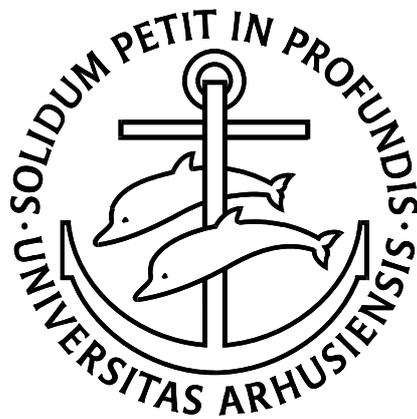


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### Labor Unions and Asset Prices

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# Labor unions and asset prices\*

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## Abstract

The paper investigates the nexus between labor and financial markets, focusing on the interaction between labor union behavior in setting wages, firms' investment strategy and asset prices. The way unions set wage claims after observing firm's financial performance increases the volatility of firms' returns and the riskiness of corporate ownership. To remunerate this higher volatility and stronger risk, firms' equities have to grant high return. This mechanism is able to offer an explanation of for the "equity puzzle", that is it can explain the difference between equity returns and the risk free rate. It is a welcome result that the simulated excess return is about the empirical estimate and this result is obtained with a logarithmic specification of the shareholders preferences.

*J.E.L. Classification Numbers:* Equity Premium, General Equilibrium, Union models.

*Keywords:* D81, E24, J23.

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# 1 Introduction

The paper investigates the nexus between labor market and the pricing of financial assets, in line with a recent literature focusing on the role of industrial relations on financial-market performances. In particular, it analyzes the interaction between labor unions' behavior in setting wages and firms' liquidity strategy, focusing on the behavior of asset prices.

The existing literature studies this topics mainly focusing on the way firms choose their investment and financial structure to deal with labor unions. In this context, there is empirically verified evidence of a correspondence between the existence of an internal strong labor union and a modified capital structure, compared to Walrasian scheme. These evidences are generally interpreted as a consequence of firms' strategic behavior conflicting with that of the labor unions. The main result of this literature is that the firms with a strong labor union decrease the available resources to prevent increases of wage claims.

This paper analyzes the interaction between labor union and firm focusing on agents' preferences and technical complementarities. We analyze these aspects within a dynamic general equilibrium model parameterized to replicate selected characteristics of US economy. The stylized economy is composed by four classes of agents (shareholder-worker, firm, labor union, government). The distinctive element of the paper is the explicit introduction of labor unions into a sequential market equilibrium formulation with complete markets in which firms issue equity securities on a period by period basis.

We assume that labor union's preferences are related to actual number of employees, to the wage salaries compared to unemployment subsidies, and to firm's performance. Specifically, we assume that labor unions link their wage claims to the liquidity of the firm, that in our framework is equal to the dividend distributed to the shareholders. Firm's liquidity (i.e. its net cash flow) depends positively on the output and negatively on the labor cost and on the investment. Given the structure of labor union's preferences, it emerges that an increase in the investment, after a positive technology shock, has a negative influence on the wage; the reduction of the wage increases the labor demand that, because of the complementarity of input factors, stimulates higher accumulation of capital. This mechanism implies that when wages are negatively related to investment, the optimal investment choice in response to a technology shock is higher, compared to a Pareto-optimal context. That increases the volatility of the cash flow-dividend and by this way conduces to an equilibrium with higher equity premium.

The paper shows that when the wage claim is linked to a indicator of firm's performance that depends negatively by investment, the volatility of firms' returns could increase. To remunerate higher volatility, firms' equities have to grant high returns. This mechanism is able to offer an explanation for the "equity puzzle"; that is, it can explain the difference between equity returns and the risk free rate. It is a welcome result that the simulated excess return is about its empirical estimate in addition to result being obtained with a

logarithmic specification of the shareholders preferences.

The paper proceeds as follows. Section 2 discusses the relations with existing literature and empirical evidences, and Section 3 details the model. Section 4 analyzes the results emerging from simulation, Section ?? shows how the results are affected from parameter values, and Section 5 concludes. Proofs and derivations are sketched in the Appendix.

## 2 Background

### 2.1 Related literature

The relationship between the labor and the financial markets is a growing-interest issue that in the last years has been studied with different approaches and from different points of view, institutional, financial and macroeconomic. The first perspective investigates how the structure of firms' ownership and of management interacts with industrial relations. When ownership of the firm is concentrated among a small number of shareholders, the distance between ownership and management is small. That allows managers to not pursue short-period results. In such environment the "voice" mechanism with the labor force is made easier and management does not contrast the formation of labor unions (Edwards 2004).

From a financial point of view, contributions mainly explore how the existence of labor unions affects firms or managers' investment and financing strategies (recent references are Matsa 2006 and Chen et al. 2007a,b). In this literature, the manager chooses how much invest and he becomes relatively more inclined to run into debt considering the effects on the bargaining process with the labor union. These choices affect the object of the bargaining and the relative position of the players. Firm's capital structure affects the size of the available resources that can be shared with the labor union (Dasgupta-Sengupta 1993), so the firm prefer to decrease the liquidity and eventually to run to debt. A capital structure characterized by high weight of debt increases the bankruptcy risk and discourages wage demands (Bronars-Deere 1991). Sunk investment increases the loss that the firm hold in case of disagreement with unions, lessening the bargaining power of the firm (Cavanaugh-Garen 1997). This literature develops partial-equilibrium models and tests the results observing if, and how, some firm's indicators change in accordance to the union bargaining power.

Macroeconomic theory, and in particular the neoclassical literature, is also attempting to uncover which aspects of labor market are relevant to explain economic fluctuations and how they influence the financial side. Because this paper embraces the macroeconomic approach to studying the interaction between labor unions and financial performance, so it is convenient briefly highlight selected contributions related to this field and relevant for our paper. Labor unions are typically introduced into dynamic general equilibrium models as an additional class of agent; their introduction is often functional to explaining how the labor

market could stand in a equilibrium with involuntary unemployment and wage above the competitive level. Unions interact with firms along many dimensions, but macroeconomic approach tends to focus on wage and employment. The formalization of the bargaining process between firms and labor unions dates back to Oswald's contributions and recently has been inserted into SDGE models (see Chiarini-Piselli 2005, Maffezzoli 2001, Zanetti 2003). These works follow the "right to manage" approach where unions set the wage knowing that firms will choose employment moving along the own labor demand function. Maffezzoli (2001) introduces unions to explain the persistence of GDP fluctuations, while Chiarini-Piselli (2005) propose unions and stochastic benefits as institutional elements explaining the low correlation between productivity and production.

Our model is based on the premise that union attributes relevance to wage considering firm's performance. The relationship between wage claims and firm's performance can be argued referring to psychological attitudes of workers. They perceive the fairness of their contract position on the basis of firm's status; even if the comparison with workers of other firms can be relevant in workers' mood, the environment inside the company has a fundamental role. In this line a large literature of efficiency wage (see Bewley 2002) has especially investigated the significance of the "gift exchange" mechanism in workers' effort decision. More specifically, Danthine-Kurman (2005) discuss the nexus between firm's performance and workers' attitude assuming that workers use as benchmark the output per worker. De Angelo-De Angelo (1991) identify some elements that seven US steel producers strategically used during '80s to soften labor unions' attitude in the negotiation.

Here comes our contribution. It departs from existing literature, and introduces labor unions with an objective function related to firm's performance. This function depends positively on employment and the "wage rent". Wage rent is the difference between the wage and a weighted sum of unemployment subsidy and firm's cash flow (dividend). The last term is the way by which unions measure firm's performance when setting wages within a neoclassical framework. The higher is firm's dividend, the higher is the preference for wage in the employment-wage trade-off.

