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Laffer Curves for Hungary*

Péter Gábriel – Lóránt Kaszab

The study uses a general equilibrium model calibrated for the Hungarian economy to estimate the Laffer curve of the labour tax rate. According to the results, the tax rate maximising budget revenues in the medium term is 55 per cent, while based on the model version taking into account the accumulation of human capital and capturing the longer-term effects of a tax cut, it is 40 per cent. The simulations showed that the self-financing rate of the reduction of the labour tax rate from its pre-crisis level to the level in 2011 is roughly 80 per cent over the medium term and that it is fully self-financing in the longer run. In the case of additional tax cuts, the self-financing rate diminishes somewhat in line with the lower tax rate at the outset, but remains high.

Journal of Economic Literature (JEL) codes: E0, E13, E2, E3, E62, H0, H2, H3, H6

Keywords: Laffer curve, fiscal policy, labour tax rate, tax cut, human capital, self-financing

1. Introduction

The quality of fiscal policy decisions is improved if the consequences of the decisions can be quantified with appropriate accuracy. In tax policy, decision-making can be strongly supported by the information obtained from the Laffer curve,[1] which shows how budget revenues change when tax rate is adjusted. This adjustment affects economic growth and thus also budget revenues via various channels, and, consequently, it is difficult to comprehensively quantify the impact that a shift in the tax rate has on budget revenues. With the availability of new databases in more and more countries, one can re-estimate the effect of changes in the tax rates on budget revenues. This helps explore the channels through which the impact of tax measures may emerge. Besides better data, Laffer curve estimates have also

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[1] The Laffer curve was first mentioned by *Wanninski* (*1978*).

became more popular again, as they can help solve economic policy debates of professional and public interest.

After the outbreak of the financial crisis and the global economic downturn, it was important to decide how much fiscal stimulus should be used to trigger economic growth. When interest rates reach their zero lower bound in an economic downturn, fiscal policy is quite effective in stimulating the economy, which, in itself, could be used as an argument for more active fiscal intervention. However, during the crisis, the sustainability of financing government debt also came into focus. The sustainability of the economic stimulus implemented via tax cuts depends strongly on the longer-term effects generated by the tax cuts in the economy. For example, if labour supply expands considerably due to the cut of the labour tax rate – in other words, the initial labour tax rate is close to the peak of the Laffer curve – the tax cut may be highly self-financing, which means that no government debt sustainability issues arise in the long run after the cut.

This study uses a general equilibrium model calibrated for Hungary to estimate Laffer curves of the labour tax rate. The Hungarian tax structure changed significantly in the past decade. Within tax revenues, the proportion of revenues from taxes on labour dropped, while the share of revenues from consumption taxes rose. The Laffer curve calibrated for the Hungarian economy helps quantify the impact of the recent and potential future tax policy measures. Our study quantifies the consequences of the reduction of the labour tax rate in 2007–2011 and another potential tax cut. It demonstrates that past tax cuts were self-financing, and that the extra revenues arising from higher economic growth and the reduction of the shadow economy also substantially dampen the direct fiscal effect of the tax cut.

2. Summary of literature

Empirical estimation of the Laffer curve and the revenue-maximising tax rate is extremely complex. First, the tax rates vary from country to country in a limited range, which usually does not include the revenue-maximising rate. Second, the impact of the labour tax rate can depend on several factors, such as the level of other tax rates and country-specific factors, which are challenging to control for. Third, some of the impact on total revenues may not necessarily be reflected directly in revenues from the labour tax rate, but rather indirectly, through the consumption and capital tax revenues which are difficult to estimate.

In view of the above-mentioned challenges, most empirical studies focus on the impact of changing the labour tax rate on the labour tax base and employment. The elasticity of the tax base and employment for the tax rate is usually estimated by using the heterogeneous effect of changing tax rules on taxpayers in a given country and time-period. *Feldstein* (*1995*) produced estimates for the US, *Kleven* *and Schultz* (*2014*) did so for Denmark, and *Jongen and Stoel* (2019) did so for the Netherlands. The estimated elasticities mostly took values of around 0.2–0.3, in other words a 1 percentage point reduction of the tax rate expanded the tax base of the labour tax rate by 0.2–0.3 per cent. Other studies indicated that the effect on the tax base from adjusting the tax rate emerges not only due to the change in employment but also, to a high degree, due to the change in tax optimisation and tax evasion. When the tax rate is raised, the number of self-employed increases, more taxpayers take advantage of the tax allowances available in the tax regime and the proportion of undeclared income increases.

Saez et al. (*2012*) explain the assumptions under which the elasticities estimated by using the micro-databases provide adequate information for calculating the revenue-maximising tax rate. Among the necessary assumptions, there are a number of fairly restrictive ones: i) the labour tax rate only affects its own tax base, and ii) the estimated elasticity does not depend on the tax rate. Nevertheless, the use of estimated elasticities is quite widespread in determining the revenue-maximising tax rate. Based on these estimated elasticities, tax revenues typically peak at high tax rates of 70–80 per cent.

Using data from 34 countries between 1978 and 2014, *Akgun et al.* (*2017*) estimates the impact of changing the tax rate on tax revenues. Their approach of using data from several countries is helpful because it allows the Laffer curve to be estimated even with a more flexible functional form. In particular, they estimate that labour tax revenues peak at a tax rate of 50–70 per cent. Their paper also pointed out that increasing the progressivity of the labour tax rate significantly reduces the tax revenues. However, the estimates are uncertain, as the revenue-maximising rates change considerably under the different specifications.

On account of the difficulties involved in the empirical estimation of the Laffer curve, several studies use macroeconomic models to specify the curve. The advantage of this approach is that the impact of changing the tax rate can be quantified comprehensively and for a longer period. Furthermore, these models can also be used to simulate the impact of economic policy measures.

