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Implications of Transitory and Permanent Changes in Tax Rates for Poland

Abstract: This article provides an analysis of the fiscal channel that assumes balancing between raised labour, capital and consumption tax rates and government consumption, calibrated for Polish data. The study is based on neoclassical, education-based semi-endogenous and exogenous growth models for a small closed economy, featuring a direct household utility from government consumption, extended to include monopolistic competition. Two perspectives are considered: 1) the transitory effects of the government consumption impulse on private consumption and 2) permanent changes in tax rates towards the top of the Laffer curve. The results of the transitory impulse confirm the crowding-in of private consumption in a fully competitive economy, but not for monopolistic competition. Permanent changes in tax rates, analysed from the perspective of the Laffer curves, show some room for higher tax revenues. Shifting the tax rates to the top of the Laffer curves improves tax revenues, but it significantly deteriorates key economic aggregates.

Keywords: Laffer curve, government spending, distortionary taxation, monopolistic competition, human capital, crowding in

JEL classification codes: E32, E62, H20, H21, H52, H60, J24

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Introduction

The labour force in some European countries is shrinking due to ageing, but at the same time people are increasing their human capital due to higher education and lifelong learning. Additionally, recent studies for Central Euro-

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pean economies, by e.g. Böwer [2017] and the European Commission [2017], point to economic threats due to a growing concentration of physical and financial capital under government control. A coincidence of these processes, i.e. population ageing and a possible drift towards monopolistic practices, may have some adverse consequences for fiscal policy. This paper addresses the effects for the real economy from the fiscal channel where raised taxes are balanced by government consumption.

The key questions are: How do key economic aggregates respond to temporary shocks, and how do they respond to permanent tax rate shifts towards the top of the Laffer curve? How does the substitution between public and private consumption and taxation of human capital affect the results? How does monopolistic competition influence the results?

To tackle these issues, the neoclassical growth model for a closed economy is used, where the government imposes varying tax rates on labour, capital and consumption, to finance lump-sum transfers, public consumption and debt servicing costs. Only several variables are fixed on their balanced growth paths: government debt and its costs, government consumption and individual types of tax revenue. The households utility function assumes substitution between public and private consumption, as in Christiano *et al.* [1992]. The endogenous growth factor for human capital relies on the estimated internal rate of return on investment in higher education and lifelong learning. The accumulation of human capital is created within the production sector, as in Rebelo [1991]. In this approach, producers decide to resign from a part of the paid labour time borrowed from households to enhance human capital via lifelong learning. In the extended version of the model, firms impose a monopolistic rent.

To answer the key questions, two scenarios are tested: 1) a transitory shock investigated in the neighbourhood of the steady state in the real business cycle model, and 2) a permanent change in the tax rate towards the top of the Laffer curve. The first scenario aims to show an exemplary post-crisis impulse from government expenditures to sustain private consumption. The second scenario is investigated in terms of consequences for the real economy after a permanent shift to the top of the particular Laffer curves in order to finance permanently growing government consumption.

With regard to literature findings for temporary impulses from government consumption, the article takes an approach close to that of Rebei [2004], Bouakez and Rebei [2007], Ramey [2011], and Ambler *et al.* [2017]. This last study shows that, provided there is a strong Edgeworth complementarity between private and public consumption, the government consumption impulse may cause a temporary crowding-in of private consumption, as observed in the data, but this is contrary to the neoclassical growth theory.

The second approach, i.e. permanent changes in tax rates analysed from the perspective of the Laffer curves, is investigated in a manner comparable

to that of Trabandt and Uhlig [2012], who show mixed evidence for European Union economies in terms of distance to the peak of the Laffer curves.

In comparison to the study by Trabandt and Uhlig, this article not only provides a pioneering adjustment to Polish data, but takes a different approach to at least two relevant theoretical aspects. First, the households utility function takes a direct utility from government consumption provided it exhibits strong complementarity with private consumption. Second, the Laffer curves are built on independently computed steady states for nearly all variables regardless of their initial steady states.

The motives for these changes need to be clarified. First, the substitution between private and public consumption seems to enable the neoclassical growth models to better reflect the data, as in e.g. Blanchard and Perotti [2002] or Linneman *et al.* [2003]. Second, the departure from the BGP for all key economic variables stems from a very restrictive approach whereby the Laffer curves are based on the balanced growth path for all variables across the tax scale. Such a restrictive approach considers tax rates that do not exist in reality, e.g. over 50% capital or consumption tax rates. Relaxing the analytical reduction of the model to a single non-linear equation (for labour supply, as in Trabandt and Uhlig [2011]) in order to achieve the BGP may produce some interesting consequences for human and capital developments, for example. This study uses the author's own estimates of the internal rate of return on investment in higher education and lifelong learning based on the de la Fuente *et al.* [2005] approach and, additionally, on the estimates of the effective tax rates, primarily attributed to Mendoza *et al.* [1994] and further developed by Trabandt and Uhlig [2011, 2012].

With regard to research reports concerning Poland, a profound analysis by Bukowski *et al.* [2005] is updated here and expanded by the human capital factor and monopolistic competition. Krajewski [2011] provides a wider perspective of the supply-side effects of public finances in the economy, while Konopczyński [2013] sheds light on interrelations between taxation, growth and human capital as reflected in the Mankiw-Romer-Weil [1992] growth model. The findings of Krajewski and Konopczyński are complemented by a real business cycle model with human capital. Meanwhile, Wnorowski [2012] focuses primarily on indirect taxation, an approach that is extended in this study to include the consumption Laffer curve and estimates of the effective consumption rate.

The paper is organised in the following way: after this introduction, section 2 describes the model and its parametrisation. Section 3 provides the results for a temporary shock. These are subsequently extended to include the Laffer curves in section 4, and then a shift towards the top of the curves is discussed in section 5. The study concludes in section 6. A technical appendix is also included with effective tax rate calculations and more detailed model statistics.

Model

The households

The framework relies on the neoclassical growth model with a discrete time, $t = 0, 1, 2, \dots, \infty$, basically¹, in two versions: a standard exogenous growth model (further marked as 'Ex') and the semi-endogenous component (further marked as 'SE') based on labour time devoted to developing human capital. In the SE model, the households devote part of the total available time to separately parametrised schooling and lifelong learning. The households directly take a part of government consumption and control the labour supply to maximise their utility function:

$$\max_{C_t, \bar{C}_t, L_t^s, H_t, q_t} U_t = \beta E_t [U_{t+1}] + \frac{\left(\bar{C}_t^\mu (1 - L_t^s)^{1-\mu} \right)^{1-\eta}}{(1-\eta)} \quad (1)$$

s.t.:

$$\bar{C}_t = \left(a C_t^{\sigma^{G-2}} (1-a) + G_t^{\sigma^{G-2}} \right)^{\sigma^{G2}} \left(\lambda_t^{C^l} \right) \quad (2)$$

$$B_t + C_t P_t^{FIN} (1 + \tau^c) = T_t + B_{t-1} (1 + r_t) + (1 - \tau^k) (\pi_t + \pi_t^{PS}) + H_{t-1} q_t L_t^s W_t (1 - \tau^l) \left(\lambda_t^{C^2} \right) \quad (3)$$

$$H_t = H_{t-1} (1 - \delta^h) + H_{t-1}^{1-\Omega} \left(A q_t L_t^s + S L_t^s (1 - q_t) \right)^\Omega \left(\lambda_t^{C^3} \right) \quad (4)$$

where E stands for the mathematical expectations operator conditional on information that households possess at time t , and value it with subjective discount factor β . Further symbols denote: K physical capital, \bar{C} total household consumption, C_t private consumption, L^s labour supply, I investments, H human capital, T government transfers, $\pi - \pi_t^{PS}$ firms' distributed profits (π) reduced by the monopolistic mark-up (π^{PS}), W gross wages, B government debt, and r debt servicing costs. The effective tax rates for labour, capital and consumption are denoted by τ^l , τ^k and τ^c respectively. The parameters are given by σ^G , which stands for the elasticity of substitution between private and public consumption; μ , which is the consumption weight in the utility function; η , which is relative risk aversion; and finally δ and δ^h , which denote the depreciation rates for fixed and human capital respectively. The substitution

