

Efficiency wages and endogenous supervision technology

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Abstract: Analyses about supervision technology are not frequent in economic literature. This paper analyses an efficiency wage model with an endogenous choice of supervision technology. Starting from Shapiro and Stiglitz (1984) and Bowles (1985) models’ I show a model with an endogenous and costly supervision technology to better explain the behaviour of firms and workers under asymmetric information in the labour market. In particular, I show how firms allocate costs between wages and supervision under these hypotheses and how unemployment affects this distribution.

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1. Introduction

The empirical literature about the labour market shows the existence, in many cases, of wages persistently above the market-clearing level and, consequently, of involuntary unemployment. A classical example of high wages is showed by Bulow and Summers (1986) for the Ford Motor Company. Among the theoretical explanations of this phenomenon suggested recent years, a promising approach is represented by the efficiency wages theory, in particular the shirking models, where individual utility is positively related to the received income, due to wages or unemployment benefits, and negatively related to the effort level.

The most important hypothesis of those models is the presence of incomplete information about the effort level of workers for the firms. Firms must offer higher wages to workers to induce them not to shirk.

This paper presents an efficiency wage model with an endogenous choice of the supervision technology. The second section briefly reviews some representative models in this literature. Section 3 presents a generalisation of the Shapiro and Stiglitz model (1984) with an endogenous supervision technology. Section 4 illustrates, graphically, the relation between the employment level and the supervision level. In the end, in section 5, we point to some general conclusions.

2. A critical analysis of the review

Many theoretical works developed in recent years can be considered shirking models. What follows is not intended to be an exhaustive survey of these models but merely serves as a starting point to develop the model illustrated in the next section.

The article by Shapiro and Stiglitz (1984) probably represents the most important contribution to efficiency wages theory. In fact, many subsequent analyses were developed starting from this work.

The two writers, starting from the assumption that firms have only incomplete information about the effort level of workers, Shapiro and Stiglitz show the impossibility of a full-employment equilibrium. In their model, it is not possible to have a positive effort level if a fired worker is immediately rehired by another firm at the same wage.

Comparing the expected utility of a non-shirking worker with the expected utility of a shirker, we can see that for a firm to extract the positive level of effort, the wage level must be increased so as to create an incentive for its employees and, at the same time, a penalty for unemployed.

This yields an equation called no-shirking condition (NSC). The NSC shows, for each employment level, the efficiency wage at which workers choose not to shirk. Equilibrium, in this market, occurs where the aggregate demand for labour intersects the NSC. In this case, the equilibrium wage is higher than the market-clearing wage and we need a positive unemployment rate for the labour market to function under incomplete information.

Calvo's model (1985) can be used to confirm the results of Shapiro and Stiglitz, even if it starts from different assumptions. Calvo uses a supervision technology which is a function of the number of employees hired by a firm (with decreasing returns to scale), whereas Shapiro and Stiglitz use an exogenous probability of supervision. In my opinion, the supervision technology in Shapiro and Stiglitz is too simple. Even in Calvo, however, the supervision technology has a limit, because it is not costly and we can't use it to minimize the cost function.

Bowles (1985) wants to show another way to analyse the production process. He defines his model "Marxian", in contrast with the neoclassical one, that presents no analysis of the internal social organisation of firms, and with the neo-Hobbesian model (represented by Shapiro and Stiglitz and Calvo). Nevertheless, in my opinion, the neo-Hobbesian approach and the Marxian one are similar, despite the differences between the concepts of shirking and social classes. In fact, Bowles's analysis, expressed in terms of class conflicts, can be redefined in terms of individual utility to yield the same conclusions. Therefore we can consider the model of Bowles as a shirking model, even if this is not true for some extensions, for instance when the author speaks about the general institutional environment.

This article is very interesting for my purposes because it uses a costly supervision technology. In fact, Bowles introduces a price for supervision, and so we can introduce it in the cost function to minimize the firm's costs.

These three articles do not add up a general model of the efficiency wages theory. Shapiro and Stiglitz and Calvo have a particular supervision technology which is not costly, while the model of Bowles, even if it embodies a refined supervision technology, can't be strictly considered a shirking model.

