The Role of Capacity Utilization Rate at the Measuring Output Gap in Turkey

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Abstract. Output gap is one of the basic indicators of the used determination of the inflation. It refers to the difference between the actual output and the potential output. If the output value is positive, there is inflationary pressure in the economy. If it's value negative, there is deflationary pressure in the economy. The correct representation of the output gaps is of particular importance under the inflation targeting regime. In the literature, it is seen that industrial production index is highly used as output indicators. In the study is search answer the "The manufacturing capacity utulization rate is more effective indicator than industrial production index indicator of determined the output gap in Turkey,? question. This study is examined the relationship between work, capacity utilization rate, industrial production index and consumer-based inflation, using the Vector Autoregressive Model (VAR) and Relative Sensitivity Analyzes for the period 2002-2016. As a result of the study, it is seen that the capacity utilization rate of the manufacturing industry is an effective indicator as output gap on inflation compared to the industrial production index.

Keywords: Output Gap, Capacity Utilization Rate, Inflation, Relative Sensitivity Analysis, VAR Analysis.

1. INTRODUCTION

One of the main variables used by central banks in inflation modeling is output gap. The output gap is the difference between the current production and the potential production level. The potential production is the highest level of production that can be achieved using production factors while technology is constant. Output is an indication that an economy is not producing at full employment. If an economy has a negative output, it is incomplete employment in the economy. Production factors are not being used effectively. If there is a positive output in the economy, then the economy is producing over capacity. In this case, real wages rise, production costs increase. This creates inflation in the economy. The relationship between inflation and output deficit can be defined as (Ünsal, 2013):

$$Y=Y_N+\alpha(P-P^e) \quad (P = P^e, Y=Y_N) \tag{1}$$

In equation 1, Y is the actual output level; Y_N, level of natural product; α, the parameter is indicating the difference between the actual and expected price levels; P is the actual price level; P^e is the expected price level. This equation is used to calculate inflation. It can be written as:

$$(P-P_{-1})= (P^e-P_{-1})+1/\alpha(Y-Y_N) \tag{2}$$

In equation 2, when the log of the price difference is taken, the inflation rate (π) is approximately obtained. Thus, the inflation equation can be defined as:

$$\pi = \pi^e + 1/\alpha(Y-Y_N) \tag{3}$$

According to equation 3, inflation depends on expected inflation (π^e) and output output. Both variables affect inflation positively.

The output gap can be measured differently. These measures are production function approach, univariate and multivariable filters and structural models. In the production function approach; technology, labor and capital variables trends are separately estimated and than the difference between trend and actual values is defined as output gap. Hodrick-Prescott (HP) and Kalman filters are widely used other measures which are output gap is measured by filters.

When we look at studies in the literature, as indicators of output gap are widely used GDP, GDP growth rate, manufacturing industry production, fiscal deficit and unemployment rate. Kravis and Lipsey (1988) found a positive and strong relationship between per capita GDP and inflation. Lim and Papi (1997) found a statistically significant relationship between the two variables, examining the relationship between the wages of workers in the manufacturing industry and inflation. Domaç and Elbirt (1998) found a positive but statistically insignificant relationship between inflation and output gap. Laryea and Sumaile (2001), Basir, Nawaz, Yasin, Khursheed, Khan, Qureshi (2011) and Lissuolik (2003) found that there is a statistically significant relationship between GDP and inflation. Andersson, Masuch and Schiffebau (2009), Greenidge and DaCosta (2009), Şahinoğlu, Özden, Başar and Aksu (2010), Kara and Öğünç (2011) have determined that arise with the delay of the relationship between inflation and output gap. Gyebia and Boafo (2013) and Lim and Sek (2015) are studies that find a positive relationship between GDP growth rate and inflation. Hossain (2013) found a positive relationship between inflation and fiscal deficit.

In fact, central banks follow the capacity utilization rate as a demand pressure. However, in the literature, it is seen that there are few studies examining the relationship between capacity utilization rate and inflation and they are largely before 2000 years (Gittings, 1989; Thomas, 1989; Finn, 1996; Emery and Chang, 1997; Bauer, 1990). In the studies conducted for Turkey, there are a lot of studies to determine the non-inflationary capacity utilization rate but a small studies about modelling inflation is used capacity utilization rate for demand pressure or output gap. Yamak and Zengin (2000) examined the relationship between capacity utilization rate and inflation in the framework of the neoclassical model developed by Finn (1996). They determined the one-way causality relationship from capacity utilization to inflation rate. Nevertheless, they point out that inflation is highly affected by capacity utilization. In this context, the study aims to contribute to the literature by including the capacity utilization rate in the inflation model.