¹ Due to capacity constraints, the analytical solution focuses on the most complex setting of the applied model, i.e. including human capital and monopolistic competition. The intermediary version of the model, i.e. exogenous growth and a fully competitive economy, are skipped.

between public and private consumption is split by the a parameter. Taxed private consumption is multiplied by monopolistic price P^{FIN} . Human capital is accumulated with a reduced labour supply by the portion of time for life-long learning $1 - q$. Higher education and lifelong learning bring extra income with the S and A parameters respectively. Total household consumption \bar{C} is aggregated private consumption C and public consumption G bearing CES, which assumes decreasing marginal returns to public consumption with respect to a given level of private consumption, to satisfy the sum of overall consumption². Equation (4) is skipped in the exogenous growth model, while the wage fund in the economy is defined only by $L_t W_t$.

The first order conditions (FOC) are derived automatically in gEcon further to the findings of Klima and Retkiewicz-Wijtiwiak [2014] as follows:

$$\beta - \lambda_t^U = 0 \quad (U_t) \tag{5}$$

$$a\mu C_t^{\sigma^{G-2}-1} \bar{C}_t^{\mu-1} (1-L_t^s)^{1-\mu} a C_t^{\sigma^{G-2}} + \left((1-a) G_t^{\sigma^{G-2}} \right)^{\sigma^{G2}-1} \left(\bar{C}_t^\mu (1-L_t^s)^{1-\mu} \right)^{-\eta} - \lambda_t^{C^2} P_t^{FIN} (1+\tau^c) = 0 \quad (C_t) \tag{6}$$

$$\begin{aligned} & (\mu - 1) \bar{C}_t^\mu (1-L_t^s)^{-\mu} \left(\bar{C}_t^\mu (1-L_t^s)^{1-\mu} \right)^{-\eta} \\ & \Omega \lambda_t^{C^3} (Aq_t + S(1-q_t)) H_{t-1}^{1-\Omega} \\ & + (Aq_t L_t^s + S L_t^s (1-q_t))^{\Omega-1} + H_{t-1} \lambda_t^{C^2} q_t W_t (1-\tau^l) = 0 \quad (L_t^s) \end{aligned} \tag{7}$$

$$E_t \left[\lambda_{t+1}^U \left(\lambda_{t+1}^{C^3} \left(1 - \delta^h + (1-\Omega) H_t^{-\Omega} (Aq_{t+1} L_{t+1}^s + S L_{t+1}^s (1-q_{t+1}))^\Omega \right) \lambda_{t+1}^{C^2} q_{t+1} L_{t+1}^s W_{t+1} (1-\tau^l) \right) \right] - \lambda_t^{C^3} = 0 \quad (H_t) \tag{8}$$

$$\begin{aligned} & \Omega \lambda_t^{C^3} (A L_t^s - S L_t^s) H_{t-1}^{1-\Omega} (Aq_t L_t^s + S L_t^s (1-q_t))^{\Omega-1} + \\ & H_{t-1} \lambda_t^{C^2} L_t^s W_t (1-\tau^l) = 0 \quad (q_t) \end{aligned} \tag{9}$$

² The elasticity of substitution is of crucial importance for the development of total consumption that reacts for exogenous shocks of government consumption, as stated in Bouakez and Rebei [2007]. However, in this study, the mid-term developments are just outlined, so the parameter is taken from the literature: $\sigma^G = 2$.

The firms

The firms maximise their profit and decide to allocate time resources from the households and govern the capital. Contrary to Trabandt and Uhlig [2011, 2012], the capital is not controlled by the households, but by the firms, which reduces the price of capital. The production process develops in stages, however, within a single time period t . The stages are intermediate production, price setting, and the final product. First, the intermediate firm maximises its product Π_t by borrowing the labour supply, and by controlling the investments:

$$\max_{K_t, I_t^d, Y_t, I_t, \pi_t} \Pi_t = \pi_t + \frac{E_t \left[\lambda_{t+1}^U \lambda_{t+1}^{C^2} \Pi_{t+1} \right]}{\lambda_t^{C^2}} \quad (10)$$

s.t.:

$$\pi_t = P_t Y_t - I_t P_t^{FIN} - H_{t-1} q_t I_t^d W_t \quad \left(\lambda_t^{I^1} \right) \quad (11)$$

$$Y_t = K_{t-1}^\alpha (H_{t-1} q_t L_t^d Z_t)^{1-\alpha} \quad \left(\lambda_t^{I^2} \right) \quad (12)$$

$$K_t = I_t + K_{t-1}(1-\delta) \quad \left(\lambda_t^{I^3} \right) \quad (13)$$

where the last equation stands for the law of motion of capital. π_t stands for the intermediary product, and I denotes investment, while λ_t^U , $\lambda_t^{C^2}$ are the Lagrange multipliers from the households' FOC that are maximised by the firms' objective. Y_t stands for product quantity, priced with P_t . Exogenous technological progress Z is given by:

$$Z_t = e^{\epsilon_t^Z + \phi \log Z_{t-1}}, \epsilon_t^Z \sim i.i.d. N(0; \sigma^2) \quad (14)$$

where ϕ denotes the autocorrelation of technological progress, and Z is a random variable independent on other variables in the model. The first order conditions for the intermediate firm are given by:

$$\frac{1}{\lambda_{t-1}^{C^2}} \lambda_t^U \lambda_t^{C^2} - \lambda_t^{I^1} = 0 \quad (\Pi_t) \quad (15)$$

$$E_t \left[\lambda_{t+1}^{I^1} \left(\lambda_{t+1}^{I^3} (1-\delta) \alpha \lambda_{t+1}^{I^2} K_t^{-1+\alpha} + (H_t q_{t+1} L_{t+1}^d Z_{t+1})^{1-\alpha} \right) \right] - \lambda_t^{I^3} = 0 \quad (K_t) \quad (16)$$

$$H_{t-1} \lambda_t^{I^2} q_t Z_t (1-\alpha) K_{t-1}^\alpha (H_{t-1} q_t L_t^d Z_t)^{-\alpha} - H_{t-1} q_t W_t = 0 \quad (L_t^d) \quad (17)$$

$$P_t - \lambda_t^2 = 0 \quad (Y_t) \tag{18}$$

$$\lambda_t^3 - P_t^{FIN} = 0 \quad (I_t) \tag{19}$$

Monopolistic competition

Then the monopolistic mark-up is imposed in the price setting block:

$$\max_{\pi_t^{ps}, Y_t^{MON}, P_t^{MON}} \Pi_t^{PS} = \pi_t^{ps} \tag{20}$$

s.t.:

$$\pi_t^{ps} = Y_t^{MON} (P_t^{MON} - P_t) \quad (\lambda_t^{PS1}) \tag{21}$$

$$Y_t^{MON} = Y_t^{FIN} \left(\frac{P_t^{MON}}{P_t^{FIN}} \right)^{-\rho} \quad (\lambda_t^{PS2}) \tag{22}$$

where the monopolistic part of the firm maximises profit Π^{PS} by imposing the additional portion of price P^{MON} in order to achieve monopolistic product Y^{MON} . The elasticity of the monopolistic power is regulated with the ρ parameter. The first order conditions for a monopolistic rent are defined below:

$$Y_t^{MON} - \rho \frac{Y_t^{FIN}}{P_t^{FIN}} (P_t^{MON} - P_t) \left(\frac{P_t^{MON}}{P_t^{FIN}} \right)^{-\rho-1} = 0 \quad (P_t^{MON}) \tag{23}$$

The product market clears by the unification of an intermediate and final product rule:

$$Y_t^{FIN} = Y_t^{MON} \tag{24}$$

With respect to the introduction to this article, where government control over a significant part of the production sector is linked with monopolistic practices, the above equation shows no strict reference in the model between the government and the firms. Such a relationship is then implicitly assumed by e.g. the decision making bodies of the firms controlled by the government. Such control is necessary for the monopolistic mark-up, which increases the consumption and capital tax revenues, as stipulated below in (28) and (29).

