), are completely focused on discussing the causal relationship between PPI and CPI, with the most significant differences of using either different countries or different time series analysis methods, with a few using the U.S. as the same research object only with different sample periods.

Adopting samplings of different individual nations and using different time series analysis methods, we arrive at different PPI and CPI causality results. For those that present no reasonable explanation or principle from different empirical results, the present study found from literature reviews that these findings highlight the situation of current debates surrounding the causal relationship between PPI and CPI as indeed a bottleneck. We adopt a novel longitudinal data analysis method that has never been used before and extend the "cost-push" theory in Clark (1995) and Rogers (1998) and the "demand-pull" theory in Caporale, Katsimi and Pittis (2002) and Cushing and McGarvey (1990). We proposed the inferences that the causal relationship between PPI and CPI in a country is impacted by its industrial development situation, along with the roles of the country in its regional economies and production supply chains and the mutual impact among different nations as evidenced by the ASEAN and G7 samples.

Table 1. Summary of empirical research verification on the relationship between CPI and PPI

Author	Country(Period)	Main Method	Results
Colclough and Lange (1982)	U.S.	The Sims and Granger causality tests	CPI→PPI
Jones (1986)	U.S. (1947M1to1983M12)	The Wald variant of the Granger direct causality test (Geweke, Meese, and Dent, 1983)	Bidirectional causality CPI↔PPI
Blomberg and Harris (1995)	U.S. (1970M1-1994M4)	VAR Models	PPI cannot help predict changes in CPI
Clark (1995)	U.S. (1959Q2-1994Q4)	VAR Forecasting Models	Changes in PPI do not systematically help predict CPI changes
Caporale et al. (2002)	G7 countries (1976M1-1999M4)	VAR Models (Toda and Yamamoto,1995)	France and Germany: PPI→CPI Italy, Japan, U.K. and U.S.:CPI↔PPI Canada: no causality found PPI×CPI
Akdi, Berument and Cilasun (2006)	Turkey (1987M1-2004M8)	(1) Conventional Engle and Granger tests; (2)Johansen's cointegration tests	Long-run: no-cointegration relationship; Short-run: move together
Ghazali, Yee and Muhammed (2008)	Malaysia (1986M1-2007M4)	(1) Johansen Cointegration method; (2) Engle Granger and Toda-Yamamoto Causality tests	Long-run：cointegration relationship Short-run：PPI→CPI
Liping, Gang and Jiani(2008)	China (2001M1-2008M8)	Granger-Causality Test	CPI→PPI
Akcay (2011)	Selected European Countries-Finland、France、Germany、Netherlands、Sweden (1995M8-2007M12)	Toda and Yamamoto causality test (1995)	Finland and France：PPI→CPI Germany：CPI↔PPI Netherlands and Sweden：nosignificant causality

3. Data and Methodology

3.1 Panel Unit Root Tests

In order to avoid spurious regression issues before long-term estimates and analysis could be conducted, a unit root test had to be performed first to determine whether the variable trend was stationary. If the changing trend of the variable is non-stationary, then the results of the empirical analysis would also be invalid. The present study implemented four different panel unit root tests, including Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), and Fisher-type tests using ADF and PP tests (Maddala and Wu (1999) and Choi (2001) to check for the existence of a single unit root. Recent literature supports that the panel unit root test has higher verifiability power than conventional unit root tests.

The null hypothesis (H0) of the four different panel unit root tests has unit root, and the alternative hypothesis (H1) has no unit root. If the verification result of the sequence does not have a single root, then the sequence would be stationary.

3.2 Panel Cointegration Test

If the panel data of the Panel Unit Root Test in this study is confirmed to show a stationary trend, the "Pedroni Residual Cointegration Test" analysis will be used to test for long-run relationships between CPI and PPI in the panel data, one of the main problems the present study hopes to investigate. The Panel Cointegration test is made up of seven different test statistics. The null hypothesis was tested for "no cointegration," but the alternative hypothesis was divided into two categories according to regression residuals of different characteristics. The seven test statistics derived by Pedroni (1999, 2004) belong to either one of the two different alternative hypotheses.