The next section outlines a shirking model with endogenous supervision technology.

3. The model

In this paper I want to propose a generalisation of the Shapiro and Stiglitz model. I want to show how wage and employment levels vary with an endogenous supervision technology.

Shapiro and Stiglitz set forth an efficiency wages model in which the no-shirking condition, NSC, is:

$$w = e + w' + \left(\frac{e}{q} \right) \left(\frac{bN}{N-L} + r \right) \quad (1)$$

where:

w is the efficiency wage;

e is the effort level (with $e=0$ if the worker shirks and $e>0$ if the worker does not shirk);

q is the probability of being detected shirking;
 b is the job separation rate;
 N is the fixed supply of identical workers;
 L is the number of employed workers;
 r is the interest rate;
 w' is the unemployment benefits.

Here the probability of being detected shirking (i. e., the supervision technology) is exogenous and firms cannot modify it. I want to introduce an endogenous supervision technology, with a positive market price, as proposed by Bowles. In this case, firms can choose the desired level of supervision to minimize their labour cost.

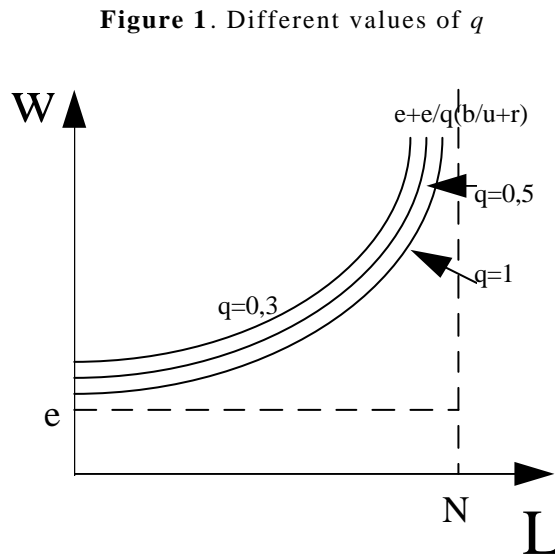
I assume that q is a function of the quantity of supervision chosen by the firm, S , $q=f(S)$, with $q=0$ if $S=0$ and $\lim_{S \rightarrow \infty} q=1$.

Moreover, I assume that supervision, S , has a market price $p_S=1$. It means that supervision has a positive cost if $q>0$, knowing that $w=\infty$ if $q=0$. Furthermore, unlike in Bowles, there is a maximum limit to the value of q , $\lim_{S \rightarrow \infty} q=1$, and so we can never arrive at complete information about the effort level of workers. With these assumptions $f'(S)$ is positive and decreasing.

For simplicity, let us now restate the NSC with $w'=0$. Equation (1) becomes:

$$w = e + \left(\frac{e}{q} \right) \left(\frac{bN}{N-L} + r \right) \quad (2)$$

which is a map of curves associated with different values of q . We define u , the unemployment rate, as $\frac{N-L}{N}$, with $L \leq N$; figure 1 represents equation (2) with three different values of q .



Equation (2) can be reinterpreted as a relation between the efficiency wage, w , and the probability q for each level of employment and for given values of parameters e , b and r .

The efficiency wage has a fixed part, e , and a variable part that we show below. We can rewrite equation (2) as:

$$w = e + \left(\frac{e}{q}\right)\left(\frac{b}{u} + r\right) \quad (3)$$

where e is the fixed part and $(e/q)(b/u + r)$ is the variable one. Equation (3) represents the relation between wage and quantity of supervision: if q increase w decrease.

Let us now consider supervision costs. With $p_s=1$, this cost is

$$C_s = p_s S = S \quad (4)$$

and this value is determined by the probability q chosen by firms. Firms will choose the value of q to minimize the costs, for given values of e , b , L and r .