The government

The government budget balance is given by:

$$T_t + B_{t-1}(1+r_t) + G_t P_t^{FIN} = \tau_t + B_t \quad (25)$$

$$\tau_t = \tau_t^C + \tau_t^K + \tau_t^L \quad (26)$$

$$\tau_t^L = \tau^l q_t H_{t-1} L_t^d W_t \quad (27)$$

$$\tau_t^C = \tau^c C_t P_t^{FIN} \quad (28)$$

$$\tau_t^K = \tau^k (P_t^{FIN} Y_t^{FIN} - I_t P_t^{FIN} - H_{t-1} q_t L_t^d W_t) \quad (29)$$

where τ , τ^L , τ^K , τ^C denote respectively government revenues from all taxes: labour taxes (PIT + social security contributions), capital taxes (mainly CIT) and consumption taxes (VAT + excise). Note that government consumption is free of consumption tax, which is not consistent among EU countries and has little quantitative impact on the results. The capital and consumption taxes are imposed on gross profit and private consumption, both with a monopolistic mark-up. The latter has a positive influence on consumption and capital tax revenues. Government debt and its servicing costs are held on their BGP for all tax rates $B_t / Y_t = \bar{B}$, $r_t = \bar{r}$. In the basic steady state, the value of government consumption is calibrated to verify the development of shocks to government consumption.

$$G_t = \bar{G} + \epsilon_t^G \quad (30)$$

A few words of explanation may help to understand the differences between the temporary impulse from government consumption, which is balanced by a respective tax category to verify the development of particular variables around the steady state. Here the labour tax balances the shock to government consumption. Contrarily, a permanent shift in tax rates towards the top of the Laffer curve respects the same fiscal channel and, as in Ayiagari *et al.* [1992], the changes are more significant than in the short term. Below, the capital and consumption tax revenues are calibrated to verify the mid-term development of the impulse response function (IRF) of government consumption balanced by the labour tax.

$$\tau_t^K = \bar{\tau}^K + \epsilon_t^{\tau^K} \quad (31)$$

$$\tau_t^C = \bar{\tau}^C + \epsilon_t^{\tau^C} \quad (32)$$

with a set of calibrating equations that match the parameter to data, i.e. the 10-year average relationship to GDP: $\bar{G}_{ss} = 0.18$, $\bar{\tau}_{ss}^k = 0.07$, $\bar{\tau}_{ss}^c = 0.13$, $\bar{B}_{ss} = 0.47$, $\bar{r}_{ss} = 0.03$. The bond market clears with $0.03 = r_t$ and $0.47 - \frac{B_t}{Y_t} = 0$. The exogenously given shocks to consecutively considered fiscal channels evolve according to:

$$\log \epsilon_t^G = \eta_t^G + \rho^G \log \epsilon_{t-1}^G \tag{33}$$

$$\log \epsilon_t^{\tau^k} = \eta_t^{\tau^k} + \rho^{\tau^k} \log \epsilon_{t-1}^{\tau^k} \tag{34}$$

$$\log \epsilon_t^{\tau^c} = \eta_t^{\tau^c} + \rho^{\tau^c} \log \epsilon_{t-1}^{\tau^c} \tag{35}$$

where η^G , η^{τ^k} , η^{τ^c} denote the exogenous shock that develops according to a stationary stochastic AR (1) process; ρ^G , ρ^{τ^k} and ρ^{τ^c} denote the autocorrelation parameter with error term ϵ_t^G , $\epsilon_t^{\tau^k}$ and τ^c stands for a joint normal distribution with zero expected value. The distribution of the autocorrelation process is simplified, as compared to e.g. Skibińska [2015], yet this is not a principal objective of this study. The equilibrium is completed with the following set of market clearing equations for prices P , quantity of the monopolistic product Y^{MON} and labour L :

$$P_t^{FIN} = 1 \tag{36}$$

$$Y_t^{MON} = Y_t \tag{37}$$

$$L_t^d = L_t^s \tag{38}$$

The latter equation provides that the labour supply is inelastic. The analytical solution of the model follows on the basis of modified capital tax revenues:

$$P_t^{FIN} G_t + T_t + (1+r_t)B_{t-1} = \tau^c C_t P_t^{FIN} + \tau^k (\pi_t - \pi_t^{ps}) + \tau^l H_{t-1} q_t L_t^s W_t + B_t \tag{39}$$

which, together with a slightly reordered formula for government revenues, can be included into the household budget constraint:

$$B_t + (1+\tau^c)C_t P_t^{FIN} = (1-\tau^k)(\pi_t - \pi_t^{ps}) + \tau^c C_t P_t^{FIN} + \tau^k (\pi_t - \pi_t^{ps}) + \tau^l H_{t-1} q_t L_t^s W_t + B_t - P_t^{FIN} G_t - (1+r_t)B_{t-1} + (1+r_t)B_{t-1} + (1-\tau^l)H_{t-1} q_t L_t^s W_t \tag{40}$$

After a simplification we get:

$$C_t P_t^{FIN} = \pi_t - \pi_t^{ps} - P_t^{FIN} G_t + H_{t-1} q_t L_t^S W_t \quad (41)$$

A formula for the firm's profit $\pi_t - \pi_t^{ps}$ can be extended to the following version:

$$C_t P_t^{FIN} = P_t^{FIN} Y_t^{FIN} - H_{t-1} q_t L_t^S W_t - P_t^{FIN} I_t - P_t^{FIN} G_t + H_{t-1} q_t L_t^S W_t \quad (42)$$

After rearranging and presenting it in real terms, the model closes with the standard equation:

$$Y_t^{FIN} = C_t + I_t + G_t \quad (43)$$

The equilibrium and the ultimate steady state relationships automatically generated in the gEcon environment can be found in Appendix 7:

Parametrisation

The table below summarises the parameters calibrated to Polish quarterly data, the same for both types of models as applicable. MC stands for the monopolistic competition versions.

Table 1. Parameters used in the model

A	S	μ_{Ex}	μ_{SE}	τ^l	τ^k	τ^c	$\tau^l(MC)$	$\tau^k(MC)$	$\tau^c(MC)$	
0.023	0.18	0.53	0.34	0.28	0.16	0.18	0.37	0.16	0.18	
Ω	a	α	δ	δ_h	β	ρ^G	φ	η	σ^G	ρ
0.91	0.9	0.316	0.025	0.02	0.99	0.95	0.95	2	2	4

Source: Own calculations.

The following parameters were taken from the general literature: δ , β , φ , η , σ^G are default values in model templates provided in the gEcon library, very similar to those from e.g. Bukowski *et al.* [2005], while ρ was adjusted to meet the aggregates in the economy. The exception from the broad literature refers to the capital share ratio α taken from Skibińska [2015] and the consumption weight in the utility function μ . The first is reduced to $\alpha = 0.316$ to reflect the lower physical capital-to-GDP ratio for the developing economy. The latter varies between the SE and Ex growth models to obtain labour supply L_s at a level of around one-third of the leisure time, which corresponds to 40 working hours per week.

