Labour Market Frictions and Heterogeneous Expectations

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Abstract

The aim of this paper is to investigate the effects of bounded rationality on labour market dynamics. The model is based on a standard New Keynesian model that incorporates labour market search and matching frictions developed by Trigari (2006). During the bargaining process, wages and working hours are jointly determined by firms and workers. Expectations heterogeneity is introduced by assuming that only a fraction of agents form expectations rationally and the remainder follow an adaptive rule. The results highlight important links between the degree of expectations heterogeneity, bargaining power and labour market dynamics. It is demonstrated that heterogeneous expectations can lead to substantial increase in the volatility of employment and vacancy posting in response to a monetary policy shock.

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1. Introduction

What is the role of labour market frictions in determining the economy's response to various macroeconomic shocks? What explains the large volatility in the employment and vacancy posting series in response to a monetary policy shock? Macroeconomists have long been concerned with these issues and ample research has been done on investigating the relationship between labour market variables and other economic aggregates. Nevertheless, the majority of research assumed rational expectations and little attention has been given to exploring the above question s in the context of bounded rationality. This paper therefore aims to fill in this gap and study how expectational heterogeneity changes the relationship between labour market dynamics and monetary policy.

There has been a growing amount of literature that criticises the rational expectations structure that is a major ingredient of most general equilibrium macro models. For example, Mankiw et al (2003) finds that heterogeneous expectations and disagreements about inflation forecasts maybe a key to understanding macroeconomic dynamics. Moreover, they find evidence that people form expectations based on outdated information which explains many features of the data better than rational expectations models. Carrol (2003) finds empirical evidence for deviations from the rational expectations benchmark, and uses a model from epidemiology to show how information can slowly diffuse through the economy. Further survey data evidence on expectational heterogeneity is provided by Branch (2004, 2007).

Given the empirical support in favour of non-rational expectations, this paper aims to explore the implications of expectational heterogeneity in a standard New Keynesian model with search and matching frictions. The main result of this paper is that heterogeneous expectations is capable of generating large volatility in employment and vacancy posting that standard New Keynesian models are not capable of.

2. Contacts with Literature

Over the last three decades, monetary macroeconomics has somewhat ignored the role of labour markets in business cycle dynamics. The major textbooks by Woodford (2003) and Walsh (2003) and Gali (2008) barely mention even the word unemployment. The standard New Keynesian monetary models (Christiano et al, 2005, Smets and Wouters 2003, 2007) intend to explain employment and working hours together with a number of other macroeconomic aggregates without explicitly accounting for the specific features of labour markets.

However, another strand of literature inspired by Diamonds (1982a, 1982b) and Mortensen (1982a, 1982b) and developed mainly by Pissarides (1984, 2000) explicitly models labour market dynamics by incorporating search and matching frictions in a general equilibrium framework. The central theme of these models is that trade in the labour market is a decentralised economic activity that is uncoordinated, time-consuming and costly for the labour market participants. A main ingredient of these models is the matching function that aims to capture the costly job finding process whereby firms and workers invest resources in order for vacant jobs and unemployed workers to be matched. The equilibrating forces of unmatched job-worker pairs meeting and some of the existing jobs breaking up give rise to the equilibrium level of unemployment (see Pissarides 2000 for a full exposition).

Merz (1995) was the first paper that created a synthesis between labour market matching frictions and stochastic neoclassical growth and real business models (RBC). This model outperformed standard RBC models with Walrasian auctioneers by being more successful in explaining the empirical observations, namely that real wage fluctuates more than labour productivity, and that unemployment and job vacancies are highly volatile compared to other labour market variables. In spite of the initial attempts to integrate labour market frictions in business cycles models, macroeconomists directed more attention to understanding the relationship between inflation, monetary policy and short-term fluctuations (Rotemberg and Woodford, 1999; Clarida et al, 1999; see Woodford, 2003, for full exposition). Consequently, the New Keynesian school emerged where driving friction was staggered price-setting originally developed by Calvo (1983). New Keynesian focused little attention to unemployment because it was thought to exert little influence on the design of monetary policy.

Cheron and Langot (2000) was the first study that combined nominal price rigidities with labour market search and matching frictions. Subsequently, Walsh (2003, 2005) and Trigari (2009) integrated a search and matching setup within a monetary DSGE model with nominal price rigidities.

In spite of the theoretical coherence and analytical tractability of the search and matching models and their synthesis with New Keynesian models, they failed to describe some of the key business cycles facts. Shimer (2005) finds strong evidence against the empirical validity of these models in that they cannot explain the cyclical behaviour of two central variables, namely unemployment and vacancies. He does not attack the search approach to labour markets, but he criticises the commonly used Nash-bargaining assumption for wage determination. He proposes alternative wage determination mechanisms that generate more rigid wages which helps explain the amplified effects of aggregate shocks on unemployment.

Consequently, Trigari (2006) and Christoffel and Linzert (2005) responded to Shimer's criticism, and relaxed the assumption of flexible wages, and introduced various forms of nominal and real wage rigidity into New Keynesian search models. Moreover, Thomas (2008) and Blanchard and Gali (2010) redirected the attention to the fundamental New Keynesian issue of optimal monetary policy in the context labour market imperfections. One of their key findings is that the presence of labour market frictions and real wage rigidities causes inflation stabilisation not to be the best monetary policy. This is because strict inflation stabilisation can lead to large and persistent movements in unemployment in response to productivity shocks. Quantitatively, Thomas (2008) shows that under plausible calibration, the welfare loss is about three times as large under zero inflation policy as it is under the optimal policy. Hence it can be optimal for monetary policy to accommodate some inflation thereby limiting the size of the fluctuations in unemployment.

One of the most recent developments in the literature has been the estimation of New Keynesian models with labour market search and matching frictions. Christoffel et al (2008) explored the role of labour markets for monetary in the Eurozone. Bayesian estimation results show that disturbances in the labour market, especially in the bargaining process, are a major contributor to inflation and output fluctuations. Gertler et al (2008) carried out a similar exercise for the US, and was able to fit the data approximately as well as the benchmark monetary models developed Smets and Wouters (2007) and Christiano et al (2005).

It is important to note that all the models discussed so far assumed homogenous, rational expectations. However, there is an increasing literature that is highly critical of the notion of perfect foresight and Muthian rationality. This critique is strongly supported by recent empirical evidence in favour of heterogeneous expectations (Mankiw et al, 2003; Carrol, 2003; Branch, 2004, 2007). There has been ample research on the theoretical formulation and modelling of heterogeneous expectations (Westerhoff, 2006a, 2006b; Lines and Westerhoff, 2007, 2010; Branch and McGough, 2005, 2009; Anufriev et al, 2008; De Grauwe, 2008).

For the model presented in this paper, Branch and McGough (2009) provides the theoretical basis for introducing expectational heterogeneity into an otherwise standard New Keynesian model with search and matching frictions.

