DUAL LABOR MARKETS AND STRATEGIC EFFICIENCY WAGE[#]

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Abstract: We consider a dual labor markets model in which the primary sector requires the presence of efficiency wage, while the secondary sector is competitive. We show that the Solow condition does not hold in a Stackelberg equilibrium where the primary sector acts as a leader and the secondary one as a follower.

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1. INTRODUCTION

The literature on efficiency wage predicts a direct and increasing relationship between the wage paid by firms and the level of effort provided by workers (Akerlof and Yellen, 1986, Katz, 1986). In equilibrium, firms may find it profitable to pay wage in excess of market clearing. Efficiency wage theories produce several interesting implications. In particular, they explain that permanent involuntary unemployment may exist under conditions of equilibrium in labor markets. Efficiency wage models are also capable of generating a number of other stylized labor markets facts, including real wage rigidity, dual labor markets, wage distributions for workers with identical productive characteristics and discrimination among observationally distinct groups.

Because of the impact of the wage setting on the workers' effort, profit-maximizing firms are expected to set an optimal wage such that the elasticity of effort with respect to wage is equal to one. This well-known result of the standard efficiency wage model is due to Solow (1979) and is known as the Solow condition. The efficiency wage minimizes the employer's wage cost per effective units of service employed and each firm hires labor up to the point where the marginal product is equal to the efficiency wage. However, it has been suggested that the Solow condition does not hold in general. In particular, Akerlof and Yellen (1986: 14-16, question 4) point out that an effort-wage elasticity of unity is undoubtedly excessive. This is an important issue, since it casts doubt on the possibility of equilibrium with unemployment in an efficiency wage model.

Numerous suggestions have been proposed in the literature to illustrate an effort-wage elasticity lower than one. Akerlof and Yellen (1986) present a static model with external costs to account for the downside risk from shirking labor. In Schmidt-Sörensen (1990), fixed employment costs per worker are introduced in the profit function. Pisauro (1991) sets out a model with specific taxes on labor. Lin and Lai (1994) show that the Solow condition does not hold in an intertemporal maximizing framework with turnover costs. Marti (1997) and Faria (2000) examine models that combine the shirking and the turnover models of efficiency wage, with the possibility of managerial supervision. The role of the quality of job matching on efficiency wages is analyzed by Jellal and Zenou (1999). When job matching is unobservable, firms can either set wages such that the effort-wage elasticity is lower or greater than one. Finally, Jellal and Zenou (2000) consider a dynamic efficiency wage model with learning by doing, where workers accumulate a stock of knowledge that allows them to increase their effort.

Rather than relying on microeconomic foundations for the efficiency wage model, such as shirking or labor turnover costs, we follow a different path in this paper to show that the Solow condition does not hold in general. For our purpose, we analyze the optimal wage policy in a dual labor markets model with efficiency wage. Following Doeringer and Piore (1971), we consider two types of sector differentiated according to the type of jobs (see also Acemoglu, 2001). In the primary sector, jobs are stable and well paid, contrary to the secondary sector. Primary jobs are more complex than secondary jobs, so that it is more difficult to monitor workers’ performance. This is the explanation of dual labor markets given by Bulow and Summers (1986), based on the Shapiro and Stiglitz (1984) labor shirking efficiency wage model. Different wage levels are due to different monitoring costs across industries, thus providing a supply side explanation of dual labor markets[1].

[1] Additional references concerning dual labor markets in the field of efficiency wages include Agénor and Santaella (1998), Albrecht and Vroman (1992), Jones (1987) and Saint-Paul (1996: Ch. 5) for an empirical survey.

We assume that wage differences between sectors stem from the presence of efficiency wage in the primary sector. Thus, in the context of dual labor markets, we prove that effort-wage elasticity is expected to be lower than unity in a Stackelberg equilibrium. The primary sector acts as a leader in setting the wage policy and the secondary sector as a follower, thus leading to a strategic efficiency wage. The remainder of the paper is organized as follows. In section 2, we present a dual labor markets model with efficiency wage. The relevance of the Solow condition is discussed in section 3. The strategic efficiency wage is further examined in section 4, and section 5 deals with policy implications. Concluding comments are in section 6.

2. A DUAL LABOR MARKETS MODEL

We consider an economy in which there are two sectors. Dual labor markets can arise when monitoring difficulties vary across firms. The wage-productivity nexus is thus important only in one sector of the economy, the primary sector. We assume that there exists one representative firm per sector.

