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Rafik A. Aliev · Janusz Kacprzyk ·
Witold Pedrycz · Mo Jamshidi ·
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Evaluation of the Tax Policy Efficiency Under Uncertainty

Aygun A. Musayeva[1,2], Shahzada G. Madatova[3,4(✉)], Yashar A. Mammadov[5], Alislam I. Gasimov[6], and Kamala N. Ahadova[6]

[1] ANAS Institute of Control Systems, B. Vahabzadeh str. 9, Baku AZ1141, Azerbaijan
aygun.musayeva@gmail.com
[2] The Azerbaijan University, J. Hajibeyli str. 71, AZ1007 Baku, Azerbaijan
[3] Training Centre of Ministry of Taxes of the Republic of Azerbaijan, Agha Nematullah str. 44, Baku AZ1033, Azerbaijan
shahzademedetova@gmail.com
[4] Azerbaijan State University of Oil and Industry, Azadlig ave. 34, Baku AZ1000, Azerbaijan
[5] ANAS Institute of Economy, H. Javid ave. 115, Baku AZ1143, Azerbaijan
mammadov60@mail.ru
[6] Azerbaijan State University of Economics (UNEC), Istiglaliyyat str. 6, Baku AZ1001, Azerbaijan
alislam.qasimovl23@gmail.com, kamalaahadova@gmail.com

Abstract. The tax burden factor of the economy is of great importance for the formation of an effective economy policy. At the same time, as it is known, when the state implements its economic functions, it has to change some of social and economic factors. This, in some cases, this may cause the tax burden to change negatively so that, it can have a significant impact on economic activity. The consumption norm, average tax burden, economic growth rate and dependence of the GDP on the structural effectiveness of the state tax policy efficiency have been evaluated through the interval analysis in the paper.

Keywords: Tax policy efficiency · Interval mathematics · Samuelson model · Macroeconomic indicators

1 Introduction

Depending on some issues of state economic policy efficiency, there are different approaches. There are such norms as population living standards, population satisfaction, social inclusiveness and others which are protected on the basis of the state economy policy, so that the state permanently controls these norms. At the same time, quantitative expressions of these norms cannot be determined by equal value. Usually, the consumption norm is determined as a result of the housekeeping survey during population census and by taking into account the physiological needs of the consumer. Other above-mentioned norms are determined by taking into account the dynamic

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sequences created by economic targets and previous experiences and they are expressed by exact cost coefficients in the inter-sectoral balance model of the economy (Leontev's model) [1, 2]. Another approach to determine these norms is an expert evaluation. Especially, the Delphi method is more widely used [3]. The above-mentioned norms were investigated in Samuelson [4], Solow [5, 6], Harrod - Domar [7] models. For the first time, in [8], the single-factor correlations of the norms were evaluated in the real number abundance. In [9], the single-factor correlations of the norms were investigated by applying interval mathematics, which is one of the means taking into account both real number abundance and uncertainty. Davudova obtained mathematical relations expressing multifactorial correlations of the norms and these dependencies were evaluated both by the real number abundance and interval analysis [10].

In some cases, the state has to increase public expenditures in order to implement its economic functions. This requires increasing the state budget revenues, i.e. tax revenues. Increasing tax revenues raises the tax burden of the economy. This weakens economic activity and thus, a closed chain is formed. Therefore, the same logic can be said about the other norms mentioned above. Hence, economy policy institutes of the state have to take into account the changing legitimacy of the other norms mentioned above during the measure which is being implemented connected with the change of each norm.

2 Problem Statement

In this paper consumption norm, average tax burden, economic growth rate of the tax policy efficiency and dependence of the GDP on the structural effectiveness have been studied by applying interval mathematics based on the open economy model in which P. Samuelson's balance of payments is not equal to zero. The lower and upper boundaries of the macroeconomic indicator norms have been determined by the Delphi method and computational experiments were conducted in Matlab environment. The visual graphics of both points and interval values of the results are presented (Table 1).