In this study, as an output deficit indicator in Turkey, the relation between the production index of industrial goods and the capacity utilization ratios are examined and it is discussed whether the capacity utilization ratio is used as output deficit indicator. In the introduction part of the study, the output gap is defined and the studies in the literature are summarized. In the second part, information about the variables and methods in the model is presented. In the third part is included empirical findings. The study is completed with the conclusion section. The stability of the variables were tested by PP and KPSS unit root test. Relationships between variables were examined by Vector Otoregresive Regression (VAR) and Relative Sensitivity (RSA) analyzes.

2. VARIABLES AND METHODS

The study was carried out in Turkey using quarterly data from 2002: 01-2016: 12. Variables are normalized using the CPI deflatore which is base year 2000. All variables was seasonally adjusted using the exponential smoothing method. In this study, inflation function is expressed as;

$$INF= f\ (PPI, INFEXP, KAPS, GAP) \quad (4)$$

Consumer inflation (INF): Inflation is calculated by percent of the 12-month change in the Consumer Price Index (CPI).

Producer Inflation (PPI): Producer Price Index (PPI) is calculated by percent of 12 months of change. In the literature, Kwon and Koo (2009) and Lissuolik (2003) used producer inflation for inflation forecasting. The economic expectation is that there is a positive relationship between these two variables.

Inflation Expectation (INFEXPC): Expected inflation forecast for the current month. This data is created by the CBRT to monitor the expectations of decision makers and specialists in the financial and real sectors regarding various macroeconomic variables. A positive relationship is expected between inflation expectations and inflation.

Capacity Utilization Ratio (KAPS): Capacity utilization ratio is prepared by the Central Bank according to the Business Tendency Survey applied to establishments operating in manufacturing industry. A positive relationship is expected between capacity utilization rate and inflation.

Production deficit (GAP): The manufacturing industry production index was used by HP Filter. When the output gap is positive, it is foreseen that demand-side inflation experienced. Variables are taken from the Central Bank, Statistics Institute and Ministry of Development of Turkey.

Time series need to be stationary for using analysis (Gujarati, 1995, p.750). Various tests are used to check if the time series is stationary or not. PP and KPSS tests are performed on the time series in this study. PP unit root test is applied a non-parametric improvement to remove the autocorrelation. On the other hand, parallel hypotheses are checked with ADF test. In both of the unit root tests, a delay length to convert the error term to white noise is determined. Various information criteria are used to determine the lag length. Some of these criteria are Akaike (ACI), Schwartz (SC) and Final Prediction Error (FPE) criteria (Johansen, 1995; Enders, 1995). The simplest form of PP test can be given as in Equations (5) and (6) (Phillips-Perron, 1988).

$$Y_t = \mu_1 + \varphi_1 Y_{t-1} + e_t \quad (5)$$

$$(1-\varphi_1 L)Y_t = \mu + e_t \quad (6)$$

The formula used for PP test is shown in Equation (7). CF is the correction factor.

$$Z_0 = T(\varphi_1 - 1) - CF \quad (7)$$

The lag length for converting the error term into white noise can be determined by Akaike and Scwartz criteria. Zero hypothesis in PP test implies that the time series which are not differentiated have unit roots which also means that these series are not stationary. In zero hypothesis, φ coefficient is tested against being zero statistically. It means that this hypothesis is rejected if φ coefficient is statistically important. In this case, the time series is stationary. The tests used for Dickey-Fuller are defined as Z in PP test.

Some studies in the literature support KPSS test since ADF and PP tests are sensitive to the lag length. KPSS test is developed by Kwiatkowski (Kwiatkowski et al, 1992). The zero hypotheses of ADP-PP tests and KPSS tests are the inverse of each other. In ADF and PP tests, the existence of unit tests implies the zero hypothesis while in KPSS test, being stationary is taken as zero hypothesis. KPSS test statistics can be given as in Equation (8) (Kwiatkowski et al., 1992, p. 54).

$$\eta_\mu = T^2 - \sum_{t=1}^{T} S_T{}^2 / s^2 \quad (8)$$

The limited delay parameter has to be determined for l → ∞ for the consistency of t=1,2,...t,. S_T shows the partial process sum of the residuals. The calculated value is compared to the critical value for testing the hypotheses.In KPSS test, the verification of the hypothesis shows that the series is stationary. The aim of the KPSS test is the removal of problem caused by the existence of the unity test from the deterministic trend via changing this trend. KPSS test is different than the similar unit root tests from this viewpoint. Another important property of the KPSS test is that the variance of the random walk test is zero since it implies the stationary trend of H_0 hypothesis (Kwiatkowski et al., 1992: 159-178).

