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ABSTRACT

The End of the Flat Tax Experiment in Slovakia

Abstract - should be <250 words

The paper provides a quantitative assessment of the consequences of departing from a flat-tax system in the context of Slovakia. A behavioural microsimulation model of the labour supply is embedded into a general equilibrium framework with search and matching frictions. Some recently implemented changes in the tax system leave aggregate labour market indicators as well as inequality measures virtually unaffected. We also examine hypothetical revenue-neutral reforms that would significantly increase the progressivity of the system through graduated marginal tax rates. We find that there are narrow limits to what policy makers could accomplish through such reforms in terms of employment and equality of income. Hence, an income tax reform should at best be seen as a complementary tool to other initiatives promoting such objectives. Moreover, we highlight an important trade-off: income tax reforms that promote employment may harm growth.

Keywords: flat tax, microsimulation, general equilibrium, search and matching, labour supply elasticity

JEL Classification: E24, H24, H31, J22

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1. Introduction

The late 1990s and early 2000s saw a wave of radical tax reforms introducing flat tax regimes in several Central and Eastern European countries. The one that took place in 2004 in Slovakia bore close resemblance to the simple system proposed in Hall and Rabushka (1983). The personal income tax element of the reform involved a simple linear schedule that many consider to be close to optimal following Mirrlees (1971).[3] Whilst in some countries, the system stood the test of times, policy makers in Slovakia opted for a gradual repeal of the simple system over time citing the need to improve overall budget balance in an equitable way.

We show that the enacted departures from the flat income tax schedule are associated with neither significant fiscal or employment gains or losses, nor a noticeable change in income inequality measures.

Moreover, in hypothetical exercises, we find that a return to an even more redistributive system of graduated marginal tax rates would generate only small employment gains or reductions in inequality if the requirement of revenue neutrality were to be observed. The associated output losses could, however, be significant. We contribute to the literature on the relative merits of flat tax regimes by highlighting this somewhat counterintuitive trade-off and by explaining its sources.[4]

We also wish to draw the attention to the importance of the labour supply response at the extensive margin of mainly lower and middle income people for the understanding of the consequences of (flat) tax reforms. This echoes the recent findings in Zidar (2015). The literature normally focuses on the intensive margin effects, and does so often for a good reason. In Fuest et al. (2008), for example, the extensive margin effect is sidelined, as their hypothetical reform increases the tax burden mainly on the upper middle class. In our paper, too, the marginal departures from the 2004 flat tax leave the income of most earners largely unaffected, and so we are left with insignificant effects on the intensive as well as extensive margins. On the other hand, when we examine more radical hypothetical reforms involving significant increases in the progressivity of the tax system, we identify the extensive margin effect as an important driving

[3] See Mankiw et al. (2009) for more recent considerations along the same lines. There is also a body of literature featuring incomplete markets supporting simple linear tax structures, e.g. Ventura (1999), Conesa and Krueger (2006), Diaz-Gimenez and Pijoan-Mas (2006), and Conesa et al. (2009). Henceforth, we shall refer to the personal income tax element of the tax reform as the "flat tax" regime.

[4] A large body of literature has questioned the optimality of flat tax regimes. See, for example, Tuomala (1984), Tuomala (1990), Diamond and Saez (2011), and Heathcote and Tsujiyama (2015). Zelenak and Moreland (1999) also provide a good non-technical overview of the arguments for a graduated tax structure.

force of the results. Reforms that involve positive net income changes for the low- to middle-income earners, with significant increases in the top rates of tax, are shown to generate positive employment effects. These employment gains, however, amount to the involvement of a pool of relatively low-skilled workers in the production process. Such gains in labour input do little to offset the negative effect of high marginal tax rates on the effective (productivity-adjusted) hours worked in the economy. Hence, employment gains are associated with a negative composition effect leading to a dilution of the overall productivity of the workforce, and a fall in output.

The fact that certain income groups could lose out (gain) ceteris paribus from the introduction (abolishing) of a flat tax reform was recognized by Hall and Rabushka (1983). This has been confirmed with particular reference to the middle classes in the simulations of Altig et al. (2001) for the United States and Fuest et al. (2008) for Germany. In Slovakia, the intention was to make the flat tax system revenue-neutral ceteris paribus relative to its predecessor, which involved moderate net income losses for many below-average earners (Krajcir and Odor, 2005). Our analysis implies that the distribution of gains and losses matters not only at the level of the individual but on aggregate too. A narrow focus on the intensive margin effects on top earners may lead to a bias in magnitudes and hide important trade-offs.

The framework we use to study the consequences of the tax reforms is close to the behavioural microsimulation model of Fuest et al. (2008) but is unique in two interesting ways.[5] First, a general equilibrium feedback into the analysis is provided via the integration of the empirical labour supply function into a theoretical macroeconomic framework with search and matching frictions. In practice, we replace the standard theoretical bargaining equation determining the allocation of search intensity between the time of searching of workers and recruiting activities of firms with a mapping of wage shocks into labour supply responses obtained from the behavioural microsimulation exercise. In the context of Farmer (2013, 2014), this means that the task of equilibrium selection in an otherwise indeterminate setup is assigned to this empirical relationship rather than a belief function. Our model thus improves Benczur et al. (2012) by explicitly modelling a macroeconomic framework consistent with involuntary unemployment. Second, such an internally consistent model allows us to capture the dynamic response of the economy to a tax reform, and therefore evaluate general equilibrium transitional effects in addition to partial equilibrium short-run effects.

[5] The approach followed is similar to Atkinson (1996) who combined a microsimulation exercise with an empirical estimate of the labour supply response. Lelkes and Benedek (2007) only looked at a static microsimulation exercise to evaluate a hypothetical Slovak-style flat-tax reform in the context of Hungary.

The microsimulation model SIMTASK that underlies the supply-side analysis is a much-improved version of the EUROMOD model for Slovakia. Customization and enlargement of some of the platforms gives us simulated output that matches data and official statistics more closely, and improves the robustness of the subsequent simulation-based estimates, as described in fine detail in Siebertova et al. (2015b).

