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Unemployment Fiscal Multiplier in a Small Open Economy with Labor Market Frictions

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Abstract

This study investigates unemployment fiscal multiplier in a small open economy with labor market frictions. Some key parameters were chosen to be consistent for Hungarian economy. The labor relations are constructed similar to the Mortensen, Pissaridies (1999) framework. I allowed three different and independent shocks (foreign output, government expenditure, productivity). The results for each of them are separately discussed and compared with other papers. Unemployment and fiscal multipliers for different horizon were calculated. Both of them are less than one for the long and short runs.

Keywords: Labor market frictions, unemployment fiscal multiplier, small open economy.

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1 Introduction

The last financial crisis started in 2008 was the source of the recent debate over the impact of the fiscal policies. Many alternative models have been proposed to discuss the impact of government expenditure. Most studies have been conducted using New Keynesian (NK) model. The presence of nominal rigidities has made the NK model the preferred tool for policy authorities. This model has been accepted and applied as the most perfect model for decades. This success might be viewed as somehow very surprising if the paradigm was considered about unemployment. The problem is that the NK model typically does not generate movements in unemployment but only causes voluntarily motions in hours worked and employment[1]. Inefficiency in the labor sphere provided by NK models seemed unsolvable. On the other hand, Diamond-Mortensen-Pissarides (DMP) model has become a useful tool to investigate labor market dynamics. The belief that hybrid model may give more reliable results played important role in the development of models with labor market frictions. Models with such characteristics have been started to be used widely, especially recent few years to obtain vital policies in different fields of economics. Especially after 2008 crises attention by governments to the regulation of unemployment was one main stimulus to use models with labor market frictions.

In my thesis, I investigate unemployment fiscal multiplier in a small open economy with labor market frictions. As a reference country I took Hungary. Some key parameters were calibrated to be consistent for Hungarian economy. The main research question is "How big is the change in unemployment rate for given one percent increase in government expenditure?"

[1] Blanchard and Gali (2006)

NK model with matching frictions extension is used many times for different types of economy (close, open and small open) to investigate different rules and policies. My aim in this thesis is to enrich literature exploring one simple case and to find unemployment effects of fiscal stimulus for Hungarian economy.

After solving the model fiscal multipliers were computed for long and short runs. Both of them are less than 1. The results I obtained seem consistent with the existing economic literature. The effect of fiscal multipliers is dampened in the models with non-Walrasian labor market which is the case in my thesis. Moreover, letting economy be open negatively affects the magnitude of multipliers in its place.

The structure of the thesis is organized as follows. In the section 2 the background information about the model and the method is provided giving examples from variety of papers. In the section 3 the model is constructed and parameters are assigned. Section 4 provides impulse response and the discussion of reliability of results with respect to other works. The final section concludes.

2 Literature review

The presence of nominal rigidities has made the NK model the preferred tool to investigate economic policies. On the other hand, DMP model has become a useful tool to investigate labor market dynamics. Blanchard and Gali (2006) combine these 2 strands of research: the NK model with its focus on nominal rigidities and the DMP model with its focus on labor market frictions and unemployment. They explain the intuition behind the consolidation of the models which served to different economic aims for a long time by stating that variations in the unemployment are an important aspect of fluctuations in the economy and labor market frictions and the nature of wage bargaining are central in understanding movements in unemployment.

The model constructed by them includes labor market frictions, real wage rigidities and staggered price rigidities. In their work some very important results were obtained. Under concave preferences assumptions technological shocks cannot generate any fluctuations in (un)employment. However, after extending the model with labor market and real wage rigidities changes in the current or anticipated productivity causes labor market tightness to vary. The changes in the labor market tightness is followed by variation in unemployment, in particular rise in productivity increases labor market tightness which in its turn is pursued a decrease in unemployment.

By extending the model with sticky prices they showed it is possible to get the relation of inflation and unemployment. Inflation negatively depends on both level and the change in unemployment rate. This fact requests making amendments to the monetary policies. This is

because the strict inflation targeting which is widely used by central banks does not take into consideration this relationship. Based on this new analysis they suggest that optimal monetary policy should be such that was able to minimize weighted average of unemployment and inflation fluctuations.

One of the most recent and influential works in this sphere is a paper by Monicelli, Perotti, Trigari (2010). The main problems they investigated in their paper are the effect of government spending shocks on hiring, unemployment and output. Beside these some other features like the role of wealth effect, labor supply, wage rigidity, distortionary taxation and government debt financing were also discussed. The whole paper can be divided into roughly two parts. The first one is the empirical part. In the first section a VAR model was estimated in order to analyze the effect of fiscal policy on labor market variables. Empirical results can be summarized as follows: in response to an increase in government spending shock normalized to 1 percent of GDP unemployment multiplier is about -0.6 at peak, employment is 1.5 percent at peak. Moreover, response of real wage productivity is 2.5%, the shock caused fall in the mark up by about 1.5 percent.[2] The second part is the theoretical. In this section the model employed to analyze the economy. Matching happens in the form of Cobb – Douglas function from vacancies and unemployment. Each firm uses capital and labor to produce goods. Production is also in the form of Cobb – Douglas function. Households act like "big family" assumption. In this part the magnitude of the response of the fiscal multipliers to the government expenditure shock depends on a key factor $\overline{w}$. $\overline{w}$ varies between 0.4 and 1. This parameter is the steady state relative value of non-work activity. The respond of output multiplier is quite small, largely below 1. It is equal to

[2] Monicelli, Perotti, Trigari (2010)

0.2 if $\overline{w}$ set sufficiently high. Unemployment multiplier also depends on $\overline{w}$. However, if $\overline{w}$ is set close to one it is possible to get unemployment fiscal multiplier very close to the estimate from empirical analysis[3].

The paper by Faia (2006) aimed to study the optimal monetary policy in a model with sticky prices and non-Walrasian labor market. The constructed economy is characterized with monopolistic competition under Rotemberg style quadratic adjustment costs and with matching frictions and wage rigidity. The search for new workers is costly and wage is determined through Nash bargaining process. Firms do not produce here single good but a variety of goods. Comparing welfare loss under different pattern rules, in the paper it was conclude that central banks should deviate from applying simple Talor rule. The reason for that is fact that unemployment causes increase in the marginal cost. A typical rule should consider unemployment effect also. Therefore, a rule is able to do unemployment inflation trade-off is the optimal. And this is the rule which calls for unemployment targeting along with inflation targeting.

In their paper Jakab and Konya (2008) developed quiet rich model to examine the impact of introducing search and matching frictions to the Hungarian economy. The model employed by them is the small open economy extended by labor market rigidities. It is simplified version of Jakab and Vilagy (2007) despite of labor market part. Economy has two final good sectors; one producing for domestic market, the other for export. All final goods are produced using capital, imported and domestically produced intermediate goods. All of the imported goods are

[3] Monicelli, Perotti, Trigari (2010)

intermediates. Domestic intermediates are produced only using labor, where matching happens. They applied Bayesian estimation using quarterly data from 1995Q2 to 2007Q2.

Impulse responses were calculated by allowing 7 type separate shocks (productivity, labor supply, demand, monetary policy, price mark up, (cost push), risk premium and activity shock). Introducing of non – Walrasian labor market created a real frictions which caused limited impact of labor market variables (hours, employment and wages) on the other variables of the model compared with Jakab and Vilagy (2007).Thus, under searching and matching frictions need for nominal rigidities is not high to explain fluctuations in inflation and real variables.

A paper by Bruckner and Pappa (2010) investigates the response of unemployment to expansionary government policy. Their paper covers empirical and theoretical parts. In the empirical part they construct a VAR model to investigate the effect of government fiscal policy in ten OECD countries.

