

**SEARCH, NASH BARGAINING AND RULE OF THUMB
CONSUMERS***

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Abstract

This paper analyses the effects of introducing two typical Keynesian features, namely rule-of-thumb (*RoT*) consumers and consumption habits, into a standard labour market search model. *RoT* consumers use the margin that hours and wage negotiation provides them to improve their lifetime utility, by narrowing the gap in utility with respect to Ricardian consumers. From a theoretical point of view, we show how this margin for optimisation contributes toward a more in-depth study of the effects of technological shocks on unemployment, vacancies, hours, wages and how they interact. Empirically speaking, it is a well-known fact that labour market matching with Nash wage bargaining improves the ability of the standard real business cycle model to replicate some of the cyclical properties featured in the labour market. However, when habits and rule-of-thumb consumers are taken into account, the labour market search model improves significantly in reproducing some of the stylised facts characterising the US labour market, as well as other business cycle facts concerning aggregate consumption and investment behaviour.

Keywords: general equilibrium, labour market search, habits, rule-of-thumb consumers.

JEL Classification: E24, E32, E62

1. Introduction

Business cycle models with search frictions and wage bargaining have improved our understanding of US labour market stylised facts, as shown by the work of Merz (1995), Andolfatto (1996), den Haan et al (2000), Walsh (2005) and Yashiv (2006 and 2007), among many others. However, the basic search model still fails to reproduce some important facts related to volatilities and correlations in labour market activity.

With respect to volatilities, Shimer (2005) shows that a conventional Mortensen-Pissarides (1994) model cannot account for the observed business-cycle fluctuations in unemployment and job vacancies. The solution to the so-called Shimer's puzzle has produced a fruitful line of research. Thus, for Hagedorn and Manovskii (2008) and Costain and Reiter (2008) this is mainly an empirical issue related to the calibration of the bargaining power and the outside option in the model. Hall (2005) and Gertler and Trigari (2009), however, face the problem by allowing for staggered wages as a way to prevent excess wage volatility, which discourages firms from hiring. Some authors have investigated micro-foundations for wage rigidities. For instance, Kennan (2006) explores a mechanism that considers that some productivity fluctuations are privately observed by employers. Given that wages do not respond directly to improvements in the private component of match productivity, the informational rent associated with this wage stickiness provides an incentive to post vacancies. Also, Rudanko (2009) enriches the Mortensen-Pissarides model by considering risk neutral firms posting optimal long-term contracts to attract risk averse workers. She shows that this model does not lead to a large increase in the cyclical volatility of unemployment. Andrés et al (2006) solve Shimer's puzzle by invoking nominal rigidities through price stickiness, which in turns contributes to generate large swings in mark-up after a supply shock, and to amplify the fluctuations of vacancies. For Menzio and Shi (2009), endogenising worker transitions between unemployment, employment and across employers, greatly improves the capability of the model to explain the aggregate behaviour of unemployment and vacancies.

As regards correlations, the basic search and matching model finds it difficult to capture those relating the labour share and output, hours worked and labour productivity, and also hours and real wages. Despite the importance of these comovements in the characterisation of business cycles, and contrary to what has happened with the study of volatility puzzles, the unskilfulness of the basic Mortensen-Pissarides model to explain these important dimensions of labour market performance has gone quite unnoticed. One exception is the work of Chéron and Langot (2004), which partially overcomes some of the limitations of the model by introducing a particular set of non-separable preferences as developed in Rogerson and Wright (1988). The idea behind this change in preferences is straightforward. Given that, in a standard bilateral bargaining environment, individuals

use insurance markets to equate consumption across states of employment and unemployment, a technological boom generates additional upward pressure on the real wage, which makes this variable correlate positively with hours worked. The reason is that in a search setting, the real wage is given by labour productivity, but also by the worker's outside option (the reservation wage). With standard preferences, the outside option behaves procyclically in an expansion because unemployed workers enjoy more leisure, putting upward pressure on the reservation wage and, thus, on the bargained wage. Chéron and Langot (2004) reverse this mechanism by changing the preferences specification in a way that makes the outside option behave countercyclically. However, the cost of this approach is that balanced growth is not guaranteed.

In this paper we pursue this second strand and, while maintaining standard preferences, propose an alternative model to overcome the shortcomings of the labour market search model to explain some key empirical cross correlations. To this end, we will introduce two typical Keynesian features simultaneously into a standard labour market search model, namely rule-of-thumb (*RoT*) consumers and consumption habits. We will show that these features improve the explanation of labour market activity, in terms of the cross-correlations of hours worked with both wages and productivity and of output with the labour share. However, because the model cannot be expected to capture all the variation in labour market aggregates, due to nominal rigidities in wages and prices not being considered, we will also show that the model does not perform well enough in terms of the volatilities of total hours worked and vacancies.

Consumers with no access to asset markets have been recurrently considered in the literature to improve the ability of models to explain many business cycle features which are difficult to capture otherwise. Some examples are, Galí, López-Salido and Vallés (2007), Andrés, Doménech and Fatás (2008), Coenen and Straub (2005), Erceg, Guerrieri and Gust (2005), Forni, Monteforte and Sesa (2006) or López-Salido and Rabanal (2006). In addition, habits in consumption, introduced in the literature to account for intertemporal non-separability in preferences, are playing an increasing role in the modelling of consumption using dynamic general equilibrium models (see, for example, Christiano, Eichenbaum and Evans, 2005 and Edge, Kiley and Laforge, 2007). However, the merits of the existence of *RoT* consumers and/or consumption habits have not yet been fully explored in the context of a labour market search model, which is the main objective of this paper¹.

In our setting, two types of households will coexist in the economy. First, optimising consumers that maximise their utility along the life-cycle having access to the credit

¹ Graham (2008) also explores the dynamic responses of macroeconomic variables to technology shocks in a model with credit constrained households and habit formation. However, he does it in a competitive labour market environment and with no simultaneous interaction between habits in consumption and constrained consumers.

market. This type of worker owns firms and can accumulate wealth along the life-cycle. Second, *RoT* consumers that have no access to credit markets and are constrained to consuming their work earnings each period. The consumption of both types of consumers is subject to consumption habits. In addition, we assume that there is risk-sharing at household level, but not between households. Thus, although optimising and *RoT* households have a different reservation wage, they delegate a trade union to bargain with firms over wages and hours and to distribute employment according to their shares in the working-age population. The implication of this simplifying assumption is that all workers receive the same wage, work the same number of hours and suffer the same unemployment rates. This approach is to some extent related to Rudanko (2009), who also considers households that consume all their income each period. However, contrary to the optimal long-term contracts that justify wage smoothing in Rudanko (2009), in our model the wage contract is unique and changes every period according to the state of the economy². In a partial equilibrium setting, Rendon (2006) estimates a model of job search and finds clear evidence that borrowing constraints significantly influence observed trends in assets, employment transitions, and wages.

The main feature of our model is that although *RoT* consumers are not allowed to use their wealth to smooth consumption over time, they take advantage of the fact that a matching today is likely to continue in the future, yielding a labour income that in turn will be used to consume tomorrow. Therefore, they use the margin that hours and wage negotiation provides them to improve their lifetime utility, by narrowing the gap in utility with respect to Ricardian consumers. This margin for intertemporal optimisation has not been studied yet, because this class of restricted agents has been mainly used in models with no equilibrium unemployment. However, when taken into account, it allows for a deeper study of the effects of shocks on vacancies, unemployment, hours, wages and how they interact. As habits increase, *RoT* consumers find it optimal, after a technology shock, to negotiate lower hours and higher wages, and this mechanism reduces the simulated correlation between the real wage (or productivity) and total hours to values closer to those obtained empirically.

The paper is organised as follows. Section 2 provides a detailed description of the theoretical model. Section 3 addresses the empirical results. Section 4 presents the main conclusions.

² There are other differences between both approaches. In Rudanko's article all consumers are non-participants in the financial market. Also, workers and firms in our model negotiate on the intensive margin, which is absent in Rudanko's model.

2. Theoretical framework

We model a decentralised, closed economy where households and firms interact each period by trading one final good and two production factors. In order to produce output, firms employ physical capital and labour. While private physical capital is exchanged in a perfectly competitive standard market, the labour market is subject to search costs.

There are two types of households that possess the available production factors. On the one hand, optimising households own all the capital of the firms operating in the economy. They rent physical capital to firms, for which they are paid income in the form of interest. On the other hand, *RoT* consumers do not have access to capital markets. However, both types of households supply their labour services to competitive firms, which pay them wages. Also, both types of consumers will display similar internal habits in consumption spending.

