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Is CPI a suitable tool for inflation targeting? A critical view

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Abstract. *Since Frankel (2011, 2012) criticizes the choice of consumer price index as a policy index for its adverse impacts on the output in the developing economies, economists suggest different policy proposals in order to stabilize price level. One of them is to change price index in measurement of inflation. In this study, we investigate the suitability of an alternative price index in inflation targeting regime instead of consumer price index in Turkish economy. In this regard, we employ the producer price index instead of consumer price index in order to investigate the suitability of Frankel's policy proposals. The empirical results, obtained from conventional VAR analysis suggest that the impact of producer price on the inflation rate is in the short term and it is weak. Similarly, MS-VAR analysis by utilizing the monthly data for the period 2003M2 - 2013M6, show that there is not a significant impact of producer price on the inflation rate during the expansionary period and it is also possible to talk about the effect of supply side shocks in the recession regime. Therefore, the consumer price index seems to be an appropriate instrument to target inflation rate, but the producer price index should also take into account to target inflation during the recessionary period in Turkey.*

Keywords: Inflation targeting, CPI, PPI, MS-VAR.

JEL Classification: E52.

1. Introduction

With the collapse of Bretton Woods monetary system in the early 1970s, high inflation rate has become one of the most important problem in both developed and developing countries (Hall and Mankiw, 1993). The monetary policymakers have begun to search for new solutions for high and permanent inflation problem. Although a number of monetary policy rules were implemented in order to stabilize economy in especially developing countries, any one of them was not more successful and popular than inflation targeting regime.

The Central Bank of Republic of Turkey has been implementing inflation targeting regime after the country's worst economic crisis in 2001. Initially, implicit targeting accepted as one of the main components of the stabilization package, called "Transition to Strong Economy Program". Later on, an explicit inflation targeting regime was initiated and, as a result, Turkey has finally seen a single digit inflation rate in 2005. While implementing inflation targeting regime, the Turkish economy has also experienced a relatively high growth period during this period.

There has been a number of researches which emphasize the importance and significance of inflation targeting regime in controlling inflation rate in the countries where it has been implemented (Svensson, 1997, 1998; Bernanke et al., 1999; Mishkin, 1999; King, 2002; Filho, 2010; Abo-Zaid and Tuzemen, 2011). However, recently inflation targeting regime in developing countries has been heavily criticized in a number of ways (Eipstein, 2003; Akyuz, 2006; Galindo, 2006; Jha, 2006; Lim, 2006; Eipstein and Yeldan, 2007; Stiglitz, 2008; Frankel, 2011, 2012). The reason for these critics is that the central banks mainly focus on inflation targeting regime instead of poverty, employment, investment or economic growth. In this regard, implementation of inflation targeting has generated significant costs: slow growth, lower employment growth and high real interest rates. The current global financial crisis and economic stagnation mainly in developed countries brings another point into mind. That is financial stability.

The aim of this paper is to empirically investigate whether consumer price index as argued by the proponents of inflation targeting or producer price index as argued by the opponents of inflation targeting (Frankel, 2011, 2012) are better tool to be employed in targeting inflation in Turkey. The contribution of this study is twofold. First, this study investigates the success of inflation targeting regime in stabilization of output. The results also indicates whether the high growth rate is a result of high foreign capital entrance into the economy or controlling inflation rate that affects the real sector positively in the Turkish economy. To this end, this paper examines the relationship among producer price index, inflation rate and industrial product index in Turkey for the period 2003M2-2012M9. Secondly, this study employs newly developed econometric methods namely frequency domain causality approach and MS-VAR methods in order to analyze interaction between variables in different frequencies and also in different regimes.

The empirical results show that there is no significant impact of producer price index on the inflation rate during the expansionary period and but there might be supply side shocks on inflation targeting in the recession regime. Therefore, the consumer price index

seems to be an appropriate instrument to target inflation rate, but the policy makers should also take into account the producer price index during the recessionary period in Turkey.

We organize the rest of paper as follows. In the next section, we try to explain details of inflation targeting regime. In the third section, we summarize the critics about the inflation targeting regime. In the fourth section, we list the alternative policy proposals and then we give information about the Turkish economy case. We present the data and the methodology in section six. Finally, we summarize the results and policy implications in the section seven and eight.

2. Details about Inflation Targeting Regime

Inflation targeting is a particular example of the neo-liberal approach to central banking. A neo-liberal central bank attempts to keep inflation at a very low level, reduces support for government fiscal deficits helps to manage the country's integration into world trade and financial markets, reduce the influence of democratic social and political forces on central bank policy (Eipstein, 2003).

Since 1990, inflation targeting has been adopted by many industrialized countries (New Zealand, Canada, the United Kingdom, Sweden, Israel, Australia and Switzerland), by several emerging market countries (Chile, Brazil, Korea, Thailand, and South Africa) and by several transition countries (Czech Republic, Poland and Hungary) (Mishkin, 2001, 1). During the past decade, popularity of inflation targeting has grown among central bankers and economists. While New Zealand was the first country adopting explicit inflation targeting regime, it is certainly no longer alone (Walsh, 2003, 830). Today it is more than ever before and the number of countries is twenty seven.