Table 1. The Results of Stationary Tests

Variables	PP, Level		KPSS, Level	
	Constant	Constant&trend	Constant	Constant&trend
INF	-11.88* (-3.55)	-10.27* (-4.12)	0.56* (0.74)	0.19* (0.22)
INFEXP	-5.11* (-3.54)	-5.29* (-4.12)	0.53* (0.74)	0.09* (0.21)
PPI	-0.34 (-3,55)	-2.59 (-4,12)	0.96 (0,46)	0.19 (0,15)
KAPS	-2.25 (-3.55)	-2.54 (-4,12)	0.33 (0.47)	0.09 (0.14)
GAP	-7.05* (-3.55)	-6.97* (-4.12)	0.04* (0.74)	0.05* (0.22)
	PP, First Difference		KPSS, First Difference	
PPI	-6.78* (-3.55)	-6.77* (-4.12)	0.97* (0.46)	0.18* (0.15)
KAPS	-5.60* (-3.54)	-5.52* (-4.12)	0.073* (0.74)	0.70* (0.22)

*, statistically meaningful according to 1% meaning level. The lag length is 5 in PP analysis (New-West Bandwith). Exponential Correction Method (Holt-Winters-No Seasonal) is used for the removal of seasonal effects. The lag length is selected according to LM statistics in KPSS test.

In the Table 1 show that INF, INFEXP and GAP are level stationary variables, KAPS and PPI are first difference stationary variables according to PP and KPSS test results.

After stationary tests, firstly Vector Autoregressive Regression (VAR) method is used in this study. VAR is introduced by Sims in 1980 for the economics for the first time (Sims, 1980). There are no a priori constraints in this method. Each variable used in the model is defined as a function of the delayed values of the other variables (Davidson and McKinnon, 1993, p. 685). VAR analysis has three tools, namely Granger causality test, impulse response analysis and variance decomposition. The results of the impulse response analysis and variance decomposition have to support by Granger causality test. Causality relationship is taken into consideration for the model setup.

The causality relationship is analyzed and the influences of each variable on the other variables are investigated by Granger Causality test. Causality relationship can also be assessed using Wald Test (Enders, 1995, p. 373).

$$F = \frac{(HKTS - HKT)}{HKT/(n-k)} \tag{9}$$

In Equation (9), *HKTS* is the sum of square errors of the constrained model, *HKT* is the sum of the errors of the unconstrained model, *n* is the number of observations, *k* is the number of parameters in the model. Calculated *F* value is compared to the *F* values in the table to test the hypotheses.

In variance decomposition, the change in variance of each variable is investigated dependent on the delay of other variables. On the other hand, impulse-response analysis shows the response of all the variables when a unit impact is given to a specified variable (Warne, 2004). Cholesky decomposition of the error terms is used to obtain the coefficients of the impulse-response function. The error terms are orthogonalized and variance-covariance matrix is diagonalized for the Cholesky decomposition. Hence, the order of the variables in the model is important. This order is determined using the causality relationship. If the variables are ordered in an improper way, impulse-response functions change and wrong estimations occur (Hamilton, 1994, p. 323).

Monte Carlo method is utilized for the calculation of confidence levels of impulse-response functions. A random sample is selected among the asymptotic distribution of VAR coefficients. This selection is repeated 100 times and then the sample distribution of impact-response coefficients is found. Standard deviations are obtained using this distribution. The obtained deviations show the standard errors of impact-response functions.

Secondly Relative Sensitivity Analysis (RSA) is used in this study. The relationships between variables can be seen in a more comprehensive way with this method. In comparative statistical analysis, changes in endogenous variables are investigated in connection with the change in exogenous variables. In other words, changes in an economic outcome is investigated and then the influences on the other economic parameters are determined. The research on the changes of economic inputs and outputs can be viewed as a branch of a more general statistics area called sensitivity analysis. Elasticity is also a subset of sensitivity analysis, which is given as the sensitivity measurement of an economic variable such as the demanded quantity to one of its determinants such as income.

Several local and global sensitivity analyses applied to microeconomic and macroeconomic problems exist in the literature. In (Borgonovo and Peccati, 2004), absolute sensitivity analysis is applied to the equations regarding the investment decisions and then the elasticity of survival risk validation is investigated. Similarly, a global sensitivity analysis is performed on investment decisions in energy sector (Borgonovo and Peccati, 2006).

In statistics, basically three types of sensitivities can be calculated in order to provide insight to the analysts, namely absolute sensitivity, semi-normalized sensitivity and the normalized (relative) sensitivity. Let the outcome of a model be y, which is a function of input variables such *x1*, *x2*,...., *xn* as shown in Equation (10).

$$y = f(x_1, x_2, \ldots, x_n) \quad (10)$$

Absolute sensitivity is defined as the absolute change in the output *y* with respect to the change in one of the input variables, *x*.

$$S_{abs} = \frac{\Delta y}{\Delta x_n} \quad (11)$$

Semi-normalized sensitivity includes the change in the output variable with the ratio of the changes of output and input variables as given in Equation (12).

$$S_{semi-norm} = y\frac{\Delta y}{\Delta x_n} \quad (12)$$

Absolute values and the rate of changes of both output and input variables exist in the definition of the relative sensitivity as formulated in Equation (13).

$$S_{abs} = \frac{y}{x}\frac{\Delta y}{\Delta x_n} \quad (13)$$

Relative sensitivity is utilized in various fields in theoretical and applied science such as medical science (Isenring et al, 2009).