In assumption (1) below, $e_{it}$is used to estimate the relational regression residual of CPI and PPI for each cross-section,

$$e_{it} = \rho_i e_{it-1} + \mu_{it} \qquad (1)$$

for t=1,2,……..,T; i=1,2………..,N

Pedroni (1999, 2004) says that the Pedroni Residual Cointegration Test of the null hypothesis is of "no cointegration," that is, when $\rho_i = 1$ was established, the two alternative hypotheses were as follows: the residual has a homogenous alternative, namely ($\rho_i = \rho$), established at <1 for all i. Pedroni called it the Within-Dimension Test or Panel Statistics Test; the alternative heterogeneous hypothesis of another residual is, ρ_i<1 for all i set up. Pedroni named it the Between-DimensionTest or Group Statistics Test.

If the test results show the analysis of the series with total integration, it is conducive to show that the next estimated relationship does not contain any spuriousness issues. In addition, Granger (1986) inferred that if there is a total integration of relationships between two variables, there is at least a unidirectional causality between the two variables.

3.3 Panel Granger Causality Test

The Granger Causality Test is derived from traditional bivariate regressions, and the general bivariate regression that was developed as suitable for use in panel data analysis and which derived the Granger Causality Test is shown below in formulas (2) and (3):

$$y_{i,t} = C_{0,i} + C_{1,i}y_{i,t-1} + \cdots + C_{l,i}y_{i,t-1} + d_{1,i}x_{i,t-1} + \cdots + d_{l,i}x_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

$$x_{i,t} = C_{0,i} + C_{1,i}x_{i,t-1} + \cdots + C_{l,i}x_{i,t-1} + d_{1,i}y_{i,t-1} + \cdots + d_{l,i}y_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

while *i* is defined as the cross-sectional dimension in panel data analysis, which is defined as a country in the present study, *t* is defined as the dimension of time.

In formulas (2) and (3) that are derived by different Panel Granger Causality Tests, the only difference lies in the assumption of homogeneity of coefficient *I* in the cross-sections of $C_{l,i}$ and $d_{l,i}$as shown in the two most commonly used methods in recent years as follows.

I. Stacked Causality Test (Common Coefficients)

The fundamental principle behind this method is that the panel data to be analyzed is an identical group of big data stack, followed by a general standardized method that is the traditional implementation of the Granger Causality Test, and then subsequently assuming that across all cross-sections, the coefficient would be the same, as shown in the following formulas (4) and (5), i.e., hypothesizing that in all cross-sections, the different individual data elements (as the "countries" in the present study) do not affect each other.

$$C_{0,i} = C_{0,j};\ C_{1,i} = C_{1,j};\ \ldots;\ C_{l,i} = C_{l,j} \quad \textit{for all } i \neq j \quad (4)$$

$$d_{1,i} = d_{1,j};\ d_{2,i} = d_{2,j};\ \ldots;\ d_{l,i} = d_{l,j} \quad \textit{for all } i \neq j \quad (5)$$

II. Dumitrescu-Hurlin Panel Causality Tests (Heterogeneous Coefficients)

The method of hypothesis is completely different than the one shown above. This method hypothesizes that among all cross-sections, the coefficients are different, as shown in the following (6) and (7) formulas, and that the method used to test its calculation principle is also completely opposite to that shown above; the method, after implementing a traditional Granger Causality test on each individual cross-section, will take averages of all the test statistics to further arrive at an average statistical verification volume, named the "W bar statistic" by Dumitrescu-Hurlin (2012), which follows a standard normal distribution.

$$C_{0,i} \neq C_{0,j};\ C_{1,i} \neq C_{1,j};\ \ldots.;\ C_{l,i} \neq C_{l,j} \text{ for all } i \neq j \quad (6)$$

$$d_{1,i} \neq d_{1,j};\ d_{2,i} \neq d_{2,j};\ \ldots.;\ d_{l,i} \neq d_{l,j} \text{ for all } i \neq j \quad (7)$$

