The Relation between the Producer and Consumer Price Indices: A Two country study

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Marketing managers are often in a dilemma about which pricing index to rely on while calculating the annual increase in the prices for their product. To provide insights that can reduce this dilemma, a critical comparison of the Producer Price index and consumer price index is called for. In this study, the relation between the Producer Price Index (PPI) and Consumer Price Index (CPI) was investigated through a comparison between Turkey and UK. Unlike many other previous studies, this study tried to determine the dominant pricing approach in an economy by examining the relation between the producer and consumer prices. In this context, VAR, impulse-response, variance decomposition, and Granger causality tests were used for the analyses of time series data. The results of study showed that there was bidirectional causality between the producer and consumer prices in both countries. Therefore, it was asserted that businesses in both countries generally apply mixed pricing approach. The results thus provide some interesting insights that can aid marketing managers in their pricing decisions.

Keywords: price indexes, general pricing approaches, time series analysis

1. Introduction

Price indices not only provide data to measure inflation which is significant for an economy but also constitute general indicators that are used quite often for purposes such as to follow pricing activities, to lead supply-demand relations, to interpret productivity, to make investment decisions, to determine salaries, and to measure cost of living (Demir, 2007). Therefore, determining the relation between the producer and consumer prices is not only important for policy makers but also for business managers as they can foresee the pricing activities and their effects (Dorestani and Arjomand, 2006).

Pricing decisions are considered as one of the most difficult decisions in marketing (Tellis, 1986). The pricing decision in a firm is typically influenced by a plethora of external and internal factors (Cavusgil, 1996). To set prices at optimum levels and forecast revenue accurately, decision makers need to closely follow several macro-economic trends spanning different dimensions of the economy. Trends in the inflation rate, employment levels, interest rates, economic growth rate etc. are some of the important trends that needs to be followed to develop scenarios (Palmer and Hartley, 1999). Macro-economic trends strongly influence consumer behavior. For instance, a constant growth in inflation rate reflects the general increase in prices of both inputs and outputs. Such a situation will naturally prompt customers to cut back on their purchases and alternatively increase the input prices presenting the decision makers with a tricky situation.

The change or forecasted change in the inflation levels in an economy is a significant factor in both determining the prices of new products as well as updating prices like providing discounts etc. for existing products. The trend in the inflation rate often acts as a signal to marketing managers across all sectors to adjust their prices either upwards or downwards. For many firms, as the trend in the inflation rate may be used as a cue by both their suppliers as well as their buyers, adjusting prices based on the inflation trends is often not just a matter of choice. Thus, tracking trends in the inflation rate as well as understanding the inherent dependencies in the trends will be critical for making intelligent pricing decision makers.

The inflation rate is expressed at two levels, the producer inflation rate – or the inflation rate for the inputs and the consumer inflation rate – the inflation rate for the goods and services most often purchased by consumers. It is well acknowledged that both the inflation rates are related, though the strength and direction of the relationship varies from one economy to the other. For decision makers, it is also important to understand the leading index – that is the index that first reflects the trend as it makes forecasting easy and accurate.

Managers determine the prices for their products by taking into account the costs, competitors, and the level of consumer demand (Liozu, 2017). However extant studies do not clarify which of the three factors should receive greater importance in deciding about the price of the product. It would therefore be immensely useful for marketing managers to know whether cost of inputs, competitors or level of consumer demand should be given more importance in setting prices. The direction of the relation between the producer and consumer prices will thus be a significant indicator to decide whether the consumer demand or the costs are the most important consideration in determining the prices in an economy. Businesses should give more weightage to costs while pricing products if it is found that the change in the producer prices actually causes a change in the consumer prices in the following periods, Instead, if it is seen that consumer prices lead producer prices, the consumer demand must be given more prominence. If no statistically meaningful relation between the producer and consumer prices is obtained, it can be claimed that pricing based on competitors in the country or a mixed pricing approach can be valid.

The relation between the producer and consumer prices is explained most simply by the production chain theory. According to this theory, the change in the producer prices leads to a change in the consumer prices which is the next link in the production chain (Clark, 1995). Presented as the supply-side approach, the production chain theory suggests that change in the prices of crude inputs gets passed on to the intermediary inputs and then finally to consumer goods sold through retailers. Hence, producer prices are sequentially passed on to the consumers after a slight delay (Rogers, 1998). The producer inflation should thus cause and lead the consumer inflation according to this theory.

