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Assessing changes of the Hungarian tax and transfer system: A general-equilibrium microsimulation approach

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(A magyar adó- és transzferrendszer változásainak elemzése általános egyensúlyi mikroszimulációs modell segítségével)

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Contents

Abstract

We present a new general-equilibrium behavioural microsimulation model designed to assess long-run macroeconomic and fiscal consequences of reforms to the tax and transfer system. General-equilibrium feedback effects are simulated by embedding microsimulation in a parsimonious macro model of a small open economy. We estimate and calibrate the model to Hungary, and then perform three sets of simulations. The first one explores the impact of personal income tax rate reductions which are identical in cost but different in structure. The second one compares three different tax shift scenarios, while the third one evaluates actual policy measures between 2008 and 2013. The results suggest that while a cut in the marginal tax rate of high-income individuals may boost output, it does not have a significant employment effect. On the other hand, programs like the Employee Tax Credit do have a significant employment effect. We find that policy measures since 2008 substantially increase income inequality in the long run; the contribution of the changes after 2010 are about three times that of the changes before 2010. Our results highlight that taking account of household heterogeneity is crucial in the analysis of the macroeconomic effects of tax and transfer reforms.

JEL: H22, H31, C63.
Keywords: behavioural microsimulation, linked micro macro model, tax system, transfers.

Összefoglalás

A tanulmány egy új, az adó- és transzferrendszer változásainak hosszú távú makrogazdasági és költségvetési hatásainak elemzésére szolgáló általános egyensúlyi mikroszimulációs modellt mutat be. Az általános egyensúlyi hatásokat egy kis, nyitott gazdaságra felírt makromodellbe ágyazott mikroszimuláció segítségével számszerűsítjük. A modellt magyar adatokra illesztjük, majd háromféle szimulációt mutatunk be. Az elsőben különböző összetételű, de egymással megegyező költségvetési hatású személyijövedelemadó-csökkentést vizsgálunk. A másodikban három adóátrendezést hasonlítunk össze, majd a harmadikban a 2008 és 2013 közötti intézkedések hatásait mutatjuk be. Eredményeink azt sugallják, hogy míg a magas keresetűek határadókulcsának csökkentése növelheti a kibocsátást, az intézkedésnek csekély hatása van a foglalkoztatottságra. Ezzel szemben adójóváírás segítségével szignifikánsan növelhető a foglalkoztatottak száma. Megmutatjuk, hogy a 2008 óta bevezetett intézkedések jelentősen növelték Magyarországon a jövedelemegyenlőtlenséget – ezen belül is a 2010 utáni intézkedések háromszor annyira, mint a 2008 és 2010 közöttiek. Az eredményeink rávilágítanak, hogy az adó- és transzferrendszer változásainak makrogazdasági hatásainak elemzésekor döntő fontosságú figyelembe venni a háztartások heterogenitását.

1 Introduction

Changes to the tax and transfer system in Hungary were frequent and large in the last decade. The Personal Income Tax (PIT) code saw major changes in five of the last ten years. The most recent changes introduced a flat tax of 16% on all personal income, reducing the tax burden on high incomes substantially (and increasing somewhat the burden on low incomes). During the last three years, the generous Employee Tax Credit (ECT) for low incomes was eliminated while the child tax credit was expanded and a cut in employee contributions for younger, older and low-skilled workers was passed into law. Meanwhile, the maximum length of unemployment benefits has been cut from 12 to 3 months. Large changes in the tax and transfer system most often serve one or more of three main purposes: consolidating the public budget, adjusting the system to the government's redistributive preferences, and stimulating the economy. While simple tools are generally sufficient to conduct a static fiscal assessment of a planned policy measure, a detailed assessment of the redistributive, labour market, and growth effects is far from straightforward.

In this paper we present a new general-equilibrium behavioural microsimulation model designed to assess long-run macroeconomic and fiscal consequences of reforms to the Hungarian tax and transfer system. We describe the model in detail and present simulations of hypothetical as well as actual reforms from the period between 2008 and 2013.[1] Besides presenting a new tool for policy analysis tailored for a particular country, we also believe that we provide a useful input for policy discussions and evaluations in other European countries about the long-run effects of structural reforms.

The microsimulation model has two important features. First, it is behavioural, which means that it takes into account the labour supply response of individuals at the intensive margin (number of effective hours worked) and at the extensive margin (labour force participation). The labour supply response at the intensive margin is calibrated using estimates of the taxable-income elasticity for Hungary by Bakos et al. (2008) and Kiss and Mosberger (2011). The labour supply response at the extensive margin is implemented using the estimations from our related work (Benczúr et al., 2012). Taking into account both margins of labour supply adjustment, the microsimulation model becomes a full labour supply model.

The second important feature is that labour supply shocks, resulting from individual behavioural responses to tax and transfer reforms, are fed into a long-run neoclassical model of a small open economy. The linked micro-macro modelling approach has important advantages. Shifts in labour supply will, in the long run, lead to changes in wages, corporate profits and thus a change in the demand for capital. By embedding the labour supply model in a macro model, we can take account of these general-equilibrium feedback effects. More importantly, this approach enables us to assess the macroeconomic and labour-market effects of changes to the corporate side of taxation. Still, the macro model is parsimonious: it consists of an aggregate production function and a capital supply curve, ensuring that input prices equal their marginal products and that capital supply is elastic.

Both main features of the model fit into recent tendencies in microsimulation modelling (see, e.g., Bourguignon and Spadaro, 2006; Williamson et al., 2009 for recent surveys).[2] Early work on incorporating behavioural responses includes work by Aaberge et al. (2000), Blundell et al. (2000), and Creedy and Duncan (2002). Recently, Immervoll et al. (2007) simulated the effects of two hypothetical welfare-reform scenarios in 15 European countries based on the EUROMOD microsimulation model. The authors stress the importance of taking into account the behavioural labour-supply response not just at the intensive margin but also at the extensive margin, since the evaluation of a welfare reform hinges crucially at the extensive-margin response. We follow the recommendations of Immervoll et al. (2007) by incorporating both margins

[1] First simulation results using the model are presented in our earlier, non-technical paper assessing the 2011 tax changes in Hungary (Benczúr et al., 2011).

[2] For a survey on previous microsimulation models and applications in Hungary, see Benedek et al. (2013).

of adjustment. Our approach differs in two ways: first, we use recent micro-level estimations on the country of study to calibrate the labour-supply response and, second, we take general-equilibrium effects into account.

Linking micro and macro models for policy analysis also fits into recent trends in microsimulation modelling. These approaches typically use Computable General Equilibrium (CGE) models to take account of the general-equilibrium effects (see Davies, 2009 for a recent survey on micro-macro modelling). CGE models are complex tools allowing the researcher to model the consumption and labour supply behaviour of one or more representative households and model the complex interrelations of wages and prices in several sectors of the economy. In most cases the linked CGE-microsimulation method is used to assess the effects of trade opening, or other large macroeconomic shocks, on the income distribution in developing countries: Cogneau and Robilliard (2006) analyse the distributional effects of productivity increases in different sectors of the economy in Madagascar; Cororaton and Cockburn (2007) analyse the effects of trade liberalisation on inequality in the case of the Philippines; while Robilliard et al. (2008) analyse effects of the 1997 financial crisis in on income inequality in Indonesia. In what is to our knowledge the only micro-macro analysis on a transition country, Rutherford et al. (2005) investigate the growth and inequality effects of Russia's accession to the WTO.

There are a few applications of micro-macro models to questions of tax policy: the first such analysis was conducted by Slemrod (1985) who focused on the incidence and the effects on portfolio choice of a hypothetical flat-rate income tax in the US. Early work used the linked CGE-microsimulation approach to model the effects of corporate taxation (Tongeren, 1994; Plumb, 2001). Closest to our focus are recent works on the interactions of labour supply and general-equilibrium feedbacks. Aaberge et al. (2004) analyse how endogenous labour supply interacts with long-term fiscal sustainability in Norway; Arntz et al. (2008) use such an approach to evaluate a hypothetical welfare reform in Germany; while Fuest et al. (2008) and Peichl (2009) simulate the effects of a hypothetical German flat-tax reform.

With the present analysis we intend to contribute to the literature on linked micro-macro modelling in two ways. First, we contribute to the scant literature on linked micro-macro modelling in transition economies.[3] Second, our contribution to the development of tools for policy analysis is that we offer an approach to micro-macro modelling which keeps the macroeconomic model parsimonious and computationally easy.

Parsimony of the macro model has the advantage that it can easily be made transparent which assumptions and parameters are responsible for the nature of general-equilibrium feedback effects. This contrasts to the complexity of most CGE models. The parsimony of the macro model also minimizes potential theoretical and practical inconsistencies between the micro and macro models. Finally, it allows both models to be fully integrated: information is not restricted to flow only one way (either from the macro model to the microsimulation in a 'top-down' approach, or the other way round in a 'bottom-up' approach). The modules are repeatedly run in an automatic iterative process until they reach full convergence.

The cost of parsimony on the macro side is that shifts among sectors (both in production and consumption) are ignored. We believe that this cost is significantly lower for our application than it may be in other cases. The interrelations of various sectors (agriculture, formal, informal) are in the very focus of studies on developing countries, especially in the analysis of sector-specific macroeconomic shocks (e.g., trade liberalisation in agriculture). In contrast, sector-specific concerns are not central for our focus, which is the reaction of labour supply to changes in the tax and transfer system and its repercussions for the whole economy. The fact that the Hungarian economy is fully integrated into the European Economic Area reinforces the point that a simple small open economy macro model is appropriate. As Davies (2009, p. 60) puts it: 'In the case of national subregions, or countries embedded in free-trade areas, it can be argued that microsimulation may adequately be combined with pure macro models. That is, CGE modelling may not be necessary.'