Each household is made up of working-age agents who may be either employed or unemployed. New jobs are created after investing in searching activities. If unemployed, agents are actively searching for a job. Firms' investment in vacant posts is endogenously determined and so are job inflows. However, job destruction is exogenous. The fact that exchanges in the labour market are resource and time-consuming generates a monopoly rent associated with each job match. It is assumed that optimising and *RoT* workers are identical in terms of working capabilities, so households pool together in the labour market and bargain with firms over these monopoly rents in Nash fashion. Thus, wages and hours of work are simultaneously determined for the two types of households through an efficient bargaining process.

2.1 Households

Following Galí et al. (2007), liquidity-constrained consumers are incorporated into the standard labour market search model. This extension is consistent with the large body of empirical research that finds consumption behaviour to deviate substantially from the permanent-income hypothesis. There are, hence, two types of representative households. One representative household, of size N_t^o , enjoys unlimited access to capital markets, so its members substitute consumption intertemporally in response to changes in interest rates. We will refer to these households as "Ricardian or optimising consumers". Another representative household, of size N_t^r , does not have access to capital markets, so its members can only consume out of current labour income. We will refer to these liquidity-constrained consumers as "rule-of-thumb (*RoT*) consumers". The size of the working-age population is given by $N_t = N_t^o + N_t^r$. Let $1 - \mu^r$ and μ^r denote the fractions in the working-age population of Ricardian and *RoT* consumers, which are assumed to be constant over time. For the sake of simplicity, we assume no growth in the working-age population.

Both types of households maximise intertemporal utility by selecting streams of

consumption and leisure. Inside each group of households, their members may be either employed or unemployed, but they internally ensure each other's consumption against fluctuations in employment, as in Andolfatto (1996) or Merz (1995). Due to labour search and matching frictions, our specification for the labour market differs importantly from other papers in the literature that introduce *RoT* consumers, such as Campbell and Mankiw (1989), Erceg, Guerrieri and Gust (2006), Galí, López-Salido and Vallés (2007) or Ratto, Roeger and in't Veld (2009).

Optimising households

Ricardian households face the following maximisation programme:

$$\max_{c_t^o, k_{t+1}^o} E_t \sum_{t=0}^{\infty} \beta^t \left[\ln (c_t^o - h^o c_{t-1}^o) + n_t^o \phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1-\eta} + (1 - n_t^o) \phi_2 \frac{(1 - l_2)^{1-\eta}}{1-\eta} \right] \quad (1)$$

subject to

$$k_{t+1}^o - (1 - \delta)k_t^o + c_t^o = r_t k_t^o + n_t^o w_t l_{1t} \quad (2)$$

$$n_{t+1}^o = (1 - \sigma)n_t^o + \rho_t^{wo}(1 - n_t^o) \quad (3)$$

All lower case variables in the maximisation problem above are normalised by the working-age population (N_t^o). In our notation, variables and parameters indexed by r and o respectively denote *RoT* and optimising households. Non-indexed variables apply indistinctly to both types of households. Thus, c_t^o, n_t^o and $(1 - n_t^o)$ represent consumption, the employment rate and the unemployment rate of Ricardian households, respectively. Risk-sharing exists at household level so that consumption is the same regardless of employment status. The time endowment is normalised to one. l_{1t} and l_2 are hours worked per employee and hours devoted to job searching by the unemployed. Note that while the household decides over l_{1t} , the same cannot be said of l_2 : time devoted to job searching is assumed to be exogenous so that individual households take it as given.

Several parameters are present in the utility function of Ricardian households. Future utility is discounted at a rate of $\beta \in (0, 1)$. The parameter $-\frac{1}{\eta}$ measures the negative of the Frisch elasticity of labour supply. In general $\phi_1 \neq \phi_2$, i.e., the subjective value of leisure imputed by workers may vary with employment status³. As consumption is subject to habits, the parameter h^o takes a positive value. Habits allow for the intertemporal

³ Notice, that the only difference in the utility function with respect to Andolfatto (1996) and Cheron and Langot (2004) is the presence of habits in consumption.

non-separability of preferences, in the sense that past consumption has an influence on current utility⁴.

Maximisation of (1) is constrained as follows. First, the budget constraint (2) describes the various sources and uses of income. The term $w_t n_t^o l_{1t}$ captures net labour income earned by the fraction of employed workers, where w_t stands for hourly real wages. There is one asset in the economy, namely private physical capital (k_t^o). Return on capital is captured by $r_t k_t^o$, where r_t represents the gross return on physical capital. Total revenues can either be invested in private capital or spent on consumption. The household's consumption and investment are respectively given by c_t^o and $i_t^o = k_{t+1}^o - (1 - \delta)k_t^o$, where δ is the exogenous depreciation rate.

The remaining constraint faced by Ricardian households concerns the law of motion employment. Employment obeys the law of motion (3), where n_t^o and $(1 - n_t^o)$ respectively denote the fraction of employed and unemployed optimising workers in the economy at the beginning of period t . Each period employment is destroyed at the exogenous rate σ . Likewise, new employment opportunities arise at the rate ρ_t^w , which represents the probability that one unemployed worker will find a job. Although the job-finding rate ρ_t^w is taken as exogenous by individual workers, it is endogenously determined at aggregate level according to the following Cobb-Douglas matching function⁵:

$$\rho_t^w (1 - n_t) = \vartheta_t (v_t, n_t) = \chi_1 v_t^{\chi_2} [(1 - n_t) l_2]^{1 - \chi_2} \quad (4)$$

Given the recursive structure of the above problem, it may be equivalently rewritten as a dynamic programme. Thus, the value function $W(\Omega_t^o)$ satisfies the following Bellman equation:

$$W(\Omega_t^o) = \max_{c_t^o, k_{t+1}^o} \left\{ \ln(c_t^o - h c_{t-1}^o) + n_t^o \phi_1 \frac{(1 - l_{1t})^{1 - \eta}}{1 - \eta} + (1 - n_t^o) \phi_2 \frac{(1 - l_2)^{1 - \eta}}{1 - \eta} + \beta E_t W(\Omega_{t+1}^o) \right\} \quad (5)$$

where maximisation is subject to constraints (2) and (3).

The solution to the optimisation programme above generates the following standard first-order conditions for consumption and capital stock:

$$\lambda_{1t}^o = \left(\frac{1}{c_t^o - h^o c_{t-1}^o} - \beta \frac{h^o}{c_{t+1}^o - h^o c_t^o} \right) \quad (6)$$

⁴ Naik and Moore (1996) found strong evidence against separable specifications of intertemporal preferences. Also Fuhrer (2000) showed that the hypothesis of no habit formation can be unambiguously rejected at conventional significance levels. As we will show later, habits also play an important role in matching empirical movements in labour market aggregates, when combined with the presence of restricted consumers.

⁵ Note that this specification presumes that all workers are identical to the firm. This assumption will be commented further when we explain the bargaining process.

$$1 = \beta E_t \frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} \{r_{t+1} + (1 - \delta)\} \quad (7)$$

According to condition (6), the current marginal utility of consumption depends on both past and expected future consumption due to the presence of habits. Expression (7) ensures that the intertemporal reallocation of capital cannot improve the household's utility.

Now it is convenient to derive the marginal value of employment for a worker (that is, the derivative of the value function with respect to employment, $\frac{\partial W_t^o}{\partial n_t^o} \equiv \lambda_{ht}^o$), as it will be used later to obtain the wage and hours equation in the bargaining process:

$$\lambda_{ht}^o = \lambda_{1t}^o w_t l_{1t} + \left(\phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} - \phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} \right) + (1 - \sigma - \rho_t^w) \beta E_t \frac{\partial W_{t+1}^o}{\partial n_{t+1}^o} \quad (8)$$

where λ_{ht}^o measures the marginal contribution of a newly created job to the household's utility. The first term captures the value of the cash-flow generated by the new job in t , i.e., the labour income measured according to its utility value in terms of consumption (λ_{1t}^o). The second term on the right hand side of (8) represents the net utility stemming from the newly created job. Finally, the third term represents the discounted present value of an additional employed worker, given that employment status will persist into the future, conditional to the probability that the new job will not be destroyed.

Rule-of-thumb households

RoT households do not benefit from access to capital markets, so that they face the following maximisation programme:

$$\max_{c_t^r} E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln(c_t^r - h^r c_{t-1}^r) + n_t^r \phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} + (1 - n_t^r) \phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} \right] \quad (9)$$

subject to the law of motion of employment and the specific liquidity constraint, whereby consumption expenditure in each period must be equal to current labour income, as reflected in:

$$c_t^r = w_t n_t^r l_{1t} \quad (10)$$

$$n_{t+1}^r = (1 - \sigma) n_t^r + \rho_t^w s (1 - n_t^r) \quad (11)$$

where n_0^r represents the initial aggregate employment rate (in terms of the working-age population of *RoT* individuals), which is the sole stock variable in the above programme.