The focal point of the paper is that the attitude of labor unions toward the firm's dividends support a capital-accumulation profile that better explains the excess return of equities over safe assets. The labor market is analyzed to identify the origin of the so called "equity puzzle". The literature about this matter is very vast and in this place we limit to indicate Kocherlacota (1996) as a enlightening survey. Our model is particularly related to Danthine and Donaldson's contributions (2002a, 2002b, 2005). They have analyzed in different papers how the contracting structure with workers and/or with delegated managers, influences the volatility of residual claimants' revenue. Workers desire a sort of insurance against income fluctuations, meanwhile delegated managers try to hold high dividends when dividends represent the most part of their income. The first mechanism tends to increase dividends volatility and by this way gives a possible explanation of eq-

uity puzzle. The second one could generate under-investment. Notwithstanding our model inserts in this research field, it suggests a completely different mechanism to explain the difference between the equity return and the risk free return. The core of the dynamic sets in labor unions' preferences and in the complementarity between product factors. When the firm decides to invest, it suffers a reduction in cash flow that induces unions to freeze wage claims. The reduction of the cost of labor pushes to hire more workers, and because of the complementary between inputs, generates a further increase in investment. The path of investment determines the path of dividends which become more volatile. The excess return remunerates the augmented volatility of firms' revenues.

## 2.2 Empirical Evidences

Many works show that exists an empirically supported relationship between unionization and firms' capital structure. This literature consider the labor union as an agent able to extract revenues from the firm. So, firms try to prevent union formation or to reduce union capacity to participate to profits. Along this way, many empirical works aim to identify which strategic components of firms' activity are influenced by the presence of labor unions.

Some papers estimate the effect of unionization on debt-equity ratio. Bronars-Deere (1991) argue that firms modify capital structure to limit the negative effect that a union has on shareholder wealth. In their framework debt is associated with higher probability of bankruptcy and such risk limits the action of the labor unions. The Authors find that evaluated at the sample mean, a 0.1 increase in the probability of unionization increases the ratio of debt to equity by 12.3 per cent. Cavanaugh-Garen (1997) find that the effect of union bargaining power on the debt-equity ratio is positive but smaller when assets are more general. Calculated at mean values of the sample, an 10% increase in firm unionization increases the debt-equity ratio by a range between 7.2% and 10.5%.

Chen et al. (2007a) find that the expected returns are higher for firms in more unionized industries and that the effect is stronger when unions face a more favorable bargaining environment. They estimate that a one-standard-deviation increase in the unionization rate increases the implied cost of equity by 1.5% points per year. In a companion paper (Chen et al. (2007b)) the Authors find that unionization reduces the moral hazard between the owners of the firm and the bondholders reducing agency costs of debt. This is consistent with the evidence concerning the debt-equity ratio because it makes cheaper the strategic use of debt.

De Angelo-De Angelo (1991) investigate how seven steel producers used the managerial compensation, financial reporting, and dividend policy in negotiations with labor unions during '80s. They find that reported net income is significantly lower during union negotiations. This result is in line with our hypothesis that labor union's attitude depends on some firm's indicators.

Ramirez (2004) argues that managers have an incentive to use dividend payments as

signal of future earnings and face the incentive not to do so to avoid an increase in labor union's claims concerning salaries. His empirical test supports the hypothesis that managers use dividends to convey information about future earnings to investors. Moreover, it emerges that the power of dividends as predictors of future earnings is higher for non-unionized firms than for highly unionized firms. Again, data show how some firm indicators have a different behavior in presence of labor unions.

### 3 The Economy

#### 3.1 Baseline economy

The stylized economy is populated by three agents: the shareholder-worker, the firm and the labor union. Firms own capital and issue equities that shareholder-workers purchase to transfer income period by period. Shareholder-workers get utility from consumption alone. Labor-leisure choice is not considered because it is assumed that labor supply never limits labor demand. All markets are in perfect competition excluding the labor market. It is assumed that there is a labor union in each firm: the former chooses the wage and the last set the employment level. The novelty with respect to the literature of the "right to manage models" is that labor unions' preferences include firms' dividends. The production function includes technology that follow a stochastic AR(1) process.

The economy is dynamically decentralized following Danthine-Donaldson (2002b); in particular, we assume that firm owe capital and maximize the presented discounted value of future cash flows (i.e. the dividends). This technique permits to evidence equities as a mean of financing (for firms) and of saving (for shareholder).

##### 3.1.1 Shareholder-workers

The decision problem of the representative shareholder-worker concerns only consumption and investment into the equity share, since in the economy it is the only a way to save. Labor union decides how much they work. Assume, next, that the utility function takes a CRRA form such as  $\frac{c_t^{1-\gamma}}{1-\gamma}$  where  $c_t$  is the individual consumption flow and  $\gamma$  measures the consumer's relative risk aversion.

The representative shareholder-worker's problem is the following:

$$\mathcal{V}(z_t, \lambda_t; \hat{s}_t) = \max_{z_{t+1}, c_t} \left[ \frac{c_t^{1-\gamma}}{1-\gamma} + \beta E_t \mathcal{V}(z_{t+1}, \lambda_{t+1}; \hat{s}_{t+1}) \right] \quad (1)$$

$$s.t. \quad c_t + q_t^e z_{t+1} = (q_t^e + d_t) z_t + w_t n_t + \bar{B}(1 - n_t) - \tau_t \quad (2)$$

$$c_t, z_{t+1} \geq 0 \quad (3)$$

$$\hat{s}_{t+1} \sim dG(\hat{s}_{t+1}; \hat{s}_t), \hat{s}_0 \text{ given}, \quad (4)$$

where  $\beta$  is the subjective discount factor,  $q_t^e$  denotes the price of the equity security and  $z_t$  is the share of the single equity share that shareholder-worker owns. Quantity  $\lambda_t$ , next, represents the technology shock and follows a stationary AR(1) process precised below. Quantities  $n_t$  and  $w_t$  represent, respectively, employed labor and the wage;  $(1 - n_t)$  measures unemployment. In each period the Government levies a lump sum tax  $\tau_t$  and delivers unemployment benefits to unemployed workers equal to  $\bar{B}(1 - n_t)$ , under a balanced government budget constraint. Finally,  $\hat{s}_t$  represents the state of the economy.

Under standard assumptions the necessary and sufficient first order condition for  $z_{t+1}$  reads

$$-q_t^e c_t^{-\gamma} + \beta v'_z(z_{t+1}, \lambda_{t+1}, \hat{s}_{t+1}) = 0, \quad (5)$$

where  $v'(z_t, \lambda_t, \hat{s}_t) = (q_t^e + d_t)c_t^{-\gamma}$ , following Benveniste and Scheinkman (1978); leading the latter equation one period ahead  $v'(z_{t+1}, \lambda_{t+1}, \hat{s}_{t+1}) = E_t(q_{t+1}^e + d_{t+1})c_{t+1}^{-\gamma}$ , substituting back into (5), and solving for the unique non-explosive solution leads to the following asset prices equation:

$$q_t^e = E_t \sum_{j=0}^{\infty} \beta^j \left( \frac{c_t}{c_{t+j}} \right)^\gamma d_{t+j} \quad (6)$$

The eq.(6) shows how shareholder-worker prices equities. Difference with the standard expression is that the employment and the capital accumulation differ from the Pareto-optimal choices. The maximization process leads to the following result:

$$c_t = \left( \frac{q_t^e}{\beta E_t(q_{t+1}^e + d_{t+1})} \right)^{\frac{1}{\gamma}} E_t c_{t+1} \quad (7)$$

The eq.(7) describes the way shareholder-worker keeps consumption path in line with financial returns (more details to come in the subsequent sections).

### 3.1.2 Firms

The representative firm begins period  $t$  with the stock of capital  $k_t$  carried over from previous period, the equity share outstanding  $z_t = 1$ . After observing the realization of the technology shock  $\lambda_t$  the proceeds of the output sale are used to pay the wage bill  $w_t n_t$ , to finance investments  $i_t$  under the knowledge of the equation of motion on capital stock  $k_{t+1} = (1 - \delta) k_t + i_t$  and, residually, to pay dividends

$$d_t = y_t - w_t n_t - i_t, \quad (8)$$

where  $y_t$  and  $i_t$  represent respectively the output and the investment. The production process follows a Cobb-Douglas production function that employs capital  $k_t$ , labor  $n_t$  and it subject to the technology  $\lambda_t$ , which evolves as  $\lambda_t = \rho \lambda_{t-1} + \varepsilon_t$  and  $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$  with

$\rho \in (0, 1)$ .

