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A labor-adverse selection model of reducing working time

Abstract: *This paper proposes a labor-adverse selection model where labor quality within an individual firm negatively depends upon the average working hours in the market. Under this setting, labor quality is a "pure public good" by nature, and the free market equilibrium will result in inefficient allocation with underprovision. We show that shorter workweek regulations will increase the provision of the public good (labor quality), and the higher labor quality will increase firms' profits and employment. Shorter workweek regulations may therefore increase the firms' profits as well as the workers' employment and bring about a Pareto improvement.*

Key words: *efficiency wage of adverse selection, minimum wages, working hours.*

The imposition of a fixed working week was first established by the British Parliament around 1890 (Cross, 1989). Nowadays, similar regulations exist in most economies of the Western world (Contensou and Vranceanu, 2000). In order to reduce unemployment, the notion of reducing working hours to share work has been widely debated and even implemented in several countries (Hunt, 1998). The potential employment effect of a reduction in working hours has been extensively analyzed from various viewpoints, but no determinate conclusion has been reached. For example, some of the previous analyses point out that the employment effects depend on the type of unemployment, the type of production function, the wage behavior, the short- or long-run analysis, overtime work, as well as other factors.[1]

This article investigates the policy implications of a legislated reduction in hours in a labor-adverse selection model. The key feature of this model is that the labor quality within an individual firm is negatively

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[1] See the relevant references cited in Calmfors (1985). For a systematic and integrated analysis regarding work sharing, see Hart (1987).

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dependent upon the average working hours in the market. Our setting is closely related to the labor-adverse selection models of Weiss (1980) and Drazen (1986).

Weiss (1980) considers a model in which workers are heterogeneous in terms of ability, and ability and reservation wages are positively correlated. Imperfect information concerning the abilities of workers provides a rationale for firms to offer higher wages in order to attract more able job candidates. This leads to a positive relationship between labor quality/productivity and wages, which is central to the efficiency wage hypothesis. Weiss assumes that labor quality within an individual firm is determined solely by the firm's own wage offer. He shows in this environment that firms may set wages above the market-clearing levels, causing equilibrium unemployment.

In an innovative paper, Drazen (1986) extends the Weiss model to a world in which labor quality within an individual firm does not depend on its own wage offer, but rather on the average wage in the market. He argues that since higher wages can attract more able workers into a market, the market wage preferred by the firms as a whole may exceed the wage that clears the labor market. However, individual firms are atomistic, taking quality as being given and completely independent of their wage offers. As a result, each firm has an incentive to undercut the wage to the market-clearing level, in an attempt to reap the quality benefits of high average wages while paying lower wages itself. The free rider problem opens a possible role for the imposition of minimum wages. Drazen demonstrates that minimum wage legislation may achieve an equilibrium Pareto superior to the competitive equilibrium.[2]

In this paper, we extend the Drazen model to incorporate working time so that labor quality within an individual firm depends both upon the average working hours and the average wage in the market. To attract more able job candidates into a market, it seems plausible that not only the average wage but also the average working hours in the market matter. Labor quality here is a "pure public good" by nature since it is impossible to exclude the benefit from a firm and the same benefit is

[2] A possible problem with Drazen's model, as pointed out by Perri (1990), is that the market wage preferred by firms will be the wage that clears the market. This outcome results because workers in the Drazen model are assumed to maximize expected income (the average wage times the probability of being employed). Since wages that are lower than the market-clearing level are not viable, free riding by individual firms will not be a problem, and hence there will be no role for minimum wages. Perri (1990) notes, however, that the case for minimum wages can be restored if workers are assumed to maximize a concave utility function rather than expected income.

available to all the firms. It is well documented that voluntary contributions to public goods typically result in inefficient allocation with underprovision. Under this setting, we demonstrate that the introduction of working time regulations will increase the provision of the public good (labor quality), and the higher labor quality will increase firms' profits and encourage them to expand their employment. By improving the welfare of the firms through higher profits and that of workers through increased employment, a shorter workweek proposal has the possibility of resulting in a Pareto improvement.

A model of adverse selection

Consider a market in which many identical firms hire workers to produce a single good. The price of the good is taken to be the numeraire and is normalized to unity. A representative firm is assumed to face the following program:[3]

$$\max_{l,h,w} \quad \pi = F\left(\bar{q}(W,H)hl\right) - wl, \tag{1}$$

where π is the profit function of the firm; $F(\cdot)$ is the production function with $F' > 0$, $F'' < 0$; $\bar{q}(\cdot)$ is the expected or average labor quality of the firm's labor force with $\bar{q}_W > 0$, $\bar{q}_H < 0$, $\bar{q}_{WW} < 0$, $\bar{q}_{HH} < 0$; l is the number of workers employed by the firm; W is the average wage in the market; w is the wage paid by the firm; H is the average working hours in the market; and h is the working hours in the firm.

