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Abstract

The dimension of the aggregate fluctuations are quite diffrent between the European and U.S. economy. Such a result fully justify the attention to non-Walrasian features for improving the empirical performance of the RBC model. Several modification of the Walrasian model have been proposed to remedy these model's weakness in labour market aggregate fluctuations, Hansen (1985)'s introduction of nonconvexities into the consumer worker's labour-leisure choice, Danthine and Donaldson (1990), efficiency wages model, and the papers surveyed in the Cooley's (1995) book are some of the most notably. We feel that for several European countries, some institutional features may be relevant or may even be crucial in explaing the employment variability puzzle. To improve the ability to account for the stylized facts, we follow a twofold routes mutually consistent; we introduce trade union behaviour on the labor market and abandon one-shock model of aggregate fluctuations.

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1 Introduction

This article is motivated by the observation that the labor market structures in the European countries suggest a need to integrate non-Walrasian elements into the RBC paradigm. Feve and Langot (1994 and 1996) have stressed this aspect, highlighting as Walrasian models cannot mimic French stylized facts. The labor market in Italy, Germany, France and other European countries are characterized by large and persistent fluctuation of unemployment and by some common feature. Existing RBC models generate several shortcomings and employment variability puzzle and productivity puzzle are troublesome outcomes often showed by their simulations. Moreover, a great deal of these models are defined, calibrated and simulated for the U.S. economy. The relevant international data assembled in the paper of Danthine and Donaldson (1993) and Fiorito and Kollintzas (1994) make clear that labor market behavior is substantially different across countries, reflecting distinct institutional arrangements. It is noteworthy that the dimension of the aggregate fluctuations are quite different between the European and U.S. economy. Such a result fully justify the attention to non-Walrasian features for improving the empirical performance of the RBC model.[1] Several modification of the Walrasian model have been proposed to remedy these model's weakness in labor market aggregate fluctuations, Hansen (1985)'s introduction of nonconvexities into the consumer worker's labor-leisure choice, Danthine and Donaldson (1990), efficiency wages model, Cho and Cooley (1995) nominal wage contracts arrangement and the papers surveyed in the Cooley's (1995) book are some of the most notably. We feel that for several European countries, some institutional features may be relevant or may even be crucial in explaining the employment variability puzzle.

To improve the ability to account for the stylized facts, we follow a twofold routes mutually consistent; we introduce trade union behavior on the labor market and abandon one-shock model of aggregate fluctuations, including a further shock. This issue is crucial: as stressed by Christiano and Echenbaum (1992) the major failure of the traditional RBC models may be attributed just to the one-technological-shock assumption which inevitably, implies a high and positive correlation between employment and productivity. In general, many authors have been emphasized that some of the business cycle dimensions seem to be very difficult to mimic with a model that has only

[1] This perspective is emphasized by Wickens (1995) and Prescott (1998).

a technology shock (Cho 1993, Feve and Langot 1996 among others) while others (e.g. Ingram, Kocherlakota and Saving 1994) argues that the one-shock model is fundamentally indeterminate (and, additionally, sorting out the separate effects of the needed multiple shocks on a single variable is impossible).

In this paper we focus on the reservation wage (benefits) variable. This variable is treated by the union model as a constant: alternative values of this variable affect positively union wage. For a monopoly or right-to-manage union model, a change in benefits will cause movements up and down the labor demand curve. Actually, there is a dearth of analysis allowing for dynamic effects of alternative wages or benefits. A positive shock to the unemployment benefits shifts the labor supply curve (the bargaining wage curve) leftward offsetting the strong positive correlation between employment and wage, predicted by the one-shock real business cycle models with stochastic shifts in the production function.

Kydland and Prescott (1996), stress that any economic computational experiment is that of deriving a quantitative answer to some well-posed question. We construct a model economy, calibrate it and run simulations to answer questions concerning the quantitative implications of theory for the employment and productivity puzzles. In particular, does the introduction of dynamic union behavior into real business cycle model for European countries, eliminate the labor market shortcomings entailed by conventional equilibrium models ? What is the contribution of the government unemployment benefits in a unionized economy to business cycle fluctuations? Our simulation results show that including into the model union behavior and randomizing unemployment benefits into the union preferences substantially improves the RBC model performance for the European countries.

The paper is organized as follows. In Section I, we describe the economy, stressing the problem facing unions and firms and that defined by the households. Equilibria with wage rigidity are defined and several implications are described in Section II. Section III reports stylized facts and model simulations generated for France and Italy, by pining down selected parameter values. In this section, we provide useful information in the form of autocorrelation functions, comovements with output and variability of the aggregate series involved. To draw additional information about dynamic response of the variables to various shocks, the impulse-response functions are also provided. Section IV concludes.

2 The economy

2.1 The facts

Recent statistics on union membership and on union coverage in the European countries and United States are presented in Table 1. Although union membership trend has undergone a sharp decline since 1985, a relevant fraction of European workers actually belong to unions. Moreover, about three-quarters of the work force have their wages and working conditions set in a collective bargaining agreement. The figures show also that U.S. union coverage and membership are much lower than those presented in European labor markets. Furthermore, unionized sectors in the U.S. economy do not offer much scope for monopolistic wage-setting, since bargaining is conducted on an enterprise-by-enterprise basis. There are no doubts that trade union influence and power cannot be measured merely in terms of the number of active members. Representatively is not the only one factor for assessing the union power. In Spain and France, for instance, the union confederations have a remarkable capacity to call for action, despite the very low unionization rate. In these countries there exists a clear political conception of industrial relations and unions are directly related to the parties: usually, government-sanctioned extension of union contracts to non-union members, a setup confirmed by the striking gap between coverage and membership in those countries.

Table 1: Union Membership, Coverage and Replacement Rates

	UNION MEMBERSHIP		COVERAGE	REPLAC. RATES
	% non-agricul. labour force	% wage-salary earner	% of employed	OECD(1994/95)*
Belgium	38.1	51.9	90	65
Denmark	68.2	80.1	90	81
France	6.1	9.1	92	68
Germany	29.6	28.9	90	68
Italy	30.6	44.1	90	19**
Netherlands	21.8	25.6	71	82
Spain	11.4	18.6	68	53
United Kingdom	26.2	32.9	47	69
United States	12.7	14.2	18	19

Sources: *ILO, World Labor Report, Geneva 1998; OECD,Economic Studies, n.26, Paris, 1996.* *Replacement rates: Entitlements calculated over 5 years of unemployment in % of previous earnings. The average excludes the Replacement rate of couple with one partner in employment. **The estimates of RR for Italy do not include the CIG (wage supplementary fund) benefits are paid to workers affected by collective lay-offs in firms with 16 or more employees as a result of a temporary decline in economic activity. Benefits are equal to 80% of gross earning up to a monthly maximum which is about 65% of average earnings.