We are aware of two studies conducting micro-macro analysis that do not use a CGE model to compute general-equilibrium effects. Cameron and Ezzeddin (2000) use a regional input-output model to assess indirect effects of regional and federal tax and transfer policies in Canada, while Lattarulo et al. (2003) use a social-accounting-matrix based multiplier approach to model the income distribution of the Italian region of Tuscany. In both of these studies, as in ours, the micro and

[3] In his survey, Davies (2009, p. 60) makes this point: 'Currently, several groups of development researchers are putting these two approaches [microsimulation and CGE modelling] together, and in some cases adding macroeconomic and financial modelling as well. With a few conspicuous exceptions, little such work is being done for the transition economies.'

the macro models are fully integrated. Our approach differs from both by using a simple, single-sector macro model to calculate general-equilibrium effects.

We perform three sets of simulations. The first one explores the impact of personal income tax reductions which are identical in cost but different in structure: an across-the-board rate cut, a flat tax with a zero rate at the bottom, and a flat tax with a tax credit scheme at the bottom. The second one compares three different tax shift scenarios: a personal income tax cut financed by a corporate tax hike, a personal income tax cut financed by a transfer tightening, and a corporate tax cut financed by a transfer tightening. And finally, the third one evaluates actual policy measures between 2008 and 2013.

The results from our hypothetical policy simulations show that while a cut in the marginal tax rate of high-income individuals may boost output, it does not have a significant employment effect. On the other hand, programs like the Employee Tax Credit do have a significant employment effect. Though a corporate tax cut financed by a personal income tax hike leads to higher labour use, its output effect is negative, driven by the elastic response of capital. Transfer tightening seems very effective in boosting employment, since it creates very strong financial incentives for work. It is important to keep in mind though that our model abstracts from potentially important features of transfers like the impact of unemployment insurance duration on matching efficiency.

Simulating the effects of actual recent policy changes we find that measures passed in the two years before the 2010 elections increase long-run employment and GDP, but there is no significant adjustment at the intensive margin of labour supply. In contrast, measures passed since 2010 produce a large gain at the intensive margin, but employment is expected to increase only due to cuts in the unemployment benefit. Both policy packages are found to substantially increase income inequality in the long run (the contribution of the changes after 2010 is about three times that of the changes before 2010), the cumulative change has the potential to place Hungary at the median of the EU-27, in a marked change from its original ranking as the country with the 6^{th} most equal income distribution.

The rest of the paper is structured as follows. In the next section we give a detailed description of the principles of the model: we describe the data, our approach to modelling labour supply adjustment, and the details and limitations of the small macro model in which the microsimulation is embedded. Section 3 presents results of the simulations followed by various robustness checks in Section 4. The final section offers some concluding remarks.

2 Description of the model

2.1 DATA

The microsimulation model runs on the 2008 wave of the Household Budget Survey (HBS) compiled by Hungary's Central Statistical Office. Though we have access to more recent waves as well, we decided to stick to the last pre-crisis year, where the assumption of the economy being 'in steady state' is more plausible. The data set provides detailed information on nearly 20,000 individuals (including information on their labour market status and income) living in nearly 8,000 households. Our analysis relies strongly on household characteristics when modelling labour supply and eligibility for social transfers. For this reason we could not base our analysis on tax return data, since these do not include information about household characteristics (not even the number of children).

The HBS, however, comes with a weakness. While it is a representative survey of households living in Hungary along many dimensions, the income distribution of individuals observed in the data set does not exactly match the official tax data. As is reportedly typical of survey data, the top 1% of the income distribution is all but missing. A possible solution to this problem is the matching of datasets: a multiple matching between individual tax returns and individuals observed in the survey is a method often used to resolve this problem. Our approach to correct the wage distribution is different but has a very similar effect. Before the actual microsimulation we include a wage-correction stage. This is done by comparing, percentile for percentile, the average gross wage income of individuals in the HBS and in tax return data for 2008. For most of the income distribution, the differences between both data sets are not large (less than 10%). The difference, however, grows bigger in the top 10% of the income distribution, reaching almost 50% in the top percentile. Thus, in the top part of the distribution we multiply the wage income of individuals in the HBS by a percentile-specific factor to match the wage income distribution in the tax return data. (The method is robust to the choice of the lowest percentile included in the correction; it is important, however, that the top 30 percentiles are included.) This step makes the static fiscal assessments based on our microsimulation model reliable.

2.2 MICROSIMULATION

The behavioural microsimulation model takes into account two types of behavioural adjustment on the individual level: labour supply response at the intensive and extensive margin. Labour supply response at the intensive margin means that individuals change their work intensity (hours, work effort, etc.) after a cut in their marginal or average tax rate (and vice versa). The general view is that such behavioural response exists for high-income earners (mostly in response to marginal rate changes) but less in the lower ranges of the income distribution. Labour supply response at the extensive margin means that an individual exits the labour force if the financial gains to market work decrease (and vice versa). The general view is that this type of behavioural adjustment is more significant in the case of secondary earners, low-income earners, women with children, young workers and the elderly (for an overview of these issues see, e.g., Meghir and Phillips, 2010).

In this paper the labour supply response at the intensive margin is calibrated based on estimations by Kiss and Mosberger (2011) of the elasticity of taxable income with respect to the tax rates. They estimate the compensated elasticity of taxable income with respect to the marginal net-of-tax rate to be approximately 0.2 for high earners. We apply this elasticity to the top fifth of wage earners; lower-income households are assumed to have no labour supply response at the intensive margin (Bakos et al., [2008] provide estimations that support this type of dependence of the elasticity on income). Robustness of the results with respect to the elasticities is investigated in Section 4.

A note is in order about the interpretation of the taxable-income elasticity as labour-supply response. Some studies (especially in the U.S.) found that part of the response in taxable income to taxation is due to tax optimisation (through itemised deductions) and has, therefore, little to do with additional real economic activity. For Hungary, however, there are good reasons to view the taxable income elasticity as labour-supply response. First, itemised cost deductions are negligible in the Hungarian personal income tax system. Correspondingly, the existing estimations on Hungarian data are lower than taxable-income elasticities estimated in the US. Second, Kiss and Mosberger (2011) present additional indirect evidence that supports this interpretation. Firstly, their estimated elasticity does not differ significantly between those individuals who have wage income only and those who have multiple sources of income (dividend, entrepreneurial income, etc.). Plausibly, the former group has less opportunity for tax avoidance and evasion. Secondly, they find no support for income shifting in the tax-reform episode they investigate.

The labour supply response at the extensive margin is calibrated based on our recent work (Benczúr et al., 2012). This study pools eleven consecutive waves of the HBS to estimate a structural model of the work decision as a function of transfers and the net wage rate. More precisely, the probability of being economically active depends on the net income an individual can achieve when out of work (the intercept of the budget set), and the 'financial gains to work', i.e., the change in disposable income due to taking up a full-time job (which equals the net wage minus lost transfers):

$$P(\text{active}) = \Phi(\gamma \log W_i + Z_i \alpha' - \bar{\psi} \log T_i).$$

Here, W_i represents the financial gains to work, T_i denotes the amount of transfers one gets (or would get) at zero hours worked plus all other non-labour income, and Z_i is a set of observable individual characteristics.

The study finds that labour supply response at the extensive margin is strongest for lower-wage groups because their financial gains to work are the most sensitive to the tax system. Further, the study confirms that the labour supply elasticity at the extensive margin is larger than average for older workers and, to a lesser extent, women in child-bearing age. Table 1 reports the conditional marginal effects relevant for the present study.

Table 1
Conditional marginal effects by subgroups

		Working-age population		Prime-age (25–54)	
		dy/dx	std. err.	dy/dx	std. err.
full sample	net wage	0.395	*0.038*	0.127	*0.014*
	transfer	−0.136	*0.013*	−0.054	*0.006*
elementary school or less	net wage	0.294	*0.089*	0.409	*0.040*
	transfer	−0.093	*0.028*	−0.194	*0.019*
secondary education	net wage	0.310	*0.031*	0.122	*0.012*
	transfer	−0.118	*0.012*	−0.054	*0.005*
tertiary education	net wage	0.139	*0.015*	0.050	*0.004*
	transfer	−0.045	*0.005*	−0.019	*0.001*
elder (>=50)	net wage	0.392	*0.065*		
	transfer	−0.103	*0.017*		
women at child-bearing age (25–49)	net wage			0.231	*0.021*
	transfer			−0.108	*0.010*
prime-age, single men	net wage			0.096	*0.012*
	transfer			−0.038	*0.005*
prime-age, single women	net wage			0.168	*0.019*
	transfer			−0.076	*0.008*
prime-age, married men	net wage			0.039	*0.005*
	transfer			−0.016	*0.002*
prime-age, married women	net wage			0.290	*0.025*
	transfer			−0.133	*0.012*

Source: Benczúr et al. (2012).

To assess the order of magnitudes of these extensive margin effects, it is instructive to compare them to the 'consensus' 0.25 value of aggregate (steady state) net wage elasticity reported by Chetty et al. (2012). The net wage marginal effects in Table 1 are somewhat larger, but there are two reasons why they are not directly comparable: (1) they correspond to various subgroups rather than the whole working-age population and (2) the reported marginal effects indicate the effect of one percent increase in net wage on the probability of being active (or on the participation rate) in *percentage points*, as opposed to the elasticity measures in Chetty et al. (2012) indicating the *percentage change* in employment to the same shock. To produce the equivalent of the exercise by Chetty et al. (2012), one needs to increase the net wage of all individuals by 1% and look at its employment effect. The resulting 0.28% increase in total employment implies an elasticity of 0.28, quite in line with the consensus.

