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Enflasyonun Türkiye için Refah Maliyeti

The Welfare Cost of Inflation in Turkey

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ÖZET

Bu çalışma, 1970-2013 yılları arasındaki veri setini kullanarak enflasyonun Türkiye için refah maliyetini Bailey'dan (1956) yola çıkarak tahmin etmektedir. Bu çalışmada, iki çeşit para talebi fonksiyonu tahmin edilecektir. Bunlardan ilki Meltzer'in (1963) log-log para talebi fonksiyonu, diğeri ise Cagan' ın (1956) yarı-logaritmik para talebi fonksiyonudur. Analiz sonuçları, enflasyonun log-log para talebi versiyonuna dayanan refah maliyeti tahmininin Türkiye için daha uygun olduğunu göstermiştir. Enflasyonun yüzde 0'dan yüzde 10'a yükselmesi sonucu, M1 para arzı kullanılarak tahmin edilen refah maliyetinin GSYİH'nın yüzde 0.52'si ve 0.54'ü arasında olduğu güzlemlenmiştir.

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ABSTRACT

This paper follows Bailey (1956) and estimates the welfare cost of inflation in Turkey by using annual data for the period 1970-2013. In this study, two functional form of money demand specifications are estimated: Meltzer's (1963) log-log specification, and (2) Cagan's (1956) semi-log specification. Based on the results of the two competing specifications, it is decided to rely more on the welfare cost measure obtained under the log-log money demand specification. Estimation results suggest that welfare cost generated by an increase in inflation from 0 to 10 percent ranges between 0.52 and 0.54 percent of GDP using M1 as the measure of money.

INTRODUCTION

In economics, the welfare cost of inflation refers to changes in welfare caused by inflation. Inflation causes several economic and social damages, and a decrease in welfare is only one of them. In literature, the effect of inflation on welfare has been subject of extensive theoretical and empirical analysis. "Traditional approach", developed by Bailey (1956), measures the welfare cost of inflation as the area under the inverse demand curve. On the other hand, Lucas (2000) takes "compensating variation approach" in order to estimate the welfare cost of inflation by using general equilibrium model of Sidrauski (1967).

In literature, welfare cost estimates vary remarkably based on the money demand specification chosen. Lucas concludes that log-log specification has a better fit for the U.S. over the period of 1900 to 1994, and the welfare gain from a monetary policy that reduces interest rates from 3 percent to zero, yields a benefit equivalent to an increase in real output of about 0.9%. Unlike Lucas (2000), Ireland (2009) indicates that a semi-log money demand specification performs better than a log-log specification based on the post 1980 U.S. data. He also concludes that an increase in inflation from 0 to 10 percent causes a welfare cost between 0.20% and 0.22% of income. Moreover, Serletis and Yavari (2004) employ log-log specification and estimate the welfare cost for Canada and the U.S. between 1948 and 2001. Reducing the interest rate from 3% to 0% implies a welfare cost equivalent to 0.18% in the U.S. These estimates are significantly lower than Lucas since their estimation of interest rate elasticity (-0.22) is much lower than one imposed by Lucas (-0.50). In addition, reducing the interest rate from 3% to 0% for Canada causes an increase in real income by 0.15%. Serletis and Yavari also indicate that welfare cost estimates for the U.S. based on the "traditional approach" and "compensating variation approach" are very close to each other.

Gupta and Uwilingiye (2008) decide to rely more on the welfare cost measure obtained under the log-log specification of money demand for South Africa, and conclude that the welfare cost of inflation ranges between 0.34% and 0.67% of GDP, for a band of 3 to 6 percent of inflation. Kimbrough and Spyridopoulos (2012) measure the welfare cost of inflation for the case of Greece. They find that the log-log model performs better than the semi-log model, and indicate that the cost of a 10 percent inflation rate lies between 0.58% and 0.91% of income. Serletis and Yaveri (2007) also estimate the welfare cost of inflation in the Eurozone covering the period of 1960 and 2000 by using the log-log functional form of the money demand. They report that the welfare cost of inflation is lower in big countries than it is in small countries. Lopez (2001), on the other hand, estimates the welfare cost of inflation for Colombia and reports that the welfare cost due to an increase of the inlation rate from 10% to 20% are equivalent to about 1% of the GDP.