Microeconometric estimates of labour supply elasticities play an instrumental role in quantifying the labour supply response to changes in the tax system. Our work builds on the extensive body of literature neatly summarized in Chetty et al. (2013) and McClelland and Mok (2012). The approach we take, set out in full detail in Siebertova et al. (2015a), is closest to the one in Benczur et al. (2014) who first extended an existing structural approach to include tax-benefit simulation tool. The results for the extensive margin elasticities indicate that that the Slovaks – including subgroups such as the low-skilled, the elderly and the females - respond to incentives in the labour market much the same way as their OECD peers. For example, on average, a one percent increase in net wage increases the probability of economic activity for males by 0.2 and for females by 0.4 percentage points.[6]

Our work is also related to the literature examining the consequences of flat tax reforms in Central and Eastern Europe. Our results confirm the importance of considering the tax reform in the wider context of tax-benefit changes, as emphasized in Keen et al. (2006). Ivanova et al. (2005) do not find strong effects on work incentives of the flat tax reform in Russia, casting doubt on the importance of the incentive effect of large cuts in top marginal rates. Whilst reporting some intensive margin effects for males in general and females at both ends of the work hour distribution, Duncan and Peter (2010) do not attribute significant aggregate employment and tax revenue gains to the introduction of the flat tax reform in Russia. Finally, we do not consider the endogenous growth implications of tax reforms, although this may be a potentially important channel in the long run as shown in Azacis and Gillman (2010), albeit one that needs to be subjected to a proper empirical test.[7]

[6] In the absence of a good dataset, we resort to calibrating the labour supply elasticity on the intensive margin. A number of studies, including Bargain et al. (2012), assert that the extensive margin is much more important than the intensive margin when it comes to the overall labour supply elasticity. One of the results of our investigations is indeed to highlight the relative importance of the response on the extensive margin. Nevertheless, the intensive margin remains important and we provide a sensitivity test over a realistic range of parameter values to illustrate the quantitative consequences of different elasticities.

[7] Cassou and Lansing (2004) have also found such growth enhancing effects of the Hall-Rabushka proposal in a theoretical framework. Holter et al. (2015) point out that the consequences of tax reforms for human capital accumulation also depend on how it is modelled.

The rest of the paper is organized as follows. Section 2 describes in greater detail the nature of the changes to the income tax system in Slovakia between 2004 and 2013. The model is formally introduced in Section 3. We provide a detailed description of the microsimulation exercise, and how it is integrated into a general equilibrium macroeconomic model. We define the equilibrium, and describe the solution algorithms to characterize the steady state and the dynamic evolution of the economy. Section 4 describes the policy experiments that we examine. Section 5 sums up the main results and, finally, section 6 concludes.

2. Tax and transfer system reforms in Slovakia

The tax and social transfer system in Slovakia went through a significant change over the past ten years. In 2004, both the tax system and social benefits were substantially redesigned. The main idea of the reform was set on the assumption that Slovak tax system is too complicated and burdensome and that all rates should be replaced by a single tax rate. Therefore, effective from 2004, the system of graduated personal income tax (PIT) rates was simplified to a 19% flat rate system.[8] Krajcir and Odor (2005) show that increases in non-taxable allowances played a key role in preserving the system as moderately progressive and ensuring that the 2004 Slovak flat tax reform made certain groups of lower middle class earners no worse off ceteris paribus. Payroll taxes, i.e. social and health insurance paid by economically active population, stayed in general unreformed, although contributions were reduced by about 2 percent. In the end, the system as a whole remained complicated, with different bases and ceilings needed to be applied to different types of social and health insurance contributions.[9] A large part of the system of social transfers was overhauled involving significant cuts in levels of benefits, with the aim to increase work incentives.[10]

Only few minor changes in the system followed this bigger overhaul, some of which can be seen as a process of a gradual – mostly symbolic - departure from the system of a single marginal tax rate. These measures are the focus of this paper. They include:

1. *Tapering of the basic tax allowance* (2007): a gradual reduction in basic tax allowance of PIT has been introduced to tax payers with annual gross earnings exceeding about 18,000

[8] Furthermore, also corporate income tax was set to 19%. Inheritance and gift taxes were nullified. Taxes from dividends were abolished using an argument that they constitute double taxation. Different VAT rates were unified to 19%.

[9] In general, revenues from personal income tax and social and health contributions generate 10% and almost 40%, respectively, of total tax and social and health contribution revenues in Slovakia in 2012.

[10] World Bank (2012) showed that these transfer system reforms substantially improved motivation to work of the low-income workers.

euros. This amount is approximately twice the Slovak average yearly gross wage and the arrangement affected roughly the top 10 percent of the tax payers.

2. *Abandonment of the flat tax rate:* an additional income tax band starting at annual earnings worth 34,400 euros with a 25 percent personal income tax rate was introduced. Based on the actual earnings distribution of economically active population, the higher tax rate applies roughly to the top 1.5 percent of Slovak tax payers.

In addition to these measures enacted in practice, we also examine two hypothetical scenarios involving a return to the system of graduated tax rates similar to the one that existed in Slovakia before the introduction of the flat-rate system. In both experiments, we uprate the tax bands valid in 2003 using the average wage index. In our first hypothetical scenario, we make sure the reform is revenue neutral by undoing the increase in the basic non-taxable allowance and the child tax credit whose introduction formed an integral part of the flat-tax reform. In the second scenario, we keep these implicit transfers at their elevated level, and adjust the top rates of income tax to ensure revenue neutrality.

3. The *w_hat if* model

The model used in our study consists of two main blocks, a behavioural microsimulation block and a theoretical macroeconomic part.[11] Together, they form an internally consistent general equilibrium framework, which allows us to go beyond simple analysis assuming constant wages, and look at transitional dynamics too.

The microsimulation block is behavioural meaning that potential financial gains and losses for every individual are calculated and consequently individual labour supply reactions to tax and transfer system changes are assessed. The aggregate labour supply shock that results from individual responses then enters into the macro part of the model, replacing a theoretical labour supply relationship. In the macro part, optimizing firms react to the changed motivation to work of agents and adjust wages. This translates into a changed aggregate level of wages which we feed back into the microsimulation exercise in which the labour income of every employed person is adjusted generating a new labour supply shock.[12] This iterative process is repeated until

[11] For the useful taxonomy of microsimulation models see Bourguignon and Spadaro (2006).

[12] The assumption of a uniform wage feedback may be a strong one, especially in the context of specific reforms. Although Slovak administrative data indicate that aggregate wage changes tend to translate into fairly uniform individual wage dynamics (see Valachyova, 2015), future work could relax this assumption.

convergence. The procedure is equivalent to a grid-based solution with a polynomial approximation of labour supply changes for different wage levels (see below).

3.1. Labour supply – a behavioural microsimulation block

In this section, we present in greater detail the microsimulation model that underlies the empirical side of our analysis. We also outline how we capture behavioural responses to income shocks both on the extensive and the intensive margin of the labour market.

3.1.1. A microsimulation model of the Slovak tax and transfer system

SIMTASK, the microsimulation model of the Slovak tax and transfer system we use is described in detail in Siebertova et al. (2015b). This static tax-benefit calculator has been developed based on the existing EUROMOD platform and it works as an independent module that is directly incorporated into our general equilibrium framework.[13] Several simulation modules were customized and enlarged compared to EUROMOD; these adjustments provide simulated output that matches official statistics more closely.