With regard to the accumulation of human capital parameters, Trabandt and Uhlig [2012] considered $\Omega = 0.5$, which was consistent with other related param-

eters, i.e. return on higher education $S = 0.5$, and lifelong learning $A = 0.25$, $q = 0.8$, with equal depreciation of human and physical capital $\delta = \delta_h = 0.025$ and the labour/leisure balance of working hours share in total available time $n = 0.25$. This study relies on the author's own estimates of parameters S and A derived as proposed by de La Fuente *et al.* [2005] and Romele [2014]³. Yet, some crucial issues are only briefly mentioned here, i.e. the human capital depreciation rate, which in the literature is generally much smaller than that of physical capital, as suggested by e.g. Weber [2008] for SUI below 2% annually, which would give $\delta_h < 0.005$ quarterly. The cross-reference tests with the models applied here suggest that the range of steady state of human capital close to the exogenous growth model is achievable in the applied model with $\delta_h > 0.015$ quarterly, so roughly three times higher. Lower amortisation rates for human capital result in a significant divergence from the steady state, which may stem from several issues, e.g. wrong calculations of the internal rate of return on investment in higher education, time devoted to self-development q_t or the model's wrong specification in this context. This study's proxy of $\delta_h = 0.02$ just marks the difference as compared with the physical capital in order to ensure that there is a stable model solution. In order to obtain the reasonable labour time L_s , Ω and the human capital depreciation rate δ_h , the consumption weight in the utility function μ is different in both models. The higher value of $\mu_{Ex} = 0.53$ is used in the exogenous growth model, while the lower one, $\mu_{SE} = 0.34$, is used in the semi-endogenous growth model, which may suggest that agents who invest in education devote some consumption in order to maximise their utility function with reduced pure labour time qL_s . The default value in many RBC models in the literature is around 3%. However, varying such key parameters makes models incomparable, which is a debatable approach in the case of representative agent models. If $\mu_E = \mu_{SE}$ then the two models yield slightly different products Y , and the labour supply L_s or human capital parameters have to be set at an awkward level, i.e. $\Omega > 1$ or depreciation rate δ_h should be set at a level of around $\delta_h > 0.08$ quarterly, which is many times higher than estimated in Weber [2008].

The parameter for splitting utility between private and public consumption, $a = 0.9$, is taken from Rebei [2004]. If the effective tax rates were applied as in Mendoza *et al.* [1994], the labour tax rate would be 41% and the labour taxes would amount to 29% of GDP, as compared with the actual average of 19%. To tackle this problem, the tax rates are adjusted to meet the respective aggregates of τ^L and G in the basic steady state, as described in Technical Appendix 7.

The model of that size is too complex to be solved analytically. Additionally, a manual solution may cause costly errors. Therefore, the solution relies on the numerical solver provided in the gEcon programming framework, which uses the solver solutions by Sims [2002]. Due to capacity limitations, these are also skipped, but can be provided on request. The steady states match the

³ Detailed calculations are skipped in this study due to capacity limitations, but can be provided upon request.

actual data quite well, provided that some of them are unobserved variables in the national accounts. The results of the model statistics compared with the actual 10-year averages from the OECD/AMECO database, updated for the same data sources as in Trabandt and Uhlig [2011, 2012], are presented in the table below⁴:

Table 2. Results of SE growth model compared with 10-year average actual data, $Y = 1$

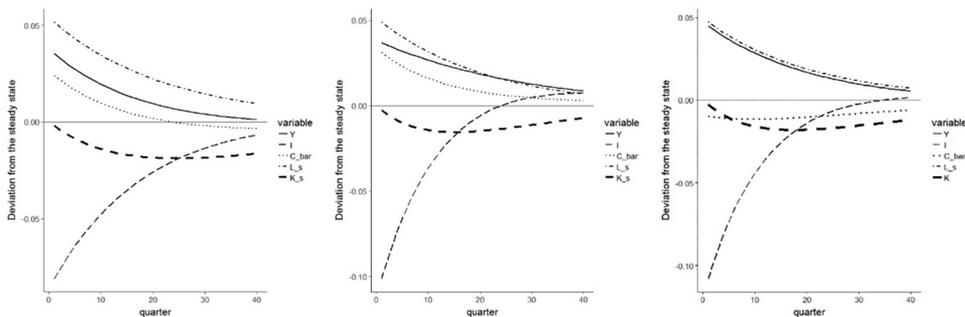
	r	P	L	π	π^{PS}	T	τ^C	τ^K	τ^L	B	Y
model	0.03	0.95	0.31	0.07	0.25	0.38	0.13	0.07	0.19	0.47	1
data	0.03	-	-	-	-	0.39	0.13	0.07	0.19	0.47	1
	C	\bar{C}	Π	Π^{PS}	G	H	K	W	I	T	q
model	0.66	0.59	6.91	0.25	0.18	1.76	6.8	1.23	0.20	0.17	0.73
data	0.65	-	-	-	0.18	-	-	-	0.18	0.19	-

Source: Own calculations, data = AMECO & OECD.

Results after a transitory shock

Since a seminal study by Christiano *et al.* [1992], it has been evident that the consequences of a transitory shock are weaker than those of a permanent one. Ambler *et al.* [2017] show a strong though temporary crowding-in of private consumption following a temporary shock in government consumption under a strong substitution between private and public consumption. The results in this study for a fully competitive economy confirm a temporary crowding-in of private consumption. However, monopolistic competition hampers this positive effect as depicted in the last graph in the row (C_bar line), while overall consumption responds negatively to the government consumption shock:

Figure 1. IRF for 1% increase in government consumption balanced by the labour tax for Ex (left), SE (centre) and SE with monopolistic competition (right)



Source: Own calculations.

⁴ The variable separating pure labour from schooling q results from the steady state calculations.

In practical terms, this means that there might be limitations for the positive effects of fiscal multipliers stemming from the government consumption impulse. Seen from a Polish perspective, these results show that a concentration of control over state-owned enterprises may cause a weaker response of private consumption to a post-crisis impulse from government consumption. This is due to the fact that private consumption may be partly absorbed by the monopolistic structure of the firm's sector. The sensitivity analysis shows that no other extension or modification is more responsible for this effect.

Laffer curves

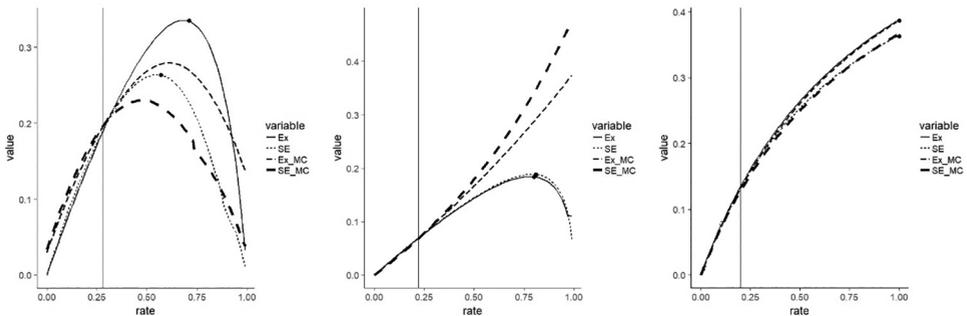
In the long run, temporary developments around the steady state are not relevant, while the Laffer curves focus on new steady states where a particular tax category is permanently changed. As stated in Aiyagari *et al.* [1992], the impact on core economic variables is then stronger. In this study, the gradually increased tax rates dynamically affect the steady state for all but calibrated variables, i.e. capital share α , government transfers T , capital and consumption tax revenues τ_k and τ_c respectively, debt B and its servicing costs r , and the pre-determined parameters. Note one important modification, which is necessary to conduct a consistent fiscal channel analysis: contrary to the temporary shocks' scenario, in the Laffer curves, transfers T are frozen on their BGP in order to allow for balancing the budget between raised taxes and government consumption G . This modification makes it possible to directly verify the difference for modified household preferences that include \bar{C} .