To further study the impact of transfer reforms on the extensive margin, we report the result of two additional labour supply simulation exercises. In the first one, we simulate the effects of the cut in maternity benefit in 1995. Köllő (2009) found a positive though often insignificant effect of this measure on the activity of mothers with infants, while Szabó-Morvai (2011) found a negative though delayed effect of the reversal of the reform. Our estimates imply a 0.11% increase in total employment, which implies a roughly 1.24 percentage point increase in the employment rate of the target group.[4] This is consistent with a positive but statistically not always significant treatment effect.

Our second exercise increases the effective retirement age by one year. There is ample of evidence for a large negative labour supply effect of pension eligibility in Hungary: examples include Köllő and Nacsa (2005) and Cseres-Gergely (2008). Our estimates imply a 1.68% increase in total employment, which translates into a 4.26 percentage point increase in the employment rate of the 55–65 age group (1.6 million in size). Consistently with earlier estimations, this is a much larger effect than that of the maternity support reform.

The labour-supply response at the extensive margin is implemented in the microsimulation in the following way. Every individual of working age is assigned an individual-specific baseline activity probability based on the underlying probit estimates (and not on some group-specific conditional marginal effect) of Benczúr et al. (2012). The labour-supply response at the extensive margin is modelled as an adjustment of this probability after any change to the tax and transfer system. This procedure means that we must simulate, for every working individual, what transfers they would receive if they did not work and, for every inactive individual, what wage they would earn if they did choose to work. Aggregate effective employment of the economy is then equal to the sum of (potential) gross hourly wages of all individuals weighted by their employment probability. This latter is measured as individuals' participation probabilities minus their group-specific unemployment probabilities conditional of being active. This implicitly assumes that labour is homogenous, and relative wages reflect relative productivities.

This formulation of the extensive margin means that the intensive response is reinterpreted as well: it represents work effort, conditional on working. In sum, a shock to the aggregate effective labour supply may come from intensive adjustment if, with all employment probabilities held constant, some individuals change their work effort (conditional on employment) or extensive adjustment if, work effort held constant, the probability of work increases for some individuals. Our model is programmed in a way that extensive and intensive adjustment can be switched on or off independently from each-other.

The microsimulation proceeds in the following steps: (1) Given the changes in the tax and transfer system, a static microsimulation is conducted first.[5] It calculates how much each individual gains (or loses) as a consequence of the changes. It also calculates the changes in the marginal and average effective tax rates (relevant for the intensive-margin response), the financial gains to work and the hypothetical amount of transfers one would get at zero hours worked (relevant for the extensive-margin response). (2) These updated measures are fed back to the participation probit estimation (yielding a change in the individuals' probability of being active) and to the intensive-margin response (effective hours worked conditional on being employed). Summing up over individual changes in labour supply, the aggregate labour supply shock is obtained. (3) This is fed into the macro model, which calculates general-equilibrium effects on wages and the capital stock. (4) Based on the general-equilibrium change of the wage level, the microsimulation is repeated. This iterative process is

[4] According to 2008 values in our database, total employment is 4,058,000. A 0.11% increase adds 4,460 to the employed population, which is 1.24% of all the mothers with infants (a group of about 360,000).

[5] Our static microsimulation module partly builds on a tax-benefit model created by Benedek et al. (2009).

repeated until convergence; that is, until the general equilibrium of the economy is consistent with the reform-induced labour supply shock.

2.3 GENERAL EQUILIBRIUM

The general-equilibrium macro model is a long-run model of a small open economy. Thus, capital supply is almost perfectly elastic. Capital and labour are paid their marginal products, according to a constant-returns-to-scale production function. In the following we describe the model in detail. Since the labour supply shock comes from microsimulation and we are not interested in the change in sectoral consumption patterns, the general-equilibrium model does not detail the household side.

The production function of the representative firm exhibits constant elasticity of substitution (CES).[6] The profit-maximisation problem of firms can be formulated as:[7]

$$\max\left(\alpha K^{\beta}+(1-\alpha)L^{\beta}\right)^{\frac{1}{\beta}}(1-\tau_s)-w(1+\tau_W)L-\frac{r}{1-\tau_K}K.$$

Here, τ_s is the effective tax rate on sales (representing, in the baseline, the effects of the local business tax), w is the gross wage, τ_W is the rate of employer-side social security contributions (equivalent to a payroll tax), τ_K is the effective tax rate on capital and $\frac{r}{1-\tau_K}$ is the net user cost of capital.

The model is closed by the equation that determines the aggregate supply of capital. Capital is provided by an international capital market. Its supply is modelled in a reduced form: $\hat{K}=\eta\hat{r}$ where η is the elasticity of capital supply K with respect to the after-tax rate of return r (and $\hat{x}$ denotes the percentage change of variable x).

It is easiest to present the comparative statics results if we log-linearise the model around the equilibrium. After deriving the first-order conditions and log-linearisation, we arrive at the following four equations:

$$\hat{k}=\frac{1}{\alpha\bar{k}^{\beta}}\left(\frac{1}{1-\alpha}\right)^{\frac{\beta}{1-\beta}}\frac{1}{1-\beta}\left(\frac{\bar{w}(1+\overline{\tau_W})}{1-\overline{\tau_s}}\right)^{\frac{\beta}{1-\beta}}\left(\hat{w}+\widehat{(1+\tau_W)}-\widehat{(1-\tau_s)}\right)$$

$$\hat{k}=\frac{1}{\alpha\bar{k}^{\beta}}\left(\frac{1}{\alpha}\right)^{\frac{\beta}{1-\beta}}\frac{1}{1-\beta}\left(\frac{\bar{r}}{(1-\overline{\tau_K})(1-\overline{\tau_s})}\right)^{\frac{\beta}{1-\beta}}\left(\hat{r}-\widehat{(1-\tau_K)}-\widehat{(1-\tau_s)}\right)+\left(\frac{1}{\alpha}\right)^{\frac{1}{1-\beta}}\hat{k}$$

$$\hat{k}=\hat{K}-\hat{L}$$

$$\hat{K}=\eta\hat{r}.$$

Here, k is the capital-labour ratio and $\bar{x}$ denotes the ex-ante equilibrium value of variable x. The first equation ensures that wages are equal to the marginal product of labour, while the second equation ensures that the return on capital is equal to its marginal product. The labour supply shock $\hat{L}$ is the result of microsimulation (reflecting both the exogenous labour supply response to the policy shock and the endogenous response to the change in wages).[8] A balanced budget restriction is not imposed (see a discussion of this point below).

To interpret these equations, we first look at the case of perfectly elastic capital supply ($\eta = \infty$). In this case the domestic rate of return is pinned down to the international rate and is thus constant ($\hat{r}$ = 0) while the last equation does not

[6] Previous estimations of factor demand and the substitutability between labor and capital rejected that the Cobb-Douglas production function can be used. See Kátay and Wolf (2004) for an estimation of the demand for capital.

[7] We write the firm's problem in net terms, so it does not contain the value-added tax (VAT). The VAT is, however, included in the net wage entering the labour supply decision.

[8] VAT and labour taxes directly affect labour supply.

determine the capital stock. This implies (through the second of the four equations), that the capital-to-labour ratio *k* must also stay constant which, in turn, implies (through the first equation) that wages will also stay constant. We thus get the usual result that with perfectly elastic capital supply the capital stock adjusts to shocks, so that the capital-labour ratio and factor prices can return to their equilibrium values. For example, if there is a positive labour-supply shock following a tax cut, capital accumulation will follow in identical proportion, so that a new equilibrium is reached with an unchanged capital-labour ratio.

If capital is calibrated to be imperfectly elastic (which will be the case in our baseline), wages will decrease and the return on capital will increase somewhat after an increase in aggregate labour supply. While capital accumulation will mitigate these effects, it will not neutralise them completely.

2.4 CALIBRATION OF THE MACRO MODEL

The parameters of the model are calibrated based on previous estimations and simple statistics taken from the National Accounts.

1) Taxes on capital (corporate income tax and other, less significant, corporate taxes) and consumption (VAT and other, less significant, consumer taxes) are calculated as effective tax burdens on aggregates taken from the National Accounts. The initial (2008) effective tax rate on capital is $\tau_K = 0.073$, while the initial effective tax rate on sales (calculated as total tax revenue divided by GDP) is $\tau_S = 0.0174$. The effective tax rate on consumption is $\tau_{VAT} = 0.182$.

2) The elasticity of substitution between capital and labour in the production function is chosen based on estimations of Kátay and Wolf (2004): $\beta = (\sigma-1)/\sigma = (0.8-1)/0.8 = -0.25$.

3) The capital income share is calibrated based on averages from the National Accounts:

$$\left[\frac{r}{(1-\tau_K)(1-\tau_s)}K\right] / \, Y = 0.35.$$

4) The net user cost of capital is computed as described in Kátay and Wolf (2004). Its average value for the period 2005–2008 is 0.155.

