

# MINIMUM WAGE SETTING AND THE DYNAMICS OF THE CZECH LABOR MARKET

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## Abstract

The main goal of this paper is to evaluate the impacts of alternative statutory minimum wage settings on the dynamics of the Czech economy and its labor market through the lens of a dynamic stochastic general equilibrium model. Our results are based on a medium-scale model that allows for an analysis of the macroeconomic impacts of the minimum wage. We simulate endogenous variables of the model for a calibration corresponding to the current Czech labor market characteristics and compare them with alternative scenarios for the minimum wage setting and the proportion of unskilled households in the economy. The short-run effects of these alternative scenarios are evaluated with regards to the impulse response functions of selected labor market measures on three exogenous shocks of interest, a technology shock, a shock to the minimum wage setting, and a shock to the unemployment benefits.

## Keywords

DSGE Model, Impulse Response Functions, Labor Market, Minimum Wage, Unemployment

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## I. Introduction

The minimum wage has recently become a highly debated political topic in the European Union. The debate started when the President of the European Commission, Ursula von der Leyen, presented a fair minimum wage for every worker in the European Union as one of its political priorities (Von der Leyen, 2019). As a matter of fact, the second phase consultation of social partners on this topic has already started (European Commission, 2020). Regarding the situation in the Czech Republic, it has a minimum wage policy in place since February 1991. Based on the data from the Czech Statistical Office (CZSO), after a long period of zero nominal growth between the years 2008-2013, the government has raised it gradually in recent years. Since the beginning of 2015, it regularly grows by at least 7.6 % every year and is currently set to a level of 14 600 Czech crowns per month.

Even without the ongoing political debate on the minimum wage and the regular significant increases in its nominal level in the Czech Republic in recent years, the topic of the minimum wage has already been getting attention in the academic discussion for years. Probably the most debated work in this field of research is the paper written by Card and Krueger (1994). In their paper, the authors analyzed the impact of a minimum wage increase on employment in fast-food restaurants in New Jersey in 1992. They found consistent positive employment response to the minimum wage increase. Since then, a considerable amount of studies on minimum wage impact on the economy has been published, yet without a definite conclusion regarding its size and causal direction. The very detailed review explicitly focused on minimum wage theories as well as empirical findings is provided in (Neumark & Wascher, 2008). Often, the minimum wage effects on economic performance are studied only in labor market sectors with a higher proportion of workers with a lower level of human capital (low-skilled workers), e.g. (Bell, 1997; Neumark, 2001; Sabia, 2014; Sabia, 2015). The idea of mutual analysis of both high-

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skilled and low-skilled workers in the environment of partial equilibrium can be found in (Cahuc et al., 2001).

A natural next step in the research on the minimum wage impacts is to look at the changes in the macroeconomic aggregates and the economy as a whole. The idea that minimum wage can affect not only the sectors with a high number of minimum-wage workers but also the rest of the economy leads to the question of the macroeconomic consequences of the minimum-wage setting. The dynamic stochastic general equilibrium (DSGE) framework represents a suitable structural approach where the existence and dynamics of a minimum wage are based on formalized and logically built comprehensive microeconomic foundations. As far as we know, only a few studies are using the DSGE framework for this goal, and none of those focuses on the Czech Republic. Probably the first attempt to explicitly model the minimum wage in the DSGE framework is (Porter & Vittek, 2008), where an introduction of a statutory minimum wage in the Hong Kong economy is discussed and analyzed. Authors conclude that introduction of a statutory minimum wage may potentially elevate macroeconomic volatility and distort the ability of the economy to cope with external shocks. Another example of an analysis regarding the minimum wage setting in the DSGE model can be found in (Buřs, 2017). However, the minimum wage is not modeled explicitly, and the analysis focuses only on studying the effects of a permanent increase in the minimum-to-average wage ratio. One of the most recent contributions to this discussion is the paper by Šauer (2018), which presents a medium-scale DSGE model of a closed economy, with a mechanism allowing for explicit setting of the minimum wage and unemployment benefits, estimated on the US data.

Our contribution aims to evaluate the impacts of alternative statutory minimum wage settings on the dynamics of the Czech economy and its labor market through the lens of a DSGE model. The resulting research questions we try to answer are as follows:

- Does the increase in the minimum wage hinder the impact of a technology shock?
- Does the increased minimum wage provide incentives to the low-skilled workers for improving their participation in the labor market?
- Are there any differences between the impacts of increased unemployment benefits and minimum wage on the labor market dynamics?

The DSGE model we utilize in this contribution is based on the model proposed in (Šauer, 2018). It allows for an analysis of the macroeconomic impacts of several labor market institutions, such as the minimum wage or unemployment benefits, taking into account the complexity of the relations between different economic subjects on the microeconomic level and translating them into the general-equilibrium effects on the macroeconomic level. We simulate endogenous variables of the model for a calibration corresponding to the current Czech labor market characteristics and compare them with alternative scenarios for the minimum wage setting and the proportion of unskilled households in the economy. The short-run effects of these alternative scenarios are evaluated with regards to the impulse response functions of selected labor market measures on three exogenous shocks of interest, a technology shock, a shock to the minimum wage setting, and a shock to the unemployment benefits.

## II. Model

In this section, we present the main attributes of the model used in our analysis. The model describes mutual interaction between households, firms, government, and a central bank. The model economy is populated by a  $[0; 1]$  continuum of households, with each household consisting of a  $[0; 1]$  continuum of individuals. Households can be of one of the following two types: unskilled households, represented by a fraction  $\omega$  of the whole population; or skilled households, forming the remaining part of the population,  $(1 - \omega)$ . The main difference

between these two types of households lies in the professional qualification of their members (e.g., attained education, work experience, etc.). The head of each household sends part of its members out to the labor market (i.e., decides on the labor force participation rate), where they are hired by firms operating in a monopolistic competition market. The firms in the modeled economy can perfectly distinguish between skilled and unskilled labor force, thus paying real minimum wage,  $w_t^{min}$ , only to the unskilled workers. In contrast, skilled individuals are paid a higher real wage,  $w_t^s$ , as a result of a competitive labor market. The government controls the minimum wage setting up to a stochastic shock representing the ability of the government to correctly estimate what would be the wage for unskilled workers in the absence of the minimum wage. The central bank sets the interest rate to follow a simple interest-rate rule controlling for inflation and unemployment rate. In what follows, we briefly describe optimization problems faced by the households and the firms and the role of the government. For a more detailed description of the model, please refer to (Šauer, 2018).

### Unskilled households

The optimization problem for an unskilled household  $h$  has the following form:

$$\max_{\{L_t^u(h)\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} (\beta^u)^t \left\{ \ln \left[ \zeta^u (C_t^u(h))^{\sigma^u} + (1 - \zeta^u) (X_t^u(h))^{\sigma^u} \right]^{\frac{1}{\sigma^u}} - \frac{Y^u}{2} \left( \frac{L_t^u(h)}{L_t^{u,Ref}(h)} - 1 \right)^2 \right\}, \quad (1)$$