3.4 Data

We obtained the CPI and PPI data of the ASEAN5 members and the seven members of the G7 from the International Financial Statistics (IFS) Database. The sample period was January 1999 to August 2015, and data used was the monthly data during the sample period, as shown in Table 2. The samples from the ASEAN 5 member countries are from Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Although ASEAN now has 10 member countries, there are only five countries that have been officially documented in the IFS Database that have PPI and CPI figures, which only include the five countries, which is also shown in Table 3. Samples of the seven members of the G7 include those from Canada, France, Germany, Italy, Japan, the UK and the U.S. This study took the natural logarithm of PPI and CPI data (Ln (PPI) and Ln (CPI)) for analysis purposes. Descriptive statistics are shown in Table 2 and Table 3, which clearly show that the Ln(CPI) and Ln(PPI) of all the sample countries in this study are in abnormal distribution.

Table 2. Descriptive statistics for Ln(CPI) and Ln(PPI) of selected ASEAN countries

Panel A. Ln(CPI)

	Indonesia	Malaysia	Philippines	Singapore	Thailand
Mean	4.3492	4.5335	4.4498	4.5547	4.5200
Median	4.4038	4.5239	4.4390	4.4943	4.5245
Maximum	4.8959	4.7353	4.7672	4.7371	4.7186
Minimum	3.7265	4.3687	4.1042	4.4286	4.3252
Std. Dev.	0.3552	0.1123	0.2115	0.1081	0.1315
Skewness	-0.2592	0.1114	-0.0492	0.5333	0.0191
Kurtosis	1.7751	1.6192	1.6213	1.7266	1.5397
Jarque-Bera	14.7431***	16.3029***	15.9204***	22.9925***	17.7821***

Panel B. Ln(PPI)

	Indonesia	Malaysia	Philippines	Singapore	Thailand
Mean	4.2775	4.4756	4.4568	4.5589	4.4092
Median	4.3137	4.5132	4.5293	4.5860	4.4343
Maximum	4.9354	4.7212	4.7003	4.8258	4.6929
Minimum	3.5071	4.1736	3.9044	4.3072	4.0565
Std. Dev.	0.4413	0.1850	0.2093	0.1139	0.2226
Skewness	-0.1488	-0.2028	-0.9968	-0.1141	-0.1968
Kurtosis	1.5559	1.4679	2.8557	1.9983	1.4747
Jarque-Bera	18.1173***	20.9327***	33.2969***	8.7953**	20.6787***

Table 3. Descriptive statistics for Ln(CPI) and Ln(PPI) of G7 countries

Panel A. Ln(CPI)]

	Canada	France	Germany	Italy	Japan	U. Kingdom	U. States
Mean	4.5471	4.5536	4.5593	4.5425	4.6167	4.5362	4.5330
Median	4.5625	4.5590	4.5623	4.5448	4.6131	4.5135	4.5546
Maximum	4.6941	4.6648	4.6748	4.6811	4.6444	4.7207	4.6954
Minimum	4.3639	4.4104	4.4286	4.3553	4.5971	4.3801	4.3221
Std. Dev.	0.0940	0.0791	0.0759	0.1004	0.0126	0.1138	0.1134
Skewness	-0.2333	-0.2078	-0.0351	-0.2016	0.6598	0.3156	-0.2146
Kurtosis	1.8888	1.7545	1.7079	1.8214	2.3094	1.6466	1.7176
Jarque-Bera	12.1032***	14.3661***	13.9532***	12.9310***	18.4859***	18.5848***	15.2394***

Panel B. Ln(PPI)