Note that *RoT* consumers do not save and, as a result, they do not hold physical capital. These consumers face also habits in consumption, captured by parameter h^r . In this case, the value function $W(\Omega_t^r)$ satisfies the following Bellman equation:

$$W(\Omega_t^r) = \max_{c_t^r} \left\{ \ln(c_t^r - h^r c_{t-1}^r) + n_t^r \phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1-\eta} + (1 - n_t^r) \phi_2 \frac{(1 - l_2)^{1-\eta}}{1-\eta} + \beta E_t W(\Omega_{t+1}^r) \right\} \quad (12)$$

where the maximisation is subject to constraints (10) and (11).

The solution to the optimisation programme is characterized by the following first-order condition:

$$\lambda_{1t}^r = \left(\frac{1}{c_t^r - h^r c_{t-1}^r} - \beta \frac{h^r}{c_{t+1}^r - h^r c_t^r} \right) \quad (13)$$

The marginal value of employment for a consumption-restricted worker ($\frac{\partial W_t^r}{\partial n_t^r} \equiv \lambda_{ht}^r$) can be obtained as,

$$\lambda_{ht}^r = \lambda_{1t}^r w_t l_{1t} + \left(\phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1-\eta} - \phi_2 \frac{(1 - l_2)^{1-\eta}}{1-\eta} \right) + (1 - \sigma - \rho_t^w) \beta E_t \frac{\partial W_{t+1}^r}{\partial n_{t+1}^r} \quad (14)$$

which can be interpreted analogously to that of optimising households.

Contrary to standard models with *RoT* consumers, it is worth mentioning that the optimising behaviour of *RoT* households preserves to some extent the intertemporal dynamic nature of the model, due to consumption habits and the dynamic law of motion of employment⁶. From equation (14) it is clear that, given the search and matching friction in the labour market, habits influence the value of a job through their effect on the marginal utility of consumption λ_{1t}^r .

2.2 Firms

The profit maximisation problem faced by each competitive producer can be written as

$$\max_{k_t, v_t} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} (y_t - r_t k_t - w_t n_t l_{1t} - \kappa_v v_t) \quad (15)$$

subject to

$$y_t = z_t k_t^{1-\alpha} (n_t l_{1t})^\alpha \quad (16)$$

$$n_{t+1} = (1 - \sigma) n_t + \rho_t^f v_t \quad (17)$$

⁶ Thus, the existence of *RoT* consumers in our model cannot be justified on the basis of pure myopic behaviour.

where, in accordance with the ownership structure of the economy, future profits are discounted at the household relevant rate $\beta^t \frac{\lambda_{1t+1}^o}{\lambda_{1t}^o}$. The firm incurs a cost of renting capital, hiring labour and posting vacancies ($\kappa_v v_t$) where v_t stands for the number of vacancies posted and κ_v for the cost of one vacancy open. Producers use two inputs, namely private capital and labour, so that technological possibilities are given by a standard Cobb-Douglas production function with constant returns to scale where z_t is a stochastic term representing random technological progress. The variable ρ_t^f represents the probability that a vacancy will be filled in any given period t . It is worth noting that the probability of filling a vacant post ρ_t^f is exogenous from the firm's perspective. However, this probability is endogenously determined at aggregate level according to the following Cobb-Douglas matching function:

$$\rho_t^f v_t = \chi_1 v_t^{\chi_2} [(1 - n_t) l_2]^{1-\chi_2} \quad (18)$$

Analogously to households, we can express the maximum expected value of the firm in state Ω_t^f as a function $V(\Omega_t^f)$ which satisfies the following Bellman equation

$$V(\Omega_t^f) = \max_{k_t, v_t} \left\{ y_t - r_t k_t - w_t n_t l_{1t} - \kappa_v v_t + \beta E_t \frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} V(\Omega_{t+1}^f) \right\} \quad (19)$$

Under the assumption of symmetry, the solution to the optimisation programme above generates the following first-order conditions for private capital and the number of vacancies

$$r_t = (1 - \alpha) \frac{y_t}{k_t} \quad (20)$$

$$\frac{\kappa_v}{\rho_t^f} = \beta E_t \frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} \frac{\partial V_{t+1}}{\partial n_{t+1}} \quad (21)$$

where the demand for private capital, determined by (20), is positively related to the marginal productivity of capital $(1 - \alpha) \frac{y_t}{k_t}$ which, in equilibrium, must equate to the gross return on physical capital. Expression (21) reflects that firms choose the number of vacancies in such a way that the marginal recruiting cost per vacancy, κ_v , is equal to the expected present value of the job once the vacancy has been filled.

Using the Bellman equation, the marginal value of an additional employment in t for a firm ($\lambda_{ft} \equiv \frac{\partial V_t}{\partial n_t}$) is

$$\lambda_{ft} = \alpha \frac{y_t}{n_t} - w_t l_{1t} + (1 - \sigma) \beta E_t \frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} \frac{\partial V_{t+1}}{\partial n_{t+1}} \quad (22)$$

where the marginal contribution of a new job to profits equals the marginal product net of the wage rate, plus the capital value of the new job in t , corrected for the probability that the job will continue in the future. Now using (22) one period ahead, we can rewrite condition (21) as

$$\frac{\kappa_v}{\rho_t^f} = \beta E_t \left[\frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} \left(\alpha \frac{y_{t+1}}{n_{t+1}} - w_{t+1} l_{1t+1} + (1 - \sigma) \frac{\kappa_v}{\rho_{t+1}^f} \right) \right] \quad (23)$$

2.3 Trade in the labour market: the labour contract

The key departure of search models from the competitive paradigm is that trading in the labour market is subject to transaction costs. Each period, the unemployed engage in search activities in order to find vacant posts spread across the economy. A costly search in the labour market implies that there are simultaneous flows into and out of the state of employment, such that an increase (reduction) in the stock of unemployment results from the predominance of job destruction (creation) over job creation (destruction). Stable unemployment occurs whenever inflows and outflows cancel each other out, i.e.,

$$\rho_t^f v_t = \rho_t^w (1 - n_t) = \chi_1 v_t^{\chi_2} [(1 - n_t) l_2]^{1 - \chi_2} = \sigma n_t \quad (24)$$

Because it takes time (for households) and real resources (for firms) to make profitable contacts, pure economic rent emerges with each new job, which is equal to the sum of the expected transaction (search) costs that the firm and the worker will further incur if they refuse to match. The emergence of such rent gives rise to a bilateral monopoly framework.

Ricardian and *RoT* workers have a different reservation wage, but once a job-seeking (Ricardian or *RoT*) worker and a vacancy-offering firm match, the worker delegates a trade union to negotiate a labour contract in hours and wages. This trade union puts together the surpluses from employment, in terms of consumption, of both types of households and uses this aggregate surplus (λ_{ht}) in the negotiation of hours and wages⁷. The implication of this simplifying assumption is that all workers receive the same wages, work the same number of hours, and suffer the same unemployment rates⁸. Thus, following standard practice, the Nash bargaining process maximises the weighted product of the parties'

⁷ In doing so, we circumvent problems associated with incentives for workers to reveal preferences and firms to perform screening.

⁸ An interesting but not immediate extension suggested by a referee would consist in allowing agents to acquire costly education, so that agents with access to capital markets might outspend those with no access in terms of human capital. Thus, different productivities between workers would give scope for a separate equilibrium in wages.

surpluses from employment

$$\max_{w_t, l_{1t}} (\lambda_{ht})^{\psi^w} (\lambda_{ft})^{1-\psi^w} = \max_{w_t, l_{1t}} \left((1 - \mu^r) \frac{\lambda_{ht}^o}{\lambda_{1t}^o} + \mu^r \frac{\lambda_{ht}^r}{\lambda_{1t}^r} \right)^{\psi^w} (\lambda_{ft})^{1-\psi^w} \quad (25)$$

where $\psi^w \in [0, 1]$ reflects workers' bargaining power. The first term in brackets represents the worker surplus (as a weighted average of *RoT* and Ricardian worker surpluses), while the second is the firm surplus. More specifically, $\lambda_{ht}^o/\lambda_{1t}^o$ and $\lambda_{ht}^r/\lambda_{1t}^r$ respectively denote the earning premium (in terms of consumption) of employment over unemployment for a Ricardian and *RoT* worker. Notice that earning premia of workers are weighted according to the share of *RoT* consumers in the population (μ^r).