Where  $E_t$  is the expectation operator at time  $t$ ;  $\beta^u$  is the discount factor of the unskilled households;  $\zeta^u$  and  $\sigma^u$  are parameters of the utility function;  $Y^u$  is a parameter of habit formation. Variable  $L_t^u(h)$ , representing the household's labor-force participation, is the only variable households decide about when maximizing their utility. Note that the utility function also includes habit formation for the household's decision making about the labor force participation, hence  $L_t^{u,Ref}$  is the reference amount of supplied labor, in what follows we will assume an external habit defined as the average previous labor-force participation rate of all unskilled households, i.e.  $L_t^{u,Ref}(h) = L_{t-1}^u$ . Variable  $C_t^u$  represents the consumption of an unskilled household. In the model, we assume that the unskilled households spend their whole income on consumption goods only; therefore, their budget constraint is of the following form:

$$C_t^u(h) = (1 - \tau_t) [w_t^u(h)(1 - z_t^u(h)) + q_t^u z_t^u(h)] L_t^u(h), \quad (2)$$

where  $\tau_t$  denotes an income tax applied to both, the wage of unskilled household members,  $w_t^u$ , and also unemployment benefits,  $q_t^u$ ;  $z_t^u$  is the unemployment rate for unskilled households. Finally,  $X_t^u$ , from eq. (1), stands for non-tradable and non-storable home-produced goods. Its production function forms the second condition for the unskilled households optimization problem:

$$X_t^u(h) = J_t (1 - L_t^u(h)), \quad (3)$$

where the productivity  $J_t$  follows a stochastic process:

$$J_t = \exp(\epsilon_t^J), \quad (4)$$

$$\epsilon_t^J = \rho^J \epsilon_{t-1}^J + v_t^J. \quad (5)$$

Only unemployed members of the household contribute to the home-production. The solution to the maximization problem leads to the following first-order condition:

$$\frac{\zeta^u (c_t^u(h))^{\sigma^u} \frac{1}{L_t^u(h)} - (1-\zeta^u) J_t \sigma^u (1-L_t^u(h))^{\sigma^u-1}}{\zeta^u (c_t^u(h))^{\sigma^u} + (1-\zeta^u) [J_t (1-L_t^u(h))]^{\sigma^u}} = \frac{\Upsilon^u}{L_{t-1}^u} \left( \frac{L_t^u(h)}{L_{t-1}^u} - 1 \right). \quad (6)$$

Although individuals are sent out to the labor market, they do not automatically accept every job offer. A firm offers a contract to an individual  $j$ , where it defines a proposed real wage and expected effort,  $e_t^u$ , in return. We assume that the firms can monitor the tasks of the unskilled workers, and if they detect workers provide less effort than required, they can immediately terminate the contract. This also causes such individuals to lose the opportunity to get unemployment benefits. Therefore, this mechanism allows firms to specify the effort level. However, for a firm to persuade an individual to accept the job offer, the following participation constraint has to be satisfied:

$$\ln(\zeta^u [(1-\tau_t) w_t^u(j)]^{\sigma^u})^{\frac{1}{\sigma^u}} - \kappa e_t^u(j) \geq \ln(\zeta^u [(1-\tau_t) q_t^u]^{\sigma^u})^{\frac{1}{\sigma^u}} + \chi. \quad (7)$$

Thus, the unskilled individual  $j$  accepts the firm's offer, if the obtained utility from wage decreased by the disutility from the required work effort,  $\kappa e_t^u$ , is greater or equal to the utility from unemployment benefits plus term  $\chi$  that captures two effects. If a negative social stigma from unemployment is the dominating effect, then  $\chi$  is negative; if the positive impact of having more time as an unemployed person is more prominent, then it has a positive value.

### Skilled households

In contrast to unskilled households, skilled households behave in a Ricardian manner and face a more complex optimization problem. Besides the labor-force participation,  $L_t^s$ , the skilled household also decides on the level of consumption,  $C_t^s$ ; investment,  $I_t^s$ ; bond purchases,  $b_t^s$ ; and supplied effort,  $e_t^s$ :

$$\max_{\{C_t^s(h), I_t^s(h), b_t^s(h), L_t^s(h), e_t^s(h)\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} (\beta^s)^t \left\{ \ln \left[ \zeta^s (C_t^s(h))^{\sigma^s} + (1-\zeta^s) (X_t^s(h))^{\sigma^s} \right]^{\frac{1}{\sigma^s}} - \frac{\Upsilon^s}{2} \left( \frac{L_t^s(h)}{L_t^{s,Ref}(h)} - 1 \right)^2 - (1-z_t^s(h)) L_t^s(h) (e_t^s(h) - n_t^s(h))^2 \right\}, \quad (8)$$

where all parameters and variables with superscript  $s$  have a similar meaning as their counterparts for unskilled households, and  $n_t^s$  denotes a social norm for the supply of effort. The optimization problem of skilled households is subject to: (i) the home production function:

$$X_t^s(h) = J_t (1 - L_t^s(h)), \quad (9)$$

(ii) capital accumulation equation, with depreciation rate of capital denoted as  $\delta$ :

$$K_{t+1}^s(h) = (1 - \delta)K_t^s(h) + I_t^s(h), \quad (10)$$

and (iii) their budget constraint:

$$\begin{aligned} C_t^s(h) + I_t^s(h) + b_t^s(h) &= (1 - \tau_t)[w_t^s(h)(1 - z_t^s(h)) + q_t^s z_t^s(h)]L_t^s(h) \\ &+ r_t^K K_t^s(h) + b_{t-1}^s(h) \frac{1+i_{t-1}}{\Pi_t} + d_t^s(h), \end{aligned} \quad (11)$$

where  $r_t^K$  is a real return on capital,  $i_t$  represents nominal interest rate,  $\Pi_t$  is the gross inflation rate, and  $d_t^s$  stands for real dividends. Again, similarly as in the case of unskilled households, we assume an external habit for labor force participation:  $L_t^{s,Ref}(h) = L_{t-1}^s$ .

The solution of the maximization problem leads to the following first-order conditions and optimality conditions for labor force participation and effort:

$$f_1(h, t) = \beta_s E_t \{f_1(h, t+1)(1 + r_{t+1}^K - \delta)\}, \quad (12)$$

$$f_1(h, t) = \beta_s E_t \left\{ f_1(h, t+1) \frac{1+i_t}{\Pi_{t+1}} \right\}, \quad (13)$$

$$f_2(h, t) + f_1(h, t)(1 - \tau_t)[w_t^s(h)(1 - z_t^s(h)) + q_t^s z_t^s(h)] = \frac{Y^s}{L_{t-1}^s} \left( \frac{L_t^s(h)}{L_{t-1}^s} - 1 \right), \quad (14)$$

$$e_t^s(h) = n_t^s(h), \quad (15)$$

where

$$f_1(h, t) = \frac{\zeta^s (c_t^s(h))^{\sigma^s - 1}}{\zeta^s (c_t^s(h))^{\sigma^s} + (1 - \zeta^s) [J_t (1 - L_t^s(h))]^{\sigma^s}}, \quad (16)$$

$$f_2(h, t) = \frac{-(1 - \zeta^s) (J_t)^{\sigma^s} (1 - L_t^s(h))^{\sigma^s - 1}}{\zeta^s (c_t^s(h))^{\sigma^s} + (1 - \zeta^s) [J_t (1 - L_t^s(h))]^{\sigma^s}}. \quad (17)$$

Unlike tasks for unskilled individuals, work tasks for skilled individuals are complex and hard to control. However, the amount of effort skilled individuals supply is known thanks to the social norm:

$$e_t^s(h) = n_t^s(h) = \phi_0 + \phi_1 \ln w_t^s(h) + \phi_2 \ln w_t^s + \phi_3 \ln w_{t-1}^s + \phi_4 \ln z_t^s + \phi_5 \ln q_t^s. \quad (18)$$

According to the social norm, one would expect  $\phi_1, \phi_4 > 0$ , i.e., skilled individuals supply more effort if they are given higher wages or experience a higher unemployment rate of their social class. On the other hand,  $\phi_2, \phi_3, \phi_5 < 0$ , since workers reduce their effort if the average wage of their social class increases in general, or in case of more generous unemployment benefits.

In what follows, we assume that all households are identical within their type. Therefore, we abstract from heterogeneity in consumption and asset holdings of individuals and households, thus we can drop any individual ( $j$ ) or household ( $h$ ) specific indices.

