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## Unemployment and the "Labour-Management Conspiracy"\*

by Larry Karp\*\* and Thierry Paul\*\*\*

### Abstract

We study a model in which management and a union bargain sequentially, first choosing a rule that will later determine the level of employment, and then choosing a wage. The government then chooses an output or an employment subsidy. An exogenous natural turnover rate in the unionized sector creates unemployment whenever the union wage exceeds the competitive wage. Government intervention can increase both the equilibrium amount of unemployment and worsen the intersectoral allocation of labour, because of the induced change in the endogenous wage. Unemployment weakens but does not eliminate the possibility of a "labour-management conspiracy".

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## 1. Introduction

Persistently high unemployment has perhaps been the greatest economic problem in continental Europe in the 90's. High unemployment rates [e.g. France (12.1%), Italy (12.0%), Germany (11.5%), Spain (19.8%) as of May 1998] have led to renewed calls for governments to subsidize industries. These demands oppose the efforts many governments have made to reduce direct state involvement by privatizing industries and reducing subsidies. Most economists and some politicians believe that the solution to unemployment requires labour market reform rather than increased direct government support [e.g. Bean (1994), Bertola and Ichino (1995), OECD (1995), St Paul (1996)].

Well-intentioned government intervention may increase unemployment and labour market inefficiency, when wages and employment decisions are endogenous. Industry anticipation of government assistance encourages firms and the union to choose a high wage and an employment contract that results in too little employment. The government steps in to correct the effects of these decisions, confirming industry expectations. However, the government is not able to offset completely the effects of industry decisions. The net effect is a transfer to the industry, a loss of national income, and an increase in unemployment. If the government could commit not to intervene, the industry would have less incentive to make inefficient choices. This interpretation sees government involvement as a cause, not a remedy to unemployment.<sup>1</sup>

The wage explosion following the unification of Germany, for example, was partly due to trade union pressures and government willingness to exceed its budget to support failing industries [Akerlof *et al.* (1991); Begg and Portes (1992); Burda and Funke (1992)]. According

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<sup>1</sup> Well-known models (e.g. Shapiro and Stiglitz (1984), Rey and Stiglitz (1994)) show how government attempts to reduce the personal cost of unemployment, e.g. by providing unemployment benefits, can increase employment. The source of unemployment in our model is unrelated to the efficiency wage argument.

to Akerlof *et al* (page 61), "...the unions may assume that the Treuhandanstalt simply will not permit firms to go out of business, regardless of their financial viability...". Other European governments also use state aid to protect employment in strongly unionized sectors. For example, after the Gulf War, AirFrance's management proposed a program of redundancies while the union bargained to maintain wages. To avoid job cuts, the French government made large capital transfers to AirFrance.

Pigouvian taxes, designed to correct distortions, can generate inefficiencies when agents are able to bargain.<sup>2</sup> The possibility that distortions are endogenous, and that government intervention may exacerbate rather than correct them, has appeared in many papers, including Rodrik (1986, 1987), Staiger and Tabellini (1987) and Matsuyama (1990). We extend Matsuyama's model, in which a firm and a union bargain sequentially (as in Manning, 1987a,b), first deciding on an employment contract and then on the wage. The employment contract specifies the rules that later determine the level of employment. There are two possible contracts. The industry can choose an "efficient contract", i.e., one that equates the value of marginal product of a worker to the opportunity cost of her employment. Alternatively, the industry can choose a "profit-maximizing contract", i.e., one that equates the value of marginal product of the worker to the unionized wage. The level of employment is chosen after the government chooses a subsidy.

In a model without unemployment, Matsuyama shows that the union and firm both prefer the inefficient contract *and high wages*. By adopting the inefficient employment contract they

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<sup>2</sup> Coase (1960, page 28) writes "The kind of situation which economists are prone to consider as requiring corrective Government action is, in fact, often the result of Government action. Such action is not necessarily unwise. But there is a real danger that extensive Government intervention in the economic system may lead to the protection of those responsible for harmful effects being carried too far."

create a distortion which summons government intervention, and a transfer to the industry. The firm prefers high wages because the subsidy more than offsets the increased wage bill. Thus, the union and firm "conspire" at two stages, in choosing the type of employment contract and the level of the wage. The government makes a large transfer to the industry, but achieves the first best outcome with efficient allocation of labour. We study the effect of endogenous unemployment on the incentives to conspire.<sup>3</sup> We also explain how government intervention affects the equilibrium level of unemployment and the sectoral allocation of labour.

