Optimal Choice of Exchange Rate Regimes with Labour Market Frictions*

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Abstract

This paper studies the optimal choice of exchange rate regimes in a two country model with sticky prices and matching frictions in the labour market. Currency fluctuations by affecting the price of tradable goods tend to exacerbate movements in and out he labour market and the volatility of vacancy creation which in turn tend to increase overall macroeconomic volatility. For this reason and despite the well-known insulating properties of currency fluctuations the monetary authority can accomplish domestic stabilization and increase welfare by having exchange rate as an independent target in the monetary policy rule. The paper also shows that the model presented is compatible with well-known stylized facts of both the international transmission of shocks (such as positive co-movements of output and employment) and of the labour market (such as the Beveridge curve, the procyclicality of labour market tightness and the high volatility of labour market variables).

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1 Introduction

This paper provides a quantitative assessment of the optimal choice of exchange rate regime for a two country model with price stickiness and matching frictions. The reason for posing this question is twofold. First labor market flows and labor costs are an important determinant of the international transmission mechanism of shocks and have been advocated in the past as a solution to international co-movements puzzles[1]. Hence the optimal choice of the exchange rate target cannot neglect the impact that relative movements of unemployment, wages and job flows have on currency fluctuations. On the other side it is well known that both asymmetric shocks and exchange rate fluctuations have a significant impact on labor market dynamics[2]. Hence in this context the optimal degree of exchange rate stabilization is an important determinant of international business cycle fluctuations.

To analyze the aforementioned issues I use a DSGE two country model with matching frictions and price rigidity. The labor market is characterized by exogenous job destruction and wages are determined through an efficient Nash bargaining. Those elements allow to characterize the dynamic of unemployment and labor market participation in response to external shocks and exchange rate fluctuations. The product market is characterized by monopolistic competition with firms facing an adjustment cost of changing prices. This is an essential assumption for the comparison of different monetary policy rules and exchange rate arrangements. The analysis is then divided in two blocks. First, I study the international transmission of shocks to evaluate whether the model employed is compatible with the main stylized facts concerning the labor market and the international co-movements. Secondly, I study the impact on macroeconomic volatility and welfare of different monetary policy rules and exchange rate arrangements. A crucial element of this second part of the analysis is the use of second order approximation methods which allows to study policy rules in a dynamic economy that evolves around a steady-state which remains distorted[3]. In our context, the steady state of the economy is distorted by the presence of matching frictions and of the monopolistic distortion. As emphasized by Kim et al. (2003) and Schmitt-Grohe and Uribe

[1] Hairault (1998).

[2] See Blanchard and Katz (1992), Decressin and Fatas (1995), Obstfeld and Peri (1998) for a decomposition of the adjustment of regional labor markets to asymmetric shocks. See Gourinchas (1998) for an analysis of the impact of exchange rate fluctuations on labor market variables.

[3] See Kollmann (2003a, 2003b) and Schmitt-Grohe and Uribe (2003, 2004b),

(2004b), this strategy requires that an accurate evaluation of welfare be based on a *higher order approximation* of all the conditions that characterize the competitive equilibrium of the economy.

Several results stand out. Concerning the international transmission of shocks, I find that the model is able to generate positive co-movements of employment and output thereby resolving the well-known puzzle even in presence of country specific shocks. In a two country model with sticky prices but in absence of matching frictions a (positive) foreign productivity shock induces a fall in foreign inflation and a shift in consumption demand from domestic to foreign produced goods (*switching expenditure effect).* This implies a depreciation in the terms of trade (a loss in competitiveness for the domestic economy), a fall in domestic consumption demand and output. This effect per se would induce negative correlations of output and employment, a fact which is incompatible with data observations[4]. In my model a (positive) foreign productivity shock induces an increase in vacancies, employment and wages for the foreign economy. Due to a wealth effect the increase in wages induce an increase in foreign consumption demand and in foreign inflation. The increase in foreign inflation induces in turn a shift in consumption from foreign to domestically produced goods. Due to the increase in exports domestic firms increase vacancies, employment and production as well. As a result we observe an increase in employment and output in both countries (even in response to a shock originated only in the foreign economy).

The successful replication of the international co-movements comes together with the ability of the model to reproduce at a country level the main stylized facts that characterize the labor market such as the Beveridge curve (the negative correlation between vacancies and unemployment), the procyclicality of labour market tightness and the high volatility of job flows.

The core results of the paper concern the evaluation of the optimal choice of exchange rate regimes as characterized by the monetary policy rules. Results show that increasing the response to exchange rate fluctuations in the monetary policy rule reduces macroeconomic volatility. As agents are risk averse the fall in macroeconomic volatility implies an increase in welfare. The model features a tension between the beneficial properties of exchange rate movements as insulating devices from asymmetric shocks and the negative impact that currency volatility has on job flows in the trading sector (in response to currency appreciations jobs are destroyed and vacancies reduced;

[4]See Backus, Kehoe and Kydland (1985).

the opposite is true for currency depreciations). The second consideration seems to prevail in our case. Increasing the degree of exchange rate stabilization in the monetary policy rule tends to stabilize job flows, employment and output. As agents features less unemployment risk they are able to smooth consumption as well. Finally since agents are risk averse stabilization of consumption comes together with an increase in welfare.

This paper is related to two different strands of the literature. On the one side its motivation is grounded on a series of empirical studies that have documented the link between currency fluctuatiuons and labour market instability. Branson and Love 1988, Revenga 1992, Burgess and Knetter 1996 and Campa and Goldberg 1998 show that exchange rates have significant implications for employment in the U.S. Glodberg and Tracy 1999 and Aronson, Goldberg and Tracy 1999 show that for the U.S. manufacturing industry (a tipycal tradable good sector) both wages and job flows are very sensitive to dollar fluctuations. Topel 1986 finds that wages increase in response to current relative demand shocks and decrease in response to expected future relative demand shocks. Finally Davis and Haltiwanger 1997 find that the labour force adjusts significantly to external shocks such as oil price shocks.