Relative sensitivity differs from absolute senstivity in two ways. The first difference is that relative sensitivity considers the values of the input and output variables such that the effects caused from the amounts are taken into account. While absolute sensitivity is merely a ratio of the change of input and output variables, relative sensitivity gives a better understanding of the effects of input variables on the output variables. Secondly, it is easier to obtain the time dependent sensitivity with the relative sensitivity concept. Hence, because of these reasons, it is logical to use relative sensitivity as well as absolute sensitivity for econometric applications.

3. VAR and RSA ANALYSIS RESULTS

The model selection criteria and the tests for the error term are included in the annexes of the study (Annex 1-4). In the three-delayed VAR model; there are no varying variance and autocorrelation problems among the error terms and error terms have normal distribution. The causality relation among the variables are shown in Table 3 with three periods of lag.

Table 2. VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: CPI			
Excluded	Chi-sq	Df	Prob.
CPI	16.42807	4	0.0025
KAPS(-1)	9.744451	4	0.0450
INFEXP	6.162070	4	0.1874
GAP(-1)	5.145529	4	0.2727
Dependent variable: PPI			
Excluded	Chi-sq	Df	Prob.
CPI	3.491921	4	0.4791
KAPS(-1)	5.510710	4	0.2388
INFEXP	4.341631	4	0.3617
GAP(-1)	0.679434	4	0.9538
Dependent variable: KAPS(-1)			
Excluded	Chi-sq	Df	Prob.
CPI	4.870592	4	0.3008
KAPS(-1)	3.032306	4	0.5524
INFEXP	0.912321	4	0.9228
GAP(-1)	4.055715	4	0.3985
Dependent variable: INFEXP			
Excluded	Chi-sq	Df	Prob.
CPI	2.590674	4	0.6285
KAPS(-1)	6.963939	4	0.1378
INFEXP	10.67665	4	0.0304
GAP(-1)	5.320962	4	0.2559
Dependent variable: GAP(-1)			
Excluded	Chi-sq	Df	Prob.
CPI	2.002292	4	0.7353
KAPS(-1)	11.21413	4	0.0243
INFEXP	11.64935	4	0.0202
GAP(-1)	1.823377	4	0.7682

According to the Granger causality analysis results in the Table 3, inflation has single direction relationship with PPI, INFEXP and KAPS. There is not Granger causal relationship between inflation and GAP.

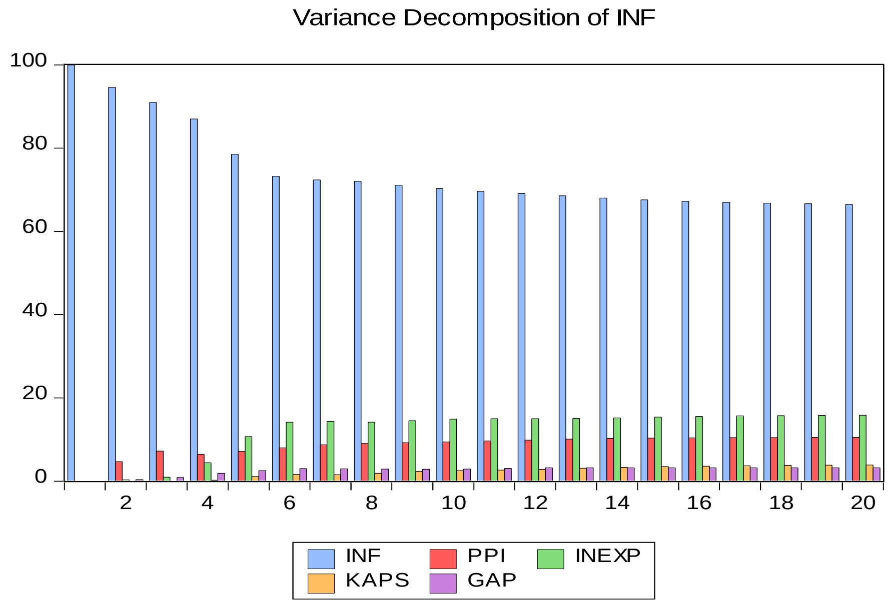

Fig. 1. Varyans Decomposition of Inflation.