The Laffer curves are defined in two versions: (i) for a particular tax category $\tau_{ss}^j \{L, K, C\}$, so for (27), (28) and (29), and (ii) for the overall tax wedge from (26) τ_{ss}^j , with a single rate varying as a looped steady state for $j = \{0.01, 0.02, \dots, 1\}$ tax rates⁵. The charts below show the consecutive Laffer curves for the three considered types of tax rates, starting with each tax category in a fully competitive economy. The single dots mark the top of the Ex&SE Laffer curves, while the vertical line denotes the current effective tax rate for a fully competitive economy⁶:

⁵ As compared with Trabandt and Uhlig [2011], these are balanced by government consumption, hence the G-Laffer curves.

⁶ Note that the effective tax rates are different for two types of the economy; for details see Appendix 7.

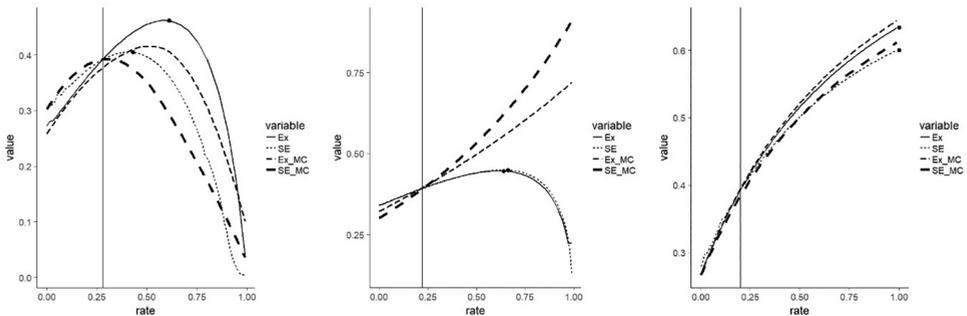
Figure 2. The Laffer curve for specific tax revenues with varying rates for labour (left), capital (centre) and consumption (right) taxes



Source: Own calculations.

The Laffer curves for the entire tax revenue come with additional curves for monopolistic competition settings, marked with *MC*:

Figure 3. Laffer curves for total tax revenues with varying rates for labour (left), capital (centre) and consumption (right) taxes in Poland



Source: Own calculations.

The results for a fully competitive economy are close in shape to those obtained by Trabandt and Uhlig [2011, 2012] for other countries. This indicates that in Poland there is room for an increase in labour and capital tax rates to reach the peak of the SE and Ex growth models. The introduction of a modified utility function for the households, based on the consumption of composite good \bar{C} , results in a slower reduction of their utility in response to the increased tax rates. Therefore, the labour and capital Laffer curves exhibit a peak for the higher tax rates than in an alternative scenario with the utility function as in Trabandt and Uhlig [2011].

There are differences for monopolistic competition. First, the peaks are lower and come with smaller labour tax rates. Without reinventing the wheel, this proves that a monopolistic economy is less efficient. Second, the capital tax curve has its maximum point above 100%, unlike in the study by Trabandt

and Uhlig [2012], where monopolistic competition barely influences the basic shape of the capital tax Laffer curve. There are two combined reasons for this effect: a lack of BGP assumption, and a different way of creating the monopolistic mark-up in this study.

Switching tax rates to the top of the Laffer curves

This section aims to show that, since there are no free lunches, tax revenue maximisation has a serious negative impact on key economic factors provided that most variables are not on their BGP.

The analysis of the Laffer curve usually focuses on e.g. the self-financing rate⁷, while this study shows the consequences of moving the tax rates to the top of the Laffer curve, i.e. $max(\bar{\tau}_{ss}^i)$, for the key economic variables considered in the model. The table below shows this kind of impact by comparing the changes in key economic aggregates and factors between their basic steady state point ($ss_0 = 1$) and the new steady state with tax rates moved to the top of the Laffer curve. For the previously explained reasons, only the top of the labour and capital curves will be investigated for a fully competitive economy.

Table 3. Changes between steady states if τ^l increased from 28% to 48% for SE and from 28% to 59% in Ex model, fully competitive economy, $ss_0 = 1$

model	τ	τ^c	τ^K	τ^L	B	C	\bar{C}
SE	1.02	0.66	0.79	1.36	0.79	0.66	0.73
Ex	1.17	0.60	0.82	1.71	0.82	0.60	0.72
model	G	I	K	L/H	T	W	Y
SE	1.32	0.79	0.79	0.89	0.79	1.00	0.79
Ex	1.75	0.82	0.82	0.82	0.82	1.00	0.82

Source: Own calculations.

First, it needs to be pointed out that in the long term an increase in labour tax balanced by an adequate raise in government consumption shows a modestly negative influence on the economy, compared to a scenario where it is balanced by transfers, as stated in e.g. Levine and Renelt [1992]. Consequently, the negative effect increases if the government raises transfers instead of consumption. Second, compared to the results based on the households' utility function, as in Trabandt and Uhlig [2011, 2012], overall consumption \bar{C} is fuelled by raised government consumption G , which causes a smaller reduction in the product by around 7 pp. for SE and by 6 pp. in the Ex growth model. However, the difference between the Laffer curve peaks and the impact on

⁷ One of the most valuable and straightforward examples is presented in Mankiw and Weinzeirl [2006], an intuitive model based on the dynamic scoring exercise.

the aggregates shows how arbitrary the Laffer curve peak can be, depending on the internal structure of the model.

The second analysed fiscal sub-channel is based on capital tax balanced by government consumption, including for a fully competitive economy. The table below summarises the consequences of switching to the top of the capital tax Laffer curve for the entire tax revenues, which occurs for a rate of around 65% in the semi-endogenous growth model, and for the 67% rate in the exogenous growth model.

Table 4. Changes between steady states if τ^t is increased from 22% to 65% for SE and from 22% to 67% in Ex, fully competitive economy, $ss_0 = 1$

model	τ	τ^c	τ^k	τ^l	B	C	\bar{C}
SE	1.11	0.83	2.05	0.86	0.86	0.83	0.90
Ex	1.13	0.81	2.56	0.84	0.84	0.81	0.91
model	G	I	K	L/H	T	W	Y
SE	1.40	0.60	0.60	1.00	0.86	0.85	0.86
Ex	1.59	0.57	0.57	1.00	0.84	1.05	0.84

Source: Own calculations.

The raise in the capital tax rate has more complex implications for the economy and a far stronger negative impact on investment than the labour tax. Consequently, with less capital, the economy creates a reduced product with the same labour supply.

Conclusions

This paper investigates the fiscal channel for temporary and permanent increases in labour, capital and consumption tax rates balanced in the budget by government consumption. The results rely on neoclassical exogenous (Ex) and semi-endogenous (SE) growth models for a small closed economy, featuring the substitution between public and private consumption, monopolistic competition (MC), with the calibration adjusted to Poland. The endogenous growth factor for human capital relies on the internal rate of return on investment in higher education that is estimated at 18%, while the return on lifelong learning is just 2%.

Two perspectives are considered. First, temporary shocks to government consumption are investigated, which in a fully competitive economy confirm the crowding-in of private consumption, with the crowding-out effect in the MC model stronger for the SE/MC. The multiplier effect of the government consumption impulse may then be negative for private consumption, e.g. in the post-crisis period.