The main purpose of this study is to derive a money demand function that appropriately fits the money market in Turkey and estimate the welfare cost of inflation based on the Bailey's (1956) approach. For this purpose, annual data over the period of 1970 to 2013 are used. In order to estimate the appropriate long run money demand equation in Turkey, classic ADF unit root and Johansen (1991) cointegration tests are conducted. Then, appropriate long run money demand function is estimated by Dynamic OLS regression since Stock and Watson (1993) show that the dynamic OLS estimates are asymptotically efficient under the assumption of cointegration.

The organization of the article proceeds as follows. The next section provides a brief summary of the theoretical framework of the welfare cost of inflation. Sections 2 and 3 introduce the data definitions and estimation method, respectively while section 4 presents empirical estimates regarding the interest rate elasticity of money demand and welfare cost estimates of Turkey. Finally, last section contains a brief summary and conclusion.

1. Money Demand and Welfare

As stated earlier, the estimation of the welfare cost of inflation is quite sensitive to the specification of the appropriate money demand specification chosen. By following Lucas (2000), two competing specifications for money demand will be analyzed in this study. One is introduced by Meltzer (1963), and relates the natural logarithm of m, the ratio of money balances to nominal income, to the natural logarithm of nominal interest rates i via:

$$m = A i^{-\gamma} \quad \text{and} \quad \ln(m) = \ln(A) - \gamma \ln(i) \tag{1}$$

where A > 0 is a constant and γ > 0 measures the absolute value of the interest rate elasticity of money demand. This specification is also called log-log specification of money demand. The rival specification is adapted from Cagan (1956), and relates the log of m to the level of i via:

$$m = B e^{-\mu i} \quad \text{and} \quad \ln(m) = \ln(B) - \mu i \tag{2}$$

where B > 0 is a constant and μ > 0 measures the absolute value of the interest rate semi-elasticity of money demand. This specification is also called semi-log specification of money demand[1]. Based on Bailey's (1956) approach, the welfare cost of inflation is defined as the area under the inverse function of money demand or the "consumer surplus" that can be gained by reducing the interest rate from positive level (average or steady-state) of i to the lowest possible level (perhaps zero). Now, suppose m = f(i) is the estimated money demand function. Let i=ψ(m) and w(i) denote the inverse function of money demand, and the measure of welfare cost, respectively. Then, welfare cost can be defined as:

$$w(i) = \int_{m(i)}^{m(0)} \psi(x)dx \tag{3}$$

Lucas (2000) defined w(i) as "*fraction of income people would require as compensation in order to make them indifferent between living in a steady state with an interest rate constant at r and an otherwise identical steady state with an interest rate of (or near) zero*" (p. 250). He also shows that when money demand function takes the log-log form, the welfare cost of inflation as a percentage of GDP is obtained as follows:

$$w(i) = A\left(\frac{\gamma}{1-\gamma}\right) i^{1-\gamma} \tag{4}$$

On the other hand, when the money demand takes the semi-log form, the welfare cost of inflation as a percentage of GDP is obtained as follows:

$$w(i) = \frac{B}{\mu}\left[1 - (1 + \mu i)e^{-\mu i}\right] \tag{5}$$

As seen from equations 4 and 5, the estimations of the interest rate elasticities are very crucial to measure the welfare cost of inflation.