Schmitt-Grohe and Uribe (*1997*) employ a simple business cycle model, where the government balances its budget in all periods only by changing the labour tax rate. The two authors show that the Laffer curve can be derived in such a model. They also find that balanced-budget fiscal rules can be detrimental to an economy, because they overstimulate it during an upswing with lower taxes and higher government expenditure, while in a recession the situation is exacerbated by raising taxes and curbing spending.

Ireland (*1994*) and *Novalez and Ruiz* (*2002*) examine the impact of tax cuts on revenues in an endogenous growth model. According to their findings, tax cuts significantly influence growth due to the incentives to accumulate human capital, and therefore other measures to maintain a balanced budget are not necessary, even in the long run.

Floden and Lindé (*2001*) analysed the impact of government transfers on welfare in a model calibrated for Sweden and the US with heterogeneous agents, where individuals face idiosyncratic, uninsurable, individual-specific productivity shocks. Besides the welfare-maximising tax rates, the revenue-maximising rates are also quantified. According to their results, in the case of taxes on labour, the Laffer curve peaks at around 50 per cent. They also found that the shape of the Laffer curve depends mainly on the elasticity of the labour supply and the level of the consumption and capital tax rate, while all other parameters are of secondary importance.

Trabandt and Uhlig (*2011*) performed fiscal analyses for the Laffer curve fitted to 1995–2007 in the EU-14 and the US. They found that cutting the labour tax rate was more self-financing in the EU-14 than in the US, because the average effective tax rate was closer to the peak of the Laffer curve in the former. *Trabandt and Uhlig* (*2012*) extended the analysis until 2010, thereby facilitating the examination of the European sovereign debt crisis with a Laffer curve. Their results show that in 2010 the tax hikes aimed at fiscal consolidation had a very limited revenue-increasing effect in European economies.

Nutahara (*2015*) used the models described by *Trabandt and Uhlig* (*2011; 2012*) to estimate Laffer curves for the Japanese economy. According to his calculations, the tax rate maximising the revenues from labour taxes may be around 50–60 per cent. He also found that since in Japan the capital tax rate was high and the labour tax rate was relatively far off from the peak of the Laffer curve, a reduction in the capital tax and an increase in the labour tax rate, which offsets the budget revenue losses, could significantly boost welfare overall.

Féve et al. (*2018*) expanded the models of Trabandt and Uhlig to include liquidity-constrained households. Their results show that the shape of the Laffer curve hinges on whether the amount of debt or transfers changes after the tax rate is cut. Nonetheless, their results on the shape of the Laffer curve mainly deviate from the calculations of earlier studies with respect to the scenarios assuming negative government debt. In such a case, the Laffer curve becomes horizontally S-shaped.

This study basically used the model in *Trabandt and Uhlig* (*2011*) calibrated for Hungary to quantify the Laffer curve. The analysis of changing the labour tax rate was also performed using the model version with human capital accumulation.

Taking into account the findings of empirical studies, the original model was extended, explicitly incorporating the impact of changing the labour tax rate on tax evasion. We believe that this model version is able to capture all major mechanisms that can significantly influence the shape of the Laffer curve estimated for the Hungarian economy.

3. Hungarian tax reform

The shape of the Laffer curve is relevant for the Hungarian economic policy as well, as it can help quantify the impact of already implemented and announced future measures.

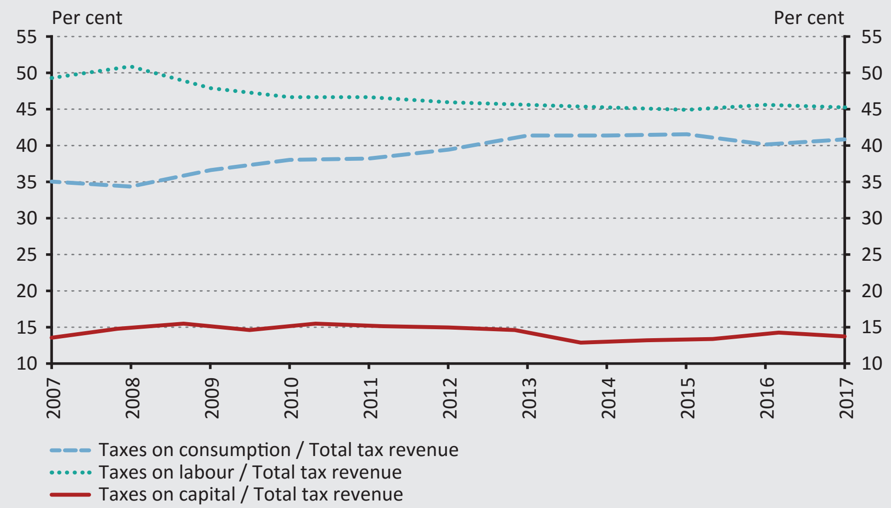
The Hungarian tax regime changed significantly in the past decade.[2] Until 2010, taxes on labour were characterised by extremely high rates and progressivity. The large tax wedge curbed labour supply and encouraged income underreporting. In 2011, the government introduced a flat-rate personal income tax, and the progressivity of taxes on labour was eliminated after the gradual phase-out of the tax credit, the super gross tax base and the pension contribution cap.[3] With a view to supporting economic growth, the corporate profit tax rate was also lowered from 2017, to 9 per cent for all small and large enterprises. To ensure a balanced budget, the value added tax was raised as labour and corporate taxes were reduced, and the government introduced special sectoral taxes in the services sectors. Consumption tax revenues were further increased by the government measures aimed at reducing the shadow economy. Due to changes of the tax structure the share of labour taxes within tax revenues decreased, while the proportion of consumption taxes increased (*Figure 1*).