Second, permanent changes in tax rates are examined, which for the Laffer curves show the top for all revenues, for the SE model labour Laffer curve at

48%, while for the Ex at the 59% tax rate. For the capital tax Laffer curve, the rates are 65% for SE and 67% for Ex. Raising the labour tax rate to the curve's peak, i.e. from 28% to 48%, would bring 2% more revenue in the SE model and 17% more revenue in the Ex growth model. The product would shrink by 21% (SE) and 18% (Ex) respectively. A comparable shift for the capital tax rate in the SE growth model, from 22% to 65%, would create only 11% more tax revenue, but the product would decrease by 14%. A shift to the maximum revenue point for the Ex growth model, i.e. from 22% to 67%, would bring an additional 13% of total tax revenues, but the product would shrink by 16%. The MC model does not show the maximum point for either the capital or consumption tax Laffer curves. The results provide some fresh insights to an ongoing debate on the estimated effective tax rates and the rates of return on investment in human capital.

To conclude, if the tax rates were raised in Poland, additional tax revenues could be generated, however, with a significant possibility of worsening the economic potential. On the one hand, if the Polish economy indeed drifts towards monopolistic competition coinciding with the growing human capital of a shrinking labour force, fiscal expenditure impulses may face some efficiency limitations. This may diminish its power to sustain private consumption in case of a sudden crisis as well as in the long term if excessive taxation of time invested in human capital formation undermines labour productivity.

On the other hand, if private consumption exhibits a strong Edgeworth complementarity with government consumption, the households' utility may be less affected under inelastic demand. This last scenario, however, is beyond the scope of this study.

References

- Aiyagari R., Christiano L., Eichenbaum M. [1992], The output, employment and interest rate effects of government consumption, *Journal of Monetary Economics*, no. 30: 73–86.
- Ambler S., Bouakez H., Cardia E. [2017], Does the crowding-in effect of public spending on private consumption undermine neoclassical models? forthcoming *Research in Economics*.
- Blanchard O., Perotti R. [2002], An empirical characterization of the dynamic effects of changes in government spending and taxes on output, *The Quarterly Journal of Economics*, no. 27: 1329–68.
- Bouakez H., Rebei N. [2007], Why does private consumption rise after a government spending shock?, *Canadian Journal of Economics*, vol. 40, issue 3, 954–979.
- Böwer U. [2017], State-owned enterprises in emerging Europe: the good, the bad, and the ugly, *IMF Working Paper series*, no. 17/221.
- Bukowski M., Kowal P., Lewandowski P., Zawistowski J. [2005], Impact of the structure and level of public sector revenues and expenditures on the labor market: international experiences and implications for Poland, *National Bank of Poland Working Paper Series*, no. 155.
- Christiano L., Eichenbaum M. [1992], Cyclical effects of government's employment and good purchases, *American Economic Review*, no. 82: 430–50.

- de la Fuente A., Jimeno F.J. [2005], The private and fiscal returns to schooling and the effect of public policies on private incentives to invest in education: a general framework and some results for the EU, *Working Papers 0509, Banco de España*, Working Papers Homepage.
- European Commission: European Semester 2017, <https://ec.europa.eu/info/sites/info/files/2017european-semester-country-report-poland-en.pdf> (as of November, 2017).
- gEcon [2015] gEcon – General Equilibrium Economic Modelling Language and Solution Framework, Chancellery of the Prime Minister of the Republic of Poland 2012–2015, as of November 2017, package version 1.0.1.
- King R.G., Plosser C.I., Rebelo S. [1987], Production, growth, and business cycles: technical appendix, *Draft*, University of Rochester.
- Klima G., Retkiewicz-Wijtiwiak K. [2014], On automatic derivation of first order conditions in dynamic stochastic optimisation problems, *MPRA Paper 55612* University Library of Munich, Germany.
- Konopczyński M. [2014], How taxes and spending on education influence economic growth in Poland, *Contemporary Economics*, vol. 8, no. 3: 329–348.
- Krajewski P. [2011], Supply effects of fiscal policy in the real business cycle model and some results for the Polish economy, *Ekonomista*, no. 4: 551–571.
- Laffer A.B. [1981], Government exactions and revenue deficiencies, *Cato Journal*, no. 1: 1–21.
- Laffer A.B. [2004], The laffer curve: past, present, and future, *The Heritage Foundation Backgrounder*, no. 1765.
- Levine R., Renelt D. [1991], A sensitivity analysis of cross-country growth regressions, *Policy Research Working Paper Series*, no. 609, The World Bank.
- Linneman L., Schabert A. [2003], Fiscal policy in the new neoclassical synthesis, *Journal of Money, Credit and Banking* 35, no. 911/29.
- Mankiw N.G., Romer D., Weil D.N. [1992], A contribution to the empirics of economic growth, *Quarterly Journal of Economics*, no. 107: 407–437.
- Mendoza E., Razin A., Tezar L. [1994], Effective tax rates in macroeconomics: cross-country estimates of tax rates on factor incomes and consumption, *Journal of Monetary Economics*, no. 34: 297–323.
- Polityka Insight [2016], *Jak naprawić klin podatkowy w Polsce*, Research Polityka Insight.
- Ramey V. [2011], Can government purchases stimulate the Economy?, *Journal of Economic Literature*, vol. 49, no. 3: 673–685.
- Rebei N. [2004], Characterization of the dynamic effects of fiscal shocks in a small open economy, *Bank of Canada Staff Working Papers* 04–41.
- Rebelo S. [1991], Long run policy analysis and long run growth, *Journal of Political Economy*, no. 99(3): 500–521.
- Romele L. [2013], Estimation of internal rate of return (IRR) to investments in education in Latvia, *International Journal of Social Science and Humanity*, vol. 3, no. 1: 1–4.
- Sims E. [2002], Solving linear rational expectations models, *Computational Economics*.
- Skibińska M. [2015], What drives the labour wedge? A comparison between CEE countries and the euro area, *NBP Working Paper*, no. 220.

Uhlig H., Trabandt M. [2011], The laffer curve revisited, *Journal of Monetary Economics*, vol. 58, issue 4, May 2011: 305–327.

Uhlig H., Trabandt M. [2012], How do laffer curves differ across countries?, *NBER Chapters: Fiscal Policy After the Financial Crisis*: 211–249, University of Chicago Press.

Weber S. [2008], Human capital depreciation and education level, *International Journal of Manpower*, vol. 35, issue 5: 613–642.

Wnorowski H. [2012], Excise tax revenue on spirits in Poland. An attempt for Laffer Curve theory verification, *Optimum. Studia Ekonomiczne*, no. 5: 67–76.

Technical Appendix

The equilibrium and steady state relationships

The equilibrium relationships, generated originally in gEcon, were adjusted for readability as follows:

$$\frac{\beta}{\lambda_t^{C^2}} E_t \left[\lambda_{t+1}^{C^2} \left(1 - \delta + \alpha P_{t+1} K_t^{\alpha-1} (H_t q_{t+1} L_{t+1}^s Z_{t+1})^{1-\alpha} \right) \right] - 1 = 0 \quad (44)$$

$$\beta E_t \left[\lambda_{t+1}^{C^3} \left(1 - \delta^h + \frac{(1-\Omega) H_t}{\Omega} (A q_{t+1} L_{t+1}^s + S L_{t+1}^s (1 - q_{t+1}))^\Omega \right) \lambda_{t+1}^{C^2} q_{t+1} L_{t+1}^s W_{t+1} (1 - \tau^l) \right] - \lambda_t^{C^3} = 0 \quad (45)$$

$$\Pi_t^{PS} - \pi_t^{ps} = 0 \quad (46)$$

$$Y_t (-P_t + P_t^{MON}) - \pi_t^{ps} = 0 \quad (47)$$

$$\tau^l H_{t-1} q_t L_t^s W_t - \tau_t^l = 0 \quad (48)$$

$$\left(a C_t^{\sigma^{G-2}} + (1-a) G_t^{\sigma^{G-2}} \right)^{\sigma^{G2}} - \bar{C}_t = 0 \quad (49)$$