2. Data

The data are annual observations for Turkey, and the sample consists of T=44 observations extending from 1970 to 2013. The monetary variable data used in this study are M1, and M1 data were obtained from Federal Reserve Economic Data (FRED). Nominal income data are measured by nominal GDP and obtained from Organisation for Economic Co-operation and Development (OECD). The interest rate data were obtained from "Statistical Indicators 1923-2013" published by Turkish Statistical Institute-TUIK (2014). Further, both the ratio of money balances and the interest rate are transformed into their logarithmic values, and are denoted by ln(m) and ln(i), respectively, for the estimation of the log-log specification.

3. Estimation Method

The estimation methodology applied in this study is Dynamic OLS. As stated by Stock and Watson (1993), the dynamic regression estimates are asymptotically efficient under the assumption of cointegration. In addition, Dynamic DOLS method is a single equation approach which fixes regressor endogeneity by adding lags and leads of first differences of the regressor(s), and it is specified as follows:

[1] Note that income elasticities of money demand in both specifications are assumed to be one.

$$Y_t = \beta_0 + \beta X_t + \sum_{j=-p}^{p} d_j \, \Delta X_{t-j} + e_t \qquad (6)$$

Y_t: dependent variable

X_t: matrix of explanatory variables

p= number of leads and lags

The dynamic regressions for each specification will be estimated based on the general specification (6), and these dynamic regressions are:

$$\ln(m) = \ln A + \gamma \ln(i) + \sum_{j=-p}^{p} b_j \Delta \ln(i)_{t-j} + u_{1t} \qquad (7)$$

$$\ln(m) = \ln B + \mu i + \sum_{j=-p}^{p} c_j \, \Delta i_{t-j} + u_{2t} \qquad (8)$$

Johansen (1991) cointegration methodology is employed to test the cointegration relation for the variables in each specification (1) and (2) being based on the maximum-likelihood estimation technique. Any VAR (Vector Autoregression) with p lags can be written as:

$$\Delta Z_t = v + \Pi Z_{t-1} + \sum_{i=1}^{m-1} \Gamma_i \, \Delta Z_{t-i} + \varepsilon_t \qquad (9)$$

where Z_t is a Nx1 vector of variables, v is a Nx1 vector of parameters, ε_t is a Nx1 vector of disturbances such that ε_t is iid(0, Σ). Suppose that the vector Z_t contains integrated of order one, I(1), variables. When Π has reduced rank $0<r<N$ then it can be expressed as $\Pi=\theta\beta^T$, and both θ and β are Nxr matrices. β is a matrix containing the cointegration vectors.

The first step in the Johansen methodology is to determine the order of integration of each variable. Dickey and Fuller (1979) developed a procedure for testing whether a variable y_t has a unit root or not, and they regress a model of the form:

$$\Delta y_t = \Phi + \psi y_{t-1} + \omega t + \sum_{j=1}^{k} \gamma_j \, \Delta y_{t-j} + \rho_t \qquad (10)$$

where k is the number of lags used in (10), and t is time trend. ADF test involves estimating regression (10) for each series and tests the null hypothesis of a unit root, H_0: $\psi=0$ versus the alternative of a stationary process.

4. Empirical Estimates

The computation of the welfare cost requires estimates of the money demand specifications (1) and (2). As is standard in time series analysis, the statistical properties of the variables are examined using standard Augmented Dickey-Fuller (ADF) (1979) unit root test. The Akaike (1973) Information Criterion (AIC) is used to determine the optimal lag length. KPSS (1992) test is also employed since unit roots tests have poor power characteristics when the process is stationary but with a root it is close to the nonstationary boundary. In order to conduct KPSS test, serial correlation lag length should be selected to calculate a robust estimate of the variance for the error. Table 1 and 2 display results from ADF unit root test and KPSS stationary test, respectively.