### Firms

In the model economy, we distinguish two production sectors. In the final-good sector, a price-taking representative firm buys intermediate goods and create bundles of final products, demanded by households, government, and intermediate-goods firms. Its optimization problem is a standard profit maximization problem:

$$\max_{Y_t(g) \forall g \in [0;1]} P_t Y_t - \int_0^1 P_t(g) Y_t(g) dg, \quad (19)$$

subject to

$$Y_t = \left[ \int_0^1 (Y_t(g))^{\frac{\theta-1}{\theta}} dg \right]^{\frac{\theta}{\theta-1}}, \quad (20)$$

where  $P_t(g)$  denotes the price of an intermediate good  $g$ ;  $P_t$  is the aggregate price level;  $Y_t(g)$  represents the production of an intermediate good  $g$ , and  $Y_t$  overall product;  $\theta$  is price elasticity. The solution to this problem has the form of the following demand function for intermediate goods:

$$Y_t(g) = \left( \frac{P_t(g)}{P_t} \right)^{-\theta} Y_t. \quad (21)$$

The intermediate-good sector is populated by a  $[0; 1]$  continuum of monopolistically competitive firms, where each firm ( $g$ ) has a standard Cobb-Douglas production function with constant returns to scale and the following inputs: technology, capital, effort, and employment ( $N_t^u$  for unskilled, and  $N_t^s$  for skilled workers). In addition, the technology follows a stochastic process.

$$Y_t(g) = A_t [K_t(g)]^\alpha [e_t^u(g) N_t^u(g)]^\gamma [e_t^s(g) N_t^s(g)]^{1-\alpha-\gamma}, \quad (22)$$

$$A_t = \exp(\epsilon_t^A), \quad (23)$$

$$\epsilon_t^A = \rho^A \epsilon_{t-1}^A + v_t^A. \quad (24)$$

The intermediate-good firm's optimization problem can be split into two parts. In the first part, the firm minimizes costs deciding about the size of capital and the number of workers to hire, what skilled and unskilled wages to offer, and how much unskilled effort to demand:

$$\min_{K_t(g), w_t^u(g), e_t^u(g), N_t^u(g), w_t^s(g), N_t^s(g)} r_t^K K_t(g) + w_t^u(g) N_t^u(g) + w_t^s(g) N_t^s(g), \quad (25)$$

subject to  $Y_t(g) \geq \bar{Y}_t(g)$  and equations (7), (18), and (22). As Šauer (2018) argues, inequality (7) has to be binding and therefore, can be rewritten as an effort function:

$$e_t^u(g) = \frac{1}{\kappa} \ln w_t^u(g) - \frac{1}{\kappa} \ln q_t^u - \frac{\chi}{\kappa}. \quad (26)$$

The resulting optimality conditions are as follows:

$$r_t^K = \alpha mc_t(g) \frac{Y_t(g)}{K_t(g)}, \quad (27)$$

$$N_t^u(g) = \gamma mc_t(g) \frac{Y_t(g)}{e_t^u(g)} \frac{\partial e_t^u(g)}{\partial w_t^u(g)}, \quad (28)$$

$$w_t^u = \gamma mc_t(g) \frac{Y_t(g)}{N_t^u(g)}, \quad (29)$$

$$N_t^s(g) = (1 - \alpha - \gamma) mc_t(g) \frac{Y_t(g)}{e_t^s(g)} \frac{\partial e_t^s(g)}{\partial w_t^s(g)}, \quad (30)$$

$$w_t^s(g) = (1 - \alpha - \gamma) mc_t(g) \frac{Y_t(g)}{N_t^s(g)}, \quad (31)$$

where  $mc_t$  stands for real marginal costs. Šauer (2018) shows that in the absence of the binding minimum wage, the optimal effort levels can be described as constant:  $e_t^u(g) = 1/\kappa$  and  $e_t^s(g) = \phi_1$ . This allows us to formulate wage equations using the effort functions (18) and (26) and the optimal level of effort. For skilled workers, the wage equation is of the following form:

$$\ln w_t^s = \Phi_0 + \Phi_1 \ln w_{t-1}^s - \Phi_2 \ln z_t^s + \Phi_3 \ln q_t^s, \quad (32)$$

where  $\Phi_0 = \frac{\phi_1 - \phi_0}{\phi_1 + \phi_2}$ ,  $\Phi_1 = \frac{-\phi_3}{\phi_1 + \phi_2} > 0$ ,  $\Phi_2 = \frac{\phi_4}{\phi_1 + \phi_2} > 0$ , and  $\Phi_3 = \frac{-\phi_5}{\phi_1 + \phi_2} > 0$ . For unskilled workers, in the absence of binding minimum wage, the wage is determined by the following expression:

$$w_t^{u,CM} = \exp(1 + \chi) q_t^u, \quad (33)$$

where  $w_t^{u,CM}$  denotes the unskilled wage that would arise in a competitive market. For the discussion on the role of optimal wages in this model, please refer to Šauer (2018).

In the second part of the intermediate-good firm's optimization problem, the firm takes the pricing decision to maximize its profit.

$$\max_{\{P_t(g)\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} (\beta^s)^t \frac{f_1(t) P_0}{f_1(0) P_t} \left\{ P_t(g) \left( \frac{P_t(g)}{P_t} \right)^{-\theta} Y_t - P_t m c_t(g) \left( \frac{P_t(g)}{P_t} \right)^{-\theta} Y_t - P_t \frac{\Xi}{2} \left( \frac{P_t(g)}{P_{t-1}(g)} - 1 \right)^2 \right\}. \quad (34)$$

Thanks to the fact that all intermediate-good firms make decisions in the same way, the resulting first-order condition can be written without the firm-specific index  $g$ :

$$Y_t(1 - \theta + \theta m c_t) + \beta^s \Xi E_t \left\{ \frac{f_1(t+1)}{f_1(t)} (\Pi_{t+1} - 1) \Pi_{t+1} \right\} = \Xi (\Pi_t - 1) \Pi_t. \quad (35)$$

## Government

The role of government in this model is defined by a set of equations that describe government consumption,  $G_t$ , and the unemployment benefits and minimum wage setting.

$$G_t = \bar{G} \exp(\epsilon_t^G), \quad (36)$$

$$\epsilon_t^G = \rho^G \epsilon_{t-1}^G + v_t^G, \quad (37)$$

$$q_t^u = \eta^u \exp(\epsilon_t^\eta) w_t^s, \quad (38)$$

$$q_t^s = \eta^s \exp(\epsilon_t^\eta) w_t^s, \quad (39)$$

$$\epsilon_t^\eta = \rho^\eta \epsilon_{t-1}^\eta + v_t^\eta, \quad (40)$$

$$w_t^{min} = (1 + \lambda) \exp(\epsilon_t^\lambda) w_t^{u,CM}, \quad (41)$$

$$\epsilon_t^\lambda = \rho^\lambda \epsilon_{t-1}^\lambda + v_t^\lambda. \quad (42)$$

Parameters  $\eta^u, \eta^s$  represent replacement rates for unskilled and skilled workers, respectively. The minimum wage is binding only for the unskilled labor market, i.e.,  $w_t^{u,CM} \leq w_t^{min} \leq w_t^s$ , parameter  $\lambda (> 0)$  represents a wedge between the minimum and the competitive unskilled wage set by the government. As a consequence, all occurrences of  $w_t^u$  in previous sections should be substituted with  $w_t^{min}$ . Finally, the government also faces the following budget constraint and adjusts the income tax to keep the budget balanced in every period:

$$\tau_t w_t^{\min} N_t^u + \tau_t w_t^s N_t^s = G_t + \bar{b} \left( \frac{1+i_t-1}{\pi_t} - 1 \right) + (1 - \tau_t) q_t^u (\omega L_t^u - N_t^u) + (1 - \tau_t) q_t^s [(1 - \omega) L_t^s - N_t^s],$$

(43)

where  $\bar{b}$  expresses the government's objective to hold a constant real debt over the business cycle.

