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Abstract

In this paper, the economic impact of the 2006–2008 personal income tax (PIT) reform in Lithuania is analyzed applying model-based simulations. We find that the undertaken PIT reform is unsustainable as it leads to permanent government budget deficits and ever increasing public debt. This result holds even allowing for endogenous reduction in tax evasion. After introducing permanent compensatory fiscal measures ensuring long-term sustainability of the PIT reduction, we demonstrate that the lower PIT produces higher output and lower prices in the long run. Higher domestic spending is supported by higher employment and after-tax wages. Moreover, following a reduction in the marginal production costs, producer prices fall enhancing economy's international competitiveness and boosting domestic exports. Pre-announcement of the tax reform implies early macroeconomic reaction, and thus in most cases smoother adjustment of the economy to the tax change.

Keywords: fiscal policy, taxation, tax evasion, dynamic general equilibrium model.
JEL classification: E62, H24, H25, H26.

Santrauka

Taikant kalibruotą Lietuvos ekonomikos dinaminį stochastinį bendrosios pusiausvyros modelį, darbe nagrinėjamas 2006–2008 m. gyventojų pajamų mokesčio (GPM) reformos poveikis šalies ekonomikai. Nustatoma, kad jis yra reikšmingas ir teigiamas. Sumažėjusi GPM norma lemia didesnį bendrąjį vidaus produktą ir mažesnį kainų lygį ilgu laikotarpiu. Šalies vartojimo išlaidų didėjimą skatina didesnis užimtumas ir darbo užmokesčio atskaičius mokesčius kilimas. Kainų mažėjimui turi įtakos ribinių gamybos sąnaudų sumažėjimas, kurį lemia sumažėjusios darbo sąnaudos. Visa tai prisideda ir prie Lietuvos eksporto konkurencingumo didėjimo, vadinasi, skatina šalies eksporto augimą. Pastebima, kad mokesčių reformos išank-stinis paskelbimas lemia ankstyvesnę makroekonominę reakciją į mokesčių normos pokyčius ir šiek tiek sklandesnį ekonomikos prisitaikymą. Kita vertus, ilgu laikotarpiu GPM reforma gali lemti valdžios sektoriaus finansų nestabilumą, t. y. nuolatinį valdžios sektoriaus biudžeto deficitą ir beribį valdžios sektoriaus skolos augimą. Tokio GPM reformos poveikio valdžios finansams neatsveria net mokesčių slėpimo masto sumažėjimas. Valdžios sektoriaus finansų ilgalaikiam tvarumui užtikrinti darbe siūloma taikyti tokias GPM reformos negatyvų poveikį valdžios sektoriaus finansams atsveriančias fiskalinės politikos priemones, kaip vyriausybės vartojimo ir (arba) namų ūkių pervedamųjų išmokų mažinimas, kitų mokesčių didinimas.

Albert Einstein: *"The hardest thing to understand in the world is the income tax".*

1 Introduction

On 7 June 2005, the Seimas of the Republic of Lithuania passed the Law Amending of the Law of the Republic of Lithuania on Personal Income Tax[1] (PIT), which provided for a gradual reduction, in the period 2006–2008, of the rate of PIT from 33 to 24 percent: to 27 percent (by 6 percentage points) from 1 July 2006 and to 24 per cent (by 3 percentage points) from 1 January 2008. According to the Convergence Programme of Lithuania of 2006, the reform had three major objectives: (1) to achieve a better balance between labor and capital taxation, (2) to cut labor costs and create favorable conditions for the growth of competitiveness vis-à-vis neighboring countries, (3) to ease tax burden on labor and increase net wages.[2] In order to keep the present and future budgetary commitments, the temporary offsetting measures were adopted. On 1 January 2006, a temporary social tax on corporate income was introduced at the level of 4 percent. Since 1 January 2007 the social tax rate was reduced to 3 percent and was abolished by end of the year. Application of the temporary social tax in fact implied an increase in the corporate income tax (CIT) over 2006–2007. The graphical representation of the impact on statutory tax rates of the reform can be found in Figure 6 in Appendix C.

Undoubtedly, the 2006–2008 PIT reform is one of the most important fiscal event in the recent economic history in Lithuania which is expected to have substantial effects on the domestic economy. Nevertheless, virtually no sound analysis of potential impact of the proposed measures on the Lithuanian economy can be found.[3] There are no studies quantifying possible macroeconomic impact of the reform or discussing its microeconomic implications (welfare analysis). Nor do we find any discussion on the long-run sustainability of the proposed PIT cut which is questionable noting that budget revenue compensatory measures are of temporary nature only. Such discussion is highly desirable in the light of Lithuania's aspiration to join the European Monetary Union. The latter requires fulfillment of public deficit and debt criteria as a part of meeting the Maastricht criteria of convergence.

In this paper, we attempt to address some of the implication of the proposed

[1] Admittedly, from the conceptual point of view the tax reform deals with changes to labor tax rather than personal income tax. Nevertheless, in this paper we use title employed in the official translation of the Law. The terms "labor tax" and "personal income tax" are used interchangeably in the paper.

[2] See GLR (2006) for more details.

[3] Careful evaluation of the full range of potential macroeconomic effects of fiscal policy change is a well-established international practice. For example, in the US model-based analysis of fiscal policy decisions is extensively used in debating alternative fiscal policy choices and explaining its macroeconomic implications to all interested parties (CBO (2004) provides with the example of such analysis).

tax reform. In particular, using a calibrated dynamic stochastic general equilibrium (DSGE) model for Lithuanian economy we investigate macroeconomic effects of the PIT reform as well as its welfare implications. The main features of the model are optimal choice, forward-looking expectations, nominal and real rigidities. Sound microeconomic foundations of the model allow conducting welfare analysis which makes the model a very useful tool to address policy dilemmas policymakers face when choosing the course of policy action. Special attention is paid to issue of pre-announcement of the reform as well as implications of endogenous response of tax evasion to tax policies in Lithuania.

We find that the proposed PIT reform is unsustainable as it stands and additional compensatory measures beyond temporary increase in CIT are required. In its present formulation, the PIT reform leads to permanent government budget deficits and ever increasing public debt. Assumption of endogenous reduction in tax evasion enhances self-financing of the tax cut to some extent, however, it does not fully solve the problem of sustainability. The proposed compensatory mechanism is based on a fiscal rule featuring endogenous adjustment of the level of government expenditure to deviation of the actual public debt from its steady state level. Having ensured sustainability of the PIT reduction, we show that the permanently lower PIT rate results in higher output and lower prices in the long run. Higher domestic spending is supported by higher employment and after-tax wages. Moreover, following a reduction in the marginal production costs, producer prices will fall enhancing economy's international competitiveness and boosting domestic exports. Temporary increase in the CIT introduces visible macroeconomic volatility in the short run via significant fall in investment expenditure. Pre-announcement of the tax reform implies early macroeconomic reaction and thus smoother adjustment of the economy to the tax change afterwards.

The rest of the paper is structured as follows. In Section 2 we discuss the theoretical underpinnings of economic impact of changes in distortionary tax rates and review some of the recent empirical findings on macroeconomic impact of PIT reform in the literature. A brief introduction into the applied benchmark model structure and its extensions are provided in Section 3. The scenarios of Lithuanian PIT reform implemented in this paper and the model simulation results are discussed in Section 4. Lastly, in the concluding part (Section 5) we draw conclusions and discuss future potentially fruitful research directions.

2 Transmission Channels of Taxes

There is large array of literature focusing on macroeconomic implications of tax changes. The arsenal of empirical models used to quantify impact of tax reform ranges from structural vector autoregressive models to large scale traditional macroe-

conometric models. More recently the literature has been enriched by empirical studies applying DSGE models. Being set up on the first principles with tight microeconomic foundations the new generation of models allows sound analysis of variety of economic issues including tax policies. Consequently, by now DSGE models have become the workhorse of modern macroeconomic research. The present analysis of the fiscal reform in Lithuania is based on applying an open economy model featuring the DSGE approach, therefore, in discussing channels of tax policy below we focus on potential tax effects within a DSGE framework.

In a typical DSGE model, income tax policies have both supply and demand side effects on economy (see Kumhof et al., 2005). On the supply side, changes in taxes operate through their impact on agents' incentives to work and to invest. For example, an increase in PIT is expected to reduce labor supply via fall in after-tax wage (labor supply channel).[4] Higher CIT reduces after-tax return on investment and, therefore, results in lower desired capital stock, investment, and long-term (or potential) economic growth (cost of capital channel). From the welfare point of view, an increase in PIT and CIT implies greater inefficiency in the labor and capital markets (the deadweight loss will rise). On the demand side, response of private consumption depends on whether changes in taxes affect consumers' permanent income. The latter depends on persistence of changes in taxes and extent to which consumers are impatient (high preference of current consumption over future consumption). Moreover, in the presence of large share of credit-constrained (rule-of-thumb) consumers and shorter consumer spending planning horizon, transitory changes in tax will also have significant impact on consumption. In an open economy setup, lower PIT and CIT are expected to enhance firms' international competitiveness acting as real depreciation, thus, boosting exports (see also Botman and Kumar (2006), Botman et al. (2006)).

