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Investigation of Asymmetric Relationship Between Consumer and Producer Prices in Turkey: Evidence from Hidden Cointegration and Asymmetric Causality Analyses

(Research Article)

Türkiye'de Tüketici ve Üretici Fiyatları Arasındaki Asimetrik İlişkinin Araştırılması: Saklı Eşbütünleşme ve Asimetrik Nedensellik Analizlerinden Kanıtlar

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ABSTRACT

The continuity of price stability is a necessity for the successful management of economic policy, especially monetary policy. Considering that price instability will lead to policy failure, it is extremely important that the general level of prices be accurate and predictable. When the interaction of prices within its own internal mechanism is considered within the scope of the production chain, an evaluation can be made with the distinction of producer and consumer prices. In this regard, the literature has two different views as supply-side and demand-side price transmission. In this study, it is aimed to determine which view is dominant between producer and consumer prices in Turkey. In addition, asymmetric techniques were used while investigating long and short-term relationships based on the idea that there may be an asymmetric structure in price transmission. In the analysis process, the interaction of domestic, agricultural and service producer prices with consumer prices was investigated. According to the results, although supply-side price transmission is valid in the long run, it is seen that the demand-side effect is more significant. In the short run, it can be stated that there is a supply-side price transmission. It is thought that the obtained findings will make significant contributions to the authorities and researchers in the formation of policies based on the inflation targeting regime in terms of the variables used and the analysis technique.

Anahtar Kelimeler:

Üretici Fiyatları, Tüketici Fiyatları, Asimetrik Fiyat Aktarımı

ÖZET

Para politikası başta olmak üzere ekonomi politikasının başarılı yönetilmesi için fiyat istikrarının devamlılığı bir gerekliliktir. Fiyat istikrarsızlığı politika başarısızlığına yol açacağı düşünüldüğünde, fiyatlar genel seviyesinin doğru ve önceden belirlenebilir olması son derece önemlidir. Fiyatların kendi iç

mekanizması içerisindeki etkileşimi üretim zinciri kapsamında ele alındığında, üretici ve tüketici fiyatları ayrımıyla değerlendirilmektedir. Bu hususta literatür arz yönlü fiyat aktarımı ve talep yönlü fiyat aktarımı şeklinde iki farklı görüşe sahiptir. Türkiye'de üretici ve tüketici fiyatları arasında hangi görüşün hakim olduğunun belirlenmesi amaçlanmıştır. Ayrıca fiyat aktarımlarında asimetrik bir yapının olabileceği düşüncesine dayalı uzun ve kısa dönem ilişkiler araştırılırken asimetrik teknikler kullanılmıştır. Analiz sürecinde yurtiçi, tarım ve hizmet üretici fiyatlarının, tüketici fiyatları ile olan etkileşimi araştırılmıştır. Ulaşılan sonuçlara göre uzun dönemde arz yönlü fiyat aktarımı geçerli olsa da talep yönlü etkinin daha önemli düzeyde olduğu görülmüştür. Kısa dönemde ise arz yönlü bir fiyat aktarımının söz konusu olduğu belirtilebilir. Elde edilen bulguların enflasyon hedeflemesi rejimine bağlı politika oluşturulmasında otoriteler ve araştırmacılar için kullanılan değişkenler ve analiz tekniği açısından katkı sunacağı düşünülmektedir.

1. INTRODUCTION

The inflation targeting regime, which has been implemented since the early 1990s and is increasingly accepted by the central banks of many countries, has made it necessary to carefully monitor prices. Because under the inflation targeting regime, monetary policy should be determined according to the situation of price indices and the necessary policy should be put forward for the desired price level (Tiwari, Mutascu and Andries 2012; Su, Khan, Lobont and Sung 2016). Ensuring price stability with inflation targeting supports the economy in many ways. However, a rising inflation situation not only has a negative effect on the purchasing power of the household, but also leads to a decrease in economic welfare (Rao and Bukhari 2011). For this reason, economic authorities follow price indices closely and implement policies that can direct the course of prices in accordance with the target.

Although price indices are designed for different purposes, two of the most important price indices stand out in the world of international economy and finance. These are the Consumer Price Index (CPI) and the Producer Price Index (PPI). In the past years, Wholesale Price Index (WPI) was published instead of PPI in many countries and this index was the subject of many studies. However, as of the 1970s and 1980s, the WPI was replaced by the PPI in most of the countries. One of the differences between these two indices is that WPI includes profit margin and taxes within the previous production processes, whereas PPI includes a tax-free price because it is the price formed in the production process. Another difference is that WPI only takes into account the prices of goods, not including the prices of services, in terms of scope, while the PPI includes the prices of raw materials, intermediate goods and final goods at the production stage of the goods and services ready to be offered to the market (Mohanty 2010). Therefore, with a general definition, PPI is a price index that measures the price changes of goods and services produced in an economy due to input, labor and market, without including taxes (TURKSTAT, 2014). In Turkey, WPI was used until 2006, while PPI began to be published in 2005 and covered the main sectors of agriculture, industry, mining and quarrying, manufacturing, electricity, gas production and distribution, and water supply. Since 2014, the PPI has undergone a significant revision, and different producer price indices have been published over some scope changes. These are domestic PPI (hereafter PPI), non-domestic PPI (NDPPI) and agricultural PPI (APPI). PPI is an index covering the main sectors of mining and quarrying, manufacturing, electricity, gas production and distribution, and water supply, taking into account the sales prices of manufacturers covering the domestic market (TURKSTAT, 2014). NDPPI, on the other hand, covers the producer prices of the products within the scope

