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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, question 4, pp. 14–16) 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 an 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-Sørensen (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 which 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 worker performance. This is the explanation of dual labor markets given by Bulow and Summers (1986), based on the Shapiro and Stiglitz (1987) 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].

We assume that wage differences between sectors stem from the presence of efficiency

[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, chapter 5) for an empirical survey.

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. In section 3, we determine the strategic efficiency wage and examine the relevance of the Solow condition. Concluding comments are in section 4.

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, 2001). 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, p. 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 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 which leads to a strategic efficiency wage. The

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

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 :

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

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 are :

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

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

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 :

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

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

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

Let $\epsilon(\frac{w}{w_0}) = \frac{e'}{e}\frac{w}{w_0}$ 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 :*

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

Proof : Using (6) and (7), and by rearranging some terms, 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, we deduce that $\epsilon(\frac{w}{w_0}) = (L-N)/(L-N+\nu N)$. QED

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

Thus, in this framework, we provide formal proof that the Solow condition does not hold with dual labor markets. Indeed, the production function 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 clearly $\epsilon(\frac{w}{w_0}) < 1$. 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[3].

[3] With a production function of the sort $F(e, N)$, there is not necessarily a lower equilibrium effort-wage elasticity. This result is standard in the efficiency wage literature (see Ramaswamy and Rowthorn,

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 (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. There is 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).

4 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

1991). In the dual labor market case, the strategic efficiency wage is :

$$\epsilon\left(\frac{w}{w_0}\right) = \frac{\xi_N}{\xi_e}\frac{1}{1+\nu\frac{N}{L-N}}$$

where $F_e = \partial F/\partial e$ and $F_N = \partial F/\partial N$ are elasticities of production with respect to effort and employment in the primary sector. Thus, $\epsilon\left(\frac{w}{w_0}\right)$ is greater (respectively lower) than one when the inequality $\frac{\xi_N}{\xi_e} > 1+\nu\frac{N}{L-N}$ holds (respectively $\frac{\xi_N}{\xi_e} < 1+\nu\frac{N}{L-N}$).

examining efficiency wage, both from a theoretical and empirical viewpoint.

In addition, the dual labor markets model with efficiency wage provides a new explanation concerning the presence of a minimum wage in the labor market. While the low-technology firm is characterized by a wage which depends on its marginal productivity, the minimum wage is not affected by the structure of employment. Thus, by setting a minimum wage, the public authority prevents the firm characterized by leadership to influence the wage level in the low-technology firm. It follows that the Solow condition is restored in the case of dual labor markets when a minimum wage exists.

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