	Canada	France	Germany	Italy	Japan	U. Kingdom	U. States
Mean	4.5848	4.5629	4.5510	4.5348	4.6024	4.5377	4.4922
Median	4.5811	4.5732	4.5768	4.5668	4.6039	4.5026	4.5173
Maximum	4.7238	4.6849	4.6794	4.6983	4.6939	4.6904	4.7252
Minimum	4.4367	4.4091	4.3735	4.3192	4.5445	4.4116	4.1927
Std. Dev.	0.0797	0.0824	0.0986	0.1140	0.0323	0.1011	0.1731
Skewness	0.1757	-0.1534	-0.2549	-0.2574	0.2227	0.2920	-0.1919
Kurtosis	1.7757	1.6557	1.5856	1.6550	2.9076	1.4428	1.5545
Jarque-Bera	13.5193***	15.8435***	18.8360***	17.2821***	1.7242	23.0485***	18.6411***

4. Empirical Results

4.1 Panel Unit Root Tests

Panel A of Table 4 illustrates that the first order logarithms of CPI and PPI all appear to reject the null hypothesis (H0) and the four Panel Unit Root Test results are identical, i.e., the CPI and PPI of the selected ASEAN countries are stable panel data. Similarly, from Panel B, we can prove that the CPI and PPI of the G7 countries are also stable panel data. Therefore, according to the Panel Unit Root Tests results, this study could proceed to the next stage of "Panel Cointegration Test" analysis. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Table 4.Panel Unit Root Tests

Panel A. Selected ASEAN countries

Method	Ln(CPI)		Ln(PPI)		ΔLn(CPI)		ΔLn(PPI)	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Levin, Lin & Chu t	-0.486	0.314	-3.240	0.001	-21.814	**0.000**	-25.690	**0.000**
Im, Pesaran and Shin W-stat	3.327	1.000	-1.302	0.097	-19.612	**0.000**	-22.842	**0.000**
ADF-Fisher Chi-square	1.022	1.000	21.355	0.019	305.451	**0.000**	362.056	**0.000**
PP-Fisher Chi-square	0.917	1.000	17.530	0.063	389.981	**0.000**	350.626	**0.000**

Panel B. G7 countries

Method	Ln(CPI)		Ln(PPI)		ΔLn(CPI)		ΔLn(PPI)	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Levin, Lin & Chu t	-4.029	0.000	-2.420	0.008	-15.387	**0.000**	-19.117	**0.000**
Im, Pesaran and Shin W-stat	-0.024	0.490	0.105	0.542	-15.411	**0.000**	-19.144	**0.000**
ADF- Fisher Chi-square	11.285	0.664	10.026	0.760	281.151	**0.000**	335.261	**0.000**
PP- Fisher Chi-square	12.186	0.591	8.202	0.879	634.016	**0.000**	422.581	**0.000**

4.2 Panel Cointegration Test

Table 5 demonstrates whether there is a long-run relationship between the CPI and PPI of the five ASEAN countries using the Pedroni Residual Cointegration Test. The null hypothesis tested (H0) is the “no cointegration” alternative hypothesis (H1). There are two alternative hypotheses, the first four statistics in the table are suitable for use in the alternative hypothesis of residual homogeneity (referred to as the within-dimension test or Panel statistics test); the latter three statistics are suitable for use in the alternative hypothesis of residual homogeneity (called the Between-Dimension Test or Group Statistics Test).

However, as seen in Table 5 seven statistics belonging to the two different types of alternate hypotheses cannot reject the "no Cointegration" null hypothesis. In other words, the test results show that there is no cointegration between the CPI and PPI of the selected ASEAN countries, meaning no long-run relationship exists between the CPI and PPI of these countries.

Table 5. Pedroni Residual Cointegration Test for Ln (CPI) and Ln (PPI) of selected ASEAN countries

Alternative hypothesis: common AR coefs. (within-dimension)

Method	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-1.563421	**0.9410**	-1.659132	**0.9515**
Panel rho-Statistic	2.637532	**0.9958**	2.695831	**0.9965**
Panel PP-Statistic	4.610966	**1.0000**	4.696054	**1.0000**
Panel ADF-Statistic	4.581638	**1.0000**	4.391285	**1.0000**

Alternative hypothesis: individual AR coefs. (between-dimension)

Method	Statistic	Prob.
Group rho-Statistic	2.655813	**0.9960**
Group PP-Statistic	5.052112	**1.0000**
Group ADF-Statistic	4.906688	**1.0000**

Table 6 shows whether a cointegration relationship exists between the CPI and PPI of the G7 countries using the Pedroni Residual Cointegration Test. The table clearly demonstrates that none of the seven statistics can reject the "no cointegration" null hypothesis whether under the significance level of 5% or 1%, that is no long-run relationship exists between the CPI and PPI of the G7countries.

