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Reciprocity and Matching Frictions

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No. 1616 | April 2010

Web: www.ifw-kiel.de

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*: I would like to thank the EES network for financial support. Main part of this research was conducted during my visit of the Department of Economics at the University of Pavia, whose hospitality is gratefully acknowledged. The opinions and analyses in this paper are the responsibility of the authors and, therefore, do not necessarily coincide with those of the Kiel Institute.

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1 Introduction

In order to explain equilibrium unemployment, nobel laureate George A. Akerlof developed his well-known fair wage approach using insights gained from sociology. The underlying process is mainly driven by the idea of workers anthropomorphizing, i.e. they develop sentiments for the firm and for each other, and hence *"acquire utility for an exchange of gifts with the firm."*[1] The concept of gift giving is determined by norms of behavior and can be mainly characterized by the reciprocal nature of gift giving.[2] In the model, norms are mainly influenced by the wage and legal restrictions. From the worker's perspective, the gift is mainly to provide more effort than required (e.g. minimum work standard) in order to receive a wage (the firm's gift) that is above a certain reference wage (e.g. the unemployment benefit), that is considered to be "fair". The worker ensures fairness by comparing her wage with the group's wage. Equilibrium unemployment arises due to the optimal response of firm's to workers behavior, viz. the wage is above the market-clearing wage in order to receive a higher level of effort and hence labor demand falls and unemployment arises.

Cheron (2002) introduces a model with search frictions (with exogenous separations) and efficiency wages to resolve the "real wage puzzle". He shows that in this environment real wages evolve acyclical over the cycle. Furthermore, Tripier (2006) supports the interaction of nominal and real rigidities. He finds that the introduction of sticky prices and efficiency wages is able to reproduce co-movements of labor productivity and unemployment in the long-run and over the business cycle but not in the short-run.

Some authors stressed the role of efficiency wages for inflation dynamics, e.g. Danthine and Kurmann (2003) and de la Croix et al. (2009). These papers use the fair wage approach to reduce the sensitivity of marginal costs to exogenous disturbances in order to generate persistence.

However, the aim of this paper is to analyze the importance of efficiency wages and matching frictions for labor market dynamics and - in particular

[1] Because worker also develop sentiment for each other, the firm has to treat them as a collective and is not able to negotiate individually with the worker.

[2] See Mauss (1954).

- for the cyclical patterns of unemployment and vacancies. We know that the endogenous separations matching model has problems in generating the Beveridge curve - the negative correlation between unemployment and vacancies - and observed volatilities jointly. In this context, Krause and Lubik (2007) have shown that the introduction of real wage rigditiy generates the Beveridge curve, but fails to match standard deviations.

To address this problem, we build a general equilibrium RBC model with matching frictions and efficiency wages. The efficiency wage friction follows the approach in de la Croix et al. (2009). Along the lines of den Haan et al. (2000) and Krause and Lubik (2007) we develop an endogenous separations model and show that the model creates a Beveridge curve and is able to replicate stylized facts in response to an aggregate productivity shock. The paper is structured as follows. The next section derives the model and section 3 closes the model. Section 4 discusses the response of the model economy to an aggregate productivity shock, while section 5 provides a robustness analysis. Section 6 concludes.

2 Model Derivation

In this section, we present a general equilibrium model with endogenous separations, search frictions and efficiency wage frictions. Households maximize utility by choosing the optimal path of consumption and provide effort in exchange for wage payments. Following Akerlof (1982), firms set wages according to the reciprocity of gift giving. In addition, firms choose the optimal levels of vacancies and employment. Separations are driven by job-specific productivity shocks affecting new and old jobs generating a flow of worker.

2.1 Preferences

Within a discrete-time economy, an infinite living representative household seeks to maximize its utility given by

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma} - 1}{1-\sigma} - n_t G(e_t) \right], \tag{1}$$

where E is the expectation operator, $C_t = \left[\int_0^1 C_{it}^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}}$ is the Dixit-Stiglitz aggregator, β is the discount factor, and the degree of risk aversion is given by σ. We assume that a household consists of a continuum of members, inelastically suppling one unit of labor and being represented by the unit interval.[3]