The last column of Table1 reports another characteristic that influence the labor market, the OECD measure of benefits entitlements: the entitlements calculated over 5 years of unemployment in percentage of previous earnings. Unemployment benefits are multidimensional and, therefore, difficult to define in a single indicator. Here, simply on the basis of replacement rates summary estimates, we emphasize that in most European countries insurance benefits have a role in the labor market. Union behavior may be influenced by unemployed benefits because a generous system implies that those who may lose their jobs may take greater risk in collective bargaining over wages. Unemployed benefits, tend to reduce the cost of becoming unemployed. Given these extreme features of the European labor markets, setting out a real business cycle model represents an interesting challenge.

2.2 Union and firms

In this economy there is a large number of identical and infinitely-lived households and firms which produce an homogeneous output. The economy is characterized by two goods, labor and output. To define an equilibrium for this economy we need to look separately both of the problems facing union and firms and the problems facing households and labor market outcomes.

Identical firms i use the same constant returns-to scale production function to produce an unique homogeneous good. In the United States and many European countries capital and labor shares of output had been approximately constant . The Cobb-Douglas production function with its unit elasticity of substitution allows labor's share of product to be constant, event though wages and rental price are different (Prescott 1986; 1998):[2]

$$Y_t = A_t K_t^{\theta} N_t^{1-\theta} \tag{1}$$

[2]Provided no firms has any market power, we can treat all firms as one production entity.

The production function is subject to an aggregate productivity shock A_t, common to all the firms, while K_t and N_t denote, respectively, capital stock and employment.

The technology shock follows the stationary $AR(1)$ process

$$\ln A_{t+1} = (1-\rho)\ln A + \rho \ln A_t + \varepsilon_t \tag{2}$$

where $0 \leq \rho \leq 1$ and ε_t is a $i.i.d$ random variable with the following distribution $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$. $\ln(A)$ is the mean of the log technology shock process.

Each firm accumulates capital K_t according to

$$K_{t+1} = (1-\delta)K_t + I_t \tag{3}$$

where the term δ represents depreciation $(0 \leq \delta < 1)$. The right to determine the quantity of labor employed in period t is ceded to the union by the firm. In fact, it is common knowledge that under union wage, the firm solves the profit-maximizing problem,

$$\Pi_t = \max A_t F(K_t, N_t) - W_t^U N_t - R_t K_{t,} \text{ with } K_t \geq 0, N_t \geq 0,$$

reaching the following result:

$$\begin{aligned} AF_1(K,N) &= R_t \\ AF_2(K,N) &= W_t^U \end{aligned}$$

Namely, in our economy

$$W_t^U = (1-\theta)A_t\left(\frac{K_t}{N_t}\right)^\theta \tag{4}$$

$$R_t = \theta\left(\frac{Y_t}{K_t}\right) + (1-\delta) \tag{5}$$

After the technology shock is revealed at the beginning of period t, firm and union determine wage and quantity of labor employed in that period. Once the quantity of aggregate labor input is determined by the union, the representative agent's choice of hours per employed and the number of employed in the market sector should be restricted by the quantity chosen by the union.

The monopoly union solves a dynamic optimization problem. The trade union has to select a time path for the wage rate or, alternatively, for employment. We assume as in Kidd and Oswald (1987), that new employees join the union (a post entry closed-shop model): $M_{t+1} = N_t$ This difference equation says that membership tomorrow is determined by employment today, that all the new employees join the union and all the individuals that lose their jobs leave it, and that rises and falls are symmetric. Moreover, this membership rule leads the trade union to take care of both current and future members.

If we set the union's utility function as $Nu(W) + (M - N)u(B)$,where $u(.)$ is the individual worker's concave utility function, M is the stock of membership, N_t is a measure of employment, W is the average wage for unionized employees, B is the reservation wage, received by non-unionized employees, then we may state the union preferences as follows,

$$\max_{N_t, M_t} E_t \sum_{j=0}^{\infty} \beta^t \left[N_t \left(\frac{W_t^{1-\eta}}{1-\eta} \right) + (M_t - N_t) \left(\frac{B_t^{1-\eta}}{1-\eta} \right) \right] \tag{6}$$

$$s.t. \quad M_{t+1} = N_t \tag{7.1}$$

$$s.t. \quad W_t = f'(N_t) \tag{7.2}$$

This utility function has the property that relative risk aversion, defined as $-\left[u''(w)w\right]/u'(w)$, is given by η.[3] Clearly, if the value of η is not different from zero, then the utility function is linear in wages (risk-neutral).Moreover, it should be noted that, in the latter case, (6) nests the rent maximization utility function as special case. The dynamic model of membership, assumes that the current number of workers who join the union is exactly equal to the level of employment in the previous period. This post-entry closed shop may be made less stringent, assuming a more general formulation where a rate at which new workers join the union and, possibly, a rate of separations are included, for respectively, N_t and M_t. However, this assumption is complicated because it involves a richer heterogeneity. Below, we simplify

[3]Farber (1978) and Carruth A. and Oswald (1985) provides some estimation of this model for the U.K. and the U.S economy.

the heterogeneity implied by the union behavior by using a representative household.

Throughout, we assume that union considers B_t as an exogenous, uncontrollable $AR(1)$ stochastic process,

$$B_{t+1} = (1-\omega)B + \omega B_t + \xi_t \tag{8}$$

where $0 \leq \omega \leq 1$ and ξ_t is a $i.i.d$ random variable with the following distribution $\xi_t \sim N(0, \sigma_\xi^2)$. In such a case $B = 1$ in the steady state. Thus, technology shocks are not the only source of fluctuations. The subjective discount rate is fixed at β $(0 \leq \beta < 1)$. In picking a time path for, say, employment, union considers the labor demand curve (4). The union problem yields the following first order conditions (see Appendix A):

$$M_{t+1} = N_t \tag{9.1}$$

$$\left(\frac{B_t^{1-\eta}}{1-\eta}\right) - \lambda_t = 0 \tag{9.2}$$

$$\beta^t [\frac{f'(N_t)^{1-\eta}}{1-\eta} - \frac{B_t^{1-\eta}}{1-\eta} + N_t f'(N_t)^{-\eta} f''(N_t)] + \beta^{t+1} E_t \lambda_{t+1} = 0 \tag{9.3}$$

It can be showed that the union's utility function is concave in M e N, so that first order conditions are sufficient for a maximum. These provides the following dynamic solution[4]

$$N_t = P B_t^{\frac{1}{\theta(\eta-1)}} A^{\frac{1}{\theta}} K_t \tag{10.1}$$

$$M_{t+1} = N_t \tag{10.2}$$

with $P = (\frac{1}{\Psi})^{\frac{1}{\theta(\eta-1)}} (1-\theta)^{1/\theta}$.The steady state equilibrium is

$$N = P B^{\frac{1}{\theta(\eta-1)}} K \tag{11.1}$$

[4]In order to evaluate the expected value in (9.3), we use the linear approximation around the steady state $(B = 1)$ $\left(\frac{B_t^{1-\eta}}{1-\eta}\right) = B_t + o(B_t)$.

$$M = N \tag{11.2}$$

The capital accumulation rule, the technological processes and the reservation wage (benefits) are the equations of motion for this economy, $S_t = (K_t, A_t, B_t)$.