This paper is also related to the a strand of the theoretical literature that introduces matching frictions in RBC[5] and New Keynesian models[6]. More recently some authors have studied the impact of matching frictions in an open economy context. Hairault (1998) shows that the introduction of matching frictions in a standard two-country two-good model allows to resolve the output/employment co-movement puzzle[7], while Faia and Campolmi (2004) use a two country New Keynesian model with matching frictions to analyze the impact of different labor market institutions on inflation differentials in the EMU. Finally the paper is related to a very recent strand of the literature which studies the principles of optimal monetary policy in presence of labor market rigidities and of an inflation/unemployment trade-off (see Blanchard and Gali' (2006), Faia (2006a, 2006b) and Thomas (2006)).

[5] See Merz (1995), Andolfatto (1996), Cooley and Quadrini (2000) among others.

[6] Several other authors, ranging from Walsh (2003) to Blanchard and Gali' (2005), have recently introduced matching frictions into new Keynesian models.

[7] Notice that Hairault (1998) assumes that productivity shocks produce international spillovers. He attributes the resolution of the puzzle to the fact that in models with matching frictions expected return to search induces responses to search and recruiting activity which are propagated through time and this allows to amplify the impact of productivity spillovers.

The paper proceeds as follow. Section 2 presents the model. Section 3 presents the dynamic and quantitative properties of the model. Section 4 analyzes the welfare properties of the different monetary policy rules. Finally section 5 concludes.

2 A Two Country Model with Labor Market Frictions

There are two regions of equal size. Each country is inhabited by a continuum of agents with measure one. Each economy is populated by households who consume different varieties of domestically produced and imported goods, save and work. Households save in international non-state contingent securities and in an insurance fund that allows them to smooth income fluctuations associated with periods of unemployment. Each agent can indeed be either employed or unemployed. In the first case he receives a wage that is determined according to a Nash bargaining, in the second case he receives an unemployment benefit. The labor market is characterized by matching frictions and exogenous job separation. The production sector acts as a monopolistic competitive sector which produces a differentiated good using labor as input and faces adjustment costs a' la Rotemberg (1982).

2.1 Households in the Domestic and Foreign Country

Let's denote by $c_t \equiv [(1-\gamma)^{\frac{1}{\eta}} c_{h,t}^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} c_{f,t}^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}}$ a composite consumption index of domestic and imported bundles of goods, where γ is the balanced-trade steady state share of imported goods and by $p_t \equiv [(1-\gamma)p_{h,t}^{1-\eta} + \gamma p_{f,t}^{1-\eta}]^{\frac{1}{1-\eta}}$ the CPI index with $\eta > 0$ being the elasticity of substitution between domestic and foreign goods. Optimal allocation of expenditure between domestic and foreign bundles yields:

$$c_{h,t} = (1-\gamma)\left(\frac{p_{h,t}}{p_t}\right)^{-\eta} c_t;\; c_{f,t} = \gamma\left(\frac{p_{f,t}}{p_t}\right)^{-\eta} c_t \tag{1}$$

Each bundle is composed of imperfectly substitutable varieties, $c_{h,t} \equiv \int_0^1 [(c_{h,t}^i)^{\frac{\epsilon-1}{\epsilon}} di]^{\frac{\epsilon}{\epsilon-1}}$ and $c_{f,t} \equiv \int_0^1 [(c_{f,t}^i)^{\frac{\epsilon-1}{\epsilon}} di]^{\frac{\epsilon}{\epsilon-1}}$, with $\varepsilon > 1$ being the elasticity of substitution. Hence optimal allocation of expenditure for each variety is given by $c_{h,t}^i = \left(\frac{p_{h,t}^i}{p_{h,t}}\right)^{-\varepsilon} c_{h,t}$; $c_{f,t}^i = \left(\frac{p_{f,t}^i}{p_{f,t}}\right)^{-\varepsilon} c_{f,t}$. There is continuum of agents who maximize the expected lifetime utility[8]:

[8]Let $s^t = \{s_0, ...s_t\}$ denote the history of events up to date t, where s_t denotes the event realization at date t. The date 0 probability of observing history s^t is given by ρ_t. The initial state s^0 is given so that $\rho_0 = 1$. Henceforth,

$$E_t \left\{ \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma} \right\} \tag{2}$$

where c denotes aggregate consumption in final goods. Households supply labor hours inelastically h (which is normalized to 1). Total real labor income is given by w_t and is specified below. Unemployed households members, u_t, receive an unemployment benefit, b. The contract signed between the worker and the firm specifies the wage and is obtained through a Nash bargaining process. In order to finance consumption at time t each agent also invests in non-state contingent nominal bonds b_t which pay a gross nominal interest rate $(1+r_t^n)$ one period later and in non-state contingent nominal bonds which are internationally traded, b_t^*, and which pay a gross nominal interest rate $(1+r_t^{n,f})$ one period later. As in Andolfatto (1996) it is assumed that workers can insure themselves against earning uncertainty and unemployment. For this reason the wage earnings have to be interpreted as net of insurance costs. Finally agents receive profits from the monopolistic sector which they own, Θ_t, and pay lump sum taxes, τ_t. The sequence of budget constraints in terms of domestic CPI consumption goods reads as follows:

$$c_t + \frac{b_t}{p_t} + e_t^r \frac{b_t^*}{p_t^*} \leq w_t(1-u_t) + bu_t + \frac{\Theta_t}{p_t} - \frac{\tau_t}{p_t} + (1+r_{t-1}^n)\frac{b_{t-1}}{p_t} + (1+r_{t-1}^{n,f})e_t^r \frac{b_{t-1}^*}{p_t^*} \tag{3}$$

where e_t^r is the real exchange rate and is given by $e_t^r = e_t \frac{p_t^*}{p_t}$ where e_t is the nominal exchange rate. Households choose the set of processes $\{c_t, b_t, b_t^*\}_{t=0}^{\infty}$ taking as given the set of processes $\{p_t,$ $w_t,$ $r_t^n, r_t^{n,f}\}_{t=0}^{\infty}$ and the initial wealth b_0, b_0^* so as to maximize (2) subject to (3). The following optimality conditions must hold:

