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THE IMPACT OF TAXES ON THE CONSUMPTION TO INCOME RATIO

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Abstract. *This article, in the statistical analysis of possible cointegration relationships among the variables from the expenditure approach to the GDP formula, explains how taxes affect the consumption to income ratio. A causal relationship that defines investment as the leading factor in GDP formation was rearranged and applied for the study of taxation effects under various income levels. The technique that was used for the estimation of taxation effects was based on the deterministic part of causal relationship, though the results must be interpreted very carefully. This analysis demonstrates that, when taken to the extreme, higher taxes have a huge negative effect on consumption and a very small effect on savings; in addition, these effects depend on the level of income. The higher the incomes are, the more deteriorating the effects of taxes on consumption can be observed; therefore, an economy cannot afford a high level of taxes, even when the income level is also high. As taxes have negative effects on consumption and, with lesser extent, on savings, tax-based fiscal consolidation has to be avoided at any cost, and governments should rely on tax-based fiscal consolidation only if no other option is available.*

Keywords: *Consumption, Savings, Taxes, Granger causality, Cointegration.*

1. Introduction

Taxes are one of the most popular instruments of the politicians. In good times, when the economy is booming, politicians and bureaucrats tend to lower taxes, or at least they start and initiate a media debate about the revision of taxes. In bad times, when the economy is in a slump and the resources are scarce, they do the opposite – they raise taxes for the sake of financial stability. One of the questions, which is equally important for all sides of the political spectrum when it comes to political tax debates, is how taxes affect consumption and saving. Will the increase in taxes result in a smaller decrease in consumption and a larger decrease in savings or vice versa, or will it affect both of them equally? The permanent income hypothesis states that if tax changes are perceived as permanent, they will affect consumption, whereas if these changes are conceived as temporary, they will affect savings (Romer 2011). For some readers, this statement may be too general, as some taxes, like the tax on income or the value added tax, are applied

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on individuals, while some others, like corporation taxes, are applied on firms and on producers. Despite the fact that the intentions and plans of individuals and firms are very different and not comparable, their preferences between consumption and saving have many similarities. The majority of firms and individuals save and invest in order to achieve their long-term plans and won't give them up even when taxes are raised, while the current consumption for the majority of economic actors is only a mean to achieve long run targets. This statement requires a short clarification regarding the behavior of both actors – individuals and firms. It is not likely that individuals will give up their plans to buy property or firms will refuse to follow their long-term plans because of the increased tax rate. As for the firms, higher taxes usually disturb current projects and summon certain adjustments, but only in rare cases do they force the closures of factories or the abandoning of long-term plans. All economic actors know that governments raise the taxes in order to eliminate or to reduce the budget deficit and, from time to time, taxes are raised almost everywhere. These explanations are based on real-life observations, though initially one can guess that increases in taxes will lower consumption, while savings will stay unchanged or their level will decrease at a lower rate.

The importance of tax effects analysis is obvious, as nowadays fiscal consolidation and responsible budgetary policy are among the top priorities of every trustworthy government. Since the start of the financial crisis, various political decisions to increase the taxes or to cut the expenditures led to social turmoil and unrest in many countries; therefore, the analysis of taxation effects is vital for the government and for the society as well. One of the things that has not changed over time is the way governments deal with deficits. Disregarding one-time or continuous debt depreciation as an option, the governments are either borrowing money to finance their needs, raising taxes or cutting the expenditures. Although this article does not compare the pros and cons of these options, it outlines the one huge deficiency of tax increments. The late financial crisis and budgetary troubles of many leading economies provoked an ongoing discussion in academia and among the policymakers on how to achieve fiscal consolidation with the best outcomes. Borrowing money was not the acceptable option for many countries, as many of them have already accumulated huge debts in the recent past, or borrowing alone could not be seen as the ultimate solution. In choosing from the remaining options, politicians usually prefer the combination of expenditure cuts and tax increases, or they are more eager to raise the taxes when compared with the expenditure cuts. The main reason for preferring these options is that increases in taxes are easier to implement and it is less likely that they will cause any social unrest, as it is usually the case with the budgetary cuts.

Contrary to what politicians prefer, economists usually advocate for budgetary cuts or a certain mix of both alternatives – and for good reason. During the last ten years, academic articles that analyze how fiscal consolidation affects the economy have attracted high interest from both academics and the general public. Although the subject itself is not a new one and prominent scholars like Alesina, Ardagna or Giavazzi wrote a number of articles, focused on these issues long before this dilemma became a subject of media debates, the rise in the popularity of this subject is directly related to the recent crisis. In these publications, authors defended the view that expenditure cuts, as compared with tax increases, are less harmful. Certain statements and conclusions speak for themselves, such as that debt reduction was associated with higher growth rates if it was achieved by spending cuts and not by the increases in taxes (Alesina and Ardagna 2010), or that expenditure-based adjustments can be associated with minor output losses and a quick recovery of investors' confidence (Alesina et al. 2015).

The majority of subsequent researchers found supportive evidence for the above-mentioned statements or provided some additional clarifications on the matter. Pappa, Sajedi and Vella concluded that output drops in Portugal were presumably caused by the tax-based consolidation package (Pappa et al. 2015). Erceg and Linde presented supporting conclusions for expenditure cuts, but pointed out that this may not be true for the economy, which is constrained by the currency union membership (Erceg and Linde 2013). Gravelle and Hungerford, in their CRS report for Congress, noted that similar findings may be obtained only if the economy is close to full employment (Gravelle and Hungerford 2011). Overall, the dominant opinion among the economists is that expenditure-based fiscal consolidation is a better option than the tax-based one.

The primary aim of this research is to define what is the main reason why taxation is such an obstacle for development and growth – that is to say, are economies more affected via consumption or via savings channels. A very popular view is that when government runs deficit and raises the taxes, it reduces savings, which, in turn, leads to lower investment. The main deficiency of this explanation is that it ignores the fact that in modern economies, savings, credit and investment are less tightly linked than they were half a century ago and firms, as well as individuals, have long-term plans and strategies for the implementation of whom the resources are actually saved. Beside this, it is also important to know whether taxation effects depend on the level of income and, if yes, in what manner exactly. If this dependency exists, policy recommendations of tax increases vs. budget cuts should be formulated taking under consideration of the actual level of income in the economy.