Thus, we adopt a monopoly union model to set unilaterally the employment (or equivalently the wage level), subject to the firm's labor demand curve. Firms, therefore, read off from labor demand curve the number of workers to hire at the union wage. Three aspects must be stressed for characterizing a monopoly union outcome in a general equilibrium framework. First, under this simple model, the union selects wages (or employment) on its own, with no bargaining. Second, the model assumes unemployment insurance by specifying a guaranteed income flow to each worker unemployed (reservation wage or benefit). Below, we deal with unemployed individuals assuming identical families with two heterogeneous members, employed vs. unemployed, but with identical preferences for consumption. Such an environment is not equivalent to one where the market for unemployment insurance provides a means to attain risk sharing.[5] Albeit the family individuals consume identical amounts regardless of their employment status, we does not assume, as in Hansen (1985), that firms offer labor contracts (including unemployment insurance) that are traded competitively, but rather, labor market is imperfectly competitive, and union wages are higher than unemployment benefits. Third, the union, seeking its highest level of utility, subject to the constraint of the labor demand curve, takes into account that its behavior may reduce employment and, therefore, union members and utility: in equilibrium marginal benefits (any member employed will receive an higher wage) and marginal cost (any member faces an higher probability of being unemployed) should be equal.

2.3 The Solow residual in a unionized economy

Prescott (1986) measures the stochastic impulse to the economy, as the change in total factor productivity. Assuming a Cobb-Douglas production function (constant returns to scale) and perfect competition, that amounts to calculate the Solow residual

[5] See Li (1999) for an updated discussion.

$$\ln A_t = \log Y_t - \theta \log K_t - (1-\theta) \log N_t$$

Recent developments of literature in this field have pointed out that this residual is not a correct measure of technical change in case of labor hoarding, imperfect competition or measurement errors in variables (e.g. Hall 1986, 1990). Moreover, theoretical analysis and empirical evidence suggest that many other factors beyond technological shocks can affects economy both from supply-side or from demand-side. Others (e.g. Evans,1992) find some robust evidence for Solow residual not to be exogenous, but be Granger-caused by some policy variables such as interests rates or government spending.

Technology shock is an important contributor to fluctuations in the economy. However, it is only a factor, other determinants may foster or curb technological growth. Hansen and Prescott (1993) emphasize that from the point of business cycles, changes in the legal and regulatory system may turn out to be crucial. These changes may be positive, because they allow an industry to develop and, therefore, increase the business sector productivity, but these shocks may also be negative changes in technology, because they result in a change in resources allocation from productive to unproductive type activities. Empirical evidence of these shocks may be found in all of industrialized countries and their effect. Likewise the effect of a new invention, their effect is to shift the production function of the economy, however, contrary to a new knowledge effect, these shocks may have adverse effects on the production possibilities sets.

As a consequence of this interpretation of the TFP shocks, in the European labor market context, we identify the industrial relation structure as a further leading factor to change of the "production possibility sets of the profit centers". Changes in the industrial relation system should affect the conduct of business for they have important consequences for the incentives to adopt more advantage technologies and for achieving a more efficient resources allocation. This may represent a difference between the United States and European business cycles.

Thus, in a unionized labor market, industrial relations can be a further variable to account for changes over time of the level of economic activity. For instance, from the end of 1960s to 1980, Italy experienced an extraordinary increase in unionization. The sharp rise in the unionization rate has been interpreted as a growth of members in already highly unionized sectors of industry and to a greater diffusion of union membership among white-collar workers in industry and public administration. The 1970s started off with a major change in industrial relations, in a context of high unemployment and a rapid growth in conflict. In the period 1969-77, the number of industrial disputes was on average more than 4 thousand per year with about 6.5 million workers involved each year, and the number of hours lost through strikes averaged 154 million per year. The rise of conflict was related to a greater wage push from the rank and file in a context of considerable rationalization (innovation) of the productive system (see, for instance Tarantelli and Willke 1981). In the successive two decades, a more comprehensive and centralized unions and employers' organizations were oriented towards responsible strategies of collective action. As a result, the Italian economy has benefited from a remarkable change in labor market structure. The first step in this direction was the 1983 agreement. Union modifications to the wage indexation scheme and some concessions regarding hiring procedures were obtained in the subsequent years along with several attempts to set out an income policy. Matters radically changed from July 1993 when under an incomes policy accord the government abolished the wage indexation mechanism. The result was a policy of wage restraint while labor market regulation became more flexible and collective agreements signed at national level were coupled to negotiations at company level.

These different regimes of industrial relations have impinged on the production possibility sets. Figure 1 reports the deviations of the Solow residual from a HP time trend, calculated for the Italian economy using the "indirect evidence" suggested by Farmer (1993). We assume $\alpha = 0.45$, a value used by Censolo and Onofri (1993) for the Italian economy. Furthermore, K_t is disaggregated by interpolation using quarterly investments (see Levy-Chen, 1994) and includes the stock of residential houses, but excludes durables goods (Evans,1992). It should be noted how the deviations from trend are highly persistent (with long swings away from trend) in the first part of the period, when the industrial relations system is extremely conflictual. Subsequently, the Solow residual reflects a better climate in the labor market and structural adjustments which, determining a sizeable transformation in Italy's production structure and in its industrial relations, affected the observations on the total productivity disturbance: the residual takes short swings away from the trend and is far less persistent than that measured in the previous period.