The theoretical part is constructed using non-Walrasian labor market. The economy is closed and firms use capital beside labor as their input. The main specification of this paper is related with matching function. They use an assumption proposed by Lindbeck and Snower (1988). The assumption is that unemployment occurs in equilibrium because some agents called outsiders cannot sell their labor as much as they want. There are also insiders in the economy. These people lose their job by certain rate and enter to unemployment period.
They may find new job, remain unemployed or become outsider. The paper carries the heterogeneity of agents to the matching function.

Albertini, Kamber, Kirker (2010) used a small open economy with labor market frictions to estimate the model of the economy of New Zealand using Bayesian estimation. The economy

consists of three sectors, intermediate, retail and import sectors. Market for intermediates is perfectly competitive, but import sector and domestic retailers act in a monopolistic environment and face quadratic adjustment costs. Matching takes place in the domestic intermediate sector. Employment is the sum of old workers (keeping their position at least more than one period) and new matches. This specification allows a worker lose his job and find a new one during one period. Labor adjustments happen through extensive margin (employment) and intensive margin (hours).

The main question of the paper by Campolmi, .Faia, Winkler (2010) is weather strong stimuli can defeat recession. They employed the New Keynesian model with labor market frictions and exogenous job separation to explore the research question. The economy is closed and populated by continuum of agents normalized to one. They consume, work and save. A worker can either be employed or unemployed. As in Andalfatto (1996) and Merz(1995) a worker can insure himself against unemployment and wage uncertainty. Matching is standard Cobb - Douglas function happens in monopolistic good sector. They calculated fiscal multipliers for long and short run considering two alternative fiscal packages. Moreover, effect of financing was also explored. Robustness of result checked letting different starting scenario, different values for price rigidity, wage rigidity, fixed interest rate and endogenous labor market participation.

3 Model

3.1 Economic environment

The model I construct to study the effect of government spending shock is a small open economy DSGE model with labor market matching frictions. Domestic decision policies have no impact on the rest of the world. I assume that all countries share identical preferences, technology and market structure. In the domestic, there is non–Walrasian labor market. Posting new vacancies is costly. Following the convention in the literature, I assume that new hires happen in the form of Cobb – Douglas function from vacancies and unemployment. Time is discrete. The economy is populated by homogeneous and infinitely-lived households and identical firms. Households consume varieties of domestically produced or imported goods. They work and save in domestic bonds. Wages are determined through Nash bargaining processes between each worker and firm. Firms face real wage rigidities. They can change prices in each period but face quadratic adjustment costs. Government spending is assumed to be composed from only domestic goods. International risk sharing, law of one price are assumed to hold.

3.2 Matching

Firms in the production sector meet workers on a matching market. Search and matching takes place in the domestic intermediate sector. The labor relations are constructed similar to the Mortensen, Pissaridies (1999) framework. Workers must be hired from an unemployment pool and searching for a worker involves a fixed cost. The cost of the posting a new vacancy is equal

to the fixed amount *k* for all periods. Matching function is the standard Cobb-Douglas function, widely used in the labor market search literature:

$$m_t = \zeta u_t^{\gamma} v_t^{1-\gamma} \quad (1)$$

m_t is the number of matches which derived from unemployed people (u_t) and the vacancies(v_t) posted at the current time period *t*, where $v_t = \int_0^1 v_t^{(i)}$. ζ is the measure of matching efficiency.

Labor force is constant over time and it is normalized to 1. Labor market observes worker flows each period. Flows of new workers are given by:

$$n_t = (1-\rho^x)n_{t-1} + m_t \quad (2)$$

Employment at period *t* is the sum of workers who saved job from previous period and new matches. This specification considers instantaneous hiring. New matches do not wait until next period; they start working within the same period. ρ^x fraction of total works is destroyed in each period. Rest of the labor force forms unemployment:

$$u_t = 1 - n_t \quad (3)$$

Labor market tightness is defined as $\theta_t \equiv \frac{v_t}{u_t}$. Firms meet a job seeker at the rate: $q(\theta_t) = \frac{m_t}{v_t} = \zeta \theta_t^{-\nu}$. This is the probability that a vacancy will be filled. The probability that a worker can find a job is $h_t = \theta_t q(\theta_t) \equiv \zeta \theta_t^{1-\nu}$.

3.3 Household's problem

In the economy, there are households distributed uniformly on the unit interval. Their preferences for consumption are as usual. They face standard consumption saving problem. Following Andolfatto (1996) and Merz (1995) I assumed that they act convenient to a 'big family' assumption. They can insure themselves from earning uncertainty and unemployment pooling all incomes, and then allocating total consumption among members. Therefore, wage earnings have to be accepted as the net of insurance costs.

A typical household seeks to maximize her expected lifetime utility.

$$max_{\{c_t D_t\}} E_0 \sum_{t=0}^{\infty} \left\{ \beta^t \frac{c_t^{1-\sigma}}{1-\sigma} \right\}$$

Where c_t is a composite consumption index of imported and domestically produced bundles of goods defined by:

$$c_t = \left[(1-\alpha)^{\frac{1}{\eta}} c_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} c_{F,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \quad (4)$$

α is the degree of openness, i.e. the steady state share of imported goods on GDP. η is the elasticity of substitution between domestic and imported goods. $C_{H,t}$ is aggregate consumption index given in the form of CES functions:

$$c_{H,t} = \left(\int_0^1 c_{H,t}^{j \frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad (5)$$

$j \in [0,1]$ is sign for variety of goods. ε is the elasticity of substitution among goods produced within a country and assumed to be the same for all countries. Index for imported goods is given by:

$$c_{F,t} = \left(\int_0^1 c_{i,t}^{\frac{\gamma-1}{\gamma}} dj \right)^{\frac{\gamma}{\gamma-1}} \quad (6)$$

$c_{i,t}$ denotes the quantity of goods which produced in country i and consumed by domestic households. $c_{i,t}$ is defined by analogous CES function where *j* stands for variety of goods and ε is the elasticity of substitution between goods produced within country i:

$$c_{i,t} = \left(\int_0^1 c_{i,t}^{j\,\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad (7)$$

There is a variety of notations for SOE models. The ones I used are proposed by Gali and Monocelli (2005). This specification has the advantage that it clarifies the symmetric equilibrium where each country has the same export-import structure. Foreign countries and the home country are identical and they all are integrated to the world economy as a whole.

The budget constraint of households is given below (in nominal terms):

$$\int_0^1 P_{H,t}^{(j)} c_{H,t}^{(j)} dj + \int_0^1 \int_0^1 P_{i,t}^{(j)} c_{i,t}^{(j)} dj di + D_t = D_{t-1}(1+i_{t-1}) + W_t n_t + (1-n_{t-1}) P_t b + \Pi_{H,t} + \Pi_{F,t} + P_t \tau_t \quad (8)$$

The price for good "j" is $P_{H,t}^{(j)}$ if it is produced in the country, $P_{i,t}^{(j)}$ if it is imported from country 'i'. D_t denotes domestic bonds which households possess at the end of period *t-1*. i_t is interest rate for domestic bonds. W_t is the nominal wage level received corresponding her labor, n_t, if the consumer is employed, otherwise she receives unemployment benefit, b. τ_t is lump-sum tax. $\Pi_{H,t}$ and $\Pi_{F,t}$ are profits from domestic and foreign firms owned by consumers. Optimal expenditure for any given variety of goods yields the demand functions:

$$c_{H,t}^{(j)} = \left(\frac{P_{H,t}^{(j)}}{P_{H,t}}\right)^{-\varepsilon} c_{H,t} \quad (10) \qquad c_{i,t}^{(j)} = \left(\frac{P_{i,t}^{(j)}}{P_{i,t}}\right)^{-\varepsilon} c_{i,t} (11)$$