5) Parameter α is obtained by rearranging the first order condition of profit maximisation with respect to capital:

$$\propto \left(\alpha K^\beta + (1-\alpha)L^\beta\right)^{\frac{1}{\beta}-1} K^{\beta-1}(1-\tau_s) = \frac{r}{(1-\tau_K)}$$

$$\rightarrow \alpha = \left(\frac{\frac{r}{(1-\tau_K)(1-\tau_s)}K}{Y}\right)^{1-\beta} \left(\frac{r}{(1-\tau_K)(1-\tau_s)}\right)^{\beta} = 0.429$$

6) It is left to calibrate η, the elasticity of capital supply with respect to the after-tax return on capital. The two extreme cases are perfect capital mobility ($\eta = \infty$) and perfectly inelastic supply of capital ($\eta = 0$). The former is a reasonable assumption in the long run, supported either by a small open economy assumption (the rental rate is set by the world rate) or a closed economy Ramsey model (the rental rate is determined by the rate of time preference); while the latter is probably a good description of the very short run. While the model can be run with any of these values, the results shown below are based on a quite elastic capital supply ($\eta = 15$).

2.5 LIMITATIONS

Based on a limited set of ingredients (most importantly the estimated behavioural elasticities and the small-open economy macro framework) the model is able to give an assessment of the long-term effects of changes of the tax and transfer system to the macroeconomy and the government budget. But precisely because of its relative simplicity the model has a number of limitations:

(1) The model is suitable for comparative statics exercises. The dynamics of the adjustment path from pre-reform to post-reform steady state equilibrium is not modelled.

(2) Following from the fact that the model is supply-driven, the consumption-savings decision of households is not modelled. Economic growth is determined by the supply of labour and capital. The consumption decision affects our results in only one way: it affects the fiscal effects through the VAT. Our simplified assumption that all disposable income is consumed by households admittedly results in the overestimation of the VAT effect of policy measures.

(3) The model is not closed on the side of government. Budget balance is not enforced either directly or by an assumption that higher debt results in higher interest rates paid on government debt. This simplification is innocuous if the policy measures analysed are approximately budget neutral or small in magnitude. Otherwise, the macroeconomic effects estimated by the model are overly optimistic in the case of measures that weaken the position of the government budget, and vice versa.

(4) The search-and-matching mechanisms on the labour market are not modelled explicitly. If a policy measure changes the equilibrium unemployment rate of any demographic or skill group, the model will not take this into account. It might be, for instance, that shortened eligibility for unemployment benefits, in addition to strengthening job-search incentives, reduces the success rate and average quality of matches between job openings and the unemployed. In this case the long-run employment and the output effect of the transfer cut will be overestimated by the model.

(5) Different types of labour are perfect substitutes in the model. In this supply-driven model it follows that, subject to a group-specific equilibrium unemployment rate estimated on pre-crisis statistics, all individuals who would like to work are able to find a job. This may be an overly optimistic assumption if there are structural mismatches between job-seekers and job openings in the economy.

(6) It follows from points (4) and (5) that the model might overestimate the long-run macroeconomic benefits from transfer cuts. In addition, since it is a long-run, supply-driven model, it does not take into account the short-run macroeconomic cost of transfer cuts in a depressed economy with inefficient aggregate demand.

(7) The effects of the minimum wage (and changes thereof) are not taken into account in the model. The model operates on the assumption of perfectly flexible real wages in the long run. If the minimum wage is raised to a level that is 'too high', this might hamper the adjustment of the real wages of low-skilled workers. In this case, employment effects of tax and transfer changes may be overestimated by the model.[9]

(8) The informal economy and the behaviour of self-employed are not modelled explicitly. The model takes into account these issues only in the degree that the behavioural elasticities reflect the behaviour of the self-employed and those employed in the informal sector. The estimation of the labour supply elasticity at the extensive margin by Bakos et al. (2012) does include the self-employed. Also, since that analysis is based on survey data, it may include individuals working in the informal or semi-formal sector. The estimations of the taxable income elasticity by Bakos et al. (2008) and Kiss and Mosberger (2011) exclude the full-time self-employed and are based on the officially reported income of individuals (whether or not that income is underreported). While the estimated taxable-income elasticity may under- or overestimate the real economic effect, it is, by definition, the correct measure for fiscal purposes.

[9] The minimum wage was increased substantially in 2012.

3 Simulation results

We present results from three sets of simulations. First, we analyse three different versions of a personal income tax (PIT) cut. Second, we analyse three complex hypothetical policy packages which are approximately revenue neutral in the absence of behavioural responses. Third, we analyse actual changes of the tax and transfer system between 2008 and 2013. In this latter case, we complement the analysis by simulating the long-run value of certain inequality measures before and after the reforms, and also identify winners and losers of reforms by income quintiles.

Tables 2 to 4 in this section consist of two panels. The top panel shows the macroeconomic effects: figures are to be interpreted as percentage changes of macroeconomic variables *in levels* as compared to the scenario with no change in legislation. For example, Table 2 indicates that an 'across-the-board' tax cut would increase the level of long-run GDP by 1.4%.

The bottom panel in each table presents the fiscal effects: the unit of these figures is billion Hungarian forints (HUF billion) at 2008 prices. To facilitate the interpretation of these figures we note that, on average, 1 EUR was equivalent to about HUF 270 during the period 2008–2011. Therefore, a tax package that costs HUF 240 billion is the equivalent of about EUR 0.9 billion (or about 0.9% of Hungary's GDP in 2008).

The tables below show the *static* and *dynamic* effects of various policy packages. The static effect is calculated before the labour supply reaction of individuals (or any macroeconomic adjustment) takes place. It is however assumed that additional disposable income is consumed by households: static fiscal effects therefore include a VAT effect. While this is a technical assumption that is plausible in the long run, for realistic short-run fiscal assessments the VAT effect has to be discounted. Dynamic effects include all the adjustments: a labour supply response of individuals at the intensive and extensive margins and general-equilibrium macroeconomic effects.

Table 2 shows the static and dynamic effects of three scenarios in which PIT revenues decrease by about HUF 240 billion (or 0.9% of GDP) before behavioural changes. All three scenarios are defined as changes relative to the 2008 PIT system. In 2008 there were three tax brackets in the Hungarian PIT. The lower rate was 18% and applied to income up to approximately the average yearly income; a rate of 36% applied to income above that up to the pension contribution ceiling; and a rate of 40% applied to income above that. Besides the PIT, individuals paid social security contributions at a rate of 17% up to the pension contribution ceiling and 7.5% above that. In 2008 the employee tax credit (ETC; in Hungarian: *adójóváírás)* reduced the PIT liability of individuals earning the monthly minimum wage (HUF 69,000 ≈ EUR 250) to almost zero. The ETC was phased out at a rate of 9% around the average yearly income.

In the first scenario of Table 2 ('across-the-board PIT cut'), all three PIT rates are reduced by 3.5 percentage points. In the second scenario a 0% tax rate applies to income up to the minimum wage, and a rate of 29.5% to income above that (in this scenario the ETC is eliminated). In the third scenario a single basic tax rate applies to all taxpayers (23%), but there is an ETC that makes the minimum wage PIT-free and is phased out in roughly the same income interval as the actual 2008 ETC. The parameters of all three scenarios were adjusted so that all three have a direct fiscal cost of about HUF 240 billion (the parameters of the PIT scenarios are summarised in Table A1 of the Appendix).

Table 2 shows that different ways of reducing the PIT burden have starkly different aggregate effects. It immediately implies that inserting a change in an economy-wide average tax rate (tax revenues per tax base) into a standard macro model would be highly misleading. In terms of the employment effect, it is positive in all three scenarios but it is negligible in the two-rate scenario in which the ETC is abolished and very small in the flat-rate scenario with ETC. This means that those tax reforms will have a positive employment effect that keep the average tax rate low for low earners. The most

Table 2
Personal income tax scenarios

	Across-the-board PIT cut		2 tax rates (0% + 29.5%)		1 tax rate (23%) + tax credit	
	static	dynamic	static	dynamic	static	dynamic
Effective labour		1.5%		1.8%		3.0%
Employment		0.9%		0.1%		0.3%
Capital stock		1.2%		1.4%		2.4%
GDP		1.4%		1.7%		2.8%
Average gross wage		–0.1%		–0.1%		–0.3%
Disposable income		3.5%		3.6%		4.3%
Personal income tax	–253	–222	–234	–193	–235	–179
Employee contributions	0	16	0	18	0	30
Employer contributions	0	36	0	43	0	74
Taxes on consumption	46	58	42	58	43	71
Taxes on capital	0	9	0	11	0	18
Taxes on sales	0	7	0	8	0	13
Transfers	0	10	0	1	0	0
Change of budget balance	–207	–87	–191	–54	–192	27

Note: The upper panel of the table shows percentage changes of macroeconomic variables in levels. The bottom panel shows fiscal effects in HUF billion expressed in 2008 prices. (Positive numbers indicate an improvement of the government balance. In 2008, nominal GDP was HUF 26,545 billion. During the period 2008–2011 the exchange rate was EUR 1 ≈ HUF 270.) Static effects are short-run, immediate effects with no behavioural adjustment. Dynamic effects include labour supply reaction of individuals as well as long-run, general-equilibrium macroeconomic effects. The VAT estimate is based on a simplifying assumption.

significant employment gain is observed in the case of the 'across-the-board' tax cut (a gain of 0.9%), since in this scenario the average (and marginal) tax rate is lowest for low-income earners above the minimum wage, influencing their financial gains to work positively. The finding that employment gains depend mostly on the average tax burden of low incomes is consistent with the fact that in Hungary, as in most countries, inactivity is concentrated among the low-skilled groups, thus their incentives for participation matters most for employment.