The rest of the paper is organised as follows. Section 3 presents the expectations structure and the baseline model in both linear and log-linearised forms. Section 4 shows the simulation results of the baseline model and under different bargaining assumptions. Section 5 provides some discussion and ends with some concluding remarks.

3. Model

3.1 Expectations structure

Bounded rationality is captured by the heterogeneous expectations structure that is composed of rational and adaptive expectations. Agents of type 1 are rational in the traditional Muthian (1960) sense, whereby they have step ahead perfect foresight on the forecasted variables:

$$E_t^1 A_{t+1} = E_t\left(A_{t+1} \mid \Omega_t\right) \qquad (1)$$

Agents of type 2:

$$E_t^2 A_{t+1} = \psi^2 A_{t-1} \qquad (2)$$

that is obtained by iterating forward the simple adaptive rule, $E_t A_t = \psi A_{t-1}$, obeying to the rule of iterated expectations. Expectations of this form have been studied by Pesaran (1987), Minford (2002). Assuming that $\psi < 1$, adaptive expectations are naive-adaptive as used by Cagan (1956), Nerlove (1958), Phelps (1968) and Friedman

(1970). Based on Branch and McGough (2009), the aggregate, heterogeneous expectations structure is given by:

$$\hat{E}_t A_{t+1} = \eta E_t A_{t+1} + (1-\eta)\psi^2 A_{t-1} \tag{3}$$

where η is the proportion of agents that have rational expectations (type 1), whereas $(1-\eta)$ is the proportion of agents with adaptive expectations (type 2).

3.2 Households

Consider an economy in which individuals are infinitely-lived and derive utility from private consumption (C_t), leisure (H_t) and public consumption expenditure (G_t^c).

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, H_t) \tag{4}$$

Assuming that leisure (H) and work (L) are normalised to one, $1 = H_t + L_t$, the period utility – common to all households – is specified as follows:

$$U(C,L) = \ln C - \Psi \frac{L^{1+\eta}}{1+\eta} \tag{5}$$

The period budget constraint has the form as follows:

$$P_t C_t + \frac{B_t}{r_t} \leq P_t Q_t + B_{t-1} \tag{6}$$

The log-linearised Euler-equation with heterogeneous expectations is given by:

$$\hat{\lambda}_t = \tilde{E}_t \lambda_{t+1} + \hat{r}_t = \left[\eta E_t \hat{\lambda}_{t+1} + (1-\eta)\theta^2 \hat{\lambda}_{t-1}\right] + \hat{r}_t \tag{7}$$

And the relationship between the log-linearised shadow price and consumption is the following:

$$\hat{\lambda}_t = -\hat{c}_t \tag{8}$$

3.3 Production and labour markets

Based on the modelling approach of Pissarides (2000), it is assumed that job finding is a decentralised economic activity whereby firms actively search for workers (u_t) in the unemployment pool by posting vacancies (j_t). The interaction of these two variables is captured by the matching function (m_t) that gives the number of jobs formed at any moment in time by the following constant-returns-to-scale rule:

$$m_t = \nu_m u_t^{\nu} j_t^{1-\nu} \qquad (9)$$

where ν_m is the labour matching efficiency parameter analogous to that in standard production functions. It only affects that steady-state level of matching and does not enter the log-linearised matching function that takes the following form:

$$\hat{m}_t = \nu \hat{u}_t + (1-\nu)\hat{j}_t \qquad (10)$$

The matching function can be used to express the probability (q_t) with which an open vacancy is matched with a job searching worker:

$$q_t = \frac{m_t}{j_t} \qquad (11)$$

The corresponding log-linearised form is:

$$\hat{q}_t = \hat{m}_t - \hat{j}_t \qquad (12)$$

The matching function can also be used to express the probability (s_t) with which a job searching worker is matched with an open vacancy:

$$s_t = \frac{m_t}{u_t} \qquad (13)$$

And the log-linearised form is:

$$\hat{s}_t = \hat{m}_t - \hat{u}_t \qquad (14)$$

Steady state unemployment persists because as unmatched workers are matched with vacancies, some of the existing jobs break up at a constant rate (ρ), that is called the probability of separation. Before separation occurs, workers participate in the individual intermediate goods sector firm's production that is defined by the following function:

$$y_t = z l_t^{\alpha} \qquad (15)$$

The aggregate intermediate goods sector production is obtained by the following aggregation:

$$Y_t = n_t (1-\rho) y_t \qquad (16)$$

Where n_t denotes total number of workers employed at time t, and $(1-\rho)$denotes the situation when workers have jobs. Consequently, the log-linear form of the aggregate production function is given by:

$$\hat{Y}_t = \hat{n}_t + \alpha \hat{l}_t \qquad (17)$$

The employment rate evolves according to the following law of motion:

$$n_t = (1-\rho) n_{t-1} + m_{t-1} \qquad (18)$$

and the corresponding log-linear expression can be written as:

$$\hat{n}_t = (1-\rho)\hat{n}_{t-1} + \rho \hat{m}_{t-1} \qquad (19)$$

The relationship between unemployment and employment is determined by the separation rate in the following way:

$$u_t = 1 - (1-\rho)n_t \tag{20}$$

In terms of deviation from the steady state, it is defined as:

$$\hat{u}_t = -\frac{n}{u}(1-\rho)\hat{n}_t \tag{21}$$

3.4 Value functions

Both the firms and the workers face an infinite-horizon optimisation problem when they decide on how much wage and labour to demand and supply. In all cases, the current values are given by the net flow benefits and the expectations of the continuation values appropriately discounted. One of the main departures of this paper from previous models is the introduction of heterogeneous expectations which substantially changes the dynamic optimisation problem by generating behavioural persistence.

From the firms' point of view, the following two Bellman equations define the asset values of a filled (J_t) and a non-filled (V_t) vacancy in terms of current consumption:

$$J_t = x_t y_t - w_t l_t + \tilde{E}_t \beta_{t,t+1}(1-\rho)J_{t+1} \tag{22}$$

$$V_t = -\frac{\kappa}{\lambda_t} + \tilde{E}_t \beta_{t,t+1}\left[q_t(1-\rho)J_{t+1} + (1-q_t)V_{t+1}\right] \tag{23}$$

Assuming that there are no barriers for firms to post new vacancies, the competition drives the value of a vacancy to zero at all times, that is, $V_t = 0$. This implies the following "job creation" equation:

$$\frac{\kappa}{\lambda_t q_t} = \tilde{E}_t \beta_{t,t+1}(1-\rho)J_{t+1} \tag{24}$$

where the left-hand side denotes the hiring cost that the firm has to bear, and the right-hand side is the discounted expected value streams of future matches. Substituting the value function for the filled vacancies, we get the following dynamic equation:

$$\frac{\kappa}{\lambda_t q_t} = \tilde{E}_t \beta_{t,t+1}(1-\rho)\left(x_{t+1}y_{t+1} - w_{t+1}h_{t+1} + \frac{\kappa}{\lambda_{t+1}q_{t+1}} \right) \tag{25}$$