2. GDP by the Expenditure Approach Model

Although this article puts forward an explanation of how taxes are responsible for the slowdown in growth, it initially started as the statistical analysis of a possible cointegration relationship, based on the set of variables from the expenditure approach to the GDP formula:

$$Y = C + K + G + (X - M) \tag{1}$$

Here Y stands for GDP, C for consumption, K for gross fixed capital formation, which is a proxy for investments, G for government expenditures and $X - M$ is net export. Very often some of these variables or their transformed forms are used in models seeking to find what effects consumption, investment or government expenditures exhibit on each other.

It is not difficult to transform the model into one that suits the needs of a taxation effects analysis, as almost all variables in equation (1), with the exception of net exports, may be expressed as certain income proportions that are related to taxes. The initial version of a stochastic model for tax impact assessment may be obtained by dropping net exports and log transforming the variables. The obtained model in some sense is a quintessential aggregate demand model, where lowercase letters denote the logarithms of corresponding variables:

$$y_t = \beta_0 + \beta_1 c_t + \beta_2 k_t + \beta_3 g_t + e_t \tag{2}$$

Equations like (2) are intuitive and very frequently used for the study of interrelationships. In 1994, Edward Hsieh and Kon S. Lai, by using the per capita growth rate of GDP, the share of government spending in GDP and the ratio of private investment to GDP analyzed the relationship between government expenditures and economic growth in a three-variable VAR model (Hsieh and Lai 1994). Their analysis started with stationarity tests for the variables and ended with an estimation of the VAR model. By employing impulses-responses and forecast error variance decompositions, the authors found "no convincing evidence that government spending can increase per capita output growth." Very well-known econometricians Hendry, Pagan and Sargan also used consumption and income in various examples of dynamic specifications for time series models (Hendry 2000).

The multiplicative version of the model (2), which is identical to the Cobb-Douglas production function in form, is:

$$Y_t = \exp(\beta_0 + e_t) C_t^{\beta_1} K_t^{\beta_2} G_t^{\beta_3} \tag{3}$$

Net export was omitted deliberately, what consecutively means that certain changes in foreign trade balance are captured by the $\exp(\beta_0 + e_t)$ factor. To be more specific, net export is included in GDP and certain changes in it may define the behavior of the error term i.e., its stationarity and volatility. This can be clearly seen from the rearranged equation (3):

$$\exp(\beta_0 + e_t) = C_t^{-\beta_1} K_t^{-\beta_2} G_t^{-\beta_3} (C_t + K_t + G_t + (X_t - M_t))$$

This choice to discard net exports does not restrict the model to a closed economy analysis. Still, it requires to treat foreign balance as an exogenous factor, one that affects consumption, investment and government expenditures, but is itself affected by a much broader number of domestic and foreign factors that are beyond the scope of this model.

Returning back to model (2), there are several economic and statistical aspects of fundamental importance that must be discussed. First of all, when analyzing these macro aggregates, it is worthy to keep in mind that equation (2) stems from a very popular expenditure approach to the GDP relationship (see equation (1)) without the foreign trade component. Weights β_1 to β_3 are such that innovations e_t, with a constant β_0 , i.e., $\beta_0 + e_t$ more or less approximate the transformed remainder with net export that is not directly included into the model. It is difficult to find any term or words to define the meaning of the $\beta_0 + e_t$ factor, but it is clear that this part, from a logarithmic specification, has direct links to export and import saldo from equation (1). As all common estimation procedures and methods usually treat the error term e_t as a zero mean component, estimation will be in line with the properties of the economy, if export and import saldo will tend to fluctuate around a certain more or less fixed value on the long run.

3. An Empirical Analysis of Taxation Effects

All empirical models of this research are usual vector autoregressions for stationary variables, which were used in the direct Granger procedure and vector error correction models. Granger causality tests results were used for the selection of the variables that have to be included into the error correction model and for the determination onto which the variable cointegrating vector has to be normalized. Lag length selection was based on this rule: the lowest order model with white noise errors is the one required.

Lithuanian data for all models, with the exception of stationarity tests, was taken from Eurostat and covers the historical period starting with the first quarter of 2002 and ending with the last quarter of 2016. Observations from the turbulent transitory period were deliberately omitted, because the relationship in those years was in the stage of formation and was not stable. Summing up, the sample starts with the end of the recession, caused by the Russian financial crisis and ends with the most recent observations. The selection of the starting point is somewhat arbitrary, but with no doubt this sample represents the Lithuanian economy as it is nowadays. Unit root tests were performed using the same data source but with a bigger sample, which started with the first quarter of 1996. This choice follows the recommendation that in order to highlight the long run properties of the variable, the sample that is used for the unit root test must be as large as possible and may be larger than the sample for the model.

3.1. Two Causal Relationships

Equation (3) was solved for the GDP arbitrary and presented only for demonstration purposes, ignoring actual causal relationships and their possible direction. In order to specify the empirically based correct forms of model equations, bivariate Granger causality tests were performed. Causal interdependencies were tested for the stationary forms of the variables, which means that the growth rates of GDP Δy_t, final consumption expenditures Δc_t, gross fixed capital formation Δk_t and government expenditures Δg_t are analyzed but not their levels. Stationarity and the order of integration of variables was checked with the Zivot-Andrews test, as the dynamics of all variables under consideration were heavily affected by the structural breaks of the recent financial crisis. Unit root test results and corresponding critical values for the levels and growth rates are presented in Table No. 1, while the results of direct Granger procedure are given in Table No. 2.

TABLE No. 1**. Zivot-Andrews unit root test results**

Variable	Equation order	Test value	Critical value (0.95)
y	3	-3.89	-4.42
Δy	0	-8.02	-4.80
k	8	-2.90	-4.42
Δk	7	-6.06	-4.80
c	3	-4.38	-4.42
Δc	0	-7.44	-4.80
g	4	-2.48	-4.42
Δg	3	-6.34	-4.80

Source: author's calculations, using Eurostat's data on the Lithuanian economy.