### III. Calibration and methodology

We calibrate the model described in the previous section to reflect specific characteristics of the Czech economy and, more importantly, its labor market. The summary of the benchmark calibration of selected parameters can be found in Table 1. The share of the unskilled households,  $\omega$ , is calibrated using the economy-wide, the unskilled, and the skilled labor force participation rate and the corresponding unemployment rate averages for the year 2019 from the CZSO database. As the unskilled labor force, we consider individuals with at most the lower secondary education (ISCED 0-2, which corresponds to the Eurostat's "low education" category), the rest of the population forms the skilled labor force. The reason behind this dichotomy lies in the model logic and structure, only unskilled individuals are paid minimum wage, and all the unskilled individuals are paid only the minimum wage for their work effort. We also use information about the proportion of employees working for the minimum wage as of 2014, from Eurostat (2020). Details on the computation of the parameter value can be found in (Šauer, 2018). Replacement rates,  $\eta^u, \eta^s$ , roughly match the Czech unemployment benefit system concerning the decreasing amount of unemployment benefits for subsequent months of unemployment and the limit for high-income workers. The replacement rate for unskilled workers is based on the information about skilled wage proxied as the gross average wage in the Czech Republic in 2019. The values of the remaining parameters presented in Table 1 are taken from the literature, mainly based on (Aliyev et al., 2014) and (Brůha & Polanský, 2014). All the other model parameters are set in line with the initial setting presented in (Šauer, 2018).

**Table 1 Overview of the benchmark calibration of model parameters**

Description	Parameter	Value
Share of the unskilled households	$\omega$	0.0967
Replacement rate – unskilled households	$\eta^u$	0.22
Replacement rate – skilled households	$\eta^s$	0.50
Discount factor – skilled households	$\beta^s$	0.99
Capital share	$\alpha$	0.53
Capital depreciation rate	$\delta$	0.015
Smoothing parameter in the monetary policy rule	$\psi_i$	0.52
Inflation weight in the monetary policy rule	$\psi_\pi$	0.5
Unemployment gap weight in the monetary policy rule	$\psi_z$	0.5

*Source: Own calculation*

Table 2 presents the steady-state values that are based on information obtained from Czech macroeconomic indicators. The given steady-states are average values for available data from

2019. Steady-state value for the nominal interest rate is based on an average from 3-month interest rate PRIBOR rates in 2019. The steady-state value for the tax rate is based on tax quota data. Finally, to compute the minimum to skilled workers wage ratio, we again used the gross average wage in the Czech Republic in 2019 as a proxy for the skilled worker wage. The remaining steady-state values are expressed as functions of model parameters and other steady-state values.

To evaluate the impacts of alternative minimum wage setting, we carry out a set of model simulations based on changes in the steady-state values of the minimum wage ratio and the share of the low-skilled workers (households) operating under minimum wage framework. We simulate the dynamic response of the selected variables (consumption, labor force participation, unemployment, and output) on the shocks in technology,  $v_t^A$ , minimum wage,  $v_t^\lambda$ , and unemployment benefits,  $v_t^\eta$ , using the Dynare toolbox (version 4.6.1) for MATLAB by Adjemian et al. (2011). The corresponding impulse response function is evaluated concerning the benchmark-setting of the model. We aim at the relative differences of the responses and the cumulative impacts of the shocks at selected variables. The standard deviation of the shocks is set at the value of  $\log(1.2)$ . This value corresponds to the 20 % increase in the shocks.

**Table 2 Data-driven steady-state values**

Description	Variable	Source	Value
Consumption to GDP ratio	$\bar{C}/\bar{Y}$	Eurostat*	0.505
Investment to GDP ratio	$\bar{I}/\bar{Y}$	Eurostat*	0.280
Government expenditure to GDP ratio	$\bar{G}/\bar{Y}$	Eurostat*	0.215
Debt to GDP ratio	$\bar{b}/\bar{Y}$	Eurostat	0.308
Economy-wide labor force participation rate	$\bar{L}$	CZSO	0.600
Labor force participation rate – unskilled households	$\bar{L}^u$	CZSO (ISCED, 0-2 cat.)	0.208
Labor force participation rate – skilled households	$\bar{L}^s$	CZSO (ISCED, >2 cat.)	0.642
Economy-wide unemployment rate	$\bar{z}$	CZSO	0.022
Unemployment rate – unskilled households	$\bar{z}^u$	CZSO (ISCED, 0-2 cat.)	0.107
Unemployment rate – skilled households	$\bar{z}^s$	CZSO (ISCED, >2 cat.)	0.019
Nominal interest rate	$\bar{r}$	CNB	0.021
Tax rate	$\bar{\tau}$	OECD	0.353
Minimum to skilled worker wage ratio	$\bar{w}^{min}/\bar{w}^s$	CZSO	0.391

*\*Adjusted for the closed economy model*

*Source: Own calculation*

Our simulations are based on seven scenarios, as depicted in Table 3. These scenarios cover the possible increase and decrease of the minimum wage (measured as the ratio to the wage of skilled workers) and the increase of the share of unskilled workers in the economy.

**Table 3 Overview of the simulated scenarios**

Minimum wage ratio, $\bar{w}^{min}/\bar{w}^s$	Labor share of the unskilled workers, $\omega$	
	no change	doubled
-5 %	scenario 1 (Sim1)	scenario 5 (Sim5)
no change	benchmark	scenario 4 (Sim4)
+5 %	scenario 2 (Sim2)	scenario 6 (Sim6)
+10 %	scenario 3 (Sim3)	scenario 7 (Sim7)