The ratio PPI, INFEX and KAPS are the effective variables on the inflation rate in accordance with Granger causality analysis. According to Fig. 1, inflation rate is affected mostly from own past values. Second effective parameter on the inflation rate is the PPI which is supports Granger causality tests. The third most influential variable is the INEXP. KAPS and GAP have a low effect than PPI and INFEXP. Beside this, first thirteen periods, GAP's effect is high than KAPS on the inflation, after than KAPS is more effect on the inflation than the GAP.

In Figure 3 the response of inflation to the other variables in the model. According to response functions; firstly, inflation response to the own past values are rather high. Secondly, inflation is more reacts to PPI and INFEXP than to other variables. However, the relationship between capacity utilization rate and inflation is continues for a longer period than GAP. In Figure 4 the responses of the variables to the inflation.

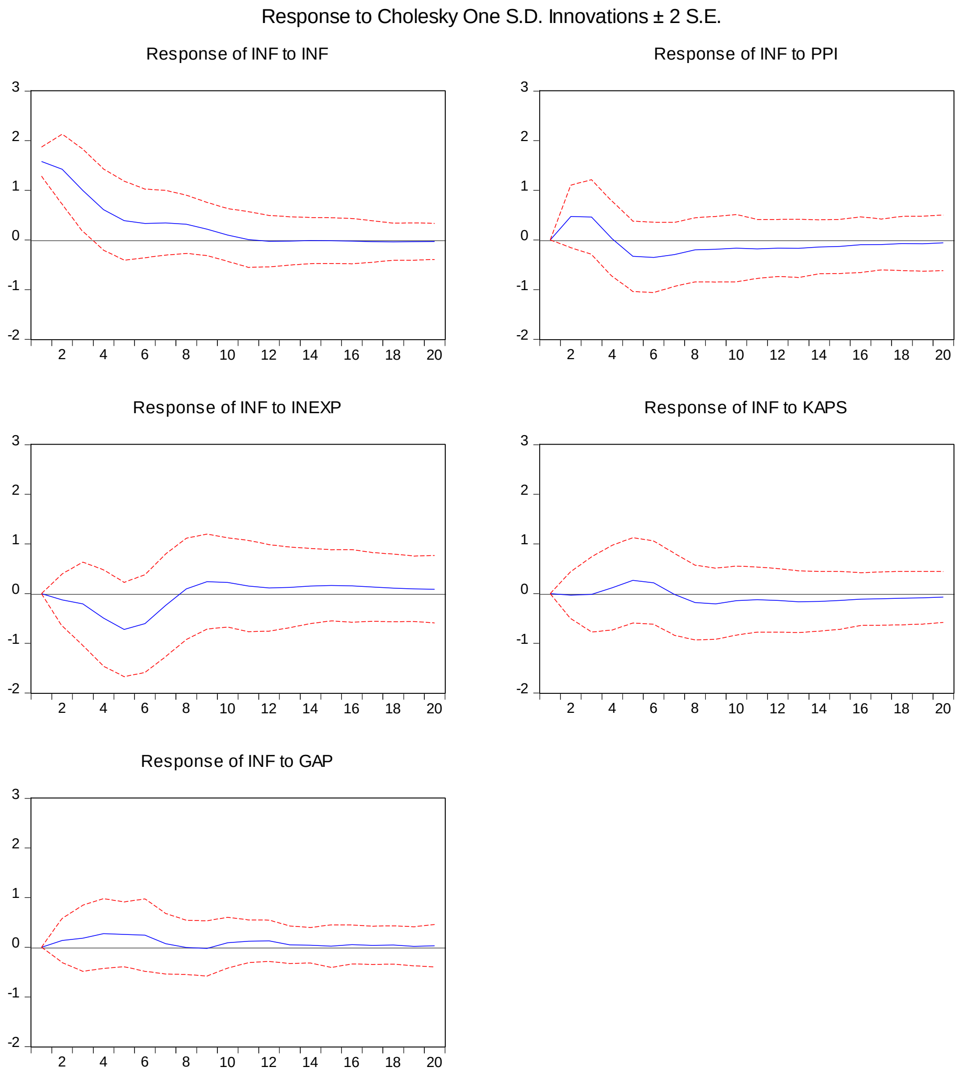

Fig. 3. The response of the inflaton to the variables.

Fig. 4. The responses of the variables to the inflation.