The Slovak tax and transfer system is a complex and unified system. Income is taxed on the individual level (joint taxation of couples is not possible), SIC and social benefits are exempt from the tax base, i.e. the tax base is given as gross earnings net of employee contributions. Simulations covered by the model include direct taxes (labour and capital income taxes), social and health insurance contributions (SIC) paid both by employees and employers and selected transfers. The Slovak transfer system is composed of three components termed as: contributory (old-age, disability pensions, unemployment benefit, maternity benefit, etc.), social assistance and poverty (material needs benefit), and state social support (family related transfers). Transfers that are simulated in the model include material need benefit, unemployment benefit and most family related programs.

The microsimulation SIMTASK model is based on the SK-SILC database, which is the national version of EU-SILC[14]. Data are collected on an annual basis by the Statistical Office of the Slovak Republic. The dataset contains cross-sectional data on household and individual level and provides in-depth information on income, living conditions, social exclusion and poverty. The original dataset used in our analysis correspond to the income reference period 2012, which is

[13] EUROMOD is a multi-country tax-benefit model that presently covers the majority of EU member states. For the details of the EUROMOD project, its development process and current state, see Sutherland and Figari (2013). The Slovak EUROMOD model is well documented in the EUROMOD Country Report by Strizencova and Hagara (2014).

[14] The abbreviation SILC stands for "Statistics on Income and Living Conditions".

the last available dataset at the time of writing, and collects information on more than 15,000 individuals living in 5,400 households.

The SK-SILC contains detailed data on personal characteristics of individuals and includes information like age, gender, education and region of permanent residency and marital status. The information on household composition is also available. The dataset also contains broad information related to labour market status – whether the survey participant was employed (full-time, part-time), self-employed or remained to be unemployed in the reference period. The main focus is on the income data and the extensive information on the structure of individual income is available. Among others, respondents were asked to report their yearly gross earnings from employment and self-employment, fringe benefits, and also transfers from the state, e.g. family related benefits, unemployment benefits or pensions (old-age, disability). This wide-ranging information allows the SIMTASK model to simulate individual tax liabilities, social insurance contributions and benefits mentioned above.

The SK-SILC dataset is a representative sample of Slovak households taking into account a number of aspects, but it is not representative with respect to individual income distribution when compared to the official statistics. [15] The data display a caveat often observed in sample surveys: high-income individuals are under-sampled and low-income significantly over-sampled compared to the official data. Technically, a possible approach to overcome this problem is to conveniently adjust the sample weights in the dataset. Using the calibration software recently developed by the Slovak Statistical Office, the income distribution taken from the administrative source has also been used and the sample weights were correspondingly adjusted. For a detailed description and mode of use of the calibration tool "Calif", see Glaser-Opitzova et al. (2015).

3.1.2. Extensive margin

The extensive margin response on reforms is computed as the adjustment of individuals' probability of being economically active. [16] This adjustment can be evaluated by using the structural econometric model presented in detail in Siebertova et al. (2015). In this paper, individuals' decision about supplying labour is modelled by applying the discrete choice approach following the methodology proposed by Benczur et al. (2014). [17] Using this framework,

[15] The SK-SILC dataset is currently calibrated and integrated weights are provided by the Statistical Office of the Slovak Republic. The calibration does not take into account income distribution.

[16] Using the same methodology, we estimate also the adjustment of individuals' probability of being employed.

[17] For an overview of alternative approaches of modelling labour supply, see for example Blundell and MaCurdy (1999) or Blundell et al. (2011). Our approach is primarily motivated by the virtual non-existence

taxes and social transfers are simultaneously taken into account. Two labour market states of an individual are distinguished: being economically active (and work full-time) and being inactive. Probability of being economically active is estimated by a structural probit equation:

$$\mathrm{p}\left(\mathrm{activity}_j\right) = \Phi\left(\gamma\, \widehat{\log W_j} + Z_j'\alpha + \psi \log NY_j\right).$$

The main variable of interest, the financial "gains-to-work" W_j of individual j should be interpreted as a difference between the net wage when working full-time and conditional transfers when not working. NY_j stands for non-labour income and social transfers that one receives when not working and Z_j denotes a set of observable individual characteristics. This setup implies that for every working individual it is necessary to simulate the amount of transfers he would receive if not working and for every inactive individual a potential wage he would earn when get employed. Gains-to-work is predicted by using the Heckman's sample selection methodology. The vector $\widehat{\log W_j}$ that enters the structural probit equation is an estimate that comes out as a result of the unconditional linear prediction from Heckman's model.

The computed elasticities are broadly in line with the results usually reported in the literature. Based on the pooled data from 2009 to 2012 estimated results coming from the structural probit model show that low-skilled, females and the elderly are the groups that are particularly responsive to changes in taxes and transfers. The main estimation results, i.e. conditional marginal effects of net wage and transfers evaluated at sample means of selected subgroups are summarized in Table 1. [18]

The results from the estimation can be directly used to assess the participation effect of the analysed reforms. First, using the microsimulation model of tax and transfer system, the "gains-to-work" W and non-labour income NY is computed for every individual both in baseline (pre-reform) and scenario (post-reform). In the next step, using the estimated coefficients from the probit model, individual participation probabilities $\widehat{p_j} = \Phi\left(\hat{\gamma} \log W_j + Z_j'\hat{\alpha} + \hat{\psi} \log NY_j\right)$ are evaluated both in baseline and scenario cases.

of part-time employment in Slovakia. In 2013, only seven percent of the employed were registered as working part time.

[18] Based on the structural probit equation defined above, marginal effects of gains-to-work and non-labour income can be computed directly. In order to evaluate also the impact of net wage and transfers (being a part of gains-to-work and non-labour income, respectively), these need to be separated analytically.

Table 1: Marginal effects by selected subgroups

Females	**dy/dx**	**std err**	**Males**	**dy/dx**	**std err**
Net wage	0.401	0.038	Net wage	0.206	0.026
Transfers	-0.051	0.004	Transfers	-0.028	0.002
Prime age, females			**Prime age, males**		
Net wage	0.210	0.021	Net wage	0.055	0.008
Transfers	-0.043	0.003	Transfers	-0.012	0.001
Prime age, married females			**Prime age, married males**		
Net wage	0.200	0.020	Net wage	0.031	0.004
Transfers	-0.034	0.003	Transfers	-0.005	0.001
Age 50+, females			**Age 50+, males**		
Net wage	0.367	0.040	Net wage	0.271	0.038
Transfers	-0.028	0.002	Transfers	-0.028	0.003
Elementary education, females			**Elementary education, males**		
Net wage	0.426	0.042	Net wage	0.207	0.029
Transfers	-0.091	0.007	Transfers	-0.038	0.003
Secondary education, females			**Secondary education, males**		
Net wage	0.213	0.022	Net wage	0.055	0.008
Transfers	-0.044	0.004	Transfers	-0.012	0.001
Tertiary education, females			**Tertiary education, males**		
Net wage	0.180	0.018	Net wage	0.041	0.006
Transfers	-0.037	0.003	Transfers	-0.009	0.001

Note: Probit estimates are computed separately for males and females and marginal effects are evaluated at sub-group specific sample means. Reported marginal effects indicate semi-elasticities, i.e. the estimated effect should be interpreted such that a 1% rise in net wage of females increases their probability of supplying labor by 0.401 percentage points.