Log-linearising the "job creation" equation above yields the following:

$$\hat{q}_t = \frac{-\beta(1-\rho)}{\Theta}\left(\frac{\tilde{E}_t x_{t+1}}{\alpha} - \tilde{E}_t w_{t+1} \right) + \beta(1-\rho)\tilde{E}_t q_{t+1} - (1-\beta(1-\rho))\tilde{E}_t \lambda_{t+1} \tag{26}$$

Substituting the heterogeneous expectations structure into the above formula results in the following second-order difference equation in $\hat{q}_t$:

$$\hat{q}_t = \eta\left[\frac{-\beta(1-\rho)}{\Theta}\left(\frac{E_t\hat{x}_{t+1}}{\alpha} - E_t\hat{w}_{t+1}\right) + \beta(1-\rho)E_t\hat{q}_{t+1} - (1-\beta(1-\rho))E_t\hat{\lambda}_{t+1}\right] + \qquad (27)$$
$$(1-\eta)\psi^2\left[\frac{-\beta(1-\rho)}{\Theta}\left(\frac{\hat{x}_{t-1}}{\alpha} - \hat{w}_{t-1}\right) + \beta(1-\rho)\hat{q}_{t-1} - (1-\beta(1-\rho))\hat{\lambda}_{t-1}\right]$$

Similarly, the workers' undertake similar optimisation exercise in order evaluate employment and unemployment in terms of current consumption. The Bellman equations corresponding to asset values for employment and unemployment can be written as:

$$W_t = w_t l_t - \frac{\Psi}{1+\phi}\frac{l_t^{1+\phi}}{\lambda_t} + \tilde{E}_t\beta_{t,t+1}\left[(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1}\right] \qquad (28)$$

$$U_t = b + \tilde{E}_t\beta_{t,t+1}\left[s_t(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1}\right] \qquad (29)$$

Consequently, the net value of taking a job can be written as:

$$W_t - U_t = w_t l_t - \frac{\Psi}{1+\phi}\frac{l_t^{1+\phi}}{\lambda_t} - b + \tilde{E}_t\beta_{t,t+1}\left[(1-\rho-s_t)(W_{t+1} - U_{t+1})\right] \qquad (30)$$

3.5 *The wage bargaining*

In this paper, working hours and wages are determined according to the efficient bargaining process whereby both labour variables are subject to negotiation between firms and workers at each period. The other type of bargaining process (right-to-manage), whereby firms retain the right to determine hours will be subject to future research. During the wage contract negotiations, firms and workers aim to maximise the following Nash product with respect to wage and working hours:

$$\max_{w_t, l_t}(W_t - U_t)^{\chi}(J_t - V_t)^{\chi} \qquad (31)$$

where χ denotes the bargaining power of the workers. The first order condition takes the following form:

$$\chi J_t = (1-\chi)(W_t - U_t) \qquad (32)$$

By substituting out J_t, W_t and U_t, we get the following wage equation:

$$w_t = \chi\left(\frac{x_t mpl_t}{\alpha} + \frac{\kappa}{\lambda_t}\frac{\theta_t}{l_t}\right) + (1-\chi)\left(\frac{mrs_t}{1+\phi} + \frac{b}{l_t}\right) \qquad (33)$$

It is important to note that the negotiated wage does not directly depend on expectations, hence expectations heterogeneity does not modify the functional form of wage determination used by standard NK models. Log-linearisation yields the following:

$$\hat{w}_t = \frac{\chi}{\alpha}\left(\hat{x}_t + m\hat{p}l_t\right) + \chi\Theta s\left(\hat{\theta}_t - \hat{l}_t - \hat{\lambda}_t\right) + \frac{1-\chi}{1+\phi} m\hat{r}s_t - (1-\chi)\Delta\hat{l}_t \tag{34}$$

Where $\Delta = \dfrac{b}{wh}$

Similarly, the determination of hours depends only on contemporaneous variables:

$$x_t mpl_t = mrs_t \tag{35}$$

$$\hat{x}_t + m\hat{p}l_t = m\hat{r}s_t \tag{36}$$

3.6 *Price setting and monetary policy*

Price setting takes place in a staggered fashion as explained by Calvo (1983) that has become standard in the New-Keynesian literature. There is a continuum of monopolistically competitive final goods producing firms index by *i* on the unit interval, whereby the aggregate final goods production is written as:

$$Y_t = \left(\int_0^1 Y_{i,t}^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{37}$$

where ε is the elasticity of substitution between final goods and expresses the degree of differentiability of the final goods which will be crucial determining firms' mark-up model price-stickiness. For each final good there is an individual consumer demand relation that is assumed to be known by the firms when they set the price (For further exposition, see Gali, 2009):

$$Y_{i,t} = \left(\frac{p_{i,t}}{p_t}\right)^{-\varepsilon} Y_t \tag{38}$$

The price aggregator is then written as:

$$p_t = \left(\int_0^1 p_{i,t}^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}} \tag{39}$$

Price stickiness derives from the assumption that only a fraction $(1-\varphi)$ of the final goods producers can set new prices each period. Moreover, an individual firm's probability of re-optimising at any period is independent of the time elapsed since it last reset the price. Based on Gali (2009), the log-linearised optimal price-setting rule can be written as:

$$p_{i,t} = \mu \widetilde{E}_t \sum_{k=0}^{\infty} \omega_{t,t+k} mc_{t+k}^n \tag{40}$$

where $\mu = \dfrac{\varepsilon}{\varepsilon-1}$, which corresponds to the log of the gross markup in the steady state.

The price-setting behaviour of the final goods sector is entirely forward-looking, since the optimal price is a function of the discounted stream of future marginal costs adjusted by the gross mark-up. This price-setting behaviour leads to the New-Keynesian Phillips-curve that takes the following form:

$$\hat{\pi}_t = \gamma \hat{m}c_t + \beta \widetilde{E}_t \hat{\pi}_{t+1} \tag{41}$$

where $\gamma = \dfrac{(1-\beta\varphi)(1-\varphi)}{\varphi}$

However, with heterogeneous expectations, the above relationship resembles the Hybrid Phillips-curve because of the persistence implied by the adaptive agents;

$$\hat{\pi}_t = \gamma \hat{m}c_t + \beta\left(\eta E_t \hat{\pi}_{t+1} + (1-\eta)\theta^2 \hat{\pi}_{t-1}\right) \tag{42}$$

The monetary authority follows a forward-looking Taylor-type rule with interest rate smoothing, whereby the interest rate responds to lagged interest rate, expected future inflation and the current out gap. The log-linearised formula can be written as:

$$\hat{r}_t = \zeta_i \hat{r}_{t-1} + \zeta_\pi \widetilde{E}_t \hat{\pi}_{t+1} + \zeta_y \hat{y}_t + \varepsilon_t \tag{43}$$

4. Results

This section aims at analysing the responses of the baseline model to a -25 basis monetary policy shock under difference degrees of expectations heterogeneity. Figure 1a and 1b plot the impulse responses of the main macroeconomic and labour market variables. More specifically, figure 1a plots the responses of the nominal interest rate, the real interest rate, inflation, marginal cost, the shadow price, output, consumption, marginal product of labour and marginal rate of substitution between labour supply and leisure. Monetary policy tightening reduces the real interest rate because of price rigidity. This in turn increases consumption, output for final goods and working hours. As a result, wages and the marginal cost of production increases that causes higher inflation as well. Figure 1b plots the responses of employment, working hours, wage, matches, unemployment, vacancies, the labour market tightness, the probability of a vacancy being filled, the probability of a searching worker finding a job. Figure 1b shows that as the falling real interest rate raises current and expected aggregate demand, firms increase their hiring activity. The rising job creation increases employment and the probability of a searching worker finding a job.