In addition, $G(e_t)$ is the disutility of providing the effort level e_t. However, there is no explicit labor supply decision, due to the presence of search and matching frictions. Following de la Croix et al. (2009)

$$G(e_t) = \left(e_t(j) - \frac{\phi_1}{\zeta} \left[(w_t(j))^\zeta - \phi_2 \left(\frac{1}{u_t} \right)^\zeta - \phi_3 w_t^\zeta - (\phi_0 - \phi_2 - \phi_3) \right] \right)^2, \tag{2}$$

where $e_t(j)$ is worker j's effort and $w_t(j)$ indicates worker j's real wage. Then, the optimal level of effort is determined by

$$e_t(j) = \frac{\phi_1}{\zeta} \left[(w_t(j))^\zeta - \phi_2 \left(\frac{1}{u_t} \right)^\zeta - \phi_3 w_t^\zeta - (\phi_0 - \phi_2 - \phi_3) \right]. \tag{3}$$

In the spirit of Akerlof (1982) and following de la Croix et al. (2009) we impose the following parameter restrictions $\phi_0 \in \Re, \phi_1 > 0, \phi_2 > 0, \phi_3 \in [0,1), \zeta \in [0,1)$. Parameters ϕ_0 and ϕ_1 are scale parameters, while ϕ_2 measures the effect of unemployment on individual effort. ϕ_3 covers the influence of the reference wage on the effort decision of the household. Finally, ζ defines the degree of substitutability between single elements in the effort function. The household maximizes consumption subject to the intertemporal

[3] Following Andolfatto (1996) we assume consumption pooling.

budget constraint

$$C_t + T_t = w_t(j)n_t + bu_t + \Pi_t, \tag{4}$$

where b is the value of home production, such that bu_t accordingly is the income of unemployed household members. $w_t(j)n_t$ is labor income and Π_t are aggregate profits. In addition, households pay, T_t, being real lump sum taxes. By minimizing total expenditures, we obtain the demand function

$$C_{it} = \left(\frac{P_{it}}{P_t}\right)^{-\epsilon} C_t, \tag{5}$$

where ϵ is the demand elasticity. By solving the households maximization problem, we obtain the standard Euler equation for intertemporal consumption flows, i.e.

$$C_t^{-\sigma} = \iota_t, \tag{6}$$

where ι_t is the Lagrange multiplier on the budget constraint.

2.2 The Labor Market

We incorporate search and matching friction by following Mortensen and Pissarides (1994), such that trade in the labor market is uncoordinated, costly and time-consuming. Therefore, we implement a matching function with constant returns to scale, i.e.

$$\Psi(u_t, v_t) = m(u_t)^{\mu}(v_t)^{1-\mu}. \tag{7}$$

The function gives the number of new employment relationships at the beginning of the next period. Where u_t is the number of unemployed worker and v_t is the number of open vacancies, assumed to lie on the unit interval $v_t = \int_0^1 v_{it} di$. Where $\mu \in (0, 1)$ is the elasticity of the matching function with respect to unemployment and the matching efficiency is governed by $m > 0$. The matching function is homogenous of degree oneand hence the

probability of a vacancy being filled in the next period is $q(\theta_t) = m\theta_t^{-\mu}$, where $\theta_t = v_t/u_t$ corresponds to labor market tightness.
The firm's exit site is determined by endogenous separations only. Therefore, the total number of separations at firm i is given by $\rho_{it} = F(\tilde{a}_{it})$, where $\tilde{a}_{it}$ is an endogenously determined critical threshold. If the specific productivity of a job is below this threshold, it is not profitable and separation takes place. $F(a)$ is a time-invariant distribution with positive support $f(a)$. Connecting the results for job creation and the job destruction enables us to determine the evolution of employment at firm i as

$$n_{it+1} = (1 - \rho_{it+1})(n_{it} + v_{it}q(\theta_t)). \tag{8}$$

The firm adjusts employment by posting vacancies and by setting the critical threshold, which then influences the separation rate.

2.3 The Firm's Problem

If the matching process has been successful, production commences along the production function given by

$$y_{it} = A_t e_{it} n_{it} \int_{\tilde{a}_{it}} a \frac{f(a)}{1 - F(\tilde{a}_{it})} da = A_t e_{it} n_{it} H(\tilde{a}_{it}), \tag{9}$$

where aggregate productivity A_t is common to all firms, the specific productivity a_{it} is idiosyncratic and every period it is drawn in advance of the production process from the corresponding distribution function. The firm then chooses $\{n_{it}, v_{it}, P_{it}\}_{t=0}^{\infty}$ by maximizing

$$\Pi_{i0} = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left[\frac{P_{it}}{P_t} y_{it} - n_{it} w_{it}(j) - c v_{it} \right], \tag{10}$$

subject to the production function eq. (9), the demand schedule eq. (5), the evolution of employment eq. (8), and the effort function eq. (3). Here, we assume that the vacancy posting process creates a constant cost $c > 0$.