of manufacturing, mining and quarrying sectors, which are exported abroad.[1] APPI, on the other hand, covers agriculture, hunting, forestry and fishing activities and is calculated separately from the PPI content.[2] In addition, as of 2017, the Service PPI (SPPI) began to be published. The service is formed from producer prices within the scope of PPI, transportation and storage services, accommodation and food, services information and communication services, real estate services, professional, scientific and technical services, administrative and support services.[3]

The ready-to-sale retail price of any goods and services that have completed the production process is known as the consumer price in the literature. Considering that there are many goods and services subject to consumption in an economy, a general index is followed in order to follow the price changes of these products. This index, called the consumer price index (CPI), represents the general level of prices in a country's economy and forms the basis of the inflation rate followed by the authorities. CPI in Turkey is an index covering the prices of 415 items, including 12 main groups and 43 subgroups.[4]

There are two different approaches in the literature regarding the relationship between producer and consumer prices. The first is the supply-side approach. According to this approach, it is argued that the increased pricing of the elements that may create production costs, such as raw materials and intermediate goods, which are needed until the product is finalized, will be reflected in consumer prices through the input cost (Clark, 1995).In short, in the supply-side approach, producer prices are accepted as the pioneer of consumer prices (Akçay, 2011). This approach has started to gain more acceptance in the literature, especially with the empirical findings of the study of Silver and Wallace (1980). Because Silver and Wallace (1980) concluded that changes in producer prices cause changes in consumer prices.

Colclough and Lange (1982) found a bidirectional causality relationship between producer and consumer prices in their study. In this case, it has been revealed that the supply-side approach, which is based on the fact that producer prices affect consumer prices, is not valid alone. An interaction from consumer prices to producer prices is accepted as a demand-side approach. According to the demand-side approach, an increase in the demand for final goods and services also increases the need for input use at the production stage and has an upward effect on input prices. Therefore, consumer prices affect producer prices (Jones, 1986).

Although it is argued that there is a supply-side or demand-side effect between price indices, there are also opinions based on the fact that there may not be a relationship between these two indices. This view is based on the fact that producer and consumer prices are based on different populations and different samples (Guthrie 1981). In addition, some factors that are thought to weaken the relationship between price indices can be mentioned. One of these factors is that producer prices take into account the prices of produced goods, but consumer prices consist of the prices of final goods and services.[5] Other factor is that consumer prices cover import-based final goods and services, while producer prices consider production-based goods prices.

[1]https://data.tuik.gov.tr/Bulten/DownloadFile?p=j1Y0eqwUYUEclvGvlelgUgsuRcwGZ304PJjpyDKZsMb9HkfVFhlEq9CoOIf6olZNj43OG8vAMWiosGjiT2simVLzdPGdEX5lbHzhopiMVKM= (Date of access: 08.09.2021)
[2]https://data.tuik.gov.tr/Bulten/DownloadFile?p=V6l5eFnB05pUiSfO8aojGW6264DE/3qF/SgTTIKpMyhOyrfJ457XjFqRP54xUSHjumb10LhUInS0ddJVIOx8dE0L/y2DP25csy4FqwydWl0= (Date of access: 08.09.2021)
[3] https://data.tuik.gov.tr/Kategori/GetKategori?p=enflasyon-ve-fiyat-106&dil=1
(Date of access: 08.09.2021)
[4] The items in the index are updated every year. The number of items mentioned is the information that is taken into account for 2021 and shared by TURKSTAT.
[5] The index, which started to be published as SPPI, has partially eliminated this deficiency.

Another factor is that producer prices do not include taxes, but consumer prices include taxes. (Saatçioğlu and Karaca 2017; Terzi and Tütüncü, 2017).