Despite this simple theory, it is asserted in several studies that consumer prices may also affect the producer prices. According to these studies, the change in the demand for final goods results in a change in the demand of primary goods (Colclough and Lange, 1982; Granger et al., 1986). The theory of derived demand on which this assertion depends suggests that the developments in the industrial market are derived from the changes in the consumer market (Cushing and McGarwey, 1990). Thus, the changes in the demand of final goods affect the producers' input demand and price.

The results of many previous studies show that supply side approach has been confirmed (Balliger et al., 2009; Caporale et al., 2002; Clark, 1995; Cushing and McGarvey, 1990; Cutler et al., 2005; Dorestani and Arjomand, 2006; Silver and Wallace, 1980). These studies reached the conclusion that the change in the producer prices, depending on the production chain, lead the consumer prices in the coming periods. Similarly, recent studies (Sidaoui et al., 2009; Ghazali et al., 2008) determined that producer prices are the reason for the change in the consumer prices.

On the other hand, in their study, where Colclough and Lange (1982) claimed that there could be feedback causality between wholesale prices and consumer prices. Then, they determined that there is bidirectional causality between those two. In his study where Jones (1986) examined the causality relation between the wholesale product prices and consumer prices confirmed that there is bidirectional causality between the wholesale product and consumer prices like Colclough and Lange (1982) did. Similarly, Shahbaz et al. (2009) found out that there is bidirectional causality between the producer and consumer prices; although, the causality was stronger from producer prices to consumer prices than vice versa.

In addition to these results presented by previous studies, it is also possible to come up with studies which confirm the derived demand theory between the producer and consumer prices is valid. For example, in their studies Mehra (1991) and Huh and Trehan (1995) reached the conclusion that consumer prices direct the labor cost which is a significant element for producer prices. In another study where causality between the producer and consumer prices was examined Gang et al. (2009) determined causality from consumer prices to producer prices. Based on their findings, the authors asserted that demand -consumer- side factors play a more important role than supply -cost- side factors for the Chinese economy.

In this study, we attempt to look at the Producer – Consumer inflation relationships from the perspective of two countries: UK an Turkey. While UK is a developed country with per capita GDP of USD 38900.00, Turkey is considered as a middle income country with a per capita GDP of USD 23679.00 in 2016 (www.tradingeconomics.com). The comparison is important as UK is a low inflation economy with inflation rate ranging between 0.5 to 4 percent during the study period (www.rateinflation.com) while Turkey has historically been a high inflation economy which was well about 10% during the study period with maximum inflation rate even touching almost 100% in 1999 (www.inflation.eu).

Previous studies have pointed to the role of governmental regulation in shaping the impact of producer inflation on consumer inflation. For instance, Tiwari et al (2014) and Tiwari et al (2013) point out the role of the central bank in Mexico and Romania in shaping the relationship between the two indices. UK is a country with an effective policy to curb inflation and hence it will be interesting to study whether such regulations could influence this relationship.

Comparison between UK and Turkey is also interesting from another perspective. The UK retail market is heavily consolidated with a small number of players dominating the market wielding immense power over the producers. According to Kantar world panel (www.kantarworldpanel.com), four largest retailers account for about 70% of the market share in 2016. Hence in the UK market, producer lead inflation in prices can be controlled by the retailers to an extent if they so desire. However, in the case of Turkey, small retailers called 'Bakkals' still dominate the grocery sector and during the year chosen for this study. According to (Koc, Boluc and Kovaci, 2010), these small retailers account for about 80% of the market in 2009. In general, small retailers are expected to pass on the producer lead inflation to the consumers easily. Apart from a few exceptions, most of the extant studies that look at the relationship between producer and consumer inflation trends have been single country studies or multi-country studies on countries that have similar economic conditions.