The first-order conditions are then given by

$$\partial n_{it} \quad : \quad \xi_t = -w_t(j) + \varphi_t e_t A_t n_t H(\tilde{a}_t) + E_t \beta_{t+1}(1-\rho_{t+1})\xi_{t+1}, \tag{11}$$

$$\partial v_{it} \quad : \quad \frac{c}{q(\theta_t)} = E_t \beta_{t+1}(1-\rho_{t+1})\xi_{t+1}, \tag{12}$$

here φ_t is the Lagrange multiplier on the production function and reflects real marginal costs.[4] In addition, ξ_t is the Lagrangian multiplier on the employment barrier eq. (8) and gives the worker's marginal value.

The job creation condition is then a combination of (11) and (12), i.e.

$$\frac{c}{q(\theta_t)} = E_t \beta_{t+1}(1-\rho_{t+1}) \left[\varphi_{t+1} A_{t+1} e_{t+1} n_{t+1} H(\tilde{a}_{t+1}) - w_{t+1}(j) + \frac{c}{q(\theta_{t+1})} \right], \tag{13}$$

where $\beta_{t+1} = \beta \frac{\lambda_{t+1}}{\lambda_t}$ is the stochastic discount factor. This condition reflects the hiring decision as a trade-off between the costs of a vacancy and the expected return. Where $1/q(\theta_t)$ is the duration of the relationship between firm and worker.

2.4 Efficiency Wages

From the discussion of the household side of the economy we know that the optimal effort niveau is element of the effort schedule (3). Then, in order to determine the real wage, we use the Solow condition[5]

$$\frac{w_t(i)}{e_t(i)} \frac{\partial e_t(i)}{\partial w_t(i)} = 1, \tag{14}$$

to find the desired level of effort by the firm[6]

$$e_t(i) = \phi_1 w_t(i)^{\zeta}. \tag{15}$$

[4]Since we assume a time-invariant demand elasticity, real marginal costs are simply determined by $\varphi_t = (\epsilon - 1)/\epsilon$.

[5]The Solow optimality condition finds the point that minimizes the wage costs per efficiency unit.

[6]One obtains this expression by applying the Solow condition to the effort function and by respecting the fact that all firms will pay the same wage in equilibrium, i.e. $w_t(i) = w_t \; \forall i$. The latter follows from the fact that all components of the wage function are predetermined for the firm.

The corresponding real wage is then obtained by combining (3) and (15)[7]

$$w_t = \left[\frac{\phi_2}{1-\zeta-\phi_3} \left(\frac{1}{u_t} \right)^{\zeta} + \frac{\phi_0 - \phi_2 - \phi_3}{1-\zeta-\phi_3} \right]^{\frac{1}{\zeta}}. \tag{16}$$

For the separation decision of the firm, we infer that the firm will endogenously separate from a worker if and only if

$$S_t(a_t) < 0, \tag{17}$$

i.e. if the worker's asset value S is smaller than zero. In the following, we have to determine the value of the worker for the firm, i.e. the asset value S_t. In terms of a Bellman equation this value can be written as[8]

$$S_t(a_t) = \varphi_t A_t e_t a_t - w_t + \frac{c}{q(\theta_t)}. \tag{18}$$

The first term gives the output of one worker depleted by her wage, the second term. The latter describes the opportunity cost character by representing re-hiring costs.

After some algebra, the threshold is then defined by

$$\tilde{a}_t = \frac{w_t - \frac{c}{q(\theta_t)}}{\varphi_t A_t e_t}. \tag{19}$$

3 Model Solution

3.1 Closing the Model

The model is closed by the resource constraint

$$Y_t = C_t + c v_t. \tag{20}$$

[7]Here, for w_t to be defined, we set $1 - \zeta - \phi_3 > 0$.

[8]Notice that the latter term can be derived by using the standard vacancy posting asset value function. To be precise, the latter $c/q(\theta_t)$ equals the expected profit of posting a vacancy in steady state, which is its value to the firm.