The solution of the Nash maximisation problem yields the optimal real wage and hours worked (see Appendix 1 for further details)

$$\begin{aligned} w_t l_{1t} &= \psi^w \left(\alpha \frac{y_t}{n_t} + \frac{\kappa_v v_t}{(1 - n_t)} \right) \\ &+ (1 - \psi^w) \left(\frac{(1 - \mu^r)}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r} \right) \left(\phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} - \phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} \right) \\ &+ (1 - \psi^w) (1 - \sigma - \rho_t^w) \mu^r E_t \beta \frac{\lambda_{ht+1}^r}{\lambda_{1t+1}^r} \left(\frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} - \frac{\lambda_{1t+1}^r}{\lambda_{1t}^r} \right) \end{aligned} \quad (26)$$

$$\alpha \frac{y_t}{n_t l_{1t}} = \left[\frac{1 - \mu^r}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r} \right] \phi_1 (1 - l_{1t})^{-\eta} \quad (27)$$

Unlike the Walrasian outcome, the wage prevailing in the search equilibrium is related (although not equal) to the marginal rate of substitution of consumption for leisure and the marginal productivity of labour, depending on worker bargaining power ψ^w . Putting aside the last term on the right hand side, the wage is a weighted average between the highest feasible wage (i.e., marginal productivity of labour plus hiring costs per unemployed worker) and the outside option (i.e., the reservation wage as given by the difference between the leisure utility of an unemployed person and an employed worker). This reservation wage is, in turn, a weighted average of the lowest acceptable wage of Ricardian and *RoT* workers. They differ in the marginal utility of consumption (λ_{1t}^o and λ_{1t}^r). If the marginal utility of consumption is high, workers are prepared to accept a relatively low wage.

The third term on the right hand side of (26) is a part of the reservation wage that depends only on the existence of *RoT* workers (only if $\mu^r > 0$ this term is different from zero). It can be interpreted as an inequality term in utility. The economic intuition is as follows. *RoT* consumers are not allowed to use their wealth to smooth consumption over

time, but they can take advantage of the fact that a matching today is to some extent likely to continue (with probability $(1 - \sigma)$) in the future, yielding a labour income that in turn will be used to consume tomorrow. Therefore, they use the margin that hours and wage negotiations provide them to improve their lifetime utility by narrowing the gap in utility with respect to Ricardian consumers. In this sense, they compare the intertemporal marginal rate of substitution as if they were not constrained $\left(\frac{\lambda_{1t+1}^o}{\lambda_{1t}^o}\right)$ with the expected rate, given their present rationing situation $\left(\frac{\lambda_{1t+1}^r}{\lambda_{1t}^r}\right)$. For example if, *caeteris paribus*, $\frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} > \frac{\lambda_{1t+1}^r}{\lambda_{1t}^r}$ the third term in (26) is positive, which indicates that *RoT* consumers put additional pressure on the average reservation wage as a way to ease their period-by-period constraint in consumption. The importance of this inequality term is positively related to the earning premium of being matched in the next period $\left(\frac{\lambda_{1t+1}^r}{\lambda_{1t+1}^o}\right)$, because it increases the value of a matching to continue into the future, and negatively related to the job finding probability (ρ_t^w) , that reduces the loss of breaking up the match. Finally, notice that when $\mu^r = 0$, all consumers are Ricardian and, therefore, the solutions for the wage rate and hours simplify to standard values (see Andolfatto, 1996).

2.4 Aggregation and accounting identities in the economy

Aggregate consumption and employment can be defined as a weighted average of the corresponding variables for each household type:

$$c_t = (1 - \mu^r) c_t^o + \mu^r c_t^r \quad (28)$$

$$n_t = (1 - \mu^r) n_t^o + \mu^r n_t^r \quad (29)$$

For the variables that exclusively concern Ricardian households, aggregation is merely performed as:

$$k_t = (1 - \mu^r) k_t^o \quad (30)$$

$$i_t = (1 - \mu^r) i_t^o \quad (31)$$

Gross output is defined as the sum of consumption, investment and the cost of vacancies:

$$y_t = c_t + i_t + \kappa_v v_t \quad (32)$$

whereas the value added generated in the economy is given by:

$$gdp_t = y_t - \kappa_v v_t \quad (33)$$

3. Empirical Results

3.1 Model parameterisation

Our strategy for calibrating the model involves two steps. First, some model parameters have been set to consensus values drawn from previous related papers in the literature. Second, some other parameters have been obtained from the steady-state relationships in the model. It has to be noted that whenever a parameter value is modified, other parameters obtained from the steady-state relationships change to guarantee that the simulated long-run averages of the variables remain the same.

Except for habits and the rate of *RoT* consumers, model parameters have been fixed as in Cheron and Langot (2004) in order to obtain the same steady state and dynamics when the share of *RoT* consumers (μ^r) is equal to zero.

Following the strategy of these authors, we take a set of parameters and restrictions on steady state values that rely on Andolfatto (1996). These include the exogenous job destruction rate, $\sigma = 0.15$, the elasticity of matchings to vacant posts, $\chi_2 = 0.6$, worker bargaining power, ψ^w , is set at $1 - \chi_2$,⁹ and some average values as the employment ratio, $\bar{n} = 0.57$, the average fraction of working time, $\bar{l}_1 = 1/3$, the fraction of time devoted to looking for a job, $l_2 = 1/6$, and the average probability of filling a vacant position, $\bar{\rho}^f = 0.9$.

Another set of parameters in Cheron and Langot (2004) is taken from other sources. Thus, the Cobb-Douglas production function parameter $\alpha = 0.6$, the subjective discount rate, $\beta = 0.985$, and the depreciation rate, $\delta = 0.012$, come from the work by Cooley and Prescott (1995). From Abowd and Kramarz (1998) they take an overall cost of vacant posts in the steady state equilibrium equal to 0.5 percentile points of output ($\frac{\kappa_v \bar{v}}{\bar{y}} = 0.005$). The intertemporal substitution parameter, η , has been set to a value of 4 compatible with the estimates in the literature for the labour supply.

The rest of parameters are obtained from steady state conditions, once average output has been previously normalised to one ($\bar{y} = 1$). Thus, from the steady state version of (17) we recover the steady state value for vacancies $\bar{v} = \sigma \bar{n} / \bar{\rho}^f$. Using the assumption that $\frac{\kappa_v \bar{v}}{\bar{y}} = 0.005$, we calibrate $\kappa_v = 0.0526$. Also, from the employment creation condition (24) the parameter χ_1 is calibrated as $\chi_1 = \frac{\sigma \bar{n}}{\bar{v} \chi_2 [(1 - \bar{n}) l_2]^{1 - \chi_2}}$. From (7) we calculate the long-run

⁹ This follows the condition for a socially efficient unemployment (see Hosios, 1990).

TABLE 1 – STEADY STATE

Basic search model (BSM)				BSM with RoT and habits			
c_t	0.819	y_t	1.00	c_t	0.819	n_t	0.57
i_t	0.176			c_t^o	1.043	n_t^o	0.57
k_t	14.69			c_t^r	0.594	n_t^r	0.57
l_{1t}	0.333			i_t	0.176	r_t	0.027
n_t	0.57			i_t^o	0.352	v_t	0.095
r_t	0.027			k_t	14.69	w_t	3.129
v_t	0.095			k_t^o	29.38	y_t	1.00
w_t	3.129			l_{1t}	0.333		

average for the rental rate of capital $\bar{r} = 1/\beta - 1 + \delta$ and by means of (20) the steady state value for the capital stock is computed as $\bar{k} = (1 - \alpha)^{\frac{\bar{y}}{\bar{r}}}$. Next, the average long run value for the technology parameter, \bar{z} , is easily obtained from the production function (16) as $\bar{z} = \frac{\bar{y}}{\bar{k}^{1-\alpha}(\bar{n}\bar{l}_1)^\alpha}$, as well as the steady state level of aggregate investment $\bar{i} = \delta\bar{k}$. The steady state value for consumption can be obtained from the definition of gross output (32) as $\bar{c} = \bar{y} - \bar{i} - \kappa_v\bar{v}$, whereas from (23) we can write the steady state condition for wages as $\bar{w} = \frac{1}{l_1} \left[\left(\alpha \frac{\bar{y}}{\bar{n}} + (1 - \sigma - \frac{1}{\beta}) \frac{\kappa_v}{\bar{r}} \right) \right]$. The long run values for consumption of restricted and optimising consumers are obtained, respectively, from the budget constraint of *RoT* households (10) as $\bar{c}^r = \bar{w}\bar{n}\bar{l}_1$, and the aggregate constraint (28) as $\bar{c}^o = \frac{(\bar{c} - \mu^r \bar{c}^r)}{(1 - \mu^r)}$. This allows to obtain from 6 and 13 the steady state values for λ_{1t}^o and λ_{1t}^r . Finally, preference parameters in the household utility functions, ϕ_1 and ϕ_2 , are computed to be consistent with previous steady-state restrictions. To accomplish this, we solve directly ϕ_1 from the steady-state version of the hours equation (27) and ϕ_2 from the equation for wages (26). The values for ϕ_1 and ϕ_2 imply that the imputed value for leisure by an employed worker is situated well above the imputed value for leisure by an unemployed worker.