2. Methodology

In this study, the relationships between producer and consumer prices are analyzed using by Vector autoregressive model (VAR). We use three different methods associated with the VAR model to analyze the date: impulse-response analysis, variance decomposition and Granger causality test. Monthly producer and consumer price indices data used in the study covers the period January 1996-August 2011 for both countries. Data are provided by UK National Statistics Office for United Kingdom and Turkstat for Turkey, and the data series are seasonally adjusted. Descriptive statistics are in Appendix A, and correlation coefficients table is in Appendix B. Correlation coefficient for United Kingdom data is 0.361 and it is 0.935 for Turkey data.[1]

The period chosen for the study provides for testing the relationships in the context of significant external factors that impacted the economies. For instance, during late 90's Turkey went through a phase of political instability and economic difficulty as well as economic recovery and then finally the worldwide recession in the aftermath of the credit crisis after 2008.

Testing for stationarity is one of the first stages in the time series analysis based on VAR models. Time series data can or cannot include unit root. If the mean and variance of a variable change with the time, it can be said that this variable is not stationary, i.e. it includes unit root. Many macroeconomic data are usually not stationary. For this reason, it should be examined that stationarity of the data based on time series. Several tests were developed to examine stationarity. In this study, stationarity tests are done by using Augmented Dickey-Fuller (ADF). The results of ADF unit root test for both countries data are in Table 1.

Table 1. Estimation of Unit Root Test

Variables	**Augmented Dickey-Fuller (ADF)**		**Results of the ADF test**
	t-Statistic[*]	*Prob.*	
CPI_UK	1.796(1)	0.99	Non-Stationary
PPI_UK	0.487(1)	0.99	Non-Stationary
ΔCPI_UK	-11.829(0)	0.00	Stationary at %1 sig. level
ΔPPI_UK	-7.667(0)	0.00	Stationary at %1 sig. level
CPI_TK	-2.245(10)	0.46	Non-Stationary
PPI_TK	-2.295(1)	0.43	Non-Stationary
ΔCPI_TK	-5.943(0)	0.00	Stationary at %1 sig. level
Δ*PPI_TK*	-6.523(1)	0.00	Stationary at %1 sig. level

[*] The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of the null hypothesis for ADF test is based on the MacKinnon critical values (with trend and intercept). Values in parentheses are optimal lag lengths according to the Akaike Information Criteria.

ADF test results show that although level values of all variables are not stationary, the percentage change values of those are statistically stationary. Therefore, VAR models can be run by using the percentage change values. Figure 1 shows the percentage change series for both countries.

[1] TK and UK denotes Turkey and United Kingdom data, respectively. CPI: consumer price index, PPI: producer price index.

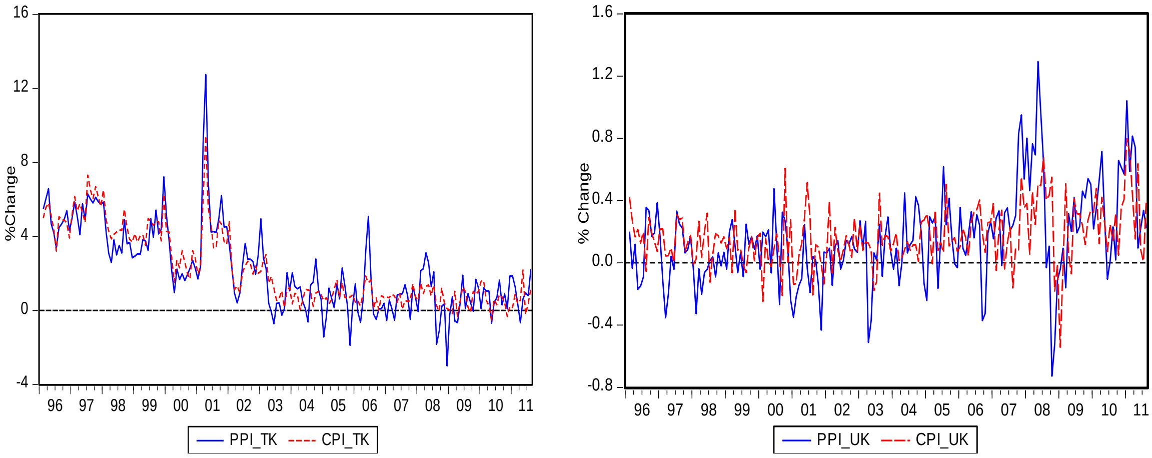

Figure 1. The percentage change Series for CPI and PPI

Another operation needed to be done for VAR models is to determine optimal lag length. The results for the lag length selection are shown in Appendix C and Appendix D. In this study, optimal lag length is 2 for UK data, and it is 3 for Turkey data, determined by Akaike Information Criterion (AIC).