The labor supply and cost of capital are traditional channels through which taxes affect economy. Other important transmission channels are tax evasion and expectations. Tax evasion describes efforts taken by economic agents to evade taxes by illegal means: dishonest tax reporting (such as declaring less income, profits or gains than actually earned or overstating tax deductions). As evidenced by experience of many countries tax evasion can be substantial. In practice, it can significantly alter effectiveness of fiscal policy in achieving its objections. On the other hand, in case of a tax cut endogenous reduction in tax evasion will enhance self-financing of the tax cut reducing its negative impact on government revenues.[5] It should be noted,

[4]The opposite relationship between PIT rate and employment is well documented in Prescott (2004). The impact of PIT cut on endogenous labor supply is estimated by Cardia et al. (2003). They find that a reduction in PIT rate by 10 percentage points would increase weekly hours worked by 4.5 percent in Germany, 9.9 percent in Canada, 12.8-18.0 percent in the USA and 14.5 percent in Japan.

[5]Agell et al. (2004) investigate the importance of tax avoidance in analysis of economic impact of tax changes. They show that failure to account for tax avoidance may lead to poor prediction

that, although there are some interesting extensions of DSGE models incorporating tax evasion in the literature (see, for example, Busato et al. (2005)), tax evasion behavior is not a common feature of DSGE models. Nevertheless, in estimating the macroeconomic impact of the tax reform in Lithuania we analyze the role of endogenous reaction in tax evasion by extending the benchmark model with (PIT) tax evasion behavior. This extension allows us to explore extent to which the endogenous reduction in the tax evasion could contribute to the PIT self-financing – an argument often cited in the policy debates over the tax system reform in Lithuania.

As it was exemplified above in discussing the response of private consumption, the expectations' channel plays a crucial role in short to medium-term macroeconomic reaction to the tax changes (permanent versus temporary). Another important example of the role of expectations is related to pre-announcement of tax changes. Given forward-looking behavior of agents, pre-announcement of credible policy change will have immediate impact on economy. Effectively, it implies that pre-announcement of the reform reduces the macroeconomic impact of the reform on the date of actual implementation of the policy change. For instance, Trabandt and Uhlig (2006) examine the effects of expected and unexpected permanent labor and capital tax cut. Using a DSGE model calibrated for the USA and EU-15 economies, they find that an announced labor tax cut leads to a drop in tax revenues in the short run. The results are mainly due to decreased incentives for household to work and invest in capital. Consequently, the tax revenues from labor and capital decline. The effects of an announced capital tax cut are opposite. The announcement of lower capital taxes leads to the investment boom that positively affects the employment. Therefore, the tax revenues from labor and capital increase. Since the pre-announcements have important dynamic effects, we will additionally analyze the impact of pre-announcement of future tax changes on estimation of macroeconomic effects of the tax reform in Lithuania.

The analytical and presentational frameworks employed in this paper in many respect mimic approach undertaken by Botman and Danninger (2007) in their analysis of the effects of the recent fiscal reform in Germany.[6] The authors use the IMF's Global Fiscal Model, which is a DSGE type model, to demonstrate long-term unsustainability of the proposed tax changes in Germany and to investigate alternative tax and expenditure measures that could be used to deal with the fiscal unsustainability issue.

of the impact of tax changes on labor supply, tax revenues and welfare both quantitatively and qualitatively.

[6]Differently from Botman and Danninger (2007), we consider infinitely-lived agents, whereas Botman and Danninger (2007) use a model featuring an overlapping generation structure.

3 Model

To examine the impact of the proposed fiscal reform on the Lithuanian economy and welfare, we utilize Karpavičius (2008) quarterly model calibrated to fit the Lithuanian macroeconomic data. The model belongs to the class of the New Keynesian DSGE open economy models with sticky prices and nominal wages. Theoretical setup of the benchmark model is largely based on Smets and Wouters (2003), Kollmann (2002) and Dam and Linaa (2005). For the sake of current analysis, we modify the benchmark model by introducing endogenous government debt and assuming exogenous government expenditure, i.e. we assume that government consumption to GDP ratio is constant. This enables us to capture the effects of decrease in PIT rate on government debt if any.

3.1 Benchmark Model

Our small open economy model features five sectors: households, intermediate-good producers, final-good producers, fiscal and monetary authorities. Infinitely lived households maximize the intertemporal utility from consumption and leisure subject to budget constraint and consumption habit. Each household is a monopolistic supplier of a differentiated labor service implying explicit wage equation featuring Calvo (1983) stickiness. Moreover, households own all domestic capital stock. They rent capital to the domestic firms and decide how much to invest in the capital stock given certain investment adjustment costs. Intermediate-good producers use labor and capital to produce differentiated intermediate goods which are sold under monopolistic competition to final-good producers at home and abroad. Producers of intermediate goods re-optimize prices infrequently á la Calvo, but can set different prices in the domestic and foreign markets. Final-good producers transform both domestic and imported intermediate goods into homogeneous final goods and sell the latter in perfectly competitive markets. Fiscal authority collects taxes, purchases public goods and makes transfers to households. The government budget's balance is achieved by endogenous variation in public consumption which ensures zero public debt in the steady state. The monetary policy is described by a fixed exchange rate regime. The interest rate at which households and government can borrow funds abroad depends on foreign interest rate and a risk premium which is an increasing function of net foreign debt. A more formal description of the structure and calibration of the model is provided in Appendix A.

Analysis of welfare implications of the tax reform is based on the non-stochastic utility of households. In particular, we consider two measures of welfare both expressed in terms steady state level of consumption: the measurement of instantaneous welfare gains and the lifetime consumption equivalent measure of welfare. Details regarding derivation of the welfare measures used in the paper are presented in Ap-

pendix B.

3.2 Model Extension: Tax Evasion

In order to analyze the impact of the PIT cut in Lithuania in the presence of tax evasion, we modify the benchmark model by including the disutility of tax evasion into the instantaneous utility function of a representative household:

$$\begin{aligned}\mathbb{U}_t &= \zeta_t^b \left[\frac{(C_t(j) - hC_{t-1}(j))^{1-\sigma_C}}{1-\sigma_C} - \zeta_t^l \frac{(l_t(j))^{1+\sigma_L}}{1+\sigma_L} \right. \\ &+ \left. \frac{\bar{G}}{\bar{C}} \frac{(G_t - hG_{t-1})^{1-\sigma_C}}{1-\sigma_C} - \frac{(n_t(j))^{1+\sigma_L}}{1+\sigma_L} \right],\end{aligned}$$

where C_t denotes private consumption; G_t denotes public consumption; l_t is labor supply; σ_C is the inverse of the intertemporal elasticity of substitution of consumption (the coefficient of relative risk aversion); σ_L is inverse of the elasticity of labor supply; $n_t(j)$ stands for the degree of the individual tax evasion, i.e., the part of labor income that is not reported to the authority; h is the habit formation parameter; ζ_t^b and ζ_t^L denote correspondingly a shock to the discount rate and labor supply shock both specified as stationary autoregressive processes. From the utility function specification follows that in maximising the utility a representative household takes the level of public goods as given. Our specification implies non-substitution between private and public consumption. The latter assumption reflects observation that substantial part of government consumption (for example, military, police expenditures) cannot be substituted by private consumption.

In the presence of tax evasion, a representative household earns labor income $w_t(j)l_t(j)$ and pays labor income tax $(1 - n_t(j))\tau_t^l w_t(j)l_t(j)$ instead of $\tau_t^l w_t(j)l_t(j)$. As a result, the households face the trade-off between fraudulent tax report and lower net incomes. Compared to the benchmark specification, the household's budget constraint is modified accordingly:

$$\begin{aligned}&(1+\tau_t^c)C_t(j) + I_t(j) + e_t \frac{B_{t-1}(j)}{P_t}(1+i_{t-1})\exp(-\omega) \\ = \;& (1-\tau_t^k)K_{t-1}(j)R_t + (1-\tau_t^k)\frac{\pi_t(j)}{P_t} \\ + \;& w_t(j)l_t(j) - (1-n_t(j))\tau_t^l w_t(j)l_t(j) + S_t(j) + S_t^s(j) + e_t \frac{B_t(j)}{P_t},\end{aligned}$$

where I_t stands for investment; K_t denotes the stock of capital at the end of period t; B_t denotes the stock of nominal foreign debt at the end of period t; π_t is the redistributed nominal corporate profits; S_t is state subsidies; S_t^s is payments from state-contingent securities; w_t denotes real (gross) wage; τ_t^c, τ_t^k, τ_t^l are the effective tax rates levied on respectively consumption, capital and labor income; e_t is the

nominal exchange rate; ω denotes the labor-augmenting technological (deterministic) change; i_t denotes the nominal interest rate paid on foreign borrowing.

Solving the utility maximization problem results in the following equation for the optimal level of tax evasion:

$$n_t^{\sigma_L}(j) = \frac{(C_t(j) - hC_{t-1}(j))^{-\sigma_C}}{1+\tau_t^c}\tau_t^l w_t(j) l_t(j). \quad (1)$$

Equation (1) shows that the optimal level of tax evasion is the one at which marginal disutility from misreporting extra income is equal to marginal disutility from foregone consumption when extra income are correctly reported to the tax authorities. It follows from the optimality condition, that the higher (lower) labor income tax causes the higher (lower) level of tax evasion. This implies that the change of the statutory labor income tax rate will result in less than proportional change of the effective labor income tax rate. Therefore, in the presence of tax evasion, variation in the statutory income tax will have lesser impact on the government's revenues than in a model without tax evasion behavior.