$P_{H,t}$ and $P_{i,t}$ are price indexes of domestic and imported goods, where $P_{H,t} = \left(\int_0^1 P_{H,t}^{(j)\,1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}}$ and $P_{i,t} = \left(\int_0^1 P_{i,t}^{(j)\,1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}}$ for all i *and* j . Combining these price indexes with the optimality conditions it is possible to get: $\int_0^1 P_{H,t}^{(j)} c_{H,t}^{(j)} dj = P_{H,t} c_{H,t}$; $\int_0^1 P_{i,t}^{(j)} c_{i,t}^{(j)} dj = P_{i,t} c_{i,t}$. By country of origin the optimal expenditures on different goods yields:

$$c_{i,t}^{(j)} = \left(\frac{P_{i,t}}{P_{F,t}}\right)^{-\gamma} c_{F,t} \quad (12)$$

for all $i \in [0,1]$, and where $P_{F,t} \equiv \left(\int_0^1 P_{i,t}^{(j)^{1-\gamma}} dj\right)^{\frac{1}{1-\gamma}}$. Finally, using equation (5) the overall expenditure on imported goods can be obtained: $\int_0^1 P_{i,t}\, c_{i,t} = P_{F,t} c_{F,t}$. Assuming symmetry across differentiated goods, optimal expenditure on imported and produced goods is given: $c_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} c_t$ *and* $c_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} c_t$. Where P_t denotes CPI:

$$P_t \equiv \left[(1-\alpha) {P_{H,t}}^{1-\eta} + \alpha {P_{F,t}}^{1-\eta}\right]^{\frac{1}{1-\eta}} \quad (13)$$

Total consumption expenditure, using definitions above, can be simplified to the following form: $P_{H,t} c_{H,t} + P_{F,t} c_{F,t} = P_t c_t$. Thus, the period budget constraint that a representative household maximizes the present value utility subject to it takes the following form (in real terms):

$$c_t + \frac{D_t}{P_t} + = \frac{D_{t-1}}{P_t}(1+ i_{t-1}) + w_t n_t + (1-n_{t-1})b + \frac{\Pi_{H,t}}{P_t} + \frac{\Pi_{F,t}}{P_t} + \tau_t \quad (14)$$

Households choose the set of processes $\{c_t, D_t\}$ and take as given $\{w_t, i_t\}$. The optimality conditions are given below respectively:

FOCs

c_t: $c_t^{-\sigma} = \lambda_t$; (15)

D_t: $\frac{\lambda_t}{P_t} = \beta E_t\{(1+i_t)\, \lambda_{t+1} \frac{1}{P_{t+1}}\}$; (16)

3.4 Domestic intermediate sector

Market for domestic intermediate goods is perfectly competitive. Producers of intermediate goods use labor as their only input. Production function is linear in n_t: $y_{I,t} = z_t n_t$. z_t is a technological shock and follows AR(1) process. Posting a new vacancy is costly and it is equal to k for all periods. The producers of the domestic intermediate goods maximize the following intertemporal function choosing the set of processes $\{v_t, n_t\}$:

$$\max E_0\{ \sum_{t=0}^{\infty} \left\{\beta^t \frac{\lambda_t}{\lambda_0}\right\} [mc_t y_{I,t} - \frac{W_t}{P_{H,t}} n_t - kv_t]\}; \quad (17)$$

$\{v_t, n_t\}$

s.t. $n_t = (1 - \rho^x)\, n_{t-1} + q(\theta_t) v_t;$

FOCs

$$\mu_t = \frac{k}{q(\theta_t)} \; ; \quad (18)$$

$$\mu_t = mc_t z_t - \frac{W_t}{P_{H,t}} - (1 - \rho^x) \frac{\lambda_{t+1}}{\lambda_t} \mu_{t+1} \; ; \quad (19)$$

Job creation condition is obtained through combining first order conditions.

$$\frac{k}{q(\theta_t)} = mc_t z_t - \frac{P_t}{P_{H,t}} w_t + \beta E_t (1 - \rho^x) \frac{\lambda_{t+1}}{\lambda_t} \frac{k}{q(\theta_{t+1})} \; ; \quad (20)$$

$\frac{P_t}{P_{H,t}} \equiv \phi_t$ this variable can be interpreted as a proxy of term of trade. Firms evaluate wages paid to workers in terms of domestic prices; however workers evaluate their income in terms of CPI price index. Because of the mismatch in the units of account ϕ_t is needed and entered to the

wage equation. It has twofold economic meaning: "first, it summarizes all the international spillovers from one economy to the other … secondly, ϕ_t represents a wedge that by entering the wage equation distorts the labor market equilibrium"[4].

3.5 Domestic retail firms

Retail firms that act in monopolistically competitive market unlike good producers. Retail firms combine the differentiated goods to the final good $y_{H,t}$ and sell it to the representative household. Final good is derived from intermediate goods according to the Dixit – Stiglitz aggregator:

$$y_{H,t} = \left(\int_0^1 y_{H,t}^{(j)\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad (21)$$

Where differentiated goods produced from intermediate ones by the linear production technology $y_{H,t}^{j} = y_{I,t}^{j}$. Retail firms can set price in each period but face Rotenberg style quadratic adjustment cost. They seek the solution of following optimization problem:

$$max_{\{P_{H,t}^{(j)}\}} E_0 \{ \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} [\frac{P_{H,t}^{(j)}}{P_{H,t}} y_{H,t}^{(j)} - mc_t y_{H,t}^{(j)} - \frac{\psi_H}{2} (\frac{P_{H,t}^{(j)}}{P_{H,t-1}^{(j)}} - 1)^2 y_{H,t}]\};$$

subject to $y_{H,t}^{(j)} = (\frac{P_{H,t}^{(j)}}{P_{H,t}})^{-\varepsilon} y_{H,t}$;

FOC

[4] Campolmi and Faia (2009)

$$(1-\varepsilon)\frac{P_{H,t}^{(j)\,-\varepsilon}}{P_{H,t}^{\,1-\varepsilon}}y_{H,t}+\varepsilon mc_t\frac{P_{H,t}^{(j)\,-\varepsilon-1}}{P_{H,t}^{\,-\varepsilon}}-$$

$$\psi_H\left(\frac{P_{H,t}^{(j)}}{P_{H,t-1}^{(j)}}-1\right)\frac{1}{P_{H,t-1}^{(j)}}y_{H,t}+\beta E_t\{\frac{\lambda_{t+1}}{\lambda_t}\psi_H\left(\frac{P_{H,t+1}^{(j)}}{P_{H,t}^{(j)}}-1\right)\frac{P_{H,t+1}^{(j)}}{P_{H,t}^{(j)\,2}}y_{H,t+1}=0;$$

Multiply with ($P_{H,t}^{(i)}$), then divide by ($Y_{H,t}$) and rearrange

$$\psi_H\left(\pi_{H,t}^{(j)}-1\right)\pi_{H,t}^{(j)}=(1-\varepsilon)$$

$$\left(\frac{P_{H,t}^{j}}{P_{H,t}}\right)^{1-\varepsilon}+\varepsilon mc_t\left(\frac{P_{H,t}^{(j)}}{P_{H,t}}\right)^{-\varepsilon}+\beta E_t\{\frac{\lambda_{t+1}}{\lambda_t}\psi_H\left(\pi_{H,t+1}^{(j)}-1\right)\pi_{H,t+1}^{(j)}\frac{y_{H,t+1}}{y_{H,t}};$$

New Keynesian Phillips Curve is obtained after dropping subscript by symmetry:

$$\psi_H\left(\pi_{H,t}-1\right)\pi_{H,t}=(1-\varepsilon)+\varepsilon mc_t+\beta E_t\{\frac{\lambda_{t+1}}{\lambda_t}\psi_H\left(\pi_{H,t+1}-1\right)\pi_{H,t+1}\frac{y_{H,t+1}}{y_{H,t}} \quad (23)$$