The implied steady-state values of the endogenous variables are given in Table 1. In the left panel we show the steady state from the basic labour market search model (BSM model), i.e., the model assuming no *RoT* consumers and no habits, which coincides with Cheron and Langot (2004). The right panel displays steady state values from our complete model including *RoT* and habits. The value chosen for habit parameters ($h^o = h^r = 0.7$) is slightly higher than that chosen by Smets and Wouters (2003), but lower than in many other studies. We assume that the fraction of *RoT* consumers in the economy is $\mu^r = 0.5$. In any case, we analyse the robustness of our results to changes in these parameters later.

3.2 Comparing models

Assuming no habits ($h^o = h^r = h = 0$) and no *RoT* consumers ($\mu^r = 0$), the model

produces the impulse-response functions (Figure 1) of what we will call the Basic Search Model (*BSM*).¹⁰ It is a well-known fact that a positive productivity shock triggers an increase in vacancies, a rise in labour productivity and a positive impact on the real wage and hours worked in a search model. The shock also has positive effects on both consumption and investment and, thus, output also grows on impact. As a result of the size of the impacts of the relevant variables, the labour share is reduced initially, to grow afterwards and gradually recover its long run level.

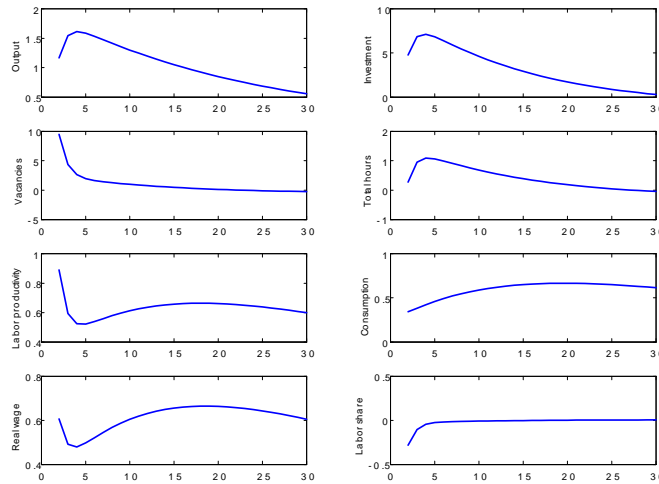


Figure 1: IRF for the Basic Search Model ($\lambda^r = h^o = h^r = 0$)

In the first columns of Table 2 we report statistics describing the cyclical properties of the US economy (for the 1964:1-2008:1 period), as well as the statistics stemming from a positive technological shock simulated in a standard real business cycle model (RBC) and in the basic search model (*BSM*).¹¹ As expected, the RBC model is not capable of accounting for the stylised facts featured in the US labour market or the behaviour along the business cycle of both aggregate consumption and investment. However, the standard

¹⁰ Given our calibration, this model coincides exactly with the *LMS1* model in the terminology of Cheron and Langot (2004).

¹¹ In particular, we consider a stochastic process for the technological level of the form:

$$\log(z_t) = \rho_z \log(z_{t-1}) + (1 - \rho_z) \bar{z} + \varepsilon_t^z$$

where \bar{z} stands for the average long run technological level and ε_t^z is normally distributed with zero mean and a standard deviation σ_{ε^z} . Following Prescott (1986), the value for ρ_z is set to 0.95 and σ_{ε^z} is assumed to be 0.007.

labour market search model clearly improves the explanation of some of the labour market facts. Although some relative volatilities improve, namely that of total hours worked, basically the *BSM* model reduces the correlations of certain variables to bring them in line with observed ones. Thus, correlations of output with the real wage (w_t) and with labour productivity ($\frac{y_t}{l_{1t}n_t}$), and of total hours ($l_{1t}n_t$) with productivity and the real wage come closer to US data. Nevertheless, the contemporaneous correlations of the real wage and of total hours worked with output are still clearly overestimated, as is the case with the correlation between hours and labour productivity. Furthermore, the volatilities of both consumption and investment are the same as in the RBC model, and even now far from the real ones. The *BSM* model also allows to compute other moments of labour market variables that are not present in an RBC model. In this sense, results in column (3) show that the *BSM* model captures the high negative correlations of unemployment with both output and vacancies (the Beveridge curve) well. However, the model over accounts for the volatility of unemployment and falls short in simulating the volatility of vacancies and the positive correlation between vacancies and output.¹²

We overcome the empirical shortcomings of the *BSM* model related to the volatilities of consumption and investment by incorporating *RoT* consumers (see column 4). This is a well-known result (see, for example, Galí, López-Salido and Vallés, 2007) in models with no search and matching frictions in the labour market. Moreover, the presence of rationed consumers exerts a positive impact on the explanation for the relative volatilities of labour productivity and wages with output. Nevertheless, the excessive procyclicality of labour productivity and real wages is increased in this model with respect to the *BSM* model, along with the cross correlations between total hours worked and both wage and labour productivity are further increased.

In column 5 of Table 2 we present the results of incorporating habits in consumption ($h^o = h^r = h = 0.7$) into the *BSM* model. In this case we assume no presence of *RoT* consumers ($\mu^r = 0$). As is readily apparent by comparing columns 5 and 3, introducing habits has little effect on the cyclical characterisation of the US economy simulated by the search model.

Finally, in column 6 we present the main result of this paper, i.e., the joint introduction of *RoT* consumers and consumption habits. The interaction of habits and restricted consumers significantly affects many of the second moments displayed in the table. As can be observed, the search model augmented with restricted consumers and habits improves the description of some of the business cycle facts of the US economy. This model

¹² The analysis carried out by Cheron and Langot (2004) does not pay attention to the behaviour of vacancies and unemployment, or their volatilities.

TABLE 2 – CYCLICAL PROPERTIES

	US		RBC		BSM		SM		SM		SM	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					$\mu^r = 0$ $h = 0$		$\mu^r = 0.5$ $h = 0$		$\mu^r = 0$ $h = 0.7$		$\mu^r = 0.5$ $h = 0.7$	
$\sigma(y)$	1.58		1.08		1.46		1.24		1.46		1.09	
ρ_y	0.91		0.72		0.84		0.80		0.84		0.87	
Variable x	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
c_t	0.49	0.93	0.26	0.90	0.25	0.89	0.45	0.98	0.24	0.80	0.44	0.98
i_t	2.86	0.97	4.59	0.99	4.60	0.99	3.60	0.99	4.75	0.99	3.64	0.99
$l_{1t}n_t$	1.09	0.82	0.26	0.99	0.70	0.94	0.49	0.93	0.70	0.94	0.59	0.62
$\frac{y_t}{l_{1t}n_t}$	0.66	0.45	0.75	0.99	0.42	0.82	0.57	0.95	0.42	0.82	0.78	0.81
w_t	0.59	0.31	0.75	0.99	0.32	0.89	0.50	0.98	0.32	0.90	0.80	0.78
$\frac{w_t l_{1t} n_t}{y_t}$	0.60	0.14	0.0	0.0	0.13	-0.41	0.11	-0.46	0.13	-0.41	0.04	-0.13
$1 - n_t$	7.04	-0.80	-	-	11.04	-0.99	7.86	-0.99	10.76	-0.99	7.51	-0.99
v_t	8.54	0.88	-	-	4.37	0.56	3.16	0.65	4.25	0.57	2.46	0.70
$corr(1 - n_t, v_t)$	-0.93		-		-0.64		-0.64		-0.64		-0.67	
$corr(l_{1t}n_t, \frac{y_t}{l_{1t}n_t})$	0.01		0.98		0.57		0.77		0.57		0.04	
$corr(l_{1t}n_t, w_t)$	-0.01		0.98		0.69		0.85		0.70		-0.01	

Columns (a): $\sigma(x)/\sigma(y)$, Columns (b): $corr(x, y)$.

produces no significant correlation between the labour input (total hours) and both labour productivity and real wages. In addition, the cross-correlation of the labour share with output is close to that observed in the data.¹³ Also, labour productivity, consumption and investment display standard deviations with respect to output that are not far from those observed. This model is, however, unable to explain the high observed volatility of total hours and the labour share. With respect to vacancies and unemployment, introducing habits and RoT consumers has an ambiguous effect. Thus, a search model with $\lambda^r = 0.5$ and $h = 0.7$ does better than the BSM model in explaining the volatility of unemployment and the correlation of vacancies and output, but worse in terms of the volatility of vacancies, which is reduced with respect to the BSM model.¹⁴

The main conclusion from the results in Table 2 is that the interaction of consumption habits and RoT individuals allows the basic labour market search model to account better for important correlations in the labour market at business cycle frequencies.¹⁵

¹³ Notice that the observed (0.14) and simulated correlation (-0.13) are not significantly different from zero at conventional significance levels.