The ranking of the three scenarios is very different with respect to the incentives of top earners. Effective marginal tax rates were relatively high in Hungary in 2008 and a 3.5 percentage point across-the-board tax cut of the first scenario does little to change that: the 1% increase of effective labour comes almost exclusively from the adjustment at the extensive margin. In contrast, in the other two scenarios individuals in the top 20% of the income distribution increase their labour intensity so that aggregate effective labour increases by 1.8% (two-rate scenario) and 3.0% (single-rate scenario).

Since the only macroeconomic shock here is the labour supply shock, GDP and the capital stock adjusts almost perfectly in proportion to the effective labour supply. This improves public finances in the long run relative to the static effect (as can be seen in the bottom panel of Table 2).

These results illustrate that the ranking of scenarios depends on the criteria used. While an across-the-board tax cut has the highest employment effect (since, unlike the two other scenarios, it decreases the tax burden of low and middle income individuals), the scenario with a single rate plus ETC performs best in terms of GDP. The across-the-board tax cut comes in last according to this criterion. The two-rate system without ETC is dominated by the single-rate system with ETC in every aspect. Both the two-rate system and the ETC keep the average tax rate zero at the minimum wage, but the ETC is less costly. This relative budget surplus can be used to lower marginal tax rates for higher earners, which creates additional incentives at the intensive margin and therefore stimulate the economy.

Table 3 shows three scenarios which are approximately revenue neutral in their direct static effect. Each scenario is the combination of two measures: one that costs about HUF 240 billion and one that improves the government balance by about the same amount. All scenarios are hypothetical but are similar to policies proposed or enacted in Hungary in recent years. In the first scenario we introduce the across-the-board PIT cut (as analysed above) and balance the budget by increasing the effective tax rate on capital earnings (equivalent to an increase of the corporate income tax, CIT). In the second scenario

Table 3
Tax shift scenarios with a neutral direct fiscal effect

	Capital tax increase + labour tax cut		Restricted early retirement + labour tax cut		Restricted early retirement + capital tax cut	
	static	dynamic	static	dynamic	static	dynamic
Effective labour		0.7%		4.4%		3.7%
Employment		0.1%		4.1%		3.9%
Capital stock		−6.7%		3.6%		10.1%
GDP		−1.9%		4.1%		5.9%
Average gross wage		−3.2%		−0.3%		2.8%
Disposable income		1.3%		2.8%		1.4%
Personal income tax	−253	−318	−260	−195	−7	146
Employee contributions	0	−30	1	53	1	84
Employer contributions	0	−70	0	103	0	173
Taxes on consumption	46	21	3	46	−42	22
Taxes on capital	234	204	0	26	−234	−178
Taxes on sales	0	−9	0	19	0	28
Transfers	0	1	241	255	238	250
Change of budget balance	27	−201	−14	307	−44	523

Note: The upper panel of the table shows percentage changes of macroeconomic variables in levels. The bottom panel shows fiscal effects in HUF billion expressed in 2008 prices. (Positive numbers indicate an improvement of the government balance. In 2008, nominal GDP was HUF 26,545 billion, while during the period 2008–2011 the exchange rate was EUR 1 ≈ HUF 270.) Static effects are short-run, immediate effects with no behavioural adjustment. Dynamic effects include labour supply reaction of individuals as well as long-run, general-equilibrium macroeconomic effects. The VAT estimate is based on a simplifying assumption.

we introduce the same across-the-board PIT cut and finance it by a targeted cut in old-age pension benefits. Resembling actual government proposals, we analyse a hypothetical scenario under which the opportunities of retirement become very restricted before the regular retirement age. In 2008 the regular pension age was 62 for both sexes, but a kind of regular early pension was available under some circumstances from the age of 57. Some individuals, especially in special occupational groups (armed services, miners, etc.) could retire even before the age of 57. In our specific scenario, the government saves about HUF 240 billion annually by a hypothetical measure that practically prohibits retirement before the age of 62. In the third scenario we cut the corporate income tax and finance it by the restrictions on early old-age pensions just described.

In the first scenario the employment gain of the PIT cut is neutralised by the increase in the effective tax rate on capital. The overall effect on GDP is negative which makes the government balance deteriorate through the dynamic effects. This is a reflection of the fact that in this long-run open-economy model the capital stock adjusts very sensitively to the rate of return on capital.

Restricted early retirement is part of the policy package both in the second and third scenario of Table 3. In the simulations we modelled restricted early retirement as a loss of eligibility for pension benefits of the respective age group. In this way, the individuals of a given age in 2008 represent individuals that will be the same age at the future time of the reform. The model predicts the ability and willingness to work of those affected based on the behaviour of individuals who are similar to them in observable characteristics. In our estimation the reform increases employment by about 3.2% (compare the middle columns of Table 3 to the first two columns of Table 2). Comparing scenario 2 and 3 it is apparent that decreasing the capital tax boosts the capital stock and GDP significantly more than an across-the-board cut in the PIT of approximately the same cost. Conversely, individuals' disposable income, and to a minor extent employment, is increased more when transfer tightening is accompanied by a labour tax cut instead of a capital tax cut.

In the last set of policy packages analysed, Table 4 shows the simulated effects of changes to the tax and transfer system that actually took place from 2008 to 2010 and from 2010 to 2013.[10] As elections were held in 2010, these columns correspond to changes passed by the Socialist majority in the legislature before the elections and the Conservative majority after the elections.

During the period from 2008 to 2010, there were some changes in the transfer system (both the so-called thirteenth-month pension payments and sick leave payments were cut) but these do not enter into our simulations as they do not have a significant effect on the labour supply choice of individuals (we will address other changes to the rules of retirement later on). At the same time, the following tax policy changes took place. The VAT was increased from 20% to 25% (which translates in our model to an increase of the effective consumption tax rate from 18.2% to 19.4%), partially paying for a five-percentage-point cut in employer contributions (from 32% to 27%). At the same time PIT rates were adjusted so that middle-income tax payers got a notable tax relief. In particular, the three tax brackets were consolidated into two, with the upper limit of the lowest tax bracket increased significantly. The rates increased slightly in the meantime: the lower tax rate became 21.6% (instead of 18%) while the upper tax rate 40.6% (instead of 36% and 40%).

During the period 2010 to 2013, the most important change affecting the transfer system was the shortening of the maximum period of unemployment benefits from 12 months to 3 months. The changes to the tax system included a radical cut in the top PIT rate (from 40.6% to 20.3%), a large expansion of the child tax credit, a 1.5 percentage point increase in the employee contributions and a further increase of the VAT to 27% as well as significant increases in excise taxes (taken into account, similarly to the VAT, in the effective tax rate on consumption). The ETC was eliminated in 2012 to be replaced by an employer-contribution relief for young, old and unskilled employees starting in 2013. At the same time, a CIT cut took place, counterbalanced by extraordinary ('crisis') taxes on the banking and telecommunication sectors as well as large retail companies. We fed these changes into the model by changing the effective tax rate on capital from 7.3% to 6.2%. In calculating this, we took into account only that part of the extraordinary taxes that are to be made permanent, based on the stated intentions of the government (i.e., about one-third of the bank tax). A further sectoral tax, passed into law in 2012, is to be levied on bank transactions starting from 2013. We accounted the bank transaction tax partly as a tax on consumption, partly on sales as it is paid by businesses, too. Altogether, we estimate that the effective tax rate on consumption increases from 19,4% in 2010 to 23.2% in 2013; while the effective tax rate on sales increases from 1.65% in 2010 to 2.28% in 2013. The exact parameters used in the simulations of actual changes between 2008 and 2013 are summarised in Table A2 of the Appendix.

In both periods 2008–2010 and 2010–2013 Parliament enacted legislation that restricted retirement. In 2009 the regular retirement age was increased from 62 to 65 (the transition occurring between 2014 and 2022). A law passed in 2011 restricts the possibilities of retiring before the official retirement age with some occupational exceptions (although rules became stricter even for the occupational groups with a special treatment). This latter policy change is equivalent to the hypothetical retirement reform analysed in Table 3.

Fiscal assessment of these reforms is not an easy task since the government does not publish detailed projections of pension expenditures. Our crude estimates (using past aggregate data) suggest that raising the retirement age with immediate, or rather retroactive, effect would have saved about HUF 250 billion in pension payments in 2008, whereas restricting early retirement in 2008 would have saved about HUF 240 billion in pension payments in 2008. These estimates are to be taken as indicative and should be updated if more reliable estimates become available. With this caveat in mind, we created scenarios that change pension eligibility in the affected age group and have a fiscal effect that corresponds to our crude estimates. In Table 4 we present the results for the periods 2008–2010 and 2010–2013 both with the pension measures and without them. (Since pension measures are implemented gradually, rather than with immediate effect, static results are only shown for the scenarios without pension measures.)

Table 4 shows that while both periods saw a net cut in PIT and employer contributions and an increase in the effective consumption tax rate, this was accompanied by different measures in other parts of the tax and transfer system. Measures between 2008–2010 had a negative overall static fiscal effect of about HUF 530 billion (about 2% of GDP), although savings

[10] The 2013 scenario takes into account mesures announced until August 2012.