TABLE No. 2. **Granger causality test results**

Null hypothesis	Alternative hypothesis	VAR order	F statistic	p value
$\Delta y \nrightarrow \Delta c$	$\Delta y \rightarrow \Delta c$	VAR(3)	0.0784	0.9716
$\Delta c \nrightarrow \Delta y$	$\Delta c \rightarrow \Delta y$	VAR(3)	0.8246	0.4834
$\Delta y \nrightarrow \Delta k$	$\Delta y \rightarrow \Delta k$	VAR(2)	1.8684	0.1595
$\Delta k \nrightarrow \Delta y$	$\Delta k \rightarrow \Delta y$	VAR(2)	5.1615	0.0073
$\Delta c \nrightarrow \Delta k$	$\Delta c \rightarrow \Delta k$	VAR(2)	1.0216	0.3636
$\Delta k \nrightarrow \Delta c$	$\Delta k \rightarrow \Delta c$	VAR(2)	2.2604	0.1094
$\Delta y \nrightarrow \Delta g$	$\Delta y \rightarrow \Delta g$	VAR(2)	2.8263	0.0638
$\Delta g \nrightarrow \Delta y$	$\Delta g \rightarrow \Delta y$	VAR(2)	1.6844	0.1906
$\Delta c \nrightarrow \Delta g$	$\Delta c \rightarrow \Delta g$	VAR(4)	3.7717	0.0069
$\Delta g \nrightarrow \Delta c$	$\Delta g \rightarrow \Delta c$	VAR(4)	0.4727	0.7556
$\Delta k \nrightarrow \Delta g$	$\Delta k \rightarrow \Delta g$	VAR(4)	3.4868	0.0107
$\Delta g \nrightarrow \Delta k$	$\Delta g \rightarrow \Delta k$	VAR(4)	0.1743	0.9511

Source: author's calculations, using Eurostat's data on the Lithuanian economy.

The stationarity of levels was checked using the testing equation for the break that may have affected the linear trend, while testing of the growth rates used an equation that allows a break in intercept. A number of lagged changes in the testing equation (equation order) was determined after a careful examination of the residual properties, searching for the lowest order testing equation with white noise errors. By comparing test values with critical values, one can easily notice that all test values for the levels are larger than the corresponding critical values, while all values for the growth rates are less than the critical values. This means that null hypotheses of nonstationarity cannot be rejected for the levels of GDP, consumption, investment and government expenditures, but they can be rejected for their growth rates, i.e., the levels are integrated of order one and nonstationary (possibly cointegrated), while growth rates are stationary. The results of remaining popular unit root tests are not included in this paper for conciseness, as they do not offer any additional insights.

The p values in Table No. 2 imply that private consumption and investment cause government expenditures with conventional confidence levels, while GDP has minor, if any at all, impact on government spending. Causality tests also characterize investment as the leading factor in GDP formation. These causal links may be used to form two stochastic interrelationships among the variables, the first of which is the government expenditure equation that defines government expenditures as the result of consumption, investment and aggregate income:

$$G_t = \exp(\beta_0 + e_t) C_t^{\beta_1} K_t^{\beta_2} Y_t^{\beta_3} \tag{4}$$

Although the effect of GDP on government expenditures is insignificant with 95 percent of confidence, it is significant with 90 percent of confidence. Due to this reason, GDP is included in the initial form of the model. There are several pros and cons regarding the inclusion of the income level. On the one hand, the inclusion of GDP may be redundant, because incomes are mainly predetermined by investment and investments are already in the model. For this reason, income may duplicate information that is already in the gross fixed capital formation or any other component, while the rest of this aggregate may be irrelevant. Of course, the opposite may also be true. Despite the fact that gross domestic product is the aggregate that consists of consumption, investment and government spending, the aggregate on its own may contain useful information for government spending prediction.

The second causal relationship defines GDP as a function of investment:

$$Y_t = \exp(\beta_0 + e_t) K_t^{\beta_1} \tag{5}$$

As mentioned before, models like these can be easily employed for the analysis of taxation effects on consumption and savings. The analysis of taxation effects will start with the government expenditures relationship in equation (4) and continue with GDP and capital relationship in equation (5).

A proper form for the estimation of causal relationships may be chosen after a careful examination of the statistical properties of variables. For this, it is necessary to put an eye on the plots of all variables in the relationships (4) and (5).

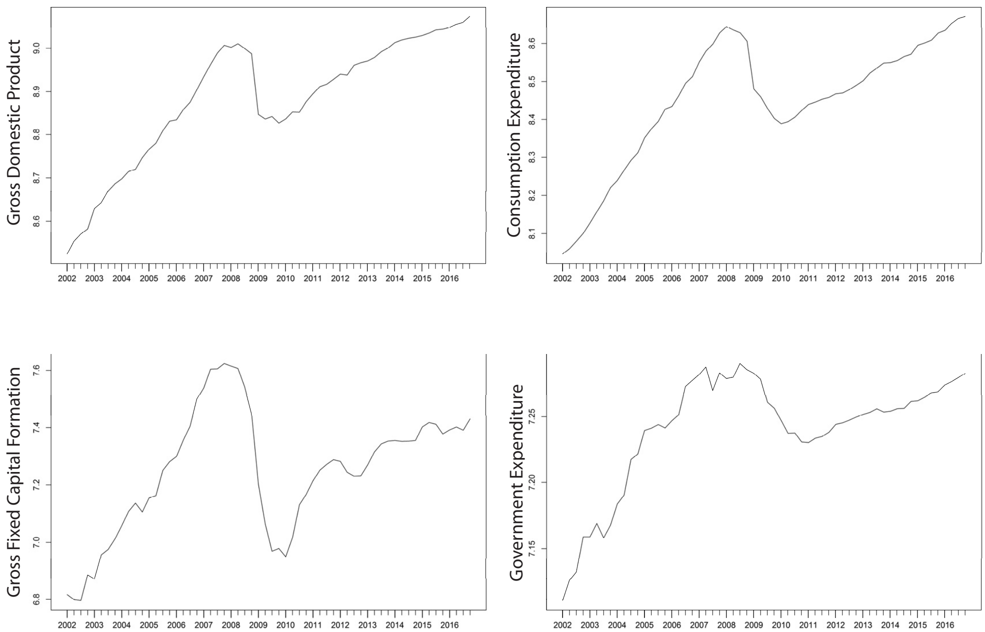

FIG. No. 1. **Logarithmically transformed variables from causal relationships (4) and (5)**

Source: Eurostat's data on the Lithuanian economy.

A visual analysis of the changes reveals that the dynamics of GDP and consumption expenditures were almost identical before the crisis, during the crisis and after the crisis. Changes in government expenditures were similar, only that the government expenditure growth prior to the crisis was sharper and more volatile as compared with the remaining variables. The dynamics of capital also differ from the rest in two aspects. First, the decrease in capital was huge and much more noticeable than the decreases of the remaining factors. Second, the dynamics of capital are more volatile after the crisis, and not prior it, contrary to what was observed with the government expenditures. Despite these differences, the dynamics of these four variables are very much alike. The similarity of dynamics, obvious nonstationarity and the fundamental functional relationship in formula (1) allows to suspect that the stochastic trends of these variables may be interrelated, or, in other words, these variables may be cointegrated.

