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Monopolistic Competition And Contract Wage Bargaining

Competição Monopolítica e Negociação de Salário de Contrato

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RESUMO

Este modelo propõe uma estrutura em que a rigidez no mercado de bens advém da estrutura de competição monopolista e a rigidez no mercado de trabalho da configuração dos contratos salariais. Além disso, a rigidez do mercado de trabalho segue Blanchard (1991) e McDermott (1998). O principal objetivo aqui é explicar tanto as fontes de choque, tanto da oferta como da demanda. No curto prazo, uma implicação é que, se houver equilíbrio com simetria, um choque monetário positivo aumentaria o emprego e causaria uma transferência de renda de lucros para salários. A longo prazo, um choque de demanda positivo proveniente do aumento dos encaixes reais aumentaria o consumo agregado. Além disso, um choque de oferta positivo nos salários reais aumenta a demanda por encaixes reais.

Palavras-chave: Rigidez; Competição monopolista; Oferta e demanda.

JEL: E2; E4; E5

ABSTRACT

This model proposes a framework in which there is rigidity in the goods market from the monopolistic competition structure and in the labor market from contract wage setting. In addition, the labor market rigidity follows Blanchard (1991) and McDermott (1998). The main objective here is accounting for both sources of shock, supply and demand sides. In the short run, one implication is that if there is equilibrium with symmetry, a positive monetary shock would increase employment and cause an income transference from profits to wages. In the long run, a positive demand shock coming from the increase in real money balances would increase aggregate consumption. Moreover, a positive supply shock on real wages increases the demand for real money balances.

Keywords: Rigidity; Monopolistic competition structure; Supply and demand sides.

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1. Introduction

This paper combines some features of Dias (2002) and McDermott (1998) to construct a model capable of analyzing the implications of shocks over an economy in which the goods market is monopolistic competitive and the labor market has some degree of rigidity coming from the structure of contract wage bargaining. Although the model allows for competition in the labor market, the assumption of strong unions among laborers implies different outcomes to the effects of supply and demand shocks in the short run. The modeling here brings an economy with different relative prices facing firms in the market, and a new relative wage to consider on negotiations in the micro-level.

2. A Macroeconomic Model

The model we develop here follows the main issues discussed by Blanchard & Kiyotaki (1987) about the implications of demand shocks to output, considering monopolistic competition. Moreover, it gives some insight in the more recent debate on the consequences of organized labor over firms' decisions about prices and quantities.

2.1 The Model Over Individual Households and Firms

Assuming that there is *i* households in this economy, who can consume and work, and *j* firms producing differentiated products, let the preferences of representative household *i* ($i = 1,2,3 \ldots , \mu$) be characterized by the following utility function:

$$U_{it} = E_0 \sum_{t=0}^{\infty} \beta^t \{lnc_{it} + l_{it}\} \tag{1}$$

Where c_{it} is the real consumption of household *i* in period *t*; l_{it} represents remaining hours after work effort (n_{it}) from the time constraint of household *i*; $0 < \beta < 1$ is the traditional time discount factor of household programming, equals to $\frac{1}{(1+\rho)}$; E_t is the mathematical operator of expectations given known information at the beginning of period *t*. Consumption c_{it} is then the total amount of goods *j* purchased by household *i* in period *t*, given the state of the production market. This is assumed to be:

$$c_{it} = v^{y-1} \left[\sum_{j=1}^{v} c_{ijt}^{y} \right] \tag{2}$$

Therefore, the households' consumption depends on the purchase of each good *j*, c_{ijt}. The element *v* is the number of *j* goods available in the market. As usual, all goods are symmetric in the utility function. Since all goods are close substitutes, there is a restriction to firms choose infinite prices.

In this context, the time constraint imposed to households includes the variable leisure (l_{it}), hours of work (n_{it}), and hours spent on transactions (s_{it}). Leisure is then all other activities individual households would choose to make after working time and doing transactions. In this sense, transactions are not costless and we shall call it as the shopping time cost.[3] Thus, households' temporal constraint can be represented as follows.

$$l_{it} = 1 - n_{it} - s_{it} \tag{3}$$

Where,

$$s_{it} = \sum_{j=1}^{v} s_{ijt} = \frac{1}{\psi}\left[v^{\gamma-1}\left(\sum_{j=1}^{v} c_{ijt}^{\gamma}\right)\right]^{\psi} \frac{m_{it}}{p_t}^{-\psi}, 0 < \psi < 1 \tag{4}$$

In accordance with equations (3) and (4), the more household consumption increases, the cost measured by time spent on shopping is higher. Consequently, less time would be free to enjoy leisure. On the other hand, if more real money balances (m_{it}) are held by consumer, transactions would be closed more quickly and less time would be lost in shopping. Thus, shopping costs would reduce. Moreover, this would imply more free time to spend in the alternative activities chosen by households, leisure. Thus, m_{it} is the nominal quantity of money holding each household *i*, and *p* is the price level in the economy.