The calibration of the model parameters implies that the level of tax evasion in steady state, $\bar{n}$, is equal to 0.21, i.e., in equilibrium 21 percent of labor income is not reported to the tax authorities in Lithuania.[7]

4 Results

In this section, we present our main findings.[8] First of all, we demonstrate that the proposed reform as it stands in the Convergence Programme of Lithuania of 2006 is unsustainable. Permanent PIT cut combined with temporary increase in CIT results in permanent government deficits and ever increasing public debt. This result holds even allowing for endogenous response in tax evasion which falls following the PIT cut. To achieve sustainability of the PIT cut, we introduce additional compensatory fiscal measures which include adjustment in the government consumption. Other compensatory fiscal measures, such as cut in transfers to households and increase in other taxes, are investigated as well. Macroeconomic and welfare impact of the fiscal reform is evaluated using the benchmark model as well as an extended version featuring tax evasion. A bulk of our analysis is based on model simulation results assuming that the tax changes are implemented unexpectedly. However, we show that the short-run impact of the tax reform may depend crucially on whether the reform is credibly pre-announced or implemented unexpectedly.

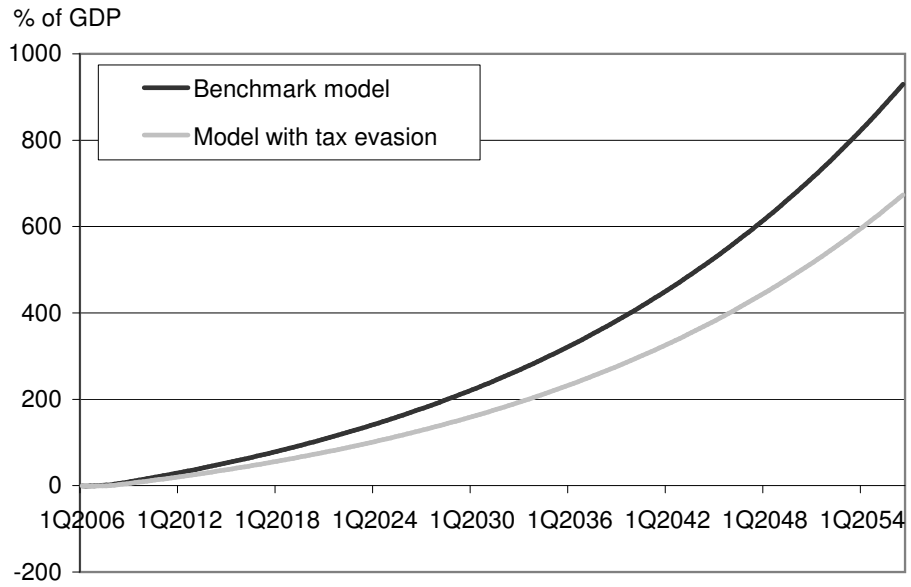
[7] The number is consistent with the estimates of State Tax Inspectorate of the Lithuanian Republic (15-20 percent (Delfi, 2006)) and not much different from the one in the USA (18 percent, according to Slemrod (2007)).

[8] The simulation results are reported in terms of percentage deviations from the balanced growth path.

4.1 Outcome of the Reform

The model-based simulations of the tax reform, outlined in the Convergence Programme, imply that the reform is unsustainable. In particular, the reform results in permanent public sector deficit and unsustainable government debt development (see Figure 1). The combined macroeconomic effect of permanent PIT cut and temporary increase in CIT is provided in Figure 2.

Figure 1: The impact of the fiscal reform on government debt

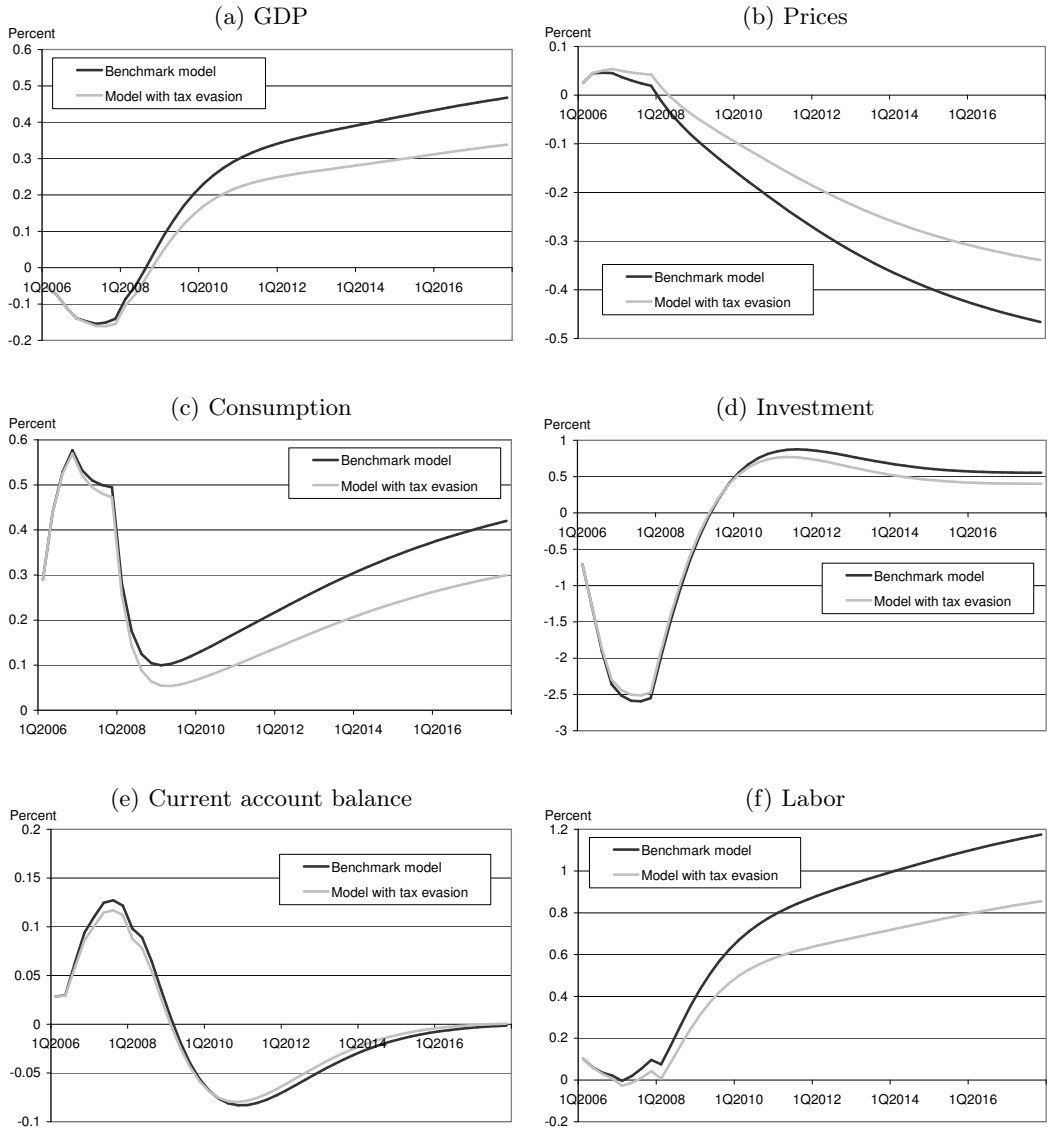


The PIT reduction leads to lower gross wages boosting employment demand, lowering marginal production costs and, as a result, domestic prices. Improvement in international competitiveness of the domestically produced intermediate goods brings permanent increase in export volumes. Lower export prices, however, offset higher export volumes, so that the nominal export is unaffected in the long run. There is a positive impact on the current account balance in the short run, though, in the long run it is left unaffected. The temporary increase in CIT leads to the lower after-tax return on capital, thus households have less incentives to invest, and the condition of optimal intertemporal consumption implies higher consumption expenditure in the short run.

Initial drop in investment negatively affects GDP, but after 2009 the impact on GDP is positive, mainly due to the boosted employment. As regards the impact of the tax reform on the public finances, we find that the temporary increase in CIT is not capable of offsetting permanent reductions in government tax income.

In the model featuring tax evasion the reform leads to reduction in the level of tax evasion (from 0.21 to 0.15) contributing to self-financing of the tax cut and partial

Figure 2: The macroeconomic impact of the fiscal reform



mitigation of the macroeconomic impact of the tax changes (see Figure 2). However, endogenous response of tax evasion is not enough to stabilize the debt to GDP ratio, leaving issue of fiscal sustainability unresolved.

Further we investigate how sustainability of the permanent PIT cut can be achieved by assuming endogenous response in the government expenditures.

4.2 Sustainability of the Reform

We showed above that without additional compensatory fiscal measures the proposed reform is not sustainable, i.e., government debt explodes in the long run. In order to ensure sustainability of the permanent reduction in the PIT we allow government to adjust its expenses according to some rule which is based on stabilization of the size of government debt. The choice of government expenditure as the key adjustment instrument is supported by observation that in the past most fiscal consolidations in Lithuania relied on changes in government consumption rather than in taxes. Let the fiscal rule be as follows:

$$g_t = \bar{g} - \phi_g \left(\frac{B_t^g}{\Psi_t} - \frac{\bar{B}^g}{\bar{\Psi}} \right), \tag{2}$$

where g_t denotes the government consumption to GDP ratio at date t; B_t^g is the government debt; Ψ_t is the GDP; the entries with a "bar" are the steady-state values of the corresponding variables.