3.6 Wage setting mechanism

Workers and employers in every period determine wage schedule solving an individual Nash bargaining process. V_t^j is marginal value that firm gains after matching:

$$V_t^j=mc_tz_t-\phi_t w_t+\beta E_t\{(1-\rho^x)\frac{\lambda_{t+1}}{\lambda_t}V_{t+1}^j\}; \quad (25)$$

V_t^E and V_t^U are values from being employed and unemployed:

$$V_t^E=w_t+\beta E_t\{\frac{\lambda_{t+1}}{\lambda_t}[(1-\rho^x)V_{t+1}^E-\rho^xV_{t+1}^U]\}; \quad (26)$$

$$V_t^U = b + \beta E_t\{\frac{\lambda_{t+1}}{\lambda_t}[\theta_t q(\theta_t)(1-\rho^x)V_{t+1}^E + (1-\theta_t q(\theta_t)(1-\rho^x))V_{t+1}^U)]\}; \quad (27)$$

Difference of these value functions gives surplus from being employed:

$$V_t^E - V_t^U = w_t - b + \beta E_t\{\frac{\lambda_{t+1}}{\lambda_t}[(1-\rho^x)(1-\theta_t q(\theta_t)(V_{t+1}^E - V_{t+1}^U)]\}; \quad (28)$$

Sum of value functions showing pay offs obtained by firm and worker gives the total surplus: $Sur_t \equiv V_t^j + (V_t^E - V_t^U)$. ς denotes worker's bargaining power. It is the share of total surplus gained by worker after matching happens. $V_t^E - V_t^U = \varsigma Sur_t$. Now Sur_t can be substituted:

$$V_t^E - V_t^U = \frac{\varsigma}{1-\varsigma} V_t^j.$$

After substituting the all previously defined equations for value functions it is not difficult to get:

$$(w_t - b)(1-\varsigma) + \varsigma \frac{P_t}{P_{H,t}} w_t = \varsigma mc_t - \beta E_t\{\frac{\lambda_{t+1}}{\lambda_t}[(1-\rho^x)\varsigma k\theta_{t+1}]\}; \quad (29)$$

Moreover, I use real wage rigidity to overcome excess volatility. Real wage rigidity first introduced by Shimer(2003) and Hall(2003) to resolve some of the puzzles in standard matching model. Following Hall(2003), the individual real wage is determined as "a weighted average of the one obtained through Nash bargaining process and the one obtained as solution to the steady state".[5]

$$w_t = \Lambda\{\frac{\varsigma}{(1-\varsigma+\varsigma\phi_t)} mc_t - \frac{\beta}{(1-\varsigma+\varsigma\phi_t)} E_t\left\{\frac{\lambda_{t+1}}{\lambda_t}[(1-\rho^x)\varsigma k\theta_{t+1}]\right\} + \frac{(1-\varsigma)}{(1-\varsigma+\varsigma\phi_t)} b\} + (1-\Lambda)\overline{w} \quad (30)$$

[5] Faia(2006), page13

3.7 Government fiscal policy

Government purchases consist of only consumption expenditure. The government changes private goods into public goods using one-for-one technology. I assume that only domestically produced goods are used for the government consumption expenditure. It is financed by lump-sum tax:

$$\frac{P_t}{P_{H,t}} g_t = \tau_t$$

In addition it is assumed that the structure of public goods is similar to private ones. Demand for government expenditure is given by:

$$g_t = \left(\int_0^1 g_t^{(j)} \frac{\varepsilon - 1}{\varepsilon} dj \right)^{\frac{\varepsilon}{\varepsilon - 1}} \qquad g_t^{(j)} = \left(\frac{P_{H,t}^{(j)}}{P_{H,t}} \right)^{\varepsilon} g_t$$

Government expenditure follows exogenous process:

$$\frac{g_t}{g} = \left(\frac{g_{t-1}}{g} \right)^{\rho_g} e^{\varepsilon_t^g} \quad (31)$$

3.8 Other conditions

3.8.1 Aggregate resource constraints

Market clearing condition for domestic and foreign good markets is defined by:

$y_{H,t} = c_{H,t} + c_{H,t}^* + g_t$ - Domestic (32)

$y_t^* = c_t^*$ - Foreign (33)

The search activity and adjusting prices are costly. A certain fraction of resources goes to cover these activities. Therefore aggregate output is equal amount of produced goods minus wasted resources:

$$y_{H,t} = n_t z_t - k v_t - \frac{\psi_H}{2} (\pi_{H,t} - 1)^2 y_{H,t} \quad (34)$$

The model is closed considering foreign consumption goods which are produced domestically:

$$c^*_{H,t} = \alpha \left(\frac{P^*_{H,t}}{P^*_t} \right)^{-\eta} y^*_t \quad (35)$$

3.8.2 Law of one price

I assume that the law of on price holds: $P_{F,t} = P^*_t e_t$, $P_{H,t} = P^*_{H,t} e_t$. e_t is the nominal exchange rate.

3.8.3 International risk sharing

International bond market is complete. The expected return of risk free domestic bond in domestic currency must be equal to the expected return of foreign risk free bonds in terms of domestic currency. Assuming symmetry across countries international risk sharing condition can be simplified following form:

$$c_t = c^*_t q_t^{\frac{1}{\sigma}} \quad (36)$$

3.8.4 Terms of trade

Terms of trade (tot) is defined as $s_t = \frac{p_{F,t}}{p_{H,t}}$. It is straight forward to get following equation determining relation between tot and its proxy from equation (13) just simply dividing by $P_{H,t}$.

$$s_t \equiv \left[(1-\alpha) + \alpha \phi_t^{1-\eta}\right]^{\frac{1}{1-\eta}} (37)$$

I also define tot in difference:

$$\Delta tot_t = \frac{S_t}{S_{t-1}} \equiv \frac{\pi_{F,t}}{\pi_{H,t}}; (38)$$

Using this auxiliary variable I define relationship between real exchange rate and tot:

$$q_t = \Delta tot_t^{1-\alpha} (39)$$

3.8.5 CPI inflation and domestic inflation

The next equation shows how CPI, domestic inflations and tot are related:

$$\pi_t = \frac{\pi_{H,t}}{(\Delta tot_t / \Delta tot_{t-1})^{\alpha}} (40)$$

3.8.6 Monetary Policy

Monetary authority adjusts nominal interest rate through deviations of inflation and unemployment rate. Central Bank applies the following rule:

$$\ln\left(\frac{1+i_t}{1+i}\right) = \varrho_\pi \ln\left(\frac{\pi_t}{\pi}\right) + \varrho_u \ln\left(\frac{u_t}{u}\right) \quad (41)$$

Foreign economy variable y_t^* is assumed to be exogenous. It follows independent autoregressive process which is not affected by policies and any shock in the domestic economy.

3.9 Parameterization

For preferences I follow the main economic literature to assign them. The discount factor β is set 0.99, so that it yields annual interest rate equal to 4 percent. The elasticity of substitution between domestic and foreign goods η is equal to 2. The elasticity of substitution between intermediate goods ε is chosen 10. Degree of openness α is set 0.5.

In choosing parameters for the labor market I closely follow Jakab and Konya (2008) to correspond to the Hungarian labor market. It is considered by them that bargaining power of workers is very low in Hungary. Therefore bargaining power ς is set very low 0.2 compared to other countries. However separation ρ^x rate is very high, 0.1. Matching function elasticity ν is 0.5. Unemployment benefit is obtained from its ratio with steady state real wage level $b/\overline{w}$ = 0.427.