$$K_{t-1}^\alpha (H_{t-1} q_t L_t^s Z_t)^{1-\alpha} - Y_t = 0 \quad (51)$$

$$Y_t - \rho Y_t (-P_t + P_t^{MON}) P_t^{MON-\rho-1} = 0 \quad (52)$$

$$e^{\epsilon_t^Z + \phi \log Z_{t-1}} - Z_t = 0 \quad (53)$$

$$a\mu C_t^{\sigma^{G-2}-1} \bar{C}_t^{\mu-1} (1-L_t^s)^{1-\mu} a C_t^{\sigma^{G-2}} + \left((1-a) G_t^{\sigma^{G-2}} \right)^{\sigma^{G-2}-1} \left(\bar{C}_t^{\mu} (1-L_t^s)^{1-\mu} \right)^{-\eta} - \lambda_t^{C^2} (1+\tau^c) = 0 \quad (54)$$

$$H_{t-1} q_t P Z_t (1-\alpha) K_{t-1}^{\alpha} (H_{t-1} q_t L_t^s Z_t)^{-\alpha} - H_{t-1} q_t W_t = 0 \quad (55)$$

$$\Omega \lambda_t^{C^3} (A L_t^s - S L_t^s) H_{t-1}^{1-\Omega} \left(A q_t L_t^s + S L_t^s (1-q_t) \right)^{\Omega-1} + H_{t-1} \lambda_t^{C^2} L_t^s W_t (1-\tau^l) = 0 \quad (56)$$

$$\bar{G} + \epsilon_t^G - G_t = 0 \quad (57)$$

$$\eta_t^G - \log \epsilon_t^G + \rho^G \log \epsilon_{t-1}^G = 0 \quad (58)$$

$$\Pi_t - \beta \lambda_t^{C^2-1} E_t \left[\lambda_{t+1}^{C^2} \Pi_{t+1} \right] - \pi_t = 0 \quad (59)$$

$$H_{t-1} (1-\delta^h) + H_{t-1}^{1-\Omega} \left(A q_t L_t^s + S L_t^s (1-q_t) \right)^{\Omega} - H_t = 0 \quad (60)$$

$$I_t - K_t + K_{t-1} (1-\delta) = 0 \quad (61)$$

$$U_t - \beta E_t [U_{t+1}] - \frac{\left(\bar{C}_t^{\mu} (1-L_t^s)^{1-\mu} \right)^{1-\eta}}{(1-\eta)} = 0 \quad (62)$$

$$(\mu-1) \bar{C}_t^{\mu} (1-L_t^s)^{-\mu} \left(\bar{C}_t^{\mu} (1-L_t^s)^{1-\mu} \right)^{-\eta} \Omega \lambda_t^{C^3} \left(A q_t + S (1-q_t) \right)$$

$$H_{t-1}^{1-\Omega} + \left(A q_t L_t^s + S L_t^s (1-q_t) \right)^{\Omega-1} + H_{t-1} \lambda_t^{C^2} q_t W_t (1-\tau^l) = 0 \quad (63)$$

$$P Y_t - H_{t-1} q_t L_t^s W_t - \pi_t - I_t = 0 \quad (64)$$

$$\tau_t^K - \tau_t + \tau_t^C + \tau_t^L = 0 \quad (65)$$

$$\tau_t + B_t - G_t - T_t - B_{t-1}(1+r_t) = 0 \quad (66)$$

$$T_t + B_{t-1}(1+r_t) - C_t(1+\tau^c) + (1-\tau^k)(\pi_t + \pi_t^{ps}) +$$

$$H_{t-1}q_t L_t^s W_t(1-\tau^l) - B_t = 0 \quad (67)$$

The ultimate steady state relationships are as follows:

$$\beta(1-\delta + \alpha P_{ss} K_{ss}^{\alpha-1} (q_{ss} H_{ss} L_{ss}^s Z_{ss})^{1-\alpha}) - 1 = 0 \quad (68)$$

$$0.03 - r_{ss} = 0 \quad (69)$$

$$0.47 - \frac{B_{ss}}{Y_{ss}} = 0 \quad (70)$$

$$\beta \left(\lambda_{ss}^{c^3} (1-\delta^h + (1-\Omega)H_{ss}^{-\Omega} + (Aq_{ss} L_{ss}^s + SL_{ss}^s (1-q_{ss}))^\Omega) \right. \\ \left. + \lambda_{ss}^{c^2} q_{ss} L_{ss}^s W_{ss} (1-\tau^l) \right) - \lambda_{ss}^{c^3} = 0 \quad (71)$$

$$\Pi_{ss}^{PS} - \pi_{ss}^{ps} = 0 \quad (72)$$

$$Y_{ss} (-P_{ss} + P_{ss}^{MON}) - \pi_{ss}^{ps} = 0 \quad (73)$$

$$\tau^l q_{ss} H_{ss} L_{ss}^s W_{ss} - \tau_{ss}^l = 0 \quad (74)$$

$$\left(aC_{ss}^{\sigma^{G-2}} (1-a) + G_{ss}^{\sigma^{G-2}} \right)^{\sigma^{G2}} - \overline{C}_{ss} = 0 \quad (75)$$

$$Y_{ss} P_{ss}^{MON-\rho} - Y_{ss} = 0 \quad (76)$$

$$K_{ss}^\alpha (q_{ss} H_{ss} L_{ss}^s Z_{ss})^{1-\alpha} - Y_{ss} = 0 \quad (77)$$

$$Y_{ss} - \rho Y_{ss} (-P_{ss} + P_{ss}^{MON}) P_{ss}^{MON-1-\rho} = 0 \quad (78)$$

$$e^{\phi \log Z_{ss}} - Z_{ss} = 0 \quad (79)$$

$$\rho^G \log \epsilon_{ss}^G - \log \epsilon_{ss}^G = 0 \quad (80)$$

$$\rho^{\tau^c} \log \epsilon_{ss}^{\tau^c} - \log \epsilon_{ss}^{\tau^c} = 0 \quad (81)$$

$$\rho^{\tau^k} \log \epsilon_{ss}^{\tau^k} - \log \epsilon_{ss}^{\tau^k} = 0 \quad (82)$$

$$\frac{a\mu \overline{C}_{ss}^{\mu-1}}{C_{ss}^{\sigma^{G-2}}} (1-L_{ss}^s)^{1-\mu} a C_{ss}^{\sigma^{G-2}} + \left((1-a) G_{ss}^{\sigma^{G-2}} \right)^{\sigma^{G-2}-1} \\ \left(\overline{C}_{ss}^{\mu} (1-L_{ss}^s)^{1-\mu} \right)^{-\eta} - \lambda_{ss}^{C^2} (1+\tau^c) = 0 \quad (83)$$

$$q_{ss} H_{ss} P_{ss} Z_{ss} (1-\alpha) K_{ss}^{\alpha} (q_{ss} H_{ss} L_{ss}^s Z_{ss})^{-\alpha} - q_{ss} H_{ss} W_{ss} = 0 \quad (84)$$

$$\Omega \lambda_{ss}^{C^3} (A L_{ss}^s - S L_{ss}^s) H_{ss}^{1-\Omega} \left(A q_{ss} L_{ss}^s + S L_{ss}^s (1-q_{ss}) \right)^{\Omega-1} + \\ \lambda_{ss}^{C^2} H_{ss} L_{ss}^s W_{ss} (1-\tau^l) = 0 \quad (85)$$