We log-linearize the following equation around the balanced growth path:

$$\hat{g}_t = -\phi_g \hat{b}_t^g, \tag{3}$$

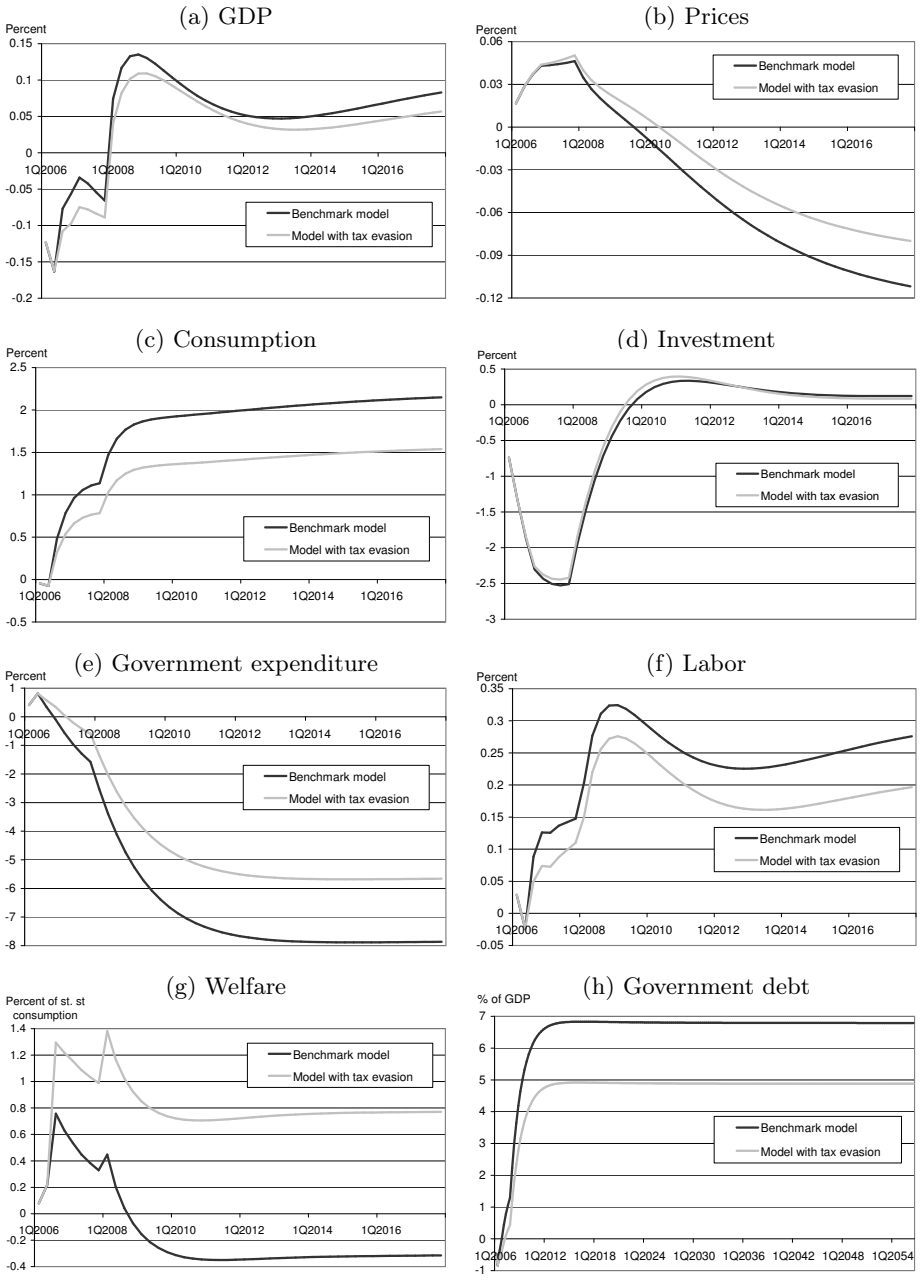
where $\hat{b}_t^g$ denotes the log-deviation of government debt to GDP ratio.

The parameter ϕ_g in Equation 3 is set to 0.2. The latter implies that the government is able to reduce the debt gap by approximately 50 percent during 1 year. Although the value of the adjustment parameter ϕ_g may seems arbitrary, our main findings of the analysis are robust with respect to alternative assumptions about the speed of adjustment in government expenditure.[9]

Response of the key macroeconomic and welfare indicators to implementation of the tax reform under endogenous reaction in the government expenditure is reported in Figure 3 and Table 2 in Appendix C. Allowing for the rule-based adjustment of government expenditure helps to stabilize government debt to GDP ratio (Figure 3h). In particular, in case of the benchmark model (i.e., without tax evasion) permanent cut in the PIT leads to a permanent increase in the debt-to-GDP ratio by 7

[9] For example, considering smaller value of the parameter of, say, 0.1 implies slower adjustment of government expenditure and, therefore, two times higher level of government debt in the long run. Overall economic activity and impact on welfare measures, however, are not significantly different from simulation results assuming $\phi_g = 0.2$.

Figure 3: The macroeconomic and welfare impact of the tax cut combined with government expenditure adjustment



percentage points. To sustain permanent cut in PIT the government is required to cut its expenditure by 8 percent in the long run.

Endogenous adjustment in the government consumption reduces the positive impact of the tax reform on the rest of the economy over the long run and significantly affects its adjustment in the short run. As households derive utility from provision of public goods, a reduction in government expenditure also implies direct welfare losses for households. The latter to certain extent is compensated with higher private consumption which is mainly financed by supplying more labor service. Overall, our welfare measure indicates the positive impact of the reform only up to 2008. In the long run, the welfare, in terms of steady state consumption, is 0.3 percent lower than in the absence of the reform. This naturally leads to a question on whether reduction in the government expenditure is an optimal compensatory measure. Later in Section 4.5, we investigate alternative compensatory mechanisms comprising increase in other tax rates and reduction in transfers to households.

4.3 The Role of Tax Evasion

In the presence of tax evasion behavior, the proposed rule-based adjustment of government expenditure allows to stabilize government debt to GDP ratio incurring less macroeconomic volatility and less hazard to welfare (see Figure 3 and Table 2 in Appendix C). More specifically, permanent cut in the PIT leads to a permanent increase in the debt to GDP ratio by only 5 percentage points. Also, stabilization of the public finances requires less cut in government expenditure, namely, 6 percent instead of 8 percent obtained in the benchmark model. These differences stem from the fact that endogenous reduction in the tax evasion (in this particular case the share of under-reported labor income drops by 6 percentage points) contributes to self-financing of the tax cut, thus, reducing the need to adjust public expenditures.

Tax evasion also carries important implications for effects of the reform on welfare. In this case, the impact of the reform on welfare measures is positive both in the short run and long run. On the one hand, compared to the benchmark case, there is less reduction in provision of public goods (welfare enhancing argument) and less increase in the labor supply. The latter directly increases welfare while reducing it indirectly via lower private consumption induced by lower labor income of households. On the other hand, households' welfare is substantially boosted by shrinking shadow economy, i.e., there is less need in engaging in illegal activities which is an important source of disutility for our households. More precisely, in the benchmark case the reform reduces the instantaneous welfare of households by 0.3 percent of households' consumption in the steady state, whereas in case of tax evasion the reform induces an increase in welfare by 0.8 percent of consumption in the steady state. The lifetime consumption equivalent measure in the benchmark and tax evasion cases is respectively –20.8 and 78.6 percent of the steady state level

of consumption.

4.4 The Role of Pre-Announcement

In this subsection, we assess the role of pre-announcement in the economic impact of the fiscal reform. In doing so we assume that the announcement of the tax reform package in the 2^{nd} quarter of 2005 is credibly received by the households and firms. The timing of actual changes in tax rates are as before (see graphical representation in Figure 6 in Appendix C). To maintain focus on the issue of the pre-announcement in what follows we ignore potential effects from tax evasion, i.e., it is treated exogenously. The impact of the pre-announced reform along with the impact of an unexpected reform is displayed in Figure 4.