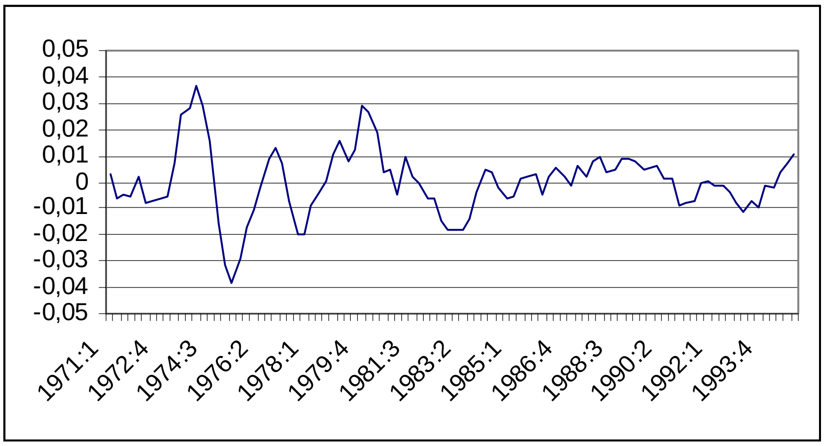


Figure 1: HP-filtered Solow Residual for Italy

2.4 Household

Empirical evidence shows that most of the variation in total hours of employment over the business cycle are due to movements in the labor force rather than in adjustments in average hours of works. In the canonical RBC models this aspect has been skipped, by characterizing agents as either continuously adjusting their hours (Kydland and Prescott) or deciding only labor force with indivisible labor (Hansen-Rogerson).[6]

We follow Cho and Rogerson (1988) family labor supply model, assuming a large number of identical families, each of which consists of two members. The heterogeneity which is of interest in our labor market is the labor supply of worker union members and unemployed. The latter have a lower earning compensation B whereas union workers have W. Thus we assume that each representative family is composed by two members, whose just one supplies labor. Moreover, as in Cho and Rogerson's work, we assume that both workers and unemployed member of the family have the same strictly convex preferences for consumption. The household problem is, therefore,

$$u(c_{it}, l_{it}, e_{it}) = 2u(c_{it}) - v(h)e_{it} - \mu(e)e_{it} \tag{12}$$

where $h = 1 - l$ is hours worked per period.[7] Individuals in this economy are supposed to make two kind of choices; they can choose the number of

[6] See, Kydland and Prescott (1982), Hansen (1985) and Rogerson (1988).

[7]

days to work in each period or the number of hours to work per each day they work. The above form of temporal preferences is, therefore, consistent with the fact that the fluctuations take place on both the intensive and extensive margins. We may let h to be the number of hours they work and e the fraction of days they work in each quarter; e is essentially the household's employment rate, and in a representative agent framework this amounts to the aggregate employment rate in equilibrium. In the utility function appears also a fixed cost $\mu(e)$, associated with each period the agent choose to work. In our context, the cost may be related to union membership, for instance, subscription dues, whilst Cho and Cooley (1994), provides family organization justifications associated with the decision to participate in the labor market.

Notice that although the utility function is assumed to be separable in consumption and leisure, the quantity of aggregate labor input is determined by the union. In selecting working hours and a fraction of the working period, the representative households must be restricted by the quantity of labor input determined by the behavior of union and firm. The labor quantity turns out to be a constraint for the household which may wishes to supply a different quantity of labor. In this economy, employment fluctuations are induced by changes in union wage curve and firm labor demand. This framework implies that employment fluctuations are not related to consumer intertemporal substitution. The optimal response of households to shocks is now reduced to a selection between h and e, while N is determined in the labor market by union and firm. In this framework the wage-setting relation replaces a standard labor-supply relation. The wage, or the employment, corresponding to

If the utility function takes the form

$$U = U(c, e, h)$$

then it must be homogenous of some degree $1 - r$ in c for the existence of a balanced growth path. This implies that the function must take the form

$$U(c, e, h) = \frac{[cV(e, h)]^{1-r} - 1}{1 - r}.$$

The above function is in this class and is therefore consistent with balanced growth. As $r \rightarrow 1$, it follows using L'Hospital's rule, that

$$U(c, e, h) \rightarrow \log(c) + \log(V(e, h)).$$

a given level of employment (wage) in the wage setting relation may be the result of a complex process of bargaining between union and firm or unilateral wage setting by unions. Here, factors such as the structure of collective bargaining, the climate of industrial relations and the dynamic structure of membership affect the wage setting relation. Obviously, these factors have no place in the standard or convexifyed

supply relation.

It is worth noting that, though the economy is characterized by trade unions behavior, the model is unable to generate data on unemployment. Unemployed people are a component of the family. Given our purpose, the model does do not involve the heterogeneity implications, but, rather, it uses a representative household, thereby eliminating wealth-redistribution effects. Although our model is simpler, the basic idea is similar to the CIA splitting model developed by Lucas (1990) and Fuerst (1992). Initially, in the labor market, the model splits the representative household into worker-individuals and unemployed-individuals, but both kind of individuals fully participate in determining the household budget constraint, with labor income and benefits.

The following lifetime expected utility is maximized by the household, taking into account his budget constraint,

$$U = E\left\{\sum_{i=0}^{\infty}\beta^t[2\left(\frac{c_{it}^{1-q}-1}{1-q}\right) - v(n_{_{it}})e_{_{it}} - \mu(e_{_{it}})e_{it}]\right\} \tag{12.1}$$

s.t.

$$2c_t + k_{t+1} = w_t e_{_{it}t}h_{it} + B_t(1-e_{it}h_{it}) + R_t k_{it} \tag{12.2}$$

The first order conditions, yield:

$$L_c = 2c_{it}^{-q} - 2\lambda_t = 0 \tag{12.3}$$

$$L_h = -v'(h_t)e_{it} + \lambda_t w_t e_{_{it}} - \lambda_t B_t e_{_{it}} = 0 \tag{12.4}$$

$$L_e = -v(h_t) - +\lambda_t w_t e_{_{it}} - \mu(e_{_{it}}) = 0 \tag{12.5}$$

$$L_k = -\lambda_t + \beta E(\lambda_{t+1}R_{t+1}) = 0 \tag{12.6}$$

$$2c_{it} + k_{it+1} - w_t n_{it} - B_t(1-n_{it}) - R_t k_{it} = 0 \tag{12.7}$$

Using $v(h) = [f/(1+\gamma)]h^{1+\gamma}$ and $\mu(e) = [g/(1+p)]e^{1+p}$ we get

$$-fh_{it}^{y} + \lambda_t w_t e_{it} - \lambda_t B_t e_{it} = 0$$

$$-f/(1+\gamma)h_{it}^{1+\gamma} - ge_{it}^{p} + \lambda_t w_t h_{it} - \lambda_t B_t h_{it} = 0$$

Solving simultaneously for h and e and using (12.3)

$$h_{it} = [C^{-\eta}(w_t - B_t)/f]^{1/\gamma} \quad (12.8)$$

$$f/(1+\gamma)h_{it}^{\gamma} + ge_{it}^{p} = \lambda_t(w_t - B_t) \quad (12.9)$$

$$e_{it}^{p} = \left\{[\gamma/(1+\gamma)g][C^{-\eta}(w_t - B_t)/f]\right\}^{1/p} \quad (12.10)$$

where we used (12.8) in (12.9) for h_{it}.