3.2. An Analysis of the First Causal Relationship

Keeping in mind that all variables from equations (4) and (5) are integrated of order one, and if first order integrated variables are cointegrated, the proper form for the estimation of causal relationships (4) and (5) is the vector error correction model. The estimates of cointegrating vector coefficients will be the substitutes for the elasticities in equations

(4) and (5). In order to find out how it is, the Johansens cointegration test procedure was carried out. VAR(5) was preselected as the best fitting model for the levels, while the error correction form was of order four:

$$\Delta x_t = \alpha\beta' x_{t-1} + \sum_{i=1}^{4} \Pi_i \Delta x_{t-i} + \varepsilon_t \tag{6}$$

Here vector x_t contains logarithmically transformed government spending g_t, the logarithm of consumption c_t , the log of capital formation k_t, the log of aggregate income y_t and a constant. The results of maximal eigenvalue tests and the speed of the adjustment coefficients are given in Tables Nos. 3 and 4.

TABLE No. 3. **Maximal eigenvalue test results for the four variable VAR(5) error correction model**

Hypothesis	Statistic	Critical values		
		0.90	**0.95**	**0.99**
$r \leq 3$	4.31	7.52	9.24	12.97
$r \leq 2$	11.04	13.75	15.67	20.20
$r \leq 1$	18.42	19.77	22.00	26.81
$r = 0$	28.27	25.56	28.14	33.24

Source: author's calculations, using Eurostat's data on the Lithuanian economy.

The initial estimation of the cointegration relationship, which is normalized with respect to government expenditures and Johansens likelihood tests, revealed that variables are cointegrated with one cointegrating vector.

TABLE No. 4. **Speed of the adjustment coefficients for four variable models and their *t* values in the parentheses**

Equation	Δg	Δc	Δk	Δy
a_i	0.0678 (1.306)	0.2352 (1.362)	1.3245 (3.568)	0.1192 (0.564)

Source: author's calculations, using Eurostat's data on the Lithuanian economy.

The significance that is posed by the speed of the adjustment coefficients unveils that only capital is an endogenous variable, while government spending, consumption and incomes are weakly exogenous factors. All this means that variables are in the long run equilibrium, but only investment or capital formation reacts to the disequilibrium. The fact that in this initial model only capital formation responds to equilibrium error is not a big surprise, as capital or investment is the main forming factor of aggregate income and also of all the possibilities to spend them, but it is a bit unusual that government expenditures are weakly exogenous. This result implies that no matter what happens, the government always sticks strictly to its budgetary plans and does not revise them, neither when actual incomes are lower than planned, neither when extra unplanned income is gained. It is not so in reality, though the obtained model is not a good sketch of reality.

The long run equilibrium relationship $\beta' x_{t-1}$, with an adjusted time index in four the variables model is:

$$g_t = 5.8449 - 0.0472 c_t + 0.2509 k_t - 0.0001 y_t \quad (7)$$

This cointegration relationship implies that consumption expenditures have a negative effect on government spending and aggregate income has almost no effect on government expenditures. The values of coefficients in the cointegrating vector also tend to strengthen the suspicion that this model can be deemed only as the initial framework. The main reason for this handling is that incomes have a minor if any effect at all (the value of coefficient speaks for itself) on government expenditures. Hence, the initial suspicion that aggregate incomes are the redundant component in the model confirmed itself, so the next step is to remove this variable from the model and to estimate the three-variable vector error correction model.

By omitting aggregate incomes from the model, the resulting relationship takes this form:

$$G_t = \exp(\beta_0 + e_t) C_t^{\beta_1} K_t^{\beta_2} \quad (8)$$

Johansens maximal eigenvalue statistics in Table No. 5 also signify about the existence of one cointegrating vector.

TABLE No. 5. **Maximal eigenvalue test results for the three-variable VAR(5) error correction model**

Hypothesis	Statistic	Critical values		
		0.90	**0.95**	**0.99**
$r \leq 2$	6.66	7.52	9.24	12.97
$r \leq 1$	9.94	13.75	15.67	20.20
$r = 0$	26.69	19.77	22.00	26.81

Source: author's calculations, using Eurostat's data on the Lithuanian economy.

The speed of the adjustment coefficients in Table No. 6 imply that government expenditures and capital are endogenous variables; furthermore, consumption also tends to be endogenous with a 90 percent confidence level.

TABLE No. 6. The **Speed of the adjustment coefficients for three-variable model and their *t* values in the parentheses**

Equation	Δg	Δc	Δk
α_i	0.1254 (2.448)	0.3460 (1.753)	1.5217 (3.813)

Source: author's calculations, using Eurostat's data on the Lithuanian economy.

The significance that is posed by the speed of the adjustment coefficients unveils that all variables tend to react to disequilibrium. The magnitudes of the coefficients signal that consumption encompasses onto the changes in three quarters, while government spending does so in two years and investments tend to overreact immediately. Also, it should not be a big surprise that all variables change in the same direction in order to eliminate the disequilibrium.

The cointegration relationship, with estimates of coefficients of equation (8) is:

$$g_t = 5.2660 + 0.0692c_t + 0.1938k_t \tag{9}$$

With three variables in the model, long run equilibrium coefficients already have meaningful signs. Overall, the estimation of the three-variable model yielded much more satisfactory results. After the excessive GDP variable was omitted, the cointegrating vector implies that government expenditures will go up by 0.07 percentage points, reacting to 1 percentage point increment in consumption; likewise, a 1 percentage point increase in capital formation tends to produce a 0.19 percentage point increase of government expenditures.

Putting aside technicalities, the question of main importance is how this cointegration relationship may be used for the analysis of taxation effects? Two causal relationships (the equation of government expenditures (8) and the equation of aggregate income (5)) can be easily rearranged to suit the purpose of tax effects modelling, as all variables in these equations can be expressed as certain tax proportions.