VAR, developed by Sims (1980), is an econometric method which reveals mutual relationships between variables, and commonly used over the last decades. VAR method assumes that a variable can explained well by the lagged values of itself and all other relevant variables (Blomberg and Harris, 1995). In a system of equations, explained variables are defined as endogenous variables, explanatory variables are defined as exogenous or predetermined variables. Due to the fact that there is no distinction in terms of endogenous or exogenous among variables in the VAR model, there is no determination problem for variables as endogenous or exogenous (Enders, 2004).

The matrix form of VAR model can be expressed as follows:

$$x_t = A_0 + J(L)x_{t-1} + u_t \tag{1}$$

x_t is the vector of variables in the model (PPI and CPI, 2x1). A_0 is vector of intercepts, and $J(L)$ shows polynomial lag operator. In equation (1), u_t denotes vector of error terms.

Since the interpretation difficulty of coefficients in the VAR model, it can be analyzed and interpreted reasonably by using the residuals obtained from estimation results. When there are standard deviation shocks to the variables in the VAR model, the responses of other variables are analyzed by impulse-response functions.

The graph of impulse-response function shows that the direction and the degree in explained variable as a consequence of a (positive) shock in explanatory variable (Müslümov, et al., 2002). Therefore, impulse-response functions derived from VAR models are frequently used in order to examine the effects of a shock in a variable in the system on the other variables in the system.

On the other hand, variance decomposition shows that the short and long run effects on the explained variable due to the shocks in explanatory variable. In other words, variance decomposition obtained from moving averages part of the VAR model represents the source of shocks in variable itself and in other variables as percentage terms. (Barışık ve Demircioğlu, 2006).[2]

According to the Granger causality test which is developed by Granger (1969) and based on a regression process, Xt Granger-causes Yt if the values of variable Yt can be explained by the values of variable Xt. Granger (1969) defined a simple causal relation as the following model:

$$X_t = \sum_{j=1}^{m} a_j X_{t-i} + \sum_{j=1}^{n} b_j Y_{t-i} + \varepsilon_t \tag{2}$$

$$Y_t = \sum_{j=1}^{p} c_j X_{t-i} + \sum_{j=1}^{q} d_j Y_{t-i} + \eta_t \tag{3}$$

the parameters *m, n, p* and *q* denote the optimal lag length determined according to one or several criteria of AIC, SC and HQ. In accordance with these models if the b_j values are significantly different from zero, Y_t Granger-causes X_t. Accordingly if the c_j values are significantly different from zero, X_t Granger-causes Y_t. If both these two cases exist, there is bidirectional relationship.[3]

[2] Most of the changes in a variable sources from the shocks in itself, this means that the variable moves exogenously (Barışık and Demircioğlu, 2006).

[3] The significances (different from zero) of the parameters in the equations are determined by F (Wald) test.

3. Empirical Results

This study makes use of impulse-response functions and variance decomposition in order to interpret VAR model outputs. Figure 2 and 3 show that impulse-response analyses results for both countries separately.[4]