Our consumption function implies the following price index to this economy:

$$p_t = \left[\frac{1}{v}\sum_{j=1}^{v} p_{jt}^{\frac{\gamma}{\gamma-1}}\right]^{\frac{\gamma-1}{\gamma}} \tag{5}$$

By assumption, the market structure in which each firm operates is a monopolistic competitive one. Mainly, we are accepting that each firm produces and offers a specific variety, or brand name, of the differentiated product *j*. There are many producers offering close substitute goods. Then firm *j* has a negative demand, which is highly elastic. However, it considers its own demand and costs to decide about price and quantities, given relative prices. In addition, the implicit assumption of monopolistic competition of free entry is holding on. The implications of this last characteristic in monopolistic competitive markets we shall return latter when analyzing the steady state conditions.

[3] This variable enters our utility function in the same manner as in Bordo & Evans (1991).

Firms are indexed by *j*, $j = 1,2,3\ \dots\ , v$. Each firm-producer faces a typical Cobb-Douglas production function to pursue final goods. This is,

$$y_{jt} = z_t n_{jt}^{\theta} k_{jt}^{1-\theta}, 0 < \theta < 1 \tag{6}$$

The variables y_{jt}, n_{jt} and k_{jt} are product, labor factor, and capital, respectively. Firm *j* combines the factors to produce the specific good type *j*, y_{jt}, given z_t. This time varying parameter is characterizing the technological conditions disposable to firms, whom rely upon it to produce *j*. Any technological shock could then change the amount of y_{jt}. Notice that z is not specific to *j* because it is the technology available to producers. It depends on developments in research over time.[4]

Each firm *j* produces with the same objective of profit maximization. This problem is characterized by traditional profit function $\Im$, displayed in the appendix. Facing a given labor supply and assuming that nominal prices are homogenous of degree one, individual firms demand the following amount of labor and capital:

$$n_{ijt} = k_{jt}\left(\theta z_t \frac{p_{jt}}{w_{jt}}\right)^{\frac{1}{1-\theta}} \tag{7}$$

$$\kappa_{jt} = n_{ijt}\left[(1-\theta) z_t \frac{p_{jt}}{r_{jt}}\right]^{\frac{1}{\theta}} \tag{8}$$

Using the first order conditions for the profit maximization function of firm *j*, we also get its capital-labor ratio (κ_{jt}), displayed below.

$$\kappa_{jt} = \left(\frac{1}{\theta z_t}\frac{w_{jt}}{p_{jt}}\right)^{\frac{1}{1-\theta}} \tag{9}$$

In line with profit maximization procedures of individual firms, the resulting supply curve of producer *j* is:

$$y_{jt} = \theta_1 z_t^{\frac{1}{\theta(1-\theta)}} n_{ijt}\left(\frac{p_{jt}}{w_{jt}}\right)^{\frac{\theta}{1-\theta}}\left(\frac{p_{jt}}{r_{jt}}\right)^{\frac{1}{\theta}} \tag{10}$$

[4] Notice also that, if technology of production (not of product differentiation) comes as shocks to firms, in such a way that development of inventions are praticed for institutions outside of R&D department of firms. Thus, all market participants would be reached by possible technological shocks.

Where $\theta_1 = \theta^{\frac{\theta}{1-\theta}}(1-\theta)^{\theta}$. Recall that $0 < \theta < 1$. Equation (10) imply that supply of good *j* is positive in n_{ijt}, z_t, and in its price (p_{jt}), but negative in relation to the costs of both labor (w_{jt}) and capital (r_{jt}) factors.

Calculating the solution of the first order conditions of $\Im$ for w_{jt} and p_{jt}, and then substituting the second into the first, give us the nominal price that firm *j* would like to charge for the sale of *j*, and the nominal wage rate that firm *j* would like to pay when hiring the labor to work in the production of *j*. These are expressed in what follows.

$$p_{jt} = \frac{r_{jt}k_{jt}^{\theta}}{(1-\theta)z_t} \tag{11}$$

$$w_{jt} = \theta z_t p_{jt} k_{jt}^{1-\theta} \tag{12}$$

From (11) we infer that the relative price ($\wp$) facing each firm in the goods market is the following:

$$\wp_t = \frac{p_{jt}}{p_t} = \frac{r_{jt}k_{jt}^{\theta}}{(1-\theta)z_t}\left[\frac{1}{v}\sum_{j=1}^{v} p_{jt}^{\frac{\gamma}{\gamma-1}}\right]^{\frac{1-\gamma}{\gamma}} \tag{13}$$

Equation (13) implies that if the number of firms in the goods market increases, the relative price $\wp$ would decrease, because the new firms would share the same consumer market as firm *j*. If the cost of capital increases, the individual firm would be willing to increase its prices relative to the others. Therefore, it would become less competitive. The same follows with the increases in κ. If the technological condition to which firm *j* was exposed to improves, at a microeconomic level, this unit of production would be able to decrease its price relative to other firm. Although we expect that, all other firms would take the same decision in such way that the overall change in relative price would be none. Thus, it would not change its competitiveness. Moreover, if in average the price of its competitors increase but its own price, firm *j* would be worsen with respect to $\wp$.