If we will assume that government taxes all income on equal tax rate τ, spending may be written as a certain fraction of income:

$$G_t = \tau Y_t \exp(\nu_t) \tag{10}$$

Here τ stands for a certain abstract tax rate, "averaging" all possible taxes that are applied and $\exp(\nu_t)$ is a multiplicative remainder. If government spending never exceeds the amount of taxes collected τY_t, then $\exp(\nu_t) = 1$. This means that the ratio of expenditures to taxes is equal to unity and the budget is perfectly balanced. Surely it is not like this and budgets are never perfectly balanced. The most any government can achieve is to keep this ratio as close to unity as it is possible. This means that if a government would decide to act like this, in the case of extra income, it would have to build up a safety stockpile that could be used to finance the needs in times of unforeseen deficits. No matter what governments decide or how they would act, the remainder $\exp(\nu_t)$ would not be a white noise in any case.

Similarly, equations for consumption and investment may be obtained. Consumption is a certain fraction κ_τ of net income $(1 - \tau)Y_t$, while investment is a fraction of income that was not consumed. With these acceptances, the equation for consumption is:

$$C_t = \kappa_t (1 - \tau) Y_t \tag{11}$$

While the equation for investment is:

$$K_t = (1 - \kappa_t)(1 - \tau) Y_t \tag{12}$$

For reasons of simplicity, by ignoring stochastic disturbances or the remainder e_t (this choice shall not cause any inaccuracies) in equation (10), and substituting equations (10), (11) and (12) into equation (8), it is possible to obtain the following representation of the cointegrating vector:

$$\tau Y_t = \exp(\beta_0)\kappa_t^{\beta_1}(1-\tau)^{\beta_1} Y_t^{\beta_1}(1-\kappa_t)^{\beta_2}(1-\tau)^{\beta_2} Y_t^{\beta_2} \quad (13)$$

As the purpose of this analysis is to study taxation effects, equation (13) can be easily rearranged to represent the proportion of consumption. Switching τ and κ to the opposite sides, we get:

$$\kappa_t^{-\beta_1} = \exp(\beta_0)\tau^{-1}(1-\tau)^{\beta_1+\beta_2}(1-\kappa_t)^{\beta_2} Y_t^{\beta_1+\beta_2-1} \quad (14)$$

Solving (14) for κ_τ yields the multiplicative version of tax effects equation:

$$\kappa_t = \exp(\beta_0)^{-1/\beta_1}\tau^{1/\beta_1}(1-\tau)^{-(\beta_1+\beta_2)/\beta_1}(1-\kappa_t)^{-\beta_2/\beta_1} Y_t^{-(\beta_1+\beta_2-1)/\beta_1} \quad (15)$$

The additive form may be obtained by logarithmically transforming equation (15):

$$\ln\kappa_t = -\frac{\beta_0}{\beta_1} + \frac{1}{\beta_1}\ln\tau - \frac{\beta_1+\beta_2}{\beta_1}\ln(1-\tau) - \frac{\beta_2}{\beta_1}\ln(1-\kappa_t) - \frac{\beta_1+\beta_2-1}{\beta_1}\ln Y_t$$

This equation expresses the consumption to income ratio as the function of taxes and income. With the use of numerical methods, it is possible to find the values of consumption to income ratios κ for the given income levels Y and various tax rates τ, where the empirical counterparts of elasticity coefficients β_i are the estimates of cointegrating vector coefficients, presented in equation (9). For this purpose, the numerical method, developed by Brent and implemented in *R*'s function *optim*, was used. Calculations were done for all possible tax rates from 0.01 to 0.70, with 0.01 step and six abstract levels of income, starting with $Y = 1000$ and ending with $Y = 3500$. The results for the selected tax rates are presented in Table No. 7 and plotted in Figure No. 2.

TABLE No. 7. **Consumption to income ratios for various tax rates and income levels**

Tax rate τ	**Consumption to income ratio κ, when**					
	***Y* = 1000**	***Y* = 1500**	***Y* = 2000**	***Y* = 2500**	***Y* = 3000**	***Y* = 3500**
0.01	0.9990	0.9993	0.9995	0.9996	0.9992	0.9997
0.10	0.9990	0.9993	0.9995	0.9996	0.9997	0.9996
0.20	0.9990	0.9993	0.9981	0.9956	0.9911	0.9840
0.30	0.9987	0.9938	0.9814	0.9562	0.9109	0.8348
0.40	0.9928	0.9660	0.8957	0.7390	0.2630	0.2630
0.50	0.9706	0.8563	0.4670	0.2630	0.2630	0.2630
0.60	0.8950	0.2630	0.2630	0.2630	0.2630	0.2630
0.70	0.6049	0.2630	0.2630	0.2630	0.2630	0.2630

Source: author's calculations.

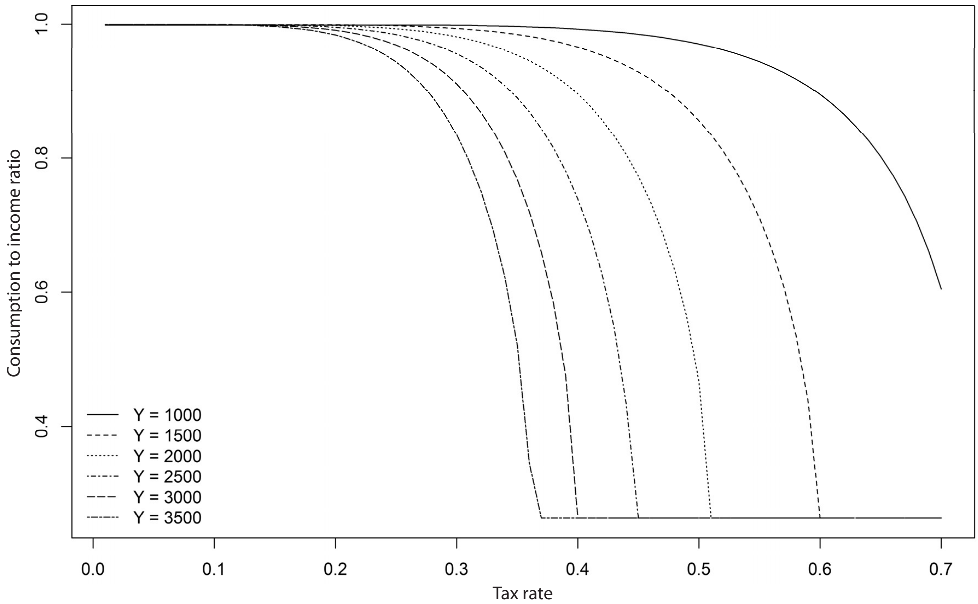

FIG. No. 2. **Consumption to income ratio for various tax rates and income levels**

Source: author's calculations.