Taking into consideration characteristics of domestic labor market, all key factors assigned are taken from Jakab and Konya (2008) which are very different from worldwide

economic literature. So that the job finding probability is 10% per month[6], which defines $\bar{h} = 0.3$. Using this value steady state of unemployment can be calculated:

$$\bar{h} = \frac{\rho^x(1-\bar{u})}{\bar{u}} \Rightarrow \bar{u} = 0.25.$$

Probability filling a vacancy is set $q(\bar{\theta})$ =2/3, which implies vacancy rate $\bar{v}$ =0.11.[7] Parameters k the cost of posting a vacancy and ζ matching efficiency are calculated from steady state conditions.

The values of all parameters are described in table (1).

[6] Jakab and Konya (2008)
[7] Jakab and Konya (2008)

4 Result

4.1 Impulse Response Analysis

In order to calculate the impulse response function three different shocks (shock to productivity(z_t), pure demand shock (g_t), and foreign output shock (y_t^*)) were allowed.

First figure contains responses to a government spending shock. The effect on the variables can be summarized as follow: Output, domestic inflation, CPI inflation, wages, employment rate were affected positively. Response of domestic output to the aggregate demand shock was 0.12 percent. An increase in domestic inflation was almost 0.2 percent. Wages were increased by 0.2 percent by government expenditure shock. A negative response to the government increase was observed in an aggregate consumption, consumption of domestic goods, exported goods, terms of trade and unemployment rate. The impulse response functions I got as the response to pure demand shock are close to the results obtained by Faia, Lechthaler, Merkl (2010) and Monacelli, Perotti, Trigari (2010).

The government expenditure increase has three detrimental effects to the domestic economy. First, it has to finance via taxes. In our case, it is lump-sum taxes. This obligation involves some recourse. This fraction of output cannot be used as consumption. Therefore, consumption responds to the government expenditure increase by reduction. Second, in an open economy context a rise in the aggregate demand in the domestic economy leads the increase in domestic prices relative to foreign prices. This condition, in turn, negatively affects the trade balance of the country. Demand in foreign countries for exported goods from home country is reduced. However, trade balance for a foreign country becomes better. Third, government

spending shock is followed by a fall in terms of trade. The fall in terms of trade impacts CPI/PPI ratio. Finally, this effect results in an increase in domestic wage. The fall in tot also affects CPI inflation. Equation (40) highlights the reason why CPI inflation rises more than domestic inflation. The answer to this question is the change in tot in difference which is inversely related to CPI inflation.

Due to increase in fiscal spending, prices for goods produced within the country rise relative to the prices of foreign goods. Hence, consumers switch from expensive domestic goods to cheaper foreign goods. Magnitude of such switching effects is managed mainly by two parameters: elasticity of substitution between domestic and foreign goods (η) and degree of openness (α).

Shock to foreign output gives the similar result to government expenditure for all variables except consumption. In figure 2, responses of variables to this shock are depicted. Slightly rise is the response of domestic output to the exogenous shock. Output was deviated from steady state level by 0.1 percent. Real wage and employment were increased by 0.57 and 0.17 percent respectively. CPI inflation, domestic inflation, nominal interest rate also responded with positive deviation. Terms of trade, consumed domestic goods and unemployment responded with fall to the foreign output shock. The only variable which gave different results to two different shocks is aggregate consumption. The graph shows that aggregate consumption rose by 1.4 percent when economy is stroke by positive foreign output shock but during the first shock the fall was observed in the aggregate consumption.

Alba, Su, Chia (2011) discuss in their paper the magnitude of the effect of foreign output shocks. They show that change in domestic output in the small open economy originated by 1

percent shock in foreign output varies between 0.3-0.45 percent, depending on the applying monetary policy. In our case, response of domestic output is even much lower. As it is stated above aggregate consumption increased, however, part of domestic goods in aggregate consumption is reduced. This is the obvious evidence that imported goods are consumed by household more than domestic goods. Terms of trade decreased. These results are logically related and can be easily interpreted. The intuition is that because of positive foreign output shock foreign goods are produced more and price of them is reduced, which leads to the fall on terms of trade. These goods are imported and consumed by domestic households. That is the reason why consumption, consisting from domestically produced goods, reduced but aggregate consumption increased.

Third one is the productivity shock. Figure 3 depicts the impulse responses of the variables to the productivity shock. The impulse response functions of the productivity shock do not coincide with the results described in Jakab and Konya (2008). I consider that the difference is originated from distinctions in economic environments and in constructions of the models. Parameterization of price rigidity is also a source of difference. For example, in Jakab and Konya (2008) after shock happens employment falls[8], which contradicts the figure 3 showing unemployment rate falls. In Jakab and Konya (2008) firms have a choice to substitute between capital and labor. Therefore, when the economy is hit by productivity shock employers incline toward capital because wages rise more than other prices[9]. So, fall in employment is an expected consequence of ongoing processes in the economy after shock. However, in our case there is only one input (labor) which firms use and this cannot be substituted to anything else. The increase in employment is an effort to get more benefit from existing temporary productivity

[8] Jakab and Konya (2008), Figure 4
[9] Jakab and Konya (2008), page 29.

shock. The increase in employment is escorted by an increase in consumption, output, consumption of exported goods ($c^*_{H,t}$) and terms of trade.

4.2 Unemployment fiscal multiplier

The main result I am interested in is the response of unemployment rate to a government expenditure shock. Other shocks were allowed to check reliability of the model. From the discussions above it seems that the impulse responses to different shocks coincide with some other important papers or just it has an explanation why it is different from other works.

Fiscal multipliers can be defined as follow; the fiscal multiplier is the ratio of a change in the variable of interest (ΔY, ΔN) to a government expenditure increase. Depending on different time frames there are several types of fiscal multiplier:

- the impact multiplier (short run); $\left(\equiv \frac{\Delta X(t)}{\Delta G(t)}\right)$
- the multiplier at some horizon; $\left(\equiv \frac{\Delta X(t+j)}{\Delta G(t)}\right)$
- the peak multiplier; $\left(\equiv max_j \frac{\Delta X(t+j)}{\Delta G(t)}\right)$
- cumulative multiplier (long run). $\left(\equiv \frac{\Sigma \Delta X(t+j)}{\Sigma \Delta G(t+j)}\right)$

Government expenditure increase may give the desired results if some conditions are satisfied:

a. If the part of government expenditure saved or spent on import contains negligible fraction of fiscal expansion;

b. If government expenditure does not generate sharp increase in interest rate;

c. If a country is fiscal sustainable after government expenditure shock[10].

The values of unemployment and output fiscal multipliers for Hungarian economy are less than one. It was expected that both of them would be less than one because papers exploring the magnitude of fiscal multipliers, especially models with matching, found them to be less than one. Table (2) contains multipliers for different time horizons.

Impact multiplier for output is 0.109. It means that output will increase by 0.109 for each unit of money spent as government expenditure which is the very low indicator. It is also the peak multiplier. The long run fiscal multiplier is almost the same, 0119. The values of output fiscal multiplier in Monacelli, Perotti, Trigary (2010), Campolmi, Faia, Winkler (2010) and Faia, Lechthaler, Merkl (2010) were also less than one. The values of short run fiscal multipliers were 0.4[11], 0.03 (with $\varphi = 0$, pure lump-sum taxation)[12], 0.12 (in an open economy with labor market frictions)[13] in each paper respectively. Long run multipliers are close to this numbers. This fact proves that in economies with non-Walrasian labor market fiscal multipliers are dampened.

Short run unemployment fiscal multiplier is -0.126. The value of unemployment multiplier in one year is -0.283, in two years is -0.327. The peak value of unemployment multiplier is equal to the value in one year horizon. The long run fiscal multiplier is -0.278.