¹⁴ As discussed in the introduction, to improve the capacity of the model to reproduce higher volatility in vacancies, the literature has explored different avenues, such as price or wage rigidities.

¹⁵ It is worth commenting that we have also departed from the calibration of Cheron and Langot (2004) to check the sensitivity of our results to some parameters. In particular, we have set the job destruction rate σ to a value of 0.10 as in den Haan et al (2000), Walsh (2005), Shimer (2005) and Hagedorn and Manovskii (2008), and the employment rate $n = 0.94$. Furthermore the subjective discount rate β has been changed to a value of 0.99,

Other alternatives in the literature have also arrived at a similar conclusion. Cheron and Langot (2004) also improved the explanatory power of the search model by introducing non-separable preferences of the type assumed by Rogerson and Wright (1988). Comparing their results with ours, there are aspects of the business cycle that are captured well in both cases (i.e., the null correlations of total hours with both labour productivity and real wages, or the correlation of the labour share with output) and others where one alternative is superior to the other. For example, Cheron and Langot's model better accounts for the low cross correlation of wages and output, whereas our model better reflects the relative volatility of labour productivity and consumption.

3.3 Explanation of results

As shown previously, the null correlations of total hours with both labour productivity and real wages and the correlation of the labour share with output are well captured, including the interaction of consumption habits and *RoT* individuals in a standard search model. However, it is necessary to understand what is behind this result. To answer this question, we depict the impulse-response functions of the augmented model ($h^o = h^r = 0.7, \mu^r = 0.5$) after a positive productivity shock in Figure 2. The differences with the *BSM* model impulse-response functions depicted in Figure 1 are very illustrative of what is going on. A transitory positive technological shock increases output and total consumption on impact. However, the effects on output and on consumption of optimising households are weaker in the economy with *RoT* consumers and habits, while the effects on consumption of restricted agents are stronger. If we look at the time behaviour of wages, total hours worked and labour productivity, it is easy to understand why the implied cross-correlations turn to null values. In the basic model, the productivity shock generates a positive response from all three variables on impact. Although this continues to be true for labour productivity and real wages, in Figure 2 hours worked react negatively to the shock, which is behind the reduction in correlations¹⁶. The negative response of hours on impact is in line with the results of Rotemberg (2003), or Galí (1999), or Andrés, Doménech and Fatás (2008). Furthermore, the empirical null correlation of the labour share with output is related to the fact that the impact on the labour share turns from negative to positive when the basic search model is enriched.

The intuition of these changes in the dynamic responses can be better understood

implying a quarterly rental rate of capital, net of depreciation, of 1%. The conclusion is the same: both habits and *RoT* are necessary to improve the ability of the model to fit some second moments related to the labour market that neither RBC nor BSM are able to capture, although for this particular set of parameters, the degree of habits and the share of non Ricardian households required is lower.

¹⁶ The increase in wages and the reduction in total hours worked also explain the reduction in the volatility of vacancies, as firms have less of an incentive to post jobs.

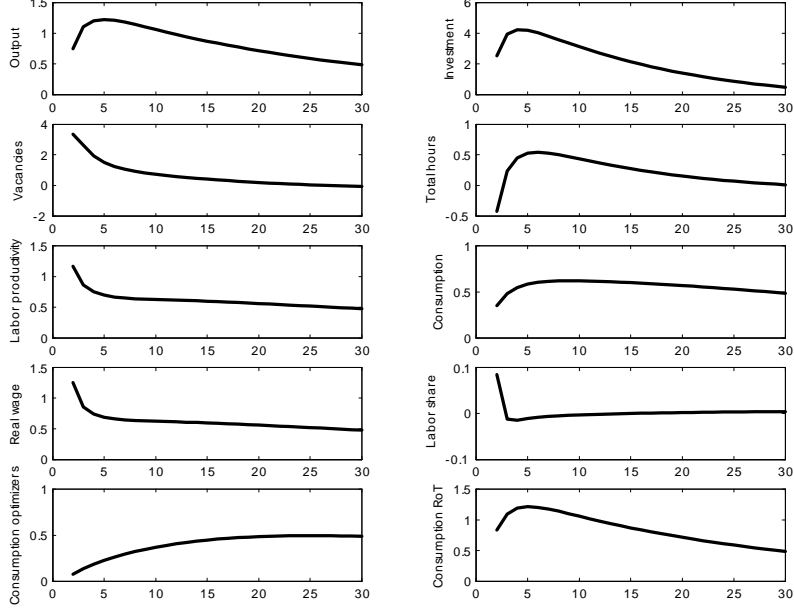


Figure 2: IRF for the augmented search model ($\lambda^r = 0.5; h^o = h^r = 0.7$)

by focusing on the response of the weighted average of the inverse marginal utilities of consumption of both types of households in the economy, $\left[\frac{1-\mu^r}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r} \right]$, which depends directly on the share of restricted households μ^r , and indirectly on the degree of habits, h^o and h^r , through their impact on λ_{1t}^o and λ_{1t}^r . The term $\left[\frac{1-\mu^r}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r} \right]$ is crucial to determine the effect of a technological shock on real wages (see equation 26) and on hours worked (see equation 27).

According to equations (6) and (13), the marginal utility of consumption for any agent can be represented in terms of deviations with respect to the steady state as:

$$\widehat{\lambda}_{1t} = \frac{1}{(1-\beta h)(1-h)} [\beta h (\widehat{c}_{t+1} - h\widehat{c}_t) - (\widehat{c}_t - h\widehat{c}_{t-1})] \equiv \frac{1}{(1-\beta h)(1-h)} \widehat{\Psi}_t \quad (34)$$

As the degree of habits in consumption increases (as h tends to 1), the impact on $\widehat{\lambda}_{1t}$ also increases for a given volatility of consumption (for given \widehat{c}_t), because $\frac{1}{(1-\beta h)(1-h)}$ tends to infinite. In other words, the higher the degree of habits, the greater the effect of variations in Ψ_t will be on $\widehat{\lambda}_{1t}$. However, variations in Ψ_t after a shock may be different depending on the type of household we consider.

Optimising consumers that are interested in smoothing not only their levels of consumption, but also their variations, will accumulate wealth by increasing savings and

smoothing consumption. This makes variations in Ψ_t^o small in absolute terms after a positive technology shock, explaining why $\widehat{\lambda}_{1t}^o$ and c_t^o do not vary much with habits for optimising consumers (see figure 3).

However, *RoT* consumers have no access to financial markets and the only way they can smooth consumption is by smoothing variations in their current income, which in deviations with respect to the steady state can be written as

$$\tilde{c}_t^r = \widehat{w}_t + \widehat{l}_{1t} + \widehat{n}_t \quad (35)$$

Therefore, equations (34) and (35) establish a relationship between $\widehat{\lambda}_{1t}^r$ and the deviations of average wages, hours and employment in the economy. Given that current *RoT* consumption is tied up with current labour income, the negative impact of the technology shock on $\widehat{\Psi}_t^r$ is greater than in the case of optimising agents and, thus, λ_{1t}^r records a larger fall on impact (notice that the effect of the term $\frac{1}{(1-\beta h)(1-h)}$ is the same for both types of individuals).