3 Equilibrium

Definition 1 *A stationary competitive equilibrium for this economy consists of a set of decision rules,* $c_{it}(s_t), e_{it}(s_t), h_{it}(s_t)$;*a set of aggregate decision rules,* $W_t(S_t), C_t(S_t), E_t(S_t), H_t(S_t)$ *and a value function* $V(s_t)$ *such that*

a) the function $V(s_t), W_t(S_t), C_t(S_t), E_t(S_t), H_t(S_t)$ *satisfy (12.1) and* $c_{it}(s_t), e_{it}(s_t), h_{it}(s_t)$ *are the associated decision rules;*

b) $e_{it}(s_t) = E_t(S_t)$, $c_{it}(s_t) = C_t(S_t)$, $h_{it}(s_t) = H_t(S_t)$ *when* $k_{it} = K_t$.

The equilibrium we are going to define cannot be obtained as a solution to a dynamic programming problem, for we need to analyze separately at the problems facing firms and households.

The link between firm's decision and household's one is the hypothesis that the quantity of labor is determined by the firm and in each period N^d, and the aggregate labor supply is the product of the employment rate E and the hours of work H.

The equilibrium wage w_t^* is obtained equating the aggregate demand and supply of labor,

(see Appendix B), $N^s = E * H = N^d$:

$$w_t^* = \frac{N_t^\tau}{S} C^\eta - b_t \tag{13}$$

where, $\tau = (1/\gamma + 1/p)$; S=$(1/f)^{(1/\gamma)}[\gamma/(1+\gamma)]^{1/p}$.

Substituting the definition of the equilibrium wage in (12.8) and (12.10), allows us to define an equilibrium for hours and employment rate. The economy that solves the problem facing by union, firms and households is described by the following Eulero equations:

$$H_t^* = \left\{ \frac{N_t^\tau}{Sf} - (1 + C_t^{-\eta}) \frac{b_t}{f} \right\} \tag{14.1}$$

$$E[\beta \left(\frac{C_t}{C_{t+1}} \right)^\eta R_{t+1} = 1 \tag{14.2}$$

$$R_t = \theta A_t K_t^{\theta-1} N_t^{1-\theta} + (1-\delta) \tag{14.3}$$

$$C_t = \frac{1}{2} \left\{ A_t K_t^\theta N_t^{1-\theta} + (1-\delta) K_t - K_t + B_t (1 - N_t) \right\} \tag{14.4}$$

$$Y_t = A_t K_t^\theta N_t^{1-\theta} \tag{14.5}$$

3.1 The steady state

Cogley and Nason (1995) emphasize three kind of stationarity: 1) stationary around a deterministic trend, 2) difference stationary model with shocks following a random walk ($\rho = 1$), 3) stationary around a steady state equilibrium. The third specification is of our interest in this paper. A steady-state for our economy is

$$\beta R = 1 \tag{15.1}$$

$$R = \theta A K^{\theta-1} N^{1-\theta} + (1-\delta) \tag{15.2}$$

$$C = \frac{1}{2} \left\{ A K^\theta N^{1-\theta} - \delta K + (1 - N) B \right\} \tag{15.3}$$

$$Y = AK^{\theta}N^{1-\theta} \tag{15.4}$$

$$H = \left\{ \frac{N^{\tau}}{Sf} - (1 + C^{-\eta})\frac{b}{f} \right\}^{(1/\gamma)} \tag{15.5}$$

$$N = PB^{\frac{1}{\theta(\eta-1)}}K \tag{15.6}$$

$$M = N \tag{15.7}$$

Given our assumptions on functional forms, technology and parameter' restrictions, the steady state solution (15.1-15.7) exists and is unique. The solution method used in this paper is that suggested by King, Plosser and Rebelo (1988a,b). The essence of this method is to transform the economy's equilibrium characterization, equations (15.1)-(15.7), into an approximating first-order autoregressive linear system.

Using linear approximations (e.g. Campbell, 1994, Ulhig 1999 among others) we can write (see Appendix C):

$$c_t = \frac{Y}{C}a_t + (\frac{Y}{C}\theta + (1-\delta)\frac{K}{C})k_t + (\frac{Y}{C}(1-\theta) - \frac{BN}{C})n_t - \frac{K}{C}k_t + (\frac{B}{C} - \frac{BN}{C})b$$

$$r_t = \theta\frac{Y}{KR}(a_t + (\theta-1)k_t + (1-\theta)n_t) \tag{16.1}$$

$$y_t = (a_t + \theta k_t + (1-\theta)n_t) \tag{16.2}$$

$$0 = E_t[\eta(c_t - c_{t+1}) + r_{t+1}] \tag{16.3}$$

$$n_t = (\frac{1}{\theta(\eta-1)}b_t + \frac{1}{\theta}a_t + k_t) \tag{16.4}$$

$$b_{t+1} = \pi b_t + \xi_t \tag{16.5}$$

$$a_{t+1} = \rho a_t + \varepsilon_t \tag{16.6}$$

The last two equations represent the stochastic processes in terms of deviations from steady state.

4 Quantitative results

4.1 The stylized facts of the European fluctuations

In a seminal paper, Prescott (1986) emphasized the three dimensions of the business cycle phenomenon, the periodicity of output, comovements of other variables with output and the relative variability of other series. This paper provides information on these dimensions, by comparing output dynamics, comovements and variability of several generated artificial data with stylized facts for two European countries, France and Italy.

In the Tables 2-3 below, we report a summary statistics for, respectively Italy and France, whereas Table 4 reproduces from Hairault (1995) some statistics for data generated from simulating a real business cycle model with labor indivisibility in the line of Hansen (1985). The data are detrended using the Hodrick-Prescott filter so that business cycles are deviations of the variables around this trend. The following calibration on French economy is:

$$\left\{\theta = 0.42; \delta = 0.0125; \rho = 0.95; \sigma_A = 0.9; \beta = 0.99; \tilde{N} = 0.2\right\}$$

Finally, a model with labor indivisibility calibrated on Italy has been tempted and reported in Table 5. To calibrate on Italian economy we use parameters defined in Censolo and Onofri (1993),

$$\left\{\theta = 0.555; \delta = 0.028; \rho = 0.88; \sigma_A = 0.7; \beta = 0.988; \tilde{N} = 0.3\right\}.$$

Although these model simulations can account for some drawbacks, some aspects of the data generated by these models and reported in the tables, appear to be inconsistent with the two European economies. The Hansen's simulations show that productivity is highly positively correlated with both output and labor input. With respect to output, the productivity variable shows a correlation of 0.93 for French economy and 0.67 for the Italian economy while the corr$(n,\ \pi)$ is respectively, 0.87 and 0.99. Actual data shows that the latter correlation is zero or negative, while the output-productivity correlation is somewhat moderate (0.45 for French data and 0.36 for the Italian economy). Literature on RBC indicates the shock on the total factor productivity as one of the major cause of this result.

