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The Calculation of Weighted Price Elasticity of Tax: Turkey (1998-2013)

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Abstract

In this study, the assumption of "the weighted price elasticity of tax is a unit in the developing countries" suggested in the first studies which examine the impacts of the inflation on tax revenues, will be reevaluated for Turkey in the period of 1998-2013. We use Turkish tax and price index data for calculating the weighted price elasticity of tax. Via the method of dynamic ordinary least squares (DOLS), the long run weighted price elasticity of tax system is guessed. The importance of this study is the fact that this is first study intended to the calculation of the weighted price elasticity of tax for Turkey. In this sense, it will be instructive study for the reconsideration of the assumption of "the weighted price elasticity of tax is a unit in the developing countries".

Keywords: Tanzi Effect, Weighted Price Elasticity of Tax, Taxation.
JEL Classification Codes: H20, H24, H30.

Verginin Ağırlıklandırılmış Fiyat Elastikiyetinin Hesaplanması: Türkiye (1998-2013)

Öz

Bu çalışma içerisinde, enflasyonun vergi gelirleri üzerindeki etkilerini inceleyen ilk çalışmalarda ortaya konulan, "gelişmekte olan ülkelerde verginin ağırlıklandırılmış fiyat elastikiyetinin birim olduğu" varsayımı Türkiye için 1998 -2013 periyodu için yeniden değerlendirilecektir. Ağırlıklandırılmış fiyat elastikiyetinin hesaplanmasında Türk vergi gelirleri ve fiyat endeksleri verileri kullanılmıştır. Dinamik En Küçük Kareler (DOLS) yöntemiyle, vergi sisteminin uzun dönem ağırlıklandırılmış fiyat elastikiyeti tahmin edilmiştir. Çalışmanın önemi Türkiye için verginin ağırlıklandırılmış fiyat elastikiyetini hesaplamaya yönelik ilk çalışma olmasıdır. Bu anlamda "gelişmekte olan ülkelerde verginin ağırlıklandırılmış fiyat elastikiyetinin birim olduğu" varsayımının yeniden gözden geçirilmesi için yol gösterici bir çalışma olacaktır.

Anahtar Kelimeler: Tanzi Etkisi, Verginin Ağırlıklandırılmış Fiyat Elastikiyeti, Vergilendirme.
JEL Sınıflandırma Kodları: H20, H24, H30.

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1. Introduction

Julio Olivera is the person who dealt with the impacts of the inflation on tax revenues for the first time (Olivera, 1967). The Brazilian economist theorized that the high inflation can deteriorate the real value of the tax revenues. While making the criticism of chronic inflation experienced by Latin American countries during 1950 and 1960s, Olivera has mentioned the length of tax collection period and claimed that the inflation could reduce the real value of tax revenues; and as a result, the inflationary financing can even increase the budgetary deficit rather than decreasing it (Şen, 2003).

Olivera's thoughts had formed the basis of Vito Tanzi's studies in 1977 and 1978. Tanzi tried to specify the average tax collection period in Argentine and examined the erosive impact of high inflation on the real value of tax revenues. Having found out some facts in his studies which support Olivera's thesis; Tanzi states that inflation has negative impacts on the tax revenues in developing countries (Şen, 2003). This situation which is seen among the developing countries in the period after 1980, has taken part in the economics literature as "Olivera- Tanzi Effect".

The title of Tanzi's first article is: "Inflation, Lags in Tax Collection, and the Real Value of Tax Revenue". The main objective of the article is to demonstrate the fact that the thought of positive impacts of the inflation on the tax revenues cannot be valid apart from some exceptional cases to the economic thinking. Tanzi (1977) claims, the fact that inflation decreases the tax revenues, is valid for the economies in which the tax collection period is long and the tax system is not elastic. The writer explains the impact of inflation on tax revenues with the lags in tax collection, the elasticity of tax, the tax incidence in the beginning, and the inflation rate.

While calculating the impact of inflation on tax revenues, Tanzi indicates that the weighted price elasticity of tax is a unit in the developed countries. He states that weighted price elasticity of tax system in developing countries is a unit when the taxes with the high and the low price elasticity are considered together.