In an inflation targeting regime, there are five important components (Eipstein and Yeldan, 2007, 2). These are absence of any other nominal anchors; such as exchange rates or nominal GDP, an institutional commitment to price stability, absence of fiscal dominance, policy independence and policy transparency and accountability.

Implementation of inflation targeting regime can be classified under different categories. If the central bank announces official targets, it will be explicit inflation targeting regime. Otherwise it is called implicit targeting regime. If the bank takes forecasts about inflation, it is called as inflation forecast targeting, otherwise actual inflation targeting regime. Another classification can be made according to price index used in measurement of inflation rate Svensson (1998). The bank may use consumer price index, inflation deflator, producer price index and etc. Frankel (2011) states that although there a number of interpretations of price index, all orthodox interpretations focus on CPI as the choice of price index.

3. Critics of Inflation Targeting Regime

Inflation targeting regime has several advantages as a medium term strategy for monetary policy (Mishkin, 2000). There are a number of economists supporting the implementation of inflation targeting regime. Svensson (1997; 1998) supports inflation targeting regime because it decreases output fluctuations and time inconsistency problems. According to Svensson (1997), inflation targeting regime reduces inflation volatility and it helps to stabilize output level if it is applied flexible. Bernanke et al. (1999) emphasize that inflation targeting regime makes the disinflation process less costly. It is also an anchor for the expectations of public. So it can reduce the inflation level. Mishkin (1999) indicates that inflation targeting regime is successful in both decreasing inflation expectations and reducing the actual inflation rate. Moreover King (2002) implies that inflation rate is not only low after the beginning of inflation targeting regime; it is also less volatile and more persistent in the inflation targeting countries.

The studies of Filho (2010) and Abo-Zaid and Tuzemen (2011) support the implications of authors above. According to Filho (2010), inflation targeting regime helps to increase GDP and to reduce unemployment level in the countries which practice inflation targeting regime. Also Abo-Zaid and Tuzemen (2011) compare the inflation targeting countries and non-inflation targeting countries and concludes that inflation targeting countries are associated with lower and more stable inflation, as well as higher and more stable GDP growth even if they are developed or developing countries.

Although there are a number of positive ascriptions to the inflation targeting regime, the number of studies criticizing the inflation targeting regime has increased after the global financial crisis has started in 2008. Initial critics belong to Eipstein and Yeldan (2007). According to them, the world economy is growing too slowly to generate sufficient jobs and it is allocating a smaller proportion of its income to fixed capital formation nowadays. Similarly, Akyuz (2006) emphasizes that the source of macroeconomic instability now is not instability in product markets but asset markets, and the main challenge for policy makers is not inflation, but unemployment and financial stability.

Especially in developing countries, the central banks focus on inflation targeting regime instead of poverty, employment, investment or economic growth. In this regard, implementation of inflation targeting has generated significant costs: slow growth, lower employment growth and high real interest rates. Besides, Frankel (2011) states that many countries have experienced highly variable terms of trade in recent years, as a result of unusually high volatility in world price of oil, minerals and agricultural products. Terms of trade volatility poses a serious challenge to the inflation targeting approach to monetary policy. Inflation targeting had been favored monetary regime in many quarters. But the shock of the last five years have shown some serious limitations to inflation targeting, much as the currency of the late 1990s showed some serious limitations to exchange rate targeting (Frankel, 2011, 78).

Moreover, Frankel (2011) suggests that inflation targeting regime is not successful in developing countries not like developed countries. Because, the theoretical models determining the intervention into the economy, usually do not take into consideration

exogenous shocks in trade conditions or difficulties in the external accounts. The theories tend to assume that countries need not to worry about financing trade deficits internationally. However, in reality, financial market imperfections are serious for developing countries (Frankel, 2012, 6). On the other hand, economists who analyze the inflation targeting regime do not take supply shocks into account sufficiently. According to Frankel (2011), supply shocks tend to be larger for developing countries than for industrialized countries. Because farming, fishing and forestry sectors have a big portion in the whole economy. An unexpected climatic event such as hurricane, floods would have affect GDP more than developed countries' GDP.

Stiglitz (2008) criticizes the application of inflation targeting regime in another way. According to him, as a result of increasing oil price, consumer price index will tend to increase and central bankers would raise the interest rate in order to prevent it. Increasing interest rate probably could not be able to decrease increasing oil and agricultural product prices in especially developing countries. Besides increasing oil price, increase in interest rates would also reduce the aggregate demand in the economy. So recession in the economy would be deeper. In this regard, Stiglitz's suggestion is that if the global food and energy prices increased, public would have to accept a higher inflation rate. Frankel (2011) implies similar results in the case of an increase in oil price. Implementation of tightening monetary policy like raising indicative interest rate in order to appreciate nominal exchange rate would contract the economy which will not be able to adjust the terms of trade in favor of the country.

On the other hand, if the price of the export commodity rises in the world markets, an inflation targeting regime based on consumer price index prevents monetary tightening consistent with appreciation as called for in response to an improvement in the terms of trade (Frankel, 2012:78).