In line with the previous government decisions, overhaul of the tax structure may continue in the future. After the wage agreement with the representatives of employers and employees in November 2016, the government announced that it would gradually cut the employers' social contribution tax from 27 per cent in 2016 to 11.5 per cent until 2022 if real wages continue to expand rapidly. The planned measures may bring about further significant changes in the tax structure.

[2] The major measures are listed in the Annex.

[3] The steps of the Hungarian tax reform are discussed in detail in *Baksay and Palotai* (*2017*) and *Matolcsy and Palotai* (*2018*).

Figure 1
Components of government tax revenues



Source: MNB (2018)

4. The model

The economic model used in our study is based on *Trabandt and Uhlig* (*2011*). The original model was extended to incorporate the interaction between tax rates and tax evasion. Following *Trabandt and Uhlig* (*2011*) we use two model versions. In the first, the labour input of the production function is defined as the number of hours worked by employees, in other words the quality of human capital is assumed to be homogeneous and constant in time. In the second version, human capital can be accumulated, and therefore the labour input of production also includes the quality of employees. Three agents are included in the model: households, companies and the state.

Households

The household maximises the following utility function (U) over an infinite time horizon:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[U(c_t, n_t) \right],$$

where c_t and n_t denote consumption and the number of hours worked. Consumption and leisure time (total time less the number of hours worked) increase the utility of the household.

β denotes the discount factor, which is typically between zero and one and captures the impatience of the household: it prefers consumption in the present to consumption in the future, and therefore future consumption is taken into account with a lower weight (it is discounted). E_0 denotes rational expectations, which are formed by the consumer looking ahead from the initial, period zero. The sum symbol (Σ) captures the fact the household sums its utility in the present and the future (discounted to the present).

Based on *Trabandt and Uhlig* (*2011*), the following utility function with constant Frisch elasticity is employed:

$$U(c_t,n_t)=\begin{cases} \dfrac{1}{1-\eta}\left\{c_t^{1-\eta}\left[1-\kappa(1-\eta)n_t^{1+1/\varphi}\right]^{\eta}-1\right\}, & \text{when } \eta\neq 1, \\ \log(c_t)-\kappa n_t^{1+1/\varphi}, & \text{when } \eta=1. \end{cases}$$

In the previous equation, $\eta > 0$ denotes risk aversion (and its inverse is the intertemporal elasticity of substitution), κ is a parameter used to set the n_t proportion of the number of hours worked (25 per cent) in the steady state within the whole time frame, which is normalised to one. $1 - n_t$ denotes leisure time, while φ means the Frisch elasticity of labour supply. Household preferences satisfy the requirements of the balanced growth path (see, for example, *King and Rebelo 1999*). The second row of the above equation shows that consumption is logarithmic when $\eta = 1$.

In the baseline model, the actual income from work (declared plus concealed) is derived by multiplying real wages and the number of hours worked ($w_t n_t$).

The baseline model can be supplemented with so-called second-generation human capital accumulation based on *Trabandt and Uhlig* (*2011*). Households can accumulate human capital by learning. They spend a fraction of total time endowment on work ($q_t n_t$) and learning ($(1 - q_t)n_t$), and the rest on leisure time. Taking into account human capital accumulation, earned income can be stated as follows:

$$L_t=w_t h_{t-1} q_t n_t$$

The restriction $h_{t-1}q_t = 1$ delivers our baseline medium-term model without human capital accumulation.

Progressivity

The introduction of progressive taxation requires that households vary, which is captured in the steady state with the following assumptions. It is assumed that households differ in terms of human capital, and the distribution of households' human capital is normalised to one: $1 = \int hH(dh)$, where the integral (∫) captures that human capital (h) is summed. Let $\overline{n} = \int h\overline{n}_h H(dh)$ denote the average labour supply weighted by households' human capital, which can be regarded as a sort of aggregate labour supply. Then the pre-tax earned income of a particular household h at time t is given by $w_t h n_{h,t}$. In the case of progressive taxation, the average and marginal tax rates differ. Based on *Heathcote et al.* (*2010*), it is assumed that the marginal tax rate responds to the changes in net income with constant elasticity. Elasticity is denoted by ʋ, and earned income taking into account human capital accumulation is weighted as follows:

$$L = w(\overline{n})^{1-\upsilon}(h\overline{n}_h)^{\upsilon}$$

Concealed income and reduction of the shadow economy

Concealed income is calculated using the following rule-of-thumb (with a given labour tax rate, which is denoted by τ_i^n):

$$\breve{E}(\tau_i^n) = \epsilon L + \epsilon(\tau_i^n - \tau_{ref}^n)L\phi$$

where $\breve{E}(\tau_i^n)$ is the concealed income for a given labour tax rate. L denotes the product of wages and the number of hours worked. τ_{ref}^n is the reference tax rate. ϵ shows the proportion of concealed income with the reference tax rate $(\tau_i^n = \tau_{ref}^n)$. The parameter ϕ helps calibrate the sensitivity of concealed income to the tax rate for given wage bill (L).