$$c_t^{-\sigma} = \beta(1+r_t^n)E_t \left\{ c_{t+1}^{-\sigma} \frac{p_t}{p_{t+1}} \right\} \tag{4}$$

$$c_t^{-\sigma} = \beta(1+r_t^{n,f})E_t \left\{ c_{t+1}^{-\sigma} \frac{p_t^*}{p_{t+1}^*} \frac{e_{t+1}^r}{e_t^r} \right\} \tag{5}$$

$$c_t^{-\sigma} = \lambda_t \tag{6}$$

Equation (4) is the Euler condition with respect to domestic bonds. Equation (5) is the optimality condition with respect to internationally traded bonds. Equations (6) is the marginal utility of

and for the sake of simplifying the notation, let's define the operator $E_t\{.\} \equiv \sum_{s_{t+1}} \rho(s^{t+1}|s^t)$ as the mathematical expectations over all possible states of nature conditional on history s^t.

consumption. Optimality requires that No-Ponzi condition on wealth is also satisfied. Due to imperfect capital mobility and/or in order to capture the existence of intermediation costs in foreign asset markets workers pay a spread between the interest rate on the foreign currency portfolio and the interest rate of the foreign country. This spread is proportional to the (real) value of the country's net foreign asset position:

$$\frac{(1+r_t^{n,f})}{(1+r_t^{n,*})} = \zeta\left(e_t^r \frac{b_t^*}{p_t^*}\right) \tag{7}$$

where $\zeta > 0$[9], $\zeta' > 0$. In addition we assume that the initial distribution of wealth between the two countries is symmetric.

Workers in the Foreign Country. We assume throughout that all goods are traded, that both countries face the same composition of consumption bundle and that the *law of one price* holds. This implies that $p_{h,t} = e_t p_{h,t}^*, p_{f,t} = e_t p_{f,t}^*$. Foreign workers face an allocation of expenditure and wealth similar to the one of workers in the domestic economy except for the fact that they do not pay an additional spread for investing in the international portfolio. Arbitrage condition between the two economies implies the following expectational uncovered interest rate parity:

$$E_t\left\{\frac{\lambda_{t+1}^*}{\lambda_t^*}\right\} = E_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\frac{e_{t+1}^r}{e_t^r}\zeta\left(e_t^r\frac{b_t^*}{p_t^*}\right)\right\} \tag{8}$$

which states that marginal utilities across countries are equalized up to the spread for the country risk.

2.2 The Production Sector In the Domestic and the Foreign Country

The maximization problem which characterize the production sector are symmetric across the two economies. Firms in the production sector sell their output in a monopolistic competitive market and meet workers on a matching market. The labor relations are determined according to a standard Mortensen and Pissarides (1999) framework. Workers must be hired from the unemployment pool and searching for a worker involves a fixed cost. Workers' wages are determined through a Nash

[9] As shown in Schmitt-Grohe and Uribe (2001) and Benigno (2002) this assumption is needed in order to maintain the stationarity in the model. Schmitt-Grohe and Uribe (2001) also show that adding this spread - i.e. whose size has been shown negligible in Lane and Milesi-Ferretti (2001) - does not change the dynamic behavior of the economy as compared to the one observed with complete asset market assumption. See also Mendoza (1991), Senhadji (1994).

decentralized bargaining process and the relationship between a matched worker and a firm can be exogenously discontinued.

In what follows I show all relations for the labour market of the domestic economy. Symmetric relations apply to the foreign economy.

2.2.1 Search and Matching in the Labor Market of the Home and the Foreign Country

The search for a worker involves a fixed cost κ and the probability of finding a worker depends on a constant return to scale matching technology which converts unemployed workers u and vacancies v into matches, m:

$$m(u_t, v_t) = m u_t^{\xi} v_t^{1-\xi} \tag{9}$$

where $v_t = \int_0^1 v_{i,t} di$. Defining labor market tightness as $\theta_t \equiv \frac{v_t}{u_t}$, the firm meets unemployed workers at rate $q(\theta) = \frac{m(u_t, v_t)}{v_t} = m\theta_t^{-\xi}$, while the unemployed workers meet vacancies at rate $\theta_t q(\theta_t) = m\theta_t^{1-\xi}$. If the search process is successful, the firm in the monopolistic good sector operates the following technology:

$$y_{i,t} = z_t n_{i,t} \tag{10}$$

where z_t is the aggregate productivity shock which follows a first order autoregressive process, $e^{z_t} = e^{\rho_z z_{t-1}} \varepsilon_{z,t}$, $n_{i,t}$ is the number of workers hired by each firm. Matches are destroyed at an exogenous rate ρ. Labor force in this economy is normalized to unity. The number of employed people at time t in each firm i is given by the number of employed people at time $t-1$ plus the flow of new matches concluded in period $t-1$ who did not discontinue the match:

$$n_{i,t} = (1-\rho)(n_{i,t-1} + v_{i,t-1} q(\theta_{i,t-1})) \tag{11}$$

Unemployment is given by total labor force minus the number of employed workers:

$$u_t = 1 - n_t \tag{12}$$

Finally we define the job creation rate as:

$$jc_t = \frac{(1-\rho) v_{t-1} q(\theta_{t-1})}{n_{t-1}} \tag{13}$$

2.2.2 Open Economy Relations

The consumers and workers maximization problems have been derived assuming normalization to CPI index since the bundles consumed are aggregates of domestic and foreign goods. On the other side firms will deflate their profits by referring to the domestic GDP deflator. It is necessary at this point to introduce a series of relationships linking real quantities to the relevant relative prices. The terms of trade is the relative price of imported goods, $s_t \equiv \frac{p_{f,t}}{p_{h,t}}$. It can be related to the CPI-PPI ratio as follows:

$$\phi_t \equiv \frac{p_t}{p_{h,t}} = [(1-\gamma) + \gamma s_t^{1-\eta}]^{\frac{1}{1-\eta}} \tag{14}$$