In this setting of effectively complete markets, the firm's objective function is clear: maximize the pre-dividend stock market value of the firm,  $d_t + q_t^e$  period by period.

More formally, representative firm solves the following decision problem:

$$\mathcal{J}(k_t, \lambda_t, w_t) = \max_{n_t, k_{t+1}} [d_t + q_t^e] \quad (9)$$

$$s.t. \quad d_t + q_t^e = E_t \left( \sum_{\kappa=0}^{\infty} \beta^\kappa \left( \frac{c_t}{c_{t+\kappa}} \right)^\kappa d_{t+\kappa} \right); \quad d_t = y_t - w_t n_t - i_t \quad (10)$$

$$y_t = \lambda_t k_t^\alpha n_t^{1-\alpha} \quad (11)$$

$$\lambda_t = \rho \lambda_{t-1} + \varepsilon_t \text{ with } 0 < \rho < 1, \quad \varepsilon_t \sim N(0; \sigma_\varepsilon^2) \quad (12)$$

$$k_{t+1} = (1 - \delta)k_t + i_t, \quad (13)$$

where eq. (11) defines the production function where  $\alpha$  measures the elasticity of substitution between capital and labor. The eq.(12) describes technology process and the eq.(13) is the law of motion of capital where  $\delta$  is the depreciation rate of capital.

Formulation (9) requires that shareholders convey to the firm a complete listing of their future inter-temporal marginal rates of substitution. In the present complete markets setting and, a fortiori, in a homogenous agent environment, there would be perfect unanimity vis-a-vis the information to be provided.<sup>1</sup>

Problem (9) admits an equivalent sequential formulation; it may be recursively expressed as:

$$\mathcal{J}(k_t, \lambda_t) = \max_{n_t, i_t} (\lambda_t k_t^\alpha n_t^{1-\alpha} - w_t n_t - i_t) + \beta E_t \left( \frac{c_t}{c_{t+1}} \right)^\gamma \mathcal{J}(k_{t+1}, \lambda_{t+1}),$$

$$s.t. \quad k_{t+1} = (1 - \delta)k_t + i_t; \quad \lambda_t = \rho \lambda_{t-1} + \varepsilon_t \text{ with } 0 < \rho < 1, \quad \varepsilon_t \sim N(0; \sigma_\varepsilon^2)$$

The necessary and sufficient first order conditions are

$$w_t = (1 - \alpha) \lambda_t k_t^\alpha n_t^{-\alpha} \quad (14)$$

$$\beta E_t \left[ \left( \frac{c_t}{c_{t+1}} \right)^\gamma (\alpha \lambda_t k_{t+1}^{\alpha-1} n_{t+1}^{1-\alpha} + (1 - \delta)) \right] = 1. \quad (15)$$

Eq. (14) suggests that the firm chooses labor demand so that wage equals marginal productivity of labor; eq. (15) is the Euler equation that determines the optimal level of investment. By construction, our firm discounts the future flow of dividends by the consumer discount factor.

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<sup>1</sup>Alternatively, the shareholders could appoint one of their own members to manage the firm, knowing that his preference for future consumption is an exact representation of their own.

### 3.1.3 Labor unions

Our economy is characterized by a monopolistic labor union operating in each firm, as a variant of “right to manage” models, when unions have the maximum contracting power (Oswald 1982). In this context, unions set wages knowing the firm’s labor demand schedule, and firms choose how much labor to employ at the chosen wage.

Unions’ objective functions typically include two components: employment and “wage rent”, where the latter denotes the difference between actual wage and unemployment benefit. The novelty of our model is that the union, when setting the wage, considers firm’s financial performance in addition to the customary real quantities. The natural quantity measuring firm financial performance is, in this context, the so called free cash flow, which is the dividend distributed to the shareholders (i.e. eq. 8).

Formally, the representative labor union’ maximization problem reads:

$$\mathcal{U} = \max_{w_t} n_t^\eta (w_t - \bar{B} - d_t^\pi) \quad (16)$$

$$s.t. \quad n_t = ((1 - \alpha)\lambda_t)^{\frac{1}{\alpha}} k_t w_t^{-\frac{1}{\alpha}} \quad (17)$$

$$\ln \lambda_t = \rho \ln \lambda_{t-1} + \varepsilon_t \text{ with } 0 < \rho < 1, \varepsilon_t \sim N(0; \sigma_\varepsilon^2), \eta > 0 \quad (18)$$

where  $\pi$  denotes a power weight that labor union attributes to dividends. It can be showed that the labor union optimization problem is well behaved; given that, the necessary and sufficient first order condition with respect wage rate  $w_t$  reads:

$$w_t : \left(1 - \frac{\eta}{\alpha}\right) w_t^{-\frac{\eta}{\alpha}} + \frac{\eta}{\alpha} w_t^{-\frac{\eta}{\alpha}-1} B_t + \frac{\eta}{\alpha} w_t^{-\frac{\eta}{\alpha}-1} d_t^\pi = 0. \quad (19)$$

Proposition 1 below derived the optimal contract set by the labor union; the concept of optimality is in the sense of maximizing labor union welfare function (16):

**Proposition 1** *The optimal wage contract imposed by labor union reads:*

$$w_t^* = \frac{\eta}{\eta - \alpha} (\bar{B} + d_t^\pi). \quad (20)$$

#### **Proof. Appendix ■**

The eq.(20) suggests that labor union chooses a wage that is a growing function of subsidy and dividend. It emerges clearly how firm’s liquidity can affect wage claims. This is in accordance to the cited literature, especially with De Angelo-De Angelo (1991). Moreover, as expected, the higher is union’s preference for employment, measured by  $\eta$ , the lower is the equilibrium wage asked to firm.

### 3.1.4 Government

Government simply collects lump sum tax revenue and return it to the shareholder-workers as unemployment benefits. It follows that in each period government's balance is in equilibrium

$$\int B_{i,t}(1 - n_{i,t})di = \int \tau_{i,t}di \quad \forall t \quad (21)$$

where  $i$  identifies the single shareholder-worker.

## 3.2 Asset prices

As the economy is characterized by representative agents (consumer, firm, labor union, government) the equilibrium solution requires a unique pricing kernel,  $\beta \left( \frac{C_t}{C_{t+1}} \right)^\gamma$ . Since firms use  $\beta \left( \frac{C_t}{C_{t+1}} \right)^\gamma$  as discount factor, its co-movement with firms' return determines the premium that equities has to pay in order to be held in equilibrium. Now, we briefly explain the last sentence.

Recall eq(15). Indicate with  $R$  the gross rate of return of capital and with  $H$  the growth rate of consumption, so the eq(15) can be written as:  $E_t[H^{-\gamma}R] = \beta^{-1}$ . Make the second order Taylor approximation of  $H^{-\gamma}R$  evaluating at the point  $\{1, 1\}$ :

$$H^{-\gamma}R \simeq 1 + (R - 1) - \theta(H - 1) + \frac{1}{2} \left[ \theta(\theta + 1)(H - 1)^2 - 2\theta(H - 1)(R - 1) \right]$$

Passing to net rates,  $r = R - 1$ ,  $h = H - 1$  and evaluating the expected value

$$E[H^{-\gamma}R] \simeq 1 + E[r] - \theta E[h] + \frac{\theta(\theta+1)}{2} E[h^2] - \theta E[hr]$$

that is equivalent to

$$E[H^{-\gamma}R] \simeq 1 + E[r] - \theta E[h] + \frac{\theta(\theta+1)}{2} \left( (E[h])^2 + var[h] \right) - \theta E[h]E[r] - \theta cov[h, r]$$

At this point we can evaluate the premium of a generic equity with respect to risk free rate  $r_f$ , subtracting to the last equation the same equation evaluated for the risk free rate (we can ignore  $E[h]E[r]$  and  $(E[h])^2$  since are very small numbers):

$$E[r] - r_f \simeq \theta cov[h, r] = \theta (corr[h, r] \times sd[h] \times sd[r]) \quad (22)$$

The eq.(22) indicates that in equilibrium the premium paid by a risky asset is increasing in consumers' aversion to risk and in covariance of the returns with growth rate of consumption.