The aggregate productivity shock is formulated as a standard AR(1), i.e.

$$A_t = A_{t-1}^{\rho_A} e^{\alpha_{A,t}}, \tag{21}$$

where the i.i.d. error term is $\alpha_{A,t} \sim N(0, \sigma_A)$ with $cov(A_{t-1}, \alpha_{A,t}) = 0 \; \forall \; t$. Finally, we define the job finding rate by

$$jfr_t = m\theta^{1-\mu}. \tag{22}$$

Then the model is linearized around its deterministic steady state and simulated using Dynare.

For the given stochastic process $\{A_t\}_{t=0}^{\infty}$ a determined equilibrium is a sequence of allocations and prices $\{\tilde{a}_t, C_t, \iota_t, e_t, jfr_t, m_t, n_t, \rho_t, \theta_t, u_t, v_t, w_t, y_t\}_{t=0}^{\infty}$, which for given initial conditions, satisfies equations (6), (7), (8), (9), (13), (15), (16), (19), (20), (21), (22), the definitions for labor market tightness, the law of motion for unemployment, and the separation rate.

3.2 Calibration

We calibrate the model on a quarterly basis for the United States and set parameter values according to stylized facts and the relevant literature. The risk aversion parameter σ is set to a value of 2. The discount factor β is set to 0.99. Efficiency wage parameters are all taken from the estimations of de la Croix et al. (2009). Therefore, we set $\zeta = 0.36$, while $\zeta = 0$ would be the case of a logarithmic utility function. In addition, we impose $\phi_2 = 0.004$, such that unemployment affects effort only slightly. Furthermore, $\phi_3 = 0.795$ such that spill-overs between firms are quite important, such that small employment changes will be transmitted more strongly towards aggregate wages. Finally, $\phi_0 = 0.3$ and $\phi_1 = 1.7$ are scaling parameters. Steady state unemployment is set to 12% in line with Krause and Lubik (2007), while separations in steady state are set to 0.15 in line with the estimation of Lubik (2009). The distribution parameters μ and σ_{ln} of the log-normal distribution are chosen to match the observed volatility of job destruction and hence set these parameters to 0, 0.12 respectively. The elasticity of matches with respect to unemployment μ is 0.74 according to Lubik (2009). The job filling rate is assumed to equal 0.7 which corresponds to a monthly rate of 0.3 which is consistent with U.S. data.[9] The productivity shock is autocorrelated with $\rho_A = 0.95$ as usual in the literature. Missing parameter values are computed from the steady state.

4 Discussion

Let us consider a temporary one percent increase in productivity. As a result, the firm starts to separate from less productive workers such that the threshold - and consistently the job destruction rate - increases (see Figure 1). Workers realize that only the more productive workers stay within the firm and demand a higher wage, since now the dispersion of idiosyncratic productivity among workers is smaller. To be more precise, assume that the wage is a linear combination of the wage demanded by the worker with the lowest and the highest idiosyncratic productivity. Then, if the firm moves the cut-off point towards more productive workers, the worker with the lowest productivity is now more productive and hence the wage increases. Since firms are fully rational - and determined by (15) -, they set higher wages, in order to ensure that the Solow condition holds. More precisely, they produce on the highest stream - given the wage schedule - in the effort-wage figure that yields the highest effort-to-wage ratio. As a consequence of higher productivity, raised effort, and the positive demand effects from the higher wage, output increases. While unemployment increases, vacancies decrease. This results is driven by the fact that expected profits from posting a vacancy decrease, since (i) wages increase and (ii) the labor market becomes less tight, implying lower re-hiring costs.

If we turn to the second moments of our simulation presented in table 1, we conclude that the model fits the empirical values reasonably well. In our RBC Version of the matching model, we do not find the Shimer puzzle, i.e. the standard devitaions of vacancies and unemployment are quite close to their empirical counterparts. Interestingly, the volatility of the separation

[9] See Blanchard and Gali (2007).

margin, ρ, is close to the data value, which is usually a problem of endogenous separation models, creating too much volatility along the exit site of the firm. In addition, the model is able to replicate sign and magnitude of the correlations, with the productivity shock being the only exception.
Effort has a small standard deviation, is pro-cyclical and moves one-to-one with wages as implied by (15).
We can draw the conclusion,that the model is able to replicate the stylized facts reasonably well. In the next section, we provide a robustness analysis of effort function parameters.