The possibility of unemployment arises in our model because of a natural turnover rate in the unionized sector. The nonunionized (competitive) sector hires all workers willing to enter the sector, so unemployment is voluntary. If union and competitive wages were equal, a worker who lost her job in the unionized sector would move to the competitive sector, and be replaced by a worker from the competitive sector. Therefore, if wages in the two sectors were equal, a positive turnover rate would affect the identity of workers in the two sectors, but otherwise would have no effect on equilibrium.

However, if the union wage is higher than the competitive wage, some workers remain unemployed in the unionized sector in the hope of getting a job there in the future. Their chance of getting a job is positively related to the turnover rate: the more likely a unionized worker is to lose her job, the more likely an unemployed worker is to get it. In this model, for a given industry bargain, the amount of unemployment increases with the turnover rate.

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<sup>3</sup> Matsuyama studies a variation in which the government incurs a deadweight cost in raising revenue to finance the subsidy. This cost reduces its incentive to subsidize the industry, and thus reduces the industry's incentive to raise the wage. Unemployment in our model imposes a direct cost both on the government and the union, unlike the deadweight cost of public finance, which imposes a direct cost only on the government. We assume that the government pays for the subsidy using a nondistortionary tax, such as a poll tax.

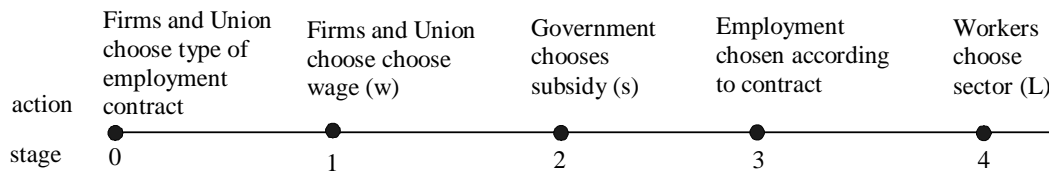
At a given wage, the government subsidy increases employment in the unionized sector, but also increases workers' willingness to remain unemployed there. The subsidy improves the labour allocation across sectors, at the cost of increasing unemployment. Since unemployment imposes costs on both the union and the government, it reduces both wage demands and the equilibrium subsidy. If the natural turnover rate is high, the threat of unemployment is a strong restraint on the union and government. A low natural turnover rate reduces the restraining influence of unemployment, both for the union and government.

Three main conclusions arise from this model. First, for a given turnover rate, government intervention increases the level of unemployment and may increase the misallocation of labour. The misallocation effect is due to the endogenous change in the employment contract and the wage resulting from the intervention. Second, the presence of unemployment eliminates the harmony of interests between the union and firm in setting high wages, but they still prefer the inefficient contract. Thus, unemployment weakens but does not destroy the "labour-management conspiracy". Third, government intervention reverses the relation between the turnover rate and unemployment. Absent government intervention, an economy with a low turnover rate has low unemployment. If the government intervenes, this economy suffers high unemployment.

Section 2 describes the timing of the game. Section 3 shows how the wage and the subsidy determine labour allocation and unemployment. Section 4 analyzes the equilibrium subsidy and wage under the two types of contracts. Section 5 discusses the choice of the contract and shows how government intervention affects unemployment and welfare levels.

## 2. Overview of the Game

Figure 1 shows the time line of moves. At stage 0 firms and the union decide how the level of employment in the unionized sector will ultimately be determined. One possibility is that the firms will be allowed to choose the level of employment to maximize their profits. The other possibility is that employment will be chosen to maximize industry surplus. We refer to a rule for choosing the level of employment as a contract. Firms would not want less employment than the profit-maximizing level, and unions would not demand more employment than the surplus-maximizing level (for reasons we explain in Section 4.4, where we consider more general employment-setting contracts). These two contracts are therefore the interesting polar



**Figure 1** The Time Line

cases.

In stage 1 firms and the union determine the wage ( $w$ ) by bargaining.<sup>4</sup> In stage 2 the government chooses a unit output subsidy, ( $s$ ). (In Section 4.4 we consider the case where the government subsidizes employment rather than production.) In stage 3, employment ( $e$ ) is chosen according the type of contract selected at the initial stage, taking as given the predetermined wage and subsidy. Finally, in stage 4 workers decide whether to remain in the

<sup>4</sup> The decisions at stages 0 and 1 could be made simultaneously, without altering our results. We treat them as occurring sequentially in order to simplify the exposition. This timing also captures the stylized fact that there appears to be more flexibility in changing wages than in changing the institutions that determine employment levels.

unionized sector, where they earn a higher wage but risk unemployment. Agents have rational expectations.