Figure 2 and 3 plot the responses of the same variables to an identical monetary policy shock under different degree of expectational heterogeneity. Figure 2a and 2b depict the case, when $\eta = 0.75$, that is, when 75% of the agents are rational and 25% follow an adaptive rule. The limited sophistication of this forecasting rule leads to an overestimation of firms' expected future profits in response to an increase in aggregate demand. This leads to an "overshooting" effect and results in a substantial increase in job creation and new vacancy posting compared to the perfectly rational case. As vacancy posting rises more than the number searching workers, the probability of vacancies being filled drops. In addition, the number of matches and the labour market tightness increases as well. It is important to note that expectations heterogeneity does not affect wages directly, since wages are a function of contemporaneous and not of forward-looking variables. Consistently, the simulation results give almost identical wage responses regardless the degree of expectations heterogeneity.

Figure 3a and 3b illustrate the case when $\eta = 0.5$, that is, when 50% of the agents are rational and the rest follow an adaptive rule. Similar to the situation depicted in figure 2a and 2b, expectational heterogeneity leads to firms' overreaction to the aggregate demand shock and results in a substantial increase in their hiring activity. Quantitatively, a drop in the fraction of perfectly rational agents from 100% to 50% increases the positive employment response to a monetary policy shock by about 800% without changing the wage level and thereby inflation dynamics. This is primarily because an increase of similar magnitude in the number of posted vacancies, and a rise in matches and the job finding probability.

So far, it has been assumed that workers have relatively high bargaining power, $\chi = 0.5$, which corresponds to large wage responses. However, there has been ample empirical evidence for the presence of wage rigidities calling for a lower value for the bargaining power compared to that used in the baseline model. Figures 4-6 therefore present the results under different degrees of expectations heterogeneity when workers have very little bargaining power, $\chi = 0.01$.

Figure 4-6 show that reduced bargaining power substantially reduces the wage response without changing the response of working hours compared to the baseline model. This is because of the neoclassical nature of the labour market with efficient bargaining, whereby working hours are dependent on marginal rate of substitution and the marginal product of labour and not affected by the wage level. Moreover, reduced bargaining power however does not change the positive job creation and employment effects of expectations heterogeneity that are similar in magnitude to the baseline model.

5. Conclusion

This paper extended the current New Keynesian labour market literature by introducing heterogeneous expectations. Relaxing the assumption of perfect rationality substantially changes the dynamics of the labour market variables, while leaving the dynamics of the main macroeconomic variables relatively unchanged compared to standard New Keynesian labour model with search and matching frictions. The main contribution of the paper is to show how expectations heterogeneity can generate large unemployment and vacancy responses that a broad class of search models cannot generate (Shimer, 2005). The key insight is that boundedly rational beliefs amplify firms' increasing vacancy-posting activity in response to innovations in monetary policy and aggregate demand compared to the model under perfect rationality. Future research can incorporate the presented expectational heterogeneity into medium-scale empirical labour DSGE models such as Gertler et al (2008) and Christoffel et al (2008).

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Appendix A

Table 1: Parameter values

Descriptions	Parameter	Value
Elasticity of intertemporal substitution in the supply of hours	ϕ	10
Calvo parameter	φ	0.85
Elasticity of substitution between goods	ε	6
Discount factor	β	0.99
Steady state employment rate	n	0.8
Elasticity of matches to unemployment	ν	0.5
Technology parameter	α	0.9
Bargaining power	χ	0.5
Probability of vacancy filling	q	0.5
Separation rate	ρ	0.08
Probability of job finding	s	0.25
Relative benefit from unemployment	b	0.47
Steady state working hours	l	1
Interest rate smoothing	ζ_i	0.9
Monetary policy's reaction to inflation	ζ_π	1.5
Monetary policy's reaction to output	ζ_y	0.5
Proportion of RE agents	η	$0.5 \leq \chi \leq 1$
Expectation operator	ψ	0.8

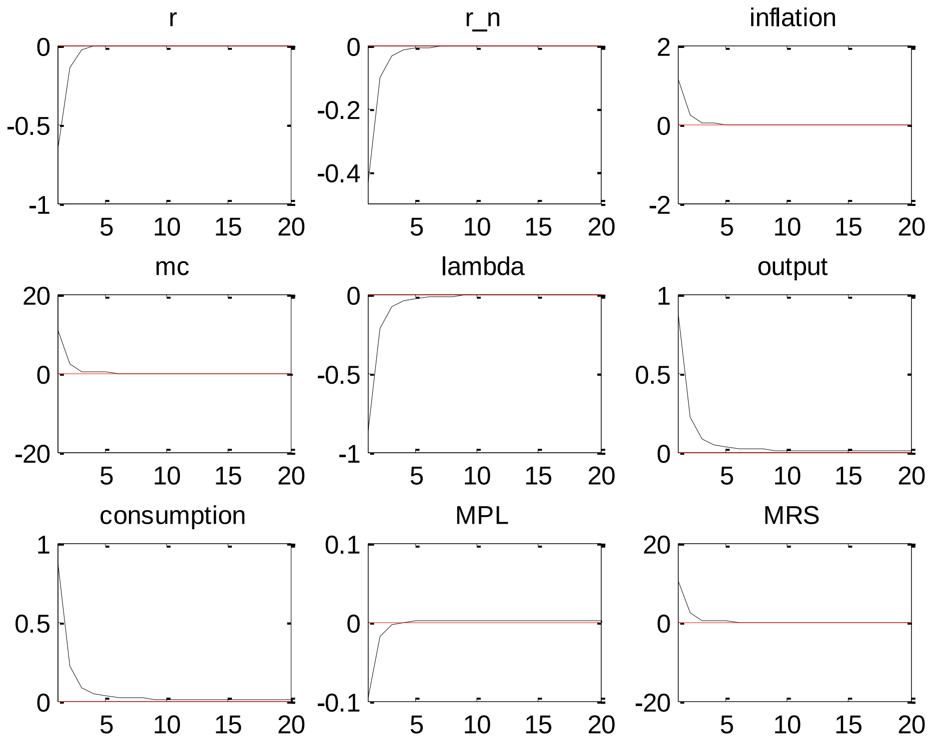

Figure 1a: Impulse responses of macro aggregates to a -25 basis point monetary policy shock, when $\eta = 1$ (RE), and workers' bargaining power is $\chi = 0.5$. The x-axis is quarters.