The terms of trade and the inflation rates are linked through the following equation:

$$s_t = \frac{\pi_{f,t}}{\pi_{h,t}} \frac{e_{t-1}}{e_t} s_{t-1} \tag{15}$$

2.2.3 Monopolistic Firms

Firms in the monopolistic sector (of the home country) use labor to produce different varieties of consumption good and face a quadratic cost of adjusting prices. The representative firm in the domestic region chooses $\left\{p_{h,t}^i, n_{i,t}, v_{i,t}\right\}$ (taking as given the wage schedule) to solve the following maximization problem (in real terms):

$$Max\Pi_{i,t} = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left\{ \frac{p_{h,t}^i}{p_{h,t}} y_t^i - \phi_t w_{i,t} n_{i,t} - \kappa v_{i,t} - \frac{\psi}{2} \left(\frac{p_{h,t}^i}{p_{h,t-1}^i} - 1 \right)^2 y_t \right\} \tag{16}$$

subject to

$$\text{s.to:} \qquad y_t^i = \left(\frac{p_{h,t}^i}{p_{h,t}} \right)^{-\epsilon} y_t = z_t n_{i,t} \tag{17}$$

$$\text{and: } n_{i,t} = (1-\rho)(n_{i,t-1} + v_{i,t-1} q(\theta_{i,t-1})) \tag{18}$$

where $\frac{\psi}{2} \left(\frac{p_{h,t}^i}{p_{h,t-1}^i} - 1 \right)^2 y_t^i$ represent the cost of adjusting prices, ψ can be thought as the sluggishness in the price adjustment process and κ as the cost of posting vacancies. Let's define mc_t, the lagrange multiplier on constraint (17), as the marginal cost of firms and μ_t, the lagrange multiplier on constraint (18), as the marginal value of one worker. Since all firms will chose in equilibrium the same price and allocation we can now assume symmetry and drop the index i. First order conditions for the above problem read as follows:

- n_t :

$$\mu_t = mc_t z_t - \phi_t w_t + \beta E_t(\frac{\lambda_{t+1}}{\lambda_t})((1-\rho)\mu_{t+1}) \tag{19}$$

- v_t :

$$\frac{\kappa}{q(\theta_t)} = \beta E_t(\frac{\lambda_{t+1}}{\lambda_t})((1-\rho)\mu_{t+1}) \tag{20}$$

- $p_{h,t}$:

$$\frac{c_{h,t} + c^*_{h,t}}{y_t}[1-(1-mc_t)\varepsilon] - \psi(\pi_{h,t}-1)\pi_{h,t} + \beta E_t(\frac{\lambda_{t+1}}{\lambda_t})[\psi(\pi_{h,t+1}-1)\pi_{h,t+1}\frac{y_{t+1}}{y_t}] = 0 \tag{21}$$

Merging equations (19) and (20) and rearranging we obtain the marginal cost of firms, mc_t,:

$$mc_t = \frac{\mu_{t-\frac{\kappa}{q(\theta_t)}}}{z_t} + \frac{w_t}{z_t} \tag{22}$$

2.2.4 Bellman Equations, Wage Setting and Nash Bargaining

The wage schedule is obtained through the solution to an individual Nash bargaining process. The sharing rule of the bargaining process will depend on the marginal values of a match for the both, firms and workers. Let's denote by V_t^J the marginal discounted value of posting a vacancy for a domestic firm measured in terms of domestic prices:

$$V_t^J = mc_t z_t - \phi_t w + E_t\{(\beta\frac{\lambda_{t+1}}{\lambda_t})[(1-\rho)V_{t+1}^J]\} \tag{23}$$

The marginal value of a vacancy depends on real revenues minus the real wage plus the discounted continuation value. With probability $(1-\rho)$ the job remains filled and earns the expected value and with probability, ρ, the job is destroyed and has zero value. Since the value of a vacancy for the firm must be zero in equilibrium the following zero profit condition must be satisfied:

$$\frac{\kappa}{q(\theta_t)} = E_t\{(\beta\frac{\lambda_{t+1}}{\lambda_t})[(1-\rho)V_{t+1}^J]\} \tag{24}$$

Equation (24) is an arbitrage condition for the posting of new vacancies. It implies that in equilibrium the cost of posting a vacancy must equate the discounted expected return from posting the vacancy. For each worker, the values of being employed and unemployed are given by V_t^E and V_t^U (expressed in terms of CPI):

$$V_t^E = [w_t + E_t\{(\beta\frac{\lambda_{t+1}}{\lambda_t})[(1-\rho)V_{t+1}^E + \rho V_{t+1}^U]\} \tag{25}$$

$$V_t^U = [b + E_t\{(\beta\frac{\lambda_{t+1}}{\lambda_t})[\theta_t q(\theta_t)(1-\rho)V_{t+1}^E + (1-\theta_t q(\theta_t)(1-\rho))V_{t+1}^U]\} \tag{26}$$

where b denotes real unemployment benefits. The optimal sharing rule of the standard Nash bargaining process is given by:

$$\phi_t(V_t^E - V_t^U) = \frac{\varsigma}{1-\varsigma}V_t^J \tag{27}$$

After substituting the previously defined value functions it is possible derive the following wage schedule:

$$w_t = \varsigma(mc_t z_t + \theta_t\kappa)\frac{1}{\phi_t} + (1-\varsigma)b \tag{28}$$

with ς being the bargaining power of workers.

2.3 The Monetary Policy Regimes

An active monetary policy in both the domestic and the foreign economy sets the nominal interest rate in the domestic country by reacting to inflation and output:

$$r_t^n = \exp(\frac{1}{\beta})(\pi_t)^{b_\pi}(y_t)^{b_y} \tag{29}$$

where b_π is the weight that the monetary authority puts on the deviation of CPI inflation from the steady state, b_y is the weight that the monetary authority puts on the deviation of output. To compare different exchange rate arrangements I assume that the domestic monetary authority follows the rule:

$$r_t^n = \exp(\frac{1}{\beta})(\pi_t)^{b_\pi}(y_t)^{b_y}(e_t)^{b_e} \tag{30}$$

where b_e is the weight that the foreign monetary authority puts on the deviation of the exchange rate from the steady state. In a regime of floating exchange rates b_e is set to zero, while it has a positive value in a regime of pegged exchange rates.