Although there are technical differences between price indices, there are studies to determine the relationship between producer and consumer prices in the international literature. However, when the studies are examined, it is seen that different findings have been reached on the relations between price indices. The aim of this study is to investigate the relationship between producer and consumer prices, which has controversial results in the literature. According to Anoruo (2011) there is an emphasis on the fact that linear models will be weak in determining nonlinear relationships between variables because of the nonlinear relationship between time series. The reason for the non-linearity of the relationship between the variables is that there are different interactions in positive and negative shocks. From this point of view, it was preferred to use the hidden cointegration approach, taking into account the possibility of asymmetric pass-through between price indices. Asymmetric causality test was used to determine the short-term relationships between price indices. In this context, in the second part, the literature findings examining the relations between price indices were mentioned and in the third part, the econometric analysis stage was started. Considering that the steps to be taken in monetary and fiscal policies should be aimed at price stability, the importance of determining the asymmetric relationships between producer and consumer prices cannot be denied. In this respect, it is thought that it will contribute to the literature empirically by considering different producer prices (PPI, APPI and SPPI) and focusing on the asymmetric relationship between price indices.

2. LITERATURE

Although the transmission between producer and consumer prices has taken an important place in the literature, it remains up-to-date as a research topic. When the studies in the literature are examined, it is seen that the results obtained differ. Silver and Wallace (1980), Guthrie (1981), Cushing and McGarvey (1990), Caporale, Katsimi and Pittis (2002), Katsouli, Vogiatzis and Manitsaris (2002), Belton and Nair-Reichert (2007), Ghazali, Yee and Muhammad (2008), Sidaoui, Capistran, Chiquiar, and Ramos-Francia (2009), Rao and Bukhari (2010), Martinez, Caicedo, and Tique (2013), Su, Khan, Lobont, and Sung (2016) concluded that there is a transmission from producer prices to consumer prices. In addition, according to Alemu (2012), who reached a similar finding by detecting an asymmetric pass-through, increases in the transmission from producer prices to consumer prices are transmitted faster than decreases. However, there are also studies that find that there is no transmission from producer prices to consumer prices (Blomberg and Harris 1995 and Clark 1995). Considering the studies of Colclough and Lange (1982), Fan, He and Hu (2009), Shahbaz, Tiwari and Tahir (2012) and Tiwari (2012), which concluded that there is a pass-through from consumer prices to producer prices, it has been determined that there is a demand-side price transmission. When looked comparatively, it can be said that the studies that conclude that there is a demand-side transmission between consumer and producer prices are in a minority compared to the studies that have determined the supply-side transmission. However, it is also possible that demand and supply-side transmission between prices are valid together. Findings that this idea is valid Jones (1986), Samanta and Mitra (1998), Shahbaz, Awan and Nasir (2009), Shahbaz, Wahid and Haider (2010), Tiwari and Shahbaz (2013), Tiwari, Suresh, Arouri and Teulon (2014), Sui and Li (2019) and Özpolat (2020) studies have revealed that there is a bidirectional causality relationship between price variables, with examples from different countries.

In Turkey, which has been struggling with high inflation for years, the source of inflation (demand-side and/or supply-side) is frequently discussed and researches are conducted on this issue. When the studies within the scope of Turkey are examined, it is seen that there are differences in the findings. The studies of Zortuk (2008), Ülke and Ergün (2014), Öner (2018), which found that there is a transition from consumer prices to producer prices, and Tarı, Abasız and Pehlivanoğlu (2012), which reached a similar finding for the long term, can be given. Saraç and Karagöz (2010), Erdem and Yamak (2014), Taban and Şengür (2016), and Saatçioğlu and Karaca (2017) found that producer prices have an effect on consumer prices. Tarı, Abasız, and Pehlivanoğlu (2012) determined that this pass-through, which can be defined as supply-side transmission, is valid in the short run. In addition, Erdem and Yamak (2014) stated that the transition from producer prices to consumer prices decreased after 2003. It has also been found that consumer and producer prices are in motion together. Some of the studies that reached these findings; Abdioğlu and Korkmaz (2012), Tailor and Tütüncü (2017), Topuz, Yazdifar and Sahadev (2018) and Koçak (2021).

In general, it has been observed that a definite result could not be determined due to different findings about the relationship between consumer and producer prices in Turkey-wide studies. In the aforementioned studies, analyzes were carried out using CPI and PPI (WPI in a small number of studies). In addition to considering these indices, analyzes based on sub-price indices remained rather shallow. In this regard, Abdioğlu and Korkmaz (2012) made analyzes based on sectoral distinctions such as food, clothing, housing, health, as well as general price indices. According to their results, they determined a unidirectional causality relationship from consumer prices to producer prices within the scope of clothing and housing sectors, and a bidirectional causality relationship between general price indices. Koçak (2021), on the other hand, used the Agricultural Producer Price Index together with the general price indices within the scope of the analysis. Koçak (2021), who determined that there is a bidirectional causality relationship between CPI and PPI, also obtained findings that CPI and PPI have an effect on APPI. However, Koçak (2021) did not include the SPPI in the analysis because it did not have sufficient number of observations.