Table 2. Cyclical Properties on French Data

variable (v)	y	c	i	n	π
s.d.	0.91	0.81	3.64	0.83	0.65
s.d./s.d.(y)	1	0.90	4.01	0.92	0.72
AR(1)	0.76	0.67	0.82	0.89	0.63
Corr(y,v)	1	0.63	0.80	0.71	0.45
Corr(n,v)					-0.35

Table 3. Cyclical Properties on Italian Data

variable(v)	y	c	i	n	π
s.d.	1.46	1.24	3.70	1.39	2.78
s.d./s.d.(y)	1	0.85	2.53	0.95	1.90
AR(1)	0.85	0.92	0.91	0.90	0.80
Corr(y,v)	1	0.80	0.78	0.63	0.36
Corr(n,v)					0.19

Table 4. Hansen's model: French Economy

variable(v)	y	c	i	n	π
s.d.	1.85	0.57	5.0	1.32	0.57
s.d./s.d.(y)	1	0.30	2.69	0.71	0.30
AR(1)	0.68	0.73	0.67	0.67	0.73
Corr(y,v)	1	0.93	0.99	0.98	0.93
Corr(n,v)					0.87

Table 5. Hansen's model: Italian Economy

variable(v)	y	c	i	n	π
s.d.	1.45	0.29	3.44	1.27	0.29
s.d./s.d.(y)	1	0.20	2.37	0.88	0.20
AR(1)	0.65	0.86	0.64	0.63	0.86
Corr(y,v)	1	0.67	0.99	0.99	0.67
Corr(n,v)					0.99

4.2 Calibrating union model

Random shocks are artificial, and there is no way of comparing generated time series with historical data. This led Kydland and Prescott to model the productivity shock as a random process with selected parameter, chosen to mimic the variance of GNP in the US economy. Beginning with Prescott (1986), technology had been estimated by the Solow residual. Nevertheless, calibration of technology parameter based on variance of GNP has been recently used in Cogley -Nason (1995). In this paper we follow the latter approach for the two European economies.

The summary statistics from the French and Italian unionized economies are in Tables 6 and 7. The main differences in the statistics presented here from those found with the Hansen's model, are in the union preferences and the additional shock variable for unemployed benefits.

The parameters, determining the union behavior are the risk aversion parameter $\eta = 0.46$, the persistence of the shock $\omega = 0.65$, and its size $\sigma_B = 0.05$. The benefit shock parameter is set to provide a lower degree of persistence with respect to the technology parameter. To select this parameter we account for ordinary wage supplementary fund benefits, which are paid to Italian workers affected by collective lay-offs in firms with 16 or more employees as a result of a temporary decline in economic activity. Since benefit insurance is highly procyclical, its effect should be less persistent. We extend this consideration to the Franch labor market. With regard the risk aversion parameter, the value selected suggest that both the Italian and French workers are relatively risk averse. This indicates that unions in these countries, consider in some way the employment consequences of their wage policies. Our unionized economy offers a scope for monopolistic wage setting since bargaining is concluded, in these countries, on an central-sectorial basis. However, because union membership is conditional upon employment, the danger of monopolistic wage-setting is reduced: union may takes a lower risk in disputes with employers associations. The remaining parameter is the correlation between the random technology and benefit shocks, assumed to be $\zeta_{A,B} = 0.12$. (below, in a further experiment, we relax this assumption, running a model with orthogonal random processes).

Table 6. Union's model: French Economy

variable(v)	y	c	i	n	π
s.d.	2.25	0.45	8.11	2.16	0.51
s.d./s.d.(y)	1	0.20	3.61	0.96	0.23
AR(1)	0.45	0.87	0.44	0.46	0.70
Corr(y,v)	1	0.40	1	0.98	0.30
Corr(n,v)					0.15

Table 7. Union's model: Italian Economy

variable(v)	y	c	i	n	π
s.d.	1.44	0.45	3.48	1.32	0.63
s.d./s.d.(y)	1	0.31	2.41	0.92	0.44
AR(1)	0.60	0.92	0.58	0.60	0.79
Corr(y,v)	1	0.53	1	0.93	0.40
Corr(n,v)					0.18

One fact worth noting is that the new model simulations yield a remarkable improvement of the "troublesome facts"depicted by the prototype RBC models. The most successful features of the model are in the implied correlation structure. Under the above conditions, the models seem display realistic features for both, the employment variability puzzle and the productivity puzzle (contrast Tables 2 and 3 with Tables 6-7). Although the Italian union RBC model predicts that employment is less variable than in realty, its improvement with respect the Hansen version is remarkable. Comparing with the actual data, a model's unsuccessful feature is the ratio of standard deviation of employment relative to productivity. This ratio is 0.5 in the Italian economy and 4.38 in the Hansen model solution. The union model, however, lessens the volatility of employment to labor productivity to 2.1 whereas for the French economy this feature remains unsatisfactory: the ratio is 1.3 in the French economy but it is 4.2 in the union model economy (4.4 in the Hansen's model). Moreover, the correlations concerning the labor productivity variable with output and employment are moderate and very close to the realty as expressed by the statistics in Tables 2 and 3. Overall, the model seem to explain the volatility of output and the other variables except consumption.

In order to analyze the employment and productivity puzzle of the calibrated Union's RBC model, may be useful carry out an experiment with a lower correlation for the two random shocks. To this end, we set the following parameters $\left\{\theta; \delta; \rho; \omega; \sigma_A; \sigma_B; \eta; \beta; \tilde{N}\right\}$ as in the previous experiment. Also persistence and variance of the shocks are unchanged, whilst the impose orthogonality of the stochastic processes, $\zeta_{A,B} = 0$, for both the economies (French and Italian). Interestingly, reducing correlation between the shocks causes a countercyclical behavior of productivity and employment. The productivity correlation structures is for the Italian model, Corr(y,π)=-0.23 Corr(n,π)=-0.39, while for the French model is Corr(y,π)=0.11, Corr(n,π)=-0.24.

Figure 2 and 3 trace out the impulse-response functions that result from the resolution of the model. The two features that are most noticeable are the the contrasting performance of the variables under the two shocks. First, the responses of output, consumption, investment and employment due to the effect of the benefit shock are instantaneously below their steady state level and then increase to their lower stationary levels. The consumption path displays a declining path. The picture is reversed when the economy is hit by a productivity shock. For instance, the figures indicate that the two shocks change employed and unemployed consumption by the same amount above (TFP shock) and below (benefit shock) their respective steady state values. The second distinguishing result, concerns the latter shock; the shift in technology does not affect labor productivity. In figure 2 there is no productivity deviation from the steady state: equation (16.2) and (16.4) above, indicate that for the chosen specification (Cobb-Douglas production function) and with employment fluctuations which do not depend on the consumer optimal response, but are uniquely determined in the labor market, a technology shock causes an equal increase of employment and output above the steady state.