Lim (2006) emphasizes on the supply side of the inflation. According to Lim (2006), a currency depreciation, oil price shock or agricultural price shock generate the supply side of inflation rate. In this context, he criticizes the inflation targeting regime, because it takes demand side of the inflation into consideration only. According to him, as a result of increase in interest rate due to increase of oil price, stagflation problem would occur.

Insufficient conditions for implementing the inflation targeting regime are another argument to discuss. Jha (2006) states that in the presence of high capital inflows and outflows, inflation targeting regime can not be conducted as a single monetary policy. Addition to Jha (2006), Galindo (2006) indicates that there are important concerns about the effectiveness of an inflation targeting regime under weak fiscal conditions, poorly regulated financial systems, large potential external shocks, low institutional credibility and currency substitution phenomena.

The costs of implementation of inflation targeting regime are listed by Eipstein (2003, 4) as follows:

1. It is true that countries that adopt inflation targeting often achieve lower inflation rates, but they do not do so at any lower cost than other countries in terms of forgone output.

2. Inflation targeting regime does not appear to increase credibility of central bank policy.
3. Central banks reduce inflation do so old-fashioned way: by raising interest rates, causing recessions or slow growth.

It is clear that inflation targeting regime is not robust to supply side shocks such as oil price increase as indicated by a number of researchers. In the case of an increase in inflation rate because of supply shock, monetary authorities would raise the monetary policy interest rate and it would reduce the level of output in addition to supply shocks' negative effect on output level.

4. Alternative policy proposals

The negative impacts of inflation targeting regime on the economy bring some policy proposals for developing countries. These can be classified under two groups. In the first group, policy proposals suggest different nominal anchors. Meltzer (1987) and McCallum (1988) suggest monetary base as a nominal anchor while Ball (1998) suggests the nominal exchange rate as an anchor. In the nominal targeting regime Meade (1978) suggests the GDP as an alternative. Although each targeting proposal has some advantages, inflation targeting regime is superior to all of them and a lot of them were tested before. So, it is the question that how we can recover the inflation targeting regime?

It is clear that inflation targeting has advantages compare to other policy implementations. In contrast to an exchange rate peg, inflation targeting enables monetary policy to focus on domestic considerations and respond to shocks to the domestic economy. In contrast to monetary targeting, inflation targeting has the advantage that a stable relationship between money and inflation is not critical to its success (Mishkin, 2000). Also it is easily understood by the public. Despite all superiorities of inflation targeting regime, it is built on aggregate demand; application of the regime reduces aggregate demand. The regime skips one of the main sources of inflation: supply side inflation. So if we can include the supply side of the economy into the index employed in the inflation targeting regime, it is possible to overcome the problem indicated above. Because of these reasons, in the second group of proposals, authors suggest to employ a different price index including components belonging employment and growth.

Frankel (2011, 2012) suggests alternative price indexes. First of them is to peg to export price (PEP). The proposal is to fix price of the commodity which the country is heavily specialized in the production, in terms of domestic currency. Frankel (2011) suggest to Chile to peg its currency to copper, to Jamaica to peg it currency to bauxite, to Argentina to peg its currency to soybean and so on. The central bank can adjust the price automatically in the case of appreciation or depreciation of national currency. The advantage of the PEP compare to CPI targeting is its ability to accommodate terms of trade shocks. Frankel (2011) investigates two categories of adverse terms of trade shocks: First, a fall in the price of the export in world markets and second, a rise in the dollar

price of the import on world markets (Frankel, 2011, 15). In the first case, PEP automatically depreciates national currency against the Dollar vice versa.

Frankel's (2012) second index proposal is to consider an export price index instead of a single commodity's export price: peg to export price index (PEPI). The mechanism of PEPI is the same with PEP. The difference is that to target a broad index of all export prices instead of only one commodity price. Because the economies has more than one main export commodity would need to take all commodities into consideration while adjusting nominal exchange rate parity.

Last index proposal suggested by Frankel (2011) is employing a product price index instead of consumer price index. It is a way to moderate the proposal still further to target a broad index of all domestically produced goods, whether exportable or not (Frankel, 2011, 16). The selling point of a production-based price index is it could serve as a nominal anchor while yet accommodating terms of trade shocks, in comparison to a CPI target.

Addition to Frankel's index proposals, Eipstein (2003) suggests an alternative policy. According to him, central banks are given a country appropriate target such as employment growth, unemployment, real GDP or investment, usually subject to an inflation constraint.

5. An alternative price index for the Turkish economy: producer price index

The Central Bank of Republic of Turkey has started to implement implicit inflation targeting regime in 2002 as one of the main components of "Transition to Strong Economy Programme". In this regard, consumer price index is employed to measure inflation rate movements. The bank has started to announce inflation targets officially and implemented explicit inflation targeting regime in 2006.

Contrary to implications of Stiglitz (2008) and Frankel (2011) criticizing inflation targeting because of contraction in the GDP, the Turkish economy grown continuously averaged 5,9% annually between years 2002 and 2008 while inflation targeting regime has been implementing. By the way, another important improvement in the economy is increasing amount of foreign capital inflow into the economy during this period. The total amount of foreign capital between 2003 and 2008 is 75.3 billion USD. While the Turkish economy experiences high growth rate for six years, a group economists claim that the high growth rate depends on the high amount of foreign capital entered into the economy.