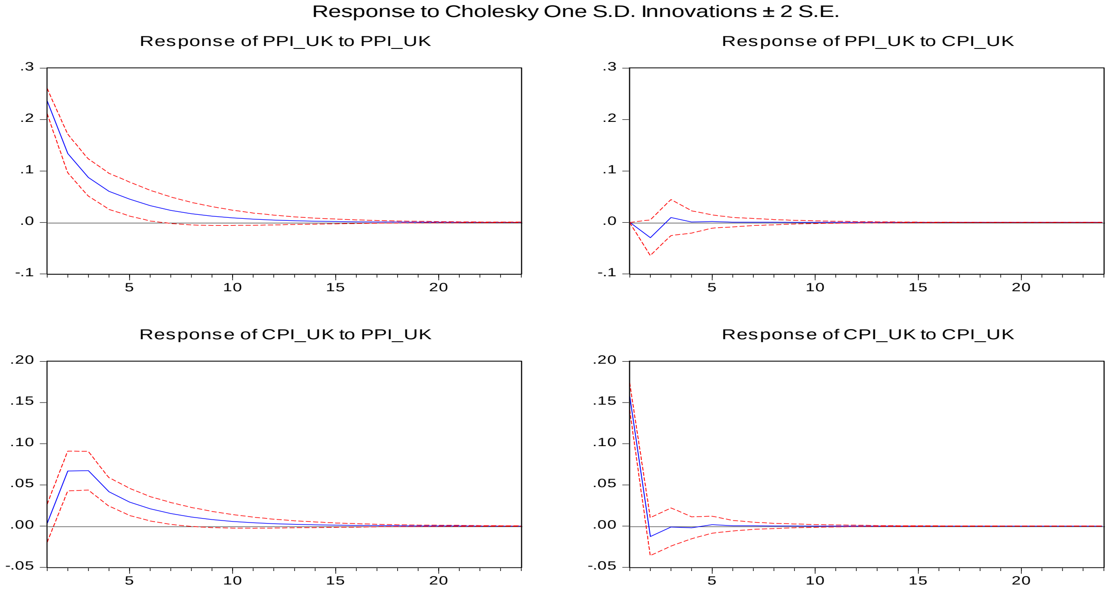

Figure 2. Impulse Response Results for PPI_UK and CPI_UK

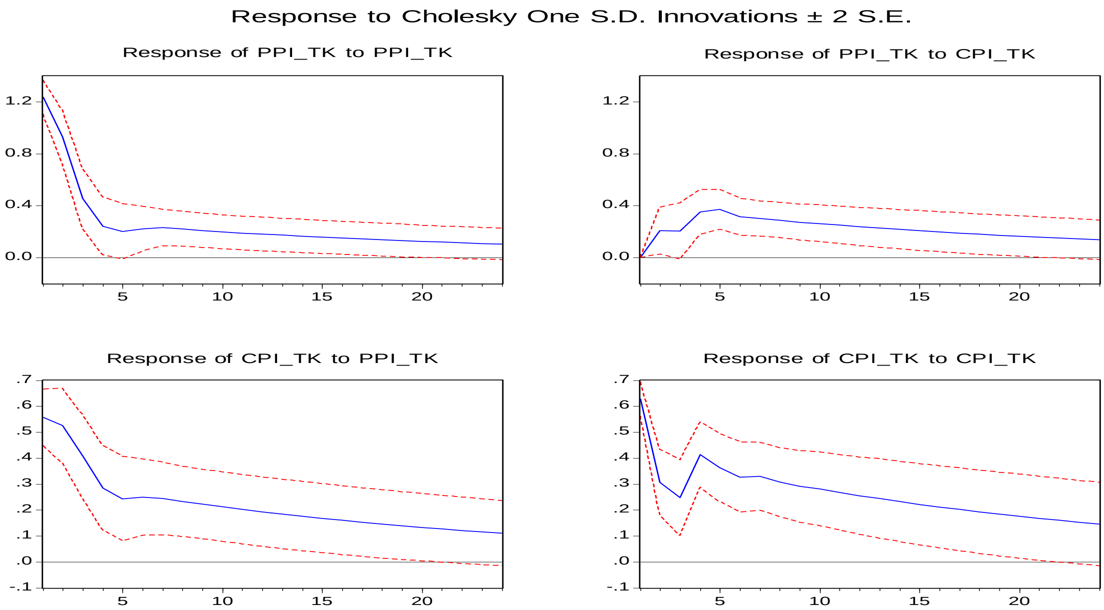

Figure 3. Impulse Response Results for PPI_TK and CPI_TK

[4] In this study is not restricted by way of any selection for endogenous and exogenous variables.

Impulse-response analysis show that the response of the dependent variable within the time on account of a shock in independent variable. For the case of United Kingdom data, from the Figure 2 it can be seen that although PPI_UK has a negative but indefinite and insignificant response to a shock in in CPI_UK for the first two periods, CPI_UK has a positive and increasingly response to a shock in in PPI_UK for the first three periods. In Turkish case, from the Figure 3 it can be seen that PPI_TK has a significant positive response to a shock in CPI_UK for the first period. Also, CPI_TK has a substantial positive response to a shock in PPI_UK for the first period, and this effect decreases after three periods.