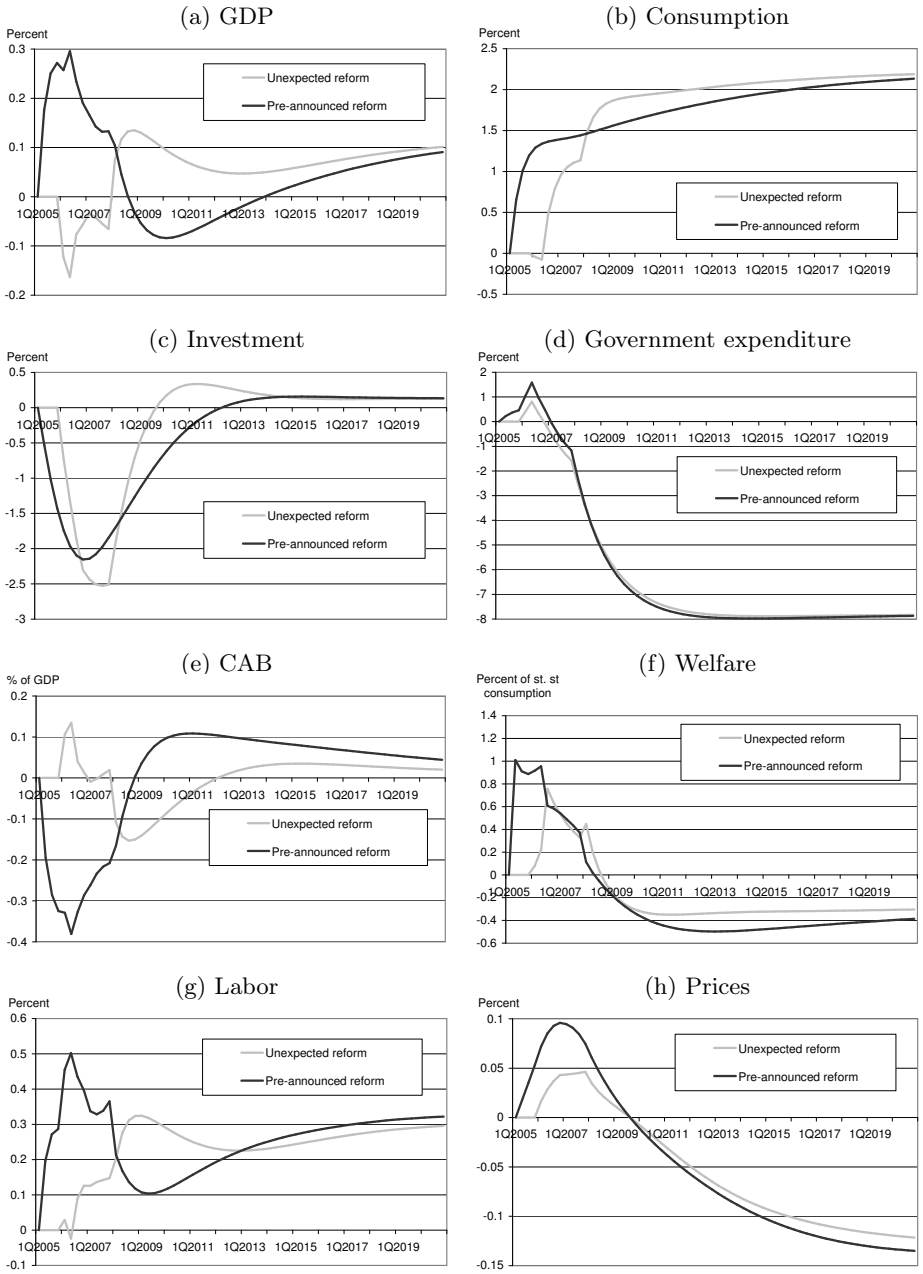
Compared to the unexpected reform scenario, the pre-announcement of the tax reform has similar implications for the long-run impact of the tax changes. The main differences between the two scenarios are in the short run. Visually, in case of the pre-announced reform the responses of the main macroeconomic variables at the reform implementation dates are smoother than in case of the unexpected reform. The pre-announcement of the tax changes leads to an earlier macroeconomic adjustment. Households observe that their intertemporal after-tax income from labor activities is affected positively, thus, they optimally decide to open their purses just after the announcement. As macroeconomic adjustment starts before actual tax rate changes take place, the size of the effect of the reform on impact is lower than in case of the unexpected reform.

The front-loading behavior in private consumption results in substantial increase in economic activity in 2005–2007 with visible stabilization in 2008–2010. Rising economic activity positively affect the labor market and prices in the short run. In particular, employment raises by 0.4 percent already by 2007. The pre-announcement of the tax cut also leads to higher inflationary pressure in the early periods.

As regards the external sector, current account reaction in the short run depends crucially on whether the tax reform is pre-announced or implemented unexpectedly. In the former case, the households' decision to advance their consumption immediately boosts the import of intermediate goods resulting in deterioration of the current account. However, as actual cut in PIT takes place, international competitiveness gains are released enhancing domestic exports. Higher exports offset the initial rise in imports and bring the current account closer to the balance.

With respect to welfare implications, compared to the unexpected reform scenario, the pre-announcement of the reform produces higher welfare level in earlier periods (in 2005 the instantaneous welfare gains are approximately 0.8 percent of the steady state level of consumption) and lower welfare levels in the subsequent periods. Surprisingly, in the long run, the pre-announced reform leads to slightly lower welfare level in comparison to the unexpected reform: lifetime consumption

Figure 4: Macroeconomic and welfare implications of the pre-announced and unexpected fiscal reform



equivalent measure, is smaller by 1.1 percent.[10]

4.5 Choice of Compensatory Measure

Previously we saw that the use of the government consumption as the main stabilization tool might result in substantial welfare losses for the households. In this subsection, we assess long-run macroeconomic and welfare implications of application of alternative compensatory mechanisms. In the following set of simulations, the PIT cut is implemented as in the Convergence Program, but instead of temporary CIT increase we apply a set of permanent compensatory measures, one at a time: government expenditure, transfers, CIT, consumption tax (value added tax – VAT).[11] We assume that tax evasion is exogenous (previously we saw that this feature decreases the scale of impulse responses and positively affects welfare) and that the reform is implemented unexpectedly. The latter assumption is used since here we are only interested in the long-run effects.[12]

In Figure 5, we present the macroeconomic and welfare impact of the permanent cut in the PIT when different compensatory measures are employed ("G" stands for lower government expenditure, "Transfers" means that whole PIT cut is compensated by an increase in lump-sum taxes or lower transfers to households). Whenever the PIT cut is not compensated by lower government expenditure, we assume that government expenditure to GDP ratio is constant.

Overall, we find that sustainability of the permanent PIT cut requires the government to increase CIT and VAT rates permanently by respectively 3.6 and 2.8 percentage points. Similarly, transfers and government expenditure should be decreased by respectively 1.5 and 1.3 percent of GDP.

Compensating the PIT cut with adjustment in transfers, which is a non-distortionary fiscal measure, allows to reduce distortions in the economy induced by use of incentive-altering taxation system. In our model, adjustment in transfers leads to the largest positive impact on GDP, but since lower transfers *ceteris paribus* imply lower consumption gains (via negative impact on disposable income) and longer working hours, the households' welfare loss is also the highest among all the compensatory measures considered in the analysis.

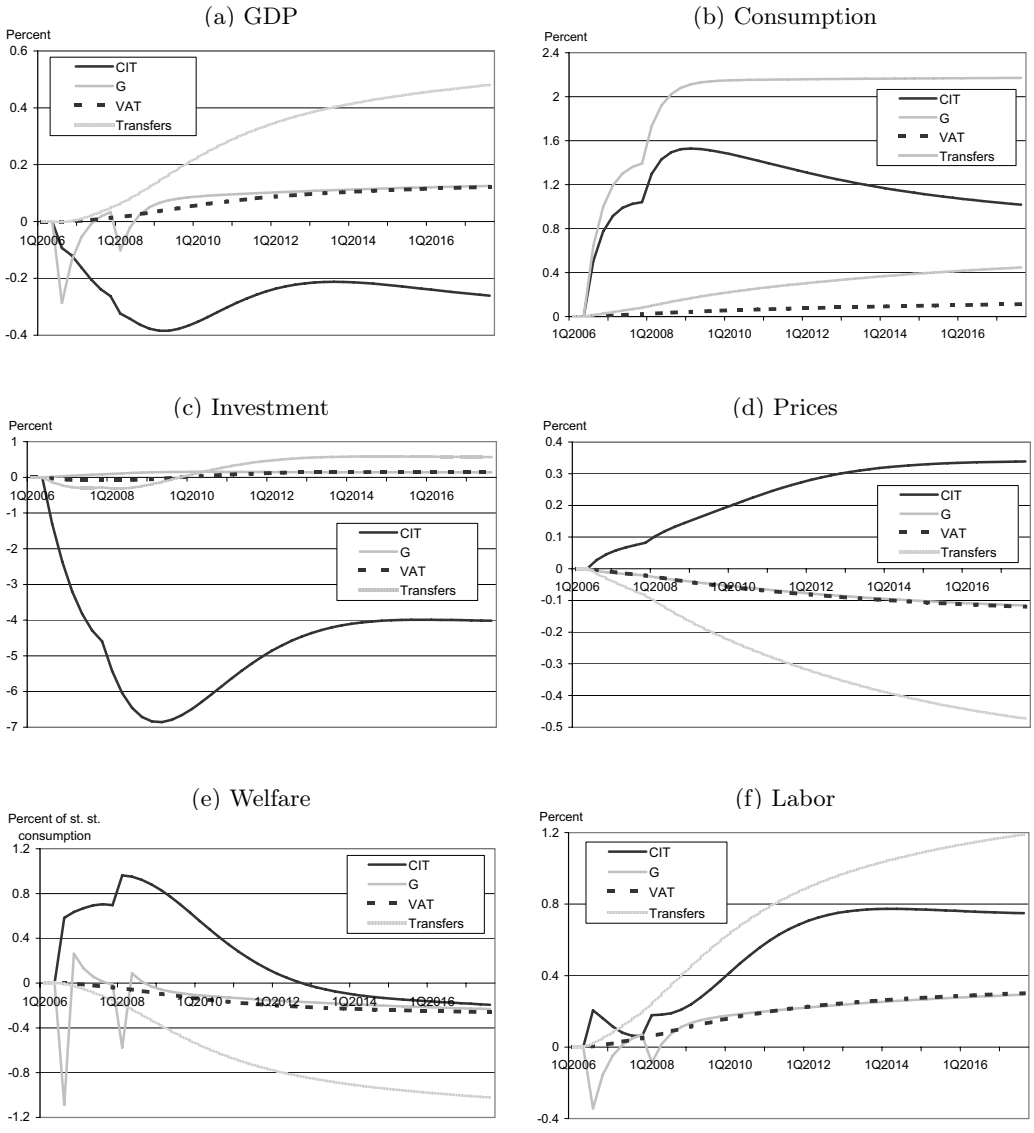
On the other hand, while using of CIT as a compensatory measure is preferable

[10] Although, compared to the unexpected reform, the pre-announcement of the reform does not seem to be beneficial for the economy in the long run, the pre-announced fiscal reform might be still an attractive option for politicians thinking in terms of impact on the electorate. Indeed, in the short run, the pre-announcement creates surge in economic activity and results in higher income from taxes, thus creating illusion of sustainability of the reform without any need for future fiscal restraint.