Let us reconsider the term $\left[\frac{1-\mu^r}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r}\right]$ and its relevance in explaining the effect of a technological shock on real wages and on hours worked. As we have just explained, after a technological shock both λ_{1t}^o and λ_{1t}^r fall, and this fall is more pronounced in the case of the marginal utility of consumption of restricted consumers. Also, the higher the parameter of habits the more intense is the drop in λ_{1t}^r , and the larger the share of *RoT* consumers in the economy, the larger the weight of λ_{1t}^r in $\left[\frac{1-\mu^r}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r}\right]$ will be. Thus, the main result is that increasing the parameter of habits and/or the share of *RoT* consumers provokes, after a positive technological shock, an increase in $\left[\frac{1-\mu^r}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r}\right]$. This, in turn, induces a lower impact on hours worked and greater pressure on wages, as shown by the expressions for optimal real wages, as shown by the expressions for optimal real wages (27) and hours worked (26) (see third row in figure 3).

Overall, as habits and the share of *RoT* consumers increase, the impact of the technology shock on total labour income is reduced due to the pressure of *RoT* consumers to smooth consumption by means of labour market negotiation in hours and wages. The gain in utility through *RoT* consumers accomplishing a smoother path of consumption, together with less hours of work, more than compensates the loss of utility due to the decrease in consumption on impact. In summary, the result is that as habits and the share of restricted consumers increase, total hours change by less on impact after the technology shock, while there is a larger increase in the real wage and, therefore, the correlation between the real wage and total hours is reduced. Notice that for similar reasons, increasing the degree of habits in consumption reduces the cross-correlation between total hours and labour productivity, in accordance with the reduction of the impact of the shock on total hours worked.

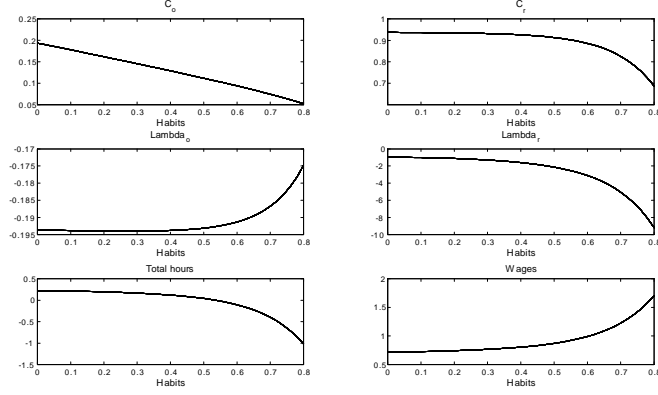


Figure 3: Impacts of habits on key variables for $RoT=0.5$

3.4 Sensitivity analysis

To finish our discussion of the results, Figures (4) and (5) depict three-dimensional plots showing the effects of habits and the share of RoT consumers on the cross-correlations between total hours worked and both wages and labour productivity. The aim of these graphs is to check the sensitivity of our results to different values of μ^r and h , given that the literature has used a relatively wide range of these values in different models. Three results emerge from these figures. First, assuming no habits, a higher share of RoT consumers in the economy increases both correlations, further distancing them from empirical zero values, as shown in the bottom rows of column 4 in Table 2. Second, if there are no restricted consumers, more habits has little effect on these correlations (see column 5 in Table 2). Finally, for a wide range in the share of RoT consumers and in the degree of habits, cross-correlations record similar values to empirical results. Notice that correlations can even become negative and significant for high values of both parameters.

A complementary way to Figures (4) and (5) for assessing the contribution of our model to explain some features of the data is presented in Table 3. There we display the values, for different combinations of μ^r and h , of the following quadratic distance function $d(\mu^r, h)$ between the simulated correlations and the observed ones:

$$d(\mu^r, h) = \left[\left(\rho_{(l_{1t}n_t, \frac{y_t}{l_{1t}n_t})}^* - \rho_{(l_{1t}n_t, \frac{y_t}{l_{1t}n_t})} \right)^2 + \left(\rho_{(l_{1t}n_t, w_t)}^* - \rho_{(l_{1t}n_t, w_t)} \right)^2 \right]^{\frac{1}{2}}$$

where $\rho_{(l_{1t}n_t, \frac{y_t}{l_{1t}n_t})}^*$ and $\rho_{(l_{1t}n_t, w_t)}^*$ represent the simulated correlation coefficient between

TABLE 3 – VALUE OF THE DISTANCE FUNCTION

$h \setminus \mu^r$	0.0	0.1	0.2	0.3	0.4	0.5	0.6
0.0	0.90	0.97	1.03	1.08	1.12	1.15	1.17
0.1	0.90	0.97	1.03	1.07	1.11	1.13	1.16
0.2	0.90	0.97	1.02	1.06	1.09	1.11	1.12
0.3	0.90	0.97	1.01	1.04	1.06	1.07	1.07
0.4	0.90	0.96	0.99	1.01	1.01	1.00	0.98
0.5	0.91	0.95	0.96	0.95	0.92	0.87	0.79
0.6	0.91	0.92	0.88	0.82	0.72	0.59	0.43
0.7	0.92	0.84	0.69	0.49	0.26	0.03	0.22
0.8	0.94	0.57	0.12	0.28	0.58	0.78	0.93

productivity and hours and between wages and hours respectively, being $\rho_{(l_t n_t, \frac{y_t}{l_t n_t})}$ and $\rho_{(l_t n_t, w_t)}$ the corresponding observational coefficients¹⁷. The results in the table make it clear that a relatively high degree of habits and a high share of *RoT* consumers in the economy seems to be necessary in order to match the empirical values of these correlations. In fact, when the values of μ^r and h coincide with the ones we have chosen in Table 2, the distance function reaches a minimum.

Therefore, the main result is that when habits and rule-of-thumb consumers are taken into account, the labour market search model gains extra power to reproduce some of the stylised facts characterising the US labour market.

4. Conclusions

Although the basic search model improves our understanding of US labour market stylised facts, it fails to explain important correlations across prominent labour market variables. Chéron and Langot (2004) partially overcame some of these limitations of the basic search model by introducing a particular set of non-separable preferences. Our paper shares the same motivation, but explores a quite different route to accomplish this task. More specifically, we have analysed the effects of introducing typical Keynesian features, namely non optimising consumers and consumption habits, into the standard labour market search model. These features are undoubtedly important nowadays to explain other business cycle facts in advanced economies like the US, as previous research has shown. For this reason, we confront the simulation results obtained with our model with a wide and sensible range of parameters that characterise the share of restricted consumers and the degree of habits in consumption.

Our results show that introducing habits alone into the search model does not improve the ability of the model to account for some labour market facts. The presence of

¹⁷ In this Table we only present the results for a grid corresponding to 0.1 intervals of λ^r and h . We have also performed the same exercise using intervals of 0.02, obtaining the same minimum value for the distance function.

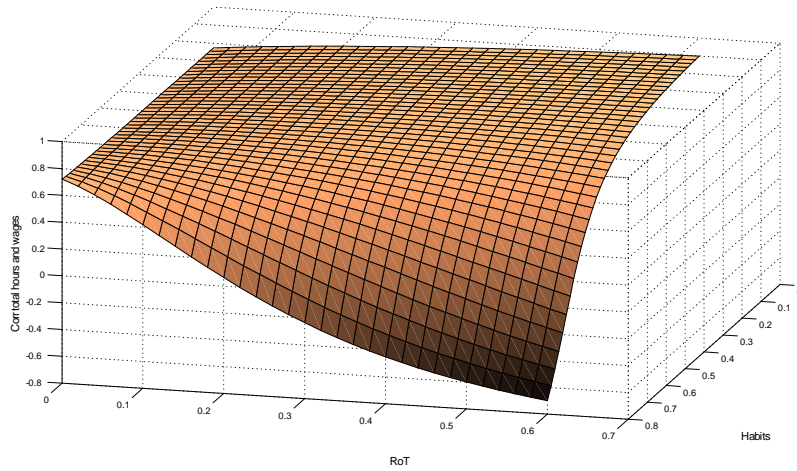


Figure 4: *Correlation between total hours and wages*

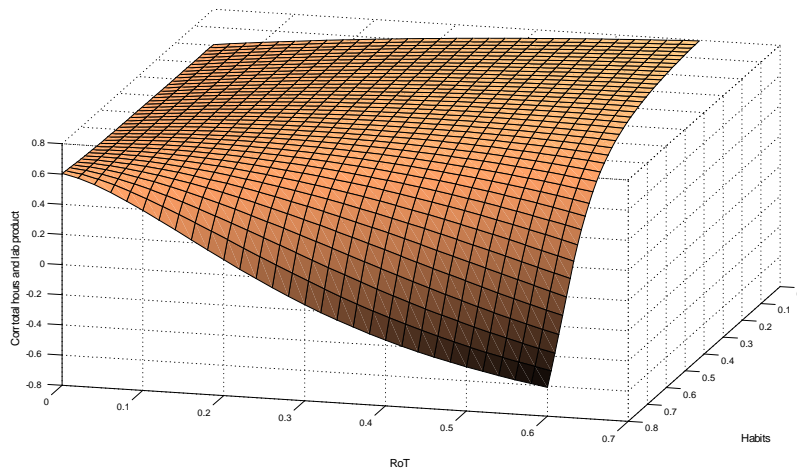


Figure 5: *Correlation between total hours and labor productivity*

RoT consumers alone even spoils the ability of the model to account for labour market correlations and volatilities. However, for a wide range in the share of *RoT* consumers and in the degree of habits, cross-correlations register values close to the empirical ones. The main feature of our model is that while *RoT* consumers are not allowed to use their wealth to smooth consumption over time, they will take advantage of the fact that they negotiate (in conjunction with optimising workers) wages and hours with the firms. Therefore, they use the margin that hours and wage negotiations provide them to improve their lifetime utility by narrowing the gap in utility with respect to Ricardian consumers. This, as we have shown in previous pages, weakens the correlations between the labour share and output, between hours and labour productivity and between hours and real wages.