Table 6. Pedroni Residual Cointegration Test for Ln (CPI) and Ln (PPI) of G7 countries

Alternative hypothesis: common AR coefs. (within-dimension)

Method	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-0.410944	**0.6594**	-0.376268	**0.6466**
Panel rho-Statistic	-1.268127	**0.1024**	-0.991279	**0.1608**
Panel PP-Statistic	-0.400515	**0.3444**	-0.179723	**0.4287**
Panel ADF-Statistic	1.549838	**0.2606**	1.696688	**0.2449**

Alternative hypothesis: individual AR coefs. (between-dimension)

Method	Statistic	Prob.
Group rho-Statistic	0.577306	**0.7181**
Group PP-Statistic	1.034394	**0.8495**
Group ADF-Statistic	-0.714253	**0.2375**

Note: ** and *** indicate a rejection of the null hypothesis of no Cointegration at 5% and 1% significance level, respectively.

4.3 Panel Granger Causality Test

We used the Stacked Causality Test to verify the results of the causality relationship between CPI and PPI results, as presented in Table 7. Panel A in Table 7 displays the data of the five ASEAN countries. We significantly declined the null hypothesis that “PPI does not possess the Granger Cause to CPI,” but also significantly could not reject the null hypothesis that "CPI does not Granger Cause PPI.” In other words, based on the empirical panel data of the five ASEAN nations, PPI shows a significant one-way impact trend to CPI in the five countries, whereas CPI obviously does not impact (Granger cause) PPI.

Panel B shows the test results for the G7 countries. We significantly declined the null hypothesis that “PPI does not Granger Cause CPI,” and at a significant level of 5% (significance level), we also rejected the null hypothesis of "CPI does not Granger Cause PPI." These results indicate a two-way causal relationship between the PPI and CPI of the seven G7 countries, i.e., the country's producer prices are one of the causes of changes in consumer prices. Similarly, consumer prices also impact producer prices. But producer prices have a very significant impact on consumer prices.

Table 7. Stacked Causality Test (Common Coefficients) for Ln (CPI) and Ln (PPI)

Panel A. Selected ASEAN countries

Null Hypothesis:	F-Statistic	Prob.
LPPI does not Granger Cause LCPI	12.8306	**0.000003**
LCPI does not Granger Cause LPPI	0.27278	0.7613

Panel B. G7 countries

Null Hypothesis:	F-Statistic	Prob.
LPPI does not Granger Cause LCPI	82.3537	**0.000000**
LCPI does not Granger Cause LPPI	4.06376	**0.0174**

As shown in Table 8, according to the panel data of either the ASEAN's five countries or the seven G7 countries, the Dumitrescu-Hurlin Panel Causality Tests results generated in the present study significantly declined the null hypothesis that "PPI does not Granger Cause CPI" and that "CPI does not Granger Cause PPI". In other words, when heterogeneity of estimated coefficients exist, assuming binary regression in the cross-section of each nation, the existence of a very significant two-way causal relationship between the PPI and CPI of the selected ASEAN countries and the G7 countries is confirmed using the Panel Granger

Causality Test, i.e., producer prices of these country are one of the most important causes of price changes in consumer prices, while consumer prices are also one of the importance reasons for changes in producer prices.