The values in Table No. 7 and curves in plot no. 2 clearly show that the negative effects of tax increases depend on the level of income. The higher the taxes are, the lower the consumption to income ratio is. This ratio tends to decrease for all income levels, but the higher the level of income is, the more visible decreases in the consumption to income ratio, even at lower tax rates, can be observed. Tax increments summon decreases in consumption and increases or smaller decreases in savings. The explanation of this dependency is simple, although not obvious. Taxes, and especially consumption taxes, make consumption pricier and, when choosing between consumption and saving, economic agents will prefer saving as less pricey and therefore a better option.

The main deficiency of this calculation is that the resulted downturns are too sharp, too large and too fast. It is impossible to assume that for taxes set at forty percent, about a tenth part of the income will be saved, but, for a fifty percent tax rate, already more than half of the income will be saved. Also, it is hard to imagine that, for any income level, at low levels of taxes, almost all incomes will be consumed, just like it is hard to believe that, for a high level of taxes, about three quarters of income will be saved. These shortcomings are not especially "large," because the whole calculation is based on "abstract levels of income," but leaves in want of better results. For this reason, let's turn to the analysis of the second causal relationship.

3.3. An Analysis of the Second Causal Relationship

Taxation effects also can be studied using the causal relationship between GDP and capital formation, which is defined by equation (5). The best fitting vector error correction model had two lags of modelled variables:

$$\Delta x_t = \alpha\beta' x_{t-1} + \sum_{i=1}^{2} \Pi_i \Delta x_{t-i} + \varepsilon_t \tag{16}$$

Here vector x_t contains the logarithm of GDP y_t and the logarithm of gross fixed capital formation k_t. An analysis of the second causal relationship and the results of Johansens maximal eigenvalue tests in Table No. 8 confirmed the initial suspicions of cointegration with one cointegrating vector.

TABLE No. 8. **Maximal eigenvalue test results for two variable VAR(3) error correction model**

Hypothesis	Statistic	Critical values		
		0.90	**0.95**	**0.99**
$r \leq 1$	11.28	7.52	9.24	12.97
$r = 0$	21.48	13.75	15.67	20.20

Source: author's calculations, using Eurostat's data on the Lithuanian economy.

The significance that is posed by the speed of the adjustment coefficients reveals that capital is the only endogenous variable in this setting, while a relatively small coefficient (a bit more than one tenth) signals that error correction is very slow and it takes about two years to eliminate the disequilibrium.

TABLE No. 9. **Speed of the adjustment coefficients for the two-variable model and their *t* values in the parentheses**

Equation	Δy	Δk
α_i	-0.0352 (-1.392)	0.1196 (2.356)

Source: author's calculations, using Eurostat's data on the Lithuanian economy.

The estimated long run equilibrium relationship from the model (16) is:

$$y_t = 3.3437 + 0.7780 k_t \tag{17}$$

Parameters of the cointegrating vector imply that if capital or investments will go up by 1 percentage point, aggregate income will rise by a 0.78 percentage point. These results also can be used for the analysis of taxation effects. By substituting equation (12) into equation (5), we get:

$$Y_t = \beta_0 (1-\kappa_t)^{\beta_1} (1-\tau)^{\beta_1} Y_t^{\beta_1} \tag{18}$$

By solving equation (18) for $(1-\kappa_t)^{\beta_1}$, we get:

$$(1-\kappa_t)^{\beta_1} = \beta_0^{-1}(1-\tau)^{-\beta_1} Y_t^{1-\beta_1} \quad (19)$$

Finally, by solving equation (19) for κ_τ, we get the final version of the model that can be used for taxation analysis:

$$\kappa_t = 1-\beta_0^{-1/\beta_1}(1-\tau)^{-1} Y_t^{(1-\beta_1)/\beta_1} \quad (20)$$

By using the estimates of cointegrating parameters from equation (17) and the relationship (20), it is possible to find consumption to income ratios for different income levels and tax rates. Calculations are straightforward and were done for all possible tax rates from 0.01 to 0.70, with 0.01 step and six abstract levels of income, starting with $Y = 1000$ and ending with $Y = 3500$. The results for selected tax rates are in Table No. 10 and in Figure No. 3.

TABLE No.10. **Consumption to income ratios for various tax rates and income levels**

Tax rate τ	Consumption to income ratio κ, when					
	$Y = 1000$	$Y = 1500$	$Y = 2000$	$Y = 2500$	$Y = 3000$	$Y = 3500$
0.01	0.9014	0.8893	0.8798	0.8719	0.8651	0.8590
0.10	0.8915	0.8782	0.8678	0.8591	0.8516	0.8450
0.20	0.8780	0.8630	0.8513	0.8415	0.8331	0.8256
0.30	0.8606	0.8435	0.8301	0.8189	0.8092	0.8007
0.40	0.8373	0.8174	0.8017	0.7887	0.7774	0.7674
0.50	0.8048	0.7808	0.7621	0.7465	0.7329	0.7209
0.60	0.7560	0.7261	0.7026	0.6831	0.6661	0.6511
0.70	0.6746	0.6347	0.6035	0.5774	0.5549	0.5349

Source: author's calculations.

The findings are similar to those obtained in the analysis of the first causal relationship, but without the deficiencies that were characteristic for the calculation, which was based on the government-expenditure interrelationship. Overall, the higher the incomes are, the lower the consumption to income ratio is. The lower the incomes are, the smaller the effect of tax increases on consumption to income ratio can be observed. In a low-income setting, tax increases force the consumption to income ratio to decrease, but at smaller amounts as compared with a high-income setting. This means that economic actors tend to smooth savings at the costs of consumption and not vice versa. Though savings or future consumption is intended for the acquiring of properties or expensive durable goods and not for buying nondurables, i.e., not for the smoothing of short term consumption fluctuations. Keeping this in mind, it is not a big surprise that tax increases will affect mainly consumption, as no one (neither individuals or firms) sacrifices long run plans in favor of short term needs.