That each firm acts as a monopsonist within its sector may seem unrealistic. An interpretation is to consider that there are in fact several firms per sector, but these firms collude to act as a monopsonist (see Wauthy and Zenou, 2000, 2002). Another argument, which is more relevant in our context, is to rely on local labor markets (see Topel, 1986). For instance, let us assume the presence of a two-sectors labor market, with a high-technology sector and a low-technology sector. Workers decide to work by comparing net wages across sectors. In each sector, the same level of qualification is required by firms. So, workers are characterized by low mobility within each sector and even if firms are numerous, a monopsony market power prevails in each sector. Clearly, monopsony power is bounded by mobility costs (due to changes of industry, of city, of qualification), so that monopsonistic firms are credible as one considers sufficiently important mobility costs (see the discussion in Thisse and Zenou, 1997)[2].

The output of the primary firm is a function of the workers' level of effort, which is variable due to imperfect monitoring. The efficiency wage hypothesis is relevant in the primary sector and there are job rationing and voluntary payments by firms of wages in excess of market clearing. Thus, the output in the primary sector is a function of labor efficiency units, i.e. the product of effort and employment. The profit function of the primary firm is:

$$\Pi = F\left(e\left(\frac{w}{w_0}\right)N\right) - wN \tag{1}$$

where $e(.)$ is the aggregated effort function for the primary workers, w is the level of wage in the primary firm, w_0 is the level of wage in the secondary firm, N is the number of workers in the primary firm, and $F(.)$ is the production function of the primary firm. We make the standard assumption of concavity ($F'>0$, $F''<0$).

Conversely, for the secondary firm, the wage-productivity relationship is supposed to be nonexistent. Therefore, a fully neoclassical behavior is expected for that firm. Owing to perfect monitoring, the output in the secondary sector is supposed to depend on a constant level of effort. In the model, there is no unemployment. As claimed by Akerlof and Yellen (1986: 3), “the market for secondary jobs clears, and anyone can obtain a job in this sector, although it might be at a lower pay”. Let $G(L-N)$ be the production function of the

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[2] For empirical evidence on monopsony power in the labor market, see Boal and Ramson (1997).

secondary firm, where L is the total labor force in the economy. Thus, the wage in the competitive secondary sector is given by the marginal productivity in this sector, which is given by $G'(L-N)$. Again, we suppose that $G'>0$ and $G''<0$.

We make the following assumption concerning how dual local labor markets operate. We focus on a Stackelberg equilibrium that leads to a strategic efficiency wage. The representative primary firm acts as a leader when setting its optimal employment-wage decisions, while the secondary firm acts as a follower. Hence, the firm operating in the primary sector faces the following maximization program:

$$\max_{w,N} \Pi = F\left(e\left(\frac{w}{w_0}\right)N\right) - wN \quad s.t. \quad w_0 = G'(L-N) \tag{2}$$

which can also be expressed as:

$$\max_{w,N} \Pi = F\left(e\left(\frac{w}{G'(L-N)}\right)N\right) - wN \tag{3}$$

The corresponding first-order conditions, $\partial \Pi / \partial w = 0$ and $\partial \Pi / \partial N = 0$, are:

$$N\frac{e'\left(\frac{w}{w_0}\right)}{w_0} F'\left(e\left(\frac{w}{G'(L-N)}\right)N\right) - N = 0 \tag{4}$$

$$\left[e\left(\frac{w}{w_0}\right) + e'\left(\frac{w}{w_0}\right)wN\frac{G''(L-N)}{G'(L-N)^2}\right]F'\left(e\left(\frac{w}{w_0}\right)N\right) - w = 0 \tag{5}$$

According to (4), the marginal benefit of adjusting wages is equalized with its marginal cost, which is the optimal condition for wage setting. According to (5), the firm hires labor up to the point where the marginal cost of labor is equal to its marginal revenue.

3. STRATEGIC EFFICIENCY WAGE AND THE SOLOW CONDITION

Given the competitive behavior for the secondary firm, we can now determine the optimal value for the efficiency wage. Since the condition $G'(L-N)=w_0$ holds, equation (5) can also be expressed as:

$$\left[e\left(\frac{w}{w_0}\right)+e'\left(\frac{w}{w_0}\right)\frac{w}{w_0}\frac{N}{L-N}\frac{G''(L-N)}{G'(L-N)}(L-N)\right]F'\left(e\left(\frac{w}{w_0}\right)N\right)-w=0 \qquad (6)$$

Using (4), the marginal productivity of the primary firm is such that:

$$F'\left(e\left(\frac{w}{w_0}\right)N\right)=\frac{w_0}{e'\left(\frac{w}{w_0}\right)} \qquad (7)$$

Let $\varepsilon\left(\frac{w}{w_0}\right)=\frac{e'}{e}\frac{w}{w_0}$ be the effort-wage elasticity; $\nu=-\frac{G''(L-N)}{G'(L-N)}(L-N)$ is the elasticity of the marginal productivity (wage) in the secondary sector; $\frac{N}{L-N}$ indicates the relative size of the primary firm in comparison with the secondary firm. Hence, we obtain the optimal strategic efficiency wage given in the following proposition.