Accordingly, declared income is actual income less concealed income:

$$\dot{B}(\tau_i^n) = L - \breve{E}(\tau_i^n)$$

The collected tax revenues can be calculated by multiplying declared income and the tax rate:

$$T_i^n = \dot{B}(\tau_i^n)\tau_i^n$$

Accordingly, the effective labour tax rate implied by the model can be stated as follows:

$$\tau_{i,\,effective}^n = \frac{T_i^n}{\dot{B}_i}$$

After concealed earned income is taken into account, the household's budget constraint, physical capital and human capital accumulation equations can be stated as follows:

$$\left(1+\tau_t^c\right)c_t+x_t+b_t=\left(1-\tau_t^n\right)\dot{B}_t+\breve{E}_t+\left(1-\tau_t^k\right)\left(d_t-\delta\right)k_{t-1}+R_{t-1}^b b_{t-1}+s_t+m_t$$

$$k_t=\left(1-\delta\right)k_{t-1}+x_t$$

$$h_t=\left(Aq_t n_t+B\left(1-q_t\right)n_t\right)^v h_{t-1}^{1-v}+\left(1-\delta_h\right)h_{t-1}$$

In the previous equations, s_t, k_t, x_t, and b_t denote government transfers, physical capital, investment in physical capital and government bond holdings. The household holds the bonds issued by the government, receiving interest (R_{t-1}^b) on the bond holdings in the previous period (b_{t-1}). m_t denotes the trade balance (exports-imports), and d_t is the rental rate of capital. The labour, capital and consumption tax rates are denoted by τ^n, τ^k, τ^c. w_t denotes real wages. δ denotes the depreciation rate of physical capital. $d_t-\delta$ means that depreciation can be deducted from the capital's tax base. In the equation for human capital accumulation, A and B are constants that help calibrate labour efficiency gains and learning. δ_h measures the depreciation rate of human capital. The value of the parameter A is chosen so that q, which is the proportion of the time spent working within the time devoted to working and learning, is 0.8. B ensures that h = 1 in the steady state. $\left(1-\tau_t^n\right)\dot{B}_t$ shows net wages from the actually declared income, and $\breve{E}_t$ is concealed income.

At this point it should be noted that changes in either labour, capital or consumption taxes are equivalent to movement on the Laffer curve whereby the government's budget constraint is balanced by the change in transfers. Moreover, it is assumed that when calculating the aggregate resource constraint, which means the aggregation of the household's and the government's budget constraints, concealed income is considered as a sort of government transfer.

State

The government sets the labour, capital and consumption tax rates as well as the progressivity of the labour tax. In addition to taxes, it acquires funds by issuing government bonds. Additionally, the state transfers money to households which appears explicitly in households' budget constraint. Direct government consumption is assumed to be constant relative to GDP, and therefore adjustments to the tax rate mainly change the amount of transfers to households on the expenditure side.

The government's budget constraint can be written as follows

$$g_t + s_t + R^b_{t-1} b_{t-1} = b_t + T_t$$

The right-hand side of the government's budgetary constraint shows the revenues, derived from taxes (T_t) or bond issues (b_t). The left-hand side of the constraint shows the expenditure, which is non-productive government consumption (g_t) that does not increase the utility of the household, interest paid on the bonds in the previous period $R^b_{t-1} b_{t-1}$ and transfers to households (s_t).

The government's tax revenues T_t are summed as follows:

$$T_t = \tau^c_t c_t + \tau^n_{t,\, effective} \dot{B}_t + \tau^k_t \left(d_t - \delta \right) k_{t-1}$$

In other words, the government taxes consumption $(\tau^c_t c_t)$, labour ($\tau^n_{t,\, effective} \dot{B}_t$) and capital ($\tau^k_t \left(d_t - \delta \right) k_{t-1}$).

Company

The company maximises its profits through the optimal choice of capital and labour:

$$\max_{k_{t-1},\, n_t} \pi_t = \max_{k_{t-1},\, n_t} \left\{ y_t - w_t n_t - d_t k_{t-1} \right\}$$

where y_t is a standard Cobb–Douglas technology: $y_t = \gamma^t k^{\theta}_{t-1} \left(h_{t-1} q_t n_t \right)^{1-\theta}$, where γ denotes technology's deterministic trend growth. In the production function, θ shows the share of physical capital within production, and 1 – θ is the proportion of labour extended with human capital in production.

In equilibrium, households maximise their utility, companies maximise their profits and the government sets tax rates so that revenues cover expenditures at all points in time. It follows from the latter that the state's debt is constant. In equilibrium, the variables grow at a constant rate on the balanced growth path.

5. Calibrating the model and the solution

The calibrated model parameters for Hungary is included in *Table 1*. The parameters *η, φ* are set for their standard values in the literature. Equilibrium conditions and the depreciation rate of capital δ is used to calibrate the proportion of capital within production (θ), which is around 38 per cent in the period under review. Based on *Trabandt and Uhlig* (*2011*), it is assumed that human capital depreciates at the same rate as physical capital: $\delta_h = \delta$. The amount of hours worked in steady state (25 per cent of total time, similar to *Trabandt and Uhlig* [*2011*]) are calibrated with the parameter κ. The model captures the steady state of the economy; therefore, it was calibrated mainly by taking into account the average values of the macroeconomic variables in 2007–2018. Capital relative to GDP (*k/y*) is determined by the model parameters and the capital tax rate. The ratio of private investment and GDP (*x/y*), which is a function of the capital-to-GDP ratio, the depreciation of capital and the economic growth rate, is 25 per cent, that is close to the average of the window period (22 per cent) even though it is not calibrated. Government spending relative to GDP (*g/y*) was around 21 per cent in in the same period. The current account-to-GDP ratio (*m/y*) is 0.5 per cent on average in 2007–2018. The consumption-to-GDP ratio is derived endogenously from the aggregate resource constraint and was roughly 50 per cent in the period under review. The government debt-to-GDP ratio was approximately 75 per cent in the period under consideration.