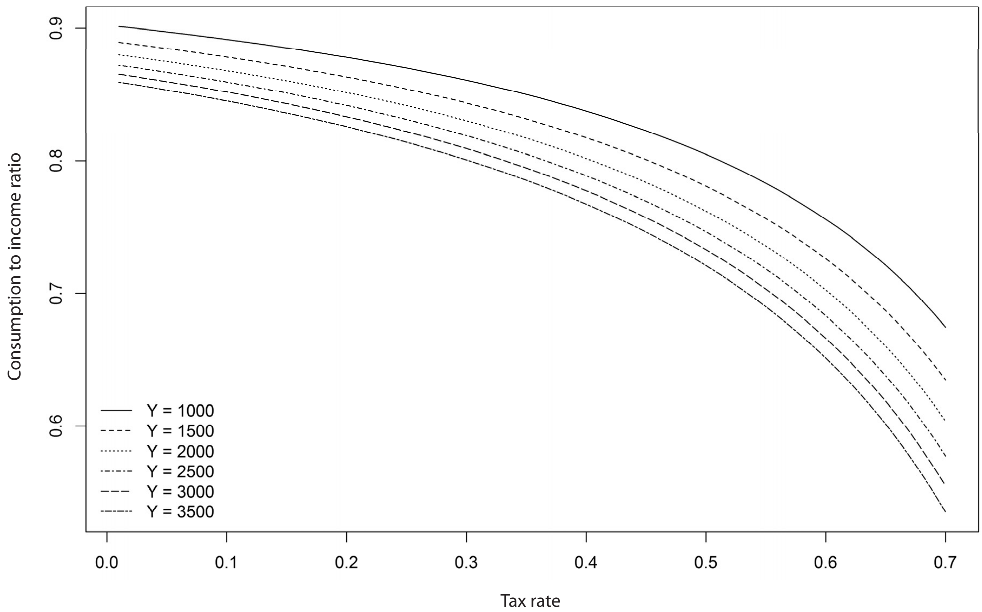

FIG. No. 3. **Consumption to income ratio for various tax rates and income levels**

Source: author's calculations.

3.4. Discussion

For an easier interpretation of results, the consumption to income ratios in Table No. 10 will be decomposed into consumption and savings levels. Corresponding levels are plotted in the Figures Nos. 4 and 5.

It is not difficult to notice that changes in taxes affect only consumption and this effect is clearly visible for all income levels. The technique that was used for the estimation of taxation effects was based on the deterministic part of a causal relationship, though the interpretation of the results must be very careful and creative. That means that, taking into account the possible effects of the remaining factors, one must recognize that taxes affect consumption more than savings do and not to treat these plots as exact proxies of the reality. Figure No. 4 illustrates that consumption tends to decrease linearly, but at a rate that is proportional to the income level. Decrease rates are higher when incomes are high and lower when incomes are low. One of the main reasons of why taxes are causing higher damage to consumption in higher income environments may be that in these economies, investment plays a much more important role as compared with low-income environments, so the costs associated with changes in plans are also much higher.

Figure No. 5 suggests on its own that despite the changes in taxes, economic agents tend to keep savings as constant as possible (and not that savings will stay constant when taxes will be raised). The richer the society is, the more its members are forward-looking

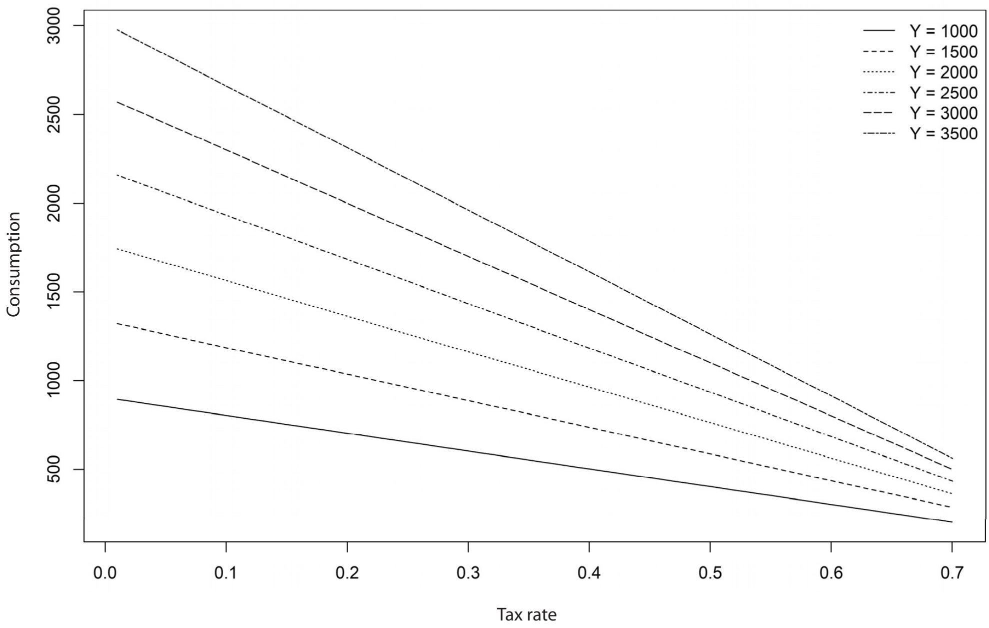

FIG. No. 4. **Consumption for various tax rates and income levels**

Source: author's calculations.

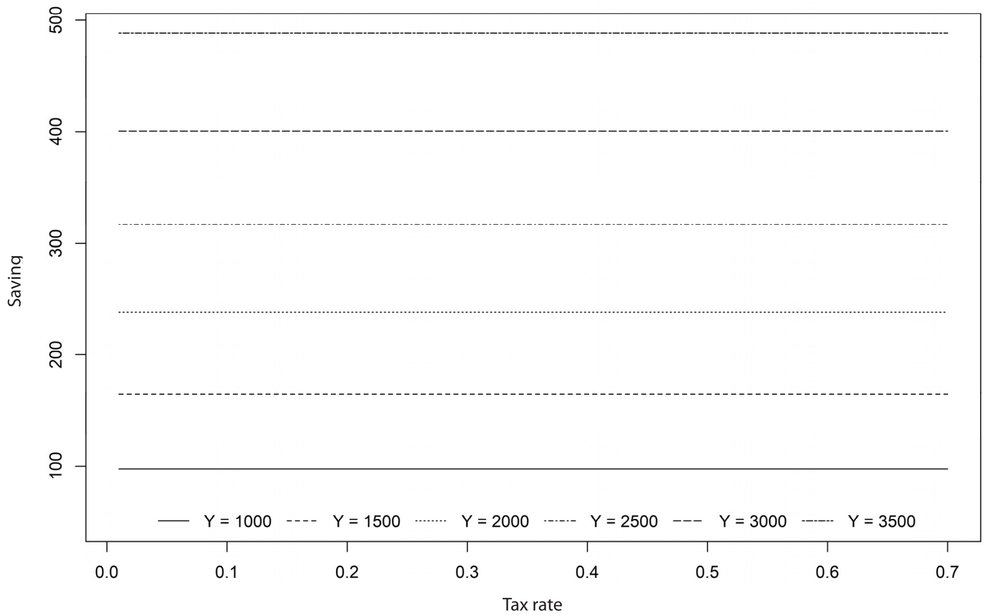

FIG. No. 5**. Savings for various tax rates and income levels**

Source: author's calculations.

and the more they rely on future consumption as compared with current consumption. In general, the majority of economic actors have certain long- or medium-term plans and work toward their fulfillment. This may be the main reason why tax increases provoke a huge decrease in consumption today, but small decreases in savings, though – a second option, the reduction of savings – may be associated with undesirable changes in plans and by all kinds of economic agents is seen as less favorable.