Table 8. Dumitrescu-Hurlin Panel Causality Tests (Heterogeneous Coefficients) for Ln(CPI) and Ln(PPI)

Panel A. Selected ASEAN countries

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
LPPI does not homogeneously cause LCPI	12.5330	11.5099	**0.0000**
LCPI does not homogeneously cause LPPI	6.67087	5.09131	**0.0000004**

Panel B. G7 countries

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
LPPI does not homogeneously cause LCPI	24.4297	29.0312	**0.0000**
LCPI does not homogeneously cause LPPI	5.06750	3.94691	**0.00008**

5. Conclusion

Why have empirical studies on the relation between the PPI and CPI always generated inconsistent answers? The CPI and PPI are both important variables for measuring the inflation and actual GDP of a country; the causal relation between the CPI and PPI is undoubtedly crucial and has long been the focus of attention of scholars, experts, and policymakers. However, the interaction between the CPI and PPI remains poorly understood, and the causality between the two seems unpredictable. Furthermore, no general theory has been proposed that could explain the various types of causal relation between the two variables. Apparently, there have been only two principles commonly referred to in the existing literature—demand pull and cost push—which have failed to fully explain the causal relation between the PPI and CPI in countries in different development stages and countries with different types of industrial development in recent years. Therefore, this study raised the question: "Why have empirical studies on the relation between the PPI and CPI always generated inconsistent answers?" followed by empirical evidence to verify our innovative hypotheses.

Existing theory and empirical literature that analyze the relationship between producer price and consumer price are divided into the "demand-pull" and "cost-push" arguments. For example, Clark (1995) and Rogers (1998), who support the “cost-push” argument, believe that PPI causes CPI; while Caporale, Katsimi and Pittis (2002) and Cushing and McGarvey (1990), who support the “demand-pull” argument, believe that CPI leads PPI. After a review of literature on the subject, this research proposes different arguments that whether a country belongs to "demand-pull" or "cost-push" depends on the industrial development patterns of the country and its role in the regional economy or production supply chain, as well as the mutual impact among different countries. Therefore, we expect that the use of panel data analysis to generate the empirical results for the emerging ASEAN 5 countries will exhibit the same trends in the causality relationship between PPI and CPI. By the same token, the seven industrially developed G7 nations should also exhibit a similar trend in the causality relationship between PPI and CPI, but the two causal relationships should not be the same.

Using seven statistics, the present study considered situations of homogeneous and heterogeneous residual errors and the test results found no existence of cointegration between the CPI and PPI of the five ASEAN nations as well as in the seven G7 nations. In other words, no long-run relationship between CPI and PPI exists in either the group of the five industrially emerging ASEAN countries or the group of G7 industrially developed countries although they are of different industry development patterns, and the results also confirm that such a relationship will not change as the mutual impact among countries of the same industrial development changes.

This research integrates and extends the literature on the "demand-pull" and "cost-driven" theories, to further propose the following inference: the causal relationship between PPI and CPI in each sample country should be related to the industrial development patterns, regional economies, and production supply chains of that country. Countries with the same industrial patterns still influence one another. The results of our Panel Granger Causality Test show a significant one-way impact of PPI towards CPI in the panel data of the five ASEAN countries, but CPI obviously cannot affect PPI. On the other hand, a two-way causality relationship was found between the PPI and CPI in the G7 countries, whose industrial development is totally different than that in the ASEAN 5 countries, i.e., the producer price in the G7 countries is one of the reasons for changes in consumer price, and simultaneously, consumer price will also affect producer price, with stronger impact from producer price to consumer price.

However, after further consideration of the regional economy or the same effects between industrial development patterns in the countries, the Panel of the Granger Causality Test results show that a very significant two-way causal relationship exists between the PPI and CPI of the selected ASEAN countries and the G7 countries. In other words, the producer price in these countries is one of the reasons for changes in consumer price, and simultaneously, consumer price also affects producer price. Empirical results derived from this section also support the further inferences proposed in the present study that are different from exiting theories. We believe that the causality relationship between the PPI and CPI of a particular country is related to the regional economy of that country or the mutual impact among the countries of same industrial development patterns.