[10] A. Spilimbergo, S. Symansky, M. Schindler (2009), page 2.
[11] Monacelli, Perotti, Trigary (2010), page 45, figure 5.
[12] Campolmi, Faia, Winkler (2010), page 25, table2.
[13] Faia, Lechthaler, Merkl (2010), page 24, figure 2.

5 Conclusion

In my thesis, I investigate unemployment fiscal multiplier in a small open economy with labor market frictions. As a reference country I took Hungary. Some key parameters were chosen to be consistent for Hungarian economy.

The model I employed is the New Keynesian model extended with labor market frictions. These types of models contain three sources of inefficiency; both in the long run and short run. The first friction is monopolistic competition which reduces the level of output. The second inefficiency is sticky prices. This friction is originated from price adjustment. The price adjustment activity is costly and the cost is covered by output resources. The third source of inefficiency is matching frictions and real wage rigidity in the labor market.

Following the economic literature, I assume that new hires happen in the form of Cobb – Douglas function from vacancies and unemployment. Households consume varieties of domestically produced or foreign goods, work and save. Wages are determined through Nash bargaining processes between each worker and firm. The whole economy consists of two sectors; intermediate goods producers and domestic retail sector. Government spending is assumed to be composed from only domestic goods and financed through lump-sum taxes. International risk sharing and law of one price are assumed to hold.

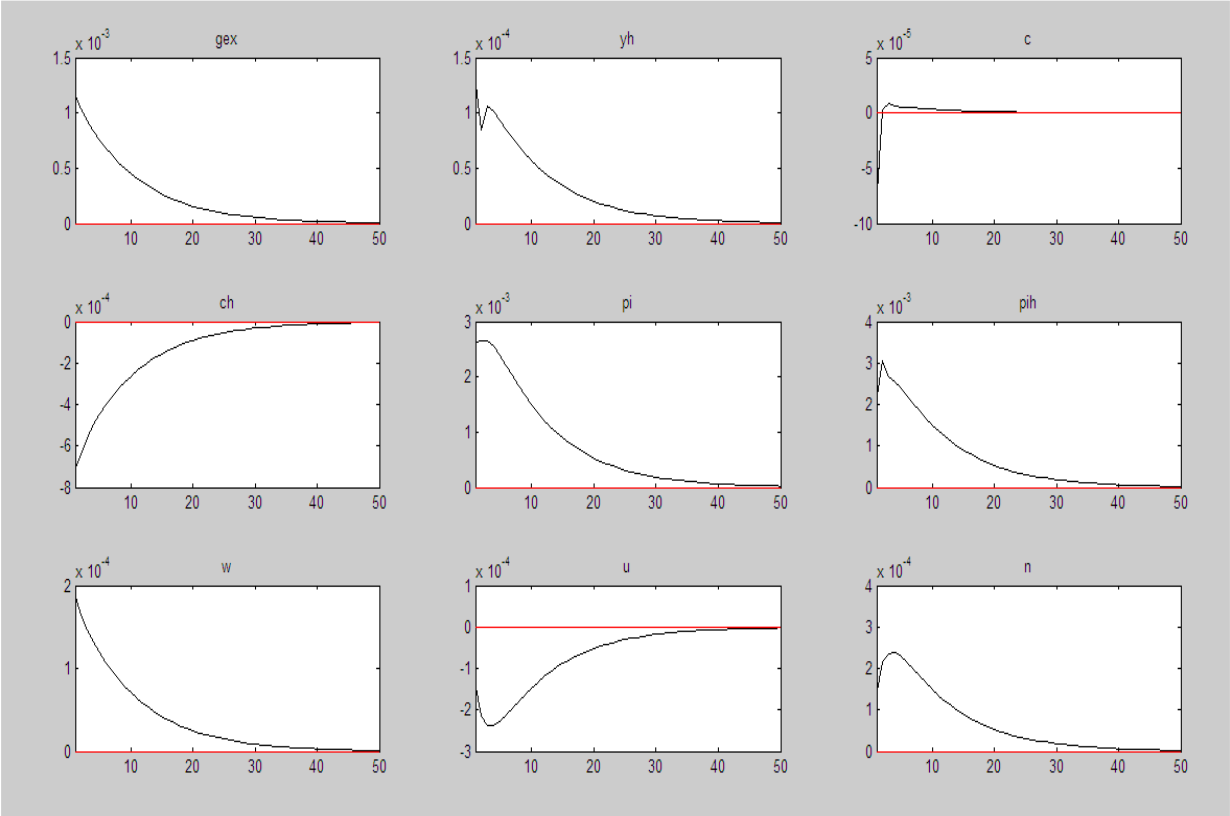
I allowed three different and independent shocks (foreign output, government expenditure, productivity). The results for each of them are separately discussed and compared with other papers. Unemployment and fiscal multipliers for different horizon were calculated. Both of them are less than one for the long and short run periods. The results I obtained seem

consistent with the existing economic literature. The effect of fiscal multipliers is dampened in the models with non-Walrasian labor market which is the case in my study. Moreover, letting economy be open negatively affects the magnitude of multipliers in its place.