As a result of the literature review, it was seen that the relations between consumer and producer prices were examined within the scope of general indices in all of the studies, with a few exceptions. However, producer prices in Turkey are not as comprehensive as they used to be, and producer price indices based on sector differences are published by the Turkish Statistical Institute (TURKSTAT). Therefore, in investigating the relationship between consumer and producer prices, it would be appropriate to use producer price indices in different scopes. In addition, in the studies in the literature, analysis techniques with a symmetrical structure were used to examine the relations between prices. The only exception to this situation is the study by Alemu (2012), which investigated the asymmetric pass-through between consumer and producer prices. His findings supported asymmetric price pass-through. Based on this result, increases and/or decreases in consumer or producer prices may not be conveyed at the same level. For this reason, considering that there may be an asymmetric pass-through in examining the relationship between consumer and producer prices, it would be more appropriate to use an econometric technique that allows this. These issues can be counted as the important features of the study that distinguish it from the others. In addition, it is thought that the study will make a remarkable contribution to the literature in this respect.

3. ECONOMETRIC ANALYSIS

The structure of price transmission has been investigated in the literature, but no clear evidence has been identified. Because the pass-through between prices can be both supply-side and demand-side. Following the studies of Colclough and Lange (1982) and Cushing and McGarvey (1990), who argue in the literature that it is more appropriate to evaluate the relationship between price variables in two ways, it was decided to analyze price indices in two directions.

In addition, regardless of whether supply or demand-side price transmission are valid, the pass-through of price increases and decreases shocks can differ from each other. If such a situation is valid, there is an asymmetric price pass-through between consumer and producer prices. Based on this information, it is useful to use approaches that allow asymmetric pass-through in addition to traditional methods (increases and decreases are considered symmetrical) in examining the relationship between consumer and producer price indices.

Table 1. Descriptive Statistics

	CPI	PPI	APPI	SPPI
Mean	5.33	5.33	5.38	4.88
Maximum	6.28	6.46	6.39	5.27
Minimum	4.55	4.55	4.52	4.57
Std. Dev.	0.46	0.48	0.46	0.20
Obs.	220	220	220	53
Sample	2003:1-2021:4	2003:1-2021:4	2003:1-2021:4	2017:1-2021:5
Base Year	2003=100	2003=100	2003=100	2017=100

Based on this motivation, CPI, PPI, APPI and SPPI were used for econometric analysis and the descriptive statistics are shown in Table 1. All series were obtained from TURKSTAT, seasonally adjusted and their natural logarithm were taken. The data of the CPI, PPI and APPI indices are monthly frequency (2003=100) and cover the period 2003:1-2021:4. SPPI, on the other hand, started to be published as of January 2017 and as a 2017 base year. For this reason, the data for SPPI and CPI used in this context in the analysis part are taken into account as the base year of 2017 at monthly frequency and cover the period 2017:1-2021:5.

3.1. Method and Model

In line with the purpose of the study, it is planned to investigate the relationship between consumer and producer price indices. When working with non-stationary time series, the series must be stationary in order not to fall into the "Spurious Regression" situation stated by Granger and Newbold (1974). Information about their stationarity can be obtained through the unit root test to be applied to CPI and PPI series. For this, Dickey and Fuller (1979, 1981)'s Extended Dickey-Fuller (ADF) and Phillips and Perron (1988) unit root tests were preferred. In both unit root tests, the null hypothesis of "the series is not stationary" is used against the alternative hypothesis of "the series is stationary". If the null hypothesis is not rejected, the tests are repeated by taking the first difference of the series. The process of taking the difference continues until the conclusion that there is no unit root in the series, that is, it is determined that the series is stationary. These difference operations cause data loss in variables as well as the disappearance of dynamic relationships.

In response to this negative situation, the cointegration approach was introduced to the literature by Engle and Granger (1987). They argued that there is a cointegration relationship between stationary variables of the same order of stationary if their deviations (residuals) from their

long-run equilibrium are stationary. If such a cointegration situation is valid, the long-term relationship between the variables can be determined without the need for difference. Using the CPI and PPI variables, the process of the cointegration approach works as follows;

Step 1: Unit root tests are applied to determine the order of integration of the variables. There are three possible situations to be reached in this step: i) both variables are stationary at the level, ii) the order of integration of the variables is different from each other, iii) both variables are stationary in the first order. The process continues when the last of the three possible situations mentioned is encountered. For other cases, suitable econometric techniques can be applied using the stationary states of the variables.

Step 2: Equation (1), which shows the long-run equilibrium relationship, is estimated. If two-way interactions of variables are to be investigated, equations (1) and (2) should be used. After estimating these equations, the residuals (ε_t ve ω_t) are obtained.

$$CPI_t = \alpha_1 + \alpha_2 PPI_t + \varepsilon_t \quad (1)$$

$$PPI_t = \beta_1 + \beta_2 CPI_t + \omega_t \quad (2)$$

Step 3: Unit root test is applied to the residuals obtained. This process is simply illustrated in equations (3) and (4). In the mentioned unit root test, the null hypothesis indicates that there is no cointegration and is shown as γ=0 for equation (3) and θ=0 for equation (4). If the null hypothesis is rejected, it is determined that there is a cointegration relationship between the variables. It should also be noted that the critical values presented by Engle and Granger (1987) or MacKinnon (1991) should be used at this stage.