Table 1
Calibrated parameter values

Parameter	Symbol	Value	Source
Depreciation of physical and human capital	$\delta = \delta_h$	0.07	*Trabandt and Uhlig* (*2011*)
Proportion of capital in production	θ	0.38	*Trabandt and Uhlig* (*2011*)
Weight of learning in human capital accumulation	ν	0.5	*Trabandt and Uhlig* (*2011*)
Inverse of intertemporal elasticity	η	2	*Trabandt and Uhlig* (*2011*)
Frisch elasticity	φ	2	*Trabandt and Uhlig* (*2011*)
Restriction	κ	3.46	$\overline{qn} = 0.25$ is satisfied
Discount factor	β	0.99	Implied by the long-term interest rate and the growth rate.
Sensitivity of concealed income to the change of the tax base	ϕ	0.05	*Clotfelter* (*1983*)
Working time/(time spent working and learning)	q	0.8	*Trabandt and Uhlig* (*2011*)
Proportion of concealed income within total earned income	ϵ	0.25	*Köllő* (*2010*)
Progressivity of the tax system	ε	0.08	Authors' estimate
Average reference tax rate	τ^n_{ref}	0.50	*Köllő (2010)*
Government spending/GDP	g/y	0.21	2007–2018 average
Government debt/GDP	b/y	0.75	2007–2018 average
Net imports/GDP	m/y	0.005	2007–2018 average

We contribute to the literature by extending the model with human capital accumulation such that it explicitly incorporates the effect of the tax rate on the concealment of income and the option of progressive taxation. Furthermore, we used the following assumptions to calibrate the effective tax rate in the model:

Reduction of the shadow economy

When calibrating the reduction of the shadow economy, it is assumed that 25 per cent of the tax base of the labour taxes is concealed at a tax rate of 50 per cent τ^n_{ref} (see *Köllő 2010*). When calibrating the effect that changing the tax rate has on declared income, we suppose that reducing labour tax by 4 percentage points decreases concealed income by 5 per cent (see, for example, *Clotfelter 1983*).

Progressivity

Prior to the flat-rate personal income tax, the progressivity of the labour tax is estimated in line with the representation of progressivity in the model, by regressing net incomes on the total wage costs, i.e. the database containing the 2007 contributions by contribution payers, similar to *Heathcote et al.* (*2009*)*:*

$$y^{net} = constant + (1 - \varepsilon)y^{total\ wage\ cost}$$

In the previous equation, ε shows the progressivity of the tax system and thus the degree of redistribution. When ε = 1, there is complete redistribution, while ε = 0 means a flat-rate system. In the calibrated model, 1 – υ is the counterpart of ε in the above regression. According to our estimates, ε is 0.08. The left-hand and right-hand side variables of the regression are logarithmic, and therefore 1 – ε can be interpreted as elasticity, so a 1 per cent change in the wage costs triggers a change of less than 1 per cent in net income.[4]

Effective tax rates

In the model, the calibration of effective tax rates is based on the actually observed tax rates. The estimated effective tax rates are the ratio of the budgetary tax revenues from the given tax type and the tax base. This allows the estimated tax rates to capture the effect of tax allowances as well. Labour tax revenues are taken from the report on the accounts of public finances. The tax base of the labour tax is the total wage cost determined by using the PIT tax base as calculated by the tax authority (NAV) and the prevailing employer's social contribution rates. The effective capital tax rate and consumption tax rate is calibrated using the calculations of the *European Commission* (*2019*). The tax base of capital tax constitutes the capital revenues as defined in the Commission's methodology, while the tax base of the consumption tax is households' final consumption. The estimated effective tax rates are shown in *Figure 2*.

[4] Estimated regression:

$$y^{net} = \underset{(0.0004)}{0.496} + \underset{(0.00002)}{0.922} y^{total\ wage\ cost},$$

where the values below the estimated coefficients denote standard errors.

Figure 2
Effective tax rates in Hungary between 2007 and 2017

Source: Taxation Trends in the European Union by the European Commission, NAV and the report on the accounts of public finances

It is important to note that the tax base of the effective labour tax rate estimated here is the sum of the tax bases declared by taxpayers. Accordingly, tax evasion does not explicitly influence the estimation of the effective labour tax rate. It must be further noted that the effective tax rate is calculated from the actual budgetary revenues and, thus, several factors can contribute to the change in the effective tax rate from one year to the next, not only the changes in tax rules. However, when a longer period is analysed, the level of the effective tax rate is mostly determined by the tax rates and other tax rules (e.g. tax allowances).

Solution of the model and simulations

The aim of this study is to estimate the Laffer curve for Hungary. To that end, the steady states of the model are computed with a numerical method (Newton's method) for each value of the labour tax rate. The budgetary revenues realised with the various labour tax rates yield the Laffer curve.

The calibrated model is also used to simulate the effect of tax policy measures. Since the calibrated model reflects the features of an economy in equilibrium, apart from the assumptions on the tax rates and progressivity, the model parameters are kept constant during the simulations. Two periods are analysed in the model: i) the labour tax cuts in 2007–2011 and ii) a hypothetical 6 percentage point labour tax cut relative to the 2018 effective tax rate. The comparison of the static (fixing the tax base) and dynamic effects (allowing for the tax base to change) of tax changes on tax revenues helps examine the tax cuts' self-financing rate.

During the simulations, the model version allowing human capital accumulation and one without accumulation are analysed as well. This is because the effect of the tax change through human capital accumulation takes hold only in the long run, and thus the results derived from the two versions of the model can be interpreted as the long and medium-term effects of the change, respectively.