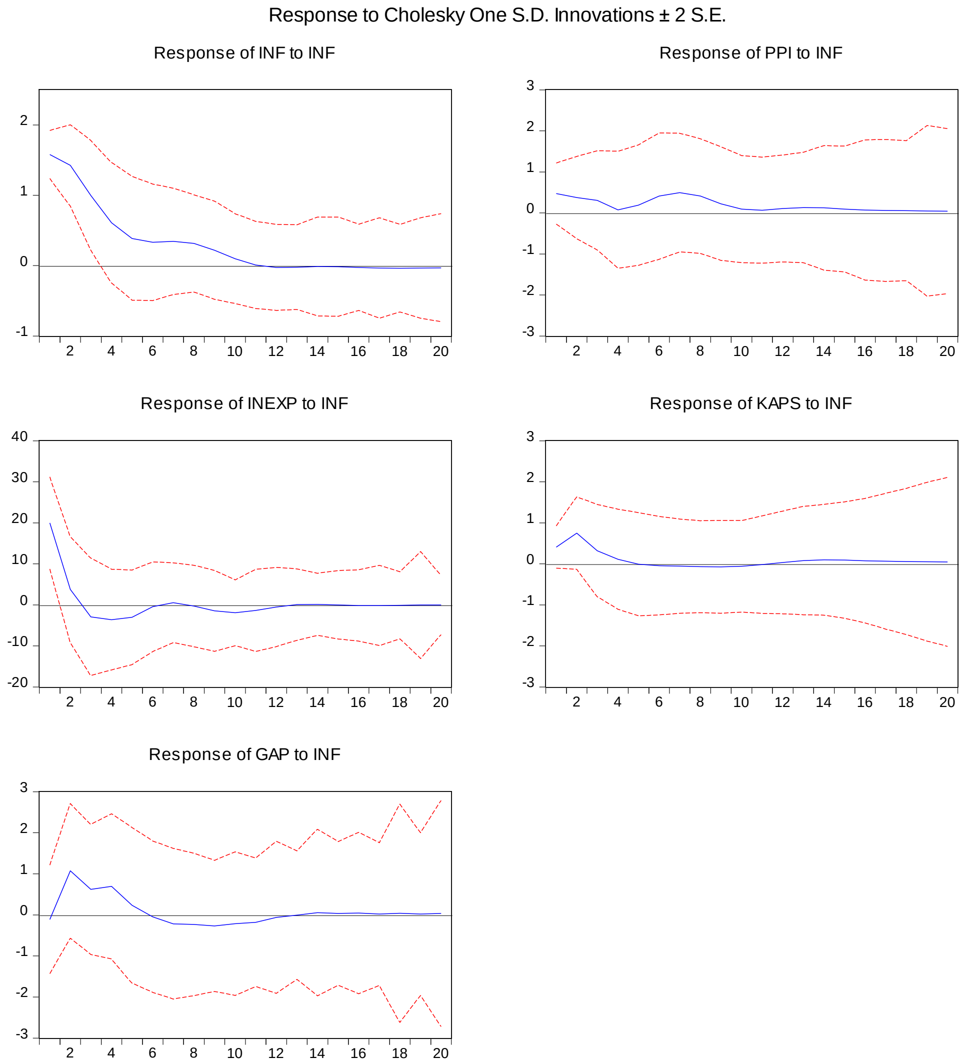

Fig. 4. The response of the variables to the inflation.

The inflation expectation is most influenced by inflation rate. The response of the PPI is high to the inflation. Although KAPS and the GAP were lower react to inflation then PPI and INFEXP. Beside this, KAPS is take longer to react to inflation than GAP.

RSA analysis results presented in the following Figures 5-8. The zero values of the sensitivities mean that the considered parameter has no sensitivity on the foreign borrowing. This analyses will contribute to the literature by answering questions like “which parameter has an effect on inflation in which year?” The sensitivity coefficients will show the effects of various economic strategies on inflation. Using this analysis, we can see comprehensive effects of the economic policies on this variables for any periods. When defining the variable’s effects on the dependent variables, we can generally explain the relationship by looking at the high and low points.