Proposition 1. The effort-wage elasticity in a dual labor markets model is:

$$\varepsilon\left(\frac{w}{w_0}\right)=\frac{L-N}{L-N+\nu N} \qquad (8)$$

Proof: Using (6) and (7) and by rearranging some terms, we obtain:

$$\left[e\left(\frac{w}{w_0}\right)+e'\left(\frac{w}{w_0}\right)\frac{N}{L-N}\frac{G''(L-N)}{G'(L-N)}(L-N)\right]=e'\left(\frac{w}{w_0}\right)\frac{w}{w_0}$$

Then, we arrive at the following expression for the effort-wage elasticity:

$$\frac{e'\left(\frac{w}{w_0}\right)}{e\left(\frac{w}{w_0}\right)}\frac{w}{w_0} = \frac{1}{1 - \frac{G''(L-N)}{G'(L-N)}(L-N)\frac{N}{L-N}}$$

From the definitions of ε and ν, it follows that $\varepsilon(\frac{w}{w_0}) = (L-N)/(L-N+\nu N)$. QED

Corollary 1. The effort-wage elasticity in a Stackelberg equilibrium is less than one.

Thus, we provide formal proof that the Solow condition does not hold with dual labor markets. Indeed, the production function in the secondary sector is characterized by decreasing returns to scale, so that we have $\nu = -\frac{G''(L-N)}{G'(L-N)}(L-N) > 0$. Hence, $L - N + \nu N > L - N$ and this clearly implies $\varepsilon(w/w_0) < 1$. Therefore, our result can be treated as theoretical support for the argument developed in Akerlof and Yellen (1986), who argue that an effort-wage elasticity of unity is quite high. Given the production technologies, the effort-wage elasticity is less than one when one accounts for strategic interactions between the primary and the secondary sectors.

Proposition 1 has the following interpretation. We restrict our attention to the case of two levels of technology, high and low. An efficiency wage is implemented for the high-technology firm because of imperfect monitoring. Hence, high wages are paid in exchange of high amounts of effort. Workers participate only in one of the two firms (there is no unemployment). By playing a Stackelberg equilibrium, the primary firm can threaten the workers not to find a job in the high-technology sector, thereby leading to a lower wage for them in the firm with low technology. The lesson of our paper is that in such a setting, the effort-wage elasticity is lower than one. As a consequence, this creates an incentive for a manager to increase the wage level in the primary firm. For a high value of w, the level of employment in this sector is low and there is a shift of labor from the primary to the secondary sector, which decreases the value of w_0 (since $L-N$ is higher).

Let us now examine the special case of constant returns to scale in the secondary sector. The elasticity ν can also be written as $\nu = -\frac{w_0'(L-N)}{w_0(L-N)}(L-N)$ since $G'(L-N) = w_0$ and then $G''(L-N) = w_0'(L-N)$. Hence, ν corresponds to the elasticity of wage with respect to the level of employment in the secondary sector. When the secondary wage is not affected by the current size of labor in that sector, it is straightforward to prove that the Solow condition is restored.

Corollary 2. With constant returns of scale in the secondary sector, the effort-wage elasticity is equal to one.

Under constant returns, the condition $G''(L-N)=0$ holds. Since we can express the effort-wage elasticity $\varepsilon(\frac{w}{w_0})$ as $\varepsilon(\frac{w}{w_0}) = 1/(1+\nu N/(L-N))$, it follows that $\varepsilon(\frac{w}{w_0}) = 1$ when $\nu = 0$. Thus, the Solow condition holds when the primary firm is not in a position to influence the behavior of the secondary firm by changing its current level of wage.

4. ADDITIONAL ISSUES

Using a dual labor markets model, we have generalized the Solow condition and shown that the strategic efficiency wage was expected to be lower than one. We now study two additional cases, which prove that our analysis is quite general.

First, instead of assuming that effort depends on the wage in the primary sector relative to that in the secondary sector, one can suppose that workers compare the difference between the efficiency wage and the competitive wage in the effort function. This affects the aggregated effort function, which is now $e(w-w_0)$. The maximization program for a firm operating in the primary sector becomes:

$$\max_{w,N} \Pi = F\left[e\left(w - G'(L-N)\right)N\right] - wN \tag{9}$$

From the corresponding first-order conditions,

$$Ne'(w-w_0)F'\left[e(w-w_0)N\right] - N = 0 \tag{10}$$

and

$$\left[e(w-w_0) + NG''(L-N)e'(w-w_0)\right]F'\left[e(w-w_0)N\right] - w = 0 \tag{11}$$

we deduce the value of the optimal strategic efficiency wage.