In the next sections we will see that this model generate high standard deviations increasing in  $\pi$ . The model does not necessitate high aversion to risk to generate a significance excess return.

### 3.2.1 Competitive Equilibrium Characterization

The competitive equilibrium consists of a set of decision rules  $c_t(s_t)$ ,  $i_t(s_t)$ ,  $w_t(s_t)$ ,  $n_t(s_t)$ ,  $z_t(s_t)$ ; a set of aggregate decision rules  $C_t(s_t)$ ,  $I_t(s_t)$ ,  $W_t(s_t)$ ,  $N_t(s_t)$ ,  $Z_t(s_t)$ ; a set of price

function  $D_t(s_t), R_t(s_t)$ ; a value function  $F(s_t)$  satisfying:

- the firm's value maximization
- the union's welfare maximization
- The shareholder-worker's utility maximization
- The aggregate resources constraint
- the government constraint

Assuming a continuum of each kind of agent (firm, shareholder-worker, labor union), uniformly distributed, market clearing conditions hold for each market. Specifically

- for employment,  $\int n_i(M_t, k_t, K_t) di = \int n_j(M_t, k_t) di = n_i(M_t, k_t, K_t) \equiv N_t$
- for consumption,  $\int c_i(M_t, k_t, K_t) di = \int c_j(M_t, k_t) di = c_i(M_t, k_t, K_t) \equiv C_t$
- for investment,  $\int i_i(M_t, k_t, K_t) di = \int i_j(M_t, k_t) di = i_i(M_t, k_t, K_t) \equiv I_t$
- for capital,  $\int k_i(M_t, k_t, K_t) di = \int k_j(M_t, k_t) di = k_i(M_t, k_t, K_t) \equiv K_t$
- for equity,  $\int z_i(M_t, k_t, K_t) di = \int z_j(M_t, k_t) di = z_i(M_t, k_t, K_t) \equiv Z_t$

## 4 Calibration and Quantitative analysis

### 4.1 Calibration

This section investigates how the stylized economy responds to technology shocks. Initially we analyze the input response function and then we simulate the model (1000 simulations of time series of 111 observations).

Figure (??) shows that after a technology shock real variables go up. The way is that emerging from empirical data and standard real business cycle models: the deviation of investment is about three times that of output, consumption follows a smooth dynamics. Instead, initially wages and dividends have a downturn. Firms accept an initial fall in dividends to invest when capital is more productive. The initial loss is then followed by a long flow of dividends' growth. On the other hand, labor unions agree to temporary reduction in wages to increase employment. The fall in dividends facilitates this kind of union's choice because it permits to limit the decline in the wage rent.

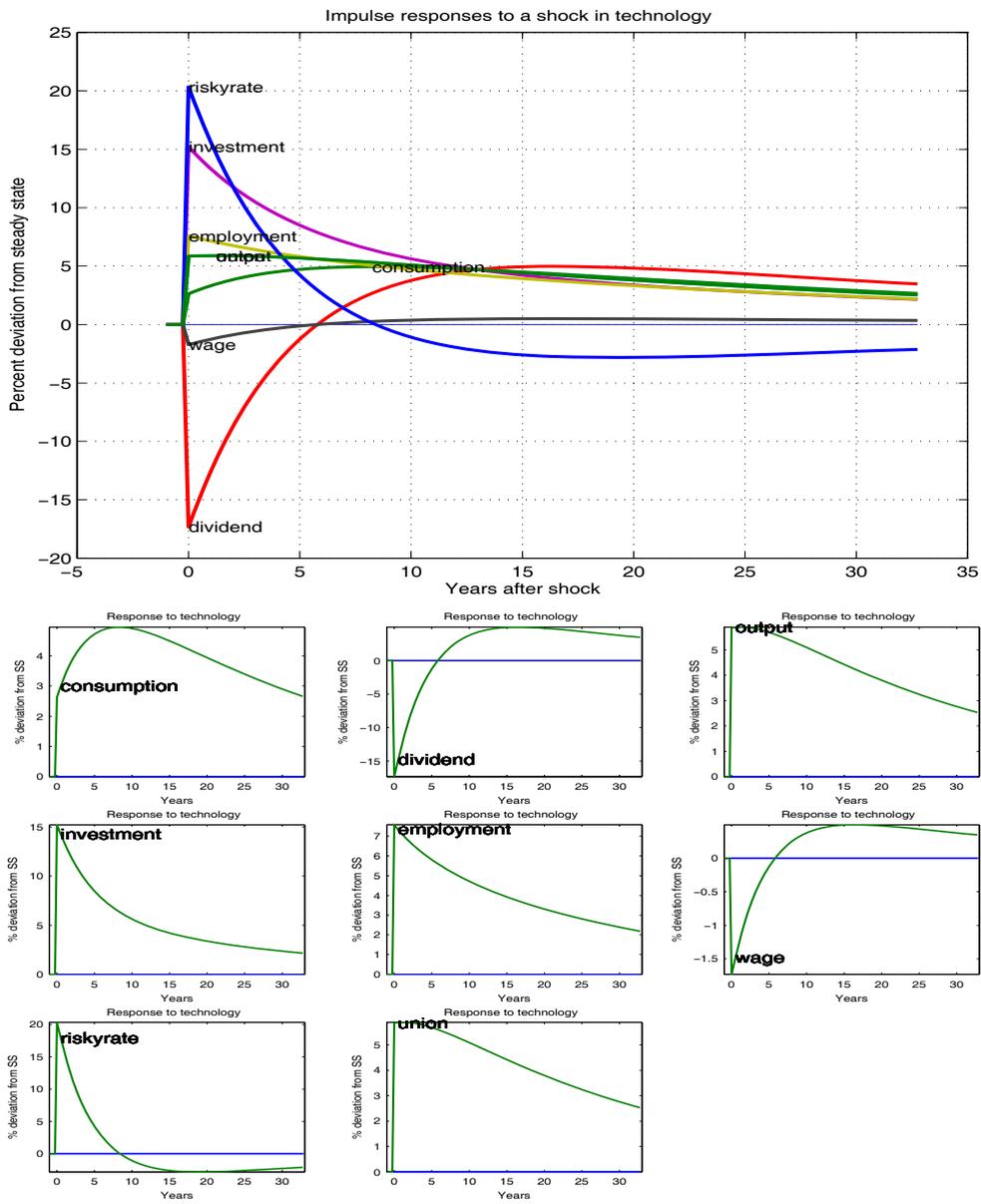


Figure 1:

|                            | US Data     |          |              | Model       |               |       | RBC |
|----------------------------|-------------|----------|--------------|-------------|---------------|-------|-----|
|                            | Long Sample | Post-War | $\pi = 0,05$ | $\pi = 0,1$ | $\pi = 0,142$ |       |     |
| E(Rs)                      | 6.89        | 7.04     | 4.41         | 4.82        | 5.86          | 4.16  |     |
| $\sigma$ (Rs)              | 18.2        | 16.7     | 9.92         | 14.08       | 21.42         | 0.37  |     |
| E(Rf)                      | 1.91        | 1.68     | 3.3          | 2.63        | 1.03          | 4.16  |     |
| $\sigma$ (Rf)              | 5.44        | 2.23     | 2.37         | 3.22        | 4.8           | 0.18  |     |
| E(Rs-Rf)                   | 4.82        | 5.36     | 1.11         | 2.19        | 4.82          | 0.004 |     |
| $\sigma$ (Rs-Rf)           | 19.1        | 16.8     | 10.34        | 14.71       | 22.33         | 0.27  |     |
| E(Rs-Rf)/ $\sigma$ (Rs-Rf) | 0.25        | 0.32     | 0.11         | 0.15        | 0.22          | 0.14  |     |
| $\sigma$ (Rs,Rf)           | -0.04       | 0.02     |              |             |               | 0.97  |     |
| Sharpe ratio               |             |          | 0.06         | 0.09        | 0.13          |       |     |

## 4.2 Asset prices

Table (4.2) compare the estimated values of selected financial variables referring to US economy with three possible outcomes of the model.