About the Tanzi Effect in Turkey, four different studies (Gürbüzer, 1997; Şen, 2003; Çavuşoğlu, 2005; Beşer, 2007) are found. These studies are analyzed in details. Following these analysis, it is found that the writers assumed that this elasticity as a unit rely on the elasticity assumption of Tanzi. In this regard, it is clear that the results of the studies would be insufficient in the case that the elasticity unit assumption is not valid. In our study, this will be econometrically analyzed, in the example of Turkey, whether the weighted price elasticity of tax is a unit or not.

2. Application

In his studies, Tanzi (1978) indicates that the weighted price elasticity of tax in the developing countries is equal to or smaller than unit; and he uses the elasticity as a unit in his calculations. In this study; this assumption will be tested for the main tax items in Turkey. For 2013, the major part of tax revenues is obviously provided from the goods and services purchased in the country. As is known, these taxes are value added tax and private consumption tax. 41.4% of total tax revenue is collected through these indirect taxes. Income tax, which is classified as direct tax, is at the level of 19.3%; on the other hand, the corporation tax is at the level of 9.4 %. As a conclusion, the aforementioned three taxes cover 70% of the total tax revenue. The tax which is collected on international trade is also wanted to be included in the analysis; however, because of the reason that this tax is related to external price level, the idea is given up.

Firstly**,** we investigate the stationary level of these series with ADF and Ng-Perron testing procedures. If these series are stationary in the same level, we can use Johansen procedure for modeling relationship in the long run. Co-integration relations give short and long run relationship between two or more series (Lütkepohl, 2004).

In order to estimate the cointegrating vector (long–run equilibrium relationship) several methods have been proposed in the literature. These are: Ordinary Least Squares (Engle & Granger, 1987), Non-Linear Least Squares (Stock, 1987), Principal Components (Stock & Watson, 1988), Canonical Correlations (Bossaerts, 1988), Maximum Likelihood in a fully specified error correction model (Johansen, 1988). Philips (1991) and Gonzalo (1994) show that the best way to proceed in the estimation of cointegrated system is the full system estimation by maximum likelihood. Similar workings on calculating income elasticity of tax revenues used co-integration methodology. For instance, Koester (2012) used this methodology in estimating income elasticity of tax for Germany, Cardenas (2008) and Fonseca (2011) used this methodology estimating income elasticity of tax for México.

The Johansen method is exposed to the problem that the estimated parameters in one equation are affected by any misspecification in other equations. The Stock Watson method, by contrast, is a robust single equation approach which corrects for endogeneity in the regressors. (Stock & Watson, 1993). Azzam & Hawdon (1999) used this methodology in estimating demand for energy in Lubnan & Masih (1996) used this method for calculation of the long run price and income elasticity of coal demand in China.

When we obtain single cointegrating vector in the set of the variables, we can use Dynamic OLS (DOLS) in estimating the long run parameter of the price elasticity in following form.

B= [c, α], X= [1, P]

$$T_t = B'X_t + \sum_{j=J}^{j=-J} \eta_j \Delta P_{t-J} + \zeta_t \quad (1)$$

In this form, T is tax revenue and P is price index. We use the Dynamic OLS(DOLS) method, concerning regressing any I(1) variables on other I(1) variables and lags of the first differences of any I(1) variables. We use the statistical program E-Views 8 in calculations.

3. Calculation

3.1. Calculation of Price Elasticity of Income Tax

2004-2013 period monthly data are used in the calculation of price elasticity of income tax. While it is possible to lead to the detailed statistics concerning tax revenues in Turkey back to 1980, indexes in price statistics become most right starting with the series based on 2003. Income tax data are obtained from Revenue Administration Department. Price data are obtained from TurkStat price index data (TUFE) based on 2003 prices.

The seasonality on monthly data was adjusted firstly through weighted-averages method and then their logarithmic values were figured. Johansen Co-integration method was used to indicate the long-term relation between two variables. In order to apply this method, the stationary of the series was examined at first. The availability of econometrically significant relations between the variables depends on the fact that the analyzed series do not have a strong trend. In other words, the series should be stationary in order to make right inferences about the structure of the series that are observed in time series analysis.

