Assessing changes of the tax-transfer system: A new equilibrium microsimulation approach[*]

Péter BENCZÚR,[a,b] Gábor KÁTAY,[a,+] and Áron KISS[a]

[a] National Bank of Hungary (Magyar Nemzeti Bank), Szabadság tér 8-9, Budapest, 1054, Hungary

[b] Central European University, Nádor utca 9, Budapest, 1051, Hungary

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This article presents a new general-equilibrium behavioural microsimulation model, calibrated for Hungary. It was designed to assess long-run output and employment consequences of reforms 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 analyze three different ways of tax relief in the personal income tax (PIT) system. Second, we analyze three complex hypothetical proposals which are revenue neutral without a behavioural response. Last, we analyze the actual changes of the tax and transfer system between 2008 and 2011. Overall, we find that the ranking of these scenarios in terms of their ability to boost the economy often depends on whether it is output, effective labour, or employment that we want to increase. This highlights the importance of heterogeneity in household and corporate behavioural responses.

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[+] Corresponding author. E-mail: katayg(at)mnb.hu.

I. Introduction

This article presents a new general-equilibrium, behavioural microsimulation model for Hungary. It was designed to assess long-run output and employment consequences of reforms both to the tax and the transfer system. Besides the output and employment effects, it assesses the static and dynamic fiscal effects of reforms. The article describes the principles of the model and presents simulations of hypothetical as well as actual reforms from the period between 2008 and 2011.

The microsimulation model runs on the 2008 wave of the Hungarian Household Budget Survey compiled by the Central Statistical Office. It has three important features. First, it takes into account the labour supply response of individuals at the intensive margin (number of effective hours worked), using previous estimates of the taxable-income elasticity for Hungary (Bakos, Benczúr and Benedek 2008; Kiss and Mosberger 2011). Second, it takes into account the labour supply response at the extensive margin, using estimations from our related work (Benczúr, Kátay, Kiss and Rácz 2012). A key feature is that the adjustment at the extensive margin is determined by the individuals' out-of-work transfers (non-labour income at zero hours worked), their potential net wage, and the transfers lost when they take up a job. The microsimulation model thus produces a labour supply curve. Finally, this labour supply curve is embedded in a small, long-run, general-equilibrium model of the macro-economy.

Such an approach has important advantages. Microsimulation is usually employed to assess the individual and household-level incidence of tax and transfer reforms. We can thus identify the main winners and losers of a reform package, which can help in designing a compensation scheme if necessary. By adding a labour supply response to such a model, we allow for a role of worker heterogeneity in shaping labour supply: different individual productivity (wage) levels, nonlinear tax schedules and heterogeneous transfer eligibility are all incorporated. A shift in labour supply, however, will in general lead to changes in wages, corporate profits and thus a change in the demand for capital. By adding a simple production function and a capital supply curve, we also incorporate these macro feedback effects. Our previous work (Benczúr and Kátay 2010) featured the same general equilibrium aspect, but it employed a much simpler microsimulation module to describe labour supply. In particular, the method used in that paper did not allow either for a role of transfers or a meaningful estimation of employment effects (the extensive margin).

Our model fits into two important recent tendencies in microsimulation modelling (see, e.g., Bourguignon and Spadaro (2006) and Williamson et al. (2009) for recent overviews). The first main direction in which microsimulation modelling has developed was the accounting for behavioural responses of individuals in these models. Early work in this direction includes work by Aaberge et al. (2000), Blundell et al. (2000), and Creedy and Duncan (2002). The second main direction was to introduce general-equilibrium feedbacks into the microsimulation models. Most recent 'micro-macro' models do this by the linking of a microsimulation model and a computable general-equilibrium (CGE) model of the economy (see, e.g., models described by Peichl and Schaefer (2006), and Clauss and Schubert (2009)).

Our model belongs to the approaches that take into account both behavioural responses and general-equilibrium feedbacks. It differs from most 'micro-macro' models by keeping the macroeconomic model simple, which makes it possible to fully integrate the microsimulation model and the macroeconomic model. Full integration means that information is not restricted to flow only one way (either from the macro model to the microsimulation or the other way round); the modules are repeatedly run in an iterative process until they reach full convergence.