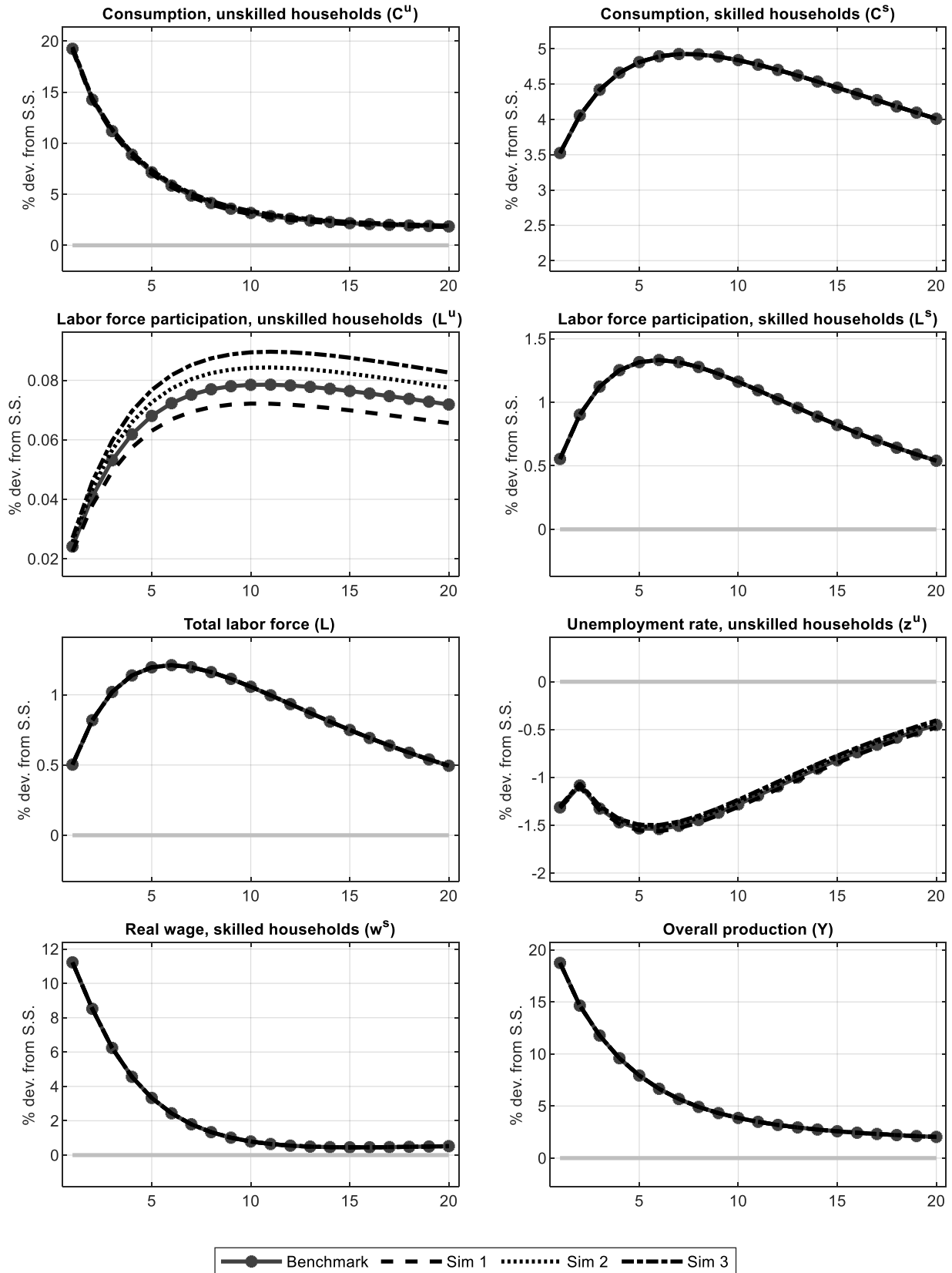
*Source: Own calculation*

#### IV. Results

Figure 1 and Figure 2 present the impulse response functions to the positive technology shock. The minimum wage changes do not affect the responses of the key macroeconomic variables (overall production, consumption, real wage, and total labor force). The main differences are connected with the labor force participation of the unskilled workers (households). The technology shocks increase the willingness of the unskilled workers to get employed concerning the increase in the minimum wage ratio. Positive technology shock contributes to the lower unemployment rate among unskilled workers. The unemployment gap is slightly deeper when considering the decrease in the minimum wage ratio. The relative increase of the minimum wage leads to a higher participation rate, but this increase is better accommodated at the labor market with a lower minimum wage.

The results depend on the share of unskilled household members. When considering the twice as big share of the unskilled workers in the economy, one can see that the technology shock influences the growth of the total labor force with less intensity in comparison with the benchmark model. The reason is that the reaction of the labor force participation of the skilled workers is much higher than the response of the unskilled employees (almost 1.5 % at maximum in comparison with less than 0.1 percent of unskilled workers). The doubled share of the unskilled labor force damped the decrease in the unemployment rate. On the other hand, it amplified the response of labor force participation in all scenarios that consider the minimum wage change.

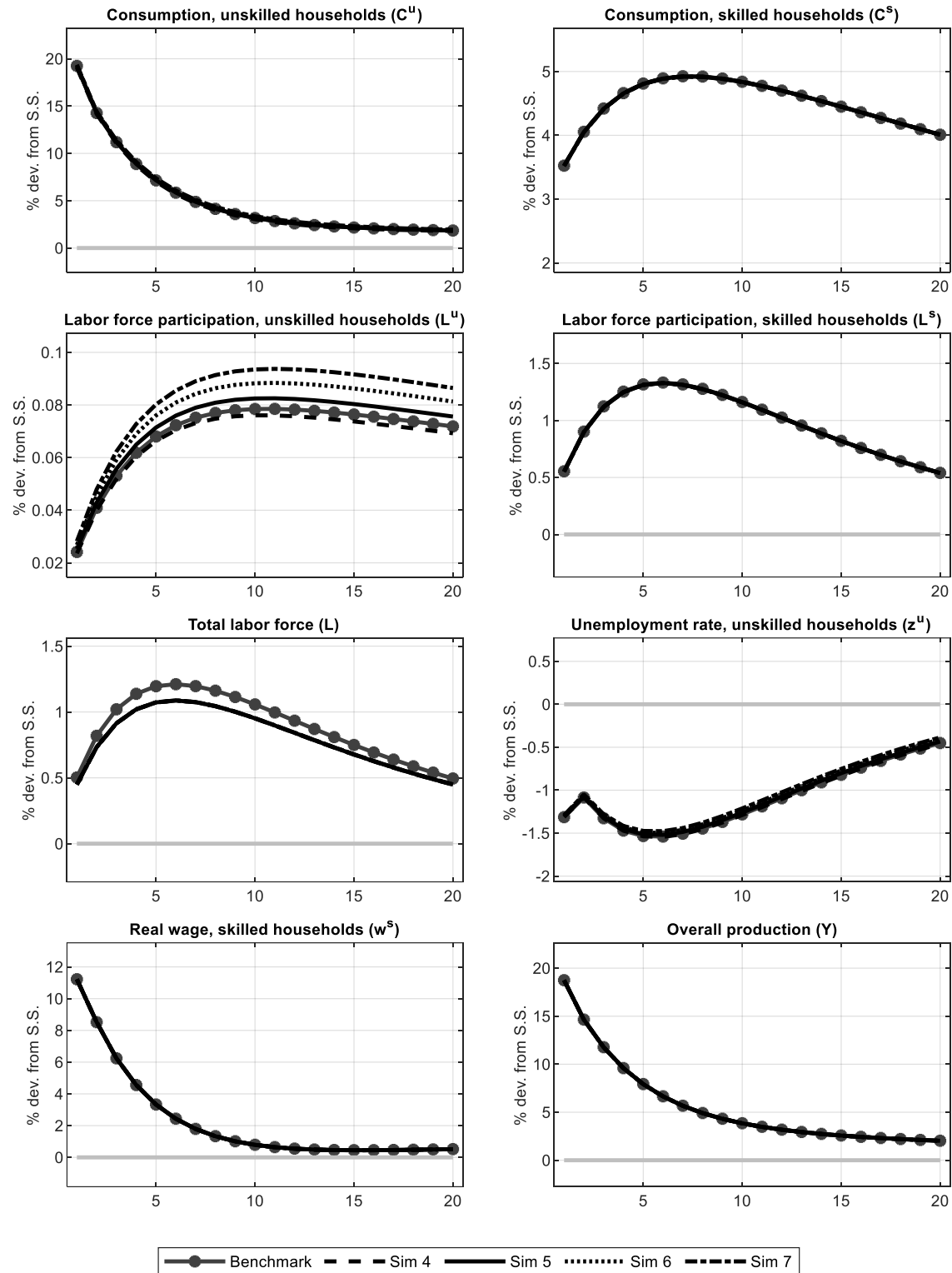
Figure 1 Impulse responses to a technology shock



Source: Own calculation

Benchmark: benchmark scenario; Sim1:  $\bar{w}^{min}/\bar{w}^s$  reduced by 0.05; Sim2:  $\bar{w}^{min}/\bar{w}^s$  increased by 0.05; Sim3:  $\bar{w}^{min}/\bar{w}^s$  increased by 0.1.

Figure 2 Impulse responses to a technology shock with double the share of unskilled households



Source: Own calculation

Benchmark: benchmark scenario; Sim4: share of unskilled households ( $\omega$ ) doubled; Sim5: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{min}/\bar{w}^s$  reduced by 0.05; Sim6: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{min}/\bar{w}^s$  increased by 0.05; Sim7: share of unskilled households doubled ( $\omega$ ) and  $\bar{w}^{min}/\bar{w}^s$  increased by 0.1.

Figure 3 and Figure 4 show the impulse response functions related to the positive shock to minimum wage. The increase of the minimum wage (or better to say possible overestimation of the minimum wage above the competitive wage) has a positive impact on the relative growth of the consumption of the unskilled households (8 % to 11 %). This increase is indirectly related to the changes in the minimum wage ratio. The same holds to the response of labor force participation. The increased minimum wage creates incentives to the unskilled households for participating in labor activities, although the increase is relatively small (about 0.04 percent at maximum). The minimum wage increase above the competitive wage causes pressure on the real wage growth of skilled workers (0.15 %). It slightly dampens down the economic activity and negatively increases the unemployment rate gap of the unskilled labor force (more than 15 %). The economic slowdown is accompanied by a decrease in the consumption of skilled households. All these mechanisms are stronger when considering the higher share of the unskilled workers in the economy.

Figure 5 and Figure 6 present the impulse response functions to the positive shock to unemployment benefits. The responses are similar to the impacts of minimum wage shock. One can observe a more significant drop in the consumption of skilled households. This result stems from the fact that the fall of the output is sharper, and the unemployment benefits need to be financed by the government revenues and the increased income tax.