3.1.3. Intensive margin

The second decision of supplying labour concerns the number of hours of work supplied (conditional on being employed). For the intensive margin response, it is necessary to calculate the changes in the effective average and marginal tax rates. The response itself is the change in effective hours worked that can be expressed as a function of marginal ($METR$) and average ($AETR$) tax rates and income growth ($\widehat{w}$):

$$\hat{\mathrm{h}} = \frac{h_{sc}}{h_{ba}} = 1 + \xi(\cdot)\left\{e^{[\varepsilon_m \Delta\ln(1-METR)+\varepsilon_a \Delta\ln(1-AETR)+(\varepsilon_m+\varepsilon_a)\widehat{w}]} - 1\right\},$$

where ξ stands for the correction function of higher order terms that is assumed to be close to one ($\xi \approx 1$). By definition, hours worked in baseline are set to 1. Expressions $\Delta\ln(1 - METR)$ and $\Delta\ln(1 - AETR)$ denote the log difference between the baseline and scenario values of effective marginal net-of-tax rates and effective average net-of-tax rates, respectively. Parameter ε_m represents the effective marginal net-of-tax rate elasticity (substitution effect) and ε_a represents the effective average net-of-tax rate elasticity (income effect).

3.2. The theoretical macroeconomic block

The labour supply model described above allows us to assess the partial equilibrium effects of the proposed policy reform. However, our intention is to evaluate the general equilibrium short- and long-run effects as well. Therefore, we embed our labour supply micro block into a small general equilibrium model. The macroeconomic block defines labour demand and the capital supply-demand equilibrium given a wage level. Another way of looking at our approach is to take Farmer (2013, 2014) and think about the behavioural microsimulation exercise as a mechanism performing the task of equilibrium selection.

Our theoretical macroeconomic model is a neo-classical model with search and matching frictions, as in Pissarides (2000). The model is consistent with the existence of involuntary unemployment, and so we can calibrate it to match the empirical ratios seen in the micro-data we use, and thus ensure consistency.

We assume that production of goods is given by a standard CES production function which combines effective labour and capital. In the model, it takes time for an unemployed to find a job and the process of searching for new employees is costly. The representative firm then maximizes its profit subject to the production function:

$$\max\left\{\left(\alpha K^{\beta}+(1-\alpha)L^{\beta}\right)^{\frac{1}{\beta}}-w(1+\tau_w)L-\frac{r}{(1-\tau_k)}K-cv\right\}.$$

Total labour cost per unit of labour L is given by $w(1+\tau_w)$, where w denote gross wages and τ_w is the payroll tax paid by employers. The net user cost of capital K is $r/(1-\tau_k)$, where r is the price of capital, and τ_k denotes the effective tax rate on capital. Hiring costs are given by the expression cv, where v is the vacancy rate and c is the corresponding cost parameter.

In what follows, we set out the relationships characterizing the long-run steady state of our economy which together give us the set of equations channeling the labour supply shock coming from the microsimulation exercise.[19]

The first-order conditions from the firms' problem (1) and (2) link the price of labour and capital to the capital-labour ratio defined in (3).

$$\left(\alpha\bar{k}^{\beta}+(1-\alpha)\right)^{\frac{1-\beta}{\beta}}=\frac{\bar{w}(1+\tau_w)+\dfrac{\lambda c}{\bar{q}(\bar{\theta})}}{(1-\alpha)} \tag{1}$$

[19] We use a bar to denote steady-state values of variables.

$$\left(\alpha + (1-\alpha)\bar{k}^{-\beta}\right)^{\frac{1-\beta}{\beta}} = \frac{\bar{r}}{\alpha(1-\tau_k)} \tag{2}$$

$$\bar{k} = \frac{\bar{K}}{L} \tag{3}$$

The variable θ stands for labour market tightness (defined below) and q is the probability of filling a vacancy.

The Slovak economy is a very open one with much of private investment taking the form of foreign direct investment. This, we believe, allows us to model capital supply in a stylized way by positing a convex capital supply function as in Benczur et al. (2012)[20]

$$\bar{K} = (1+\bar{r})^{\chi} \tag{4}$$

with χ a finite positive parameter. We use a standard Cobb-Douglas form to describe matching of the unemployed and the vacancies

$$\bar{m}(\bar{u},\bar{v}) = \mu \bar{u}^{\xi} \bar{v}^{(1-\xi)} \tag{5}$$

Here, μ and ξ are parameters. Employment N in this economy at any point in time equals past employment less separations plus new hires. In the steady state, this implies the following expression where λ is the separation rate.

$$N = \frac{\bar{v}\bar{q}(\bar{\theta})}{\lambda} \tag{6}$$

Unemployment at any point in time is then just the number of unemployed in the previous period, number of those who entered unemployment and less net job creation. Steady-state unemployment is thus given by

$$\bar{u} = \frac{\lambda}{\lambda + \bar{p}(\bar{\theta})} \tag{7}$$

Finally, the probability of filling a vacancy, the probability of being matched with a job and the labour market tightness are defined as follows

$$\bar{q}(\bar{\theta}) = \bar{m}\left(\frac{\bar{u}}{\bar{v}}, 1\right) = \mu\left(\frac{\bar{u}}{\bar{v}}\right)^{\xi} \tag{8}$$

$$\bar{p}(\bar{\theta}) = \bar{\theta}\bar{q}(\bar{\theta}) \tag{9}$$

$$\bar{\theta} = \frac{\bar{v}}{\bar{u}} \tag{10}$$

[20] Here, we also make the implicit assumption that the supply of capital is independent of the tax-benefit reforms the country enacts. In the case of large-scale reforms, this might be a strong assumption.