The rest of the article is structured as follows. In the next section we give a detailed description of the principles of the model: we describe the data, the nature of the labour supply adjustment as modelled, and the small macro model in which the microsimulation model is embedded. Then, Section 3 presents results from three sets of simulations: The first set of simulations includes three different tax relief scenarios within the personal income tax system. The second includes three complex, fiscally neutral hypothetical proposals. The third exercise analyzes long-run effects of actual changes to the tax and transfer system enacted between 2008 and 2011. In Section 4 we present results from two sets of robustness checks, while Section 5 offers some concluding remarks.

II. The Microsimulation Model

This section describes the principles of the microsimulation model. We divide the discussion into three parts. First, we will describe the data on which the microsimulation is based and the methodological issues related to the data base. Second, we present the main features of the microsimulation model. Finally, we describe the small general-equilibrium model in which the microsimulation model is embedded.

Data

The microsimulation model runs on the 2008 wave of the Household Budget Survey (HBS) compiled by Hungary's Central Statistical Office (CSO). The data set provides detailed information on nearly 20,000 individuals (including information on their labour market status and income) living in nearly 8000 households. Our analysis relies strongly on household characteristics when modelling eligibility for social transfers and labour supply. For this reason we could not base our analysis on tax return data, since they 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 that of the 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.

Microsimulation

The behavioural microsimulation model takes into account two types of behavioural adjustment on the individual level: a labour supply response at the intensive and extensive margin. Labour supply response at the intensive margin means that an individual increases their work intensity (hours, work effort, etc.) after a cut in their marginal tax rate (and vice versa). The general view is that such behavioural response exists for high-income earners 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 (as opposed to being inactive) decrease because of changes in the tax and transfer system (and vice versa). The general view is that this type of behavioural adjustment is more significant in the case of secondary earners, women with children, young workers, and the elderly, but there is some response among low-income earners in general (for an overview of these issues see, e.g., Meghir and Phillips 2008).

In the main part of this article the labour supply response at the intensive margin is calibrated based on estimations by Bakos, Benczúr and Benedek (2008) of the elasticity of taxable income with respect to the tax rates. They estimated the compensated elasticity of taxable income with respect to the marginal net-of-tax rate to be 0.34 for the top 20% of wage earners and an income effect of —0.27. These estimations imply, through the Slutsky-equation, an uncompensated elasticity of 0.34—0.27=0.07). In conformity with the estimations, we apply these elasticities to the top fifth of wage earners; lower-income households are assumed to have no labour supply response at the intensive margin. Robustness of the results with respect to these elasticities is investigated in Section 4 by using the recent estimations by Kiss and Mosberger (2011).

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 optimization (itemized deductions) and has, therefore, little to do with additional economic activity. For Hungary, however, there are good reasons to view the taxable income elasticity as labour supply response. First, itemized cost deductions are negligible in the Hungarian personal income tax system. Correspondingly, the existing estimations on Hungarian data are lower than taxable-income elasticities measured in the U.S., where tax optimization is reported to be a major factor, but they are in line with estimations from other countries. 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, Kátay, Kiss and Rácz 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 amount of transfers an individual can get at zero hours worked (the intercept of the budget set), and the change in disposable income due to taking up a full time job (which equals the net wage minus lost transfers):

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

where W_i is the change in disposable income due to getting a full time job, i.e., the difference between the market wage and the amount of transfer that the individual loses when working, T_i denotes the the hypothetical 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 gains from 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 relevant parameter estimates for our exercise.

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	0.349	0.003	0.099	0.001
	transfer	-0.162	0.001	-0.059	0.001
elementary school or less	net wage	0.488	0.013	0.358	0.003
	transfer	-0.212	0.006	-0.218	0.002
secondary education	net wage	0.270	0.002	0.102	0.001
	transfer	-0.138	0.001	-0.063	0.001
tertiary education	net wage	0.115	0.003	0.038	0.001
	transfer	-0.053	0.001	-0.022	0.001
elders (>50)	net wage	0.458	0.009		
	transfer	-0.147	0.003		
women at child-bearing age (25-49)	net wage	0.184	0.002		
	transfer	-0.115	0.001		

Source: Benczúr, Kátay, Kiss and Rácz (2012)

The labour supply response at the extensive margin is modelled in the following way. Every individual of working age is assigned a baseline employment probability based on the estimates of Benczúr, Kátay, Kiss and Rácz (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) wages of all individuals weighted by their employment probability.