Proposition 2. When the effort function depends on the difference between the efficiency wage and the competitive wage, the effort-wage elasticity is :

$$\varepsilon(w-w_0) = \frac{w - G'(L-N)}{w - NG''(L-N)} \tag{12}$$

Proof: From (11) and using $F'\left[e(w-w_0)N\right] = 1/e'(w-w_0)$ from (10), we get :

$$\left[\frac{e(w-w_0)}{e'(w-w_0)}+NG''(L-N)\right]=w$$

Hence, from the definition of the ratio $\frac{e'}{e}$ such that $\frac{e'(w-w_0)}{e(w-w_0)}=\frac{1}{w-NG''(L-N)}$, we deduce that $\varepsilon(w-w_0)=\frac{w-G'(L-N)}{w-NG''(L-N)}$ since the condition $w_0=G'(L-N)$ holds, with $\varepsilon(w-w_0)=\frac{e'(w-w_0)}{e(w-w_0)}(w-w_0)$ the elasticity of effort with respect to wage. QED

In this context, we find again that the Solow condition is not valid since we have $\varepsilon(w-w_0)<1$ given the concavity of the production function G ($G''<0$). When accounting for the difference between w and w_0 in the effort function, the primary firm will set its wage offer at a level where the elasticity of effort with respect to wage is strictly less than unity. Let us now study the special case of constant returns of scale.

Corollary 3. With constant returns of scale and when the effort function depends on the difference between the efficiency wage and the competitive wage, the effort-wage elasticity is lower than one.

With the additional restriction $G''=0$, we easily obtain the effort-wage elasticity such that $\varepsilon(w-w_0)=1-w_0/w$. Thus, both the preferences of workers and the nature of technology within both sectors matter for the relevance of the Solow condition. While the primary firm is expected to increase its current wage when preferences are defined by

$\varepsilon(w - w_0)$, there is conversely no incentive to improve wages when workers compare the ratio between the efficiency wage and the competitive wage in the effort function. So, our analysis points out that policy wages may be strongly affected by the psychology of workers, reflected by the form of the effort function[3].

A second investigation concerns the form of the production function. Indeed, Akerlof and Yellen (1986: 14-15) claim that the Solow condition depends on a production function of the sort $F(eN)$ and mention that other plausible production functions are expected to have a lower wage-equilibrium wage elasticity. In the efficiency wage literature, it is known that the Solow condition may be invalid if a general production function $F(e, N)$ is taken into account (see Rasmaswamy and Rowthorn, 1991). We also prove that the strategic efficiency wage can be greater, equal or lower than the standard one.

Let us consider a production function of the sort $F(e, N)$ in the primary sector, with output as a function with separate arguments e (effort) and N (employment). The maximization program for the primary firm is now:

$$\max_{w,N} \Pi = F\left(e\left(\frac{w}{G'(L-N)} \right), N \right) - wN \tag{13}$$

The corresponding first-order conditions may be expressed as:

$$\frac{e'\left(\frac{w}{w_0} \right) F_e}{w_0} - N = 0 \tag{14}$$

$$e'\left(\frac{w}{w_0} \right) w \frac{G''(L-N)}{G'(L-N)^2} F_e + F_N - w = 0 \tag{15}$$

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3 For related issues on consumption behaviors, see Clark and Andrew (1998).

with $F_e = \partial F / \partial e$ and $F_N = \partial F / \partial N$. We now find a more complex solution for the effort-wage elasticity. Let $\xi_e = eF_e / F > 0$ and $\xi_N = NF_N / F > 0$ be the elasticity of the production with respect to effort and employment in the primary sector.