Although equation (12) shows the desired price of labor hired by firm *j*, it does not mean that is the wage firm *j* would be able to contract *i*.[5]

[5] Blanchard & Portugal (2001) call "*the wage that satisfies the zero pure-profit condition*" as the *feasible wage*. However, it is not exactly our w_{jt} because we are not considering the moment at which the firm would laid out the worker. Nevertheless, we are also interested in the implications of technological and demand shocks over main aggregates, including level of output. The authors above argue that the inclusion of the flows of jobs (job creation and job destruction) and workers would matter to the duration of unemployment. Moreover, Blanchard (1991) had already stressed the impact of wage bargaining on the persistence of unemployment which is to increase the time duration of unemployment. Furthermore, Blanchard (2000, p. 36-7) has lectured that theoretically, "*... in sclerotic*

In the discussion we are to present, we try to bring some insight in the understating of labor contracting under bargaining wage in the contest of a macroeconomic model with monopolistic competition. It should be mentioned that the discussion is, in the sense of new entrants in the labor market, a static one.

In accordance with our production function, the wage index (w_t) would have the following format:

$$w_t = \left(\sum_{j=1}^{v} w_{jt}^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}} \tag{14}$$

Thus, there is a market price of labor, which is consistent with the conditions of production of y_{jt}, that is, with the demand for labor. Nonetheless, the assumption of existence of strong labor unions, with some degree of power in the bargaining of laborers' contracts, implies that the supply of labor shall act not as competitive as it would be with no union. However, Blanchard & Summers (1986) pointed out "*laid-off workers would be represented in wage negotiations only for some time, after which they would drift away and be forgotten…*"[6]

From wage bargaining conditions, unions would ask for the following compensation to the work effort of their members:[7]

$$w_{it} = \zeta\pi_t + a_{it} + \eta\upsilon_{it} \tag{15}$$

Where ζ is a positive and η is a negative parameter. π_t is the inflation rate of period *t*. The variable a_{it} is here the efficiency of employed labor $\left(\frac{y_{jt}}{an_{ijt}}\right)$, given that an_{ijt} is the labor hours employed by firm *j* in efficient units. υ_{it} is the unemployment rate verified among members of the union. It is meant to be:

$$\upsilon_{it} = \left(n_{it}^{u} - n_{jt}^{d}\right) \tag{16}$$

Then, υ_{it} is not the unemployment rate of overall economy but of those workers whose wages are bargaining throughout the power of unions' membership. The variable $n_{it}{}^{u}$ is the amount

markets, long term unemployment combined with duration dependence can lead to larger and longer lasting effects of shocks is indeed correct." [4] Blanchard (1991, p.280).

[6] Blanchard (1991, p.280).

[7] The equation of w_{it} presented here is a slightly modified version of (18) in McDermott (1998).

of labor hours of individuals under unions employed in the labor market.[8] Consistently, $n_{jt}{}^{d}$ is the amount of labor hours employed by the firm *j*.[9]

Thus, w_{it} is the contract real wage demand from laborers under unions. McDermott (1998) analyzed many issues involving equation (15), yet we shall recall some main points necessary to the objective of this paper. Recall that π_t is the inflation rate occurred during period *t* which will be fully known by the end of period *t*. Therefore, we think π_t to be the expected inflation rate of the economy. As laborers expect the inflation rate to increase, and affect negatively the purchasing power of their wage, unions would ask for higher nominal wages, then contract wage demand increases. Although we are expanding the concept of a_{it}, its rationality goes in the same way as in McDermott (1998, p.20). Setting, $a_{it} = Max[a_{i\tau}]$ for $0 < \tau < t$, "*organized labor sets its demands based on standards that are equal to the maximum values of a… ever attained in the economy.*" As one may notice, "*Only increases in unemployment would convince them to moderate their wage demands*." In this context, the contract wage demand (w_{it}) is positive in expected inflation (π_t), in labor efficiency units (a_{it}), and negative in the unemployment rate.