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 follows the following steps: (1) Given the changes in the tax and transfer system, a static microsimulation is conducted first. 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 and the gains-to-work (relevant for the intensive and extensive-margin response, respectively). (2) These updated measures are fed back to the participation probit (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 small macro model. The macro model 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 repeated until convergence; that is, until the general equilibrium of the economy is consistent with the reform-induced labour supply shock.

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 product, 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, the general equilibrium model does not detail the household side.

The production function of the representative firm exhibits constant elasticity of substitution (CES).[1] The profit-maximization problem of firms can be formulated as:

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[1] 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.

$$\max\left(\alpha K^{\beta} + (1-\alpha)L^{\beta}\right)^{\frac{1}{\beta}} p(1-\tau_{VAT}) - wL - \frac{\gamma}{1-\tau_c}K$$

The model is closed by the equation that determines the aggregate supply of capital. Capital is allocated on the 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-linearize the model around the equilibrium. After deriving the first-order conditions and log-linearization, we arrive at the following four equations:

$$\alpha\bar{k}^{\beta}\hat{k} = \left(\frac{1}{1-\alpha}\right)^{\frac{\beta}{1-\beta}} \frac{1}{1-\beta}\bar{w}^{\frac{\beta}{1-\beta}}\hat{w}$$

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

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

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

where 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). A balanced budget restriction is not imposed.

To interpret these results, 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 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 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 throughout the analysis), 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 neutralize them completely.

Calibration

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

1) Taxes on capital (CIT 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 $\tau_C = 0.073$, while the initial effective consumption tax is $\tau_{VAT} = 0.165$.
2) The capital-labour substitution elasticity of the production function is chosen based on estimations of Kátay and Wolf (2004), while the share parameter is calibrated based on averages from the National Accounts: $\beta = (0.7 - 1)/0.7 \approx -0.428$ and $\alpha = 0.432$.
3) 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 relatively elastic capital supply ($\eta = 15$).

III. Simulation Results

This section presents the results of three sets of simulations and a set of some robustness checks. First, we analyze three different versions of a personal income tax (PIT) cut. Second, we analyze three complex hypothetical proposals, which are revenue neutral in the absence of behavioural responses. Third, we analyze actual changes of the tax and transfer system between 2008 and 2011. In this last 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 by income quintiles.

Tables 2 to 4 in this section consist of two panels. The top panel shows the macroeconomic effects: here 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 says that an "across-the-board" tax cut would increase the level of long-run GDP by 0.9%.

The bottom panel in each table presents the fiscal effects of the respective scenarios. The unit of these figures is billion Hungarian forints (HUF billion). To facilitate the interpretation of these figures we note that during most of the year up to September 2011, 1 EUR was the equivalent of about HUF 270. Therefore, a tax package that costs HUF 230 billion is the equivalent of about EUR 0.8 billion (and, coincidentally, about 0.8% of Hungary's GDP in 2010).

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; therefore, static fiscal effects 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 effects have to be discounted. Dynamic effects include all the adjustments: a labour supply response of individuals at the intensive and extensive margin and general equilibrium macroeconomic effects.

Table 2 shows the static and dynamic effects of three scenarios in which PIT revenues decrease by about HUF 230 billion (or 0.8% of GDP) in a static calculation. 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 HUF 1.7M (≈ EUR 6,300); a rate of 36% applied to income between HUF 1.7M and HUF 7.1M (≈ EUR 26,300); and a rate of 40% applied for income above that. Besides the personal income tax, individuals paid social security contributions at a rate of 17% up to the pension contribution ceiling of HUF 7.1M, above which the contribution rate was 7.5%. In 2008 the employee tax credit (ETC; in Hungarian: *adójóváírás*) reduced the tax liability of individuals earning the minimum wage (HUF 69 000) to almost zero. The ETC was phased out at a rate of 9% between A gross income of HUF 1.25M and 2.75M.

In the first scenario of Table 2 (“across-the-board tax cut”), all three PIT rates are reduced by 2.5 percentage points. In the second scenario a 0% tax rate applies to income up to the minimum wage, and a rate of 29.4% to income above that (in this scenario the ETC is eliminated). In the last scenario a single basic tax rate applies to all taxpayers (22.5%), but there is an ETC that makes the minimum wage tax-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 230-240 billion.