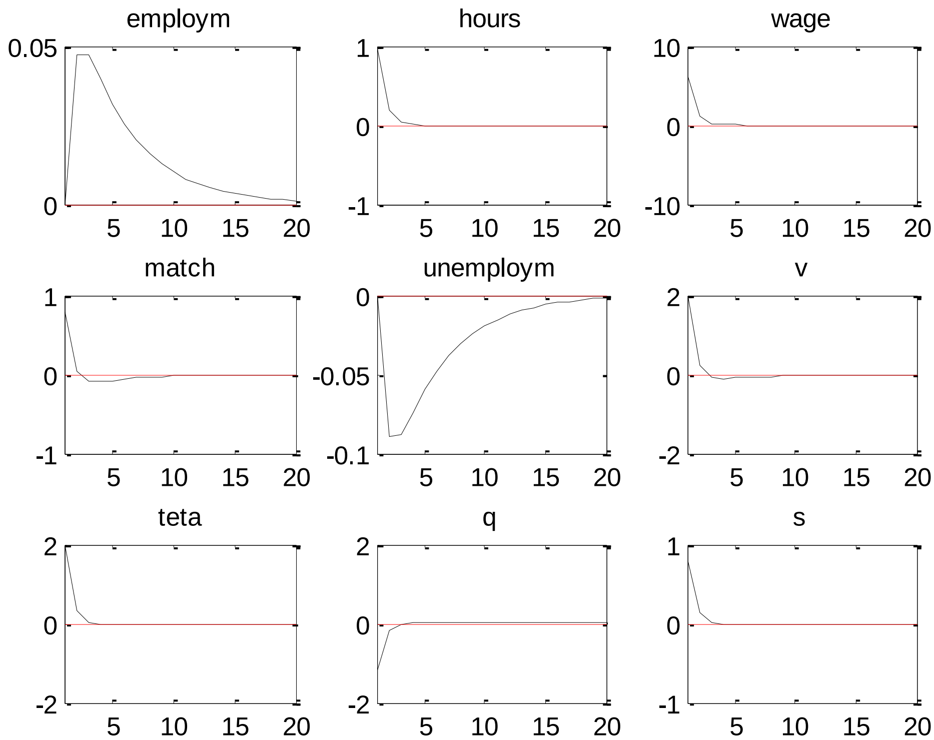

Figure 1a: Impulse responses of the labour market to a -25 basis point monetary policy shock, when $\eta = 1$ (RE), and workers' bargaining power is $\chi = 0.01$. The x-axis is quarters.

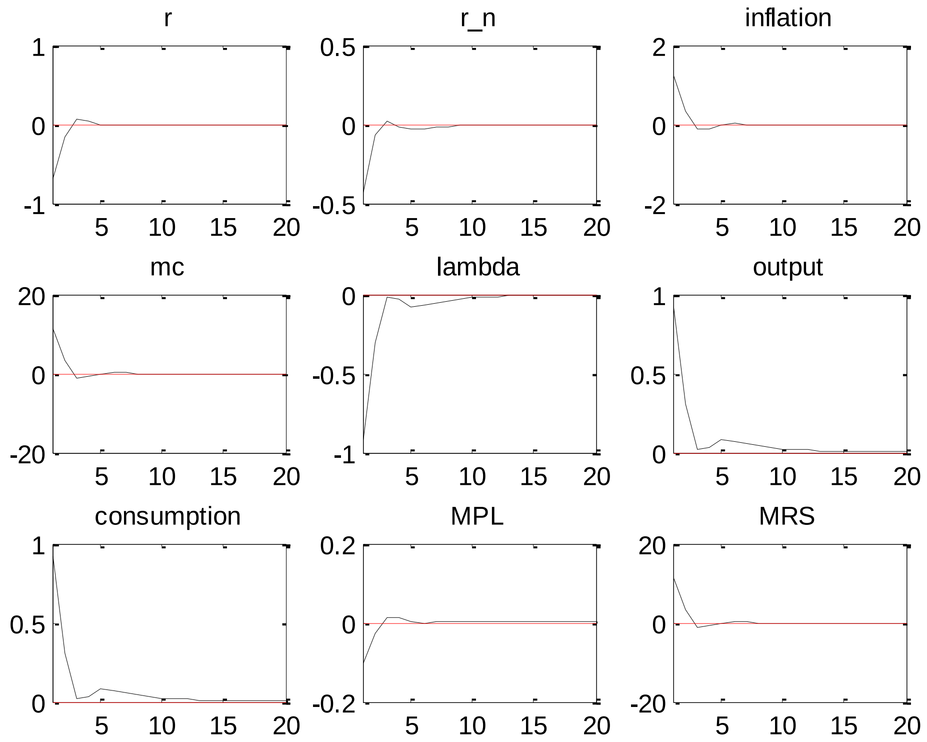

Figure 2a: Impulse responses of macro aggregates to a -25 basis point monetary policy shock, when $\eta = 0.75$ (HE), and workers' bargaining power is $\chi = 0.5$. The x-axis is quarters.

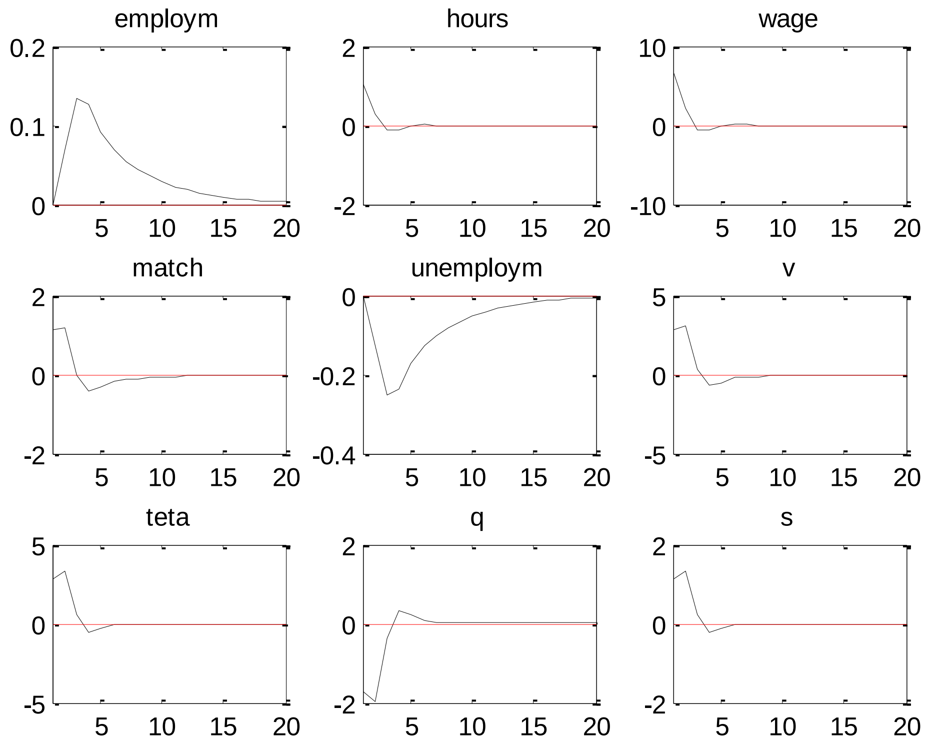

Figure 2b: Impulse responses of the labour market to a -25 basis point monetary policy shock, when $\eta = 0.75$ (HE), and workers' bargaining power is $\chi = 0.5$. The x-axis is quarters.