Table 4
Long-run effects of actual changes of the tax and transfer system
(2008–2013)

	2008–2010			2010–2013		
	without pension measure		with p.m.	without pension measure		with p.m.
	static	dynamic	dynamic	static	dynamic	dynamic
Effective labour		1.7%	4.8%		4.6%	7.9%
Employment		2.3%	5.8%		2.6%	5.8%
Capital stock		1.9%	4.4%		3.7%	6.4%
GDP		1.7%	4.7%		4.3%	7.4%
Average gross wage		4.3%	4.2%		2.3%	2.1%
Disposable income		3.6%	2.8%		1.7%	1.2%
Personal income tax	–280	–157	–119	–405	–319	–277
Employee contributions	132	214	260	105	205	255
Employer contributions	–501	–363	–304	–293	–164	–113
Taxes on consumption	135	198	184	404	504	493
Taxes on capital	0	12	31	–103	–76	–56
Taxes on sales	–24	–17	–4	169	195	214
Transfers	8	29	294	103	119	360
Change of budget balance	–530	–84	342	–20	463	876

Note: The upper panel of the table shows percentage changes of macroeconomic variables in levels. The bottom panel shows fiscal effects in HUF billion expressed in 2008 prices. (Positive numbers indicate an improvement of the government balance. In 2008, nominal GDP was HUF 26,545 billion, while during the period 2008–2011 the exchange rate was EUR 1 ≈ HUF 270.) Static effects are short-run, immediate effects with no behavioural adjustment. Dynamic effects include labour supply reaction of individuals as well as long-run, general-equilibrium macroeconomic effects. The VAT estimate is based on a simplifying assumption.

not accounted for in our simulations counterbalanced these measures to a large extent. In contrast, measures in the period 2010–2013 have an approximately neutral static fiscal effect, with cuts in the unemployment benefit, increases of employee contributions and taxes on sales and consumption making up for foregone PIT revenue.

Table 4 also shows that the policy packages of both periods differ in their macroeconomic effect. If we consider the scenarios with no pension measures we see that, mainly due to the cut in employer contributions, the changes between 2008 and 2010 increase long-run employment by 2.3% and GDP by 1.7%. Since top marginal rates remained unchanged during this period, there is much less adjustment at the intensive margin. In contrast, the combination of cuts in the CIT, PIT and unemployment benefits in the period 2010–2013 are estimated to increase long-run employment by 2.6% and the long-run level of GDP by 4.3%. Here, the employment effect is entirely due to the cuts in unemployment benefits. Since the PIT cuts are concentrated at high incomes, they increase effective labour supply, and thus GDP, but not employment. The employment effects of the elimination of the ETC and the introduction of targeted employer contribution relief roughly cancel out.

The long-run effects of pension measures in both periods are similar: by keeping individuals longer in the labour force, employment increases, inducing an accumulation of capital and an increase in the long-run level of GDP. Since our estimate of the static effects of both measures was similar in magnitude, the dynamic effects of both measures are also similar: both are estimated to increase the long-run level of GDP by about 3% and improve long-run fiscal balance by about 1.5% of GDP annually.

When interpreting the simulated effects of the policy package of the period 2010–2013, we must note that there is serious uncertainty about a number of measures including those that are to come into effect only in 2013 (especially the targeted employer contribution relief and the bank transactions tax). Also, the phasing-out of temporary 'crisis taxes' is far from complete, which means that we might underestimate the current effective tax rate on capital and its expected future value as perceived by capital owners. Partly for this reason we included below, as a robustness check, simulations where an increased risk premium on Hungarian fixed assets reflects the uncertainty about tax policy.

Table 5
Simulated measures of income inequality: long-run consequences of actual changes
(2008–2013)

	2008	2010	2013
Gini index	25.9	26.8	30.6
P90/P10	2.93	3.15	3.51
P90/P50	1.73	1.81	1.97
P50/P10	1.70	1.74	1.78

Note: Results from dynamic simulations. The 2010 and 2013 scenarios do not include pension measures. The Gini index is based on equivalised income using, in accordance with EUROSTAT methodology, the modified OECD equivalence scale.

When analyzing the 2008–2013 tax and transfer packages, we also evaluated measures of inequality and the incidence of the gains and losses. The inequality measures, resulting from a dynamic simulation, are shown in Table 5.

Table 5 shows that both sets of tax policy changes increase income inequality: the long-run Gini index is estimated to increase by somewhat less than a point (from 25.9 to 26.8) due to the changes up to 2010 and almost by four additional points (to 30.6) due to the changes up to 2013. (These measures are not sensitive to whether we include the pension measures or not.)

This is a truly significant increase in inequality. According to Eurostat (2012) data, a Gini index of 25.9 would have implied that Hungary had the 6th most equal income distribution among the EU-27 countries in 2008, after Slovenia, Slovakia, Sweden, the Czech Republic and Denmark. (Eurostat, 2012) estimates the Hungarian Gini index to be 25.2 in 2008, which also puts Hungary at the 6th place in the same ranking.) In contrast, a Gini index of 26.8 would have placed Hungary at the 8th place (passing Austria and Finland) while a Gini index of 30.6 would have placed Hungary at the 16th place, almost exactly matching the EU-27 mean of 30.7.

The other three inequality measures in Table 5 also show growing income inequality but they also help to identify which part of the income distribution the change comes from. The measure P50/P10 shows that the gap between the median earner and individuals around the 10th percentile of the income distribution grows only slightly as a consequence of the reforms. There is more significant growth in the gap between the 90th percentile and the median. There is an interesting difference between the development of this measure and the Gini index. While the increase in the P90/P50 ratio occurs in almost equal steps, the greater part of the increase in the Gini coefficient occurs in the second step. This reflects the fact that the 2010–2013 cut in top marginal tax rates caused an increase in income inequality even *within the top 10 percent*, a development that is not captured by the P90/P50 measure.[11]

Another way microsimulation can help us analyse the distributional effects of tax and transfer changes is to calculate the average gains and losses of certain types of households in the population. Table 6 reports the results of such an exercise based on the 2010–2013 policy package that included a tax cut for high-income earners, a significant extension of the child tax credit, the elimination of the ETC affecting low and middle-income earners, and a cut in the unemployment benefit. We divided households into quintiles based on equivalised income (household income corrected for household size and composition according to the modified OECD equivalence scale) and asked the following questions: How many individuals live in households in a given income quintile who gained (lost) as a consequence of the reforms? How much in average annual income did households gain (lose) as a consequence of the reforms? The results presented are static: they were calculated without any behavioural response.

The last segment of Table 6 shows that the 2010–2013 policy package made more individuals worse off than better off (about 4.5 million individuals live in households that were made worse off while about 3.2 million individuals live in households that were made better off) and that the winning households gained more than the losing households lost (the

[11] Our percentile ratios are similar to the ones published by Eurostat for 2008: According to Eurostat data, the P90/P50 ratio was 1.70 while the P50/P10 was 1.76.

Table 6
Static simulation of the incidence of actual changes
(2010–2013)

Household quintiles		Worse off	Neutral	Better off	All
1	Individuals affected (thousand)	1,151	627	305	2,083
	Change in annual household income (HUF thousand)	–65	–	102	–21
	Change in annual household income (%)	–4.4	–	5.8	–1.6
2	Individuals affected (thousand)	919	568	364	1,851
	Change in annual household income (HUF thousand)	–110	–	93	37
	Change in annual household income (%)	–5.2	–	4.0	–1.8
3	Individuals affected (thousand)	959	497	535	1,990
	Change in annual household income (HUF thousand)	–149	–	153	–31
	Change in annual household income (%)	–5.6	–	4.9	–1.4
4	Individuals affected (thousand)	952	353	689	1,994
	Change in annual household income (HUF thousand)	–158	–	220	1
	Change in annual household income (%)	–5.0	–	5.7	–0.4
5	Individuals affected (thousand)	539	150	1,283	1,971
	Change in annual household income (HUF thousand)	–156	–	868	522
	Change in annual household income (%)	–3.7	–	11.9	6.8
Total	Individuals affected (thousand)	4,520	2,195	3,176	9,891
	Change in annual household income (HUF thousand)	–122	–	444	86
	Change in annual household income (%)	–4.9	–	7.9	0.3

Note: Household quintiles defined based on equivalised income.

average gain of a household made better off is about HUF 444 thousand [about EUR 1,640] while the average loss of a household made worse off is about HUF 122 thousand [about EUR 450]) Table 6 also presents the average gains and losses by quintile. Column 4 shows that only households in the top quintile are clear winners of the changes, while the bottom three quintiles suffered an overall income loss. The effect on the fourth quintile was approximately neutral: the average of the change in annual income is near zero but positive, while the unweighted average of the percentage change in income over the households in the fourth quintile is slightly negative.

Information about the gains and losses within quintiles reinforces the notion that gains from the tax changes are concentrated at the top of the income distribution. There are more than twice as many winners than losers in the top quintile, while in each of the bottom four quintiles the losers outnumber the winners. Also, winners in the top quintile gained almost 12% of their total annual net income, while winners in the lower quintiles increased their net income by about 4–6%. All in all, the fact that there are households that gain and households that lose in all quintiles reflects another significant element of the 2010–2013 tax changes: a redistribution of income from families without children to the ones with children. This redistribution is the effect of the extension of the child tax credit (in 2011) and the elimination of the ETC (in 2012).

The immediate distribution effects shown in Table 6 are likely to be dampened in the long run by the targeted employer contribution relief passed into law in 2012, to the degree that it is passed on to the employees in their gross wages. However, this is a dynamic effect that cannot be taken into account in this static ('on-impact') simulation.

4 Robustness of the results

We perform three sets of robustness checks. The first focuses on the investment environment in Hungary. In particular, we ask how the effects of the 2010–2013 policy package depend on the perceived long-term riskiness of investments in Hungary. The exercise is motivated by both external and internal factors: while the economic crisis may have made investors more risk-averse, the perceived uncertainty of the Hungarian economic policy may also have increased. The second robustness check focuses on how the simulated effects of the 2010–2013 policy package depend on the behavioural labour supply elasticities underlying the analysis. The third exercise focuses on the robustness of the results to the calibrated macro parameters.