Table 2 shows that different ways of reducing the tax burden have starkly different labour market effects. A positive employment effect can result only from lowering the tax burden of low-income groups. This is due to two factors: First, employment is already high for the skilled groups in Hungary (high school degree and above). Second, the gains from employment are inherently lower for low-skilled individuals who have a relatively low potential wage income (given that the basic social services apply to all). This observation is in line with international experience.

Table 2. Personal income tax scenarios

	Across-the-board PIT cut		*2 tax rates (0% + 29.4%)*		*1 tax rate (22.5%) + tax credit*	
	static	*dynamic*	*static*	*dynamic*	*static*	*dynamic*
Effective labour		1.0%		1.6%		3.2%
Employment		0.8%		0.0%		0.2%
Capital stock		0.8%		1.3%		2.6%
GDP		0.9%		1.5%		2.9%
Average gross wage		-0.1%		-0.1%		-0.3%
Disposable income		2.9%		3.3%		4.4%
Personal income tax	-232	-212	-235	-196	-237	-172
Employee contributions	0	14	0	21	0	43
Employer contributions	0	24	0	40	0	87
VAT	38	46	39	53	39	70
Capital taxes	0	6	0	9	0	19
Local business tax	0	4	0	7	0	14
Transfers	0	9	0	1	0	-7
Change of budget balance	-194	-110	-197	-66	-198	53

Note: The upper panel of the table shows percentage changes of macroeconomic variables in levels. The bottom panel shows fiscal effects in HUF billion (in most of 2011, 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.

In specific, while both the two-rate and the single-rate scenarios have features to ensure the (near) tax exemption of incomes below the minimum wage, they apply higher tax rates on middle incomes to reduce tax rates at the top. Therefore, these scenarios induce no or negligible gain in employment. In contrast, the scenario in which all tax rates are reduced by 2.5 points induces a 0.8% increase in employment.

As a consequence of the same trade-off the scenarios are reversely ranked with respect to the incentives of top earners. Effective marginal tax rates were relatively high in Hungary in 2008 and an across-the-board 2.5% tax cut 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 the top 20% of the income distribution increase their labour intensity so that aggregate effective labour increases by 1.6% (two-rate scenario) and 3.2% (single-rate scenario).

Since the only macroeconomic shock here is the labour supply shock, GDP and the capital stock adjusts almost in proportion to the effective labour supply. (And, as can be seen in the bottom panel of Table 1, the long-run fiscal effects move the same way.) Thus, the single-rate scenario gives the most long-run stimulus and the best long-run fiscal effect.

These results show that the ranking of different scenarios depends on the criterion used. While an across-the-board tax cut has the highest employment effect (since it decreases most the tax burden of low and middle income individuals), the scenario with a single rate plus ETC performs best in terms of GDP and the across-the-board tax cut comes in last according to this criterion.

Table 3 shows three scenarios that are revenue neutral in their direct static effect. Each scenario is the combination of two measures: one that costs about HUF 230 billion and one that improves the government balance by about the same amount. All scenarios are purely hypothetical but are similar to policy changes planned or introduced in Hungary in recent years. In the first scenario we introduce the single-rate PIT with ETC analyzed above and balance the budget by increasing taxes on capital (corporate income tax, CIT). In the second scenario we introduce the same single-rate PIT and finance it by a targeted cut in old-age pensions. Resembling actual government proposals, we analyzed a hypothetical scenario under which no individual can receive old-age pension benefits before the age *R*—5, where *R* is the regular pension age. In 2008 the regular pension age was 62 for both sexes, but a sort of “regular early pension” was available under some circumstances from the age of 57. At the same time, old-age pensions paid to individuals below the age of 57 amounted to about HUF 230 billion. In the third scenario we cut the corporate income tax and finance it by the restrictions on early old-age pensions as described above.

In the first scenario the significant increase of labour intensity by top earners is counterbalanced by the negative effects of a decrease in the capital stock due to an increase in the effective tax rate on capital. In balance, there is a slight negative effect on GDP and employment and the dynamic effects make the fiscal effect worse. This is a reflection of the fact that in this long-run open-economy model capital adjusts very sensitively to the rate of return.