The assumption that the government chooses the subsidy after firms and the union agree on the employment-setting contract and wage, reflects the view that the government responds to endogenous industry conditions, rather than making credible commitments. In Section 5.3 we briefly consider the game in which the government moves before the industry. That model is more complex, because there the government affects the industry bargain.

The strategic choices occur in stages 0, 1 and 2. The action in stage 3 is merely the mechanical application of a previously determined rule. The outcome in stage 4 represents the equilibrium behavior of competitive agents. We solve the model by "working backwards" from the final stage.

### 3. Labour Supply and Demand (Stages 4 and 3)

We study the stationary equilibrium of a continuous time two-sector model of a small open economy. Both sectors produce one good using mobile labour. Sector 1 is unionized and has decreasing returns to scale, so there is rent in that sector. Sector 2 produces under constant returns to scale with the wage competitively determined.

In order to obtain the stationary equilibrium, we first derive the steady state labour supply function (holding fixed the wage and number of jobs,  $w$  and  $e$ ). We then consider the labor demand under the two polar assumptions that employment in the unionized sector is chosen to maximize either industry surplus or profits.

3.1 Labour Supply At a point in time, the number of workers in the unionized sector is  $L_t$ , and the number of workers employed in that sector is  $e_t$ . Hereafter we suppress the time subscript, because we consider only steady state levels. (In the absence of adjustment costs, the economy



moves immediately to the steady state equilibrium.) An employed worker in the unionized sector earns  $w$  per unit of time, and a worker in the competitive sector earns  $\tilde{w} \leq w$ . The value of  $w$  was determined in stage 1, and the value of  $\tilde{w}$  is fixed by the constant returns to scale technology in the competitive sector. The amount of unemployment is  $U \equiv L - e$ , since all workers in the competitive sector have jobs.<sup>5</sup> The employment level  $e$  is determined in stage 3, and  $L$  is the equilibrium number of competitive workers, determined in stage 4.

The probability per unit of time of a worker in the unionized sector losing her job is  $z$ , an exogenous constant. In a steady state, where the number of job losses equals the number of new jobs ( $e$  is constant), the parameter  $z$  is half the turnover rate in the unionized sector. This parameter is central to our analysis, because a positive value of  $z$  is necessary for unemployment.

In addition to the literal interpretation of  $z$  as (half) the turnover rate, we can also view it (in our model) either as an indicator of *labour flexibility* or of *potential unemployment*. With flexible labour markets, it is easier for firms to fire workers, either because their job is no longer necessary or because the worker is unsatisfactory. Economies in which there is very little movement of labour, or a large expected duration of employment (for a particular worker in a particular job) are associated with small  $z$  and inflexible labour markets.<sup>6</sup> We show below that for given  $e$ ,  $w$ , and  $s$ , the level of unemployment increases with  $z$ . Therefore, we can also interpret  $z$  as an indicator of the economy's potential unemployment. The *equilibrium* level of unemployment, however, depends on the endogenous variables  $e$ ,  $w$ , and  $s$ , which depend on  $z$ .

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<sup>5</sup> The assumption of full employment in the competitive sector can be relaxed. With unemployment in that sector, we can view  $\tilde{w}$  as the expected marginal productivity there. The variable  $U$  is then unemployment in the unionized sector, rather than total unemployment.

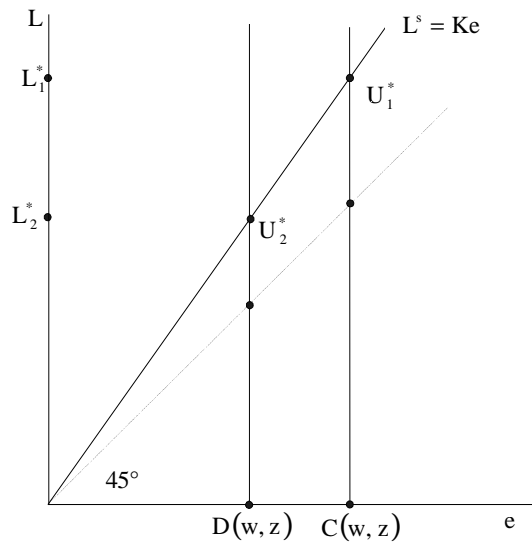
<sup>6</sup> Of course, some factors that affect the turnover rate may have nothing to do with the flexibility of labour markets (e.g. job creation or loss caused by changes in the terms of trade, technological change or bankruptcy). We also recognize that some aspects of labour market flexibility are unrelated to the parameter  $z$ .