$$\Delta\hat{\varepsilon}_t = \gamma\hat{\varepsilon}_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta\hat{\varepsilon}_{t-i} + \eta_t \quad (3)$$

$$\Delta\hat{\omega}_t = \theta\hat{\omega}_{t-1} + \sum_{i=1}^{k} \psi_i \Delta\hat{\omega}_{t-i} + v_t \quad (4)$$

Engle and Granger (1987) cointegration test is completed with the third step. If it is concluded that there is cointegration between the variables at the end of the test, it can be said that there is a long-term relationship between the variables. In this case, long-term coefficient estimates are obtained by estimating equations (1) and/or (2) using the level states of the variables.

Granger and Yoon (2002) suggested that the variables may have a cointegration relationship because they react together to shocks. However, while some variables may respond to positive shocks (or negative shocks) like other variables, they may respond to negative shocks (or positive shocks) differently from other variables. According to Granger and Yoon (2002), traditional approaches conclude that there is no cointegration relationship between variables that respond differently to shocks. Based on this view, they suggested investigating the cointegration relations by considering the positive and negative components of the variables and defined this approach as hidden cointegration. In addition, in recent years, asymmetric relations between variables can be investigated through the approach of Granger and Yoon (2002) in the literature. Traditional cointegration approaches evaluate the effect of the independent variable(s) on the dependent variable symmetrically. However, the effect of decrease and increase in the independent variable(s) on the dependent variable may not be the same. This type of transmission structure is asymmetrical. In this respect, the possibility of investigating asymmetric price transmission positions the Granger and Yoon (2002) approach

in an important place. In the Granger and Yoon (2002) approach, variables are divided into positive and negative components. These components are based on the random walk process in first-order stationary series:

$$CPI_t = CPI_{t-1} + \epsilon_t = CPI_0 + \sum_{i=1}^{t} \epsilon_i \quad (5)$$

$$PPI_t = PPI_{t-1} + e_t = PPI_0 + \sum_{i=1}^{t} e_i \quad (6)$$

CPI_0 and PPI_0 are the initial values, and ϵ_t and e_t are white noise residuals in the random walk process specified over the CPI and PPI variables. The positive and negative components of the variables are determined as follows;

$$\epsilon_i^+ = maks(\epsilon_i, 0) \text{ ve } \epsilon_i^- = min(\epsilon_i, 0) \quad => \epsilon_i = \epsilon_i^+ + \epsilon_i^- \quad (7)$$

$$e_i^+ = maks(e_i, 0) \text{ ve } e_i^- = min(e_i, 0) \quad => e_i = e_i^+ + e_i^- \quad (8)$$

If the expressions mentioned here are substituted in equation (5) and (6);

$$CPI_t = CPI_{t-1} + \epsilon_t = CPI_0 + \sum_{i=1}^{t} \epsilon_i^+ + \sum_{i=1}^{t} \epsilon_i^- \quad (9)$$

$$PPI_t = PPI_{t-1} + e_t = PPI_0 + \sum_{i=1}^{t} e_i^+ + \sum_{i=1}^{t} e_i^- \quad (10)$$

Equations (9) and (10), where initial values are constant and $CPI_t^+ = \sum_{i=1}^{t} \epsilon_i^+$, $CPI_t^- = \sum_{i=1}^{t} \epsilon_i^-$, $PPI_t^+ = \sum_{i=1}^{t} e_i^+$, $PPI_t^- = \sum_{i=1}^{t} e_i^-$ the following equations can be written on the assumptions;

$$CPI_t = CPI_0 + CPI_t^+ + CPI_t^- \quad \begin{matrix} => \Delta TUFE_t^+ = \epsilon_i^+ \\ => \Delta TUFE_t^- = \epsilon_i^- \end{matrix} \quad (11)$$

$$PPI_t = PPI_0 + PPI_t^+ + PPI_t^- \quad \begin{matrix} => \Delta UFE_t^+ = e_i^+ \\ => \Delta UFE_t^- = e_i^- \end{matrix} \quad (12)$$

With these operations, positive and negative components of the variables are created. In the next step, Engle and Granger (1987) cointegration test between positive and negative components is applied. This approach allows obtaining the long-term coefficients of the positive and negative components of the variables in case of a cointegration relationship between the variables. In other words, it shows how the long-term interaction between the CPI and PPI variables differs in positive and negative shocks, and whether there is an asymmetric price behavior.