Table 1: ADF and Ng – Perron Unit Root Test Results [LNGSM – LNFSM]

ADF TEST RESULTS			**NG – PERRON**			
Variable	**ADF Test**	**P-Value**	**MZa**	**MZt**	**MSB**	**MPT**
LNGSM	-2.10	0.53	-1.28	-0.78	0.61	69.36
Δ LNGSM	-22.84**	0.00	-78.99	-6.28	0.07	1.15
LNFSM	-1.98	0.60	-7.10	-1.72	0.24	13.07
Δ LNFSM	-7.04**	0.00	-57.50	-5.30	0.09	1.85
** significant at 5%;						
NG PERRON Critics Values %5 Fixed+Trend : [MZa]:-17.30, [MZt]:-2.91, [MSB]: 0.17, [MPT] :5.48						

Following ADF and Ng-Perron tests (Table 1), it is concluded that the two series (LNGSM: Seasonally adjusted logarithm-calculated income tax series, LNFSM:

Seasonally adjusted logarithm-calculated price series) are stationary at first differences. In order to apply Johansen co-integration method, it should be examined whether the two series are stationary at the same degree or not. In Johansen methodology, co-integration relation between the nonstationary series is analyzed by means of Trace test. Because Johansen analysis is sensible to the selection of lag length, the proper lag length is determined as one, regarding Schwarz criterion.

Table 2: Cointegration Trace Test [LNGSM – LNFSM]

	Eigenvalue	Trace Stat	Prob**
None	0.259280	36.61415	0.0000
At most 1	0.012727	1.498617	0.2209
** significant at 5%;			

At least one vector defining co-integration relation (Table - 2) between seasonally adjusted logarithm-calculated income tax series (LNGSM) and seasonally adjusted logarithm-calculated price series (LNFSM) is found. When we obtain single cointegrating vector in the set of the variables, we can use Dynamic OLS (DOLS) in estimating the long run parameter of the price elasticity. We obtain numerical value which is consistent with theory. According to this, a change of 1% in the price level causes a change of %1.64 in income tax collection. As a natural outcome of the fact that the tax revenue is progressive and that tax brackets are adjusted every year at the level of increasing prices, this coefficient is higher than the unit elasticity.

3.2. Calculation of Price Elasticity of Corporation Tax

2004-2013 period monthly data will be used in the calculation of price elasticity of corporation tax. Corporation tax data are obtained from Revenue Administration Department. Price data are obtained from TurkStat price index data (TUFE) based on 2003 prices. The seasonality on monthly data are adjusted firstly through weighted-averages method and then their logarithmic values have been figured.

Table 3: ADF and Ng – Perron Unit Root Test Results [LNKUSA – LNFSA]

ADF TEST RESULTS			NG - PERRON			
Variable	**ADF Test**	**P-Value**	**MZa**	**MZt**	**MSB**	**MPT**
LNKUSA	-2.92	0.15	-11.95	-2.37	0.19	8.02
Δ LNKUSA	-18.45**	0.00	-153.01	-8.73	0.05	0.65
LNFSA	-2.21	0.47	-7.61	-1.82	0.23	12.28
Δ LNFSA	-9.53**	0.00	-57.57	-5.32	0.09	1.75
** significant at 5%;						
NG PERRON Critics Values %5 Fixed+Trend : [MZa]:-17.30, [MZt]:-2.91, [MSB]: 0.17, [MPT] :5.48						

Following ADF and Ng-Perron tests (Table 3), it can be concluded that the two series (LNKUSA: Seasonally adjusted logarithm-calculated corporation tax series, LNFSA: Seasonally adjusted logarithm-calculated price series) are stationary at first differences. Regarding Schwarz criterion, the appropriate lag length is determined as one.

Table 4: Cointegration Trace Test [LNKUSA – LNFSA]

	Eigenvalue	Trace Stat	Prob**
None	0.390428	59.14035	0.0000
At most 1	0.010420	1.225586	0.2683
** significant at 5%;			

At least one vector defining co-integration relation (Table-4) between seasonally adjusted logarithm-calculated corporation tax series (LNKUSA) and seasonally adjusted logarithm-calculated price series (LNFSA) was found. When we obtain single cointegrating vector in the set of the variables, we can use Dynamic OLS (DOLS) in estimating the long run parameter of the price elasticity. We obtain numerical value which is consistent with theory. According to this, a change of 1% in the price level causes a change of %1.04 in corporation tax collection. This elasticity value is the natural outcome of the fact that the corporation tax is proportional.