Weiss (1980) argues that, in the presence of adverse selection, labor quality at a firm depends positively upon its own wage offer. Drazen (1986) extends the Weiss model by replacing "its own wage offer" with "the market average wage," so that there is a positive relationship between labor quality within a firm and the average wage in the market. Decisions regarding whether or not to enter a labor market are likely to depend upon the average wage in the market. Drazen gives two examples in this regard: migration into labor markets and the choice of which profession to enter at the beginning of the education process.[4] Workers

[3] Due to the concavity of the production function and the sampling of workers by the firm, Equation (1) is an approximation rather than exact; see Weiss (1980) for the detail.

[4] Causal evidence strongly supports this argument. For example, many of the best high school students intend to enter those university departments with the best prospects of getting higher pay in the future. The better the prospects of a city, the more citizens it will attract in the pursuit of higher expected wages.

may also move between jobs and accept job offers from other firms in the same market. The average wage in a labor market is relevant to worker decisions with regard to which market to enter in this context. Following the same logic, it seems plausible that not only the average wage but also the average working time in the market matters in attracting more able job candidates into the market. Equation (1) represents a straightforward extension of the Drazen model by incorporating this possibility. To be specific, it is assumed that not only higher wages but also fewer working hours in a market will contribute positively to labor quality within an individual firm by attracting more able job candidates into the market.

It should be noted that the job offered by the firm in Equation (1) is in terms of a tied package of the wage compensation, w, and the working hours, h, rather than an hourly wage rate allowing workers to unilaterally determine hours. This setting is consistent with the casual observation that jobs as a rule appear to be associated with constrained or fixed hours. The standard 9-to-5, 40-hour workweek, is the most obvious example.[5]

The Drazen analysis

Individual firms are assumed to be atomistic, as in Drazen (1986). This assumption implies that individual firms will regard labor quality as given and completely independent of their own wage-hour offers. To be comparable with the Drazen model, let us first fix hours of work exogenously in Equation (1). Then the first-order conditions with respect to l and w are:

$$\pi_l = \overline{q}\left(W,H\right)hF'\left(\overline{q}\left(W,H\right)hl\right) - w = 0, \tag{2}$$

$$\pi_w = -l < 0. \tag{3}$$

The second-order condition associated with Equation (2) is assumed satisfied. Equation (2) is the usual marginal condition in relation to employment. It states that a profit-maximizing firm expands its labor force to the level at which the marginal revenue product of labor ($\overline{q}hF'$) equals the marginal cost of labor (w). The firm behavior described by Equation (3) is due to the fact that individual firms are atomistic and so take labor

[5] In the presence of working time regulations, countries like Taiwan impose minimum wages on the compensation per workweek rather than on hourly wage rates.

quality to be given exogenously. As a result of Equation (3), wages will be driven to the market-clearing level. However, the firms in the market as a whole would like to offer the wage ($W = w$), satisfying

$$\pi_w = \bar{q}_w\left(w,H\right)hlF'\left(\bar{q}\left(w,H\right)hl\right) - l = 0, \tag{4}$$

or, more precisely, satisfying

$$\frac{\bar{q}_w\left(w,H\right)\cdot w}{\bar{q}\left(w,H\right)} = 1, \tag{5}$$

where we have substituted Equation (2) in Equation (4). The wage in Equation (5) minimizes the cost per unit of effective labor, $w/\bar{q}(w,H)$, and so is known as the *efficiency wage* in efficiency wage models. There is therefore a role for minimum wage legislation as long as the *preferred* wage satisfying Equation (5) differs from the *equilibrium* market-clearing wage prescribed by Equation (3). This is basically the argument for imposing minimum wages in Drazen (1986). He in fact proves that minimum wage legislation may achieve an equilibrium Pareto superior to the competitive equilibrium.

A reduction in working time

Now we are ready to analyze the employment effect of a shorter workweek. Due to space limitations and in order to highlight our insights in the simplest way, we will focus only on the direct employment effect stemming from the impact of a shorter workweek on the firms' labor quality and profits. We thus consider an economy in which the minimum wage legislation has been imposed to ignore the indirect employment effect arising from the impact of a reduction in working time on the equilibrium wage. In other words, we will start our analysis from where Drazen left off. In many countries, legislation interferes with employment by imposing restrictions not only on what wages can be paid (minimum wage legislation) but also on how long the workweek can be (working time regulations).

Now we take the number of working hours into consideration. Suppose that minimum wage legislation has been passed, imposing $w = \bar{w}$ so that the first-order conditions associated with l and h from Equation (1) become

$$\pi_l = \bar{q}\left(\bar{w},H\right)hF'\left(\bar{q}\left(\bar{w},H\right)hl\right) - \bar{w} = 0, \tag{6}$$

$$\pi_h = \bar{q}\left(\bar{w},H\right)lF'\left(\bar{q}\left(\bar{w},H\right)hl\right) > 0. \tag{7}$$

The second-order condition associated with Equation (6) is assumed satisfied. We examine whether the introduction of working time regulations may result in a Pareto improvement over the minimum wage legislation.