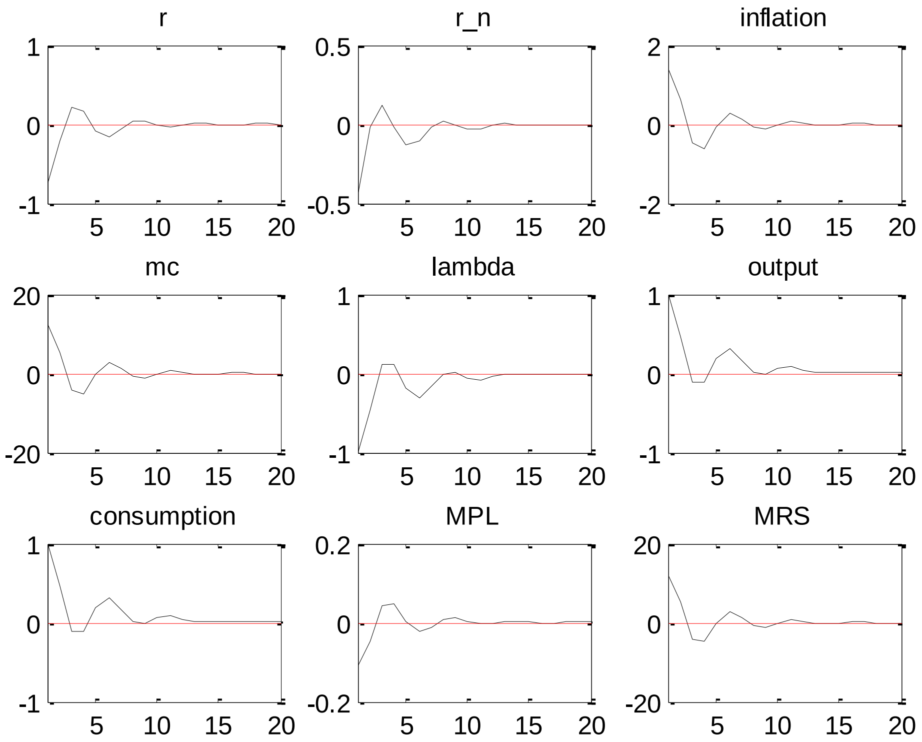

Figure 3a: Impulse responses of macro aggregates to a -25 basis point monetary policy shock, when $\eta = 0.5$ (HE), and workers' bargaining power is $\chi = 0.5$. The x-axis is quarters.

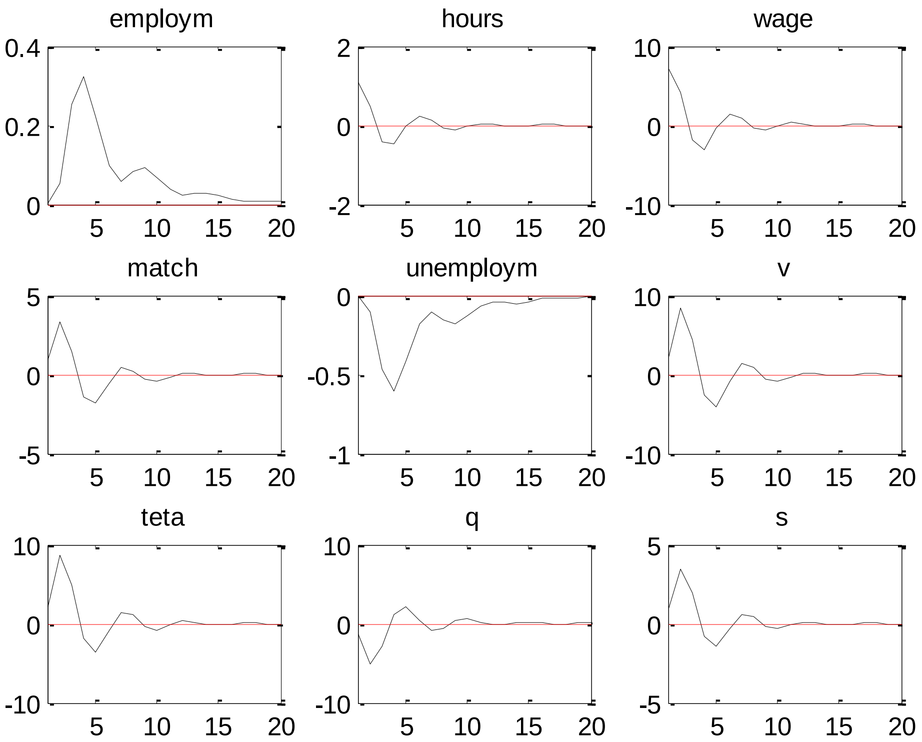

Figure 3b: Impulse responses of the labour market to a -25 basis point monetary policy shock, when $\eta = 0.5$ (HE), and workers' bargaining power is $\chi = 0.5$. The x-axis is quarters.