3.3. Model calibration and solution

The parameters of the macro model are calibrated according to Slovak data. The production function parameters ($\alpha = 0.43$ and $\beta = 1.1$) are from the CES production function estimates presented in Bencik (2008). The job separation rate ($\lambda = 0.004$) is set in line with the figures presented in Labour Market Developments in Europe 2013 (EC, 2013). The matching elasticity of the unemployed ($\xi = 0.8$) is set in line with the search and matching literature for Slovakia (see Zeleznik, 2012 or Nemec, 2013), whereas the scaling factor of matching function ($\mu = 0.05$) is computed in order to match Slovak data on vacancies and unemployment. The effective tax rate on capital ($\tau_k = 0.06$) is set as reported in ZEW (2012). The price elasticity of capital ($\chi = 5$) is calibrated as in Benczur et al. (2012), assuming that capital supply is elastic.[21] The intensive margin elasticities ε_m and ε_a are calibrated using the values reported in Kiss and Mosberger (2015) used for Hungary, i.e. ε_m is set to 0.2 for the top 20 percent of the income distribution and ε_a is set to zero.[22]

The model – both its microsimulation and theoretical macroeconomic blocks – is solved in STATA. We use an iterative algorithm to solve for the long-run equilibrium. Three variables are of interest as the output from micro part: effective employment (N), effective labour supply (L) and average effective social security contributions paid by employers (τ_w). Change in hours worked is computed as a response at the intensive margin. Effective labour supply is computed for every individual and afterwards is aggregated as

$$L = \frac{1}{s}\sum_{j=1}^{s} \widehat{p_j} h_j prod_j \,, \tag{11}$$

where $\widehat{p_j}$ stands for the probability of agent j being economically active computed at the extensive margin. Hours worked (h_j) is computed at the intensive margin. We also include productivity ($prod_j$) proxied by the normalized labour income.[23] The number of individuals in the sample is denoted as s.

[21] Varying this parameter primarily affects the size of the response in output. Having tried a wide range of values, we are confident to state that the main intuition behind the results remains unaffected by the choice of this parameter.

[22] We provide a sensitivity test of our results to the calibration of ε_m in the appendix. Although the magnitude of the intensive margin effect obviously changes, this leaves the intuition and the conclusions coming from the baseline case reported in the paper intact. As better data become available, we plan to carry out our own estimation of the elasticities.

[23] It is common in the literature to treat the wage distribution as an approximation of the distribution of productivity (see, for example, Heathcote and Tsujiyama, 2015, for a discussion and application).

The output from the microsimulation feeds into the macroeconomic block which generates a new wage shock that re-enters the microsimulation. This is repeated until convergence. It is easy to check (numerically) that the same result can be obtained by approximating the microsimulation output $x = \{N, L, \tau_w\}$ using the following polynomials

$$x = \sum_{i=0}^{n} \alpha_{x,i} \widehat{w}^{i} \tag{12}$$

estimated on a fine grid of wage shocks.[24] This numerical approach becomes useful when computing the transition.

Transitional dynamics can be computed if we consider our macroeconomic model in its dynamic form.[25] This means, in the context of the framework set out above, replacing the steady-state relationship for employment with[26]

$$N_t = (1 - \lambda)N_{t-1} + m_t$$

Unemployment is then simply given by

$$u_t = 1 - N_t$$

With this modification, we can implement the following solution algorithm:

1) Guess the length of transition T and a transition path for the number of matches m
2) Given that the final steady state is known (from the solution above), solve the model given by (1) to (5), (8) to (10) and the polynomials (12) in periods $t = 1,\ldots,T\text{-}1$.
3) Solve for a new series of m using the employment dynamic equation
4) Repeat steps 2 and 3 until convergence
5) Adjust T if necessary.

[24] We found n=7 providing sufficient accuracy of approximation.

[25] Note that this modification introduces a state variable (N_{t-1}) into the system. The solution for all endogenous variables along the transition path will in general be a function of this variable. However, we make the implicit assumption that labour supply responses as computed in the microsimulation block are independent of the state of the economy. The fact that our labour supply elasticities did not change significantly when estimated on data from individual years (during the recent volatile episode) rather than the pooled sample indicates that this is not a strong assumption.

[26] Notice the shift in timing: newly hired labour becomes productive immediately. This follows Blanchard and Galí (2010) and much of the business cycle literature which assume employment to be a non-predetermined variable, and thus able to respond to shocks.

4. Simulated scenarios

The initial steady state assumed in this study is the situation in Slovakia in 2012. The reference dataset is the SK-SILC survey corresponding to the income reference period 2012 and the reference microsimulation model is SIMTASK calibrated to replicate the state of legislation valid in 2012.

The assessment of the following four departures from the 2012 baseline is provided:

- *Scenario 1*: *abolition of the progressive reduction in tax allowance ("No tapering")*

  In this scenario, a progressive reduction in basic tax allowance of PIT, originally introduced in 2007, is abolished.

- *Scenario 2*: *two tax brackets in 2013 ("Two brackets")*

  This scenario directly assess the effect of change valid from 2013 when two tax brackets of the PIT were introduced. Incomes are taxed by the 19 percent tax rate and a 25 percent income tax is applied to earnings exceeding a threshold value.

- *Scenario 3*: *Hypothetical* larger-scale *abolition of the flat tax ("Hypothetical I")*

  This hypothetical scenario simulates the effect of introduction of tax brackets that were valid before the flat-tax reform in 2004. Five tax brackets with rates 10, 20, 28, 35 and 38 percent were defined as in 2003, their thresholds were updated according to the growth of average nominal wage between 2003-2013. Moreover, the scenario assumes the cancellation of the child tax credit and a reduction in the basic tax allowance by 22 percent. The latter makes the reform revenue neutral in partial equilibrium.

- *Scenario 4*: *Hypothetical* larger-scale *abolition of the flat tax ("Hypothetical II")*