Table 3. Tax shift scenarios with a neutral direct fiscal effect

	capital tax increase + PIT cut		*restricted early retirement + PIT cut*		*restricted early retirement + capital tax cut*	
	static	*dynamic*	*static*	*dynamic*	*static*	*dynamic*
Effective labour		2.7%		4.6%		2.2%
Employment		-0.5%		1.8%		2.4%
Capital stock		-5.4%		3.7%		9.1%
GDP		-0.2%		4.3%		4.6%
Average gross wage		-4.1%		-0.4%		3.5%
Disposable income		1.7%		2.9%		1.2%
Personal income tax	-237	-277	-241	-154	-14	143
Employee contributions	0	-22	1	65	1	89
Employer contributions	0	-45	0	123	0	170
VAT	38	27	1	46	-36	19
Capital taxes	234	213	0	27	-234	-185
Local business tax	0	-1	0	20	0	21
Transfers	0	-16	233	229	228	239
Change of budget balance	36	-121	-5	356	-54	496

Note: The upper panel of the table shows percentage changes of macroeconomic variables in levels. The bottom panel shows fiscal effects in HUF billion (in most of 2011, 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.

In both the second and the third scenario we analyze the effects of the restricted early pension policy. In the microsimulation model this is represented as an exogenous loss of eligibility for the pension benefits. The model predicts the ability and willingness to work of the individuals affected based on the behaviour of those similar to them in observable characteristics. This might overestimate the positive labour supply effect of the measure because those individuals may have self-selected into early retirement who were less willing or less able to work than others. In our estimation the measure increases employment by about 1.5% (compare the middle columns of Table 3 to the last columns of Table 2). Comparing scenario 2 and 3 it is apparent that decreasing the capital tax boosts the capital stock and wages much more and GDP slightly more than introducing the single-rate PIT with the same cost.

In the last set of policy packages analyzed, 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 2011. As elections were held in 2010, these columns correspond to changes passed by the Socialist majority before the elections and the Conservative majority after the elections.

During the period from 2008 to 2010, changes of the transfer system were small and did not affect significantly the labour supply choice of individuals. 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 16.5% to 19.9%), 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 experienced a notable tax relief. In particular, the three tax brackets were consolidated into two, with the lower limit of the upper tax bracket at HUF 4M. The rates increased slightly in the meantime: the lower tax rate became 21.6% while the upper tax rate 40.6%. The ETC was meanwhile also expanded.

The tax measures of the government elected in 2010, as effective in 2011, included the introduction of a single-rate personal income tax at 20.3% with a slightly curtailed ETC (planned was a further reduction in the statutory tax rate to 16% and the elimination of the ETC), an extended child tax credit and a half-point increase in the employee pension contribution. At the same time, there was a corporate income tax cut counterbalanced by extraordinary taxes on the banking and telecommunication sectors and large retail companies. We fed these changes into the model by changing the effective tax rate on capital from 7.3% to 5.8%. In calculating this, we took into account only that part of the extraordinary taxes that are, based on the stated intentions of the government, likely to be made permanent (i.e., about one-third of the bank tax).

Table 4. Long-run effects of actual changes of the tax and transfer system, 2008-2011

	2008-2010		*2010-2011*	
	static	*dynamic*	*static*	*dynamic*
Effective labour		1.4%		2.8%
Employment		2.5%		0.4%
Capital stock		1.0%		6.7%
GDP		1.2%		4.2%
Average gross wage		4.1%		1.9%
Disposable income		2.5%		6.8%
Personal income tax	-318	-210	-404	-312
Employee contributions	3	87	48	124
Employer contributions	-559	-419	0	126
VAT	389	457	71	135
Capital taxes	0	7	-141	-102
Local business tax	-24	-19	0	19
Transfers	4	24	-2	4
Change of budget balance	-507	-72	-427	-7

Note: The upper panel of the table shows percentage changes of macroeconomic variables in levels. The bottom panel shows fiscal effects in HUF billion (in most of 2011, 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.

Table 4 shows that both governments enacted a net tax relief with a static fiscal cost of about HUF 510 billion and 430 billion, respectively. It also shows that these packages have a different macroeconomic effect. Mainly due to the cut in employer contributions, the changes between 2008 and 2010 increase long-run employment by 2.5% and GDP by 1.2%. Since top marginal rates do not decrease, there is no significant adjustment at the intensive margin. In contrast, PIT relief between 2010 and 2011 is concentrated to the top. Therefore, the incentives of top earners improve but employment is expected to increase only by about half a percentage point, due mostly to the capital inflow followed by the decrease in the effective tax rate on capital.