2.4 Equilibrium Conditions

I assume zero total net supply of bonds. After imposing market clearing conditions, aggregating across firms and substituting optimal consumption demands (recall that $p_{h,t} = e_t p_{h,t}^*$) the resource constraint reads as follows:

$$n_t z_t = \left(\frac{p_{h,t}}{p_t}\right)^{-\eta}(1-\gamma)\ c_t + \left(\frac{p_{h,t}}{e_t p_t^*}\right)^{-\eta}\gamma^* c_t^* + \kappa v_t + \int_0^1 \frac{\psi}{2}\left(\frac{p_{h,t}^i}{p_{h,t-1}^i} - 1\right)^2 y_t \tag{31}$$

2.5 The Impact of Real Exchange Rate Fluctuations on Job Flows

Before turning to the dynamic simulation and welfare evaluation of the model it is instructive to consider the impact of real exchange rate movements on the reduced form equations of the model. Of particular interest is the analysis of the impact of real exchange rate movements on wages and job flows. From equation (28) we see that movements in the terms of trade have an impact on real wages through their impact on the CPI-PPI ratio. This implies that fluctuations in the terms of trade and consequently in the real exchange rate tend to exacerbate fluctuations in wage earnings. Variability in wage earnings tends to amplify fluctuations in consumption (through the wealth effect), in labour tightness and job flows. Indeed merging equations (19) and (20) and substituting equation (28) we obtain the equation that describes the evolution of labour market tightness:

$$\frac{\kappa}{m}\theta_t^{\xi} = E_t\{\beta(\frac{c_{t+1}}{c_t})^{-\sigma}(1-\rho)[mc_{t+1}z_{t+1} - \varsigma\frac{mc_{t+1}z_{t+1}}{\phi_{t+1}} - \varsigma\frac{\theta_{t+1}\kappa}{\phi_{t+1}} - (1-\varsigma)b + \frac{\kappa}{m}\theta_{t+1}^{\xi}]\} \qquad (32)$$

The higher are fluctuations in the CPI-PPI ratio the higher are fluctuations in the labour market tightness which in turn induce higher fluctuations in job destruction and employment.

A policy maker concerned with macroeconomic stabilization must trade-off two conflicting effects associated with exchange rate fluctuations. On the one side the classical insulating property due to which currency fluctuations can act as business cycle smoothing devices. On the other side the amplifying effect that currency fluctuations have on wages and job flows dynamics.

2.6 Calibration

Preferences. Time is measured in quarters. I set the discount factor $\beta = 0.99$, so that the annual interest rate is equal to 4 percent. The parameter on consumption in the utility function is set equal to 2.

Production. Following Basu and Fernald (1997) I set the value added mark-up of prices over marginal cost to 0.2. This generates a value for the price elasticity of demand, ε, of 6. I set the cost of adjusting prices $\psi = 200$ so as to generate a slope of the log-linear Phillips curve consistent with empirical and theoretical studies. Sensitivity checks show that results do not change by changing this parameter.

Labor market frictions parameters. The matching technology is a homogenous of degree one function and is characterized by the parameter ξ. Consistently with estimates by Blanchard and

Diamond (1989) I set this parameter to 0.4. I set the steady state firm matching rate, $q(\theta)$, to 0.7 which is the value used by denHaan, Ramsey and Watson (1997). The probability for a worker of finding a job, $\theta q(\theta)$, is set equal to 0.6, which implies an average duration of unemployment of 1.67 as reported ion Cole and Rogerson (1996). With those values it is possible to determine the number of vacancies as well as the vacancy/unemployment ratio. The exogenous separation probability, ρ, is set to 0.08 a value compatible with those used in the literature which range from 0.7 (Merz (1995)) to 0.15 (Andolfatto (1996)).The value for b is set so as to generate a steady state ratio, $\frac{b}{w}$, of 0.6 which corresponds to the average value observed for industrialized countries (see Nickell and Nunziata (2001)). The steady state scale paramter, m, is obtained using the observation that steady state number of matches is given by $\frac{\rho}{1-\rho}(1-u)$. The bargaining power of workers, ς,is set to 0.5 as in most papers in the literature, while the value for the cost of posting vacancies is obtained from the steady state version of labour market tightness evolution.

Exogenous shocks and monetary policy: The process for the aggregate productivity shock, z_t, is calibrated as RBC literature with $\sigma_z = 0.0056$ and $\rho_z = 0.95$. The baseline parameter on inflation in the monetary policy rules, b_π,is set to 1.5 and is varied for sensitivity checks. The baseline parameter on output in the monetary policy rules is set to $(0.5)/4$[10]. Finally the parameter on the exchange rate is varied in the simulation to test the effects of different degrees of exchange rate pegs

3 International Transmission of Shocks Under Different Exchange Rate Regimes

In this section I will explore the international transmission of shocks with two goals in mind. First, I want to establish whether the model is able to replicate the main stylized facts concerning the labor market and the international co-movements. Secondly, I analyze the difference between the responses of domestic and foreign variables under different exchange rate regimes (pegged versus floating). I consider foreign productivity shocks.

Figure (1) shows the impact on selected domestic and foreign variables of a 1% increase in foreign productivity under floating and pegged exchange rates. The qualitative dynamic of all vari-

[10] Given the assumption on the length of a period (quarterly) and given the in standard Taylor rules inflation is computed at annual rate we need to divide the coefficient on all other variables by 4.

ables is the same under both regimes; they differ for the magnitude of the dynamic responses. As expected in response to a foreign productivity shock foreign output rises. The increase in productivity induces firms to increase vacancy posting. The increase in vacancies reduces labor market tightness which in turn reduces unemployment in the first periods. The increase in employment tend to raise wages and marginal cost which in turn induce an increase in foreign inflation.