Let's consider Samuelson's GDP expense structure model in order to write a standard model of the open economy system:

$$Y = C + I + G + \varepsilon(Ex - Im) = C + I + G + \varepsilon B \tag{1}$$

is known to be in this form, so, here Y is gross domestic product, C is consumption, I is investment costs, G is state expenditures, Ex is export, Im is import, ε is price and $B = X = Ex - Im$ is net export – payment balance. If $c = {}^{C}/_{Y}$e housekeeping consumption rate, $s = {}^{I}/_{Y}$ investment norm, $g = {}^{G}/_{Y}$ state expenditures rate, $b = {}^{B}/_{Y}$Y payment balance norm are marked

$$c + s + g + \varepsilon b = 1 \tag{2}$$

Let's express tax revenues with T, and average tax burden with $\theta = {}^{T}/_{Y}$. Let's choose the efficiency indicator of the state tax policy as $\tau = \frac{\Delta Y}{T} = \frac{F}{\theta}$, efficiency of the consumption costs policy as $\xi = \frac{\Delta Y}{C}$, efficiency of investment policy as $S = \frac{\Delta Y}{I}$, the

efficiency of the state expenditures policy as $R = \frac{\Delta Y}{G}$ and the efficiency of foreign trade policy as $\beta = \frac{\Delta Y}{\varepsilon B}$.

The following formula [10] can be used for the purpose of evaluating:

$$\begin{cases} \tau = \frac{\Delta Y}{T} = \frac{F}{\theta};\ \xi = \frac{\Delta Y}{C} = \frac{F}{c};\ S = \frac{\Delta Y}{I} = \frac{F}{s};\ R = \frac{\Delta Y}{G} = \frac{F}{g};\ \beta = \frac{\Delta Y}{\varepsilon B} = \frac{F}{\varepsilon b} \\ \tau(\theta) = F(\theta)/\theta = \left[\theta/(1+\theta) - \varepsilon b\right]^2/\theta \\ \tau(c) = F(c)/\theta(c) = [1-c-\varepsilon b]^2(1+c-\varepsilon b)/4\,(1-c+\varepsilon b) \\ \tau(F) = F/\theta(F) = F\left(1-\sqrt{F}-\varepsilon b\right)/\left(\sqrt{F}+\varepsilon b\right) \\ \tau = F(\psi)/\theta(\psi) = \left[\frac{1}{\psi} - \varepsilon b\right]^2 \times (\psi(2+\varepsilon b)-1)/4(1+\psi\varepsilon b) \end{cases} \tag{3}$$

$$\varepsilon = \frac{1}{b}\left[\frac{\theta}{1+\theta} - \sqrt{\tau(\theta)\theta}\right] \tag{4}$$

As exchange rate policy and fiscal policy are important policies of the state, determining the interrelationship between them is one of the important problems. In this paper, the dependence between the exchange rate policy and fiscal policy has been determined with formulation (4). The interrelationship between exchange rate policy and consumption cost policy, investment policy and public expenditure policy, respectively, were also defined (Table 2). Practical calculations related to the analysis of these dependencies will be implemented in our next studies.

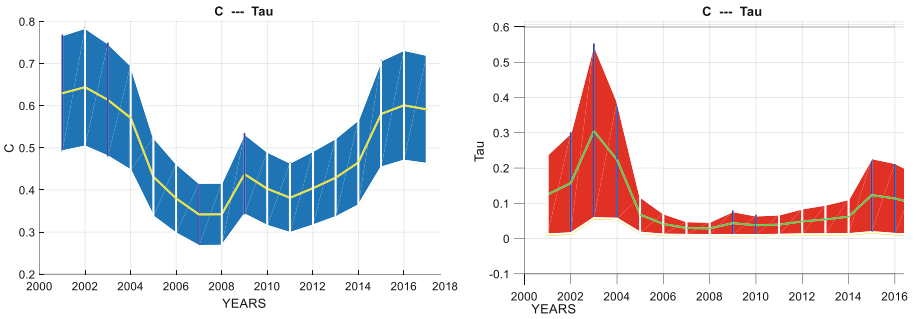
Table 1. The values of $\boldsymbol{c}$,$\boldsymbol{\theta}$, $\boldsymbol{F}$ and $\boldsymbol{\psi}$ determined by Delphi survey method.