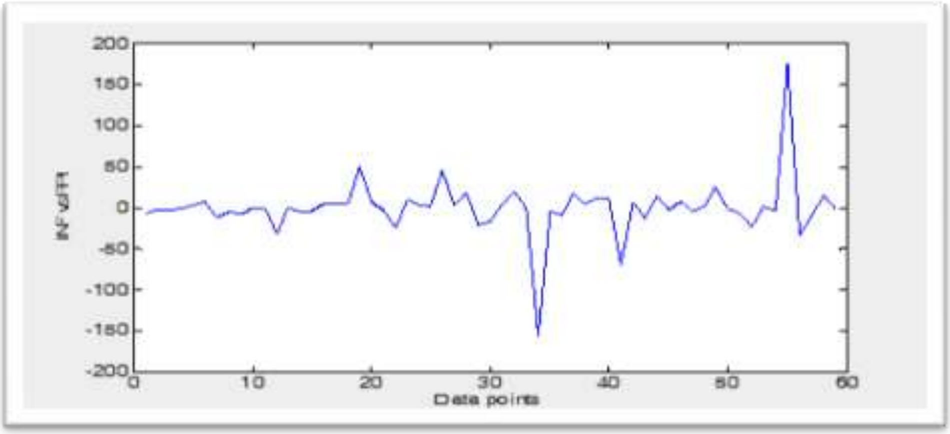

Fig. 5. Relative Sensitivity of The inflation to the PPI

Looking at the coefficients on the vertical axis, we can say that the relative sensitivity of inflation to PPI is high. We can also see the sensitivity coefficients for each period. When we look at what periods are higher; (2015: Q2), which are positive from these periods, and 34 and 41, respectively, which are negative (2010: Q1, 2011: Q4). For years when the sensitivity is very low, the first years of the period can be given as an example.

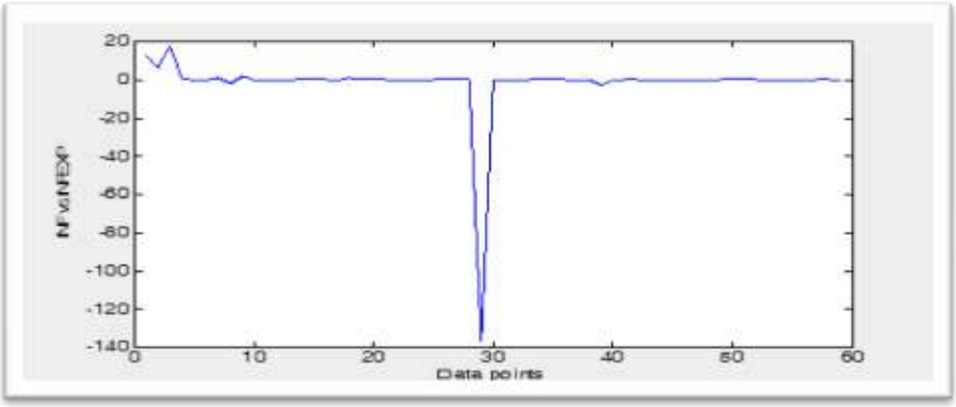

Fig. 6. Relative Sensitivity of the inflation to the INFEXP

Figure 6 shows that inflation is sensitive to inflation expectations. The trend value of these two variable's sensitivity are positive excep for 2008:Q3-2009:Q2. There was a sharp negative trend between 2008: Q3-2009: Q2. The reason for this is that the expectation of inflation is very variable at that time. In the period concerned, the inflation expectation decreased while actual inflation continued to increase. Apart from this, while the effect of the inflation expectation was high in the first years of the period, it stabilized in the following years. Individual expectations of inflation reflect trust in monetary policy. In this sense, it can be said that monetary policy is trusted.

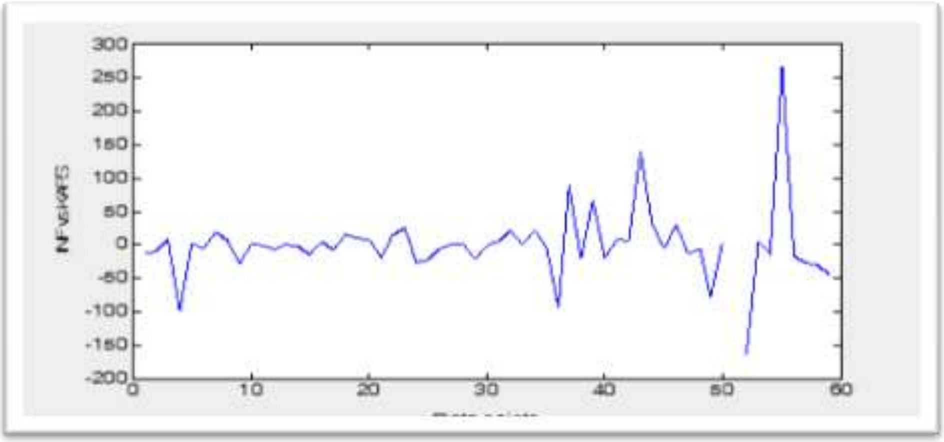

Fig. 7. Relative Sensitivity of the inflation to the KAPS

In Figure 7, the relationship between inflation and capacity utilization rate is examined. Relative sensitivity analysis shows that a strong relationship between these two variables. The highest positive sensitivity values of these variables are at 37 (2010: Q4), 39 (2011: Q2), 43 (2012: Q2), 55 (2015: Q2) periods; negative sensitivity values are at 4 (2002: Q3) 36 (2010: Q3), 52 (2014: Q3) periods.