The model economy is successful in replicating the main stylized facts of the labor market and to account for the positive international co-movements. Indeed from the impulse responses we see that the model is able to replicate the Beveridge curve (as a decrease in unemployment is accompanied by an increase in vacancies) and the pro-ciclycality of vacancies and labour market tightness. Furthermore the volatility of unemployment and vacancies is significantly bigger than the volatility of output.

Concerning the international transmission of shocks, I find that the model is able to generate positive co-movements of employment and output thereby resolving the well-known puzzle even in presence of country specific shocks. In a two country model with sticky prices but in absence of matching frictions a (positive) foreign productivity shock induces a fall in foreign inflation and a shift in consumption demand from domestic to foreign produced goods (*switching expenditure effect).* This implies a depreciation in the terms of trade (a loss in competitiveness for the domestic economy), a fall in domestic consumption demand and output. This effect per se would induce negative correlations of output and employment, a fact which is incompatible with data observations[11]. In my model a (positive) foreign productivity shock induces an increase in vacancies, employment and wages for the foreign economy. Due to a wealth effect the increase in wages induce an increase in foreign consumption demand and in foreign inflation. The increase in foreign inflation induces in turn a shift in consumption from foreign to domestically produced goods. Due to the increase in exports domestic firms increase vacancies, employment and production as well. As a result we observe an increase in employment and output in both countries (even in response to a shock originated only in the foreign economy).

Let´s now analyze the difference induced by the exchange rate regime on the dynamic path of variables. As it stands clear floating exchange rates tend to exacerbate fluctuations of labour market

[11] See Backus, Kehoe and Kydland (1985).

variables and inflation both in the domestic and the foreign country. The reason is that currency fluctuations exacerbate movements in relative prices which in turn increase relative movements in employment, participation and wages. For instance in response to an appreciation of the currency (which translates in a lower price for the traded good) jobs are destroyed and vacancies reduced. The opposite is true for a depreciation of the currency. Those external effects tend to exacerbate fluctuations in job flows and unemployment which in turn tend to increase the volatility of firms' marginal costs. The increase in the volatility of the latter then tend to increase the volatility of both domestic and CPI inflation. Overall since risk averse agents dislike macroeconomic volatility and since a benevolent central banker maximizes agents' welfare optimal monetary policy prescribes some degree of exchange rate stabilization.

3.1 The Impact of Different Exchange Rate Regimes on Macroeconomic Volatility and Welfare

To establish whether a positive degree of exchange rate stabilization allows to increase macroeconomic stabilization I now compute changes in the second moments of selected (domestic) variables in response to changes in the parameter reflecting the reaction to exchange rate movements in the policy rule of the domestic monetary authority. Figure (2) and (3) show changes in the volatility of (domestic) unemployment, CPI inflation, output and vacancies in response to changes in the degree of exchange rate stabilization as captured by the parameter b_e in the monetary policy rule. I consider a range for this parameter that goes from zero to 3.5[12]. The volatilities of CPI inflation and vacancies are monotonically decreasing, while the volatility of unemployment and output reach a minimum for a value b_e which is around 1.5 and increase again after that.

Typically exchange rate flexibility allows the monetary authority to focus on domestic stabilization since it is free from external constraints. In our context however currency fluctuations increase the volatilities of job destruction, wages and vacancies. The monetary authority must trade-off between those conflicting forces. The resolution of this conflict brings the monetary authority to follow rules that feature the exchange rate as an independent target. The coefficient that optimizes this trade-off in terms of stabilization of all variables stays around a value of 1.5.

[12] Given the assumption on the length of a period (quarterly) and given the in standard Taylor rules inflation is computed at annual rate we need to divide this coefficient by 4.

An important dimension to consider in the evaluation of the optimal choice of the exchange rate regime is the welfare effect of exchange rate stabilization. Some observations on the computation of welfare in this context are in order. First, one cannot safely rely on standard first order approximation methods to evaluate welfare since in an economy with a distorted steady state stochastic volatility affects both first and second moments of those variables that are critical for welfare. Hence policy arrangements can be correctly ranked only by resorting to a higher order approximation of the policy functions.[13] Additionally one needs to focus on the *conditional* expected discounted utility of the representative agent. This allows to account for the transitional effects from the deterministic to the different stochastic steady states respectively implied by each alternative policy rule.[14]The following provides a description of the welfare metric which applies symmetrically to both countries. Define Ω as the fraction of household's consumption that would be needed to equate conditional welfare $\mathcal{W}_0$ under a generic interest rate policy to the level of welfare $\widetilde{\mathcal{W}}_0$ implied by the optimal rule. Hence Ω should satisfy the following equation:

$$\mathcal{W}_{0,\Omega} = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U((1+\Omega)C_t) \right\} = \widetilde{\mathcal{W}}_0$$

Under a given specification of utility one can solve for Ω and obtain:

$$\Omega = \exp\left\{ \left(\widetilde{\mathcal{W}}_0 - \mathcal{W}_0 \right) (1-\beta) \right\} - 1$$

Figure (4) presents changes in the welfare of domestic residents in response to changes in the parameter b_e. Figure (4) shows that welfare increases when the parameter characterizing the response to exchange rate movements increases. Increasing the degree of exchange rate stabilization tends to stabilize all macroeconomic variables including consumption. Since agents are risk averse stabilization of consumption comes together with an increase in welfare. The figure also show that this result goes through independently from the degree of response to CPI inflation. Changes in welfare with respect to changes in the exchange rate response are shown in the top panel for a mild response to inflation ($b_\pi = 1.5$) and in the bottom panel for a strong response to inflation ($b_\pi = 2$). In both cases welfare decreases with an increase in the response to exchange rate. In addition

[13] See Kim and Kim (2003) for an analysis of the inaccuracy of welfare calculations based on log-linear approximations in dynamic open economies.

[14] See Kim and Levin (2004) for a detailed analysis on this point.

a stronger response to inflation increases welfare levels and reduces the impact of exchange rate stabilization.