6. Results

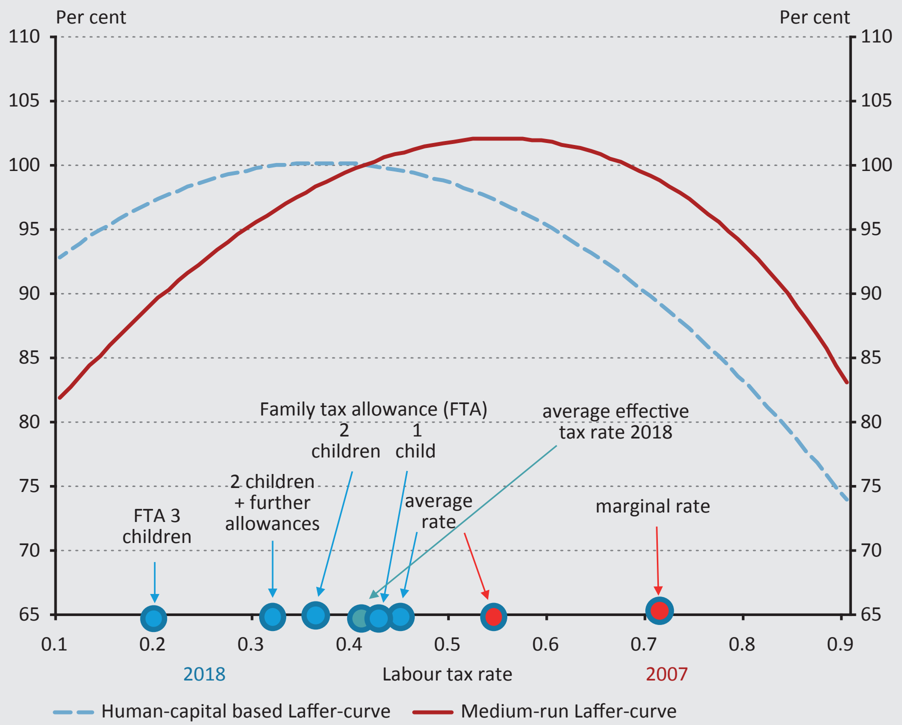
The described model is used to estimate the Laffer curve of the labour tax rate for the Hungarian economy with the version including human capital accumulation (long-term) and one without it (medium-term). *Figure 3* shows the estimated curves. The Laffer curve estimated on the basis of the 2018 tax structure peaks with a tax wedge (taxes and contributions relative to the total wage costs) of around 55 per cent based on the medium-term version and around 40 per cent based on the long-term version of the model. It is important to point out that prior to the economic turnaround in 2010, the maximum marginal tax rate was right to the peak of the Laffer curve, on the negative slope. After the 2010 tax reform, the marginal tax rate shifted to the left of the peak, to the positive slope, considerably improving the efficiency of the tax regime.

Simulations were performed with the model calibrated for the Hungarian economy to estimate the effect of a labour tax cut on budgetary revenues. The question to be answered was to what extent a tax cut performed from a given initial position can be self-financing. The self-financing rate is calculated from the static effect (denoted as direct effect in *Figures 4–7* below) and the dynamic effect of the tax cut: (static effect – dynamic effect)/static effect. We calculate the static effect of the tax cut keeping all tax bases fixed, while all three tax bases (labour, consumption, capital) may change when the dynamic effect is calculated (called labour, consumption and capital surplus in *Figures 4–7* below). Self-financing is measured for total budgetary tax revenues, where the drop in the labour tax revenues is partly offset by the expansion of the capital and consumption tax bases.

Figure 4 shows the effect of the change in the labour tax rate between 2007 and 2011, based on the model without human capital accumulation. Between 2007 and 2011, total tax revenues would have shrunk by 6 per cent[5] (direct effect), with an unchanged tax base. However, the lower taxes boost economic performance,

[5] The proportion of the labour tax revenues within total tax revenues amounted to 49 per cent in 2007. Simple calculation shows that in the case of a labour tax rate reduction from 51 to 45 per cent, tax revenues fall by $((51 – 45)/51) \cdot 100 \cdot 0.49 \approx 6$ per cent according to the static effect.

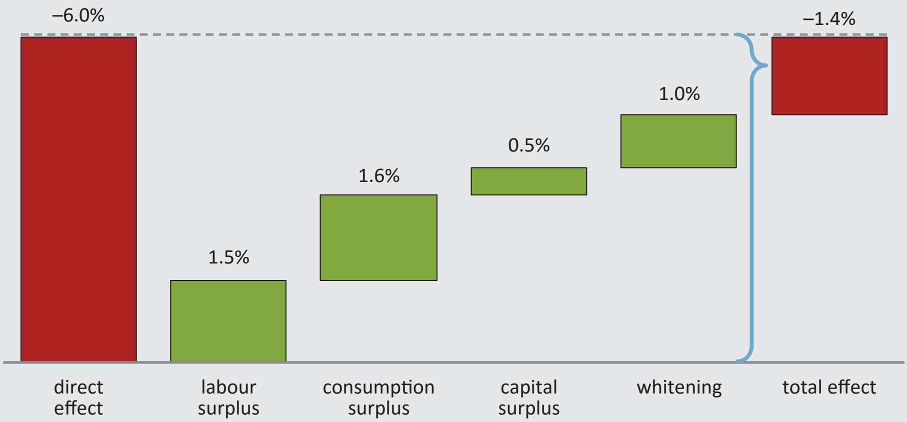
Figure 3
Laffer curve of labour taxes, with tax rates from 2007 and 2018



Note: In the case of the 2018 average effective labour tax rate, total tax revenues are normalised for 100 per cent. The blue and red circles show the tax rates calculated for the average wage, with various available allowances. The average tax rate pertains to average earners who do not claim any allowances. The Laffer curve was estimated on the basis of the 2018 tax structure.

especially employment as well as consumption, which entails an expansion in the tax bases (labour, capital and consumption tax revenues). By and large, the additional revenues from the increase of the tax bases offset most of the initial (static) revenue-reducing effect, even in the medium term. All the tax bases expand significantly, and labour tax receipts also increase significantly with the reduction in undeclared income (see the column 'whitening' in *Figure 4*). Therefore, in the medium term, tax revenues drop by merely 1.4 per cent. The simulation showed that the self-financing rate of the tax cut between 2007 and 2011 was roughly 80 per cent, even in the medium term.