It emerges that when  $\pi = 0.142$ , the model fits quite well empirical data. It replicates exactly the excess return even if it does not generate the correct value for the risky free rate and the equity return. Standard deviation are a little higher of those estimated. Comparing the results with different values of  $\pi$  it emerges that the excess return and the volatility increase with  $\pi$ . That is the stronger is the way labor unions weight firms' performance, the stronger is the way the economic system reacts to a technology shock.

## 4.3 Understanding sources of equity premium

This model confirms the idea that equity premium could be a remuneration for higher volatility of revenue but it does not identify as source of volatility the stickiness of other elements of economic system. The most of the literature about equity premium has highlighted how the presence of rigid elements increases the riskiness of the transfers to the residual claimants (the shareholders). To explain the characteristics of our model it is useful to take as benchmark Danthine-Donalson's "operating leverage". The Authors' argument starts from an empirically verified wage rigidity and claim that such rigidity causes a counter-cyclical behavior of wage share. In this context when the economy experiences a downturn, wage share increases and revenues from firm activity go down. This paper proposes another mechanism based on wage variability and production-factor complementarity that leaves wage share constant during business cycles (this is related to the use of a Cobb-Douglas production function). It has just been explained why wages could follow dividends. This co-movement makes start an accelerator mechanism of investments. Schematically the causality can be explained as follows: the productivity shock increases the return of capital so the firm increase investment; dividends go down because of the higher investment and they bring down wages too because the wage contract imposed by unions. A reduction of wages induces to hire more workers and this increase the productivity of capital (with

Cobb-Douglas production function the marginal productivity of a factor depends positively on the relative presence of other production factors). This process amplifies the reaction of investment to productivity shocks and by this way the volatility of dividends. This mechanism is reinforced with the significance the labor unions attribute to dividends, measured by  $\pi$ .

It is important to think about the way the economic mechanism described above is linked to the contributions reported at the beginning of the paper. In our stylized economy capital market is characterized by no imperfections or distortions and there are no conflicting interests between management and ownership. Furthermore there is no intermediation in credit market: the firms own capital and finance investment allotting less output to dividends. So it is irrelevant to specify the capital structure of the firm and the cash flow,  $d$ , is overburdened with different meanings: firm liquidity, dividend distributed to shareholders. There is no way to go to debt because of the feasible constraint ( $w_t n_t + i_t \leq y_t$ ) so the only way to compare our results with the cited financial literature is to assume that firm's debt is negatively related to  $d$ ; a fall in firm's liquidity can be reasonably interpreted as a larger resort to debt, consistently with the works that find a positive relationship between the debt-equity ratio and labor unions.

The model considers labor union's preferences as the crucial element characterizing the economic dynamics. The thesis is that the more union's preference for wages depends on firm's liquidity, the more is the reduction of firm's liquidity in response to a technology shock. This idea is quite new so there is no empirical study directly related to it. From a theoretical point of view we cite part of efficiency-wage literature (and in particular Danthine-Kurman) and some evidences coming from De Angelo-De Angelo's contribution, even if they refer to labor union's claims not specifying the role of wages.

Moreover, note that the paper focuses on the out-of-steady-state dynamics. In fact, we have highlighted that the investment reaction to a technology shock is increasing in  $\pi$ , but the equilibrium value of investment is decreasing in  $\pi$ . Some empirical works find a negative relationship between unionization and investment. When the empirical data are used to valid the model it is necessary to distinguish between the equilibrium value and the transition dynamic of investment.

We can easily suggest the intuition lying behind the analysis presented above representing the wage schedule (WS) and the labor demand (LD) as done in Figure 2

The WS is upward sloping because of the positive long run relationship between dividends and employment (remember eq.20). This curve could be seen as a substitute for the neoclassical labor supply curve as it represents the (W,N) pair chosen by the Union and it is augmented by dividends. This curve is drawn assuming that all variables are in steady state without setting exactly a level. That implies that we need another condition to identify the equilibrium point, and that this curve is not representative for the out-of-steady-state dynamics.

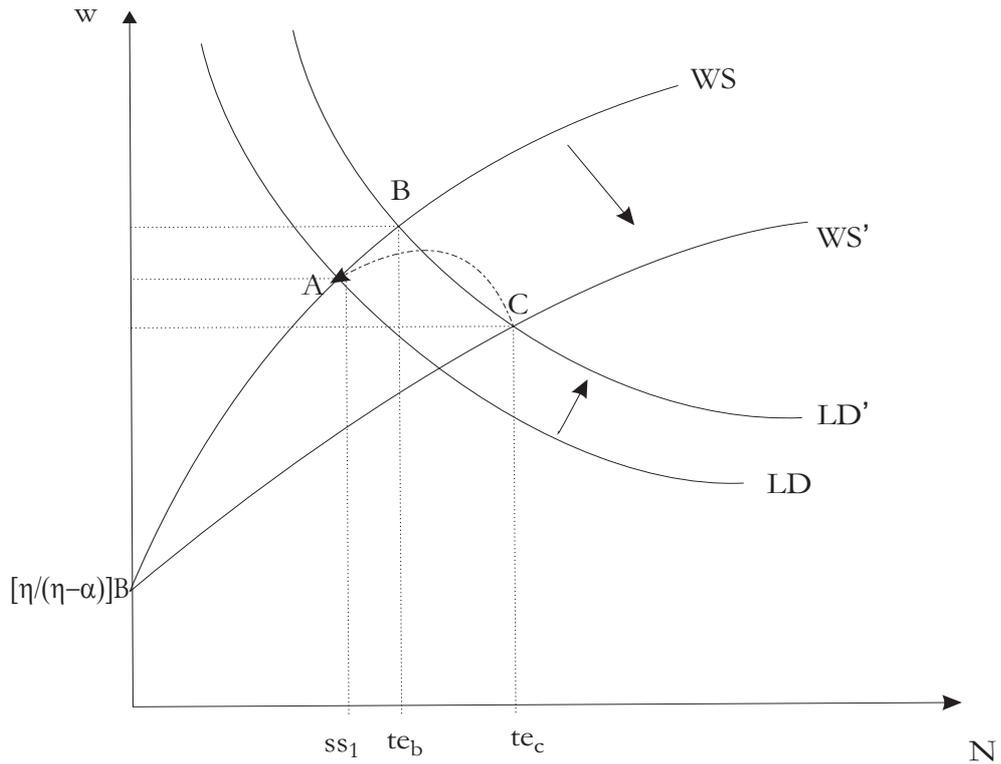


Figure 2:

The labor demand curve (LD) is downward sloping as it represents, as usual, the marginal productivity of labor. The intersection between the two curves identifies the steady state combination of employment and wage (point A in the figure).

To better understand the characteristics of business cycle dynamics it can be interesting to perform some comparative statics exercise. Suppose a greater level of technology so that the labor demand is represented by LD'. In this case the equilibrium point change from A to B. The new equilibrium point, is characterized by higher wage and higher employment. The WS is not changed because we are considering only steady state points for different values of technology.

Now, suppose a temporary increase of productivity, as before the LD shifts to the right but only for a few periods. The relationships between the variables are not those resulting in the long run. The temporary productivity shock leads to a strong rise in investments, as investors are strictly better off in accumulating capital during this phase. This implies both a fall in the dividends and a further rise in the LD curve. The first effect leads the indifference curves of the Union to become steeper, that is, this increases the Union's preference for employment. Consequently, the short run WS curve turns to the right and the economy reaches C, with a lower wages (and dividends) and a higher employment than B. Then, wages and dividends increase, because the higher accumulation of capital, and the

economy comes back to A.

It is remarkable that this simple analysis perfectly replies the evidence given by the impulse-response functions presented. Moreover, our specification is robust to a change of hypothesis, in particular we consider that: i) the wage does not depend on firm's performance (standard labor-union model): i.e., the unions are interested only in employment and in the difference between wages and subsidies; ii) the wage depends on capital revenues and not on dividends: i.e., the unions simply look  $r_t k_t$  and not on  $d_t$ .