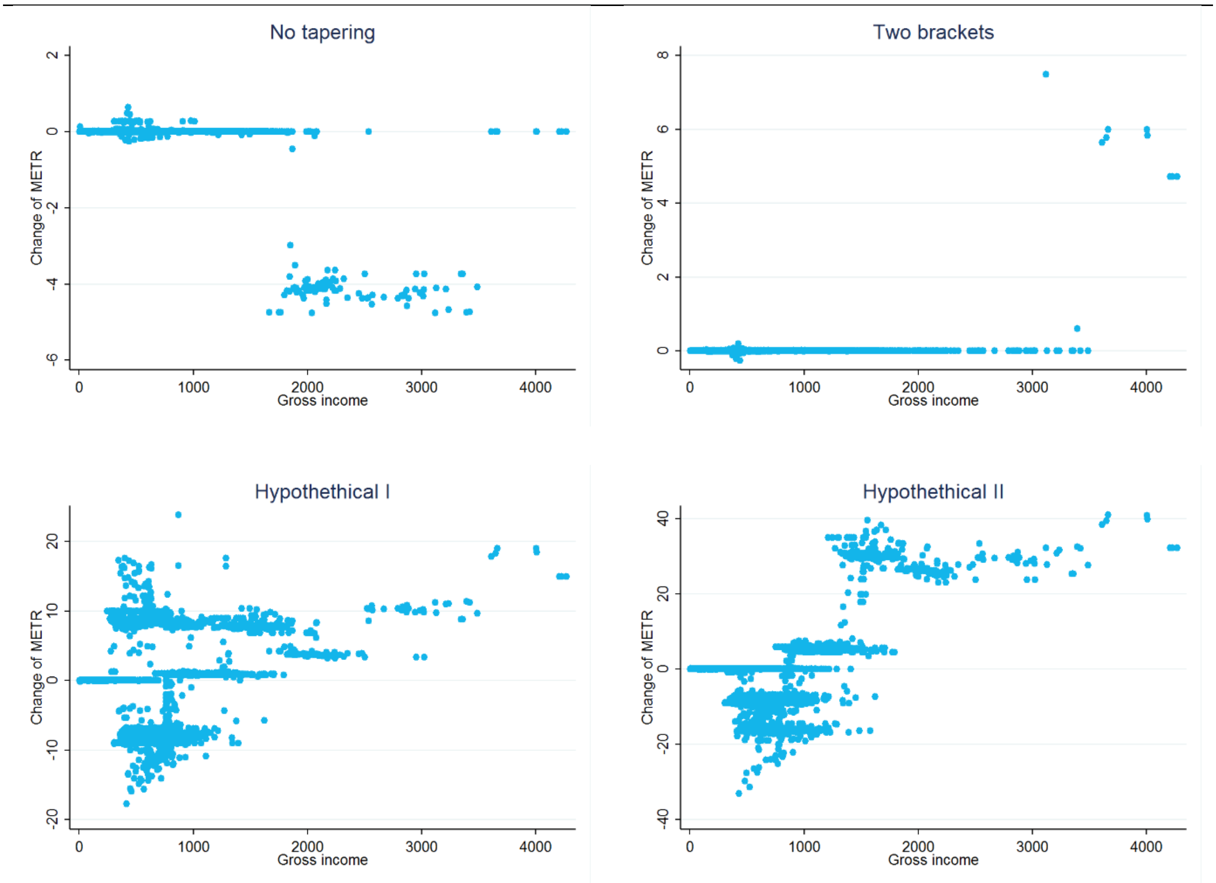
  This scenario is similar to the scenario 3 but the highest marginal rates are being adjusted to ensure revenue neutrality instead of the cuts in allowances. More specifically, the tax rates become 10, 25, 54, 56 and 60 percent.

The marginal and average effective tax rates (within the PIT system) calculated on the basis of monthly gross income under the alternative scenarios are shown in Figure 1 below.

5. Results

First, we discuss the consequences of the tax reforms of aggregate budget revenues and household disposable incomes. Then, we evaluate the impact of alternative tax reforms on the aggregate economy. In the first part, we confine ourselves to partial equilibrium analysis, whilst our macroeconomic impacts are assess in general equilibrium, both in the short run and the long run.[27]

Figure 1 Change in marginal effective tax rates (in percent)



[27] A model-consistent way of modelling individual impacts (i.e. which takes into account changes in the probability of participation/employment) needs to be developed in order to assess tax and disposable income changes at the individual level in general equilibrium accurately. This is a non-trivial extension of the analysis here, and we leave it for future research. On aggregate, the probabilistic approach to modelling labour supply is consistent with the macroeconomic model, and hence the results can be reported. These results do not indicate large changes in the aggregate employment rate (and indeed wages), which implies that a static partial equilibrium assessment of the net income/fiscal consequences of reforms should provide a good approximation to a fully consistent analysis.

5.1. Static effects on disposable income

Table 2 displays the static aggregate fiscal effects of the simulated policy changes as a percentage of baseline revenues. Personal income tax revenues would drop by 1.3 percent, should the tapering of the basic allowance be abolished. When a second rate of income tax is introduced, tax revenues increase by 0.8 percent. The last two scenarios with graduated marginal income tax rates are fiscally neutral by construction.[28] Notice that this involves changes in the volume of social transfers paid to households. Depending on the effect on low earners, the changes in the tax system may or may not lead to higher social spending. These fiscal effects are an aggregation of the changes in disposable incomes at the individual level. Figure 2 below shows the effects of simulated scenarios on the disposable income of individuals ordered into income deciles based on their income from labour.

Table 2: Change in fiscal variables under different scenarios

	No tapering	**Two brackets**	**Hypothethical I**	**Hypothetical II**
	% change	% change	% change	% change
Personal Income Tax	-1.3	0.8	0.3	-0.8
Social transfers	0.0	0.0	0.1	-0.2
Total fiscal effect	-1.3	0.8	0.0	0.0

The marginal departures from the tax system valid in 2012, simulated in scenarios 1 and 2, have only negligible impact on disposable income in every decile. The last two hypothetical scenarios show that the effect of introduction of five tax brackets influence the entire income distribution. In scenario 3, low-income earners lose out as their allowances and tax credits are cut, whereas the middle classes experience an increase in this set up mainly coming from a lower rate of tax covering a large section of their income. In scenario 4, almost all groups benefits from tax reform except for those at the very top of the distribution. This generates a rather strong extensive margin effect on employment, as we shall see in the overview of the macroeconomic consequences below.

These individual effects translate into changes in various inequality measures. They are reported in Table 3 below. As we can see, in spite of the large shifts in the degree of progressivity of the tax system in scenarios 3 and 4, as indicated by the Kakwani (1977) index, key inequality measures remain virtually unaffected. The Gini index in the baseline scenario of 2012 is estimated

[28] We believe the requirement of revenue neutrality in a partial equilibrium sense is a reasonable approximation of real-world policy design, whilst also being analytically more convenient.

at 27.1 percent, and the maximum change is only 0.7 percentage points in the simulated scenario 4.