Figure 4
Effect of the labour tax cuts in 2007–2011 on total tax revenues in the medium-term model

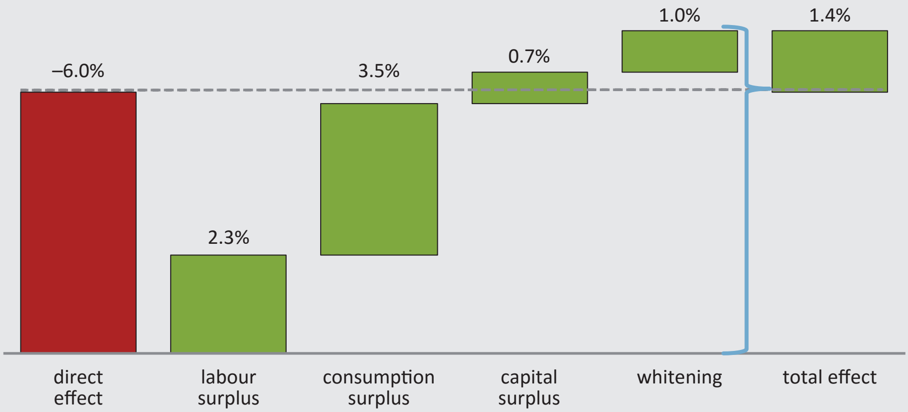


Note: The first column shows the direct (or static) effect on total tax revenues, while the next four columns show the dynamic effects by tax type as well as the impact of the reduction of the shadow economy (or whitening), as a percentage of the initial total tax receipts.

The calculations were also performed with the version allowing for human capital accumulation. Based on this, the long-term revenue-increasing effect of the tax cut more than offsets the initial loss in revenue: in the long run, budgetary revenues increase overall (by 1.4 per cent) as a result of the tax cut (*Figure 5*). This is because the model also captures the effect that – at lower labour tax rates – it is worthwhile to invest more in human capital, which employees as well as employers take advantage of. Of course, the higher quality of human capital increases potential economic performance, expanding tax bases even compared to our medium-term model.

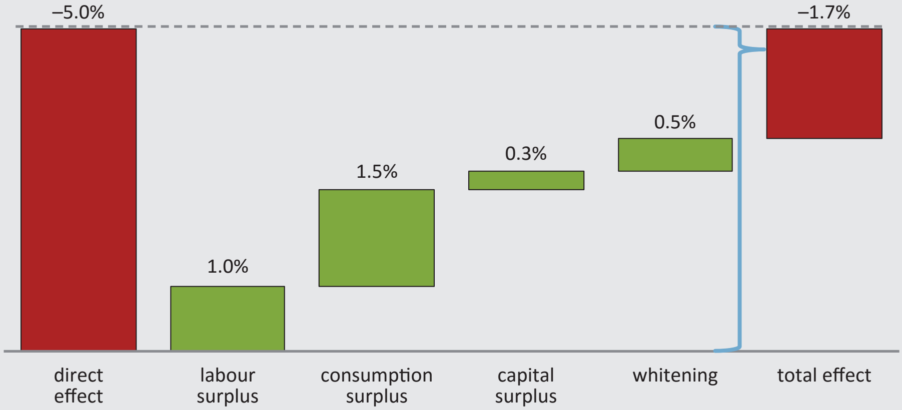
Besides the estimation of the effect of a past tax cut, the impact of a potential future tax cut was also simulated. The simulation analysed the effect of a 6 percentage point personal income tax rate cut. Based on the model capturing medium-term effects, total tax revenues fall by 1.7 per cent on account of the economic stimulus, so the self-financing rate is around 66 per cent in the medium term (*Figure 6*). Our finding that the self-financing rate of the tax cut in 2018 is lower than in 2007–2011 is attributable to the fact that the 2018 tax cut begins from a lower tax rate, where the Laffer curve is steeper.

Figure 5
Effect of the labour tax cuts in 2007–2011 on total tax revenues in the human capital-based (long-term) model



Note: The first column shows the direct effect on total tax revenues, while the next four columns show the dynamic effects by tax type as well as the impact of the reduction of the shadow economy, as a percentage of the initial total tax receipts.

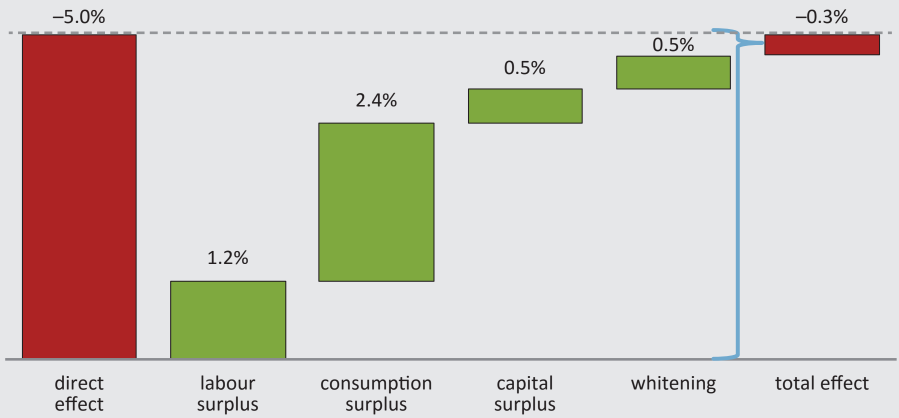
Figure 6
Impact of lowering the personal income tax rate from 15 to 9 per cent on total tax revenues in the medium-term model



Note: The first column shows the direct effect on total tax revenues, while the next four columns show the dynamic effects by tax type as well as the impact of the reduction of the shadow economy, as a percentage of the initial total tax receipts.