Years	$\boldsymbol{c}$		$\boldsymbol{\theta}$		$\boldsymbol{F}$		$\boldsymbol{\psi}$	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
2001	0.49	0.77	0.12	0.20	0.10	0.16	1.69	2.60
2002	0.50	0.78	0.12	0.20	0.11	0.17	1.40	2.15
2003	0.48	0.75	0.14	0.23	0.14	0.22	1.21	1.89
2004	0.45	0.70	0.14	0.24	0.16	0.24	1.05	1.61
2005	0.34	0.53	0.13	0.22	0.38	0.58	0.94	1.45
2006	0.30	0.46	0.17	0.28	0.40	0.61	0.91	1.40
…	…	…	…	…	…	…	…	…
2015	0.45	0.71	0.26	0.43	0.06	0.10	1.10	1.68
2016	0.47	0.73	0.23	0.39	0.09	0.14	1.21	1.86
2017	0.46	0.72	0.19	0.32	0.13	0.20	1.29	1.98

Source: The table was compiled by the authors.

3 The Results of Calculations and Their Graphic Descriptions

The change dynamics in consumption norms, tax burden, economic growth rates and generalized structural efficiency and in accordance with these efficiency of the state tax policy are presented according to the following years (Figs. 1, 2, 3 and 4):



a) b)

Fig. 1. Dependences of the state tax policy efficiency on the consumption norms (a) Consumption rate of interval of change (b) The interval of change of tax policy efficiency.

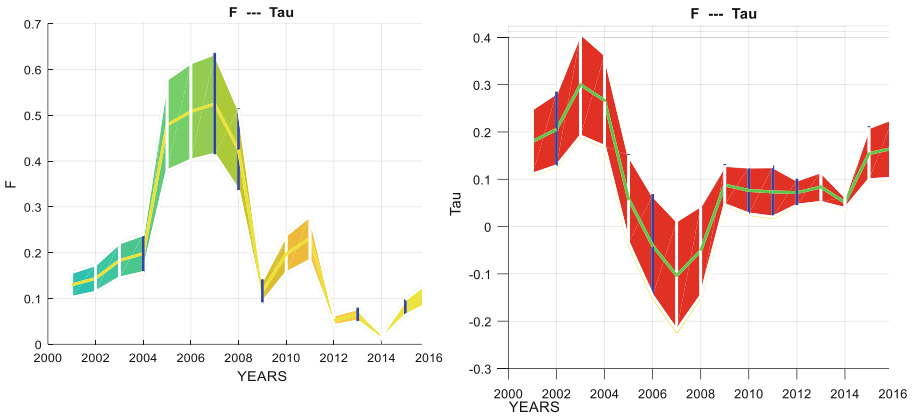
a) b)

Fig. 2. Dependences of the state tax policy efficiency on the average tax burden (a) Interval of change of the average tax burden (b) Interval of change of tax policy efficiency.

Table 2. The values calculated based on the efficiency of the state tax policy (τ), consumption norm (c), average tax burden (θ), economic growth rate (F) and GDP structure efficiency (ψ).