Proposition 3. For a production function of the type $F(e, N)$, the optimal value for the strategic efficiency wage is given by:

$$\varepsilon\left(\frac{w}{w_0}\right) = \frac{\xi_N}{\xi_e}\frac{L-N}{L-N+\nu N} \tag{16}$$

Proof: From (14), we have $we' F_e / w_0 = Nw$. Using (15) and after some manipulations, we obtain the following equality:

$$\frac{e'}{e}\frac{w}{w_0}\frac{G''(L-N)}{G'(L-N)}N + \frac{N}{e}\frac{F_N}{F_e} = \frac{e'}{e}\frac{w}{w_0}$$

We finally deduce that the strategic efficiency wage is such that:

$$\frac{e'\left(\frac{w}{w_0}\right)}{e\left(\frac{w}{w_0}\right)}\frac{w}{w_0} = \frac{N\frac{F_N}{F}}{e\frac{F_e}{F}}\frac{1}{1-\frac{G''(L-N)}{G'(L-N)}(L-N)\frac{N}{L-N}}$$

Given the definitions of ξ_N, ξ_e and ν, this proves proposition 3. QED

Corollary 4. The value of effort-wage elasticity is given by the following equivalence:

$$\varepsilon\left(\frac{w}{w_0}\right) <> 1 \Leftrightarrow \frac{\xi_N}{\xi_e} <> 1 + \nu\frac{N}{L-N} \tag{17}$$

We now find that in a dual labor markets model with a production function of the sort $F(e,N)$, the effort-wage elasticity can be lower, equal or greater than one. The Solow condition can hold only when the condition $(\xi_N - \xi_e)/\xi_e = \nu N/(L-N)$ is satisfied. Thus, the Solow condition is likely to be invalid with a general production function. In fact, this finding is not really surprising for the strategic efficiency wage, since a same result is reached in the absence of dual labor markets[4].

We can finally interpret the previous result. Let us consider the case where there exist high wage levels in the primary sector. When ξ_N is low in comparison with ξ_e, a low level of employment is expected in the primary sector and it is in the interest of the firm to set a high wage value. Conversely, when the value of ξ_N exceeds that of ξ_e, this means that the production function is not really sensitive to the workers' level of effort. Hence, more labor is needed in the primary sector and the level of wage is set at a low value in that sector. In that case, it is useless to provide incentives for primary workers to work hard.

5. POLICY IMPLICATIONS

An additional comment concerns the public policy implications of the strategic efficiency wage. Indeed, our dual labor markets analysis provides a new explanation concerning the presence of a minimum wage in the labor market. While the low-technology firm in the secondary sector is characterized by a wage that depends on its marginal

[4] When ν=0 (there are no dual labor markets), we obtain exactly the result of Rasmaswamy and Rowthorn (1991) that the effort-wage elasticity $\varepsilon(w/w_0)$ is higher (respectively lower) than 1 when ξ_N/ξ_e>(<)1.

productivity, the minimum wage is absolutely not affected by the structure of employment. In that case, it is straightforward to prove that the Solow condition holds.

Using the definition of the effort-wage elasticity $\varepsilon\left(\frac{w}{w_0}\right)=\frac{L-N}{L-N+\nu N}$, we deduce that the optimal wage in the primary sector can be expressed as $w=w_0+\varepsilon^{-1}\left(\frac{L-N}{L-N+\nu N}\right)$. Now, let us denote by $\overline{w}$ the minimum wage. Thus, there are two cases depending on the comparison between $\overline{w}$ and w_0. First, when one supposes that $\overline{w}>w_0$, the objective of the primary firm is to maximize the profit function :

$$\max_{w,N}\Pi=F\left[e\left(w/\overline{w}\right)N\right]-wN \tag{18}$$

From the corresponding first-order conditions,

$$\frac{e'}{\overline{w}}F'\left(e\left(\frac{w}{\overline{w}}\right)N\right)-1=0 \tag{19}$$

and

$$e\left(\frac{w}{\overline{w}}\right)F'\left[e\left(\frac{w}{\overline{w}}\right)N\right]-w=0 \tag{20}$$

it follows that the effort-wage elasticity is such that :

$$\varepsilon\left(\frac{w}{\overline{w}}\right)=1 \tag{21}$$

So, the public authority can prevent the primary firm characterized by leadership to influence the wage level in the low-technology firm. Then, the Solow condition is restored in the case of dual labor markets when a minimum wage exists, at least when the minimum wage exceeds the wage level in the secondary sector. Conversely, when the inequality $\overline{w} \le w_0$ holds, the effort-wage elasticity remains strictly lower than one and the public authority cannot affect the wage policy in the primary sector.

6. CONCLUSION

In this paper, we have presented a dual labor markets model with efficiency wage. Considering a Stackelberg equilibrium in which the primary sector acts as a leader and the secondary sector as a follower, we show that the Solow condition does not hold in general and an effort-wage elasticity lower than one is expected. This theoretical result puts in perspective the intuition presented in Akerlof and Yellen (1986) and indicates that it is important to account for the strategic aspects between sectors in the labor market when examining efficiency wage, both from a theoretical and empirical viewpoint. Finally, a government may restore the Solow condition in a dual labor markets by setting a minimum wage when it exceeds the current wage in the secondary sector.

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