6 Figures

Figure1

Impulse responses to government expenditure shock



Cont'd

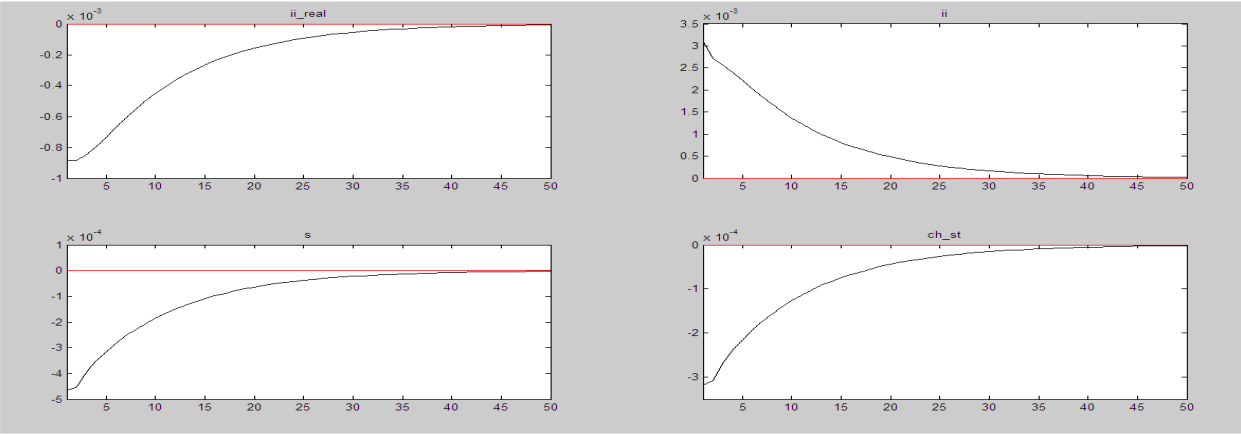


Figure2

Impulse responses to positive foreign output shock

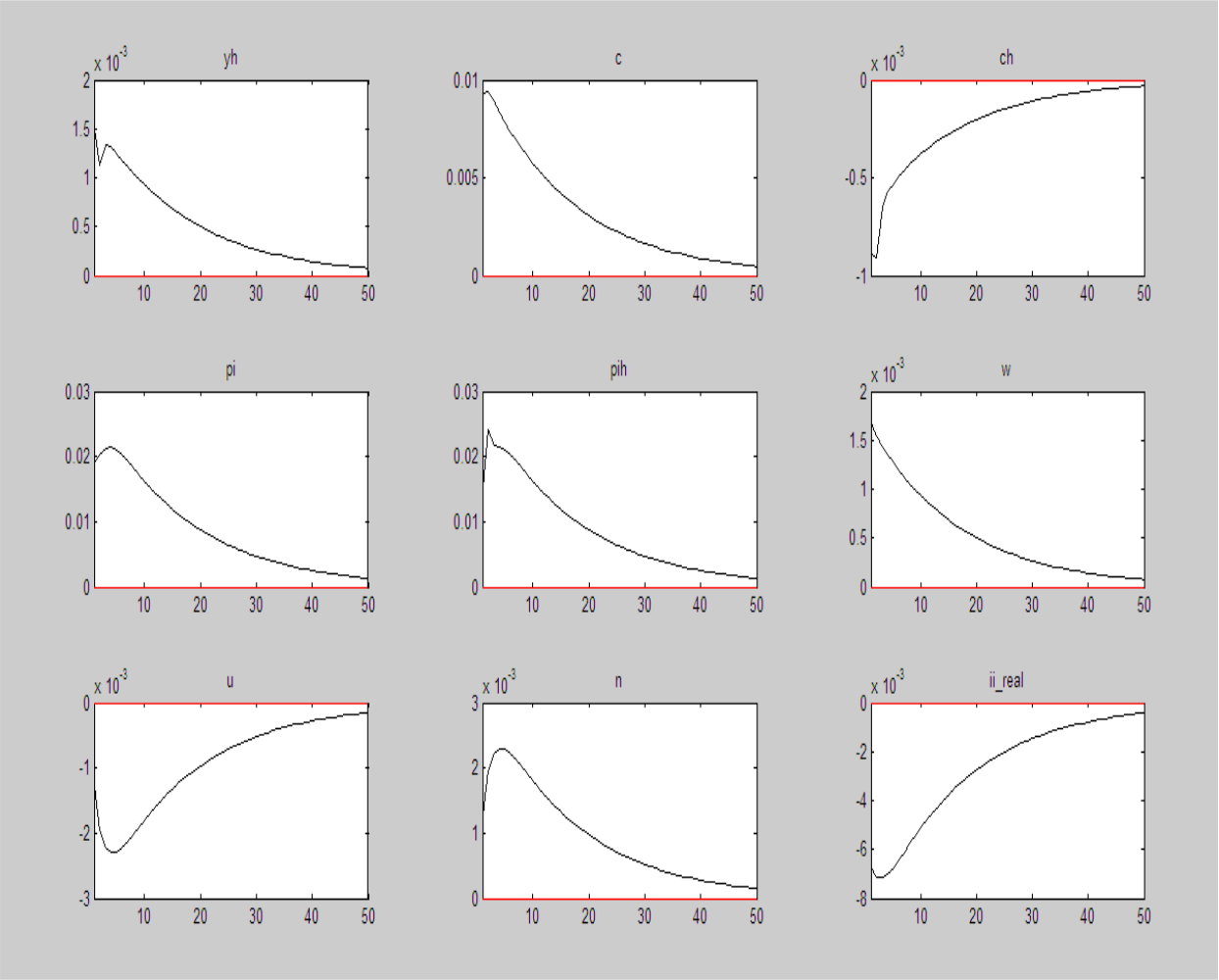
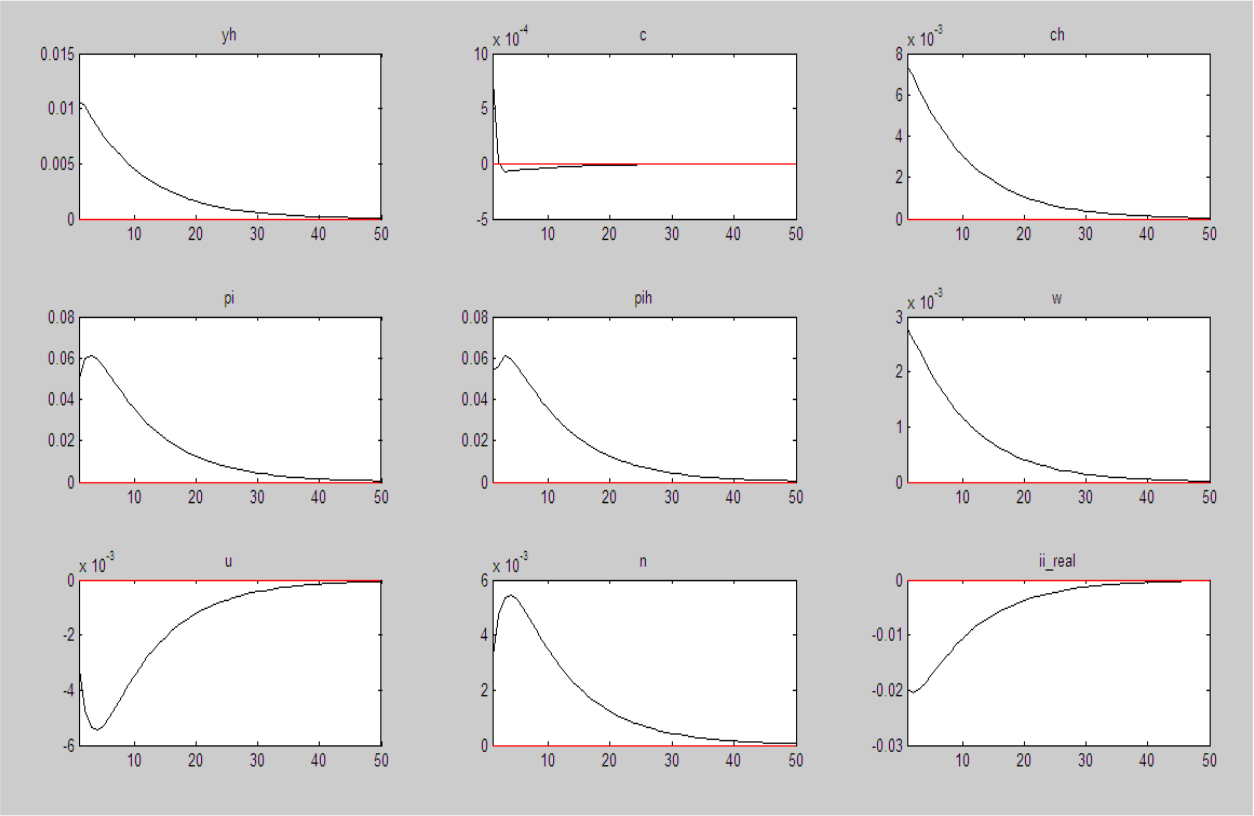


Figure2

Impulse responses to productivity shock

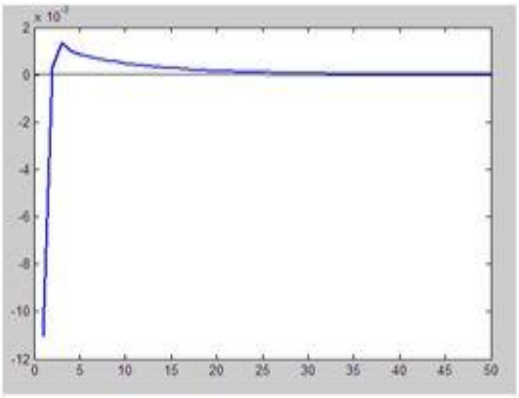


*yh – domestic output; c – aggregate consumption; ch – consumption of domestically produced goods;
pi – CPI inflation; pih – domestic inflation; w – real wage ;
u – unemployment; n – employment ii_real – real interest rate;
gex - government expenditure ii – nominal interest rate s – terms of trade;
ch_st - domestic exports;