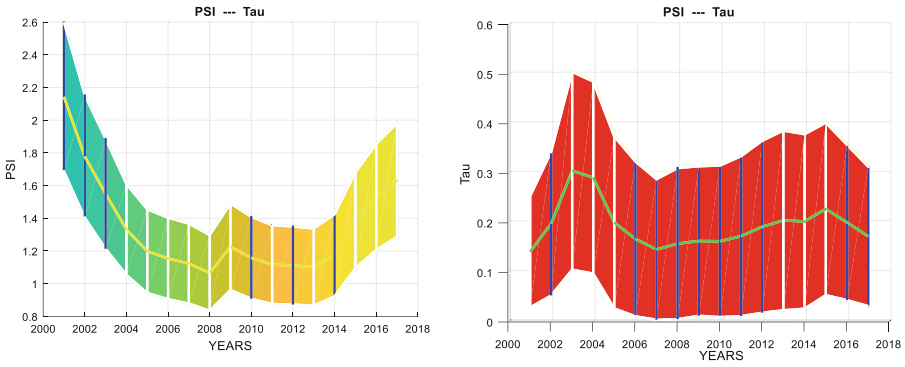
Years	τ		$\tau(c)$		$\tau(\theta)$		$\tau(F)$		$\tau(\psi)$	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
2001	0.51	1.31	0.005	0.23	−0.03	0.07	0.09	0.23	0.03	0.25
2002	0.56	1.43	0.008	0.29	0.00	0.11	0.11	0.26	0.05	0.34
2003	0.63	1.60	0.051	0.54	0.07	0.35	0.17	0.39	0.10	0.50
2004	0.66	1.67	0.048	0.38	0.04	0.26	0.15	0.34	0.10	0.48
2005	1.71	4.36	0.007	0.11	0.00	0.30	−0.05	0.14	0.03	0.37
2006	1.45	3.68	0.001	0.06	0.01	0.64	−0.16	0.05	0.01	0.32
…	…	…	…	…	…	…	…	…	…	…
2013	0.11	0.29	0.003	0.09	−0.08	0.12	0.03	0.09	0.02	0.39
2014	0.03	0.07	0.004	0.10	−0.08	0.08	0.01	0.04	0.03	0.38
2015	0.15	0.37	0.011	0.22	0.00	0.25	0.08	0.19	0.05	0.40
2016	0.23	0.59	0.006	0.21	0.00	0.20	0.08	0.21	0.04	0.36
2017	0.41	1.05	0.003	0.17	−0.04	0.11	0.07	0.21	0.03	0.31

Source: The table was compiled by the authors.



a) b)

Fig. 3. Dependences of the state tax policy efficiency on GDP growth rates (a) Interval of change of GDP growth rate (b) Interval of change of tax policy efficiency.



a) b)

Fig. 4. Dependence of the state tax policy efficiency on GDP structure efficiency (a) Interval of change of GDP structure efficiency (b) Interval of change of tax policy efficiency.

4 Conclusion

The interval analysis of the state tax policy efficiency has been carried out through interval mathematics by applying the relations and the values of macroeconomic indicators for the Republic of Azerbaijan in 2001–2017s using the Delphi survey method in order to investigate the dependence of the state tax policy efficiency on some macroeconomic indicators. As a result of these calculations, it was determined that,

- there is a direct dependence between housekeeping consumption rates (c) and the state tax policy efficiency (τ), i.e. the increase (decrease) in c leads to the increase (decrease) in τ. In addition, the state tax policy efficiency obtained its largest interval value in 2003, and the narrowest one in 2007.
- the average tax burden (θ) decreased in 2004–2005, 2009–2010, 2013–2014, 2015–2017, and increased during the rest of the research period. Using the dependence between the average tax burden and the state tax policy efficiency, the decrease in the state tax policy efficiency was observed in 2003–2005, 2007–2009, 2010–2014 and 2015–2017;
- There is an inverse dependence between the economic growth rate (F) and the state tax policy efficiency (τ);
- The structural efficiency of GDP increased in 2008–2009 and 2013–2017, while it decreased during the remaining period. Depending on this, the state tax policy efficiency decreased in 2003–2007 and 2015–2017. The structural efficiency of the GDP and the interval of change in the state tax policy efficiency almost did not change.

As a result, it should also be mentioned the interrelationship formulations between exchange rate policy and fiscal policy, consumption cost policy, investment policy, public expenditure policy, respectively, that have been defined in this paper.

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