The reasons for this interdependence may also stem from the fact that increases in taxes form expectations of further increases in the near future and force individuals to reduce consumption in order to accumulate more savings, as the worst is yet come. And it is obvious that higher levels of income leave more place for this manoeuvre. In a low-income environment, if the consumption is far below what it is supposed to be, the consumption to net income ratio will decrease less sharply as consumption is more valued than in those countries where consumption needs are met.

Although in certain aspects these findings are in line with a well-known permanent income hypothesis, in some other respects, it contradicts it. The aforementioned hypothesis states, that if poorer individuals are trying to catch up with richer individuals, they will have to save more and consume less today in order to increase the consumption sometime in the future. It is therefore not surprising that tax increases lead to decreases in consumption and not in savings. On the other hand, in the context of the famous hypothesis, the results that are in this paper may be too general and too unspecific. A permanent income hypothesis discriminates between permanent and temporary tax changes, whereas in this analysis, tax changes are not divided into permanent and temporary. According to the hypothesis, temporary tax changes may have little impact on consumption but huge impact on saving. Individuals experience temporary as well as permanent changes in income. Keeping up with the terminology, an increase in taxes, which is assumed to be temporary, will decrease the transitory income. It will force individuals to lower savings, thus increasing the consumption to income ratio. On the contrary, an increase in taxes, which is assumed to be permanent, will decrease the permanent income. It will force individuals to lower consumption; thus, it will decrease the consumption to income ratio. An apparent contradiction between the results from this research and the permanent income hypothesis occurs only if tax increases are temporary, whereas if tax increments are permanent, there is no contradiction between the results of this analysis and the permanent income hypothesis.

The concurring results that emphasize the negative effects of taxes on consumption can also be found in many other authors' studies. A decade ago, Gale and Orszag estimated a huge number of regressions with a focus on how consumption reacts to changes in incomes and taxes. Their models yielded a very wide range of estimates, where a statistically significant portion of the tax cut is saved and, of course, a statistically significant portion is consumed. When consumption was measured as a ratio to net income, the decrease in taxes could be associated with a proportional and almost identical increase in consumption as well as with a very small increase (Gale and Orszag 2004). These ambiguous results are only partly compatible with the findings of this paper, as a very huge range of possible consumption responses on tax or income changes indicate that everything is possible – consumers may be forward looking, but they also may be not.

In her study, Cardia also estimated the number of consumption regressions and obtained non-robust estimates of coefficients on taxes and robust estimates of marginal propensities to consume (Cardia 1997). The fact that marginal propensities to consume were very small means that income growth produces more visible increases in savings, compared with increases in consumption. For more realism, one should add a necessary condition: "Only if a certain level of income or consumption is attained." These partly inconclusive results imply that future consumption is of huger importance if compared with current consumption, and this comes in line with the findings within this paper. An interpretation of these results requires one to keep in mind that the authors concentrated on tax decreases and debt-financed tax cuts, as this was the prevailing debate option at that time.

The results of this and similar researches can be used for the formulation of proposals for budgetary and fiscal policy. As tax increases have a huge deteriorating effect on current consumption and so on aggregate demand, governments should avoid tax-based fiscal consolidation at all costs. Governments also do not have the opportunity to persuade tax increases more freely when incomes are higher. On the contrary – the higher the incomes are, the more damaging the effects of taxes on consumption may be observed. In other words, governments do not possess a certain kind of comfort to dismiss expenditure-based fiscal consolidation when it comes to budget balancing. The damaging effects of taxes but with a different exposure channel were determined in the recent study by Romer and Romer, where the authors pointed out that taxes have a huge effect on output, with elasticity exceeding 2.5 percent (Romer and Romer 2010). According to their study, increases in taxes cause a fall in investment, which in turn produces a sharp decline in income.

Principally, no matter how it is, tax increases hinder and block growth via consumption or investment channels. Two authors, Alesina and Ardagna, some time ago found a positive effect of expenditure-based fiscal consolidation on aggregate demand (Alesina and Ardagna 1998). Their analysis was leaning on the Ricardian equivalence, the idea that a reduction of government expenditures leads people to expect tax cuts in the future.

Despite that (a) fiscal consolidation or budgetary cuts were not analyzed here directly and (b) the interpretation of the results in this paper was based on the permanent income hypothesis and related consumption models rather than on the Ricardian equivalence, the fact that tax increases tend to decrease the consumption to income ratio in richer environments more than in poorer ones leads to the conclusion that tax increases as a remedy for budget deficits should not be seen even if the level of income is high enough.

4. Concluding Remarks

The findings and proposals of this research are based on the causal relationship between capital and income. Of all the variables that are found in the expenditure approach to GDP formula, gross fixed capital formation is the only one that causes GDP. When it comes to GDP modelling, the explanatory and predictive power of consumption or government expenditures is very small as compared with capital. As both variables are cointegrated, the proper form for the estimation of the relationship is the vector error correction model. The obtained cointegration relationship was used for the study of taxation effects on consumption and savings. The analysis presented here revealed that the increase in taxes tends to decrease consumption to income ratio differently at different levels of income. Taxes lower consumption to income ratios at all income levels, but in a high-income setting, the decrease rates are much higher. Contrary to the naïve or common-sense guess that taxes will affect savings and consumption on more or less an equal scale, it turned out that taxes lower consumption for all tax rates and have small effects on savings, because agents tend to maintain savings or future consumption as constant as possible. That on its own means that economic agents are forward-looking and that the value consumption of forthcoming periods is much greater than initially could be guessed. Taking into account that tax increments will lower consumption more heavily, when incomes are high, as compared with the relative effects when incomes are low, the government should not rely on tax-based fiscal consolidation even if the overall income level is high.

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