The graphs from the impulse response analysis seem to support the proposition that the producer inflation (PPI) leads the consumer inflation (CPI) and hence the production chain theory. In the case of Turkey, the impulse response analysis show support for a bi-directional relationship, but still the impact of PPI on CPI being stronger. In the case of UK, there is a no bi-directional relationship, but only the relationship from PPI to CPI is prominent.

Variance decomposition is alternative form of impulse-response analysis. It shows the short and long run effects of one variable on another. Variance decomposition results are in Table 2 and Table 3 for UK and Turkey data, respectively.

Table 2. Variance Decomposition of PPI_UK and CPI_UK

	Variance Decomposition of **PPI_UK**:			Variance Decomposition of **CPI_UK**:		
Period	S.E.	PPI_UK	CPI_UK	S.E.	PPI_UK	CPI_UK
1	0.235	100.000	0.000	0.157	0.050	99.949
2	0.272	98.810	1.189	0.171	15.260	84.739
3	0.286	98.814	1.185	0.184	26.552	73.447
4	0.292	98.864	1.135	0.188	30.111	69.888
5	0.296	98.887	1.112	0.191	31.739	68.260
6	0.298	98.900	1.099	0.192	32.550	67.449
7	0.298	98.907	1.092	0.192	32.975	67.024
8	0.299	98.910	1.089	0.193	33.192	66.807
9	0.299	98.912	1.087	0.193	33.303	66.696
10	0.299	98.913	1.086	0.193	33.361	66.638
11	0.299	98.913	1.086	0.193	33.391	66.608
12	0.299	98.913	1.086	0.193	33.407	66.592
Cholesky Ordering: PPI_UK, CPI_UK						

Table 3. Variance Decomposition of PPI_TK and CPI_TK

Period	Variance Decomposition of **PPI_TK:**			Variance Decomposition of **CPI_TK:**		
	S.E.	PPI_TK	CPI_TK	S.E.	PPI_TK	CPI_TK
1	1.237	100.000	0.000	0.839	43.992	56.007
2	1.561	98.257	1.742	1.036	54.532	45.467
3	1.638	96.875	3.124	1.140	57.767	42.232
4	1.692	92.797	7.202	1.245	53.635	46.364
5	1.743	88.692	11.307	1.320	51.139	48.860
6	1.785	86.148	13.851	1.382	49.883	50.116
7	1.824	84.047	15.952	1.441	48.713	51.286
8	1.860	82.251	17.748	1.492	47.896	52.103
9	1.891	80.774	19.225	1.536	47.282	52.717
10	1.919	79.486	20.513	1.576	46.735	53.264
11	1.945	78.367	21.632	1.611	46.286	53.713
12	1.967	77.405	22.594	1.642	45.916	54.084
Cholesky Ordering: PPI_TK, CPI_TK						

According to the PPI_UK variance decomposition results in Table 2, all changes (100 %) in PPI_UK for the first period arise from itself. Besides variance contributions of CPI_UK on PPI_UK are not larger than 2 % for all periods. This shown no effect of CPI_UK on PPI_U. On the other hand, according to the CPI_UK variance decomposition results, almost all changes (99.9 %) in CPI_UK for the first period stem from itself. Variance contribution of PPI_UK on CPI_UK reaches 15.2 % for the second period, 33.4 % for the third period. Which hints at an effect for PPI on CPI

PPI_TK variance decomposition results in Table 3 shows that all changes (100 %) in PPI_TK for the first period arise from itself. Besides it can be seen that variance contribution of CPI_TK on PPI_TK is 7.2 % for the fourth period, and this effect reaches 22.5 % in the period 12. This indicates a clear impact for CPI_UK on PPI_UK, but not very strong. On the other hand, according to the CPI_TK variance decomposition results, 56 % changes in CPI_TK for the first period stem from itself, as well as variance contribution of PPI_TK on CPI_TK is 43.9 % for the first period. This important impact of PPI_TK on CPI_TK reaches 57.7 % for the third period, and it can be seen that this effect decreases in the following periods, and variance contribution of PPI_TK on CPI_TK is 45.9 % in the period 12.[5] This clearly indicates an impact for PPI_TK on CPI_TK. Also in terms of magnitude, the impact of PPI on CPI is stronger. Thus while variance decomposition also show a bi-directional impact in the case of Turkey, the impact of PPI on CPI is stronger.