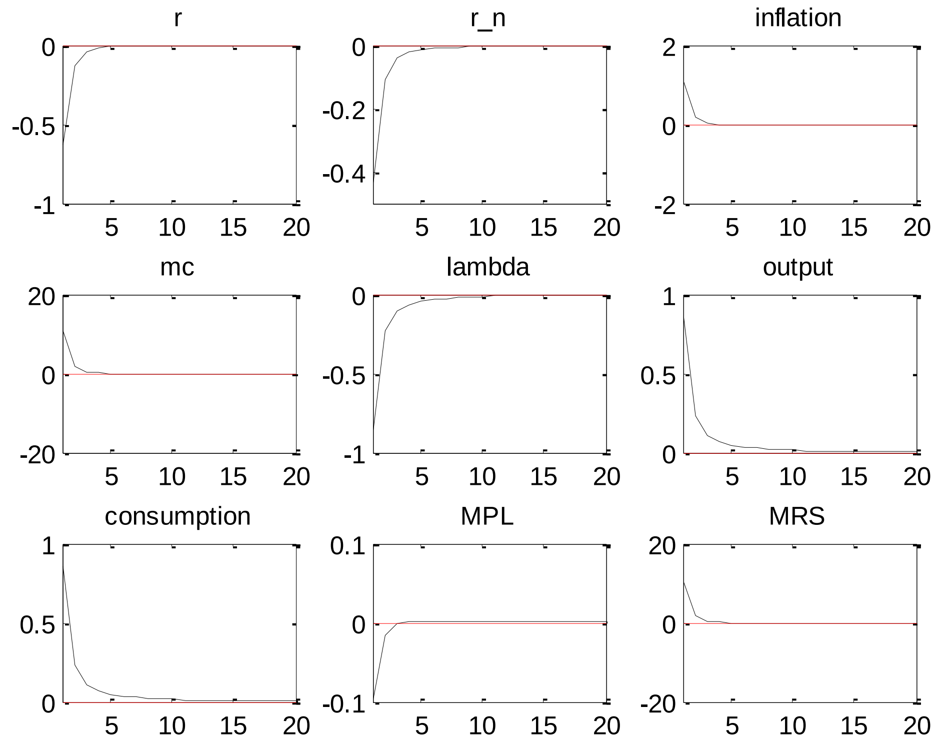

Figure 4a: Impulse responses of macro aggregates to a -25 basis point monetary policy shock, when $\eta = 1$ (RE), and workers' bargaining power is $\chi = 0.01$. The x-axis is quarters.

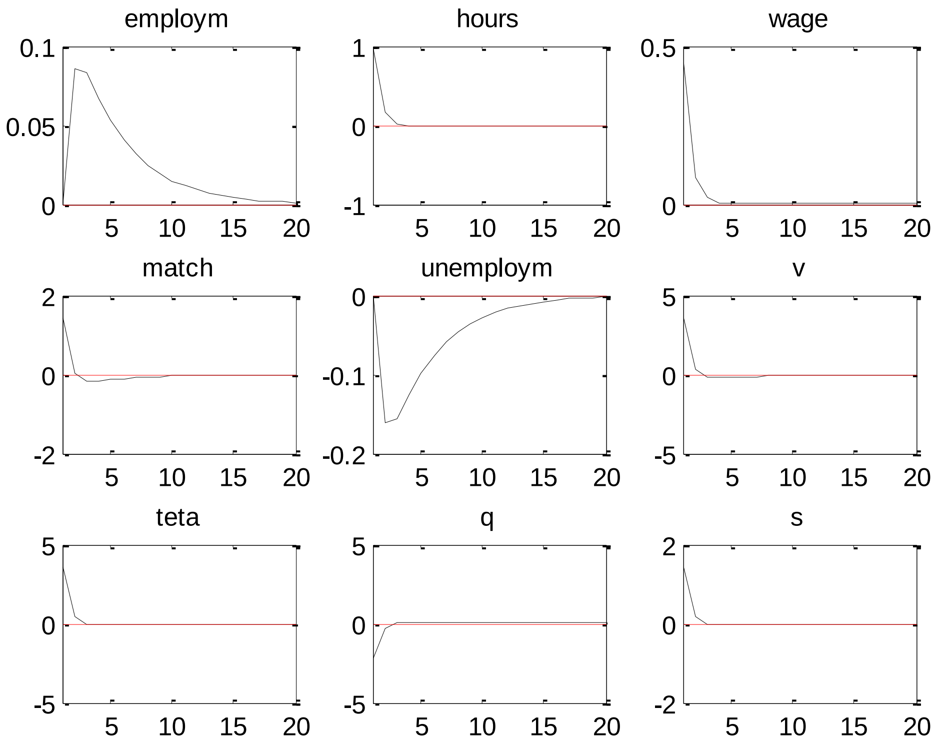

Figure 4b: Impulse responses of the labour market to a -25 basis point monetary policy shock, when $\eta = 1$ (RE), and workers' bargaining power is $\chi = 0.01$. The x-axis is quarters.

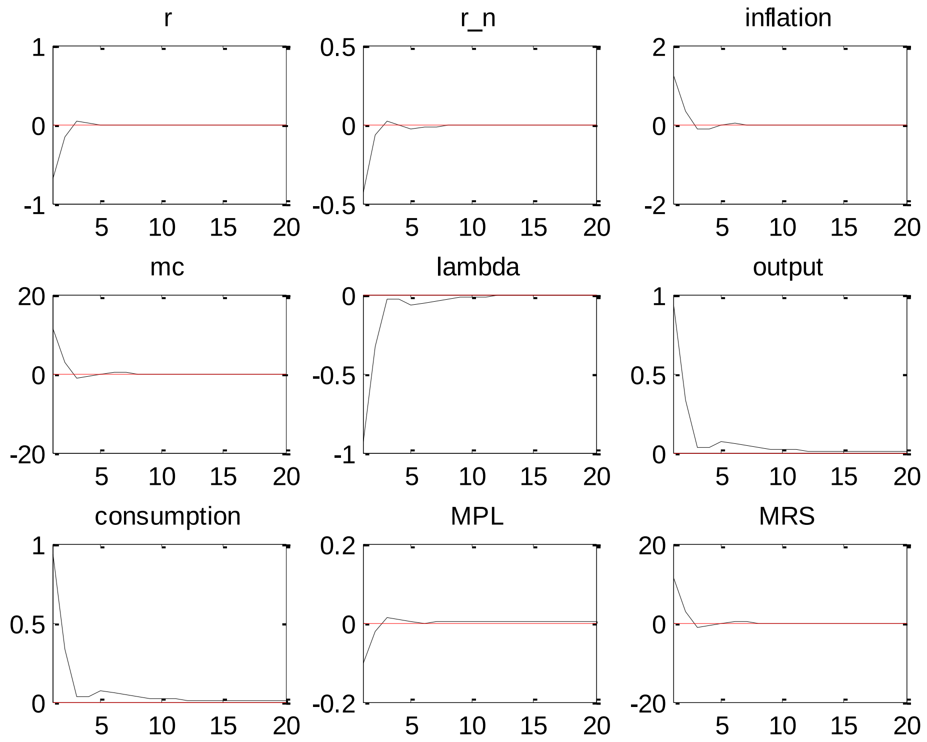

Figure 5a: Impulse responses of macro aggregates to a -25 basis point monetary policy shock, when $\eta = 0.75$ (RE), and workers' bargaining power is $\chi = 0.01$. The x-axis is quarters.