Figure 2 Change of disposable income by labour income deciles

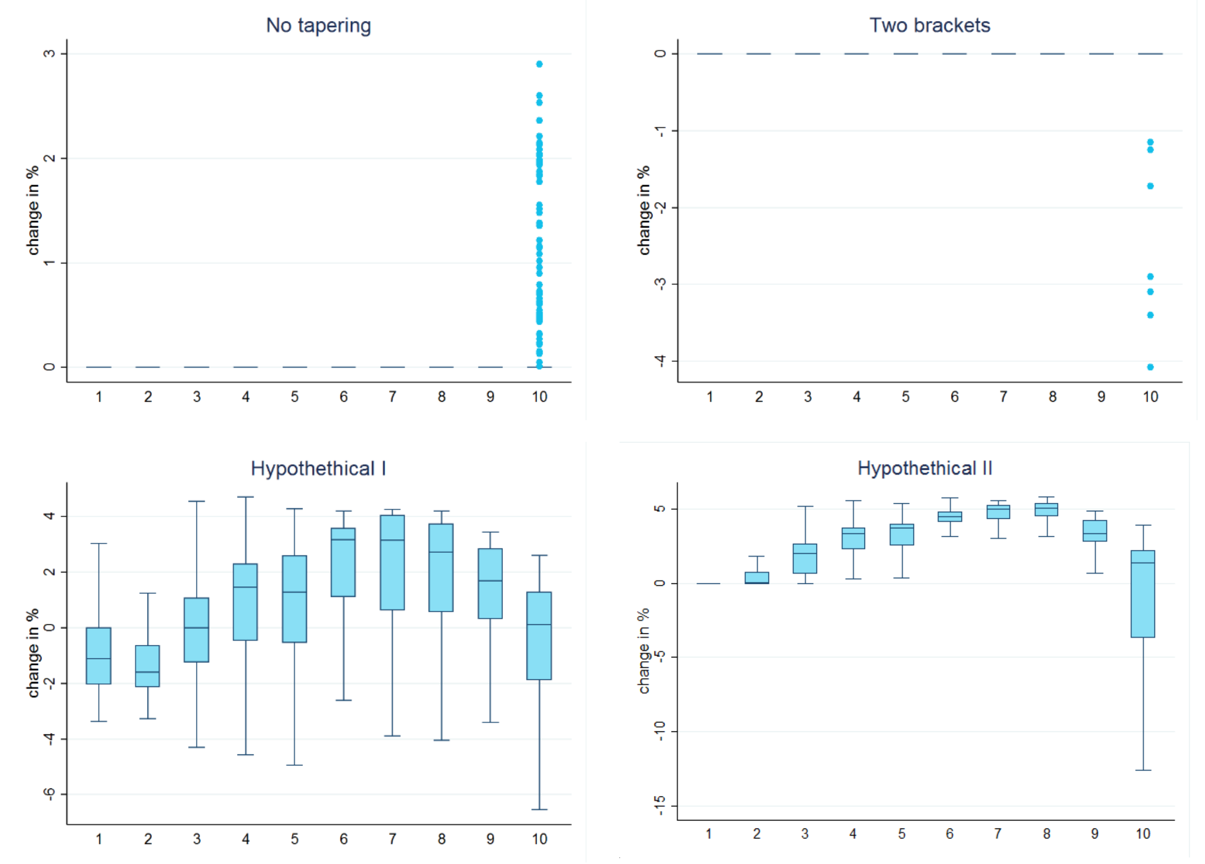


Table 3: Inequality measures

	Baseline 2012	No tapering	Two brackets	Hyp I	Hyp II
gini	27.1	27.2	27.1	27.2	26.4
p90p10	3.7	3.7	3.7	3.8	3.7
p90p50	1.8	1.8	1.8	1.8	1.8
p10p50	0.5	0.5	0.5	0.5	0.5
Kakwani index	6.8	6.6	7.0	8.0	12.4

Note: The Gini index is computed based on households' disposable income and adjusted by the modified OECD equivalence scale. We present results for the scale-free Gini and Kakwani indices multiplied by 100 (compared to standard definitions) so that small changes indicated by simulations are noticeable.

5.2. General equilibrium macroeconomic consequences

Marginal departures from the flat tax have only negligible consequences at the level of the aggregate economy. The hypothetical scenarios, however, produce more significant impacts, and indicate that policy makers may face interesting trade-offs in policy design.

Table 4 summarizes the effects of the simulated reforms on aggregate macro variables. Since we are able to compute also transitional dynamics, we present the effects in the first year as well as the long run effects in general equilibrium.

Table 4: Change of aggregate macro variables

		No tapering	Two brackets	Hyp I	Hyp II
Short-run GE effect					
Employment	p.p.	-0.02	0.00	0.06	0.23
Effective labour	p.p.	0.07	-0.04	-0.53	-1.93
Gross wages	%	0.10	0.01	-0.25	-1.65
Capital		0.04	-0.02	-0.29	-1.04
Output	%	0.07	-0.04	-0.51	-1.85
Unemployment rate	p.p.	0.02	0.00	-0.06	-0.23
Long-run GE effect					
Employment	p.p.	-0.04	0.00	0.12	0.53
Work intensity	%	0.01	0.00	-0.13	-0.46
Effective labour	p.p.	0.06	-0.04	-0.48	-1.76
Gross wages	%	0.00	0.01	0.08	0.22
Capital	%	0.03	-0.02	-0.26	-0.95
Output	%	0.06	-0.04	-0.46	-1.69
Unemployment rate	p.p.	0.04	0.00	-0.12	-0.53

The hypothetical tax reforms in scenario 3 and 4 generate a positive employment effect both in the short and in the long run, and a negative effect on work intensity. Effective labour and output fall as highly-productive workers reduce their hours at the prevailing wage. Profit-maximizing firms seek to re-gain some of their lost output by hiring more labour. Wages fall reflecting lower aggregate labour productivity and higher recruitment costs of firms. As jobs get filled and the labour market tightens, wages recover but productivity-adjusted labour input and output do not reach their pre-reform levels.[29]

Scenario 3 makes the lower-middle and middle classes better off which generates a positive extensive margin effect. In scenario 4, the extensive margin effect is even stronger, as revenue

[29] Figure A.1 in the appendix displays the transitional dynamics for key macroeconomic variables.

neutrality is achieved without cuts in allowances and tax credits for the poor, which makes all but the very rich better off. The employment rate then increases by 0.46 percentage points in the long run in scenario 4, even if work intensity drops as a result of higher tax rates. Whilst the increase in employment is significant in absolute terms, it barely matters when seen in the context of the 10+ percent persistent unemployment rate in Slovakia. Hence, we conclude that tax policy can at best only complement a more comprehensive set of policies aimed at boosting employment.

Output drops by 1.76 percent in the long run in scenario 4. This is because the tax reform changes the composition of the labour force. The employment gains are due to relatively low-skilled workers entering the labour force, whilst the high-skilled employees work with a lower intensity, which translates into an overall drop in effective labour supply. Hence, policy makers may be faced with an interesting trade-off between growth and unemployment (and inequality, to a lesser extent) when designing the tax system.

6. Concluding remarks

Our empirical investigation into the effects of departures from a flat tax regime sheds new light on some important aspects of tax reforms. We identify significant, albeit small employment effects coming from the extensive margin if the reforms are designed to increase the after-tax income of the low earners. On the other hand, reform-driven employment increases brought about through an inflow of low-skilled workers coupled with a reduction in work intensity by the highly skilled may hamper growth. Policy makers thus face non-trivial trade-offs when designing tax systems. In the context of Slovakia, we see limited room for significant effects on aggregate labour-market or cross-sectional indicators coming from revenue-neutral income tax reforms. At best, they can form a part of a broader reform agenda.