When analyzing the actual tax and transfer packages, we also evaluated various 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. Simulated measures of income inequality: long-run consequences of actual changes, 2008-2011

	2008	*2010*	*2011*
Gini coefficient	25.2	26.3	28.3
P90/P10	2.90	3.11	3.20
P90/P50	1.71	1.79	1.86
P50/P10	1.70	1.73	1.72

Note: Results from dynamic simulations.

Table 5 shows that both sets of tax policy changes increase income inequality: the long-run Gini coefficient is estimated to increase by one point due to the changes up to 2010 and further two points due to the changes of 2011. The 2008 value of the Gini coefficient calculated here is equal to the statistic published by Eurostat (2011) for Hungary for the same year. It places Hungary as the country with the 6th most equal income distribution in the EU in 2008. The 3-point cumulative change we find has the potential to bring Hungary close to the median (13th place) of EU member states, keeping income equality fixed in the rest of the countries.

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, for instance, 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: from 1.70 to 1.72. There is more significant growth in the gap between the 90th percentile and the median: the P90/P50 ratio increases from 1.71 to 1.86 as a long-run equilibrium consequence of the changes up to 2011. There is an interesting difference between the development of this measure and the Gini coefficient. While the increase in the P90/P50 ratio occurs in equal steps from 2008 to 2010 and from 2010 to 2011, the greater part of the increase in the Gini coefficient occurs in the second step. This is due to the fact that top marginal tax rates decreased only in 2011 causing an increase in income inequality *within the top 10%*, a development that is not captured by the P90/P50 measure.

A comparison of our simulated percentile ratios to the ones published by Eurostat (2011) gives similar conclusions as the comparison based on the Gini coefficient. First, our simulated percentile ratios are very similar to the official measures for 2008: the P90/P50 ratio was 1.70 while the P50/P10 was 1.76 according to Eurostat. Second, these measures placed Hungary among the EU countries with the lowest income inequality. Third, an after-reform P90/P50 ratio of 1.86 would place Hungary near the EU median, keeping inequality in other countries constant. According to the other two percentile ratio measures we see a smaller change in the ranking of Hungary.

Another way microsimulation can help us analyze 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 2010-2011 policy package that included a tax cut for high-income earners, a significant extension of the child tax credit and a cut in the ETC for low and middle-income earners. We divided households into quintiles based on equivalent income and asked the following questions: How many individuals live in households in a given income quintile who gained or lost as a consequence of the reforms? How much in average annual income did households gain or lose as a consequence of the reforms? The results presented are static results: they were calculated without any behavioural response.

The last segment of Table 6 shows that the 2010-2011 policy package made more individuals better off than worse off (about 3.3 million individuals live in households that were made worse off while about 4.4 million individuals live in households that were made better off) and that the winning households gained more than the losing households lost (the average gain of a household made better off is about HUF 287 thousand (about EUR 1050) while the average loss of a household made worse off is about HUF 31 thousand (EUR 110)). This reflects the fact that the package was not fiscally neutral.

Table 6. Static simulation of the incidence of actual changes, 2010-2011

household quintiles		worse off	neutral	better off
1	Number of individuals affected (thousand)	1083	549	948
	Change in annual household income (HUF thousand)	-9	-	99
	Change in annual household income (%)	-0.6	-	4.9
2	Number of individuals affected (thousand)	560	478	1065
	Change in annual household income (HUF thousand)	-25	-	145
	Change in annual household income (%)	-1.2	-	4.8
3	Number of individuals affected (thousand)	505	534	755
	Change in annual household income (HUF thousand)	-40	-	155
	Change in annual household income (%)	-1.5	-	4.3
4	Number of individuals affected (thousand)	637	420	711
	Change in annual household income (HUF thousand)	-44	-	239
	Change in annual household income (%)	-1.4	-	5.1
5	Number of individuals affected (thousand)	484	214	947
	Change in annual household income (HUF thousand)	-59	-	775
	Change in annual household income (%)	-1.5	-	9.5
Total	Number of individuals affected (thousand)	3269	2196	4426
	Change in annual household income (HUF thousand)	-31.2	-	287
	Change in annual household income (%)	-1.1	-	5.8