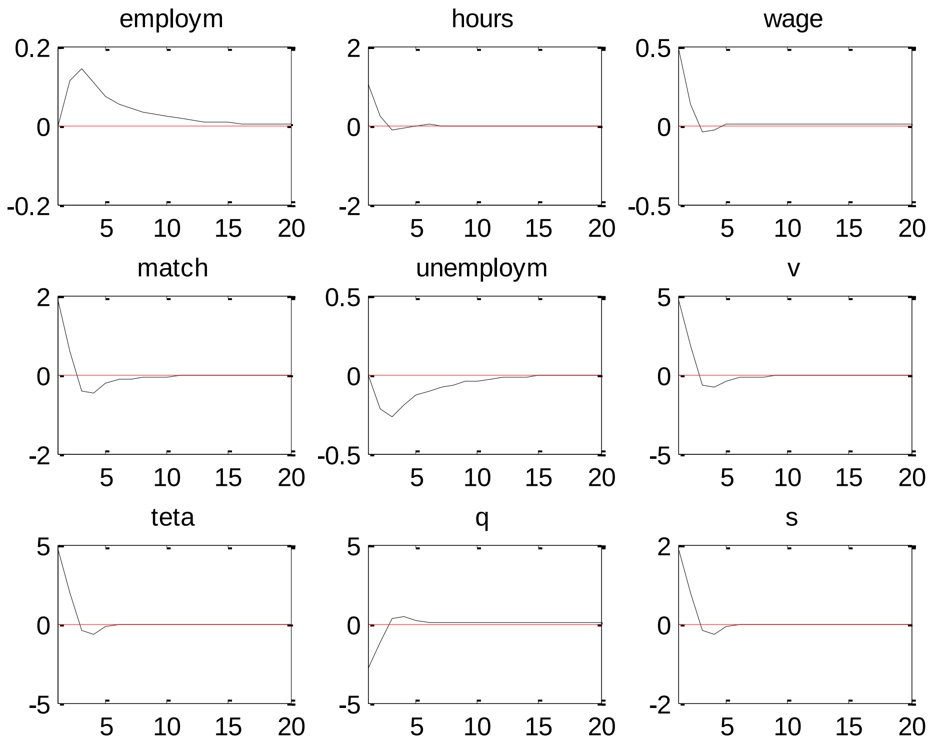

Figure 5b: Impulse responses of the labour market to a -25 basis point monetary policy shock, when $\eta = 0.75$ (RE), and workers' bargaining power is $\chi = 0.01$. The x-axis is quarters.

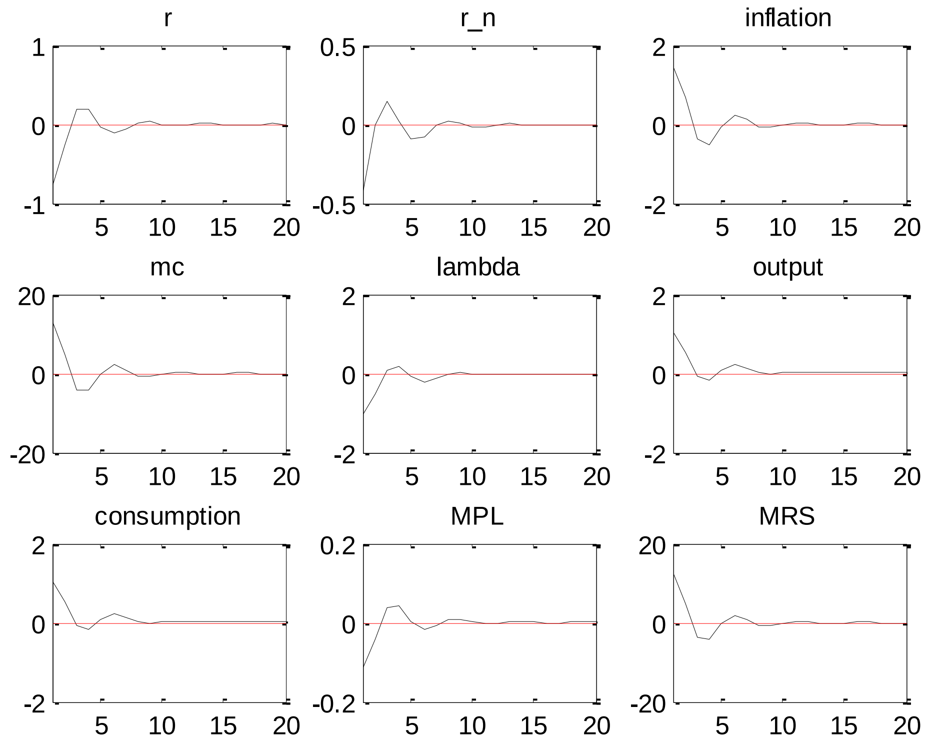

Figure 6a: Impulse responses macro aggregates to a -25 basis point monetary policy shock, when $\eta = 0.5$ (RE), and workers' bargaining power is $\chi = 0.01$. The x-axis is quarters.

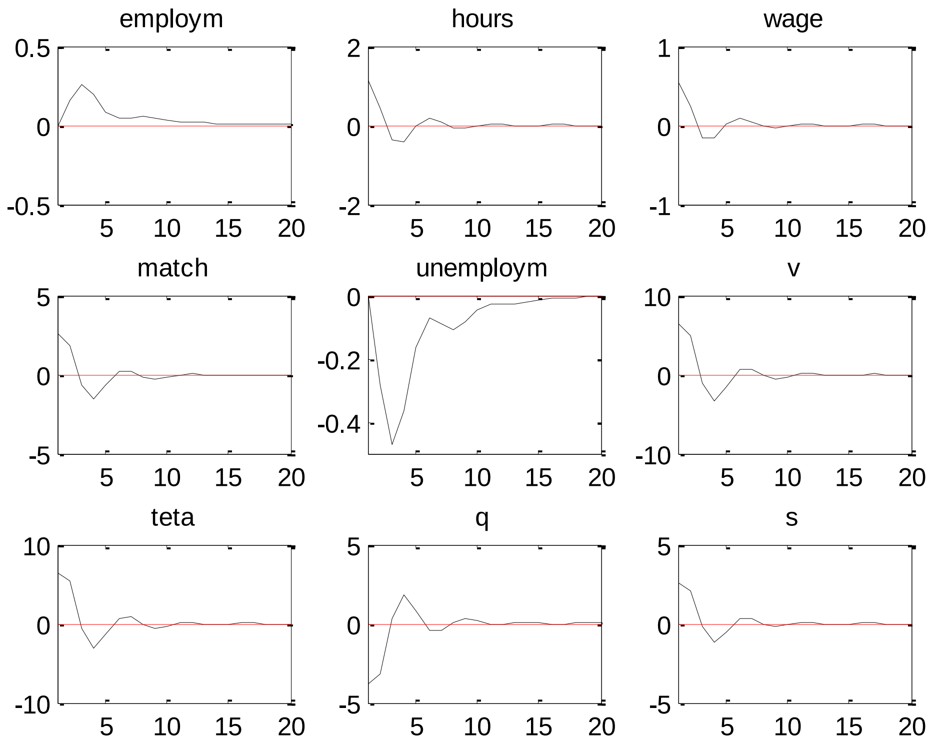

Figure 6b: Impulse responses of the labour market to a -25 basis point monetary policy shock, when $\eta = 0.5$ (RE), and workers' bargaining power is $\chi = 0.01$. The x-axis is quarters.