In the light of the explanations, it is possible to test the last policy proposal of Frankel (2011, 2012) about employing inflation targeting regime by using PPI instead of CPI. By doing so, we will be able to investigate the success of inflation targeting regime in stabilization of output in the Turkish economy, whether the high growth rate is a result of high foreign capital entrance into the economy or reduction in inflation affect the real sector positively.

6. Data and methodology

The Turkish Statistical Institute publishes a number of explanatory statistics about price movements in the economy. Although the institute announces consumer price index (CPI) and wholesale product price index, there was no indicative data about product price index. The institute has started to announce producer price index (PPI) just before the beginning of explicit inflation targeting regime in 2005. In this price index, wholesale prices are excluded from the index and constructed index of product prices weighted by shares in output.

In this study, we employ monthly data belonging the period between 2003M2 to 2013M6. The producer price index is started to announce in January 2005. But the bank published the revised data from 2003. So, we obtain the producer price index (2003=100) and consumer price index in order to calculate inflation rate from the database of the Central Bank of Republic of Turkey and the industrial production index is obtained from the International Financial Statistics database published by International Monet fund.

6.1. Vector autoregressive analysis

In VAR framework, there are no exogenous variables and no identifying restrictions. The only role for economic theory is in specifying the variables to be included (McCoy, 1997, 2). In VAR methodology, each time series has to be stationary to include into analysis. Therefore, before including a variable into system, it is important to control stationary.

We can write system of simultaneous equations in a vector form as follows.

$$Ay_t = B(L)y_{t-1} + C\varepsilon_t \qquad (1)$$

This is a general representation where y_t is a vector of endogenous variables, y_{t-1} is a vector of their lagged values, and ε_t is a white noise vector of the disturbance terms for each variable. A is a $n \times n$ square matrix and n is the number of variables that contains the structural parameters of the contemporaneous endogenous variables. $B(L)$ is a pth degree matrix polynomial in the lag operator L, where p is the number of lagged periods used in the model. C is a square matrix sized $n \times n$, contains the contemporaneous response of the variables to the disturbances or innovations.

McCoy (1997) mentioned that there is a problem with presentation in eq 1., because the coefficients in the matrices are unknown and variables have contemporaneous effects on each other. So it is not possible to determine the values of the parameters in the model. To fully identify model, it is possible to transform into a reduced-form model to derive the standart VAR representation in the following equation.

$$y_t = D(L)y_{t-1} + e_t \qquad (2)$$

In this form, $D(L)$ equals to $A^{-1}B(L)$ and e_t equals to $A^{-1}C\varepsilon_t$. The last term in equation is serially uncorrelated (Ioannidis, 1995, 256). The matrix Σ is the variance/covariance of the estimated residuals, e_t, of the standart VAR.

$$\Sigma = \begin{vmatrix} \sigma_1^2 & \sigma_{12} & \dots & \dots & \sigma_{1n} \\ \sigma_{21} & \sigma_2^2 & \dots & \dots & \sigma_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ \sigma_{n1} & \sigma_{n2} & \dots & \dots & \sigma_n^2 \end{vmatrix}$$

In this matrix Σ, there are $(n^2 - n)/2$ number of restrictions required to identify to system. Traditional VAR methodology proposes the identification restrictions based upon on a recursive structure known as Cholesky decomposition (Ioannidis, 1995, 256). Cholesky decomposition separates the residuals e_t into orthogonal shocks by restrictions imposed on the basis of arbitrary ordering of the variables and implies that first variable responds only to its own exogenous shocks, second responds to first variable 's and its own exogenous shocks. So the structure of matrix will be lower triangular, where all elements above the principal diagonal are zero (McCoy, 1997, 5).

After the identification of restrictions impulse response function (IRF) is employed to reflect the dynamic effect of each exogenous variable response to the individual unitary impulse from other variables. The IRF can explain the current and lagged effect over time of shocks in the error term (Liu, 2008, 243).

The variance decomposition is another test in the VAR analysis. Variance decomposition gives information about dynamic structure of system. The main purpose of variance decomposition is to introduce effects of each random shock on prediction error variance for future periods (Ozgen and Guloglu, 2004, 9).