Table 7 shows the results of the first robustness check. The columns of the table correspond to different assumptions about the increase of the required return (a 'risk premium') on Hungarian capital investments. The required return may increase to compensate for policy uncertainty perceived by investors if they interpret extraordinary sectoral taxes, the nationalisation of private pension funds, or retroactive taxation as a sign of growing uncertainty in the long term; or if they believe that their tax burden may rise again in the medium term due to an eventual fiscal adjustment.[12]

The first column of Table 7 repeats the fifth column of Table 4, showing the simulated dynamic effects of the 2010–2013 policy package under the assumption that the required return does not increase. The second, third and fourth columns show the simulated effects of the 2011 package in scenarios in which the required return on Hungarian capital investments increases by 25, 50 or 100 basis points. As there is great uncertainty regarding the value of the increase in the risk premium, we do not pick any of the scenarios as more realistic than the other. This exercise is simply to illustrate how an increase in risk premium could dampen the additional growth achieved by changes in the tax and transfer system.

It is possible, however, to have a rough understanding of the potential order of magnitude of these shocks. For instance, survey evidence in Fernandez et al. (2011b) might help to establish a realistic range of risk premium shocks that occurred as a side effect of the implemented policy measures. The authors published the survey results on country specific market risk premium (or equity risk premium) perceived by finance and economics professors, analysts and managers. The answers indicate that in 2011, Hungary's country specific market risk premium was 8%, 2.6 percentage points higher than in Germany and about 1.9 percentage points higher than in the Czech Republic. Survey results are very close to the equity risk premium estimates of Damodaran (2012) who estimated that Hungary's total equity risk premium is 8.31%, about 1.7 percentage points higher than the risk premium in the Czech Republic. If we compare these numbers to a previous survey in 2010 published by Fernandez and del Campo (2011a), it appears that Hungary's risk premium increased from about 6% to 8% in one year.

Another possible way of estimating the required rate of return on investment is to deduce it from an estimation of the user cost of capital. We computed this latter from the Hungarian firm level tax-return database, as described in Kátay and Wolf (2004) and Harasztosi (2011). The implied required rate of return on investment declined almost linearly between 1995 and 2005 by about 35-40 basis point per year, most probably because of the deepening economic integration into the European economy, the EU adhesion and the decreasing level and volatility of inflation. Between 2005 and 2008, the required return remained broadly stable. Based on all these, we believe that the scenarios considered in Table 7 are of a plausible order of magnitude.

[12] The risk premium on investments is not equivalent to popular country risk indicators, such as the CDS spreads related to government bonds: the risk premium relevant to us is related to the required rate of return on investments in the private sector, while the CDS spread relates to government solvency.

Table 7
The changes of 2010–2013 and hypothetical increases of the risk premium

Hypothetical shock affecting the risk premium	0 bpts	25 bpts	50 bpts	100 bpts
	dynamic	dynamic	dynamic	dynamic
Effective labour	4.6%	4.5%	4.3%	3.0%
Employment	2.6%	2.2%	1.5%	0.9%
Capital stock	3.7%	–1.0%	–5.5%	–15.4%
GDP	4.3%	2.5%	0.9%	–3.5%
Average gross wage	2.3%	0.3%	–1.6%	–5.4%
Disposable income	1.7%	0.3%	–1.1%	–4.5%
Personal income tax	–319	–347	–374	–440
Employee contributions	205	173	141	67
Employer contributions	–164	–213	–257	–368
Taxes on consumption	504	472	441	366
Taxes on capital	–76	–99	–120	–170
Taxes on sales	195	184	174	147
Transfers	119	117	113	109
Total	463	287	117	–290

Note: The upper panel of the table shows percentage changes of macroeconomic variables in levels. The bottom panel shows fiscal effects in HUF billion expressed in 2008 prices. (Positive numbers indicate an improvement of the government balance. In 2008, nominal GDP was HUF 26,545 billion, while during the period 2008–2011 the exchange rate was EUR 1 ≈ HUF 270.) Static effects are short-run, immediate effects with no behavioural adjustment. Dynamic effects include labour supply reaction of individuals as well as long-run, general-equilibrium macroeconomic effects. The VAT estimate is based on a simplifying assumption.

The results indicate that increases in the required return have a great effect on the capital stock – and thereby on output, wages and consumption – but a more limited effect on employment. The employment effect of the policy package is still positive (0.9%) following a 100-basis-point increase in the required return, while the capital stock decreases by 15% and the level of GDP decreases by almost 3.5%. The relatively low employment effect is mainly due to the high substitutability of labour and capital: as the relative price of the two input factors change as a consequence of capital tax increase or risk premium shock, capital is substituted for labour.

According to our simulations a persistent rise of the required return on capital investments has a significant impact on the budget, too: a permanent 50-basis-point increase involves a long-term annual fiscal cost of about HUF 350 billion (about 1.3% of GDP). This means that an increase in the perceived riskiness of Hungarian capital investments of this order of magnitude has the potential to neutralise fully the estimated positive dynamic fiscal effects of the 2010–2013 package.[13]

The second set of robustness checks concentrates on the behavioural assumptions underlying our analysis. Our focus is the adjustment at the intensive margin: on the one hand, this is a controversial issue in the literature (see, for example, the discussion by Meghir and Phillips, 2010); on the other hand, the impact of the 2010–2013 tax reform crucially depends on the elasticity of taxable income. Table 8 shows the effects of the 2010–2013 policy package under different behavioural assumptions. In this table, each row corresponds to a separate run of the microsimulation model, while the columns correspond to the most important macroeconomic and fiscal variables.

The first row of Table 8 repeats the results of the fifth column of Table 4: it shows the simulated effects of the 2010–2013 policy package under the baseline behavioural assumptions. In contrast, the second row shows the results of the simulation if both margins of individual adjustment are 'switched off'. Here there is no change in labour supply at all (since it is perfectly inelastic); but changes of taxes on corporate income, sales and consumption affect the macroeconomic equilibrium.

[13] Given the direct policy relevance of these results, it is important to ask how the results depend on the calibration of the macro parameters. We refer to our third robustness exercise, which looks at a CIT-financed PIT cut. This is informative since corporate taxation affects the capital stock very similarly to the risk premium. Not surprisingly, the response of the capital stock and hence also GDP is influenced strongly by the elasticity of capital supply and the degree of capital-labour substitutability. Even in those cases, whenever capital can adjust, the impact remains quite strong.

Table 8
Robustness of the simulations to labour supply elasticities: The changes of 2010–2013

	Effective labour	Employm.	GDP	Budget effect
Full effect, as presented above	4.6%	2.6%	4.3%	463
No behavioural change (only macro)	0.0%	0.0%	−0.1%	138
Only extensive response	1.9%	2.5%	1.7%	268
Only intensive response: Alternatives				
Baseline elasticity (based on Kiss and Mosberger, 2011)	2.9%	0.0%	2.7%	339
Baseline elasticity plus income effect	0.5%	0.0%	0.4%	172
Higher elasticity with income effect (based on Bakos et al., 2008)	3.7%	0.0%	3.4%	395

Note: Results from dynamic simulations. See the text for parameter values of the alternative intensive-margin elasticities.

In the third row individual adjustment at the extensive margin is 'switched on'. The policy package is estimated to increase long-term employment by 2.5%, thereby raising GDP by 1.7% and improving the dynamic fiscal balance. This result shows that all of the estimated positive employment effect comes from the labour supply adjustment at the extensive margin, rather than from other dynamic sources.

The last three rows of Table 8 show results from simulations where adjustment at the extensive margin is 'switched off' but adjustment at the intensive margin does take place. The first of these uses the 'baseline elasticity' as taken from the study of Kiss and Mosberger (2011). That study finds that higher-income earners are somewhat responsive to the marginal net-of-tax rate; the estimated elasticity is 0.2. In the simulation model this elasticity is taken to characterise the top 20% of earners; individuals with lower incomes are assumed not to adjust along the intensive margin. The point estimate of the income effect in the study of Kiss and Mosberger is sizable but very imprecisely estimated; therefore, the baseline income effect was chosen to be zero.

The results from this 'baseline elasticity' simulation support the view that most of the stimulative effect of the 2010–2013 policy package comes from labour supply adjustment at the intensive margin. Due mainly to the cuts in the marginal tax rate of high earners, the policy package is estimated to add, under these assumptions, 2.5–3 percentage points to the effective labour supply and to the level of GDP in the long run (compare row 4 to row 2).

The next row of Table 8 ('Baseline elasticity plus income effect') repeats this analysis including a non-zero income effect. The parameter chosen in the simulation is −0.5 (applied to the top 20% of the income distribution); this is the point estimate by Kiss and Mosberger (2011) of the parameter (the elasticity of reported income with respect to the average net-of-tax rate). The simulation shows that an income effect of this magnitude dampens the stimulative effects of the policy package to about one-sixth: effective labour supply and GDP is increase only by 0.5%.