Using equations (14) and (15), the relative wage facing the unions in the labor market can be representing as follows.

$$\varpi_t = \frac{w_{it}}{w_t} = \left(\zeta\pi_t + a_{it} + \eta\upsilon_{it}\right)\frac{p_t}{w_t} \tag{17}$$

One way of analyzing (17) is that, any increase in the wages paid by all other firms but *i* would make the workers under union *i* worse off.

From the point of view of the individual firm, the real wage it would like to pay to its workers would be the following:

$$\frac{w_{jt}}{p_t} = \theta z_t \kappa_{jt}^{1-\theta} \wp_t \tag{18}$$

From the point of view of the union, the real wage it would impose to labor market would follow the contract wage demand weighted by the mean of all individual firms' prices, that is:

$$w_{it} = \frac{w_{it}}{w_t} = \zeta\pi_t + a_{it} + \eta\upsilon_{it} \tag{19}$$

[8] The superscripted u is just to remind the reader that the worker is a member of some union, then he could exploit the benefits from being under unions' bargaining power. Since we are using discrete time with the distinction of individuals (i), the analysis would flow without the superscripted in the same manner.

[9] Those two elements can be thought as the flow of workers and the flow of jobs in the labor market, treated in the literature by many authors, such as: Blanchard (1998, 2000) and Blanchard & Portugal (2001).

Considering that equilibrium in the labor market is possible, that real wage proposed by firms and demanded by workers were to be equal, $\square_{it}$ would be zero and the resulting labor hours of equilibrium n_{ijt}* would be the following:

$$n^*_{ijt} = k_{jt}\left[\frac{\theta z_t \wp_t}{\zeta\pi_t + a_{it}}\right]^{\frac{1}{1-\theta}} \tag{20}$$

In accordance with equation (20), as capital factor is more employed, there is more room to contract new labor hours in the production structure. In addition, if the price of goods *j* increases, firm *j* would be able to contract more labor to rise its production. If the inflation rate is expected to increase, consumers may reduce their purchases of goods, this situation presses the equilibrium labor hours to fall. But if p_{jt} increases relatively to p_t, then n_{ijt}* would rather increase. One intriguing result comes from the possible behavior of a_{it}. If labor hours in efficiency units increase, equation (20) implies that the equilibrium labor hours would decreases. This effect should not be analyzed by itself without relating it with its possible causes. If this rise in the efficiency of labor comes from better conditions of technology, n_{ijt}* would probably decrease through z_t, but in part, offset by the pressure unions would make to have higher wages. In addition, we should recall that a_{it}= $Max[a_{i\tau}]$. Once individual labor know the new rate of efficiency of labor hours, unions would not accept wages disregarding this improvement. This would be transferred to contract wage bargaining and offset part of the positive effects of technological shocks.[10]

Now we turn to the analysis of capital accumulation and the implications of the maximization procedures of individual's utility function, given their budget constraint.

Considering that investment demand in this economy is given by a traditional structure, such that:

$$k_{j(t+1)} = (1-\delta)k_{jt} + i_{jt}\ ,\ \ 0 < \delta < 1 \tag{21}$$

Where $k_{j(t+1)}$ is the capital stock available at the beginning of period t + 1; i_{jt} represents investment realized during period *t*; and δ is a positive parameter representing the depreciation rate.

In this context, the budget constraint in real terms facing household *i*, is the following:

$$\sum_{j=1}^{v} Y_{ijt} + (1-\delta)k_{jt} + \frac{m_{it}}{p_t} = \sum_{j=1}^{v} c_{ijt} + k_{j(t+1)} + (1+\pi_t)\frac{m_{i(t+1)}}{p_{t+1}} \tag{22}$$

Where Y_{ijt} is household income, and π_t is the inflation rate verified between periods *t* e t + 1. The factor (1 + π_t) represents $\frac{(1+R_t)}{(1+r_t)}$. The left hand side of equation (22) includes the origin of

[10] With an allusion to Blanchard & Portugal (2001), because in this point of our model we are not yet in the steady state, n^*_{ijt}could be thought as an exit rate from unemployment.

resources available at the beginning of period *t*. This resources can be used to purchase goods, capital, or to hold money balances.

The maximization of utility given the budget constraint is performed through the maximization of Φ. Household *i* at the initial period *0* has to choose the maximizing levels of a sequence of variables (c_{itj}, n_{itj}, $k_{j(t+1)}$, $m_{i(t+1)}$; t = 1,2,3, …) as follows.

$$\Phi = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ ln\left(v^{\gamma-1} \sum_{j=1}^{v} c_{ijt}^{\gamma} \right) + 1 - n_{it} - \frac{1}{\psi}\left(\sum_{j=1}^{v} c_{ijt} \right)^{\psi} \frac{m_{it}^{-\psi}}{p_t} \right.$$
$$+ \lambda_t \left[p_{jt} z_t \sum_{i=1}^{u} n_{ijt}^{\theta} k_{jt}^{1-\theta} + p_{jt}(1-\delta)k_{jt} + m_{it} \right. \quad (23)$$
$$\left.\left. - \sum_{j=1}^{v} p_{jt} c_{ijt} - p_{jt} k_{j(t+1)} - (1+\pi_t)\, m_{i(t+1)} \right] \right\}$$

λ_t is a Lagrangian's multiplier associated with the budget constraint facing individuals in period t in nominal terms. The variable m_{it} represents money balances holding by households. The first-order conditions are displayed in the appendix.