6.2. Markov Switching Vector Autoregressive Model

Markov Regime Switching Model is a good tool for the monitoring the asymmetric behavior of such as unemployment rate in the historical process. The model examines behaviors of the time series in different regimes. The switching mechanism is controlled by an unobservable random variable. In these models, at any point of time during it is not possible to know which regime is effective. However, the observation probability of only one regime can be found at that time. Markov-switching autoregressive (MS-VAR) model was originally developed by Hamilton (1989) and used by Hamilton (1989, 1990, 1994, 1996), Kim and Nelson (1998), Krolzig (1997, 1998, 2000, 2001) for the empirical analysis of business cycle. Hamilton (1989) 2-regime MS-AR (p) model established by following form:

$$y_t = \begin{cases} \phi_{1,0} + \phi_{1,1} y_{t-1} + \dots + \phi_{1,p} y_{t-p} + \varepsilon_t & \text{if} \quad (s_t = 1) \\ \phi_{2,0} + \phi_{2,1} y_{t-1} + \dots + \phi_{2,p} y_{t-p} + \varepsilon_t & \text{if} \quad (s_t = 2) \end{cases} \tag{3}$$

$$y_t = \phi_{0,st} + \phi_{1,st} y_{t-1} + \dots + \phi_{p,st} y_{t-p} + \varepsilon_t \tag{4}$$

where $\phi_{1,j}$ and $\phi_{2,j}$ denote autoregressive lag parameters for every regime, s_t is the value of each regime, p shows degree of autoregressive process and ε_{it} is a sequence of independent and identically distributed random variables with mean zero and σ_i^2 ($\varepsilon_{it} \sim iid(0,\sigma_i^2)$ and $\sigma_i^2 < \infty$ (Mohd, Zahid, 2006:57, Fallahi, Rodriguez, 2007:5). Regimes are determined by unobservable regime variable which is consistent with Markov regime switching model. Regime varies depending on past value and transformation probabilities and it can be written by following form:

$$\Pr(S_t = j \mid S_{t-1} = i) = P_{ij} \geq 0 \tag{5}$$

$i, j = 1,2,...,k$ there are k different probable regimes and shows transition probabilities from regime i to regime j. This can be,

$$\sum_{j=1}^{k} \Pr(S_t = j \mid S_{t-1} = i) = 1 \tag{6}$$

the transition of regime variable between regimes is controlled with Markov model. This model is expressed as follows:

$$P\left[a < y_t \leq b \mid y_1, y_2, ..., y_{t-1}\right] = P\left[a < y_t \leq b \mid y_{t-1}\right] \tag{7}$$

If a variable removed Markov model, we have to calculate current period which will be inside next period regime and transformation probabilities. (Hamilton, 1994: 679, Owen, 2004, 9)

$$P = \begin{pmatrix} P_{11} & \cdots & P_{1k} \\ \vdots & \ddots & \vdots \\ P_{k1} & \cdots & P_{kk} \end{pmatrix} \tag{8}$$

For example, if the probability of the every regime is determined by vector $\pi_t = (P_1, P_2, ..., P_k)$ in t time, so the probability of the every regime is determined by $\pi_{t+1} = P'\pi_t$ in t+1 time. There is a ergodic probability vector, such as $\pi = P'\pi$, for stable Markov regime switching model. Ergodic probability vector can be considered as the unconditional probability of each regime. M-dimensional time series vector is defined as a conditional on $y_t = (y_{1t}, ..., y_{mt})'$, $s_t \in \{1, ..., k\}$ (Hamilton, 1998);

$$P(y_t \mid Y_{t-1}, X_t, s_t) = \begin{pmatrix} f(y_t \mid Y_{t-1}, X_t, \theta_1) & \text{if} & s_t = 1 \\ f(y_t \mid Y_{t-1}, X_t, \theta_m) & \text{if} & s_t = k \end{pmatrix} \tag{9}$$

where $P(y_t \mid Y_{t-1}, X_t, s_t)$ is the probability density function of the vector of endogenous variables $y_t = (y_{1t}, ..., y_{mt})'$ which is conditional on the past behavior of the process,

$Y_{t-1} = \{y_{t-i}\}$ exogenous variables $X_t = \{x_{t-i}\}$. The terms s_t and θ_m represent, respectively, regime variable and parameter vector when the series is in regime k (Owen, 2004:7). The model is assumed to be linear in each regime $s_t = k$. In this context, if we consider white noise model as the autoregressive model and development models, $\varepsilon_{it} \square iid(0, \sigma_i^2)$

$$y_t = n_k + a_{k1} y_{t-1} + ... + a_{kp} y_{t-p} + \varepsilon_t \tag{10}$$

Models represent soft transition following regime shifts of time series. On the contrary, it occurs a leap as the first and last time, when the time series shifted to the conditional mean in model (Ferrara, 2003:374-376);

$$y_t - m(s_t) = A_1(s_t)(y_{t-1} - m(s_{t-1})) + ... + A_p(s_t)(y_{t-p} - m(s_{t-p})) + u_t \tag{11}$$