**Table 4 Cumulative shock impacts in 20 periods (% deviation from steady-state)**

Technology shock ( $v_t^A$ )								
Variable \ Scenario	Benchmark	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$C_t^u$	104,43	102,12	106,21	107,63	102,26	104,52	106,27	107,64
$C_t^s$	89,95	89,96	89,93	89,92	89,95	89,92	89,89	89,86
$L_t^u$	1,39	1,27	1,49	1,58	1,34	1,46	1,56	1,65
$L_t^s$	19,48	19,48	19,47	19,47	19,44	19,43	19,42	19,41
$L_t$	17,73	17,72	17,73	17,74	15,94	15,95	15,97	15,98
$z_t^u$	-21,83	-22,31	-21,39	-20,99	-21,96	-21,46	-21,01	-20,6
$w_t^s$	46,27	46,28	46,27	46,26	46,22	46,21	46,2	46,19
$Y_t$	114,14	114,15	114,12	114,11	114,02	113,99	113,96	113,92
Shock to minimum wage ( $v_t^L$ )								
$C_t^u$	39,71	45,19	35,41	31,95	45,43	39,93	35,62	32,14
$C_t^s$	-0,15	-0,14	-0,16	-0,16	-0,37	-0,39	-0,4	-0,42
$L_t^u$	0,59	0,63	0,56	0,53	0,67	0,62	0,59	0,56
$L_t^s$	0,13	0,13	0,13	0,12	0,23	0,23	0,22	0,22
$L_t$	0,17	0,18	0,17	0,16	0,31	0,3	0,29	0,28
$z_t^u$	66,44	66,61	66,3	66,18	66,63	66,45	66,3	66,17
$w_t^s$	0,11	0,11	0,11	0,1	0,24	0,23	0,22	0,21
$Y_t$	-0,02	-0,01	-0,03	-0,04	-0,07	-0,09	-0,11	-0,13
Shock to unemployment benefits ( $v_t^B$ )								
$C_t^u$	42,99	49,31	38,01	34	48,91	42,47	37,39	33,27
$C_t^s$	-1,27	-1,21	-1,33	-1,4	-1,97	-2,1	-2,24	-2,37
$L_t^u$	0,64	0,69	0,6	0,56	0,72	0,67	0,62	0,58
$L_t^s$	0,04	0,05	0,03	0,01	0,02	-0,01	-0,03	-0,06
$L_t$	0,1	0,12	0,08	0,07	0,16	0,12	0,09	0,06
$z_t^u$	68,02	68,2	67,86	67,73	68,38	68,2	68,04	67,91
$w_t^s$	0,84	0,88	0,81	0,77	0,76	0,69	0,61	0,54
$Y_t$	-1,46	-1,38	-1,54	-1,62	-2,08	-2,25	-2,43	-2,6

Source: Own calculation based on model impulse response functions

*Benchmark: benchmark scenario; Sim1:  $\bar{w}^{\min}/\bar{w}^s$  reduced by 0.05; Sim2:  $\bar{w}^{\min}/\bar{w}^s$  increased by 0.05; Sim3:  $\bar{w}^{\min}/\bar{w}^s$  increased by 0.1; Sim4: share of unskilled households ( $\omega$ ) doubled; Sim5: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{\min}/\bar{w}^s$  reduced by 0.05; Sim6: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{\min}/\bar{w}^s$  increased by 0.05; Sim7: share of unskilled households doubled ( $\omega$ ) and  $\bar{w}^{\min}/\bar{w}^s$  increased by 0.1.*

Table 4 depicts the cumulative responses of the model variables to the selected shocks. The variables  $L_t^u$ ,  $L_t^s$ ,  $L_t$ , and  $z_t^u$  are stock variables and cannot be interpreted directly as the cumulative sums of responses. We will thus focus on their average one-period values. The cumulative responses follow the mechanisms described in the previous paragraphs. The minimum wage shock and the shock to unemployment benefits have similar impacts on the unemployment rate of unskilled workers. Both shocks increase the average one-period unemployment rate by 3.2 to 3.4 percent. The growth of unemployment benefits harms the economy more than the growth (overvaluation) of the minimum wage. The cumulative decrease of the economy ranged from 0.01 % to 0.13 % when the minimum wage increases, and from 1.38 % to 2.6 % when the unemployment benefits grow. Both impacts are amplified by the higher share of the unskilled workers in the economy and by the higher minimum wage ratio.

The increased minimum wage ratio has a negligible cumulative impact on the total output when evaluating the shock in the technology. The difference in the one-period average unemployment rate is 0.06 percent at maximum (when comparing the benchmark model and the scenario 7 that assumes the increase in both the minimum wage ratio and the share of unskilled workers).