The last row of Table 8 shows results from a simulation where the elasticities describing the adjustment at the intensive margin are taken from the other available Hungarian study by Bakos et al. (2008). For higher income earners they estimated a higher elasticity than Kiss and Mosberger (0.34 instead of 0.2) with an income effect of −0.27. In later follow-ups, as indicated by Benczúr et al. (2013), the marginal tax rate elasticity was found to be closer to the Kiss and Mosberger results. Nevertheless, it is still a reasonable alternative to postulate an even larger substitution effect (also coinciding with the 'consensus' intensive margin elasticity of Chetty et al., 2012) and a moderately negative income effect which leads to an almost-zero uncompensated elasticity. We find that the estimated effects of the 2010–2013 policy package with these alternative elasticities are similar to, but slightly higher than, the results estimated with the baseline elasticities in row 4. The two parametric differences between the estimations of Bakos et al. (2008) and Kiss and Mosberger (2011) have the opposite effect, nearly cancelling out.

In the third set of robustness checks we analyse how the simulation results depend on the most relevant calibrated macro parameters. Table 9 presents results from three types of alternative simulations against the baseline results from column 5 of Table 4. First, the elasticity of capital supply (parameter η) is modified: the corner cases of perfectly elastic capital supply ($\eta = \infty$) and perfectly inelastic capital supply ($\eta = 0$) are analysed. Second, the capital income share parameter

Table 9
Robustness to the calibrated macro parameters: Effects of a shift from labour to capital taxation

	Effective labour	Average gross wage	Capital stock	GDP
Baseline calibration	0.7%	−3.2%	−6.7%	−1.9%
Capital perfectly elastic (eta = ∞ instead of 15)	0.5%	−3.8%	−8.3%	−2.6%
Capital perfectly inelastic (eta = 0 instead of 15)	1.4%	−0.6%	0.0%	0.9%
Capital share = 0.3 (instead of 0.35)	0.9%	−2.3%	−5.2%	−0.9%
Capital share = 0.4 (instead of 0.35)	0.3%	−4.5%	−8.7%	−3.3%
K-L substitution (sigma = 0.7 instead of 0.8)	0.0%	−5.6%	−11.2%	−3.9%
K-L substitution (sigma = 0.9 instead of 0.8)	1.0%	−2.0%	−4.2%	−0.8%

Note: Results from dynamic simulations.

is modified from the baseline value of 0.35 to 0.3 and 0.4. Finally, the production-function parameter governing the substitutability between labour and capital (parameter β) is modified. This parameter is given in our model as $\beta = \frac{\sigma - 1}{\sigma}$. While we chose σ = 0.8 as our baseline, as a robustness check we ran simulations with σ = 0.7 and σ = 0.9.

All three types of changes in the parameters can ultimately be described by how they affect the reaction of the capital stock to changes in the marginal return of capital. Table 9 confirms that capital (and thus output, wages and effective labour) reacts more sensitively (1) the more elastic the supply of capital is; (2) the higher the income share of capital is; and, finally, (3) the more substitutable the factors of production are.

Looking at the capital-supply elasticity scenarios as compared to the baseline (the first three rows of Table 9) we see that our baseline calibration of η = 15 is indeed closer to the perfectly elastic case than to the perfectly inelastic case. Rows 4 and 5 show that, within a plausible range, the capital-income share parameter does not affect results very sensitively. Finally, the last two rows of Table 9 show how the results are affected by moving the factor-substitutability parameter. The results show that moving away from the extreme Cobb-Douglas case (of β = 0) make capital adjust more sensitively to changes in its marginal product.

Conclusion

In this paper we present a new general-equilibrium behavioural microsimulation model, designed to assess long-run output and employment consequences of recent Hungarian reforms both to the tax and the transfer system. Besides the output and employment effect, it assesses the static and dynamic fiscal consequences of reforms. We simulate three sets of scenarios. First we analyse three different ways of tax relief in the personal income tax system. Second, we analyse three complex hypothetical proposals that are fiscally neutral without behavioural change. Last, we analyse actual changes of the tax and transfer system between 2008 and 2013.

The results of the first two exercises show that the desirability of different tax policy scenarios depends greatly on the criterion used. If the main objective is employment growth, policymakers should keep (or decrease) the average tax burden of low incomes as low as possible, since the lower-wage, mostly low-skilled, groups – where the large part of the inactivity is concentrated in most countries – are the most sensitive to change in their financial gains to work. The most efficient way of keeping the average tax rate low for low-income earners is the Employee Tax Credit (ETC): similarly to a system with a zero lower tax rate, the ETC keeps the average tax rate low at low incomes, but it imposes a smaller burden on the budget. This budget surplus can be used for various policy measures such as, for example, lowering marginal tax rates for higher earners.

Our simulation exercises provide evidence that the tax system and the transfer system should be taken into account simultaneously. For example, in countries where some transfers are taxed as income, a tax rate cut (or increase) will also affect positively (negatively) the net transfers one can get at zero hours worked, which will, *ceteris paribus*, decrease (increase) individuals' incentives to work.

The highest long-run employment gain can be obtained if the tax cut is financed by transfer tightening. Such a policy package affects individuals' gains to work and therefore willingness to work both at the transfer and the net wage side. However, it is important to keep in mind that our model is solely based on financial incentives and do not take into account some potentially important features of the economy such as labour market frictions and skill mismatches. For example, the shortening of the unemployment benefit period will make the individuals want to find a job earlier and therefore they increase their labour supply, but a shorter job-search period may also impair the quality of employee-employer matches. This effect is not taken into account by the model and, as a result, we might overestimate the employment effect of such a measure. Furthermore, such a policy may have adverse effects on income inequality and poverty.

If the main objective is to boost labour productivity and GDP, different policy measures should be applied. As individuals at the top of the income distribution are relatively responsive at the intensive margin, decreasing the marginal tax rates improves incentives at the top of the income distribution and boosts effective labour and GDP in the long-run. Similar results can be obtained by decreasing capital taxes. This latter policy is especially effective in small open economies where capital supply is highly elastic. In our specific case, both decreasing marginal tax rate for the top 20% wage earners and the effective capital tax rate by a comparable amount in terms of fiscal effect would have a similar effect on GDP but a different effect on effective labour, capital stock and individuals' disposable income.

In the third exercise we evaluate the impact of actual tax and transfer changes in the two years before the general elections in 2010 and the period since. We find that the packages of the two governments during this period have different macroeconomic effects. The changes between 2008 and 2010 increase long-run employment and GDP; but there is no significant adjustment at the intensive margin. In contrast, the changes between 2010 and 2013 produce a large gain at the intensive margin of labour supply, but employment is expected to increase only due to cuts in the unemployment benefit. Both policy packages are found to increase income inequality in the long run (the changes after 2010 about three times as much as the changes before 2010); the cumulative change has the potential to place Hungary at the median of EU member states from its original ranking as the country with the 6th most equal income distribution among the EU-27.

Finally, we assess the robustness of our results with respect to three types of modifications to our assumptions. In two sets of robustness checks we run simulations with alternative values of the behavioural labour-supply elasticities and the calibrated macro parameters, respectively. In a third set of robustness checks we repeat the simulation of the 2010–2013 policy package with one difference to the baseline simulations: here we find that even a small increase in the required return (risk premium) of Hungarian capital investments has a large negative effect on the long-run capital stock and GDP and a smaller negative effect on employment. Such a development has the potential of eliminating most of the increased economic activity that results from the baseline policies.

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Appendix

Main policy parameters in the simulation scenarios

Table A1
Parameters of hypothetical tax scenarios from Table 2

	Baseline (2008)	Across-the-board tax cut	Two rates, no ETC	One rate, with ETC
Lowest PIT rate	18%	14.5%	0%	23%
Upper limit of the lowest PIT rate	1,700,000	1,700,000	828,000	–
Middle PIT rate	36%	32.5%	–	–
Upper limit of the middle PIT rate	7,139,000	7,139,000	–	–
Upper PIT rate	40%	36.5%	29.5%	–
Rate of ETC	18%	14.5%	–	23%
Maximal amount of ETC (per month)	11,340	10,005	–	15,870
Start of ETC phase-out	1,250,000	1,250,000	–	1,250,000
ECT phase-out rate	9%	9%	–	13%

Table A2
Parameters of actual tax scenarios from Table 4 and 7

	2008	2010*	2013
Lowest PIT rate	18%	21.59%	16%
Upper limit of the lowest PIT rate	1,700,000	3,937,008	2,424,000
Middle PIT rate	36%	–	–
Upper limit of the middle PIT rate	7,139,000	–	–
Upper PIT rate	40%	40.64%	20.32%
Rate of ETC	18%	21.59%	–
Maximal amount of ETC, monthly	11,340	11,890	–
Start of ETC phase-out	1,250,000	2,510,236	–
ECT phase-out rate	9%	15.24%	–
Child tax credit (monthly, 1st and 2nd child)	0	0	–
Child tax credit (monthly, 3rd, 4th... child)	4,000	4,000	–
Child tax credit (monthly per child, 1 or two children)	–	–	10,000
Child tax credit (monthly per child, 3 or more children)	–	–	33,000
Employer contribution rate	32%	27%	27%
Employee contribution rate (below contribution ceiling)	17%	17%	18.5%
Effective tax rate on consumption	18.2%	19.4%	23.3%**
Effective tax rate on corporate income	7.3%	7.3%	6.2%**
Effective tax rate on sales (e.g., local business tax)	1.74%	1.65%	2.28%**
Maximum length of unempl. benefits (months)	12	12	3

** In 2010 (unlike in 2008 or 2013) the PIT code was based on a 'super-gross' income definition. Parameters here are translated into gross terms.*
*** Effective tax rates on consumption, corporate income and sales include expert estimates of the central bank of Hungary based on legislation passed until August 2012. The effective tax rate on corporate income includes only that part of sectoral 'crisis taxes' that are to be made permanent according to official government policy.*

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