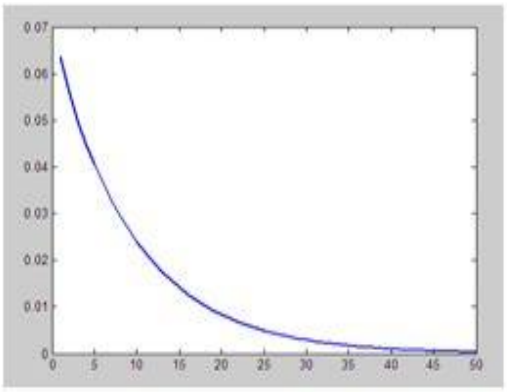
Figure 4

Responses to the fiscal shock

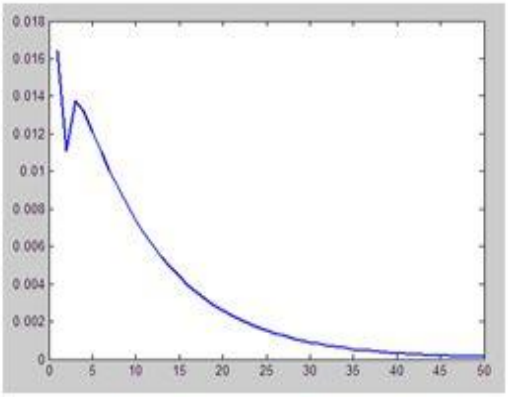
Percentage deviation from steady state



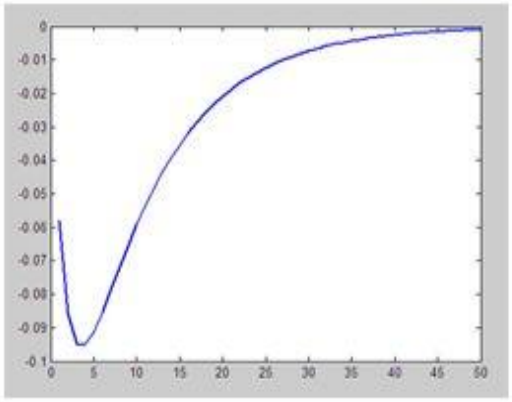
Aggregate consumption



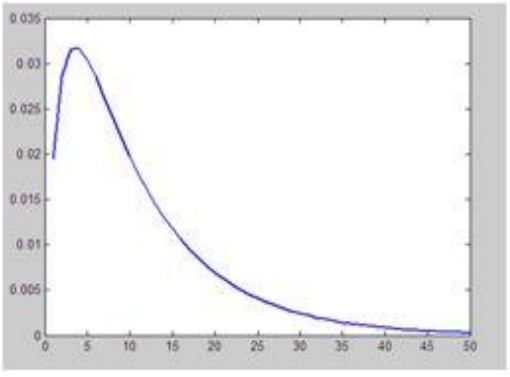
Wage



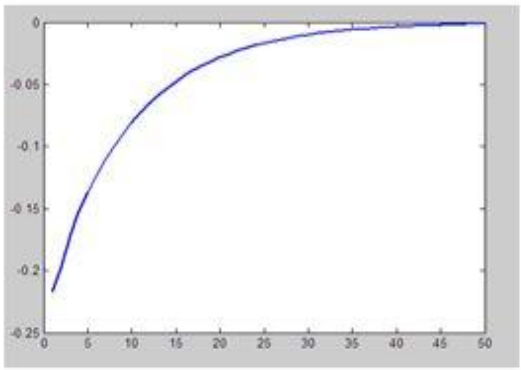
Output



Unemployment



Employment



Consumption of domestically produce goods

7 Tables

Table 1 Parameters

parameter	description	value	source
β	discount factor	0.99	standard value
σ	intertemporal substitution	2	Faia, Lechther, Merkl (2010)
ε	elasticity of demand	10	Faia, Lechther, Merkl (2010)
ρ^g	autoregressive process for gov. expen.	0.9	standard value
ρ^z	autoregressive process for tech. shock	0.9	standard value
ρ^y	autoregressive process for foreign output	0.9	standard value
ψ_H	cost adjustment	52.94	2/3 Calvo parameter.
ϱ_π	Taylor coefficient for inflation	1.5	Faia (2006)
ϱ_u	Taylor coefficient for unemployment	0.5	Faia (2006)
α	home bias	0.5	standard value
Λ	real wage parameter	0.6	Faia (2006)
η	elasticity of substitution of dom. and imp. goods	2	Faia, Lechthaler, Merkl (2010)
k	vacancy cost	0.0075	calculated from stst
$\bar{\zeta}$	matching efficiency	0.3985	Jakab and Konya(2008)
υ	matching elasticity	0.5	Jakab and Konya(2008)
b	unemployment benefit	0.1249	calculated from stst
ρ^x	separation rate	0.2	Jakab and Konya(2008)
ς	bargaining power	0.2	Jakab and Konya(2008)

Table 2

Output and unemployment fiscal multipliers

short	output		unemployment	
	0.109		-0.126	
multiplier at horizon	year 1	year 2	year 1	year 2
	0.088	0.0605	-0.283	-0.327
peak	0.109	Q1	-0.206	Q4
long	0.119		-0.278	

8 References

Alba, Joseph D., Zheng Su and Wai-Mun Chia. 2011. "Foreign Output Shocks, Monetary Rules and Macroeconomic Volatilities in Small Open Economies". *International Review of Economics and Finance.* 20:1, pp 71-81, January 2011

Albertini, Julien, Gunes Kamber and Michael Kirker. 2010. "An estimated small open economy model with frictional unemployment". Reserve Bank of New Zealand.

Andolfatto, David. 1996. "Business Cycles and Labor-Market Search", *American Economic Review.* 86: 1, pp. 112-132, March.

Arsenau, David M and Sanjay K. Chugh. 2005. "Fiscal Shocks, Job Creation, and Countercyclical Labor Markups". Federal Reserve Board, October 27.

Blanchard, Oliver and Jordi Gali. 2006. "A New Keynesian Model with Unemployment", National Bank of Belgium, Working Paper No 92.

Bruckner, Markus and Evi Pappa. 2010. "Fiscal Expansions Can Increase Unemployment: Theory and Evidence from OECD Countries". 7th ECB/CEPR Labour Market Workshop "Unemployment Developments after the Crisis", December 16-17.

Campolmi, Alessia, Ester Faia and Roland Winkler. 2010. "Fiscal Calculus in a New Keynesian Model with Matching Frictions". Kiel Working Paper No 1062.

Campolmi, Alessia and Ester Faia. 2009. "Optimal Monetary Policy in an Open Economy Labour Market Frictions". European Community grant MONFISPOL under grant agreement SSH-CT-2009-225149, July.

Faia, Ester. 2006. "Optimal Monetary Policy Rules with Labor Market Frictions". European Central Bank, Working Paper Series No 698, November.

Faia, Ester, Wolfgang Lechthaler and Cristian Merkl. 2010. "Fiscal Multipliers and the Labour Market in the Open Economy". Discussion Paper No 4849, IZA.

Faia, Ester, Wolfgang Lechthaler and Christian Merkl. 2010. "Fiscal Stimulus and Labor Market Policies in Europe".

http://www.makro.wiso.uni-erlangen.de/Publikationen/multipliers.pdf

Monacelli, Tomass, Roberto Perotti and Antonella Trigary. 2010. "Unemployment Fiscal Multipliers". NBER Working Paper Series No 15931, April.

Monacelli, Tomasso and Jordi Gali. 2005. "Monetary Policy and Exchange Rate Volatility in a Small Open Economy". *Review of Economic Studies*. 72, 707-734.

Spilimbergo, Antonio, Steve Symansky and Martin Schindler. 2009. "Fiscal Multipliers". INTERNATIONAL MONETARY FUND, the Research Department, staff position note, May 20; Available at (http://www.imf.org/external/pubs/ft/spn/2009/spn0911.pdf)

Jakab, Zoltan and Istvan Konya. 2008. "An Open Economy DSGE Model with labor Market Frictions". http://econ.core.hu/file/download/szirak2008/puskas_labor_rev1.pdf