The asymmetric causality test presented by Hatemi-J (2012) was used to determine the short-term relationships between price indices. The separation of variables into positive and negative components for asymmetric causality testing is based on the Granger and Yoon (2002) approach. Asymmetric causality testing is performed based on the Toda and Yamamoto (1995) approach. However, critical values are obtained using bootstrap. The asymmetric causality test

based on the VAR(k+d) structure is based on the equations presented in (13) for positive shocks and (14) for negative shocks, with simple notation.

$$Y_t^+ = \upsilon + A_1 Y_{t-1}^+ + \cdots + A_k Y_{t-k}^+ + u_t^+ \quad (13)$$
$$Y_t^- = \xi + B_1 Y_{t-1}^- + \cdots + B_k Y_{t-k}^- + u_t^- \quad (14)$$

In this notation, Y_t^+ and Y_t^- represent a vector of 2x1 dimensional variables consisting of positive and negative components, respectively. A_r and B_r represent 2x2 dimensional coefficient matrix with lag length of order r, υ and ξ 2x1 dimensional vector of constant terms, u_t^+ and u_t^- 2x1 dimensional vector of error terms. Considering both components, the basic hypothesis is tested that the variables are the dependent variable in turn and the lagged variables of the other variable together are equal to zero. This null hypothesis mentioned represents a result as "no causality". Following the approach of Toda and Yamamoto (1995), the test is performed on the Wald test.

3.2. Results

First of all, the order of integration of the variables should be determined through unit root tests. For this, ADF and Phillips-Perron unit root tests were applied to all series and the results are presented in Table 2.

Table 2. Unit Root Test Results (at level)

Unit Root Tests	ADF			Phillips-Perron		
Deterministic Component	-	Constant	Constant & Trend	-	Constant	Constant & Trend
CPI	7.897	2.994	1.090	14.296	2.525	0.913
CPI (2017:1-2021:5)	4.748	0.169	-2.689	7.012	0.174	-1.967
PPI	5.361	2.545	0.619	6.704	2.287	0.915
$APPI$	3.777	0.276	-2.336	5.145	0.412	-1.979
$SPPI$	2.897	0.264	-3.223*	4.401	0.586	-1.914
CPI^+	4.207	2.720	0.672	10.266	2.423	0.392
CPI^+ (2017:1-2021:5)	2.440	-0.131	-2.360	4.098	0.024	-1.947
CPI^-	2.437	-0.653	-1.848	2.828	-0.598	-1.600
CPI^- (2017:1-2021:5)	0.432	-1.233	-1.325	0.286	-1.233	-1.540
PPI^+	5.369	2.127	0.684	7.909	2.184	0.755
PPI^-	2.629	-1.753	-2.987	2.933	-1.796	-2.674
$APPI^+$	6.151	0.569	-2.494	7.532	0.653	-2.147
$APPI^-$	3.836	-0.589	-1.314	4.352	-0.553	-1.155
$SPPI^+$	2.738	0.846	-2.520	4.062	0.614	-2.307
$SPPI^-$	0.111	-1.167	-2.390	0.604	-0.871	-1.637

(*) indicates significance at the 10% significance level.

According to the unit root test results, the series are not stationary at the level. Based on this result, unit root tests were applied again to the series whose first differences were taken, and the results are shown in Table 3.

Table 3. Unit Root Test Results (first difference)

Unit Root Tests	ADF			Phillips-Perron		
Deterministic Component	-	Constant	Constant & Trend	-	Constant	Constant & Trend
ΔCPI	-1.917*	-8.670***	-9.278***	-7.041***	-10.808***	-10.950***
ΔCPI (2017:1-2021:5)	-1.559	-5.936***	-5.893***	-3.069***	-4.903***	-4.847***

ΔPPI	-6.766***	-9.026***	-9.443***	-6.756***	-7.987***	-8.023***
ΔAPPI	-10.914***	-11.854***	-11.858***	-10.963***	-11.607***	-11.647***
ΔSPPI	-3.347***	-4.596***	-4.628***	-3.322***	-4.200***	-4.226***
ΔCPI^{+}	-1.558	-10.399***	-8.459***	-6.364***	-11.028***	-11.207***
ΔCPI^{+} (2017:1-2021:5)	-1.390	-4.922***	-4.872***	-2.796***	-4.854***	-4.802***
ΔCPI^{-}	-11.259***	-12.053***	-12.032***	-11.265***	-11.815***	-11.789***
ΔCPI^{-} (2017:1-2021:5)	-5.417***	-5.535***	-5.528***	-5.429***	-5.514***	-5.475***
ΔPPI^{+}	-5.868***	-8.057***	-8.371***	-5.618***	-8.219***	-8.317***
ΔPPI^{-}	-10.977***	-11.952***	-12.032***	-11.172***	-11.833***	-11.909***
$\Delta APPI^{+}$	-5.779***	-12.122***	-12.131***	-9.295***	-12.137***	-12.123***
$\Delta APPI^{-}$	-10.459***	-12.308***	-12.291***	-10.613***	-12.136***	-12.113***
$\Delta SPPI^{+}$	-2.860***	-4.955***	-4.964***	-2.666***	-4.958***	-4.970***
$\Delta SPPI^{-}$	-3.609***	-4.396***	-4.372***	-3.438***	-3.471**	-3.424*

(***), (**) and (*) indicate significance at the 1%, 5% and 10% significance level, respectively.