5 Conclusions

We specify, solve and simulate a RBC model where the labor market is influenced by trade union behavior. A dynamic model of union and membership is defined and included in the RBC framework. Two sources of randomness, a shock to total factor productivity and a shock to the unemployed benefits, drive the model. Innovation in benefits appear to contribute considerably to macroeconomic fluctuations. Given the structure of the model, the shocks reduce remarkably some shortcoming of the canonical RBC, providing promising results. The main implication is that the union model alter the structure of the RBC model. Household, now, supplies exactly the labor quantity requested by the union, and the firm is always on its labor demand curve. Thus this model offers an alternative explanation of aggregate employment fluctuations to the canonical consumer intertemporal substitution responses. The optimal suppliers' response is constrained by the labor market outcomes. This implies that the extent to which employment (or wages) changes from a productivity shock does not depend on the slope of the labor supply curve (and finally on the intertemporal substitution of labor supply), but is defined by the characteristics of the bargaining wage curve.

References

[1] Blinder M.-Pesaran M.H. (1995) Multivariate rational expectation models and macroeconomic modelling: a review and some new results, in *Handbook of Applied Econometrics: Macroeconomics*; Oxford Basil Blackwell.

[2] Campbell J.-Y.(1994) Inspecting the mechanism, *Journal of Monetary Economics, 33*, p. 463-506.

[3] Carruth A. and Oswald A.J. (1985), Miners' wages in post-war Britain: an application of a model of trade union behaviour, *Economic Journal*, 95, 1003-1020.

[4] Censolo R.-Onofri P.(1993) Un'ipotesi di "Real Business Cycle" per l'economia Italiana, *Politica Economica*,3,dicembre.

[5] Cho J.-O. (1993), Money and the business cycle with one-period nominal contracts, *Canadian Journal of Economics*, 26, 638-59.

[6] Cho J.-O.-Cooley T.F. (1995), The business cycle with nominal contracts, Economic Theory, 6, 13-33.

[7] Cho J.-O.- Cooley T.F. (1994), Employment and hours over the business cycle, *Journal of Economics, Dynamics and Control*, 18, 411-432.

[8] Cho J.-O.- Rogerson R. (1988) Family labour supply and aggregate fluctuations, *Journal of Monetary Economics, 2*1, p. 233-245.

[9] Cogley T.-Nason J.M.(1995) Output dynamics in real-business-cycle models, *American Economic Review*, vol.85, n.3

[10] Christiano L.- Eichembaum M (1992) Current real business cycle theory and aggregate labour market fluctuations, *American Economic Review*, vol.82, n.3

[11] Danthine J.P.- Donaldson J.P. (1995) Computing equilibria of nonoptimal economies in T. Cooley (ed.) *Frontiers of Business Cycle Research*, Princeton University Press, 65-97.

[12] Danthine J.P and Donaldson J.P. (1993), Methodological and empirical issues in real business cycle theory, *European Economic Review*, 37, 1-35.

[13] Danthine J.P. and Donaldson J.B. (1990), Efficiency wages and the business cycle puzzle, *European Economic Review*, 34, 1275-1301.

[14] Evans C.L. (1994) Productivity shocks and Real Business Cycles, *Journal of Monetary Economics, 29(2)*, pp. 191-208.

[15] Farber H.S. (1978), Individual preferences and union wage determination: the case of the united mine workers, *Journal of Political Economy*, 86, 932-942.

[16] Farmer R.E.A. (1993), *Macroeconomics of Self-fulfilling Prophecies*, Cambridge Mass: MIT Press.

[17] Feve P. -Langot F. (1996) Unemployment and business cycle in a small open economy: GMM estimation and testing with French data, *Journal of Economics, Dynamics and Control*, 20, 1609-1639.

[18] Fiorito R. and Kollintzas, Stylized facts of business cycles in the G7 from a real business cycles perspective, *European Economic Review*, 38, 235-269.

[19] Fuerst T. (1992), Liquidity, loanable funds, and real activity, *Journal of Monetary Economics*, 29(1), pp.3-24.

[20] Hall R.E. (1986), Market structure and macroeconomic fluctuations, *Brookings Papers on Economic Activity*, 86, 285-338.

[21] Hall R. E. (1990), Invariance properties of Solow's productivity residual. In Peter Diamond, ed., *Growth, Productivity, Unemployment*, Cambridge Mass: MIT Press.

[22] Hansen G.D. (1985), Indivisible labour and supply and the business cycle,

Journal of Monetary Economics, 16, 309-327.

[23] Hansen G.D. and Prescott E.C. (1993), Did technology shocks cause the 1990-1991 recession?, *American Economic Review, P&P*, 83, 280-286.

[24] Hartley J.-Hoover K.D.-Salyer K.D.(1998) The limits of business cycle research in Hartley J.-Hoover K.D.-Salyer K.D.(eds), *Real Business Cycle: A Reader*. London, Routledge.

[25] Ingram B.F.-Kocherlakota N.R.-Savin N.E. (1994), Explaining business cycles. A multiple-shock approach, *Journal of Monetary Economics*, 34, 415-428.

[26] Levy D. - Chen H. (1994) Estimates of the aggregated quarterly capital stock for the post-war U.S. data, *Review of Icome and Wealth, n.3, sept.*, pp. 317-349.

[27] Li V. E. (1999), Can market-clearing models explain U.S. labor market fluctuations?, Federal Reserve Bank of St. Louis Review, 81, 35-49.

[28] Kidd D.P.-Oswald A.J.(1987) A dynamic model of trade union behaviour, *Economica,55*,pp. 355-365.

[29] King R.G.-Plosser C.I.-Rebelo S.T.(1988a) Production, growth and business cycles: I. The basic neoclassical model, *Journal of Monetary Economics, 21*,pp. 195-232.

[30] King R.G.-Plosser C.I.-Rebelo S.T.(1988b) Production, growth and business cycles: II. New directions, *Journal of Monetary Economics, 21*,pp. 309-342.

[31] Kydland F.E. Prescott E.C. (1982) Time to build and aggregate fluctuations, *Econometrica, 50*, pp. 1345-1370. *Journal of Monetary Economics, 16*, 309-327.

[32] Kydland F.E. and Prescott E.C. (1996), The computational experiment: an econometric tool, *Journal of Economic Perspectives*, 10, 69-95.

[33] Lucas Jr. R. (1990), Liquidity and interest rates, *Journal of Economic Theory*, 237-64.

[34] Prescott E.C. (1998), Business cycle research: methods and problems, Federal Reserve Bank of Minneapolis, *Working Paper* 590.

[35] Prescott E.C.(1986) Theory ahaed of business cycle measurement, *Carnegie Rochester Conference Series on Public Policy*,25,p.11-44.

[36] Rogerson R. (1988), Indivisible labor, lotteries and equilibrium, *Journal of Monetary Economics*, 21, 3-16.

[37] Sadler G.W.(1994) Real business cycle, *Journal of Economics Litterature*, vol. XXXII, december, p.1750-1783.