[5] However, it is seen that CPI_TK has a similar impact on PPI_TK in another variance decomposition analysis by using different Cholesky ordering.

For Granger causality tests in this study, it is determined that different lag length for each variable instead of using a standard lag length. Results concerning lag lengths based on Akaike Information Criterion (AIC) are in Appendix E and Appendix F. After setting the lag length determined by AIC, equation results are calculated, and then F Wald test results and probabilities are in Table 4.

Table 4. Granger Causality Tests Results (UK and TK)

Null Hypothesis	F- Statistic	Prob.
PPI_UK does not Granger Cause CPI_UK	22.239***	0.000
CPI_UK does not Granger Cause PPI_UK	3.002***	0.005
PPI_TK does not Granger Cause CPI_TK	6.644***	0.000
CPI_TK does not Granger Cause PPI_TK	3.171***	0.009

Asterisk (***) and (**) denotes that a test statistic is significant at the 1% and 5% significance level, respectively.

According to the Granger causality test results in Table 4, all results are statistically significant in terms of F test. Accordingly, there is a bidirectional causality between producer and consumer prices for both countries. In other words, producer price Granger causes consumer price, consumer price Granger causes producer price as well. As a consequence, change in PPI has impact on CPI as much as CPI has impact on PPI for both countries.

4. Conclusion and Practical implications

In the study, producer and consumer prices are examined in two ways as supply- and demand-based and by using data from two different countries. VAR, variance decomposition, impulse-response analysis, and Granger causality tests were run based on the characteristics of data.

According to the results of the impulse-response analysis and variance decomposition, producer prices are relatively more effective on the consumer prices in both countries. On the other hand, Granger causality test results showed that causality between the producer and consumer prices was bidirectional. The results provide important insights for pricing decision makers in firms. While producer level inflation and consumer level inflation may have a bi-directional impact, the producer level inflation seem to have a stronger impact on consumer level inflation. Thus, inflation at the producer level, will get reflected in the consumer prices after a lag period. Given the diversity in the economic situations in both the countries, as well as the considerable external factors that impacted the two economies during the study period chosen, this result is very important. Pricing managers – especially in both the countries as they set out to plan their long term to medium term pricing strategies can now consider the producer level inflation to be lead indicator for consumer level inflation, though the consumer level inflation can later on have a weaker influence on producer level inflation too. This result holds significance as it can help pricing managers when they develop scenarios for developing pricing policies. Gradual price changes can be planned with greater certainty thus improving the accuracy of revenue predictions. Since pricing managers can be considered as intermediaries that link the supply side and demand side of a firm, these results, which show a bi-directional relationship between the prices as well as a potential lead by supply side prices on demand side prices provides important insights for pricing managers in firms.

Interestingly, the results are similar for both UK and Turkey. Despite the inherent differences in the economic structure as well as the different economic conditions faced by the two countries during the years selected for the study, this result is very important. For instance, it shows that despite the different levels of retail consolidation the direct of impact of PPI on CPI remains the same. Similarly, even in the face of strong inflation targeting strategies by the central bank in UK, PPI leads CPI. In fact, in the recent past only one study (Liping et al, 2008) conducted in China show support for the derived demand theory where CPI leads PPI. Though there is bi-directional effect reported in several studies. The results from this study clearly strengthens the production chain theory and the premise that demand conditions and the resulting price effects are mostly transferred from the raw materials to the consumer goods. This result again provides guidelines for policy makers in scenario planning as they can use forecasts of producer level inflation to predict different levels of consumer inflation. This can improve the accuracy of scenarios developed by strategists.

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Appendix A: Descriptive Statistics

	CPI_UK	PPI_UK	CPI_TK	PPI_TK
Mean	0.170	0.155	2.276	2.213
Median	0.140	0.144	1.463	1.859
Maximum	0.798	1.293	9.432	12.741
Minimum	-0.541	-0.727	-0.517	-3.003
Std. Dev.	0.191	0.295	2.023	2.265
Observations	187	187	187	187

Appendix B: Correlation Table

	CPI_UK	PPI_UK	CPI_TK	PPI_TK
CPI_UK	1	0.363	-	-
PPI_UK	0.363	1	-	-
CPI_TK	-	-	1	0.896
PPI_TK	-	-	0.896	1

Appendix C: Lag Length Criteria** (CPI_UK and PPI_UK)