[11] We do not present the results of simulations when temporary increase in CIT is used since the temporary measure does not affect the values of the variables in the long run.

[12] Figure 4 illustrates that the impulse responses of the unexpected and pre-announced reforms converge in the long run.

Figure 5: Macroeconomic and welfare implications of alternative tax cut compensatory measures



in terms of the welfare implications, it produces the largest reduction in GDP. The increase in CIT results in lower optimal capital stock and, therefore, lower output. Similar to VAT and government expenditure, using CIT as a compensatory measure determines relatively low instantaneous welfare loss.

Interestingly, the two compensatory measures, VAT and government expenditure, lead to the identical impact on GDP and labor in the long run. Their impact on consumption, though, represents two polar outcomes. Lower government expenditure results in the largest increase in private consumption. However, when VAT rate (effective tax on consumption) is increased, consumption becomes relatively more expensive resulting in lower demand for consumption goods.

When it comes to choosing one single compensatory measure, it appears that reduction in government expenditure is indeed the most attractive option. It is equivalent to CIT and VAT in terms of welfare implications, and compared to all compensatory measures allows to achieve the highest level of consumption with minimum labor efforts.

5 Summary and Concluding Remarks

In this paper, macroeconomic and welfare implications of the recent tax reform in Lithuania are investigated using a calibrated DSGE model of the Lithuanian economy. Explicit analysis of the role of pre-announcement of the reform and endogenous response in tax evasion is undertaken. Overall, we have shown that the reform is not sustainable is the long run, unless some permanent compensatory measures are employed. These might include permanent reduction in government expenditure, transfers to households, increase in other taxes. For given specification of the benchmark model we demonstrate that, while being politically the most feasible compensatory measure, reduction in government expenditure can be also regarded as optimal one.

Using the government expenditure as the main instrument of fiscal consolidation, we find that the permanent PIT cut has positive long-run impact on GDP, consumption and employment. Furthermore, lower PIT rate reduces the labor tax wedge producing a rise in after-tax wage rate while lowering gross wage bill faced by firms. With lower marginal production costs domestic firms can reduce output prices and exploit price competitiveness gains in the foreign markets. In this regard, we can conclude that under appropriate choice of fiscal compensatory measures two objectives of the reform out of three outlined in the introduction are likely to be fulfilled, whereas we cannot say much on the objective "to achieve better balance between labor and capital taxation" due to its ambiguous formulation.

While sustainability of the permanent PIT cut requires permanent reduction in government expenditure (or increase in other taxes), the need for compensatory measures can be lightened to the extent the reform will lead to lower level of tax

evasion. The shrinkage of the labor income under-reporting can be substantial and enhance self-financing of the tax cuts.

Pre-announcement of the reform does not have significant effect regarding long-run impact on the economy; however, it carries significant implication for the short-run adjustment dynamics. In particular, compared to the unexpected reform, in case of pre-announced reform macroeconomic adjustment is characterized by greater smoothness on the dates when actual tax changes take place. On the one hand, based on our welfare measure, we do not find that pre-announcement of the reform is beneficial for the economy compared to the unexpected reform. On the other hand, the pre-announced credible fiscal policy helps to reduce the macroeconomic fluctuations, and in this regard can be of some benefit.

Finally, the paper will be complete without mentioning some caveats of our analysis. In this regard, as the main shortcoming of the modeling approach adopted in this paper, we consider the non-existence of non-Ricardian consumers. The latter implies rather smooth dynamic responses. Adding, for example, rule-of-thumb consumers would allow to generate more pronounced macroeconomic responses to the fiscal reform. Furthermore, admittedly our measure of welfare deserves further work. In particular, as a result of linearization of the model certainty equivalence holds leaving no room for welfare effects stemming from risk aversion behavior. In practice, it prevents us from proper investigation of welfare implications of pre-announced versus unexpected fiscal policy. Future research should aim addressing these unresolved issues.

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A Summary of The Model

A.1 Theoretical Setup

In what follows, we briefly describe the model structure, noting that a more detailed description (in Lithuanian) can be found in Karpavičius (2008).

Intermediate-good market

Production function of a representative final-good producer s is given by the following Cobb-Douglas production function:

$$y_t(s) = \exp(-\omega\varphi)\exp(\theta_t)\left(K_{t-1}(s)\right)^{\varphi}\left(L_t(s)\right)^{1-\varphi}, \tag{4}$$

where K_{t-1} is the capital stock at the end of period $t-1$; L_t is the employed labor; φ is the capital share; ω denotes the labor-augmenting technological (deterministic) change; θ_t denotes a first-order autoregressive shock to total factor productivity.

Optimal choices of capital and labor are derived by minimizing the cost of production subject to technological constraint characterised by the production function and taking the price of factors of production as given. The latter, in combination with an assumption of common technology of production, implies that the optimal capital-labor ratio as well as marginal cost of production, MC_t, are identical across intermediate-good producers and equal to the corresponding aggregate values:

$$\frac{L_t}{K_{t-1}} = \frac{1-\varphi}{\varphi}\frac{R_t}{w_t}, \tag{5}$$

$$MC_t = \exp(\omega\varphi)\exp(-\theta_t)R_t^{\varphi}w_t^{1-\varphi}\varphi^{-\varphi}(1-\varphi)^{-1+\varphi}, \tag{6}$$

where R_t and w_t are respectively real rental rate of capital and real wage.

Intermediate-good producers set price on their output á la Calvo (1983). Each period only $(1-\lambda_p)$ share of producers can set their prices optimally. Optimal prices on intermediate goods sold domestically and abroad are derived by maximizing the future discounted sum of profits subject to respective demand constraints. More formally:

$$\max_{\{p_t^d(s),p_t^x(s)\}}\sum_{\tau=t}^{\infty}\lambda_p^{\tau-t}E_t\left\{\kappa_{t,\tau}\left[(p_t^d(s)-MC_tP_t)q_t^d(s)+(e_tp_t^x(s)-MC_tP_t)q_t^x(s)\right]\right\},$$

subject to

$$q_t^d(s) = \left(\frac{p_t^d(s)}{P_t^d}\right)^{-\frac{1+\nu_t}{\nu_t}}Q_t^d,$$

$$q_t^x(s) = \left(\frac{p_t^x(s)}{P_t^x}\right)^{-\frac{1+\nu_t}{\nu_t}}Q_t^x,$$

where κ_t is a discount factor; p_t^d and p_t^x denote price of intermediate domestic goods sold respectively at home and abroad by individual domestic producers; P_t^d and P_t^x are aggregate prices of domestic intermediate goods sold respectively at home and abroad; P_t is price of final goods sold at home; q_t^d and q_t^x denote respectively domestic and foreign demand for output of a domestic intermediate-good producer; Q_t^d and Q_t^x denote aggregate demand for domestic intermediate goods by respectively domestic and foreign final-good producers; e_t is nominal exchange rate; ν_t is a serially uncorrelated shock to price mark-up.

Intermediate-good producers, who do not receive permission to re-optimize their price, keep the same price as in the previous period. The economy-wide price of intermediate goods, thus, evolves as follows:

$$(P_t^i)^{-\frac{1}{\nu_t}} = \lambda_p (P_{t-1}^i)^{-\frac{1}{\nu_t}} + (1-\lambda_p)(\tilde{P}_t^i)^{-\frac{1}{\nu_t}}, \tag{7}$$

where $i = (d, x)$, $\tilde{P}_t^i$ is the aggregate *optimal* price of domestically produced intermediate goods.

Final-good market

Final goods are produced by combining domestic (Q_t^d) and imported (Q_t^m) intermediate goods as inputs. More specifically, each final-good producer faces the production technology constraint summarized by the following Cobb-Douglas production function:

$$Z_t = \left(\frac{Q_t^d}{\alpha}\right)^{\alpha} \left(\frac{Q_t^m}{1-\alpha}\right)^{1-\alpha}, \tag{8}$$

where α denotes home bias.[13]

Optimal demand for domestic and foreign intermediate goods are obtained by solving the following cost minimization problem taking prices of inputs as given:

$$\min_{\{Q_t^d, Q_t^m\}} P_t^d Q_t^d + P_t^m Q_t^m.$$

The optimal demand for factors of final-good production are:

$$\begin{aligned} Q_t^d &= \alpha \left(\frac{P_t^d}{P_t}\right)^{-1} Z_t, \\ Q_t^m &= (1-\alpha) \left(\frac{P_t^m}{P_t}\right)^{-1} Z_t. \end{aligned}$$

[13] We drop index of individual final-good producer for simplicity of exposition. Due to assumption of perfect competition in the final-good market, final-good producers will be completely symmetric.