Define $C=w+S$ as the total cost of a worker for a firm. Using equation (3), this total cost becomes:

$$C = e + \left(\frac{e}{q}\right)\left(\frac{b}{u} + r\right) + S \quad (5)$$

We can write the costs minimization solution as:

$$C = \min_q (w + S) \quad (6)$$

Figure 2. Costs minimization with endogenous q

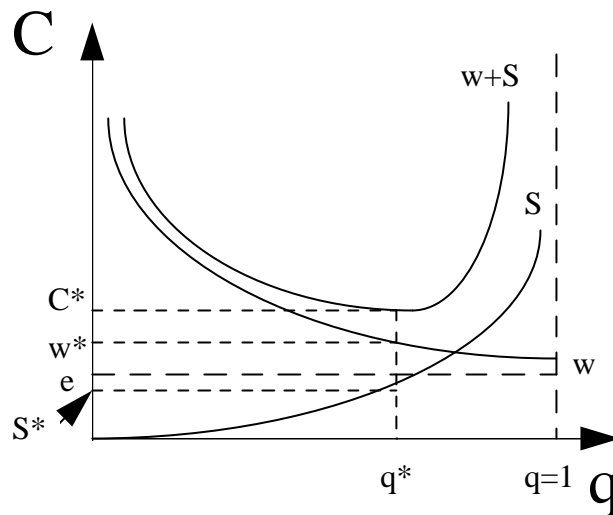


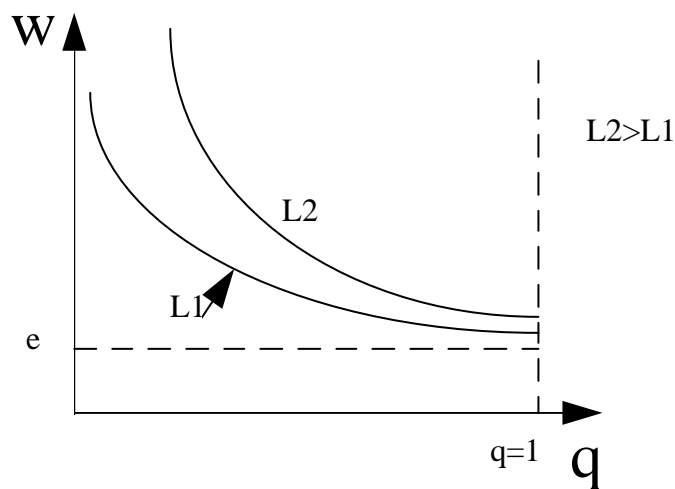
Figure 2 shows the equilibrium when firms minimize costs using w and S . We can see that figure 2 shows the values of q^* , w^* , S^* e C^* .

4. Supervision and employment level

The previous sections illustrates the relation between q and total worker cost for the firm with its two components S and w . Now, I want to show how q^* varies when L varies. It turns out that an increase in L increase the slope (in absolute value) of the wage curve for every level of q .

Figure 3 shows what happens to the wage curve, w , taken from Figure 2, with two different values of L .

Figure 3. Employment level and supervision



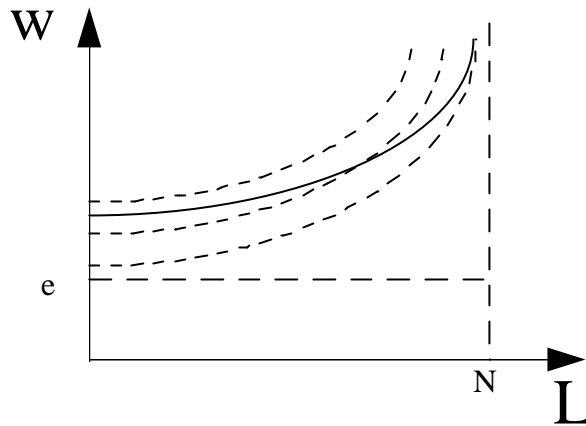
With a higher value of L , we have a lower unemployment rate and so firms must pay an higher wage to convince workers not to shirk for every level of q .

We can see that an increase of q generate a higher decrease of w in the curve where the L level is higher. Firms will choose a higher value of q if L increase because an increase in q lowers the wage cost more than it increases the supervision cost.

We may note that the NSC chosen by the firms will not have a fixed value of q^* . In fact, they will choose a higher value of q^* when L increase by applying the cost-minimizing condition (6).