Our modelling approach allows us to consider a range of effects on important aggregate and cross-sectional indicators as well as their transitional dynamics. However, further improvements to the modelling approach could expand the breadth and depth of the analysis further. For example, accounting for heterogeneity in the general equilibrium feedback could deliver a more accurate assessment of the distributive consequences of the reforms. Also, we have not considered endogenous (human) capital accumulation in the present setup. The analysis abstracts from the consumption-savings decision of agents in the economy too. Accounting for such effects would provide us with new general-equilibrium feedback channels, and allow an explicit evaluation of welfare measures.

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Appendix: Sensitivity analysis

Table A.1: Change in fiscal variables under different scenarios

	ε_m	No tapering % change	Two brackets % change	Hyp I % change	Hyp II % change
Partial equilibrium					
	0.1	-1.3	0.8	0.3	-0.8
Personal Income Tax (PIT)	0.2	-1.3	0.8	0.3	-0.8
	0.3	-1.3	0.8	0.3	-0.8
	0.1	0.0	0.0	0.1	-0.2
Social transfers	0.2	0.0	0.0	0.1	-0.2
	0.3	0.0	0.0	0.1	-0.2
	0.1	-1.3	0.8	0.0	0.0
Total fiscal effect	0.2	-1.3	0.8	0.0	0.0
	0.3	-1.3	0.8	0.0	0.0

Table A.2: Inequality measures

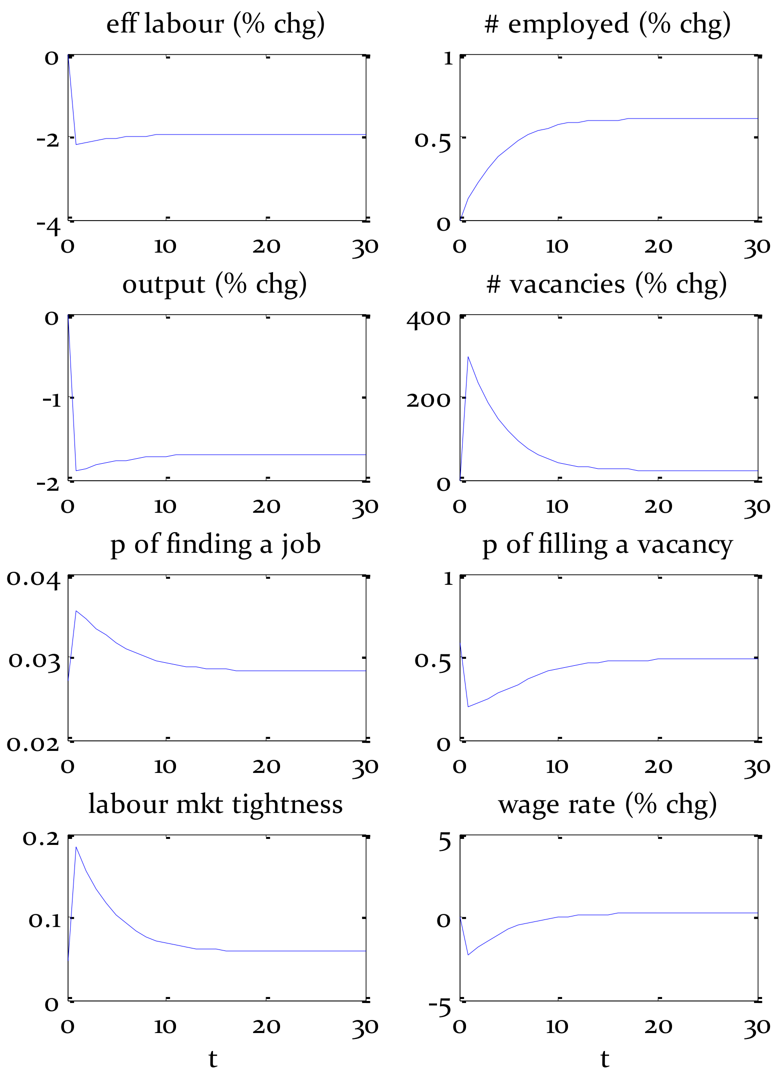
Partial equilibrium	ε_m	**Baseline 2012**	**No tapering**	**Two brackets**	**Hyp I**	**Hyp II**
	0.1		27.2	27.1	27.2	26.4
gini	0.2	27.1	27.2	27.1	27.2	26.4
	0.3		27.2	27.1	27.2	26.4
	0.1		3.7	3.7	3.8	3.7
p90p10	0.2	3.7	3.7	3.7	3.8	3.7
	0.3		3.7	3.7	3.8	3.7
	0.1		1.8	1.8	1.8	1.8
p90p50	0.2	1.8	1.8	1.8	1.8	1.8
	0.3		1.8	1.8	1.8	1.8
	0.1		0.5	0.5	0.5	0.5
p10p50	0.2	0.5	0.5	0.5	0.5	0.5
	0.3		0.5	0.5	0.5	0.5
	0.1		6.6	7.0	8.0	12.4
Kakwani index	0.2	6.8	6.6	7.0	8.0	12.4
	0.3		6.6	7.0	8.0	12.4

Note: The Gini index is computed based on households' disposable income and adjusted by the modified OECD equivalence scale.

Table A.3: Change in aggregate macro variables

			No tapering	Two brackets	Hyp I	Hyp II
GE Long-run						
		0.1	-0.04	0.00	0.10	0.50
Employment	p.p.	0.2	-0.04	0.00	0.12	0.53
		0.3	-0.04	0.01	0.12	0.56
		0.1	0.01	0.00	-0.07	-0.25
Work intensity	%	0.2	0.01	0.00	-0.13	-0.46
		0.3	0.02	0.00	-0.18	-0.62
		0.1	0.02	-0.02	-0.24	-0.97
Effective labour	p.p.	0.2	0.06	-0.04	-0.53	-1.93
		0.3	0.10	-0.06	-0.80	-2.69
		0.1	0.01	0.00	0.01	-0.02
Gross wages	%	0.2	0.00	0.01	0.08	0.22
		0.3	-0.01	0.01	0.15	0.41
		0.1	0.02	-0.02	-0.21	-0.85
Output	%	0.2	0.06	-0.04	-0.46	-1.69
		0.3	0.09	-0.05	-0.70	-2.35
		0.1	0.04	0.00	-0.10	-0.50
Unemployment rate	p.p.	0.2	0.04	0.00	-0.12	-0.53
		0.3	0.04	-0.01	-0.12	-0.56

Figure A.1 Transitional dynamics under *Hypothetical II* scenario



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