The first-order condition with respect to c_{ijt}, using the result from the maximization of n_{ijt}, leads us to the specification of the demand of household for c_{ijt}, that is,

$$\sum_{j=1}^{v} c_{jt} = \theta v z_t (\gamma - v\psi s_{it}) \kappa_t^{1-\theta} \quad (24)$$

Equation (24) implies that as z_t improves (some technological shock), the consumption of c_{jt} is likely to increase, net of its transaction costs. If shopping costs reduce, from an increase in holdings of real money balances (positive demand shock), the amount of consumption household would be able to acquire increases. By the contrary, if there is a decrease in the real money balances through the increase of prices (p_t), there would be a decrease in the consumption of goods by household *i*. The relative importance of labor hours in the production structure matters to the consumption of goods. As the participation of labor increases in relation to the participation of capital, one should expect reduction in the marginal productivity of labor, and the demand of c_{jt} falls.

2.2 The Model In The Aggregate Level

By the hypothesis that the goods have symmetry in the utility function as the factors in the production function, one can aggregate the model by summing up the individual functions.

$$U_t = \sum_{i=1}^{u} U_{it} \tag{25a}$$

$$y_t = \sum_{i=1}^{v} y_{it} \tag{25b}$$

Thus, the set of equations describing the behavior of households as consumers and firms, are displayed bellow.

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t \{lnc_t + l_t\} \tag*{(1)'}$$

Where,

$$l_t = 1 - n_t - s_t \tag*{(3)'}$$

And

$$s_t = \frac{v}{\Psi} c_t^{\Psi} \frac{m_t^{-\Psi}}{p_t}\ , 0 < \Psi < 1 \tag*{(4)'}$$

$$y_t = uz_t n_t^{\theta} k_t^{1-\theta} \tag*{(6)'}$$

Following the procedures of profit maximization in the aggregate level, the relevant amounts of labor and capital to production are:

$$n_t = k_t \left(\theta z_t \frac{p_t}{w_t}\right)^{\frac{1}{1-\theta}} \tag*{(7)'}$$

$$k_t = n_t \left((1-\theta) u z_t \frac{p_t}{r_t}\right)^{\frac{1}{\theta}} \tag*{(8)'}$$

$$\kappa_t = \left(\frac{1}{\theta z_t} \frac{w_t}{p_t}\right)^{\frac{1}{1-\theta}} \tag*{(9)'}$$

A simplified version of the new supply curve does not include the real wage paid by firms, it is the now the following:

$$y_t = (1-\theta)^{\frac{1-\theta}{\theta}}(uz_t p_t)^{\frac{1}{\theta}} n_t r_t^{\frac{\theta-1}{\theta}} \qquad (10)'$$

The relative importance of the other elements holds. Another result that remains is the wage rate that firms would like to pay to workers, described in equation (12). In this way, using equation (12) in the aggregate level and the contract wage bargaining imposed by labor unions, the relevant wage for equilibrium in the labor market would be:

$$\frac{w_t^*}{p_t} = \zeta\pi_t + a_t \qquad (26)$$

With respect to the maximization procedure of representative household, the capital accumulation description holds as well as his budget constraint, now in the aggregate form. The choice variables are the same as before. The resulting demand schedule for goods that maximizes individuals' utility in this economy is given as follows.

$$c_t = \frac{w_t}{p_t}(\gamma - \Psi s_t) \qquad (27)$$

The consumption of goods depends then of real wages, the shopping costs and the parameters γ and Ψ. According to equation (27), an increase in real wages, net of costs of transactions, would increase aggregate consumption. Recall from equation (5) that the price level is the average of all individual prices. Therefore, the higher individual prices are, the lower is the level of aggregate consumption. However, this should be a temporary effect depending of the power of unions in the economy as a whole. Because the increase of price may reduce the purchasing power of real wages, unions may ask for higher wages when contracting takes place and the effect of higher prices over consumption would vanish, but probably inflation would be higher. Besides, equation (27) can be expanded to show the effect of shocks coming from money balances relations. Notice that, it can be rewritten as follows.

$$c_t = \frac{w_t}{p_t} = \left(\gamma - vc_t^{\Psi}\frac{m_t^{-\Psi}}{p_t}\right) \qquad (27)'$$

Equation (27)' shows that if a shock is able to change money holdings would improve aggregate consumption.