3.3. Calculation of Price Elasticity of Indirect Tax

2004-2013 period monthly data will be used in the calculation of price elasticity of indirect taxes. Indirect taxes are obtained from Revenue Administration Department. Indirect taxes are charged with their real value. PPI price index (UFE) is used in the calculation of the real values of indirect taxes. We use their real values in order to reduce high volatility. Price data are obtained from TurkStat price index data (TUFE) based on 2003 prices. The seasonality seen on monthly data are adjusted through weighted-averages method and then their logarithm-calculated values have been figured.

Table 5: ADF and Ng – Perron Unit Root Test Results [LNRDVSA – LNFSA]

ADF TEST RESULTS			NG - PERRON			
Variable	**ADF Test**	**P-Value**	**MZa**	**MZt**	**MSB**	**MPT**
LNRDVSA	-2.39	0.37	-10.57	-2.29	0.21	8.61
Δ LNRDVSA	-21.26**	0.00	-70.14	-5.92	0.08	1.29
LNFSA	-2.21	0.47	-7.61	-1.82	0.23	12.28
Δ LNFSA	-9.53**	0.00	-57.57	-5.32	0.09	1.75
** significant at 5%;						
NG PERRON Critics Values %5 Fixed+Trend : [MZa]:-17.30, [MZt]:-2.91, [MSB]: 0.17, [MPT] :5.48						

Following ADF and Ng-Perron tests (Table 5), it is concluded that the two series (LNRDVSA: Seasonally adjusted logarithm-calculated indirect taxes' series, LNFSA: Seasonally adjusted logarithm-calculated price series) are stationary at their first differences. Regarding Schwarz criterion, the appropriate lag length is determined as 3.

Table 6: Cointegration Trace Test [LNRDVSA – LNFSA]

	Eigenvalue	Trace Stat	Prob**
None	0.239030	34.23517	0.0000
At most 1	0.024237	2.821586	0.1100
** significant at 5%;			

At least one vector defining co-integration relation (Table-6), between seasonally adjusted logarithm-calculated indirect taxes' series (LNRDVSA) and seasonally adjusted logarithm-calculated price series (LNFSA) is found. When we obtain single cointegrating vector in the set of the variables, we can use Dynamic OLS (DOLS) in estimating the long run parameter of the price elasticity. We obtained lower numerical value than unit, but this value is valid for theoretical concept. According to this, a change of 1% in the price level causes a change of % 0.61 in indirect taxes collection. The fact that the indirect taxes are not suitable for price adjustments causes the weighted price elasticity of tax to be equal to or smaller than unit elasticity.

Indirect taxes are collected through specific rates and it is not possible to change these rates in relation to price changes. The coefficients are generally found to be close to the expected values. The price elasticity of income tax has a higher value comparing to other taxes. This is the natural outcome of the fact that the income tax is progressive. As expected, the elasticity of corporation tax and indirect taxes are found to be close (or less than) to the unit. Through weighting the share of tax items from 1998 to 2013 within total tax collection with the elasticities of tax items, the price elasticity is calculated from this equation.

$$e = \frac{Tgv}{Tt}\left(\frac{\Delta Tgv}{\Delta \mathrm{p}}\frac{p}{Tgv}\right) + \frac{Tkv}{\mathrm{Tt}}\left(\frac{\Delta Tkv}{\Delta \mathrm{p}}\frac{p}{Tkv}\right) + \frac{\Delta Tdv}{\Delta \mathrm{Tt}}\left(\frac{\Delta Tdv}{\Delta \mathrm{p}}\frac{p}{Tdv}\right) \quad (2)$$

e : The weighted price elasticity of tax

T_t : Total tax revenues

T_{gv} : Income tax revenues

T_{kv} : Corporate tax revenues

T_{dv} : Indirect tax revenues

p : Price index (TUFE)

The weighted price elasticity of tax is figured in Figure 1.