It has been determined that the first differenced series do not contain a unit root, so they are first order stationary. Considering these results, Granger and Yoon (2002) implicit cointegration test can be performed to determine the long-term equilibrium relationship between the positive and negative components of the variables.

Table 4. Determination of the asymmetric relationship between CPI and PPI

Panel-A: Long-Term Coefficient Estimates				
Independent Variables	Dependent Variable			
	CPI^{+}	CPI^{-}	PPI^{+}	PPI^{-}
Constant	-0.032***	0.014***	0.061***	-0.043***
Trend	0.004***	-0.001***	-0.006***	-0.001***
PPI^{+}	0.483***			
PPI^{-}		0.122***		
CPI^{+}			1.888***	
CPI^{-}				0.565***
Panel-B: Hidden Cointegration Test				
Granger and Yoon (2002)	τ Stat.			
	-4.558***	-2.054	-4.288***	-3.181
Panel-C: Asymmetric Causality Test				
Null Hypothesis	Wald Stat.	Critical Value[1]		
		1%	5%	10%
$PPI^{+} \neq> CPI^{+}$	34.257	9.854	6.219	4.757
$PPI^{-} \neq> CPI^{-}$	0.017	11.616	3.933	2.279
$CPI^{+} \neq> PPI^{+}$	4.460	9.768	6.239	4.756
$CPI^{-} \neq> PPI^{-}$	1.772	11.862	4.006	2.140

[1]Critical values were determined by bootstrap with 10.000 iterations.
(***), (**) and (*) indicate significance at the 1%, 5% and 10% significance level, respectively.

In the analysis process, the hidden cointegration and asymmetric causality relationship between CPI and PPI was tested first. Long-term coefficient estimates and hidden cointegration test results of the variables are presented in Table-4 under the headings Panel-A and Panel-B, respectively. According to the results, there is a mutual cointegration relationship between the positive components of the CPI and PPI variables. No cointegration relationship was found between the negative components. Therefore, the regression consisting of the negative components of the CPI and PPI variables in Panel-A is "spurious regression". When the long-term coefficient estimation results of the positive components are examined, when PPI^{+}increases by 1%, CPI^{+}increases by approximately 0.48%. According to this result, there is a supply-side price transmission. On the other hand, when CPI^{+}increases by 1%, PPI^{+}

increases by 1.89%. Although the results obtained have determined supply-side price transmission, it can be said that demand-side price transmission is more important as producer prices are highly affected by consumer prices. In addition, it has been determined that while long-term upward movements in consumer and producer prices are transmitted mutually, the transmission between consumer and producer prices is not valid in the long-term when there are downward movements.

The results of the asymmetric causality test applied to determine the short-term causality relationship between CPI and PPI are shown in Table 4 Panel C. According to the results, there is a one-way causality relationship from producer prices to consumer prices in positive components. However, no causality relationship was found in the positive and negative components from consumer prices to producer prices. In addition, there is no causality relationship in the negative components. As a result, it can be said that in the inflationary environment there is a bidirectional interaction between CPI and PPI in the long run. However, supply-side price transmission is valid in the short run.

Tablo 5. Determination of the asymmetric relationship between CPI and APPI

Panel-A: Long-Term Coefficient Estimates				
Independent Variables	Dependent Variable			
	CPI^+	CPI^-	$APPI^+$	$APPI^-$
Constant	-0.021***	0.003**	0.005	0.055***
Trend	0.004***	-0.000***	0.010***	-0.004***
$APPI^+$	0.307***			
$APPI^-$		0.073***		
CPI^+			0.509***	
CPI^-				4.178***
Panel-B: Hidden Cointegration Test				
Granger and Yoon (2002)	τ Stat.			
	-0.979	-1.914	-2.836	-1.580
Panel-C: Asymmetric Causality Test				
Null Hypothesis	Wald Stat.	Critical Value[1]		
		1%	5%	10%
$APPI^+ \neq> CPI^+$	0.201	7.517	3.923	2.753
$APPI^- \neq> CPI^-$	8.219	8.847	3.752	2.461
$CPI^+ \neq> APPI^+$	0.407	7.374	4.117	2.855
$CPI^- \neq> APPI^-$	3.488	9.111	4.136	2.527

[1]Critical values were determined by bootstrap with 10.000 iterations.
(***), (**) and (*) indicate significance at the 1%, 5% and 10% significance level, respectively.

When the relationship between CPI and APPI is examined, according to the results in Table 5 Panel B, no cointegration relationship was found in the positive and negative components of CPI and APPI. Therefore, long-term asymmetric price pass-through between consumer and agricultural producer prices could not be determined. The regression estimates given in Table 5 Panel A are spurious because there is no cointegration relationship. However, when there are decreases in the general level of prices (negative components) in the short run, it is determined that CPI and APPI have a bidirectional causality relationship. However, such a causal relationship has not been found in inflationary situations.