Further, Table 6 gives more detail about the insight that the gains and losses are not evenly distributed across the income distribution. It is clear, for example, that the gains are concentrated to the top income quintile: households who are made better off in the top quintile increase their total annual net income by about 9.5%. Households that benefit from the reforms in the lower four quintiles gain about 5% of their previous net income. The losses, on the other hand, appear to be distributed relatively evenly across the income distribution. In all quintiles, except the bottom quintile, the loss of losing households is about 1.2—1.5% of their net income. In the bottom quintile the loss is more moderate (0.6%), probably because fewer individuals in this group work and are affected by the cut in the ETC. All in all, the fact that there are households that gain and households that lose in all quintiles reflects the other main distributional element of the 2011 tax package besides the tax cut for high earners: a redistribution of income from the childless working families to the ones with children. This redistribution is the effect of the simultaneous cut in the

ETC and the extension of the child tax credit. This effect is made more pronounced by subsequent tax changes in 2012 which eliminated the ETC.

IV. Robustness of the Results

We perform two sets of robustness checks in this section. The first focuses on one important aspect of the macroeconomic environment. Here we ask how the effects of the 2011 policy package depend on the long-term risk 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 have also increased. The second robustness check focuses on how the simulated effects of the 2011 policy package change under different assumptions about the behavioural labour supply elasticities underlying the analysis.

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 (or risk premium) of Hungarian capital investments.

The required return may increase to compensate for policy uncertainty perceived by investors if they interpret extraordinary sectoral taxes, the nationalization 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 a possible fiscal adjustment.[2]

[2] 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 2010-11 and hypothetical increases of the risk premium

Hypothetical shock affecting the risk premium	*0*	*0.5*	*1*
	dynamic	*dynamic*	*dynamic*
Effective labour	2.8%	2.0%	1.1%
Employment	0.4%	-0.6%	-1.7%
Capital stock	6.7%	-4.7%	-16.6%
GDP	4.2%	-0.4%	-5.1%
Average gross wage	1.9%	-3.3%	-8.8%
Disposable income	6.8%	2.7%	-1.7%
Personal income tax	-312	-429	-545
Employee contributions	124	25	-76
Employer contributions	126	-37	-204
VAT	135	53	-33
Taxes on capital	-102	-160	-220
Local business tax	19	-2	-23
Transfers	4	-10	-25
Total	-7	-559	-1126

Note: Values indicated in the rows of macroeconomic variables show changes in levels. Fiscal effects are indicated in HUF billion, at a 2010 price level, where positive figures indicate a balance improvement and negative figures indicate a declining balance. The VAT estimate is based on a simplifying assumption.

The first column repeats the last column of Table 4, showing the simulated dynamic effects of the 2011 policy package under the assumption of no increase in the required return. The second and third columns show the simulated effects of the 2011 package in scenarios in which the required return on Hungarian capital investments increases by 50 and 100 basis points.

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. Effective labour supply decreases by less than a percentage point following a 50 basis point increase in the required return, while capital stock decreases by over ten percent and GDP decreases by 4-5%. 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 550 billion (almost 2% of GDP). This means that an increase in the perceived riskiness of Hungarian capital investments of this order of magnitude has the potential to neutralize fully the estimated positive behavioural effects of the 2011 package.

The second set of robustness checks focuses on the behavioural assumptions underlying our analysis. Since the much of the behavioural effects in our simulations come from adjustment at the intensive margin, this is the focus of the robustness analysis. Table 8 shows the effects of the 2011 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.

Table 8: Robustness of the simulations to behavioural assumptions: The changes of 2010-11

	Effective labour	*Employment*	*GDP*	*Budget effect*
Full effect, as presented above	2.8%	0.4%	6.7%	-7
No behavioural change (only macro)	0.0%	0.0%	1.6%	-232
Only extensive response	0.4%	0.4%	1.9%	-200
Only intensive response: Alternatives				
Baseline elasticities	2.3%	0.0%	3.7%	-47
No income effect	3.6%	0.0%	4.9%	49
Smaller subst. elasticity, no income effect	2.1%	0.0%	3.5%	-73

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

The first row of Table 8 corresponds to the last column of Table 4: it shows the simulated effects of the 2011 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; but corporate tax relief has a positive effect on GDP by increasing the capital stock. In the third row individual adjustment at the extensive margin is ‘switched on’. The policy package is estimated to increase long-term employment by 0.4%, thereby raising GDP somewhat and reducing the fiscal cost of the package.