In the former assumption the WS is horizontal. After a productivity shock the economy moves to point D, with higher employment and the same wage. This is confirmed by the input-response built under such assumption<sup>2</sup>. Wage does not change and the increase of employment is lower than in the benchmark case.

The latter case inserts another firm's indicator in labor union objective function. The model assume perfect competition, so the zero profit condition is valid and define capital revenue as  $r_t k_t = y_t - w_t n_t - \delta k_t$ . In this framework firms own capital, so it is a reasonable hypothesis that labor unions could consider important the path of capital revenue. Moreover, in steady state we have:  $rk = y - wn - \delta k$ ;  $d = y - wn - i$ ;  $i = \delta k$  and consequently  $rk = d$ . If we limit to substitute capital revenue in labor unions' preference instead of dividends, the steady state does not change. But the dynamics change completely. After a productivity shock, the marginal productivity of capital, that is another way to interpret  $r$ , and capital accumulation increase. So the indifference curve (in the employment-wage space) of labor unions becomes flatter. The economy moves toward E with higher employment and higher wage. The input-response confirms such analysis and shows that this is the case with the lowest increase of employment.

Until this point we have considered only a technology shock. Now we want to investigate how the stylized economy reacts to a shock to union's preference for employment and to a shock to subsidies; to do this compare the effects in three cases: the wage depends on dividend (I), the wage depends only on subsidy (II), the wage depends on capital revenue(III). The analysis uses both the graphic representation and the input-response. The exact calibration of the stochastic processes of  $\eta$  and  $B$  it is not needed for our aims.

First, suppose a positive shock to  $\eta$ . Qualitatively the economics moves in the same direction of a positive shock to productivity, but the reason is different. In this case, the first step is a steeper indifference curve of labor unions; they increase their preference for employment and so they accept a reduction in wage. The higher employment increases the productivity of capital so capital revenue increases, meanwhile dividend goes down because of the incentive to invest. The rest of the relationships between the variables do not change from those presented above. The graphics indicate that in each case the intercept of the WS falls, and:

(I) the slope reduces because of the increase of  $\eta$  and the reduction of dividends; this

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<sup>2</sup>Note that in this case the effects on real variables are permanent.

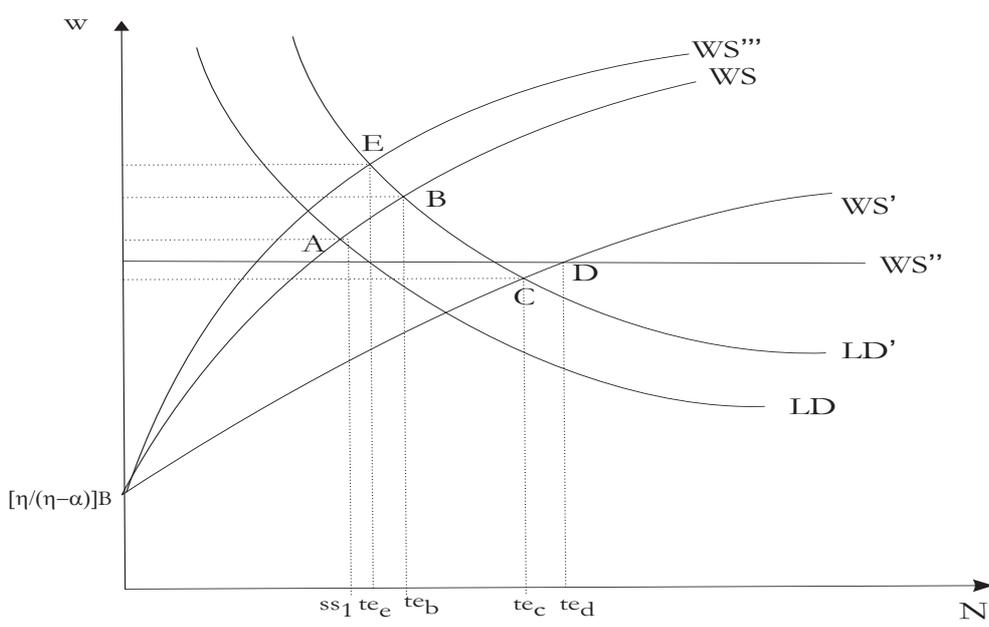
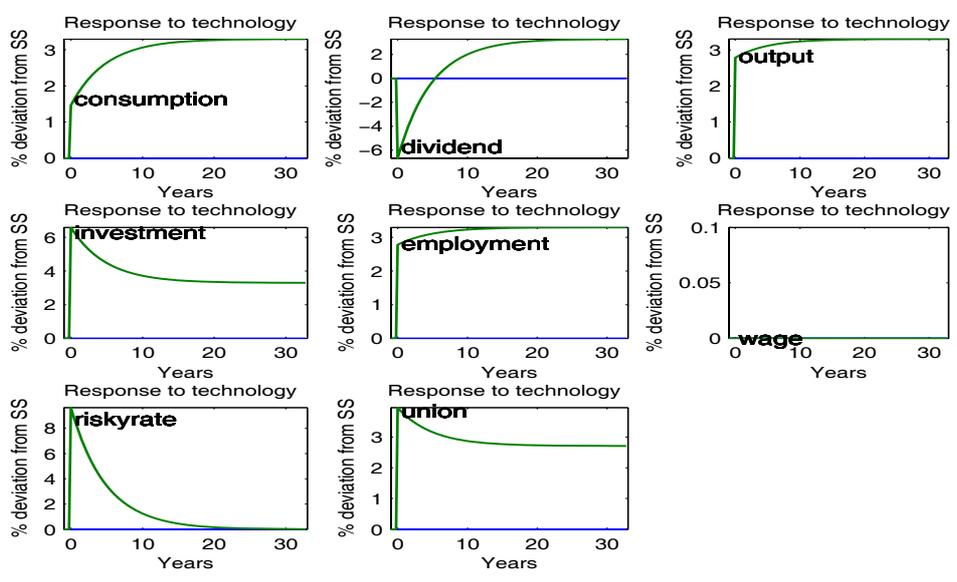


Figure 3:

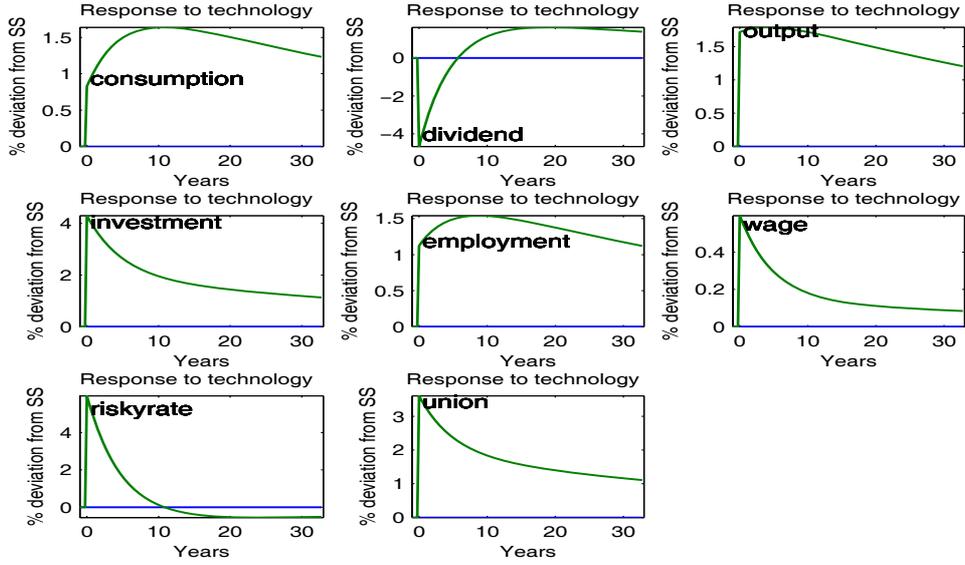


Figure 4:

predict a consistent increase of employment and a fall of wage;

(II) the slope does not change; the effect is a moderate increase in employment and a moderate reduction of wage;

(III) the slope reduces because of  $\eta$  but it increases because of capital revenue; the effect is a very moderate increase of employment and a very moderate reduction of wages.