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	13.270	NA	0.003	-0.128	-0.092	-0.114
1	72.699	116.820	0.001	-0.762	**-0.653***	-0.718
2	79.277	12.781	**0.001***	**-0.791***	-0.610	**-0.718***
3	79.863	1.124	0.001	-0.752	-0.499	-0.650
4	81.313	2.750	0.001	-0.723	-0.398	-0.591
5	82.768	2.728	0.001	-0.694	-0.296	-0.533
6	87.359	8.500	0.001	-0.701	-0.231	-0.510
7	87.671	0.569	0.001	-0.659	-0.116	-0.439
8	87.812	0.254	0.001	-0.614	-0.000	-0.365
9	91.282	6.186	0.001	-0.608	0.078	-0.330
10	93.209	3.392	0.001	-0.585	0.174	-0.277
11	94.756	2.686	0.001	-0.557	0.274	-0.219
12	102.455	**13.197***	0.001	-0.599	0.304	-0.232

* indicates lag order selected by the criterion
** Lag length is determined by Akaike information criterion (AIC)

Appendix D: Lag Length Criteria** (CPI_TK PPI_TK)

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-619.361	NA	4.160	7.101	7.137	7.115
1	-467.246	299.0137	0.765	5.408	**5.517***	5.452
2	-457.209	19.500	0.714	5.339	5.520	5.412
3	-449.262	**15.258***	**0.683***	**5.294***	5.547	**5.397***
4	-448.044	2.311	0.705	5.326	5.651	5.458
5	-443.250	8.985	0.698	5.3171	5.715	5.478
6	-441.126	3.932	0.7141	5.338	5.808	5.529
7	-439.137	3.636	0.731	5.3615	5.904	5.581
8	-436.214	5.278	0.740	5.373	5.988	5.623
9	-432.996	5.737	0.747	5.382	6.070	5.661
10	-430.971	3.563	0.764	5.405	6.164	5.713
11	-428.777	3.812	0.781	5.426	6.257	5.763
12	-425.175	6.174	0.785	5.430	6.334	5.797

* indicates lag order selected by the criterion
** Lag length is determined by Akaike information criterion (AIC)

Appendix E: The Lag Selection of Granger Granger Causality Tests For CPI_UK and PPI_UK

dependent variable	**PPI_UK**		**CPI_UK**	
Lag	Akaike information criterion		Akaike information criterion	
	PPI_UK	***CPI_UK***	***CPI_UK***	***PPI_UK***
1	0.018	0.027	-0.264	-0.682
2	**0.016***	-0.009	-0.360	-0.698
3	0.024	0.006	-0.396	**-0.699***
4	0.031	0.013	-0.392	-0.690
5	0.047	0.029	-0.380	-0.682
6	0.063	-0.023	-0.376	-0.678
7	0.059	**-0.017***	-0.385	-0.670
8	0.074	-0.003	-0.379	-0.661
9	0.088	0.004	**-0.394***	-0.654
10	0.084	0.021	-0.380	-0.640
11	0.095	0.034	-0.385	-0.628
12	0.075	0.041	-0.368	-0.613

(*) it is minimum Akaike information criterion and expresses the lag length for each variable

Appendix F: The Lag Selection of Granger Granger Causality Tests For CPI_TK and PPI_TK

dependent variable	**PPI_TK**		**CPI_TK**	
Lag	Akaike information criterion		Akaike information criterion	
	PPI_TK	***CPI_TK***	***CPI_ALL***	***PPI_ALL***
1	3.427	3.315	2.645	2.663
2	3.439	3.323	2.618	2.665
3	3.405	**3.307***	2.587	2.741
4	**3.382***	3.315	2.588	2.681
5	3.388	3.330	**2.547***	**2.680***
6	3.395	3.343	2.550	2.685
7	3.409	3.352	2.553	2.697
8	3.415	3.354	2.554	2.665
9	3.427	3.358	2.568	2.677
10	3.438	3.371	2.576	2.693
11	3.450	3.387	2.591	2.708
12	3.459	3.399	2.597	2.723

(*) it is minimum Akaike information criterion and expresses the lag length for each variable