$$\overline{G} + \epsilon_{ss}^G - G_{ss} = 0 \quad (86)$$

$$\overline{\tau^c} + \epsilon_{ss}^{\tau^c} - \tau_{ss}^c = 0 \quad (87)$$

$$\overline{\tau^k} + \epsilon_{ss}^{\tau^k} - \tau_{ss}^k = 0 \quad (88)$$

$$\Pi_{ss} - \beta \Pi_{ss} - \pi_{ss} = 0 \quad (89)$$

$$H_{ss} (1-\delta^h) + H_{ss}^{1-\Omega} \left(A q_{ss} L_{ss}^s + S L_{ss}^s (1-q_{ss}) \right)^{\Omega} - H_{ss} = 0 \quad (90)$$

$$I_{ss} - K_{ss} + K_{ss} (1-\delta) = 0 \quad (91)$$

$$U_{ss} - \beta U_{ss} - \frac{\left(\overline{C}_{ss}^{\mu} (1-L_{ss}^s)^{1-\mu} \right)^{1-\eta}}{(1-\eta)} = 0 \quad (92)$$

$$\begin{aligned}
 & (\mu - 1) \overline{C}_{ss}^{-\mu} (1 - L_{ss}^s)^{-\mu} \left(\overline{C}_{ss}^{-\mu} (1 - L_{ss}^s)^{1-\mu} \right)^{-\eta} \\
 & \Omega \lambda_{ss}^{c^3} \left(A q_{ss} + S(1 - q_{ss}) \right) H_{ss}^{1-\Omega} + \left(A q_{ss} L_{ss}^s + S L_{ss}^s (1 - q_{ss}) \right)^{\Omega-1} \\
 & \lambda_{ss}^{c^2} + q_{ss} H_{ss} W_{ss} (1 - \tau^l) = 0
 \end{aligned} \tag{93}$$

$$P_{ss} Y_{ss} - q_{ss} H_{ss} L_{ss}^s W_{ss} - \pi_{ss} - I_{ss} = 0 \tag{94}$$

$$\tau_{ss}^L + \tau^c C_{ss} + \tau^k (Y_{ss} - q_{ss} H_{ss} L_{ss}^s W_{ss} - I_{ss}) - \tau_{ss} = 0 \tag{95}$$

$$\tau_{ss} + B_{ss} - G_{ss} - T_{ss} - B_{ss} (1 + r_{ss}) = 0 \tag{96}$$

$$\begin{aligned}
 & T_{ss} + B_{ss} (1 + r_{ss}) - C_{ss} (1 + \tau^c) + (1 - \tau^k) (\pi_{ss} + \pi_{ss}^{ps}) + \\
 & q_{ss} H_{ss} L_{ss}^s W_{ss} (1 - \tau^l) - B_{ss} = 0
 \end{aligned} \tag{97}$$

with the calibrating equation for government consumption in a version where the government consumption shock is financed by the labour tax. The values used for the calibration, presented in Table 2, are the 10-year averages for individual aggregates from the national accounts in the OECD and AMECO database for government consumption G , indirect tax revenues τ_c and capital tax revenues τ_k in relation to GDP.

$$\frac{1}{G_{ss} Y_{ss}} - 0.18 = 0 \tag{98}$$

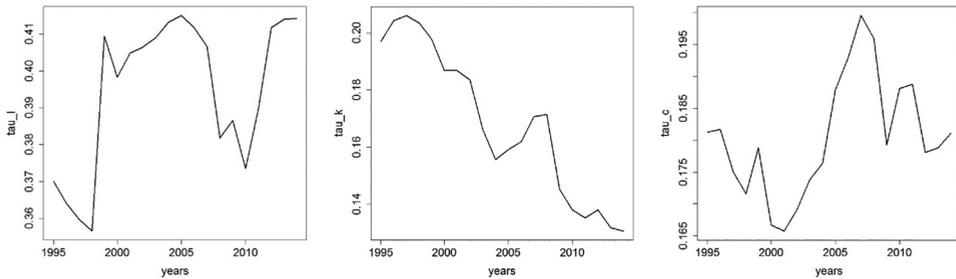
$$\frac{1}{\tau_{ss}^c Y_{ss}} - 0.13 = 0 \tag{99}$$

$$\frac{1}{\tau_{ss}^k Y_{ss}} - 0.07 = 0 \tag{100}$$

Effective tax rates

The charts below show, from left to right, the historical development of the estimated effective labour, capital and consumption tax rates in Poland based on Mendoza *et al.* [1994].

Figure 4. Estimated effective labour, capital and consumption tax rates in Poland



Source: Own calculations.

Both models used show a substantial divergence of tax revenues if calibrated with the effective tax rates, i.e. $\tau^l = 0.41$, $\tau^k = 0.16$ and $\tau^c = 0.18$, result in relation to product $Y = 1$, respectively $\tau^L = 0.29$, $\tau^K = 0.05$ and $\tau^C = 0.11$. According to these findings, the labour tax rate is overestimated, while the capital and consumption tax rates are underestimated. Empirical tests show that the modified tax rates in the table below give the best fit to the data:

Table 5. The effective tax rates in Poland estimated on the basis of Mendoza (left), and derived from the model on the basis of best fit to data (centre) and monopolistic competition model fit (right)

<i>type of tax</i>	<i>estim. as in Mendoza et al.</i>	<i>best fit to data</i>	<i>MC model</i>
τ^l	0.41	0.28	0.37
τ^k	0.16	0.22	0.16
τ^c	0.18	0.20	0.18

Source: Own calculations.

On the one hand, these findings are in line with Trabandt and Uhlig [2012], who claim that such an outcome is possible, especially for the labor tax rates. On the other hand, the initially estimated $\tau^l = 0.41$ is fairly close to the findings of e.g. Polityka Insight [2016] in terms of predominant employee contracts in Poland. However, with the applied class of quantitative tools, it can be a matter of their over-simplification and background data quality. And last but not least, the monopolistic competition model is better suited to the tax rates.

KONSEKWENCJE PRZEJŚCIOWYCH I TRWAŁYCH ZMIAN STAWEK PODATKOWYCH W POLSCE

Streszczenie

Artykuł zawiera symulacje dwóch scenariuszy dla 1) przejściowego, 2) trwałego podniesienia podatków nałożonych na pracę, kapitał i konsumpcję, bilansowane, odpowiednio przejściowym lub trwałym, wzrostem konsumpcji rządowej. Obliczenia modelowe opierają się na neoklasycznym modelu ze wzrostem 1) semi-endogenicznym i 2) egzogenicznym dla gospodarki zamkniętej. Wersja rozszerzona modelu obejmuje wpływ konkurencji monopolistycznej. Gospodarstwa domowe w tym modelu czerpią bezpośrednią użyteczność z połączonej konsumpcji prywatnej i rządowej, zaś cały model dopasowany jest do danych dla Polski. Semi-endogeniczny czynnik wzrostu wynika z inwestycji części czasu pracy w dokształcanie w sektorze przedsiębiorstw. Wyniki dla przejściowego wzrostu konsumpcji rządowej potwierdzają, obserwowany w danych dla innych krajów, tymczasowy wzrost konsumpcji gospodarstw domowych, jednak nie w wersji z konkurencją monopolistyczną. Natomiast trwale podniesienie stawek podatkowych w stronę szczytu krzywej Laffera dla sumy podatków pozytywnie wpłynęłoby na wielkość dochodów podatkowych, jednak ze znaczącym trwałym zmniejszeniem pozostałych kluczowych agregatów gospodarczych, np. produktu, konsumpcji czy inwestycji. Kształt krzywych Laffera istotnie różni się dla wersji z konkurencją monopolistyczną. Wyniki zawierają również estymacje efektywnych stawek podatkowych oraz wewnętrznych stóp zwrotu z inwestycji w wykształcenie wyższe i dokształcanie ustawiczne.

Słowa kluczowe: krzywa Laffera, wydatki rządowe, podatki zniekształcające, konkurencja monopolistyczna, kapitał ludzki, efekt przyciągania

Kody klasyfikacji JEL: E32, E62, H20, H21, H52, H60, J24