5 Robustness

Since our results depend on the calibartion of the deep parameters, we want to provide a robustness analysis of the most interesting parameters. Therefore, we analyse ceteris paribus changes to the effort function parameters. We start by setting ζ to 1. This high value implies a high degree of substitutability between wages and employment in the effort function. Therefore, the elasticity condition (15) implies that changes in employment are directly transmitted into wages. This parametrization implies a much smaller volatility of all variables, because the increase in wages decreases the adjustments in the labor market. The relative sensitivity of effort to employment, ϕ_2, increased to a value of 0.05 decreases the volatilities of key variables. The reason is that this value implies a smaller degree of real wage rigidity. Decreasing ϕ_3, the influence of the reference wage, has only very small efects on the dynamics of our system. wages become more volatile over the cycle, but the model is still able to replicate the stylized facts. C.p. changes in the scaling parameters ϕ_0 and ϕ_1 leave our results unaffected.

6 Final Remarks

This paper analyses the role of efficiency wages, endogenous separations, and matching frictions in a general equilibrium RBC model. Efficiency wages are introduced along the lines of de la Croix et al. (2009) who build on the fair wage approach by Akerlof (1982). We show that the model is able to replicate the stylized facts of labor market dynamics reasonably well. To be more precise, we do not observe the Shimer puzzle. Standard deviations of key variables are close to their empirical pendants and correlations are also in line with evidence. The seminal contribution from Krause and Lubik (2007) shows that the introduction of real wage rigidity - with an ad hoc wage norm - does generate the Beveridge curve, but fails to replicate the volatility values. In contrast, while the efficiency wage theories serves as a more self-contained foundation of real wage rigidity, the model is still able to match volatilities and correlations. We therefore draw the conclusion, that real rigidities, introduced properly, can solve various problems of the (endogenous separation) search and matching model. In addition, behavorial elements should be subject to increased investigation.

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Tables and Figures

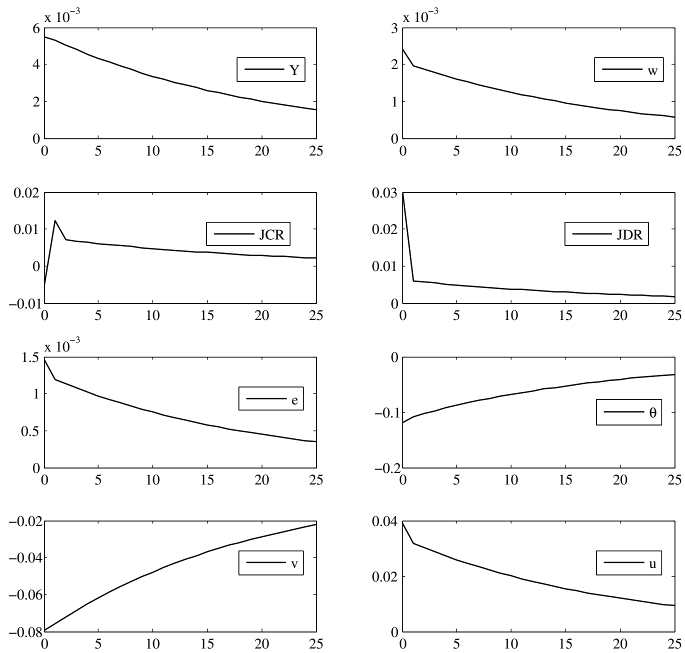

Figure 1: Impulse Responses to a 1 % Productivity Shock.

Table 1: Second Moments of the Model Economy.

		u	v	θ	jfr	ρ	p
Std Data		0.18	0.20	0.37	0.03	0.01	0.02
Std Model		0.11	0.26	0.36	0.12	0.04	0.03
AC Data		0.97	0.97	0.97	0.92	0.81	0.89
AC Model		0.93	0.95	0.95	0.95	0.42	0.95
Correlation Matrix Data	u	1	-0.89	-0.97	-0.95	0.68	-0.38
	v	-	1	0.98	0.85	-0.70	0.40
	θ	-	-	1	0.92	-0.71	0.40
	jfr	-	-	-	1	-0.55	0.41
	ρ	-	-	-	-	1	-0.50
	p	-	-	-	-	-	1
Correlation Matrix Model	u	1	-0.99	-0.99	-0.99	0.80	0.99
	v	-	1	0.99	0.99	-0.77	-1
	θ	-	-	1	1	-0.78	-0.99
	jfr	-	-	-	1	-0.78	-0.99
	ρ	-	-	-	-	1	0.77
	p	-	-	-	-	-	1

Notes: Data values are taken from van Roye and Wesselbaum (2009). Second moments of the model are theoretical moments. Std = Standard deviation, AC = Autocorrelation.