From Equation (7), we see that the representative firm will increase the number of work hours to the maximum level feasible.[6] This is again due to the fact that individual firms are atomistic and hence regard labor quality as exogenously given. However, the firms in the market as a whole would like to offer workers the work hours ($H = h$), satisfying

$$\pi_h = \left[\bar{q}_h\left(\bar{w},h\right)h + \bar{q}\left(\bar{w},h\right)\right]lF'\left(\bar{q}\left(\bar{w},h\right)hl\right) = 0. \tag{8}$$

Note that $\pi_{hh} = (\bar{q}_{hh} + 2\bar{q}_h)lF' < 0$ since $\bar{q}_{hh} < 0$, $\bar{q}_h < 0$, and $F' > 0$ according to our assumptions. Let us denote the maximal working hours derived from Equation (7) by $h^{\max}$ and the optimal working hours satisfying Equation (8) by h^*. It is clear in Figure 1 that h^* may be strictly less than $h^{\max}$. This gives rise to the possibility of imposing working time regulations to achieve a further Pareto improvement. In what follows, we prove this possibility.

Consider the introduction of a binding working hour regulation $h = \bar{h}$ and its imposition upon the binding minimum wage legislation $w = \bar{w}$. The representative firm then faces the following program:

$$\max_{l} \quad \pi = F\left(\bar{q}\left(\bar{w},\bar{h}\right)\bar{h}l\right) - \bar{w}l. \tag{1'}$$

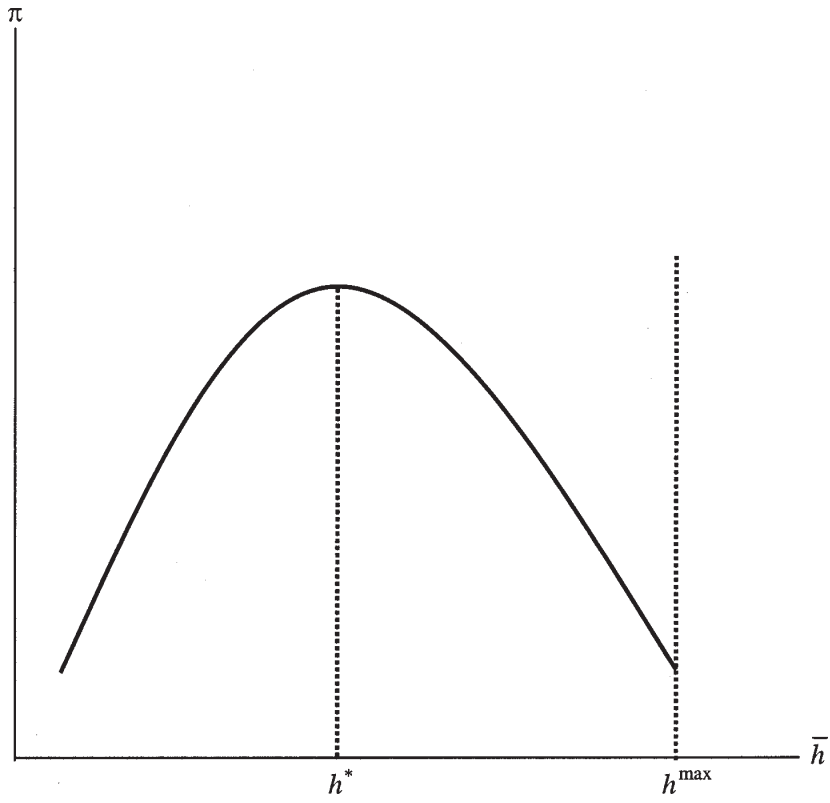
Applying the envelope theorem to the above program yields

$$\pi_{\bar{h}} = \left[\bar{q}_{\bar{h}}\left(\bar{w},\bar{h}\right)\bar{h} + \bar{q}\left(\bar{w},\bar{h}\right)\right]lF'\left(\bar{q}\left(\bar{w},\bar{h}\right)\bar{h}l\right). \tag{8'}$$

Note that the functional form of Equation (8′) is identical to that of Equation (8). Figure 1 illustrates the relationship between the profit π and the working hour regulation $\bar{h}$ for an individual firm. The relationship takes the form of an inverted U-shape, with the maximum occurring at $\bar{h} = h^*$. It is clear from Figure 1 that, as long as $h^* < \bar{h} < h^{\max}$, the working time

[6] This maximum level may be the legislated standard hours or the hours for which the worker's participation constraint is binding.