The input-responses confirm this intuition. It pass from an increase of 5 points in employment and a reduction of 1 point in wage in case (I) to (+1.5; -0.5) in case (II) and to (+0.9; -0.3) in case (III).

We construct the same exercise for a negative shock to subsidies. Again, the first change concerns the indifference curve of labor unions and again its curvature increases. The graphs are similar to those concerning a shock to  $\eta$ , so we do not present them. The intercept reduces because of the fall of  $B$ . The slope of WS is influenced only by dividends or capital revenue. Input-responses are in accordance with such intuition.

#### 4.4 Calibration

The model is parameterized for the United States Economy. The system of equations we use to compute the dynamic equilibria of the model depends on a set of **nine** parameters. **Two** pertain to household preferences,  $(\gamma, \beta)$ , **one** to the structural-institutional context (the subsidy  $B$ ), **two** to labor unions (the preference for employment  $\eta$ , the weight attributed to dividends into the wage rent  $\pi$ ) and the remaining **four** parameters to technology (the capital share  $\alpha$ , the capital stock quarterly depreciation rate  $\delta$ , the autoregressive coefficient

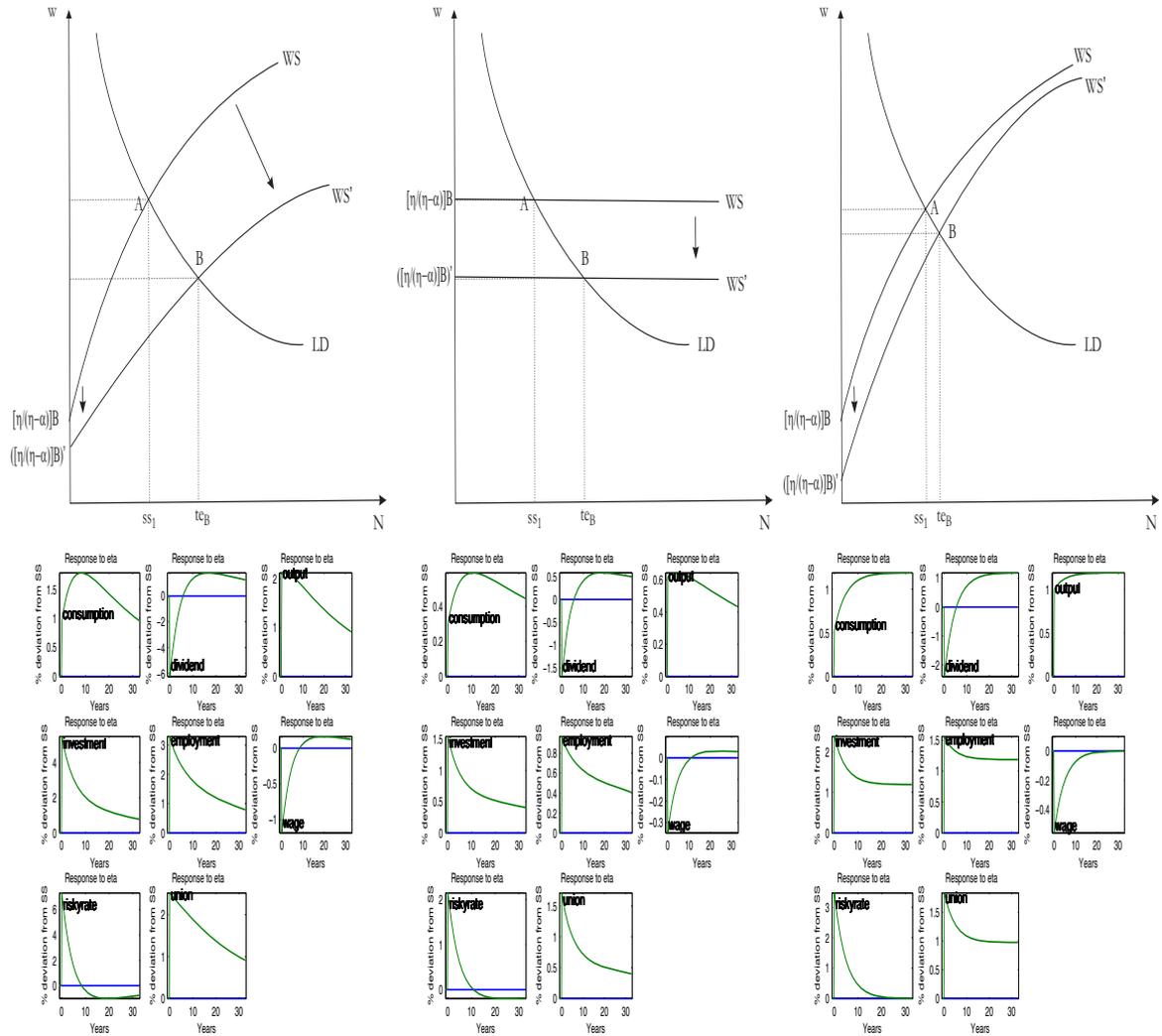


Figure 5:

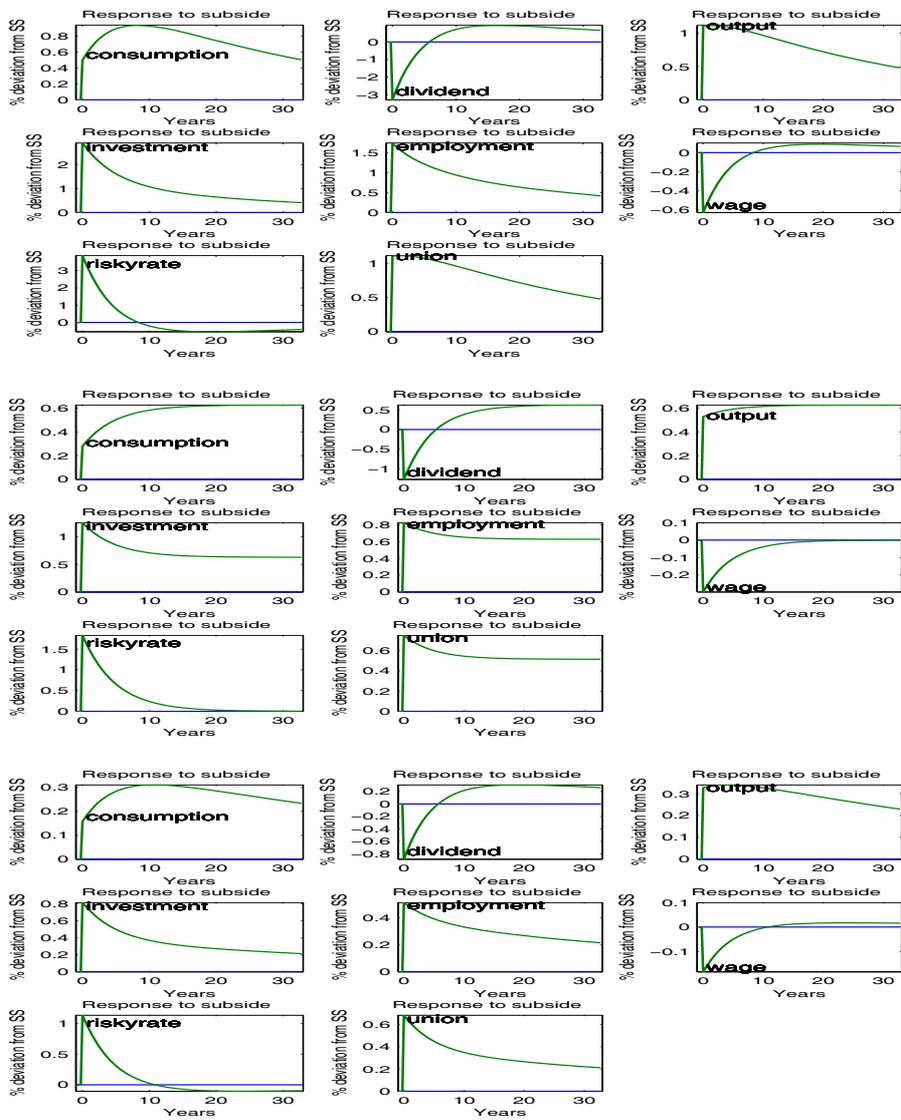


Figure 6:

|      |       |
|------|-------|
| C/Y  | 0,744 |
| I/Y  | 0,256 |
| WN/Y | 0,640 |

of the technology process  $\rho$  and the standard deviation of technology shock  $\sigma_\varepsilon$  .