If stochastic model of y_t is defined as conditional on unobservable regime s_t , full description of the data generating mechanism, aims to specify stochastic model which occurs regime (Bildirici, Bozoklu, 2007, 5-6);

$$\Pr(s_t \mid Y_{t-1}, S_{t-1}, X_t, \rho) \tag{12}$$

where $S_{t-1} = \{s_{t-j}\}_{j=1}^{\infty}$ represents the history of the regime variable and it is not possible to observe its past but it might be found from observations and r is a vector of parameters of the regime generating process. In generally the regime variable cannot be observed and the historical behavior of the series must be obtained from the actual behavior of the process. Unobservable regime variable which generated by Ergodic Markov chain explains transformation probabilities and it is defined by following form, $\sum p_{ij} = 1$ and $\forall i, j \in \{1,...,k\}$ (Fallahi, Rodriguez, 2007, 7-8);

$$p_{ij} = \Pr(s_{t+1} = j \mid s_t = i) \tag{13}$$

7. Empirical results

Before proceeding to application of conventional VAR and MS-VAR analysis, it is necessary to determine integration degree of variables. This can be done by the unit root tests of Dickey and Fuller (1979) (henceforth ADF), Phillips and Perron (1988) (henceforth PP), Elliot et al. (1996) (henceforth DF-GLS) and Kwaitkowski et al. (1992) (henceforth KPSS). The results from the unit root tests in Table 1 show that ADF, PP and DF-GLS test do not reject the null of a unit root for the levels of the variables. When the ADF, PP and DF-GLS tests are applied to the first differences of the variables, the results indicate that all variables are stationary. Consistent with these results, the KPSS test for the null hypothesis of stationary shows that the variables are stationary in the first difference form. The unit root analysis thereby implies that the variables are integrated of order one.

Table 1. *Results for unit root tests*

	Variables	ADF	DF-GLS	PP	KPSS
Levels					
Intercept	INF	-9.372 (0)	-3.695 (1)	-9.335 (6)	0.173 (2)
	PPI	0.402 (0)	2.789 (1)	0.199 (5)	1.251 (9)
	IPI	-1.426 (1)	0.087 (1)	-1.76 (0)	0.973 (9)
Intercept and Trend	INF	-9.418 (0)	-8.349 (0)	-9.378 (6)	0.036 (3)
	PPI	-2.636 (1)	-2.399 (1)	-2.615 (6)	0.14 (8)
	IPI	-2.232 (1)	-2.194 (1)	-3.217 (5)	0.101 (9)
First-differences					
Intercept	INF	-12.287 (1)	-16.733 (0)	-50.291 (50)	0.163 (28)
	PPI	-8.440 (0)	-7.667 (0)	-8.54 (5)	0.065 (5)
	IPI	-16.786 (0)	-1.839 (3)	-17.035 (2)	0.050 (5)
Intercept and Trend	INF	-12.262 (1)	-11.472 (1)	-53.798 (50)	0.12 (28)
	PPI	-8.442 (0)	-8.176 (0)	-8.537 (5)	0.032 (5)
	IPI	-16.722 (0)	-3.788 (2)	-16.978 (2)	0.051 (5)

Notes: For the KPSS test: *The asymptotic critical values of LM statistic for intercept 0.739, 0.463 at the %1 and %5 levels, ** the asymptotic critical values of LM statistic for trend and intercept 0.216, 0.146 at the %1 and %5 levels.

For the DF-GLS test: *The asymptotic critical values for without trend -2.591, -1.944 at the %1 and %5 levels. ** The asymptotic critical values for with trend -3.602, -3.1772 at the %1 and %5 levels. The figures in parenthesis denote the number of lags in the tests that ensure white noise residuals. They were estimated through the Schwarz criterion.

For the ADF test: * shows the results of Dickey Fuller test in the case of zero lag length and lag length chosen due to SIC criteria.** For the ADF test, the Mac Kinnon (1996) critical values for with constant -.3.485, -2.885, -2.579 at the 1%, 5% and 10% levels. The critical values for with constant and trend -4.035, -3.447 ve -3.148 at the 1%, 5% and 10% levels, respectively.

For the PP test: *Values in the parenthesis show bandwiths obtained according to Newey-West using Bartlett Kernel criteria. ** For the PP test Mac Kinnon (1996) critical values for with constant -3.483, -2.884, -2.579 at the 1%, 5% and 10% levels. The critical values for with constant and trend -4.033, -3.446 and -3.148 at the 1% 5% and 10% levels, respectively.

One of the important question in the VAR models is to select the optimal lag length. The most common and simple approach in selecting exact lag length is to re-estimate VAR model until the smallest Schwarz information criterion (SCI) value is found. Because comparing two or more models; the model with the lowest SCI is preferred (Gujarati, 2004, 537). According to Asteriou (2005) the judgment of the optimal length should still take other factors into account: For example autocorrelation, heteroskedasticity, possible ARCH effects and normality of residuals. In this study, we choose two lags based on Schwarz information criterion.

Another important question is the stability of the VAR model in order to get valid results from impulse response analysis. Stability would be achieved if the characteristic roots of the matrix coefficients have a modulus less than one. So we tested lag structure and

stability of the number of lag length with autocorrelation test and had a look at unit root graph. Graph showed that all roots are less than one and no roots are out of the unit circle. In autocorrelation test results imply that there is no autocorrelation.

Impulse response function derived from the VAR analysis is useful to trace out response of one variable to a shock in the error term of another variable. It can explain current and lagged effect over time of shocks in the error term (Liu et. al, 2008, 243). For this reason impulse response function is one of the important elements of the VAR analysis.