Nonetheless, if we calculate the consumption given in (27) with the consumption from full employment of labor under unions, then $[c_t - c_t^*]$ would be equal to the difference between actual real wage $\left(\frac{w_t}{p_t}\right)$ and equilibrium $\left(\frac{w_t}{p_t}\right)^*$, that is $\eta\upsilon_t$. Recall that the unemployment rate is the difference between flow of jobs and flow of workers $\left(n_{it}^{u} - n_{jt}^{d}\right)$. Thus, aggregate consumption is a positive function of this difference. In this context, any shock that is able to affect the flow of workers or flow of jobs would affect aggregate consumption.

Notice that, combining the first-order condition with respect to labor hours of household maximization with the resulting concept of capital-labor ratio of profit maximization, give us the following solution for λt:

$$\lambda_t = \frac{1}{uw_t} \tag{28}$$

Accordingly, λt depends on the value of nominal wages. Hence, nominal wages would be the appropriate variable to normalize the budget constraint.

2.3 Monetary Relations

In accordance with traditional money market relations, we suppose that money supply is given exogenously by monetary authorities. Let bt be monetary base growing at a constant exogenous rate φ. Then:

$$b_{t+1} = (1+\varphi)b_t \tag{29}$$

Moreover, let dt be nominal deposits and the exogenous and constant μ be the multiplier of monetary base, such that:

$$d_{t+1} = \mu b_{t+1} \tag{30}$$

Consequently, lagging (30) by one period, substituting bt+1 and rearranging the result imply:

$$d_{t+1} = (1+\varphi)d_t \tag{31}$$

If we let $m\bar{\ }t$ to be the sum of bt and dt, this is the total amount of money available at the beginning of period t. Thus, the equilibrium in the money market means that $m\bar{\ }t$ is equal to mt, which in turn is the total demand of money plus deposits.

2.4 Market Equilibrium with Simmetry

Achieving equilibrium in this framework requires a hypothesis about relative prices, that is $\frac{p_{jt}}{p_t}$ equals 1. Substituting into equation (13) gives us the following solution for the price level:

$$p_t^s = \theta_2 z_t^{-\theta} w_t^{\theta} r_{jt}^{1-\theta} \tag{32}$$

Where $\theta_2 = \left(\frac{1}{\theta}\right)^{\theta} (1-\theta)^{\theta-1}$. Notice that both costs of production factors are positively related to the price level. Besides, improvements in technology have the power of reducing prices. When we use the relative price condition under symmetry on equation (24), we have that:

$$p_t^d = \frac{w_{jt}}{\sum_{j=1}^{v} c_{jt}} v(\gamma - v\Psi s_{it}) \tag{33}$$

Equation (33) is basically the demand curve facing each firm j. If there is an increase in nominal wages, consumers of goods j would be willing to pay a higher price for each unit of j. On the other hand, if individuals spend all their wages on consumption, the price household would like to pay for each good j would depend on transaction costs. A shock over sit would affect demand side prices.

Equation (32) together with (33) imply that equilibrium consumption under the symmetry condition is:

$$\sum_{j=1}^{v} c_{jt} = w_{jt}^{\frac{1-2\theta}{1-\theta}} \left(\frac{z_t}{p_t}\right)^{\frac{\theta}{1-\theta}} \frac{v(\gamma - v\Psi s_{it})}{\theta_2 r_{jt}} \tag{34}$$

Notice that, if there is a shock of demand coming from increased amount of money balances, there would be an increase in the consumption facing firm j. If we are under the hypothesis of symmetric prices, firm j would rather change its production level.[11] Producing more may imply contracting more labor, decreasing the flow of workers in equation (16). This would improve labor power in bargaining and increase wit in (15). Therefore, realized higher labor hours require higher wage rates. In this way, firms would attend higher consumption with higher cost per unit of labor contracted. Thus, the positive monetary shock would increase employment and also, with this framework, causes a income transference from profits to wages.[12]

2.5 Steady State Conditions

The rationality here is that, in the short run, firms would take some advantage of selling an specific good or brand name to a quota of consumer's market. If there are innovations from firm's research and development department, these could be used as a source of monopolistic power. However, as time passes by, the innovations become more and more known. This would be an open field to imitation. In addition, the assumption of free entry throughout the path implies more competitive structure in the long run.[13]

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may bring income transference into the economy. Thus, in the short run, firms seek to create barriers to entry with product differentiation, but as time goes by, it shall become less powerful in the process of setting prices.