Table 1: ADF Unit Root Test Results

		Level		First Differences		
		Lags	ADF T-Stat [%5 Critical Value]	Lags	ADF T-Stat [%5 Critical Value]	Result
ln(m)	Trend and Constant	1	-0.754 [-3.532]	0	-6.233 [-3.532]	I(1)
	Constant	1	-1.417 [-2.952]	0	-6.065 [-2.952]	I(1)
	None	1	0.002 [-1.950]	0	-6.126 [-1.950]	I(1)

ln(i)	Trend and Constant	1	-0.870 [-3.532]	0	-6.226 [-4.224]	I(1)
	Constant	1	-1.442 [-2.952]	0	-5.666 [-2.952]	I(1)
	None	1	-0.101 [-1.950]	0	-5.728 [-1.950]	I(1)
i	Trend and Constant	1	-1.105 [-3.532]	0	-7.099 [-3.532]	I(1)
	Constant	1	-1.378 [-2.952]	0	-6.865 [-2.952]	I(1)
	None	1	-0.705 [-1.950]	0	-6.949 [-1.950]	I(1)

Table 2: KPSS Test Results

Variables	Selected Number of Lags	Test Statistics
ln(m)	0	2.32*
	2	0.825*
	4	0.523*
ln(i)	0	1.28*
	2	0.461**
	4	0.357**
i	0	1.05*
	2	0.389**
	4	0.351**

*Note: * and ** indicate that null of stationarity is rejected at 5 and 10 percent level, respectively.*

According to the ADF test results, the variables in the equations (1) and (2) are integrated of one, I(1). KPSS test also confirms that these series are not stationary at the different lag lengths. Now, Johansen (1991) cointegration test will be employed in order to test the cointegration relation for the variables in each specification (1) and (2).

For this purpose, one lag is included in the VAR for both equations (1) and (2) based on AIC, and it is allowed the level data to have trends. Johansen's (1991) testing procedure starts with the test for zero cointegration equations and then accepts the first null hypothesis that is not rejected. In the case where the null hypothesis of zero cointegration vectors can be rejected, then either equation (1) or equation (2) represents a cointegrating relationship. The results have been reported in Tables 3 and 4.

Table 3: Determination of Rank for Log-log Specification

Null Hypothesis	Alternative Hypothesis	Trace Statistics	%5 critical value
r=0	r=1	23.08	18.17
r=1	**r=2**	**3.14**	**3.8**

Table 4: Determination of Rank for Semi-log Specification

Null Hypothesis	Alternative Hypothesis	Trace Statistics	%5 critical value
r=0	**r=1**	**14.97**	**18.2**
r=1	r=2	1.98	3.74

Trace test under the log-log specification indicates one cointegration equation (r=1) at the 5 percent significance level while it indicates zero cointegration equations (r=0) under the semi-log specification. These results provide statistical evidence in favor of money demand relationship of the log-log specification. Since, ln(m) and i variables are not cointegrated, the estimation of the semi-log specification generates spurious results. In order to test for stability of the VAR model under the log-log specification, and whether or not the number of cointegrating equation has been correctly specified, eigenvalue stability condition is checked. The results indicate that VAR is stable[2].

Now, log-log specification will be estimated by using dynamic OLS. Ireland (2009) states in his paper that "*adding leads and lags of Δln(i) to the estimated equations controls for possible correlation between the log of interest rate ln(i) and the residual from the cointegrating relationship linking ln(m) and ln(i) ; however, any serial correlation that remains in the error term from the dynamic equation must still be accounted for when constructing standard errors for the dynamic OLS estimates.*" (p. 1046). The methodology to compute heteroskedasticity and autocorrelation consistent (HAC) standard errors was developed by Newey and West (1987); thus, they are referred to as Newey-West standard errors. The Newey–West standard errors are used to adjust the covariance matrix of the parameters and produce consistent estimates when there is autocorrelation in addition to possible heteroskedasticity. These standard errors are calculated conditionally on a choice of maximum lag truncation parameter, q. Therefore, dynamic OLS estimates are given by using p leads and lags of Δln(i), and various values of the lag truncation parameter q. Table 5 shows the obtained long-run relationship for the log-log specification.