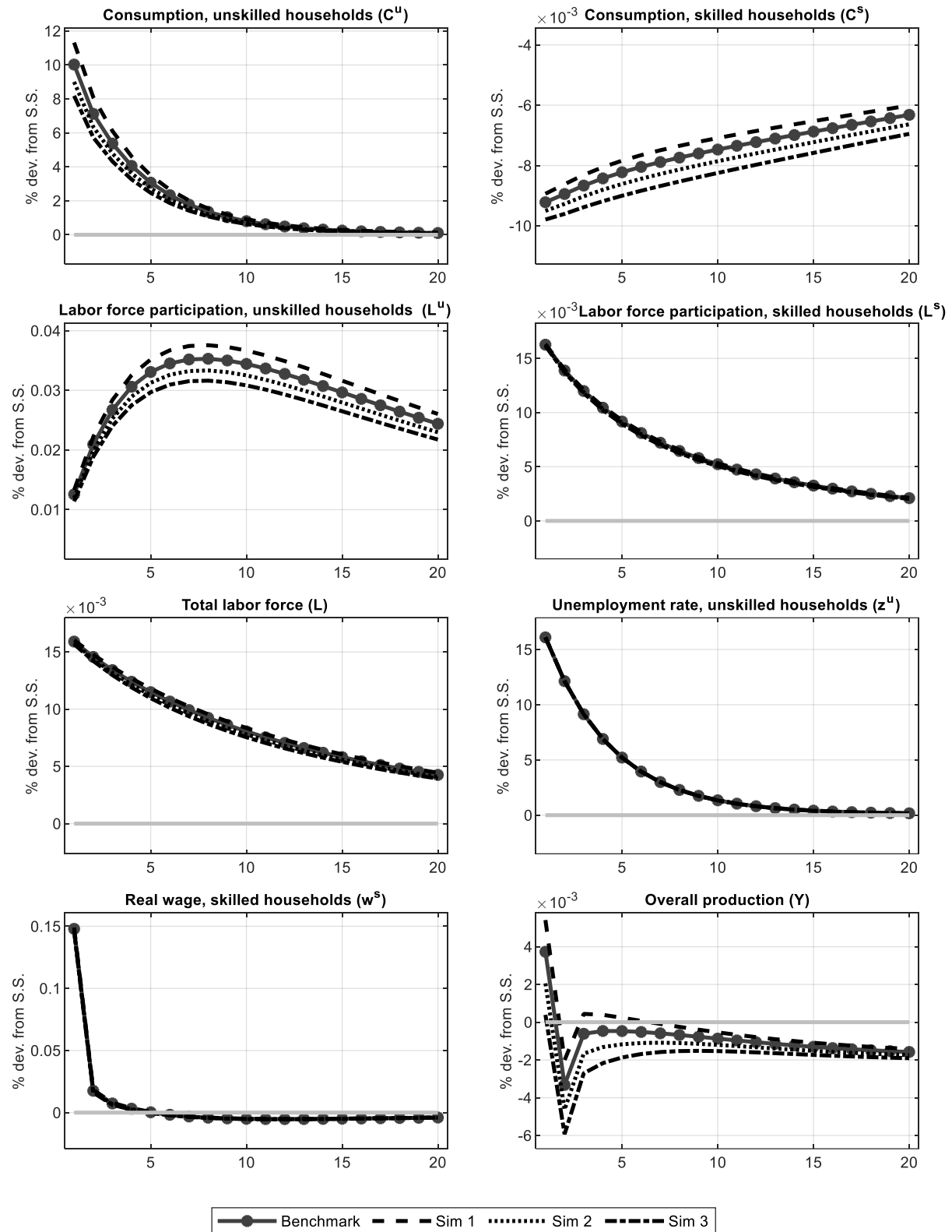
## V. Conclusion

In this paper, we have evaluated the impacts of alternative statutory minimum wage settings on the dynamics of the Czech economy and its labor market. We have used the DSGE model, as proposed by Šauer (2018), that allowed for an analysis of the macroeconomic impacts of the minimum wage setting. We have investigated the effects of alternative minimum wage settings by carrying out a set of model simulations based on changes in the steady-state values of the minimum wage ratio and an increase in the share of the low-skilled households operating under minimum wage framework. We have simulated the dynamic response of the selected variables (consumption, labor force participation, unemployment, and output) on the shocks in technology, minimum wage, and unemployment benefits. We have then compared the corresponding impulse response functions to the benchmark-setting of the model, corresponding to the current situation in the Czech labor market. We have focused on the relative differences of the responses and the cumulative impacts of the shocks at selected variables.

Based on our analysis, the increase in the minimum wage does not seem to have any adverse effect on the key macroeconomic indicators in their response to a positive technology shock. The cumulative impact of increased minimum wage ratio to the reaction of the overall output of the economy to a technology shock is negative but negligible. An increase in the minimum wage ratio only leads to a more prominent response in the labor force participation of the unskilled households, where higher the minimum wage ratio higher their willingness to participate in the labor market. Overvaluation in the minimum wage creates another stimulus for unskilled households to increase their labor force participation. However, their reaction is somewhat muted and indirectly related to the minimum wage ratio. According to the presented impulse response functions, both the possible overestimation of the minimum wage above the competitive wage and shock to unemployment benefits, lead to similar consequences regarding the labor market dynamics. The same does not hold for the overall output, where the growth of unemployment benefits causes it to decline more significantly when compared to the effect of the minimum wage increase.

Although the minimum wage setting does not seem to have any significant adverse effect on the overall economy, one has to bear in mind the costs of an increase in the minimum wage are higher with the increasing minimum wage ratio and the share of workers being subject to minimum wage setting. Thus, our findings can be of particular importance for policymakers given the ongoing discussion on the coordinated European Union minimum wage policy, which should fully respect the consequences as mentioned above.

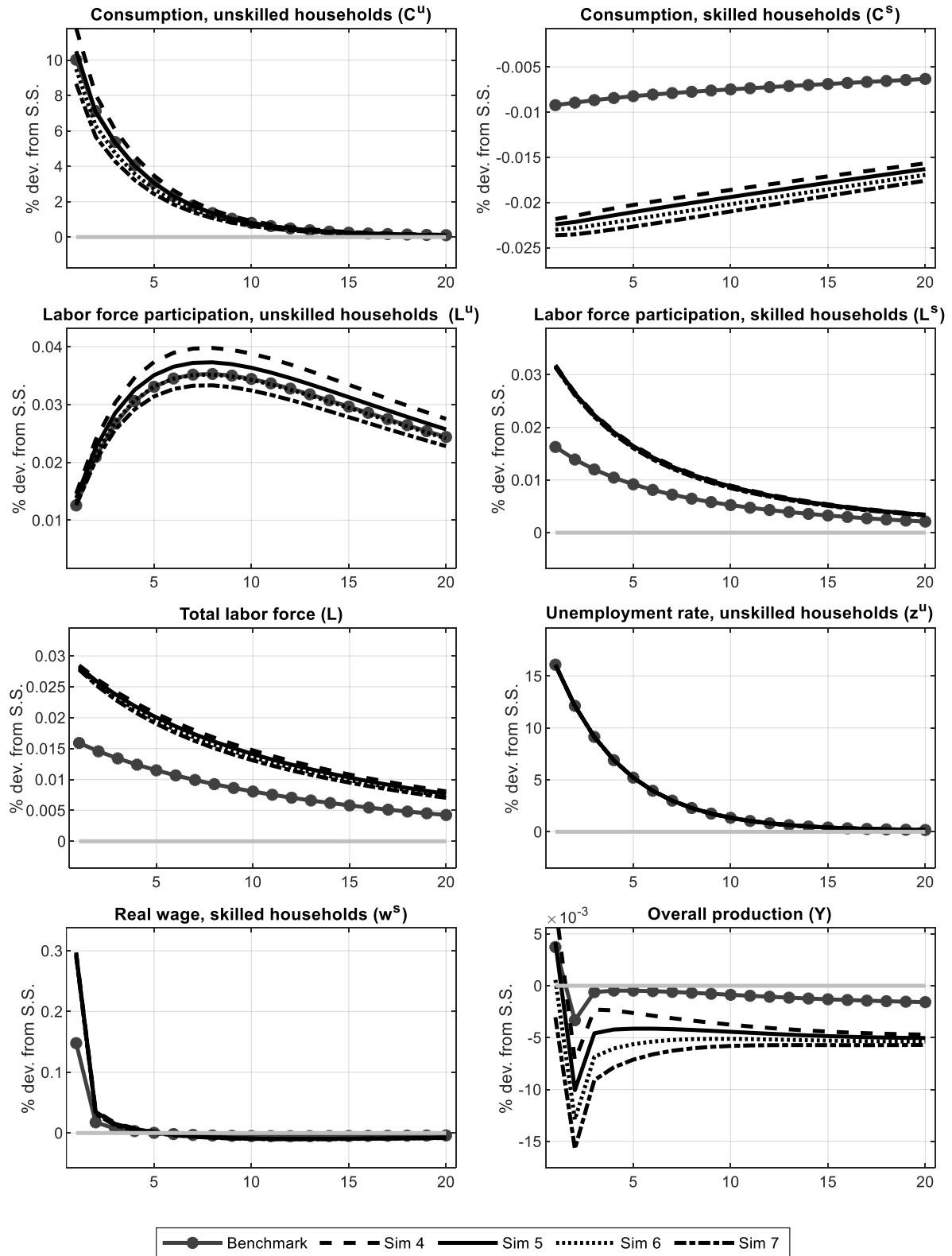
Figure 3 Impulse responses to a minimum wage shock



Source: Own calculation

Benchmark: benchmark scenario; Sim1:  $\bar{w}^{min}/\bar{w}^s$  reduced by 0.05; Sim2:  $\bar{w}^{min}/\bar{w}^s$  increased by 0.05; Sim3:  $\bar{w}^{min}/\bar{w}^s$  increased by 0.1.