In the long-term model that takes into account human capital accumulation as well, similar to the 2007–2011 tax cut, the hypothetical tax cut launched in 2018 entails a considerable expansion in the tax bases, and therefore total tax revenues contract by a mere 0.3 per cent (*Figure 7*). Accordingly, the self-financing rate continues to be high, at 93 per cent.

Figure 7
Impact of lowering the personal income tax rate from 15 to 9 per cent on total tax revenues in the human capital-based (long-term) model



Note: The first column shows the direct effect on total tax revenues, while the next four columns show the dynamic effects by tax type as well as the impact of the reduction of the shadow economy, as a percentage of the initial total tax receipts.

It should be noted that the simulations assume a neutral labour market environment (not too tight, not too loose) in the initial position. If, for example, prior to the tax cut the labour market is characterised by a large labour shortage, the tax cut can lift employment less, and its indirect impact on tax revenues is smaller than presented above.

Finally, the results should be compared to other studies. The revenue-maximising rate of the Laffer curves estimated for other economies is typically higher than our estimate, both in the versions with and without human capital accumulation. This is because the model used here incorporated the effect of the tax rate change on the share of concealed income, and therefore the effect of changing the tax rate on the labour tax base is larger in our model.

To facilitate the comparison with the results of empirical studies, it must be taken into account that these papers typically quantify the effect of the labour tax cuts on the declared labour tax base over a few years following the tax cut. This impact mostly corresponds to the tax base-expanding effect of the tax cut in our medium-term model through the rising number of hours worked (see the column labour surplus in the *Figures 4–7*) and the reduction of undeclared income (see the column whitening in the *Figures 4–7*). According to our results, the static unit reduction of tax receipts between 2007 and 2011 would dynamically increase labour tax revenues by 0.4 units ([additional work + whitening]/direct effect), while a potential tax cut launched in 2018 would do so by 0.3 units. These values are close to the estimates of the empirical studies. The value is higher for 2007–2011 because in Hungary the tax rate was high prior to the tax cut.

7. Summary

The study estimated the Laffer curve of the labour tax rate in model versions with and without human capital accumulation, using an equilibrium model calibrated for the Hungarian economy. The first version captures the long-term effects of changing the labour tax rate, while the second captures the medium-term effects. The economic model used is based on *Trabandt and Uhlig* (*2011*), which was extended with a block that allows for the interaction between the tax rates and the magnitude of undisclosed incomes.

According to our results, the revenue-maximising tax rate is roughly 55 per cent in the medium-term model and around 40 per cent in the long-term model. This implies that following the tax reform after 2010, the maximum marginal tax rate shifted to the left of the Laffer curve’s peak, where the slope is positive, considerably improving the efficiency of the tax regime.

The model calibrated for the Hungarian economy was used to estimate the impact of the tax cut on budgetary revenues for the period 2007–2011. The results show that the self-financing rate of the tax cut proved to be roughly 80 per cent over the medium term and fully self-financing over the long run. According to our calculations, the self-financing rate of a further cut to the 2018 labour tax rate would also be high: 66 per cent in the medium term and 93 per cent in the long run.

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Annex

Table 2
Main measures affecting the effective labour tax rates between 2007 and 2018

2007	• The tax base of the personal income tax taxed at 18 per cent was increased to HUF 1.7 million. Incomes over HUF 1.7 million were taxed at 36 per cent. • Pension contributions rose from 18 to 21 per cent between 2006 and 2007. • The cash health insurance contribution paid by employees rose from 2 to 3 per cent.
2008	• The contribution rate paid by employers fell by the same amount by which the rates paid by employees increased, so there was no change overall.
2009	• The tax base of the personal income tax taxed at 18 per cent was increased to HUF 1.9 million. • The health insurance contribution in kind dropped from 4.5 to 1.5 per cent for a contribution base of up to twice the prevailing minimum wage. • 50 per cent of employers' early retirement insurance contribution was taken over by the central budget, down from 75 per cent earlier.
2010	• The PIT rate falls from 18 to 17 per cent, and the cap of the consolidated tax base of the 17 per cent rate was raised to HUF 5 million. • The rate on the incomes of over HUF 5 million diminished from 36 to 32 per cent. • 25 per cent of employers' early retirement insurance contribution was taken over by the central budget, down from 50 per cent earlier. • Private pension fund contributions fell to 0 per cent, while private pension fund members' pension contribution jumped from 1.5 to 9.5 per cent. • The tax base of the PIT became the income plus the tax base supplement (27 per cent). • The labour market contribution rate dropped from 3 to 1 per cent.
2011	• The two PTI tax rates were both cut to 16 per cent. • Employees' pension contribution increased from 9.5 per cent to 10 per cent. • Family tax allowances (FTAs) were expanded: the allowance amounted to HUF 10,000 (per child) for one or two children and to HUF 33,000 (per child) for three children.
2012	• The consolidated tax base supplement shall not be determined for the portion of the income up to HUF 2.424 million, and above that a 27 per cent tax rate applies. • The cash health insurance contribution paid by policyholders rose from 2 to 3 per cent.
2013	• Super grossing was eliminated in the case of the gross monthly incomes of over HUF 202,000. • The cap on contribution payments was eliminated in the case of pension contributions. • The Job Protection Action Plan (JPAP) was introduced.
2014	• Besides spouse's combined personal income tax, the family tax allowance (FTA) can also be deducted from the 7 per cent health insurance contribution and the 10 per cent pension contribution.
2016	• Personal income tax fell to 15 per cent. • The FTA available for two children was raised from HUF 10,000 to HUF 12,500.
2017	• The social contribution tax dropped to 22 per cent. • The FTA available for two children was raised from HUF 12,500 to HUF 15,000.
2018	• The social contribution tax dropped to 19.5 per cent. • The allowance of those with two children increased from HUF 15,000 to HUF 17,500.