4 Conclusion

Labor market flows and labor costs are an important determinant of the international transmission mechanism of shocks as they impact the dynamics of terms of trade. In addition it is well known that both asymmetric shocks and exchange rate fluctuations have a significant impact on labor market dynamics. This implies that the optimal choice of the exchange rate target cannot neglect all considerations related to the relative movements of unemployment, wages and job flows. This paper analyzes the international transmission of shocks in a two country model with matching frictions and evaluates the performance of different exchange rate arrangements in terms of macroeconomic volatility and welfare. I find that exchange rate targeting allows to reduce macroeconomic volatility and increase welfare. The reason for this lies in the fact that currency fluctuations induce movements in relative prices which in turn exacerbate relative movements in labor market variables. Higher volatility in the labor market variables translates into higher volatility for the whole economy and in lower welfare for risk averse agents.

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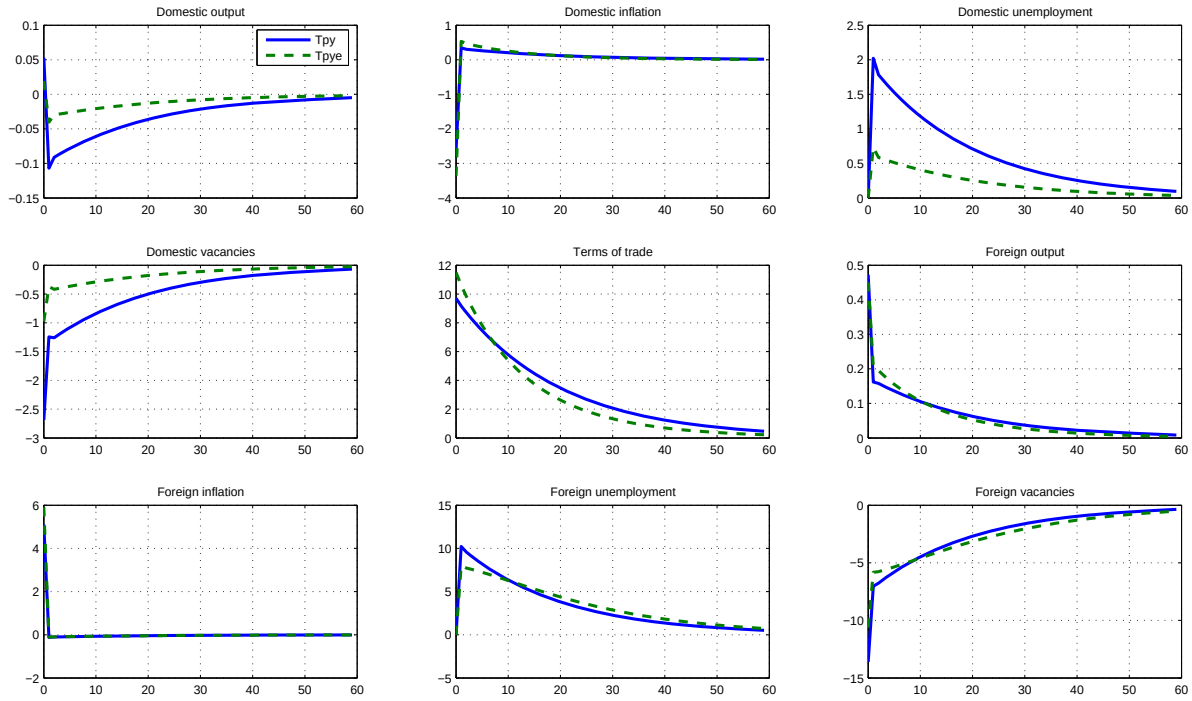

Figure 1: **Impulse responses to domestic productivity shocks of selected domestic and foreign variables under floating (solid line) and pegged (dashed line) exchange rates.**

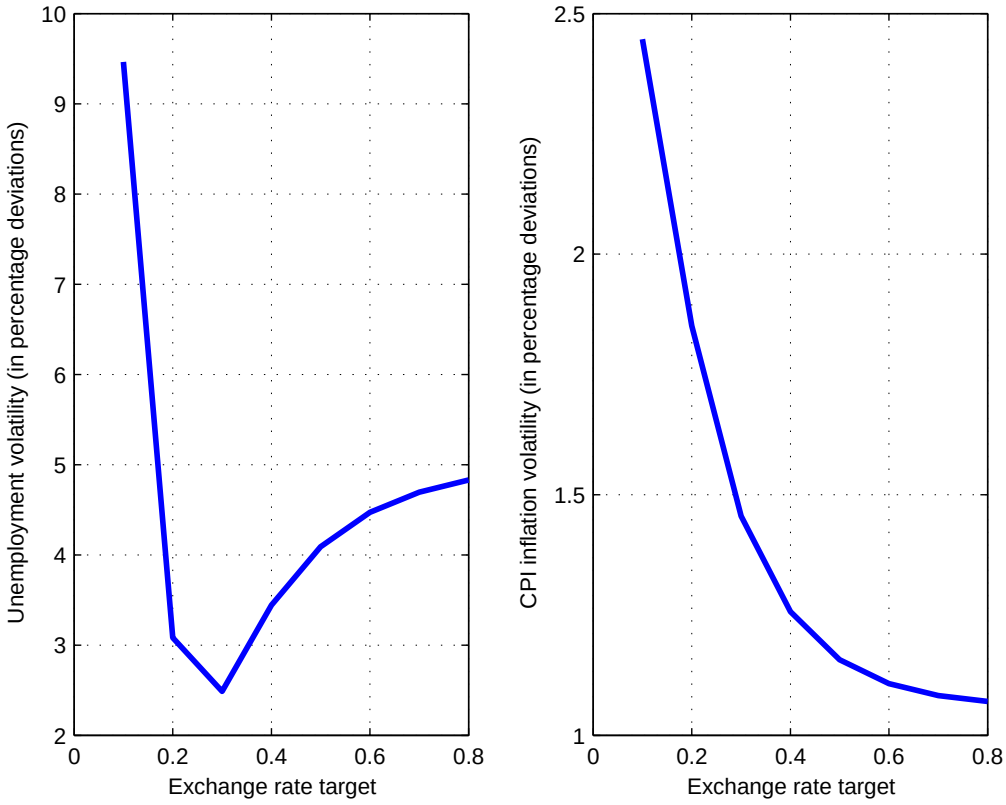

Figure 2: **Change in the volatility of domestic unemployment and inflation when changing the exchange rate target.**