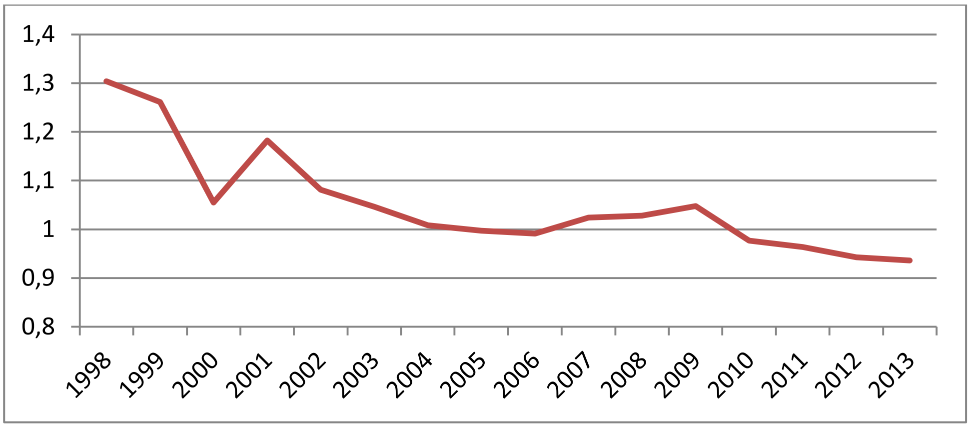

Figure 1: Weighted Price Elasticity of Tax for Turkey (1998–2013)

The weighted price elasticity of tax in the period of 1998 - 2013 is as seen in Figure 1. The most important reason of this reduction is that the increase in the weight of the indirect taxes with low elasticity and the decrease in the weight of the direct taxes with high elasticity in Turkish Tax System. In Figure 2, it is clearly seen that indirect taxes are increased in 1998, 2001 and 2008 crises. The weighted price elasticity of tax is decreased in the period of 1998-2013.

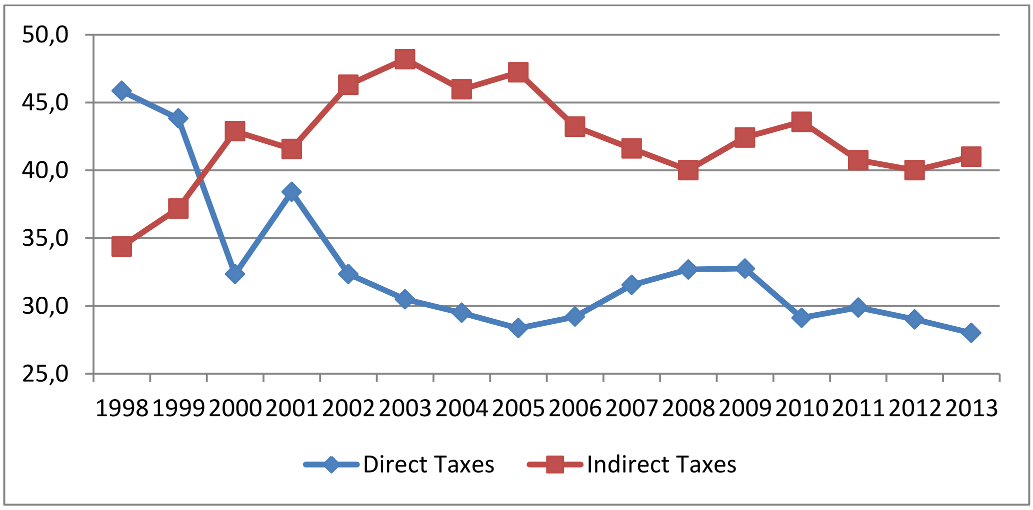

Figure 2: Direct and Indirect Taxes / Total Tax Revenues (1998–2013)

4. Conclusion

As a result of the econometric study involving 1998 – 2013 period, it is found that the price elasticity of income tax, corporation tax and indirect taxes are respectively 1.64, 1.04 and 0.61. By weighting the elasticity of these taxes with the share of the same revenues within the total tax revenues, the numbers of weighted price elasticity of the tax system are figured. After 1998, the weighted price elasticity of tax gradually decreased; while it was 1.3 band in 1998, it was carried forward to 1.1 band in the beginning of 2000s; and then backward to 0.95 band starting from 2013. This resulted from the decrease in the share of direct taxes within the total tax revenues. For 2013, a change of one unit in price results in an increase in tax revenues by the same level. Within the frame of these conclusions, it is found that the weighted price elasticity of tax in Turkey was not a unit and underwent a change in time; and it is seen that the studies determining this elasticity as unit in Turkey and developing countries are insufficient.

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