Figure 4, derived from the map of curves showed in Figure 1, depicts the NSC that embodies the different values of q optimally chosen as L changes.

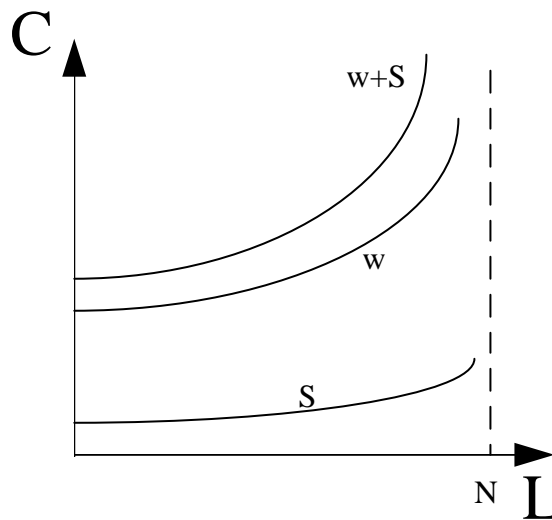
Figure 4. Optimum NSC



In Figure 4 the three dashed curves represent different NSC with constant values of q . The other curve represents the optimum NSC, with a higher value of q as L increases.

Going back to Shapiro and Stiglitz, we can now equal the aggregate labour demand to the marginal cost of labour, represented by $w+S$. Figure 5 shows how w and S change with the employment level.

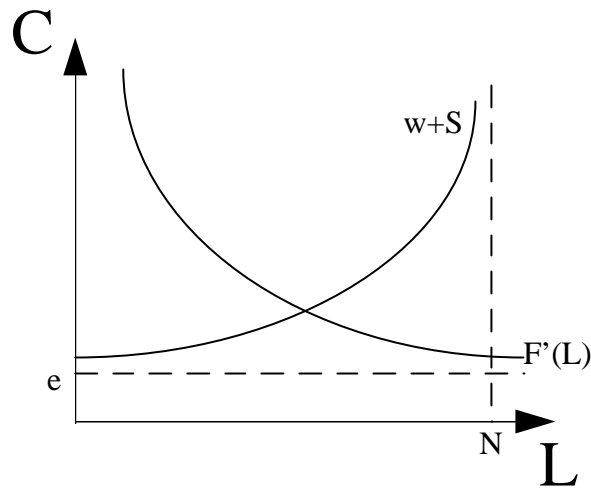
Figure 5. Worker cost



The total worker cost is represented by the sum of w , the efficiency wage, and S , the supervision cost. Supervision cost increases as L increases because we showed that firms will demand a higher level of q^* .

Figure 6 shows how firms equal their generic labour demand, $F'(L)$, to the worker cost, yielding labour market equilibrium.

Figure 6. Market equilibrium



We may conclude that, if firms can control the probability q to detect shirkers, they will spend part of their revenues to buy supervision. If the unemployment rate is high, they will spend only a small fraction of revenues on supervision and viceversa. In our model, the labour cost is influenced by supervision costs and this sets a limit to the hiring of workers.

5. Conclusions

A model built on Shapiro and Stiglitz's with an endogenous and costly supervision technology can help us to better explain the behaviour of firms and workers under asymmetric information in the labour market.

Defining an endogenous and costly probability of being detected shirking has several implications on the labour market. The firm chooses its level of q on the basis of the supervision cost, but is also influenced by the number of employed workers and, consequently, by the unemployment rate. With a higher supervision cost, the firm will choose a lower quantity of supervision, while with a lower unemployment rate the firm will choose a higher level of q and a higher expenditure on supervision. This means that with lower unemployment workers receive a lower wage increase as compared to the case of exogenous supervision technology.

These conclusions highlight the importance of an endogenous supervision technology for a generalisation of the model of Shapiro and Stiglitz. However, this is only a first step. A promising direction for further research would be to develop a model with a supervision technology in which the number of employees in a firm is relevant. In particular, It would be interesting to assume a decreasing marginal quantity of supervision needed to monitor the last worker for each level of q .

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