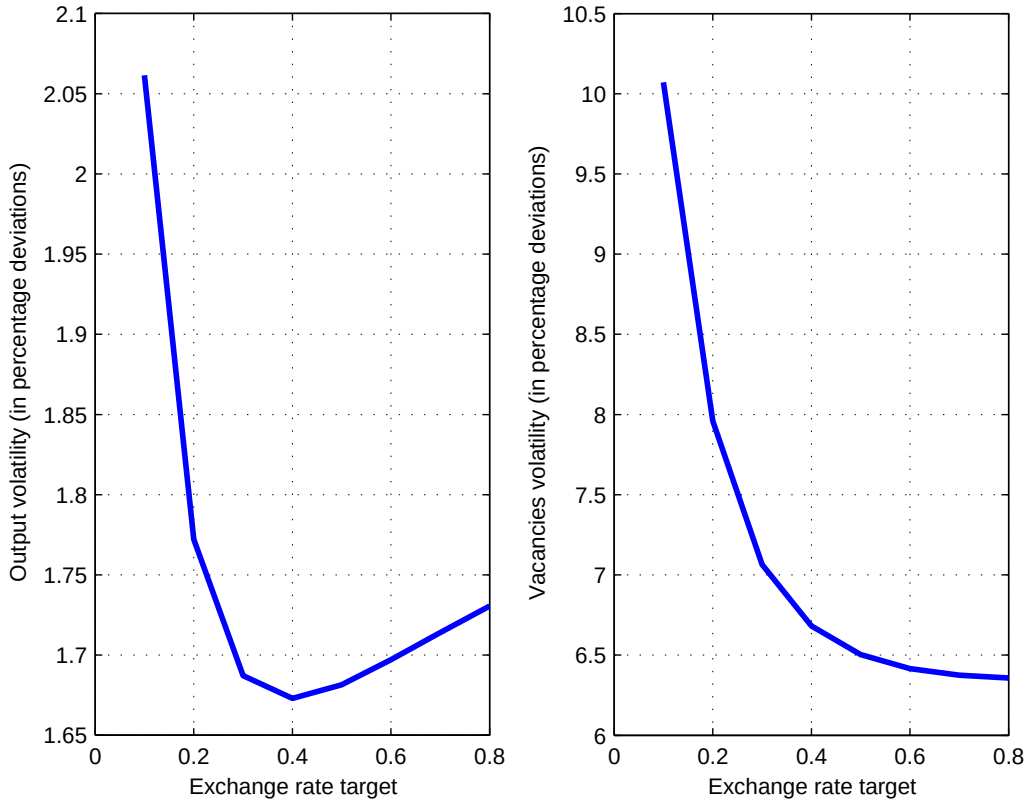

Figure 3: **Change in the volatility of domestic output and vacancies when changing the exchange rate target.**

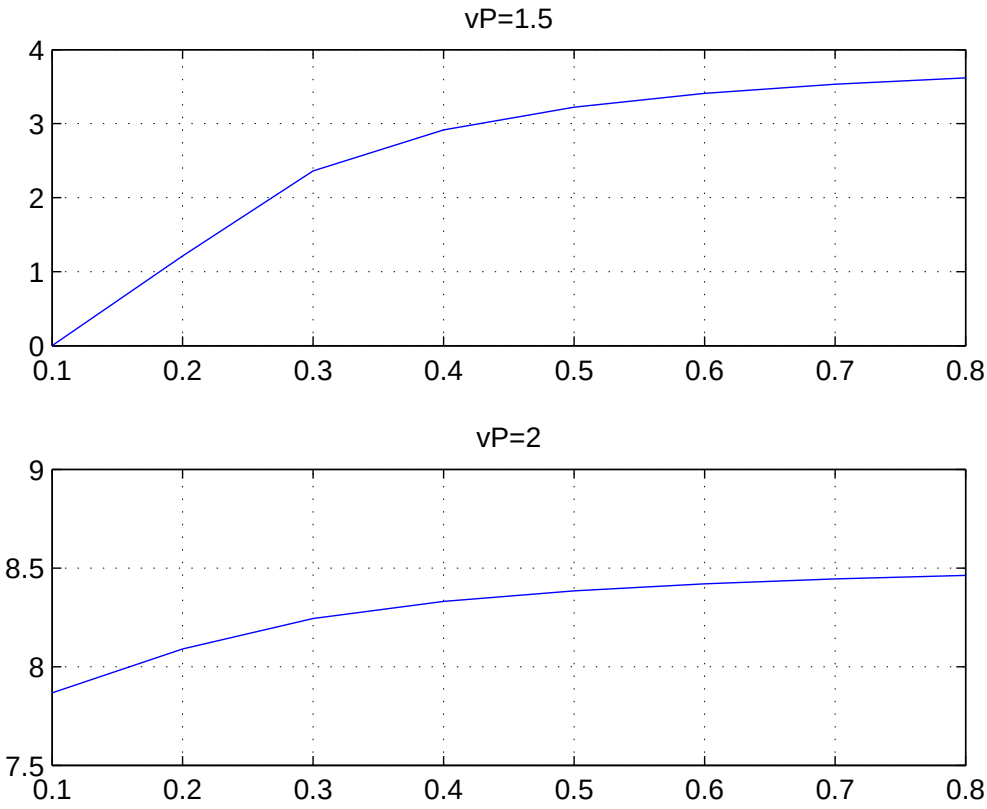

Figure 4: **Changes in the welfare of domestic residents (y-axis) with respect to changes in the degree of response to exchange rate fluctuations (x-axis). The top panel shows the welfare values for a mild response to inflation in the monetary policy rules (b_π=1.5), the bottom panel shows the welfare values for a strong response to inflation (b_π=2).**