**Shareholder-worker’s preference**  $(\beta, \gamma)$  : the subjective discount factor  $\beta$  is set to correspond to an annual real interest rate of 4% ( $\beta = 0.99$ ). The relative risk aversion  $\gamma$  is a free parameter and in the baseline model is set to one so that the CES utility function corresponds to logarithmic function ( $\gamma = 1$ ).

**Technology**  $(\delta, \alpha, \rho, \sigma_\varepsilon)$  are set to commonly used values in this literature (e.g. Danthine Donaldson, 2002 and Jerman, 1998). More precisely, we set, the capital stock quarterly depreciation rate  $\delta = 0.025$ , the capital share  $\alpha = 0.36$ , the autoregressive coefficient of the technology process  $\rho = 0.95$  and the standard deviation of technology shock  $\sigma_\varepsilon = 0.712$ .

**Labor union preferences**  $(\eta, \pi)$  :  $\eta$  is a free parameter that in the baseline model is set to 1 so that it is assumed that union weight in the same way employment and wage rent.  $\pi$  is the key parameter that in this model is free to vary between  $> 0$  and 0.142.

**Subsides** ( $B$ ) is set to a fifth of the steady state wage (more precisely to  $B = 0.19 \cdot W_{ss}$ ) as it emerges in OECD 1994.

Finally, notice that stationary equilibria of the model are consistent with selected long-run statistics measured for the developed economies. In particular, Table 4.4 below presents selected “equilibrium ratios” generated from the model.

## 5 Conclusions

This paper formulates and calibrates an equilibrium business-cycle model for a non-Walrasian Economy. Labor market is influenced by monopolistic labor unions that set wages in each firm considering firm’s dividend. In this framework, investment decisions, in response to technology shock, are amplified generating a high volatility of returns. The result is a high equity premium similar to that emerging from empirical studies.

The model has parsimonious nature, infact it assumes minimal perturbation of the standard RBC model. Notwithstanding, it replicates quite well important financial features. Moreover it takes under control some macroeconomic characteristics as relative volatilities and steady-state ratios of real variables.

It inserts in a growing-interesting-research area studying how labor-market characteristics affect the performances of real and financial markets. The peculiarity of our contribution is that volatility of firm returns is not generated by some kind of stickiness or adjustment costs but from optimizing choices of firms operating with labor costs linked to firms’ financial performances.

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## Appendix

The first order condition of labor union's problem is:

$$(1 - \frac{\eta}{\alpha}) w_t^{-\frac{\eta}{\alpha}} + \frac{\eta}{\alpha} w_t^{-\frac{\eta}{\alpha}-1} B_t + \frac{\eta}{\alpha} w_t^{-\frac{\eta}{\alpha}-1} d_t^\pi = 0$$

Then the equilibrium wage is:

$$w_t^* = \frac{\eta}{\eta-\alpha} (\bar{B} + d_t^\pi)$$

Let's verify that the second order condition calculated in the equilibrium point is negative.

$$-\frac{\eta}{\alpha} (1 - \frac{\eta}{\alpha}) w_t^{-\frac{\eta}{\alpha}-1} - (1 + \frac{\eta}{\alpha}) \frac{\eta}{\alpha} w_t^{-\frac{\eta}{\alpha}-2} B_t - (1 + \frac{\eta}{\alpha}) \frac{\eta}{\alpha} w_t^{-\frac{\eta}{\alpha}-2} d_t^\pi < 0$$

$$\text{dividing for } -\frac{\eta}{\alpha} w_t^{-\frac{\eta}{\alpha}-2}$$

$$(1 - \frac{\eta}{\alpha}) w_t + (1 + \frac{\eta}{\alpha}) B_t + (1 + \frac{\eta}{\alpha}) d_t^\pi > 0$$

calculating it in the equilibrium point

$$(1 - \frac{\eta}{\alpha}) \frac{\eta}{\eta-\alpha} (\bar{B} + d^\pi) + (1 + \frac{\eta}{\alpha}) \bar{B} + (1 + \frac{\eta}{\alpha}) d^\pi > 0$$

$$\frac{\alpha-\eta}{\alpha} \frac{\eta}{\eta-\alpha} (\bar{B} + d^\pi) + (1 + \frac{\eta}{\alpha}) \bar{B} + (1 + \frac{\eta}{\alpha}) d^\pi > 0$$

$$-\frac{\eta}{\alpha} (\bar{B} + d^\pi) + (1 + \frac{\eta}{\alpha}) \bar{B} + (1 + \frac{\eta}{\alpha}) d^\pi > 0$$

$$\bar{B} + d^\pi > 0 \text{ **VERIFIED**}$$

\*\*\*\*\*

The optimal conditions take to a unique solution. In line with Plosser-Rebelo's procedure, to study the stochastic properties of the model we assume certainty equivalence, we linearize the system around its steady state, and we solve it applying linear approximations. Details are reported in Appendix. Equations used to find the equilibrium are:

$$B_t(1 - N_t) = \bar{B}(1 - N_t) = T_t$$

$$C_t = D_t + W_t N_t + (1 - N_t) B_t - T_t$$

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

$$N_t = ((1 - \theta)\lambda_t)^{\frac{1}{\alpha}} K_t W_t^{-\frac{1}{\alpha}}$$

$$Y_t = \lambda_t K_t^\alpha N_t^{1-\alpha}$$

$$W_t = \frac{\eta}{\eta - \theta} (B_t + D_t^\pi)$$

$$D_t = Y_t - W_t N_t - I_t$$

$$RR_t = \theta \lambda_t K_t^{\alpha-1} N_t^{1-\alpha} - \delta$$

$$U = N^\eta (W_t - B_t - D_t^\pi)$$

$$\beta E_t \left[ \left( \frac{c_t}{c_{t+1}} \right)^\gamma (\theta \lambda_{t+1} K_{t+1}^{\alpha-1} N_{t+1}^{1-\alpha} + (1 - \delta)) \right] = 1$$

$$\ln \lambda_{t+1} = \rho \ln \lambda_t + \varepsilon_t$$

These equations permits to identify an unique equilibrium value of capital and the other variable are identified consequently. The capital of steady state is:

$$K^* = \frac{\beta}{1-\beta} \left( \left( \frac{\theta}{\frac{1}{\beta} - (1-\delta)} \right)^{\frac{\theta}{(1-\theta)}} \lambda^{\frac{1}{(1-\theta)}} \left( \frac{(1-\theta)(\eta-\theta)}{\eta} \right) - \bar{B} \right)^{\frac{1}{\pi}} \quad (1)$$

The dynamic equations are:

$$\begin{aligned} 0 &= -c_t + \frac{D}{C}d_t + \frac{WN}{C}n_t + \frac{WN}{C}w_t \\ 0 &= -i_t + \frac{1}{\delta}k_{t+1} - \frac{1-\delta}{\delta}k_t \\ 0 &= -n_t + \frac{1}{\alpha}a_t - \frac{1}{\alpha}w_t + k_t \\ 0 &= -y_t + a_t + \alpha k_t + (1-\alpha)n_t \\ 0 &= -w_t + \frac{\eta}{\eta-\alpha} \frac{B}{W}b_t + \frac{\eta\pi}{\eta-\alpha} \frac{D^\pi}{W}d_t \\ 0 &= -d_t + \alpha \frac{Y}{D}y_t - \frac{I}{D}i_t \\ 0 &= -rr_t + \frac{1-(1-\delta)\beta}{1-\beta}[y_t - k_t] \\ 0 &= -\gamma c_t + \gamma c_{t+1} - \beta\alpha \frac{Y}{K}(y_{t+1} - k_{t+1}) \end{aligned}$$

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