Table 2. *Conventional VAR analysis impulse response function*

M.	Response of Variables a Shock in Inflation Rate			Response of Variables a Shock in Producer Price Index			Response of Variables a Shock in Ind. Prod. Index		
	INF	PPI	IPI	INF	PPI	IPI	INF	PPI	IPI
1	0,0091	0,5185	0,5284	0,0026	1,7573	1,3504	0,0012	0,5201	4,5628
2	0,0028	0,3360	0,3235	0,0004	0,9061	-0,6810	-0,0011	0,2664	-3,0108
3	0,0015	-0,0752	-0,1225	-0,0013	0,4373	0,9313	0,0006	0,1276	1,3259
4	-0,0008	0,0340	-0,0245	-0,0031	0,2430	-0,2583	-0,0006	0,0956	-0,1912
5	-0,0001	0,0614	0,0420	0,0002	0,1728	0,1177	0,0001	0,0323	-0,1060
6	-0,0002	0,0106	0,0204	-0,0002	0,1033	0,0797	0,00004	0,0367	0,1406
7	-0,0000	0,0012	-0,0139	-0,0001	0,0488	-0,0169	-0,0009	0,0163	-0,0559
8	0,0001	0,0077	0,0039	0,0002	0,0321	0,0244	-0,0002	0,0077	0,0198
9	-0,0001	0,0043	0,0047	-0,0001	0,0206	0,0052	0,0001	0,0067	0,0027
10	-0,0778	0,0008	-0,0009	-0,0001	0,0107	0,0038	-0,0003	0,0032	-0,0024

Table 2 presents the impulse response functions of each variable. As shown Table 2, inflation rate responses positively to a positive shock in inflation rate. It is significant during a quarter. On the other hand, producer price index responses positively but it is significant less than a quarters. Finally, industrial production index responses it positively and the response is significant for two months.

In the case of a positive shock in producer price index, producer price index would response positively and it is significant for nearly four quarters. Moreover, inflation rate would response it positively, but it is weak and significant in the short term. The response of industrial production index is positive but insignificant.

Lastly, the response of industrial production index to a positive shock in industrial production index is positively. But it is insignificant after the first month. The producer price index responses positively and the response is relatively high. While it is significant for almost four quarters, the strength of the response decreases slowly. Finally the response of the inflation rate is insignificant and positive.

Secondly, we employ Markov Switching VAR (henceforth MS-VAR) model. In the MS-VAR model, the optimal lag length is found two according to Schwarz information criterion.

Table 3. *Determination of regime number and test statistics*

No. Of Regime	Log Probability	LR Linearity	Davies	AIC	SC
MS(2)	-4.261	168.7238 (0.00)	0.00	1.0572	2.4013
MS(3)	7.1379	191.5216 (0.00)	0.00	1.4011	3.4892
MS(4)	-8.2341	197.2341 (0.00)	0.00	2.8137	4.2517

Note: AIC denotes Akaike information criterion, SC denotes Schwarz information criterion, LR denotes probability rate.

According to LR linearity and Davies test statistics, all regimes have non-linear and asymmetric structure. Besides, AIC and SC test statistics accepts that there are two regimes which variables contracts or expands in recession or expansion periods. In the light of this finding, the transition probability matrices which obtained by using MSIA(2)-VAR(2) model is presented in Table 4.

Table 4. *Regime transition probability*

	Recession Regime	Expansion Regime
Recession Regime	0.3372	0.6628
Expansion Regime	0.0714	0.9286

According to regime transition probability table, the length of expansion regime is 3.5 years and the length of recession regime is nearly 2.7 years. The regime transition probability matrix also confirms that the speed of exit from recession regime is 2.09 quarters and the speed of entrance to recession regime is 1.07 quarters. The probability of entrance into a recession regime again after the recession regime is 0.34 and the probability of entrance into expansion regime again after the expansion regime is 0.92. On account of these results, prediction probability of permanency of expansion regime is very near to 1. The period which economy spends time in expansion regime is longer than the period spent in recession regime. This is an indicator of permanence in expansion regime.

After the determination of expansion and recession periods, we investigate the impulse response functions for each regime. First of all, we examine the impulse response functions for recession regime. The result is shown in Table 5. According to Table 5, the inflation rate responses positively to a positive shock in inflation rate. It is significant during a quarter. On the other hand, producer price index responses negatively and although it is significant for two quarters, it is so weak. Finally, industrial production index responses it positively and again although it is significant for two quarters, it is weak.

Table 5. *Impulse response function in recession regime*

M.	Response of Variables a Shock in Inflation Rate			Response of Variables a Shock in Producer Price Index			Response of Variables a Shock in Ind. Prod. Index		
	INF	PPI	IPI	INF	PPI	IPI	INF	PPI	IPI
1	0,9358	-0,0027	0,0002	0,0529	0,8043	-0,068	-2,709	1,51	0,091
2	0,6662	-0,0043	0,0004	0,1106	0,3990	-0,04	-1,982	2,09	-0,159
3	0,2737	-0,0046	0,0004	0,1378	-0,050	-0,005	-0,314	1,98	-0,200
4	-0,1270	-0,0037	0,0004	0,1275	-0,420	0,036	13,113	1,37	-0,160
5	-0,4362	-0,0020	0,0002	0,0868	-0,630	0,06	23,913	0,49	-0,070
6	-0,5879	-0,0003	0,00005	0,0304	-0,650	0,07	2,711	-0,36	0,0161
7	-0,5681	0,0016	-0,0001	-0,0252	-0,584	0,05	2,29	-1,01	0,090
8	-0,4076	0,0026	-0,0002	-0,0660	-0,240	0,03	1,368	-1,3	0,130
9	-0,1682	0,0028	-0,0003	-0,0841	0,030	0,004	0,2312	-1,22	0,130
10	-0,0778	0,0026	-0,0002	-0,0781	0,260	-0,02	-0,793	-0,84	0,100