Finally, the approach we follow here can be extended to consider that consumer heterogeneity stems from differences in preferences. Allowing for different discount factors would separate households between net borrowers and net lenders (see, for example, Iacoviello, 2005), which suggests interesting interaction between the labour and the financial markets that are next on our research agenda.

Appendix 1: Nash bargaining with RoT consumers

1. Maximisation problem

- The Nash bargaining process maximises the weighted product of stakeholder surpluses from employment.

$$\max_{w_t, l_{1t}} \left(\frac{\partial V_t}{\partial n_t} \right)^{1-\psi^w} \left(\frac{1-\mu^r}{\lambda_{1t}^o} \frac{\partial W_t^o}{\partial n_t} + \frac{\mu^r}{\lambda_{1t}^r} \frac{\partial W_t^r}{\partial n_t} \right)^{\psi^w} = \max_{w_t, l_{1t}} (\lambda_{ft})^{1-\psi^w} (\lambda_{ht})^{\psi^w} \quad (1.1)$$

where $\lambda_{ft} \equiv \frac{\partial V_t}{\partial n_t}$ and $\lambda_{ht} \equiv \frac{1-\mu^r}{\lambda_{1t}^o} \frac{\partial W_t^o}{\partial n_t} + \frac{\mu^r}{\lambda_{1t}^r} \frac{\partial W_t^r}{\partial n_t}$.

- Deriving w.r.t. w_t

$$(1-\psi^w) \left(\frac{\lambda_{ht}}{\lambda_{ft}} \right)^{\psi^w} (-l_{1t}) + \psi^w \left(\frac{\lambda_{ht}}{\lambda_{ft}} \right)^{\psi^w-1} \left(\lambda_{1t}^o \frac{1-\mu^r}{\lambda_{1t}^o} l_{1t} + \lambda_{1t}^r \frac{\mu^r}{\lambda_{1t}^r} l_{1t} \right) = 0 \quad (1.2)$$

or

$$(1-\psi^w)\lambda_{ht} = \psi^w \lambda_{ft} \quad (1.3)$$

- Therefore, optimisation of this joint surplus w.r.t. wages implies that

$$\psi^w \frac{\partial V_t}{\partial n_t} = (1-\psi^w) \left(\frac{1-\mu^r}{\lambda_{1t}^o} \frac{\partial W_t^o}{\partial n_t} + \frac{\mu^r}{\lambda_{1t}^r} \frac{\partial W_t^r}{\partial n_t} \right) \quad (1.4)$$

2. Solution for hours

- Deriving equation (1.1) w.r.t. l_{1t}

$$\begin{aligned} & (1-\psi^w) \left(\frac{\lambda_{ht}}{\lambda_{ft}} \right)^{\psi^w} \left(\alpha \frac{y_t}{n_t l_{1t}} - w_t \right) \\ & + \psi^w \left(\frac{\lambda_{ht}}{\lambda_{ft}} \right)^{\psi^w-1} \left(w_t + \left[\frac{1-\mu^r}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r} \right] U_{1t} \right) = 0 \end{aligned} \quad (5)$$

where U_{1t} is the marginal (des)utility of hours.

$$U_{1t} = -\phi_1 (1-l_{1t})^{-\eta} \quad (1.6)$$

- From equation (1.3)

$$\frac{\lambda_{ht}}{\lambda_{ft}} = \frac{\psi^w}{(1 - \psi^w)} \quad (1.7)$$

- Therefore, equation (1.5) can be written as

$$\frac{\alpha y_t}{n_t l_{1t}} = \phi_1 (1 - l_{1t})^{-\eta} \left[\frac{1 - \mu^r}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r} \right] \quad (1.8)$$

3. Solution for wages

- From the firm's side, we have the following FOC

$$\beta E_t \frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} \frac{\partial V_{t+1}}{\partial n_{t+1}} = \frac{\kappa_v v_t}{\chi_1 v_t^{\chi_2} [(1 - n_{t-1}) l_2]^{1-\chi_2}} = \frac{\kappa_v}{\rho_t^f} \quad (1.9)$$

- Therefore

$$(1 - \psi^w) E_t \frac{\beta}{\lambda_{1t}^o} \left((1 - \mu^r) \frac{\partial W_{t+1}^o}{\partial n_{t+1}} + \mu^r \frac{\lambda_{1t+1}^o}{\lambda_{1t+1}^r} \frac{\partial W_{t+1}^r}{\partial n_{t+1}} \right) = \psi^w E_t \beta \frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} \frac{\partial V_{t+1}}{\partial n_{t+1}} = \psi^w \frac{\kappa_v}{\rho_t^f} \quad (1.10)$$

- From (1.3) and combining (8), (14), (22) and (1.4):

$$\begin{aligned} \frac{\psi^w}{(1 - \psi^w)} \left(\alpha \frac{y_t}{n_t} - w_t l_{1t} + (1 - \sigma) \frac{\kappa_v}{\rho_t^f} \right) &= (1 - \mu^r) w_t l_{1t} + \\ &\frac{(1 - \mu^r)}{\lambda_{1t}^o} \left(\phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} - \phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} \right) + \\ &\mu^r w_t l_{1t} + \frac{\mu^r}{\lambda_{1t}^r} \left(\phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} - \phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} \right) + \\ &(1 - \sigma - \rho_t^{ws}) \left(\frac{1 - \mu^r}{\lambda_{1t}^o} \beta E_t \frac{\partial W_{t+1}^o}{\partial n_{t+1}} + \frac{\mu^r}{\lambda_{1t}^r} \beta E_t \frac{\partial W_{t+1}^r}{\partial n_{t+1}} \right) \end{aligned} \quad (1.11)$$

- Collecting terms:

$$\begin{aligned}
& \frac{\psi^w}{(1-\psi^w)} \left(\alpha \frac{y_t}{n_t} - w_t l_{1t} + (1-\sigma) \frac{\kappa_v}{\rho_t^f} \right) = w_t l_{1t} + \\
& \left(\frac{(1-\mu^r)}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r} \right) \left(\phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} - \phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} \right) + \\
(1-\sigma - \rho_t^w s) \frac{\beta E_t}{\lambda_{1t}^o} & \left((1-\mu^r) \frac{\partial W_{t+1}^o}{\partial n_{t+1}} + \mu^r \frac{\lambda_{1t+1}^o}{\lambda_{1t+1}^r} \frac{\partial W_{t+1}^r}{\partial n_{t+1}} + \mu^r \frac{\lambda_{1t}^o}{\lambda_{1t}^r} \frac{\partial W_{t+1}^r}{\partial n_{t+1}} - \mu^r \frac{\lambda_{1t+1}^o}{\lambda_{1t+1}^r} \frac{\partial W_{t+1}^r}{\partial n_{t+1}} \right)
\end{aligned} \tag{1.12}$$

or

$$\begin{aligned}
w_t l_{1t} &= \psi^w \left(\alpha \frac{y_t}{n_t} + \frac{\kappa_v v_t}{(1-n_t)} \right) + \\
(1-\psi^w) & \left(\frac{(1-\mu^r)}{\lambda_{1t}^o} + \frac{\mu^r}{\lambda_{1t}^r} \right) \left(\phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} - \phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} \right) + \\
(1-\psi^w)(1-\sigma - \rho_t^w) & \mu^r E_t \beta \frac{\lambda_{1t+1}^r}{\lambda_{1t+1}^o} \left(\frac{\lambda_{1t+1}^o}{\lambda_{1t}^o} - \frac{\lambda_{1t+1}^r}{\lambda_{1t}^r} \right)
\end{aligned} \tag{1.13}$$

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