While the aggregate home price of final goods is given as follows:

$$P_t = \left(P_t^d\right)^{\alpha} \left(P_t^m\right)^{1-\alpha}.$$

Households

A representative household j maximizes utility from leisure and consumption of both private and public final goods:

$$\begin{aligned} \max E_0 \Bigg\{ \sum_{t=0}^{\infty} \beta^t \Bigg[\zeta_t^b \Bigg(& \frac{(C_t(j) - hC_{t-1}(j))^{1-\sigma_C}}{1-\sigma_C} \\ - \quad \zeta_t^L \frac{\left(l_t(j)^{1+\sigma_L}\right)}{1+\sigma_L} & + \frac{\bar{G}}{\bar{C}} \frac{(G_t - hG_{t-1})^{1-\sigma_C}}{1-\sigma_C} \Bigg) \Bigg] \Bigg\}, \end{aligned} \tag{9}$$

where C_t denotes private final consumption goods; G_t denotes public final consumption goods[14]; l_t is labor supply; σ_C is the inverse of the intertemporal elasticity of substitution of consumption; σ_L is inverse of the elasticity of labor supply; β denotes the subjective discount factor; h denotes the habit formation parameter; ζ_t^b and ζ_t^L are correspondingly a shock to the discount rate and labor supply shock both specified as stationary autoregressive processes.

The intratemporal budget constraint faced by each household is as follows:

$$\begin{aligned} & (1+\tau_t^c) C_t(j) + I_t(j) + e_t \frac{B_{t-1}(j)}{P_t} (1+i_{t-1}) \exp(-\omega) = \\ = \quad & (1-\tau_t^k) R_t K_{t-1}(j) + (1-\tau_t^k) \frac{\pi_t(j)}{P_t} + \\ + \quad & (1-\tau_t^l) w_t(j) l_t(j) + S_t(j) + S_t^s(j) + e_t \frac{B_t(j)}{P_t}, \end{aligned} \tag{10}$$

where I_t stands for investment; B_t denotes the stock of nominal (private) foreign debt at the end of period t; π_t is the redistributed nominal profit of intermediate-good producers; S_t is state subsidies (transfers to each household); S_t^s is payments from state-contingent securities; τ_t^c, τ_t^k, τ_t^l are the effective tax rates levied on respectively consumption, capital and labor income; i_t denotes the nominal interest rate paid on foreign borrowing.

As follows from the specification of the budget constraint above, households' borrowing/lending is limited to selling/buying domestic assets to/from foreigners. This assumption reflects overwhelming role of borrowing of foreign funds by the domestic private sector behind stunning surge of Lithuania's foreign debt observed over the last decade.

[14] It is noteworthy, that while consumption of either private or public goods affects household's utility equally, in maximizing the individual utility he or she takes level of public consumption as given.

The capital accumulation evolves subject to investment adjustment cost $\Gamma^I(\bullet)$:[15]

$$K_t(j) = (1-\delta)\exp(-\omega)K_{t-1}(j) + \left[1 - \Gamma^I\left(\epsilon_t^I \frac{I_t}{I_{t-1}}\right)\right] I_t, \tag{11}$$

where δ is the capital depreciation rate; ϵ_t^I is an autoregressive shock to the investment adjustment cost function.

Since households are the monopolistic suppliers of differentiated labor services, they are able to set their wages. However, due to presence of Calvo (1983) type of staggered wage contracts only $(1-\lambda_w)$ of all households receive permission to optimally reset their nominal wage contract in a given period t. When allowed to set the nominal wage optimally, a household will choose it as a mark-up of the real after-tax wage over household's marginal rate of substitution between consumption and leisure. The nominal wage rate of those households, who do not receive permission to re-optimize their wage, remains unchanged. Thus, the economy-wide nominal wage, W_t, evolves as follows:

$$(W_t)^{-\frac{1}{\gamma_t}} = \lambda_w (W_{t-1})^{-\frac{1}{\gamma_t}} + (1-\lambda_w)(\tilde{W}_t)^{-\frac{1}{\gamma_t}}, \tag{12}$$

where $\tilde{W}_t$ is the aggregate *optimal* nominal wage; $(1-\lambda_w)$ is the probability of having permission to reset the wage contract in a given period t; γ_t is a serially uncorrelated shock to mark-up of the real after-tax wage.

Fiscal authority

In the benchmark case, the government is running balanced budget. The latter is achieved via adjustment of real public consumption, G_t. For fixed (exogenous) level of government consumption, any fiscal surplus (deficit) will result in decreasing (increasing) level of public foreign debt, B_t^g:

$$\begin{aligned} & \tau_t^c C_t + \tau_t^k R_t K_{t-1} + \tau_t^l W_t L_t + \tau_t^k \frac{\Pi_t}{P_t} + \\ + \quad & e_t \frac{B_{t-1}^g}{P_t}(1+i_{t-1})\exp(-\omega) = G_t + S_t + e_t \frac{B_t^g}{P_t}. \end{aligned} \tag{13}$$

Similar to households, we assume, that the government's borrowing relies solely on foreign funds. The latter assumption is supported by evidence of dominant role of foreign borrowing when looking at decomposition of Lithuania's public debt in terms of sources of financing.

The effective tax rates are assumed to be exogenous processes following an autoregressive specification.

[15] In Karpavičius (2008) the capital accumulation evolves subject to capital adjustment cost. Introducing this change in the model allows us to get smoother impulse responses of variables, especially of investment.

Monetary authority

In line with the currency board arrangement in Lithuania, monetary policy in the model features the fixed exchange rate regime:

$$e_t = \bar{e}(1 + \xi_t), \tag{14}$$

where $\bar{e}$ is the fixed exchange rate; ξ_t denotes a serially uncorrelated monetary policy shock.

The interest rate at which households and government can borrow funds abroad depends on foreign interest rate, i_t^*, and a risk premium which is an increasing function of net foreign debt of the whole economy:

$$(1 + i_t) = (1 + i_t^*) \exp\left(\Theta \frac{B_t + B_t^g}{\bar{P}^x \bar{Q}^x}\right) \exp(\upsilon_t), \tag{15}$$

where Θ measures degree of capital mobility; $\bar{P}^x \bar{Q}^x$ is the steady-state value of nominal exports; υ_t is a serially uncorrelated shock to the uncovered interest parity condition.

Foreign variables and home exports

Given small size of the Lithuanian economy relative to its export markets, foreign variables are modeled exogenously. In particular, foreign income (foreign GDP), prices and interest rate are assumed to follow an autoregressive process around their steady state path.

External demand for domestic intermediate goods is defined similar to Kollmann (2002):

$$Q_t^x = \left(\frac{P_t^x}{P_t^*}\right)^{-\eta} Y_t^*, \tag{16}$$

where P_t^* and Y_t^* are respectively foreign price and income, η denotes price elasticity of home exports.

Market clearing

Market clearing implies that final good, Z_t, is either consumed as the private or public good, or invested.

$$Z_t \quad = \quad C_t + I_t + G_t \tag{17}$$

Furthermore, the cash inflows of the whole economy are equal to outflows, i.e., new borrowing and exports receipts should offset the repayment of old debts and

purchase of imports:

$$B_t + B_t^g + P_t^x Q_t^x \quad = \quad (B_{t-1} + B_{t-1}^g)(1 + i_{t-1}) \exp(-\omega) + \frac{P_t^m Q_t^m}{e_t}. \qquad (18)$$

Finally, we define the gross domestic product, Ψ_t, as follows:

$$\Psi_t \quad = \quad Z_t + e_t \frac{P_t^x}{P_t} Q_t^x - \frac{P_t^m}{P_t} Q_t^m. \qquad (19)$$

A.2 Calibration

Table 1 displays the calibration of the main parameters. The model is calibrated to match quarterly Lithuanian data, however standard parameter values offered by the literature are used as well.

Table 1: Calibration of the main parameters of the model.