Tablo 6. Determination of the asymmetric relationship between CPI and SPPI

Panel-A: Long-Term Coefficient Estimates				
Independent Variables	Dependent Variable			
	CPI^+	CPI^-	$SPPI^+$	$SPPI^-$
Constant	0.010*	-0.003***	-0.036***	0.015***
Trend	0.004***	0.000**	0.004**	-0.001***

$SPPI^+$	0.524***			
$SPPI^-$		0.237***		
CPI^+			1.013***	
CPI^-				3.352***
Panel-B: Hidden Cointegration Test				
Granger and Yoon (2002)	τ Stat.			
	-3.937*	-3.236	-4.187**	-3.131
Panel-C: Asymmetric Causality Test				

Null Hypothesis	Wald Stat.	Critical Value[1]		
		1%	5%	10%
$SPPI^+ \neq> CPI^+$	7.851	11.297	6.929	5.067
$SPPI^- \neq> CPI^-$	158.14	26.582	8.738	5.408
$CPI^+ \neq> SPPI^+$	3.434	11.049	6.595	5.067
$CPI^- \neq> SPPI^-$	3.193	13.455	7.613	5.382

[1]Critical values were determined by bootstrap with 10.000 iterations.
(***), (**) and (*) indicate significance at the 1%, 5% and 10% significance level, respectively.

Finally, the hidden cointegration and asymmetric causality relationship between the positive and negative components of the CPI and SPPI variables were investigated. The analysis carried out at this stage covers the period 2017:1-2021:5. According to the results presented in Table 6, a long-term equilibrium relationship was found between the positive components of the variables. As can be seen from the long run coefficient estimation results, when $SPPI^+$ increases by 1%, CPI^+ increases by approximately 0.52%. It was determined that the price transmission from CPI^+ to $SPPI^+$ was transmited at the same level (about 1% versus 1%).

However, no cointegration relationship was found between the negative components of the variables. Therefore, while the transmission of upward movements between consumer and service producer prices occurs in the long run, there is no asymmetric pass-through in downward movements.

According to the asymmetric causality test results seen in Panel C, a causality from service producer prices to consumer prices was determined in both positive and negative components. However, there is no causality from consumer prices to producer prices of services in either component. In this case, it can be said that supply-side price transmission between CPI and SPPI is valid in the short run.

4. CONCLUSION

Consumer and producer price indices, which are most frequently used to observe prices in an economy, are an important indicator that affects all economic policy, especially monetary policy. Generally, the rate of increase based on the consumer price index is accepted as the headline inflation rate. However, these price indices are also a general indicator that includes the pricing policy of a product at the end of the production process. In other words, production prices include all input prices during the production of a good. Consumer prices, on the other hand, are the final goods price and considered as retail prices. In this respect, it is a matter of debate in the literature whether the price changes experienced during the price transmission process are from producer prices to consumer prices (supply-side) or from consumer prices to producer prices (demand-side).

In this study, it is aimed to investigate the price transmission mentioned in Turkey. However, since there may be an asymmetric price transmission, Hidden Cointegration and Asymmetric Causality Tests, which use positive and negative components of price indices, were used. In

this respect, it is clear that the findings of the study will create a different perspective to the literature. In addition to the PPI, three different producer price indices, namely APPI and SPPI, were discussed in the study. The relationships of these indices with the CPI were examined.

According to the results based on the hidden cointegration test, PPI and SPPI have a long-term relationship with CPI only in positive components. In addition, CPI has a greater effect on PPI and SPPI. However, no long-term relationship could be determined between APPI and CPI. These results show that price transmissions are asymmetrical in the long run, and demand-side price transmission is more prominent, although supply-side price transmission is also valid. According to the results of the asymmetric causality test, a causal relationship was found only in the positive components from PPI to CPI in the short run. In this respect, it can be mentioned that there is a supply-side price transmission in price increases in the short run. In addition, a causal relationship from SPPI to CPI was determined in the short run between SPPI and CPI. This one-way causality applies to both positive and negative components. Therefore, considering the producer prices of services, it can be stated that the price transmission is symmetrical in the short run and this transmission takes place on the supply side. On the other hand, there is a bidirectional causality relationship between APPI and CPI only in the negative components in the short run. In this respect, the short-term relationship between APPI and CPI is asymmetrical and includes both demand-side and supply-side price transmission.

As a result, price transmission between producer and consumer prices are in a bidirectional interaction in the long run. However, it was observed that the demand-side effect was more significant. In the short run, a supply-side transmission can be mentioned. Therefore, the importance of the findings of the study aimed at determining the direction of the inflation rate through price changes in the production chain should be emphasized. Because, in order to carry out more accurate policies in the inflation targeting regime, it is a necessity to determine what kind of relationship (supply/demand side) prices have. It is thought that the study will be beneficial to researchers and market makers in this respect.

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