In the case of a positive shock in producer price index, producer price index would response positively and it is significant for nearly a quarter. On the other hand, inflation rate would response it positively and it is relatively strong. The response of the inflation

rate increases when the time period expands. The response of industrial production index is negative and insignificant after the first quarter.

Lastly, the response of industrial production index to a positive shock in industrial production index is positively. But it is insignificant after the second month. The producer price index responses positively and the response is relatively high. While it is significant for two quarters, the strength of the response decreases slowly. Finally the response of the inflation rate is significant and negative.

According to results belonging recession regime, while the economy is into a recession period, an increase in producer price index would affect positively and induce an increase in inflation rate. This result is consistent with Frankel's (2011) policy suggestion. But the effect is relatively weak and it increases after a quarter.

Secondly, we investigate the impulse response functions for the expansion regime. The results are shown in Table 6. According to impulse response functions, inflation rate responses positively and it is significant for a quarter in the case of a positive shock in inflation rate. The producer price index and industrial production index response positively and but they are weak. While the response of producer price index is significant, another one is insignificant.

Table 6. *Impulse response function in expansion regime*

M	Response of Variables a Shock in Inflation Rate			Response of Variables a Shock in Producer Price Index			Response of Variables a Shock in Ind. Prod. Index		
	INF	PPI	IPI	INF	PPI	IPI	INF	PPI	IPI
1	0,1829	0,0010	0,0000	1,690	1,510	0,066	7,0300	-0,1300	0,4300
2	0,0130	0,0017	-0,1828	-2,400	2,250	-0,182	4,5800	-0,1820	0,1790
3	-0,0239	0,0026	0,0001	-3,350	3,360	0,205	2,4000	-0,2500	0,0600
4	-0,0391	0,0038	0,0002	-4,870	5,010	0,310	0,1321	-0,3600	0,0100
5	-0,0565	0,0057	0,0004	-7,200	7,480	0,460	0,0935	-0,5400	-0,0200
6	-0,0828	0,0086	0,0005	-10,720	11,170	0,690	0,0948	-0,8000	-0,0400
7	-0,1228	0,0128	0,0008	-15,980	16,670	1,040	0,1225	-1,2000	-0,0700
8	-0,1829	0,0191	0,0012	-23,850	24,880	1,550	0,1750	-1,7900	-0,1100
9	-0,2728	0,0285	0,0017	-35,580	37,130	2,320	0,2579	-2,6700	-0,1600
10	-0,4070	0,0424	0,0020	-53,100	55,420	3,470	0,3836	-3,9900	-0,2500

On the other hand, producer price index would response positively to a positive shock in producer price index positively as expected. Although, the response of inflation rate to the same shock is positive, it is insignificant. Similarly, industrial production index responses positively and it is insignificant too. Lastly, the response of industrial production index to a positive shock in its own structure would be positive as expected. While the response of producer price index is negative to the shock mentioned, inflation rate would response positively and strongly. The strength of the response would decrease after the first quarter.

According to results investigated above, an increase in producer price index would not affect the inflation rate not just like has been in the recession regime. As a result, the policy implication of Frankel's (2011) is not valid for the expansion regime in the Turkish economy.

7. Conclusion

In this study, we aim to analyze the effect of producer price index on the inflation rate in the context of Frankel's (2011 and 2012) policy suggestion indicating that another price index has to be used instead of consumer price index.

First of all, we employ conventional VAR analysis in order to investigate the responses of variables to a shock in other variables. VAR analysis results show that there is a weak effect of producer price index on the inflation rate. Secondly, we investigate the relation by MS-VAR approach which analyzes the time series in different regimes. This approach gives opportunity to analyze the economy in recession and expansion regimes, respectively. Results show that there is no effect of producer price index on the inflation rate while the economy is in expansionary regime. On the other hand, an increase in producer price index raises inflation rate in recession regime. That is consistent with Frankel (2011). An increase in oil price or other terms of trade shock would raise the producer price index in the recession regime in the Turkish economy. But the persistency of the effect and the weakness of the response during the time reduce the possibility of employing producer price index as a single price index while implementing inflation targeting regime.

In the light of these results, it is not possible to say that Frankel's policy proposal is suitable for the Turkish economy exactly. Because the results show that the inflation is based on demand side of the economy, while the supply side of the economy contributes to inflation during the recessionary period. Therefore, the consumer price index seems to be an appropriate instrument to target inflation rate, but the producer price index should also take into account to target inflation during the recessionary period in the Turkish economy.

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