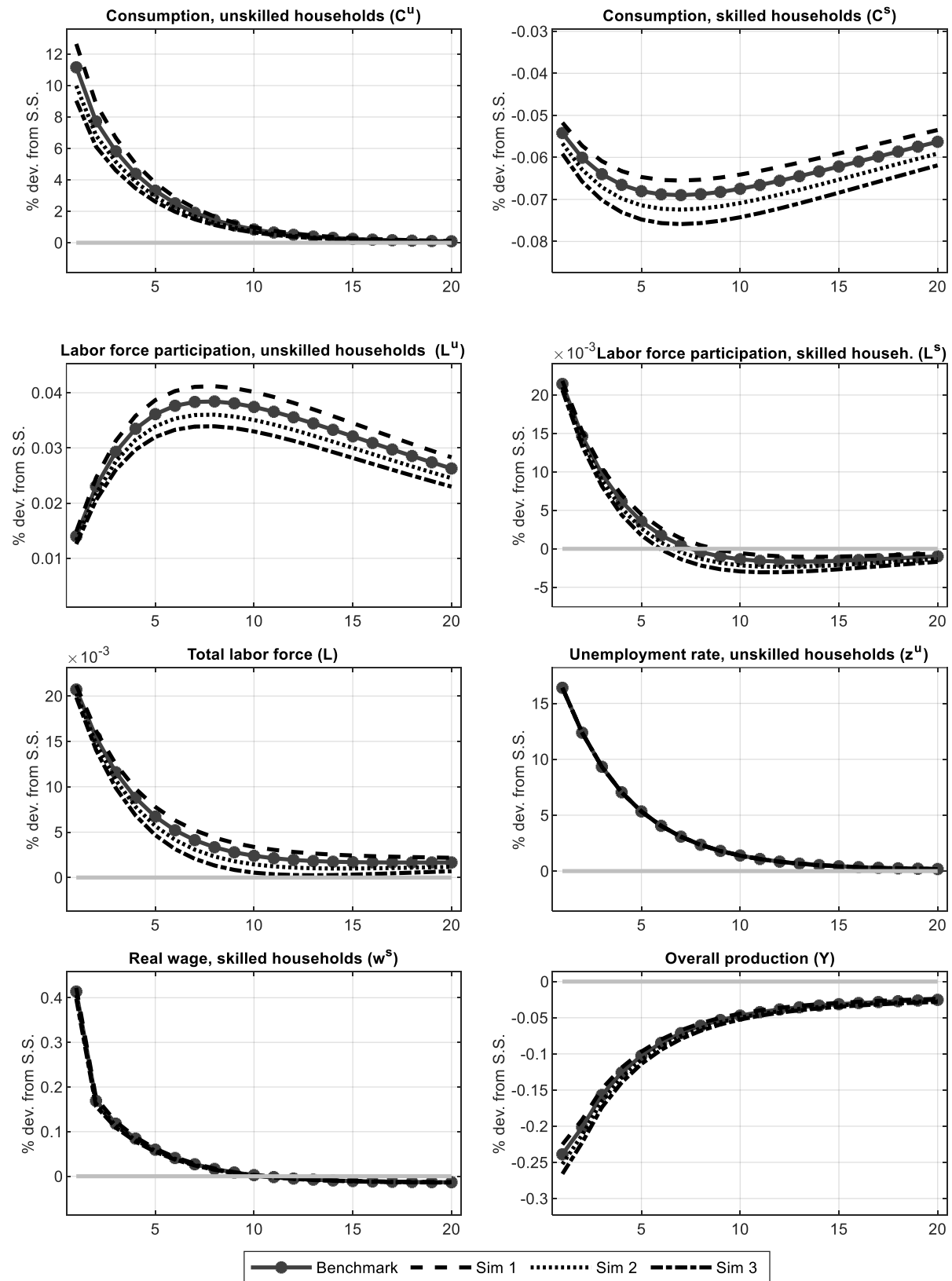
Figure 4 Impulse responses to a minimum wage shock with double the share of unskilled households



Source: Own calculation

Benchmark: benchmark scenario; Sim4: share of unskilled households ( $\omega$ ) doubled; Sim5: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{min}/\bar{w}^s$  reduced by 0.05; Sim6: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{min}/\bar{w}^s$  increased by 0.05; Sim7: share of unskilled households doubled ( $\omega$ ) and  $\bar{w}^{min}/\bar{w}^s$  increased by 0.1.

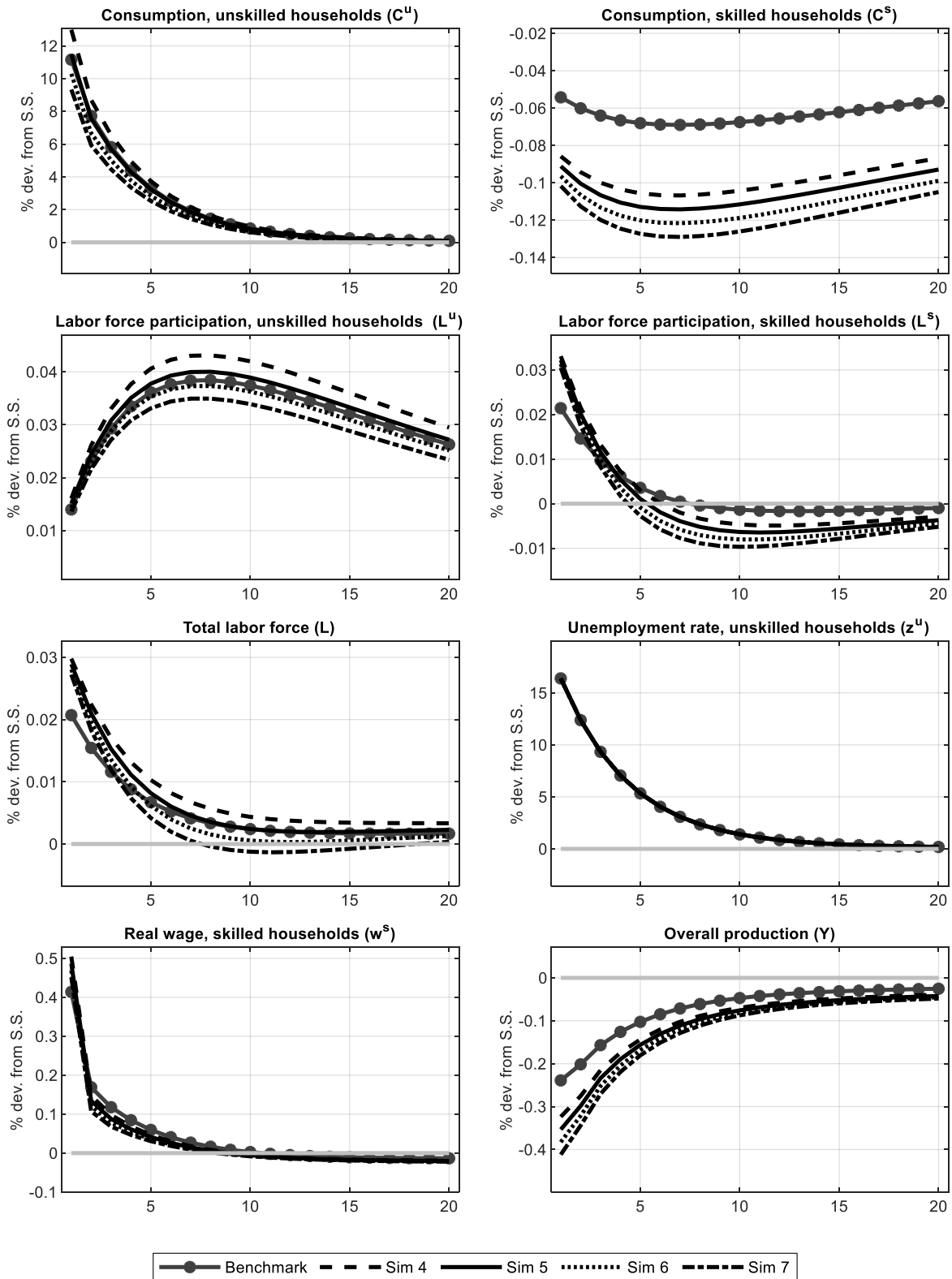
Figure 5 Impulse responses to a shock to unemployment benefits



Source: Own calculation

Benchmark: benchmark scenario; Sim1:  $\bar{w}^{min}/\bar{w}^s$  reduced by 0.05; Sim2:  $\bar{w}^{min}/\bar{w}^s$  increased by 0.05; Sim3:  $\bar{w}^{min}/\bar{w}^s$  increased by 0.1.

**Figure 6** Impulse responses to a shock to unemployment benefits with double the share of unskilled households



Source: Own calculation

Benchmark: benchmark scenario; Sim4: share of unskilled households ( $\omega$ ) doubled; Sim5: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{min}/\bar{w}^s$  reduced by 0.05; Sim6: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{min}/\bar{w}^s$  increased by 0.05; Sim7: share of unskilled households ( $\omega$ ) doubled and  $\bar{w}^{min}/\bar{w}^s$  increased by 0.1.

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