In this framework, steady state analysis uses the following hypothesis about the growth rate of the variables:

i) labor hours (n) grow at rate zero, as the growth of population;

ii) consumption (c) grows at a constant rate equal to ϕ;

iii) capital (k) follows the constant rate of growth ϕ;

iv) λ is constant over time;

v) z,μ and π are given exogenously; and

vi) real money balances (m) grow in accordance with [μ (1+π)].

In addition, applying the conditions above in our system of equations and performing the maximization procedures for the steady state of this economy result in the following aggregate demand relation:

$$c = \frac{w}{p}\left(\gamma - \frac{v}{\Psi}c^{\Psi}\frac{m^{-\Psi}}{p}\right) \tag{35}$$

Consequently, consumption depends positively on real wages. Besides, if there is a shock in such a way of increasing the transaction costs, consumption shall reduce. Moreover, since st depends on the consumption of goods (c^{Ψ}) and on real money balances $\left[\left(\frac{m}{p}\right)^{-\Psi}\right]$. Thus, a positive demand shock coming from the increase in real balances, would increase aggregate consumption.

Finally, with the steady state analysis we are capable of specifying the demand for money, such that:

$$\frac{m}{p} = \frac{1+\pi}{\mu}(vc^{\Psi}w)^{\frac{1}{(1+\Psi)}}\left[\frac{\theta\beta(1+\phi)^{\Psi}}{1+\pi-\beta}\right]^{\frac{1}{(1+\Psi)}} \tag{36}$$

Notice that, the demand for real money balances is a positive function of the volume of transactions (consumption), of the nominal wages, of the growth rate (ϕ), of the time discount factor β, of the ratio [(1+π) μ], and of the weight of labor on the production structure (θ). On the other hand, the real money balances relation described by equation (36) implies that is negative in the difference between the inflation factor (1 + π) and β. In accordance with equation (36), a supply shock that increases real wages may affect real money balances holdings by increasing them. On the other hand, if there is a shock of monetary policy such that there is an increase in the multiplier, the overall demand for money balances shall rather diminish.

3. Summary

The main objective of this research was to build a model able to comport both sources of shocks, technological and monetary ones, in which the new features of actual labor markets with unions and production structure with monopolistic competition are incorporated. The theoretical framework implies that, if there is equilibrium with symmetry, a positive monetary shock would increase employment and cause an income transference from profits to wages in the short run.

In the long run, one implication of the model is that a positive demand shock coming from the increase in real balances would increase aggregate consumption. Moreover, a positive supply shock on real wages increases the demand for real money balances.

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APPENDIX I

Each individual firm j faces the following profit function:

$$\Im = p_{jt} z_t \sum_{i=1}^{u} n_{ijt}^{\theta} k_{jt}^{1-\theta} - w_{jt} \sum_{i=1}^{u} n_{ijt} - r_{jt} k_{jt} \quad \text{(AI.1)}$$

The income restriction imposed to household (i) is given bellow.

$$\sum_{j=1}^{v} Y_{ijt} = w_{it} n_{it} + \frac{m_{it}}{p_t} + \sum_{j=1}^{v} V_{ijt} + k_{j(t+1)} + (1+\pi_t)\frac{m_{i(t+1)}}{p_{t+1}} \quad \text{(AI.2)}$$

As in Blanchard & Kiyotaki (1997), $\sum Vijt\ v\ j$=1 = $\sum rijtkjt\ v\ j$=1 is the share of profit of firm j going to household (i). In equilibrium, we expect $\sum Yijt\ v\ j$=1 = yjt. The first-order conditions from household (i) maximization problem are the following:

$$\frac{\partial \Phi}{\partial c_{jt}} \Rightarrow \frac{\sum_{j=1}^{v} c_{jt}^{\gamma-1}}{\sum_{j=1}^{v} c_{jt}^{\gamma}} - v \sum_{j=1}^{v} c_{jt}^{\Psi-1} \frac{m_{it}^{-\Psi}}{p_t} = \lambda_t p_{jt} \quad \text{(AI.3)}$$

$$\frac{\partial \Phi}{\partial n_{jt}} \Rightarrow \theta v z_t \sum_{j=1}^{v} n_{jt}^{\theta-1} k_{jt}^{1-\theta} = \frac{1}{\lambda_t p_{jt}} \quad \text{(AI.4)}$$

$$\frac{\partial \Phi}{\partial k_{j(t+1)}} \Rightarrow E_t \left\{ \lambda_{t+1} p_{j(t+1)} \left[(1-\theta) z_{t+1} \sum_{j=1}^{v} n_{j(t+1)}^{\theta} k_{j(t+1)}^{-\theta} + (1-\delta) \right] \right\} = \frac{\lambda_t p_{jt}}{\beta} \quad \text{(AI.5)}$$