The last three rows of Table 8 show results from simulations where adjustment at the extensive margin is ‘switched off’ but there is adjustment at the intensive margin. The first of these uses the ‘baseline elasticities’ as estimated by Bakos, Benczúr and Benedek (2008). Their study finds that higher-income earners (the top 20% of the income distribution) are relatively responsive to the marginal tax rate, but as opposed to the majority of international studies they also find a measurable income effect, i.e., individuals seem to work less if the tax system grants them a lump-sum tax credit. The results from this simulation support the view that most of the behavioural effect of the 2011 policy package comes from labour supply adjustment at the intensive margin. Due mainly to the cuts in the marginal tax rates, the policy package is estimated to add, under these assumptions, about two percentage points to the effective labour supply and to the level of GDP in the long run (compare row 4 to row 2).

The last row of Table 8 ("Smaller substitution elasticity, no income effect") repeats this analysis using the estimates by Kiss and Mosberger (2011). They find a smaller taxable-income elasticity than Bakos, Benczúr and Benedek (2008) and in their analysis the estimated income effect is not statistically significant in most specifications. Thus, the parameters used in this simulation are 0.2 (instead of 0.34) for the taxable-income elasticity of the top 20% of the income distribution and 0 (instead of —0.27) for the income effect for the same group. We find that the estimated effects of the 2011 policy package with these 'alternative elasticities' are very similar to the ones estimated with the 'baseline elasticities' in row 4.

The reason for this finding is simple: a higher taxable-income elasticity magnifies the behavioural effects of a tax cut for high-income earners. On the other hand, a significant income effect dampens the same behavioural effect: tax-payers work less because they have more money. Thus, the two parametric differences between the estimations of Bakos, Benczúr and Benedek (2008) and Kiss and Mosberger (2011) have the opposite effect and, coincidentally, nearly cancel each-other out. To illustrate this point we ran the simulation with the Bakos, Benczúr and Benedek (2008) substitution effect but no income effect. The results of this simulation are shown in row 5 of Table 8. They confirm that the estimated behavioural effect is greater if we assume no income effect (row 5) than if we assume a significant income effect (row 4).

V. Conclusion

This article presents a new general-equilibrium behavioural microsimulation model for Hungary. It has been designed to assess long-run output and employment consequences of 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 analyze three different ways of tax relief in the personal income tax system. Second, we analyze three complex hypothetical proposals that are fiscally neutral without behavioural change. Last, we analyze actual changes of the tax and transfer system between 2008 and 2011.

In the first exercise, we find that the policy attractiveness of different scenarios depends heavily on the criterion used. While an across-the-board tax cut has the highest employment effect, 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).

In the second exercise we find that a personal income tax cut (single rate plus ETC) financed by corporate tax hikes leads to small GDP and employment effects, while it boosts effective hours and diminishes the capital stock. A personal or corporate tax cut financed by a less generous social transfer scheme leads to an increase in effective hours, employment, GDP and the capital stock; the former has a stronger effect on effective hours, while the latter has a stronger effect on the capital stock.

In the third exercise we evaluate the impact of actual tax and transfer changes between 2008 and 2011. 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 2011 produce a large gain at the intensive margin, but employment is expected to increase only slightly (mostly due to the capital inflow induced by the decrease in the corporate tax rate). Both policy packages are found to increase income inequality in the long run; the cumulative change has the potential to bring Hungary close to the median of EU member state as opposed to being in the top quartile with respect to income equality.

Our model — like any model — employs many simplifications, and cannot address many important features of tax policy questions. We cannot incorporate the shadow economy, the impact of minimum wages, the imperfect substitutability of skilled and unskilled labour, additional special features of the labour market of the unskilled, or a change in the long-run unemployment rate. Nevertheless, we believe that our results represent a useful step towards a better understanding of the output and employment impact of tax and transfer reforms.

At the same time, we do assess the robustness of our results with respect to two types of modifications to our assumptions. In the first set of robustness checks we repeat the simulation of the 2010—2011 policy package with one difference to the baseline simulations: here we find that even a small permanent increase in the perceived risk of Hungarian capital investments has a large negative effect on long-run capital stock, GDP and a smaller negative effect on employment. In the second set of robustness checks we run simulations with alternative values of the behavioural elasticities describing labour market adjustment at the intensive margin. Here we find that our results are robust to a plausible alternative specification.

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