Figure 1 The maximum and optimal working hours



regulation designed to reduce work hours from the maximum level $h^{\max}$ will enhance the representative firm's profit (since $\pi_{\bar{h}} < 0$).

We next prove that working hour regulations may enhance worker welfare as well. With the binding minimum wage $w = \bar{w}$ and the binding working hour regulation $h = \bar{h}$, the employment is determined by

$$\pi_l = \bar{q}\left(\bar{w},\bar{h}\right)\bar{h}F'\left(\bar{q}\left(\bar{w},\bar{h}\right)\bar{h}l\right) - \bar{w} = 0. \tag{9}$$

The comparative statics from Equation (9) yields

$$\frac{\partial l}{\partial \bar{h}} = -\frac{\left(\bar{q}_{\bar{h}}\bar{h} + \bar{q}\right)\left(F' + \bar{q}\bar{h}lF''\right)}{\bar{q}^2\bar{h}^2F''}. \tag{10}$$

It is assumed that the term $F' + \bar{q}\bar{h}lF''$ in Equation (10) is positive. A similar inequality has been employed by Pisauro (1991) and others, and

it holds under the popular production function $F(x) = x^a$ $(0 < a < 1)$ as in Akerlof and Yellen (1985). If $h^* < \bar{h} < h^{\max}$, then the inequality $\bar{q}_{\bar{h}}(\bar{w},\bar{h})\bar{h} + \bar{q}(\bar{w},\bar{h}) = \pi_{\bar{h}}/lF' < 0$ will hold. As a result, the sign of Equation (10) is negative. This implies that working time regulations designed to reduce work hours from $h^{\max}$ will increase the firms' profits and induce them to expand their employment. Because working time is reduced and employment is increased, it seems fair to say that worker welfare is increasing rather than decreasing as a result of imposing working time regulations. Combined with the above result of increasing profits, we thus conclude that the introduction of working hour regulations may result in a Pareto improvement over the minimum wage legislation.

Intuitively, labor quality in our setting is a "pure public good," and the free market will naturally lead to the equilibrium with underprovision. Thus, it is not surprising that the introduction of working time regulations will increase the provision of the public good (labor quality), and the better labor quality will raise firms' profits and encourage them to expand their employment. Therefore, the shorter workweek regulation may improve the profits of the firms as well as the welfare of workers by increasing employment and result in a Pareto improvement.

Concluding remarks

A key assumption in Drazen's model or in our extension of the Drazen model is that labor quality within an individual firm is determined by the average behavior of the firms in the market. Labor quality here is a "pure public good" by nature since it is impossible to exclude the benefit from a firm and the same benefit is available to all the firms without "consumption rivalry." In this setting, offering wages above the market-clearing level or reducing work hours below the maximum level feasible is like a voluntary contribution to the provision of public goods. It is well known that voluntary contributions to public goods typically result in inefficient allocation with underprovision (Cornes and Sandler, 1996). Such a suboptimal outcome is mainly due to the free rider problem: each agent considers only his own benefit and ignores the benefits accruing to other agents from his contribution. It is also well known that a voluntary contribution to the provision of public goods is likely to become more problematic as the number of agents in question gets larger. Individual firms are assumed to be atomistic in both Drazen's and our model. This is basically equivalent to assuming that the number of firms in the market is infinite. As such, it is not surprising to find that, without legislation or regulations, there will be no voluntary provision of public goods

by individual firms so that wages will be driven to the market-clearing level and work hours will be set at the maximum feasible in equilibrium.

The crucial assumption in our model is that labor quality within a firm depends positively upon the average wage but negatively upon the average working hours in the market. As in Weiss (1980) and Drazen (1986), imperfect information plays a key role here. A basic objection to the efficiency wage model of adverse selection is that uninformed firms can develop mechanisms to distinguish or screen workers. The labor quality of a worker may then be revealed through screening. However, labor quality is likely to be multi- rather than one-dimensional. It is related to many worker characteristics including intellectual faculties, devotion to tasks, physical conditions, psychological development, and so on. Recent work on the multidimensional issue of private information indicates that "bunching" (that is, a group of agents are treated identically in the optimal solution even if they are of different types) is present in the solution to most multidimensional screening problems. For example, Rochet and Chone (1998) consider a bi-dimensional version of the Mussa and Rosen (1978) model in which consumers' types are uniformly distributed on a square. They show that it is optimal for the seller to offer only limited choices for the lower part of the qualities spectrum so as to induce some degree of bunching in consumers with different tastes. If "bunching" at the lower part of the qualities spectrum is a general pattern for multidimensional screening problems (Rochet and Chone make this conjecture), then the application of adverse selection models will be most suitable for low-wage or low-end jobs. These are exactly the jobs that working time regulations as well as minimum wage legislation are likely to bite.

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