$$\frac{\partial \Phi}{\partial m_{i(t+1)}} \Rightarrow E_t \left\{ \lambda_{t+1} + \left[\sum_{j=1}^{v} c_{j(t+1)} \right]^{\Psi} \left(\frac{m_{i(t+1)}}{p_{t+1}} \right)^{-\Psi-1} \right\} = \frac{\lambda_t (1+\pi_t)}{\beta} \quad \text{(AI.6)}$$

$$\frac{\partial \Phi}{\partial \lambda_t} \Rightarrow p_{jt} z_t \sum_{j=1}^{v} n_{jt}^{\theta} k_{jt}^{1-\theta} + p_{jt}(1-\delta) k_{jt} + m_{it} - \sum_{j=1}^{v} p_{jt} c_{jt} - p_{jt} k_{j(t+1)} - (1+\pi_t) m_{i(t+1)} = 0 \quad \text{(AI.7)}$$

APPENDIX II

The representative households' budget constraint after aggregation is:

$$Y_t + (1-\delta) k_t + \frac{m_t}{p_t} = v c_t + k_{t+1} + (1+\pi_t)\frac{m_{t+1}}{p_{t+1}} \quad \text{(AII.1)}$$

The programming of households is to maximize the following function:

$$\Phi = E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ \ln u + \gamma \ln v + \gamma \ln c_t + 1 - n_t - \frac{v}{\Psi} c_t^{\Psi} \frac{m_t}{p_t}^{-\Psi} + \lambda_t \big[p_t \big(u z_t n_t^{\theta} k_t^{1-\theta} \big) + p_t (1-\delta) k_t + m_t - v p_t c_t - p_t k_{t+1} - (1+\pi_t) m_{t+1} \big] \Big\} \qquad \text{(AII.2)}$$

The set of equations representing first-order conditions to maximize households satisfactions are:

$$\frac{\partial \Phi}{\partial c_t} \Rightarrow \frac{\gamma}{c_t} - v c_t^{\Psi-1} \frac{m_t}{p_t}^{-\Psi} = \lambda_t v p_t \qquad \text{(AII.3)}$$

$$\frac{\partial \Phi}{\partial n_t} \Rightarrow \theta u z_t n_t^{\theta-1} k_t^{1-\theta} = \frac{1}{\lambda_t p_t} \qquad \text{(AII.4)}$$

$$\frac{\partial \Phi}{\partial k_{t+1}} \Rightarrow E_t \{ \lambda_{t+1} p_{t+1} [u(1-\theta) z_{t+1} n_{t+1}^{\theta} k_{t+1}^{-\theta} + (1-\delta)] \} = \frac{\lambda_t p_t}{\beta} \qquad \text{(AII.5)}$$

$$\frac{\partial \Phi}{\partial m_{t+1}} \Rightarrow E_t \left\{ \lambda_{t+1} + v c_{t+1}^{\Psi} \frac{m_{t+1}}{p_{t+1}}^{-\Psi-1} \right\} = \frac{\lambda_t (1+\pi_t)}{\beta} \qquad \text{(AII.6)}$$

$$\frac{\partial \Phi}{\partial \lambda_t} \Rightarrow p_t u z_t n_t^{\theta} k_t^{1-\theta} + p_t (1-\delta) k_t + m_t - v p_t c_t - p_t k_{t+1} - (1+\pi_t) m_{t+1} = 0 \qquad \text{(AII.7)}$$

APPENDIX III

The set of equations to represent the first-order conditions of households maximization problems in the steady state are the following:

$$\frac{\partial \Phi}{\partial c} \Rightarrow \frac{\gamma}{c} - v c^{\Psi-1} \frac{m^{-\Psi}}{p} = \lambda v p \qquad \text{(AIII.1)}$$

$$\frac{\partial \Phi}{\partial n} \Rightarrow \theta u z n^{\theta-1} k^{1-\theta} = \frac{1}{\lambda p} \qquad \text{(AIII.2)}$$

$$\frac{\partial \Phi}{\partial k} \Rightarrow (1-\theta) u z n^{\theta} [(1+\phi)k]^{-\theta} + (1-\delta) = \frac{1}{\beta(1+\pi)} \qquad \text{(AIII.3)}$$

$$\frac{\partial \Phi}{\partial m} \Rightarrow \frac{m^{-1-\Psi}}{p} [\mu^{-\Psi-1}(1+\pi)^{1+\Psi}] v c^{\Psi} (1+\phi)^{\Psi} = \lambda \left[\frac{(1+\pi)}{\beta} - 1 \right] \qquad \text{(AIII.4)}$$

$$\frac{\partial \Phi}{\partial \lambda} \Rightarrow p\big(u z n^{\theta} k^{1-\theta}\big) + p k [(1-\delta) - (1+\phi)] + m(1-\mu) - v p c = 0 \qquad \text{(AIII.5)}$$