[38] Tarantelli E. and Willke G.(1981), The Management of Industrial Conflict in the Recession of the 1970s, Florence: European University Institute Press.

[39] Uhlig H. (1999), A toolkit for analysing nonlinear dynamic stochastic models easily, in Marimon R and Scott A. (eds) *Computational Methods for the Study of Dynamic Economies*, Oxford University Press: Oxford.

[40] Wickens M. (1995), Real business cycle analysis: a needed revolution in macroeconometrics, *Economic Journal*, 105, 1637-1648.

6 Appendix A: the union model.

Substituting equation (9.2) into (9.3) and rearranging, dividing for $f'(N)$ and multiplying for $f'(N)^{\eta-1}$ we have a term in $\left(\frac{f''(N)}{f'(N)}\right) N$. Using the firm problem first order condition (4) this term reduces to,

$$N_{i,t}\frac{f''(N_{i,t})}{f'(N_{i,t})} = \frac{\theta(1-\theta)A_t\left(\frac{K_t}{N_{i,t}}\right)^{\theta-1}\left(-\frac{K_t}{N_{i,t}^2}\right)N_{i,t}}{(1-\theta)A_t\left(\frac{K_t}{N_{i,t}}\right)^{\theta}} = -\theta$$

We may rewrite (9.2) as follows:

$$\frac{1}{1-\eta} - \theta = (1-\beta\omega)B_t f'(N_{i,t})^{\eta-1} \tag{A.1}$$

With $\Psi = \frac{(\frac{1}{1-\eta}-\theta)}{(1-\beta\omega)}$

$$\Psi = B_t\left[(1-\theta)A_t\left(\frac{K_t}{N_{i,t}}\right)^{\theta}\right]^{\eta-1}$$

$$N_{i,t} = [\frac{1}{\Psi}(1-\theta)^{\eta-1}B_t A_t^{\eta-1}K_t^{\theta(\eta-1)}]^{1/\theta(\eta-1)} \tag{A.2}$$

Equation (A.2) yelds the labour demand (10.1).

7 Appendix B: the equilibrium wage.

The equilibrium wage w_t^* is obtained equating the aggregate demand and supply of labour,

$$N^s = E * H = N^d$$

$$[\gamma/(1+\gamma)g][C^{-\eta}(w_t-b_t)/f]^{1/p}[C^{-\eta}(w_t-b_t)/f]^{1/\gamma} = N \tag{A.3}$$

$$S[C^{-\eta}(w_t - b_t)/f]^{(1/p+1/\gamma)} = N \tag{A.4}$$

where S=$(1/f)^{(1/\gamma)}[\gamma/(1+\gamma)]^{1/p}$. From (A.3) and (A.4) we achieve equation (13) in the paper.

8 Appendix C: Linear approximations.

$$Cc_t = AK^{\theta}N^{1-\theta}(a_t+\theta k_t+(1-\theta)n_t)+(1-\delta)Kk_t-Kk_t+Bb-BN(b+n) \tag{A.5}$$

$$Rr_t = \theta AK^{\theta-1}N^{1-\theta}(a_t + (\theta-1)k_t + (1-\theta)n_t) \tag{A.6}$$

$$0 = E_t(\eta(c_t - c_{t+1}) + r_{t+1}) \tag{A.7}$$

$$Nn_t = PB^{\frac{1}{\theta(\eta-1)}}K(\frac{1}{\theta(\eta-1)}b_t + \frac{1}{\theta}a_t + k_t) \tag{A.8}$$

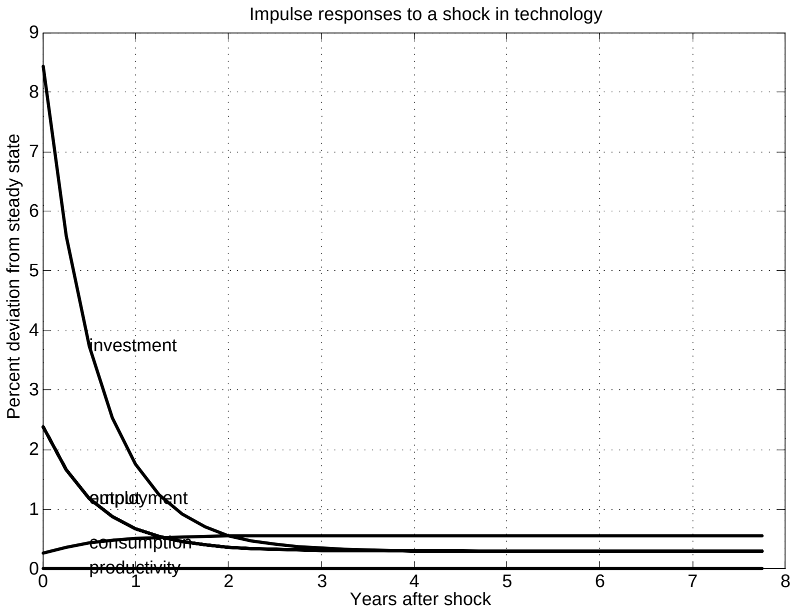
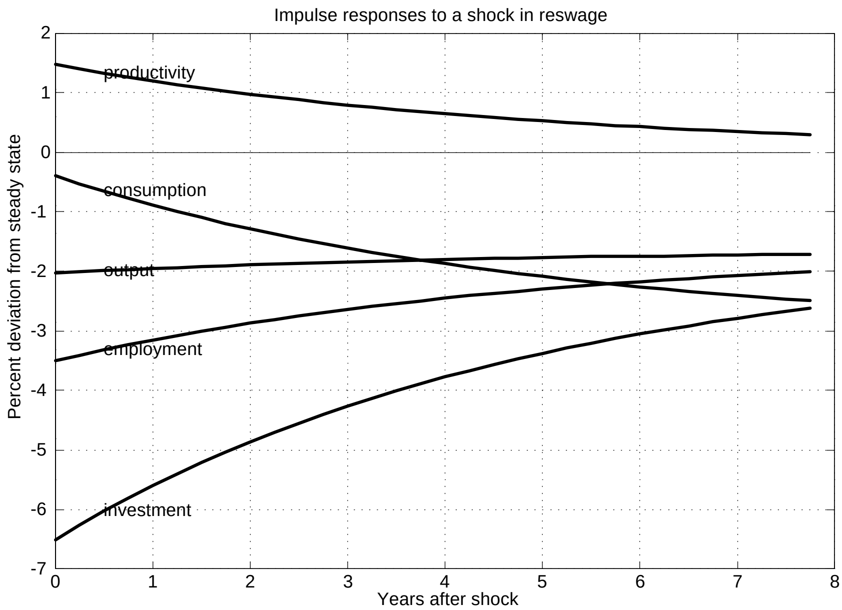


Figure 2:



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