With the globalization of supply chain, suppliers and consumers are no longer confined to the same country. In contrast, with the rise of regional economies, such as the G7 and ASEAN, the production and consumption patterns of a country are now inevitably affected by other countries in the same region. Moreover, countries in the same region often share the same industrial development pattern. These factors could all lead to the ineffectiveness of the traditional principles of demandpull and costpush in explaining the causal relation between the PPI and CPI in a country today. Therefore, this study adopted Panel Data Analysis that has never been used to address these related questions. The empirical results of Panel Data Analysis confirmed that the causal relation between the PPI and CPI is related to the following: the industrial development pattern of the sample countries, role of the sample countries in the regional economy or the supply chain, and mutual influence among countries sharing the same development pattern. The conclusion of this study will provide a new thinking to the government authorities and future researchers that creates a breakthrough from the traditional theories, a more accurate research direction, and a reference for decision makers.

References

Akcay, S. (2011),"The Causal Relationship between Producer Price Index and Consumer Price Index: Empirical Evidence from Selected European Countries," *International Journal of Economics and Finance,* 3(6), 227-232.

Akdi, Y., H. Berument, and S.Y. Cilasun (2006), "The relationship between different price indices: Evidence from Turkey," *Physica* A-360, 483-492.

Blomberg, S. B., and E.S. Haris (1995), "The commodity-consumer price connection: fact or fable?," *Federal Reserve Bank of New York Economic Policy Review*, 1(3), 21-38.

Choi, I (2001),"Unit Root Tests for Panel Data," *Journal of International Money and Finance*, 20, 249-272.

Colclough, W. G., and M. D. Lange (1982), "Empirical evidence of causality from consumer to wholesale prices," *Journal of Econometrics*, 19, 379-384.

Clark, T. (1995),"Do producer prices lead consumer prices?," Federal Reserve Bank of Kansas City Economic Review, Third Quarter, 25-39.

Caporale, G.M., M. Katsimi, and N. Pittis, (2002),"Causality links between consumer and producer prices: some empirical evidences," *Southern Economic Journal*, 68, 703-711.

Clark, T. (1995),"Do producer prices lead consumer prices?," Federal Reserve Bank of Kansas City Economic Review, Third Quarter, 25-39.

Cushing, M. J., and M. G. McGarvey (1990), "Feedback between wholesale and consumer price inflation: A reexamination of the evidence," *Southern Economic Journal*, 56, 1059-1072.

Dumitrescu, E. Ivona, and H. Christophe (2012), "Testing for Granger Non-Causality in Heterogeneous Panels," *Economic Modelling*, 29(4), 1450-1460.

Granger, C.W. (1986), Developments In The Study Of Cointegrated Economic Variables, *Oxford Bulletin of Economics and Statistics*, 48(3), 213-228.

Ghazali, M.F., O.A. Yee, and M. Z. Muhammed (2008),"Do Producer Prices Cause Consumer Prices? Some Empirical Evidence," *International Journal of Business and Management*, 3(11), November 2008, 78-82.

Im, K.S., M.H. Pesaran, and Y. Shin (2003),"Testing for Unit Roots in Heterogeneous Panels," *Journal of Econometrics*, 115, 53-74.

Jones, J. D. (1986),"Consumer prices, wholesale prices, and causality," *Empirical Economics*, 11, 41-55.

Levin, A., C.F. Lin, and C.S. Chu (2002),"Unit Root in Panel Data: Asymptotic and Finite-Sample Properties," *Journal of Econometrics*, 108, 1-24.

Liping, H., F. Gang, H. Jiani, (2008), "CPI vs PPI: Which Drives Which?," *Economic Research Journal*, 43(11), 16-27.

Maddala, G.S. and S. Wu (1999),"A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test," *Oxford Bulletin of Economics and Statistics*,61, 631-652.

Pedroni, P. (1999), "Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors, "*Oxford Bulletin of Economics and Statistics*, 61, 653-70.

Pedroni, P. (2004), "Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis," *Econometric Theory*, 20, 597-625.

Rogers, R. M. (1998),"A Primer on Short-Term Linkages Key Economic Data Series," *Federal Reserve Bank of Atlanta Economic Review*, Second Quarter, 40-54.

Toda, H.Y. and T. Yamamoto(1995), "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes," *Journal of Econometrics* 66, 225-250.