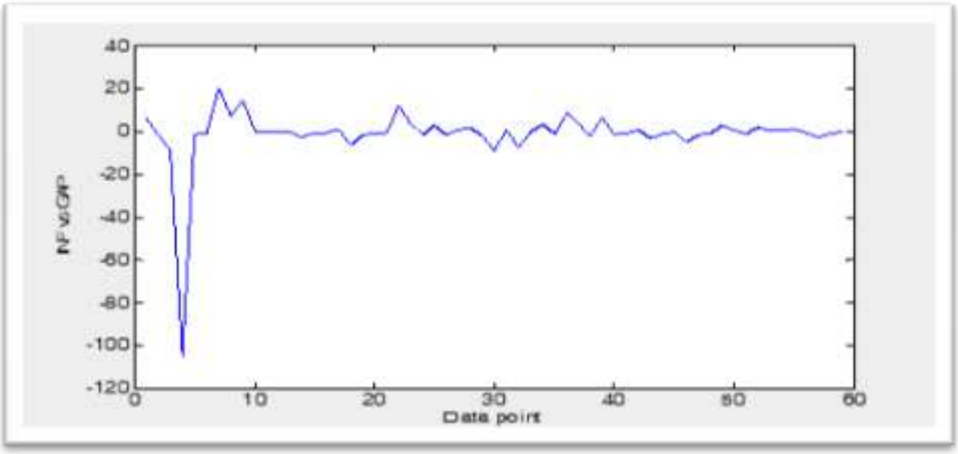

Fig. 8. Relative Sensitivity of the inflation to the GAP

Table 8 shows the relationship between inflation and output gap. Trend of the sensitivity values is positive for these two variables, except for 2002. In 2003: Q2 and 2003: Q4, the relative sensitivity coefficient reached the highest negative values. In this period, while inflation is increasing, production of industrial goods is decreasing. Figures 7 and 8 show that there is a more significant relationship between capacity utilization and inflation than output gap.

CONCLUSION

Correct representation of the output gaps contributes to the correct prediction of inflation. In the literature, large indices of production index are used as output indicators. In the study, it is argued that the capacity utilization ratio is a more effective variable than the industrial production index in measuring the demand pressure. In this context, the relationship between capacity utilization rate, industrial production index, producer prices and inflation expectations and inflation are examined in Turkey using the Vector Autoregressive Model (VAR) and Relative Sensitivity Analyzes for the period 2002-2016. As a result of the study, according to the results of VAR analysis, one-way Granger Causality relationship was found between producer prices, inflation expectations and capacity utilization rate and inflation. This result is consistent with Fin (1996) and Yamak and Zengin (2000). Analysis of variance and impact-response supported Granger's results. Relation between producer prices, inflation expectations and capacity utilization rate are strong. The results of the relative sensitivity analysis show that the sensitivity between inflation, producer inflation and capacity utilization are higer than the industrial production index. These results support that capacity utilization ratio as output gap is more effective indicator than industrial production index for the modeling of the inflation.

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ANNEXES (Annex 1-4)

Annex-1: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-652.0109	NA	27205137	31.30811	31.68335	21.45197
1	-617.9080	39.78847	1316711.	27.99646	32.12409	29.57890
2	-573.3144	40.56850	817518.4	27.24286	32.30859	29.18494
3	-536.4562	42.87850*	821565.0	26.78678	32.79060*	29.08850
4	-499.2207	28.48198	1103881.	26.31618	33.25811	28.97755
5	-402.2355	30.30200	264278.9*	23.54752*	31.42754	26.56853

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

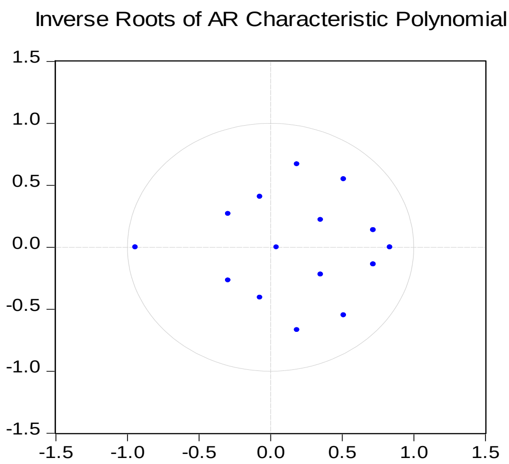
Annex-2: VAR Residual Serial Correlation LM Tests

Lags	LM-Stat	Prob
1	42.50397	0.0159
2	42.10269	0.0175
3	41.79922	0.1296
4	44.46806	0.1576
5	21.22538	0.3800
6	29.64212	0.2380
7	34.13909	0.1050
8	25.44743	0.4375

Probs from chi-square with 25 df.

Annex- 3: Joint test

Chi-sq	df	Prob.
499.4520	480	0.2608



Annex-4: Inverse Roots of AR Characteristic Polynominal