Parameter		Value	Source
Preferences			
Habit formation	h	0.550	Smets and Wouters (2003)
Elast. of substitution: consumption	σ_C	1.000	Christiano et al. (2005)
Elast. of substitution: labor supply	σ_L	1.000	Christiano et al. (2005)
Discount factor	β	0.990	Smets and Wouters (2003)
Wage and Price setting			
Wage mark-up: steady state	$\bar{\gamma}$	0.050	Christiano et al. (2005)
Price mark-up: steady state	$\bar{\nu}$	0.160	Martins et al. (1996)
Calvo parameter for wages	λ_w	0.750	Smets and Wouters (2003)
Calvo parameter for prices	λ_p	0.750	Smets and Wouters (2003)
Final-good production			
Home bias	α	0.500	Industrial statistics
Price elasticity of exports	η	1.000	Dam and Linaa (2005)
Intermediate-good production			
Capital share	φ	0.297	National accounts
Deterministic productivity growth	ω	0.014	Jakaitienė (2006)
Depreciation rate	δ	0.025	Smets and Wouters (2003)
Fiscal and monetary policy			
Transfers to GDP (in %): steady state	$\bar{s}$	0.730	National accounts
Consumption tax rate: steady state	$\bar{\tau}^c$	0.162	National accounts
Capital income tax rate: steady state	$\bar{\tau}^k$	0.051	National accounts
Labor income tax rate: steady state	$\bar{\tau}^l$	0.091	National accounts
Capital mobility	Θ	0.002	Kollmann (2002)
Autoregressive coefficients			
Total factor productivity shock	ρ^{θ}	0.850	Smets and Wouters (2003)
Shock to the discount rate	ρ^{b}	0.850	Dam and Linaa (2005)
Labor supply shock	ρ^{L}	0.850	Dam and Linaa (2005)
Investment-specific shock	ρ^{ϵ^I}	0.850	Smets and Wouters (2003)
Consumption tax rate	ρ^{τ^c}	0.300	Karpavičius (2008)
Capital income tax rate	ρ^{τ^k}	0.280	Karpavičius (2008)
Labor income tax rate	ρ^{τ^l}	0.500	Karpavičius (2008)
Foreign income	ρ^{Y^*}	0.730	Karpavičius (2008)
Foreign prices	ρ^{P^*}	0.310	Karpavičius (2008)
Foreign interest rate	ρ^{i^*}	0.880	Karpavičius (2008)

Note: All tax rates are expressed as effective ratio of the tax revenues and the respective tax bases.

B Derivation of Welfare Measure

We base our welfare analysis upon the computation of the non-stochastic instantaneous utility function of the household:

$$\mathbb{U}_t = \frac{(C_t - hC_{t-1})^{1-\sigma_C}}{1-\sigma_C} - \frac{L_t^{1+\sigma_L}}{1+\sigma_L} + \frac{\bar{G}}{\bar{C}}\frac{(G_t - hG_{t-1})^{1-\sigma_C}}{1-\sigma_C} - \left[\frac{n_t^{1+\sigma_L}}{1+\sigma_L}\right].$$

Note that the last term (in brackets) is optional and used in case of tax evasion. The impact of tax evasion on household's utility is similar to the one of working time. Therefore, the disutility of tax evasion has the same structure as the disutility from labor in the utility function.

We log-linearize the utility function around consumption in steady state:

$$\mathbb{U}_t \approx \bar{\mathbb{U}} + \bar{C}\hat{\mathbb{U}}_t.$$

Therefore, the measure of welfare, $\hat{\mathbb{U}}_t$, shows the changes of the utility of household in terms of consumption:

$$\begin{aligned}\hat{\mathbb{U}}_t &= \left[(1-h)\bar{C}\right]^{-\sigma_C}\hat{C}_t - h\left[(1-h)\bar{C}\right]^{-\sigma_C}\hat{C}_{t-1} + \\ &+ \left(\frac{\bar{G}}{\bar{C}}\right)^2\left[(1-h)\bar{G}\right]^{-\sigma_C}\hat{G}_t - \left(\frac{\bar{G}}{\bar{C}}\right)^2 h\left[(1-h)\bar{G}\right]^{-\sigma_C}\hat{G}_{t-1} - \\ &- \frac{(\bar{L})^{1+\sigma_L}}{\bar{C}}\hat{L}_t - \left[\frac{(\bar{n})^{\sigma_L}}{\bar{C}}\hat{n}_t\right]. \qquad (20)\end{aligned}$$

Notice that $\hat{n}_t$ shows not the deviations in percent, but the percentage points deviations from $\bar{n}$.

$\hat{\mathbb{U}}_t$ can be considered as the measurement of instantaneous welfare gains in terms of consumption. In addition, the respective literature (e.g., Prescott, 2004) suggests to use the *lifetime consumption equivalent* measure. It shows the percentage of consumption today and in all future periods must be increased in order that the households would be indifferent to the proposed policy change.

In this paper, the lifetime consumption equivalent measure, $\hat{\mathbb{W}}_t$, is simply:

$$\hat{\mathbb{W}}_t = \sum_{t=0}^{\infty}\beta^t\hat{\mathbb{U}}_t. \qquad (21)$$

C Tables and Figures

Figure 6: The changes in the statutory tax rates implied by the fiscal reform

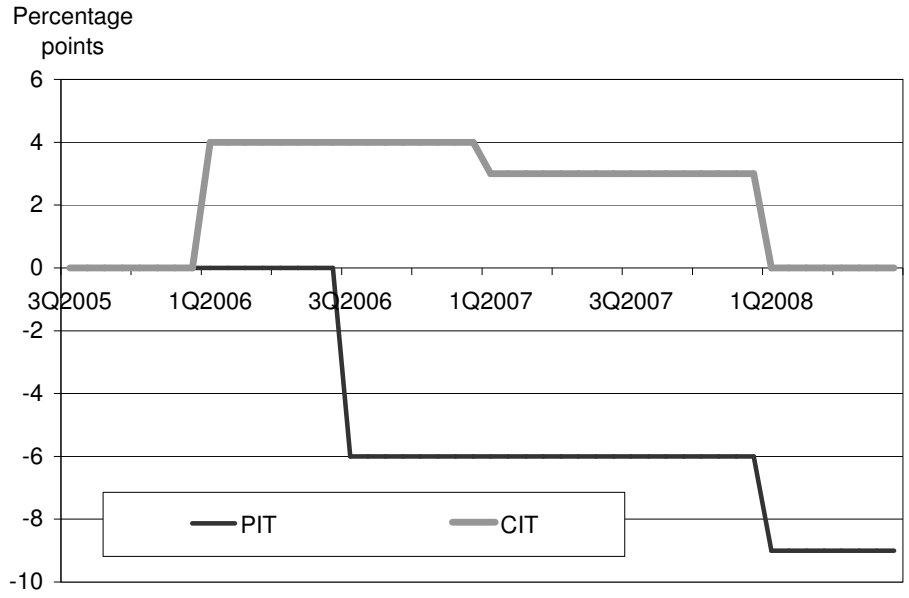

Table 2: Macroeconomic and welfare impact of the fiscal reform assuming endogenous government expenditure adjustment

Variable	Date										
	2006				2007						
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	4Q2011	4Q2015	∞
Government debt											
Benchmark model	-0.46	-0.84	-0.36	0.02	0.44	0.78	1.06	1.30	6.58	6.83	6.79
Model with tax evasion	-0.45	-0.84	-0.58	-0.38	-0.12	0.10	0.29	0.44	4.73	4.92	4.88
GDP											
Benchmark model	-0.12	-0.16	-0.08	-0.06	-0.03	-0.04	-0.05	-0.07	0.05	0.07	0.12
Model with tax evasion	-0.12	-0.16	-0.11	-0.10	-0.07	-0.08	-0.08	-0.09	0.04	0.04	0.09
Welfare $\mathbb{U}_t$											
Benchmark model	0.08	0.22	0.78	0.63	0.53	0.45	0.38	0.33	-0.35	-0.32	-0.25
Model with tax evasion	0.08	0.22	1.29	1.22	1.15	1.09	1.03	0.99	0.72	0.77	0.82
Consumption											
Benchmark model	-0.04	-0.07	0.48	0.79	0.96	1.06	1.11	1.14	1.99	2.11	2.25
Model with tax evasion	-0.04	-0.07	0.32	0.54	0.66	0.73	0.77	0.78	1.41	1.51	1.62
Investment											
Benchmark model	-0.74	-1.33	-1.88	-2.30	-2.44	-2.51	-2.53	-2.51	0.32	0.13	0.12
Model with tax evasion	-0.74	-1.33	-1.86	-2.26	-2.38	-2.43	-2.45	-2.42	0.35	0.09	0.09
Capital											
Benchmark model	-0.03	-0.08	-0.15	-0.23	-0.32	-0.40	-0.48	-0.56	-0.35	-0.10	0.12
Model with tax evasion	-0.03	-0.08	-0.15	-0.23	-0.31	-0.39	-0.47	-0.55	-0.30	-0.08	0.09
Labor											
Benchmark model	0.03	-0.02	0.09	0.13	0.13	0.14	0.14	0.15	0.23	0.25	0.30
Model with tax evasion	0.03	-0.02	0.05	0.07	0.07	0.09	0.10	0.11	0.18	0.18	0.22
Prices											
Benchmark model	0.02	0.03	0.04	0.04	0.04	0.04	0.05	0.05	-0.05	-0.10	-0.12
Model with tax evasion	0.02	0.03	0.04	0.04	0.04	0.05	0.05	0.05	-0.03	-0.07	-0.09
Wages before taxes											
Benchmark model	-0.04	-0.07	-0.11	-0.15	-0.17	-0.18	-0.20	-0.22	-0.18	-0.19	-0.18
Model with tax evasion	-0.04	-0.07	-0.11	-0.14	-0.16	-0.17	-0.19	-0.20	-0.14	-0.14	-0.13

List of Bank of Lithuania Working Papers

No 2: "Personal Income Tax Reform: Macroeconomic and Welfare Implications" by Sigitas Karpavičius and Igor Vetlov, 2008.

No 1: "Short-Term Forecasting of GDP Using Large Monthly Datasets: A Presudo Real-Time Forecast Evaluation Exercise" by G. Rünstler, K. Barhoumi, S. Benk, R. Cristadoro, A. Den Reijer, A. Jakaitienė, P. Jelonek, A. Rua, K. Ruth, C. Van Nieuwenhuyze, 2008.