Table 5: Dynamic OLS Estimates, Log-log Specification

	α_e	γ_e	s.e.(γ_e)	p	q
ln(m)= α – γln(i)	-0.6364	0.6259	0.0552*	1	2
			0.0576*		4
			0.0582*		6
	-0.6274	0.6290	0.0633*	2	2
			0.0593*		4
			0.0568*		6
	-0.6350	0.6287	0.0828*	3	2
			0.0804*		4
			0.0760*		6

*Notes: Table 5 reports α_e and γ_e, the intercept and slope coefficients from the cointegrating vector linking ln(m) and ln(i) obtained from a dynamic OLS regression with p leads and lags on Δln(i). Also, Newey-West standard errors are calculated conditionally on a choice of various values of the lag truncation parameter q. * indicates that slope coefficient is statistically significant at 5 percent significance level.*

The interest rate elasticities estimated by dynamic OLS, in absolute term, is 0.62 based on different p and q. More importantly, the signs of the interest rate elasticities adhere to economic theory. Now, welfare cost of inflation can be estimated for Turkey based on the interest rate elasticities obtained from the log-log specification. The values in Table 5 will be plugged into the corresponding formula for the welfare cost measures, given by equation (4) by using the fact that the average real rate of interest[3] over the sample period is equal to 15 percent. Thus, a zero rate of inflation would imply a nominal rate of interest equal to 15 percent. Assuming that the average real rate of interest is 15 percent, i=0.18

[2] The result is available from the author upon request.

[3] The real rate of return is defined to be equal to the difference between the nominal interest rate and the inflation rate. Inflation rate is obtained as the percentage change in the GDP deflator. GDP Deflator (1987=100) data are obtained from "Statistical Indicators 1923-2013" published by Turkish Statistical Institute-TUIK (2014).

corresponds to a 3 percent annual inflation, i=0.21 corresponds to a 6 percent annual inflation while i=0.25 corresponds to a 10 percent annual inflation.

Table 6 displays the measures of the welfare costs of inflation under the log-log specifications for the annual inflation rates of 0, 3, 6 and 10 percent based on the regression results obtained from Table 5. For an inflation rate of 0 percent, the cost of inflation ranges between are 0.43 and 0.44 percent of GDP. Moreover, the welfare cost generated by an increase in inflation from 0 (also called price stability) to 10 percent ranges between 0.52 and 0.54 percent of GDP using M1 as the measure of money.

Table 6: Welfare Cost of Inflation (Percent of GDP), Turkey

			w(i)			
Dynamic OLS Regression	$A=\exp(\alpha_e)$	$\gamma = \gamma_e$	Zero percent inflation w(0.15)	Three percent inflation w(0.18)	Six percent inflation w(0.21)	Ten percent inflation w(0.25)
p=1	0.5291	0.6259	0.435	0.466	0.493	0.527
p=2	0.5339	0.6290	0.447	0.479	0.507	0.541
p=3	0.5299	0.6287	0.443	0.474	0.502	0.536

CONCLUSION

In this paper, two competing specifications for money demand are analyzed. Based on Bailey's (1956) traditional approach, the welfare cost of inflation is defined as the area under the inverse demand function or the "consumer surplus" that can be gained by reducing the interest rate from average level of i to the lowest possible level. This paper uses the Johansen (1991) cointegration technique to obtain an appropriate long-run money demand relationship for Turkey. Based on the cointegration results, it is found that the log-log specification of money demand performs better than the semi-log specification. Hence, welfare cost of inflation is calculated based on the estimation of the log-log inverse money demand specification. Estimation results suggest that welfare cost generated by an increase in inflation from 0 to 10 percent ranges between 0.52 and 0.54 percent of GDP using M1 as the measure of money. The result is significantly higher than one obtained by Lucas (2000), Ireland (2009), and Serletis and Yavari (2004) for the U.S. However, it is consistent with Serletis and Yavari (2007) concluding that the welfare cost of inflation is lower in big countries than it is in small countries. Also, absolute value of the interest rate elasticity of money demand is estimated around 0.62.

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