Workers are free to move between the competitive sector and the pool of unemployed in the unionized sector. Infinitely lived workers with rational expectations are able to calculate the expected present value of either having a job or being unemployed in the unionized sector. The present value of a job in the competitive sector, for a worker who intends to remain there, is  $\tilde{w}/r$ , where  $r$  is the discount rate. Equilibrium requires that the value of being unemployed in the unionized sector equals  $\tilde{w}/r$  at every instant.

The steady state supply of workers in the unionized sector is  $L^s$ , derived in Appendix A:

$$L^s = K(w; z; \tilde{w}, r)e; K \equiv \frac{\tilde{w}r + zw}{\tilde{w}(r+z)} \geq 1. \quad (1)$$

Figure 2 shows the labor supply curve, as a function of the amount of employment. For each employed worker in the unionized sector,  $K \geq 1$  workers are attracted to the sector in the hope of getting a job there. The amount of unemployment is  $(K-1)e$ . For  $e > 0$  and  $w > \tilde{w}$ , there is



**Figure 2** Labour Supply and Demand

unemployment if and only if  $z > 0$ .

We briefly discuss the comparative statics of the labour supply function. An increase in the probability that an employed unionized worker loses her job,  $z$ , also increases the probability of an unemployed worker obtaining a job. Consequently, it becomes more attractive to remain unemployed in the unionized sector, and  $K$  increases:  $\partial K(w; \cdot)/\partial z > 0$  for  $w > \tilde{w}$ . When  $z = 0$  an employed unionized worker never loses her job; given that the amount of

employment is fixed, an unemployed worker in that sector would have no chance of getting a job there. Consequently, if  $z = 0$  workers would always prefer to work in the competitive sector rather than being unemployed in the unionized sector:  $K(w)|_{z=0} = 1$ .

A decrease in the wage differential,  $w - \tilde{w}$ , makes it more attractive to work in the competitive sector, causing a decrease in  $K$ . An increase in the discount rate,  $r$ , decreases the present value of jobs in both the unionized and competitive sectors. However, when  $w > \tilde{w}$ , the net effect is to make waiting in the unionized sector more attractive, so  $\partial K / \partial r > 0$ .

**3.2 Labour Demand** Demand for labour is chosen either to maximize industry profits or industry surplus, depending on which contract was chosen at stage 0. Industry profits are

$$\Pi(e, s, w) = (p + s)F(e) - we, \quad (2)$$

where  $p$  is the constant world price of output,  $s$  is the previously determined subsidy, and the production function  $F$  is increasing and concave. Workers' surplus ( $\Lambda$ ) is the difference between the wages they receive in the unionized sector,  $w e$ , and their opportunity cost,  $wL = wKe$ :<sup>7</sup>

$$\Lambda(w, e) = [w - \tilde{w}K(w)]e. \quad (3)$$

The marginal (social and union) opportunity cost of employment is  $\tilde{w}K > \tilde{w}$ , since hiring one more worker in the unionized sector attracts  $K$  workers from the competitive sector. Increases in  $K$ , caused by an increase in the unionized wage or  $z$ , or a decrease in the discount rate, increase the opportunity cost of employment in the unionized sector. Provided that  $e > 0$ , union surplus is positive if and only if  $w > \tilde{w}$ , since  $w - \tilde{w}K = r(w - \tilde{w}) / (r + z)$ .

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<sup>7</sup> The present value of the stream of the wage bill,  $we/r$ , equals the weighted present discounted benefit of employed and unemployed workers in the unionized sector, where the weights are  $e$  and  $U = L - e$ . Thus, our measure of union surplus includes the payoff to both employed and unemployed workers in the sector ("insiders" and "outsiders").

Industry surplus (as distinct from social surplus), the sum of  $\Pi$  and  $\Lambda$ , is

$$\Pi + \Lambda = (p + s)F(e) - \tilde{w}Ke, \quad (4)$$

i.e., the private value of output minus the opportunity cost of the input.

When employment is chosen to maximize industry surplus, the equilibrium level of  $e$  is  $C(w,s)$ , which solves the first order condition

$$(p + s)F'(e) = K(w)\tilde{w}. \quad (5)$$

At the equilibrium, the private value of marginal product equals the opportunity cost of an additional unit of employment.

When employment is chosen to maximize industry profits, the equilibrium level of  $e$  is  $D(w,s)$ , which solves the first order condition

$$(p + s)F'(e) = w. \quad (6)$$

At the equilibrium, the value of marginal product equals the firm's costs of an additional unit of employment.

Figure 2 shows the surplus-maximizing level of employment as the vertical line at  $C(w,s)$  and the profit-maximizing level at  $D(w,s)$ . The equilibrium amount of labour in the unionized sector is  $L_1^*$  and  $L_2^*$  in the two cases, and the amount of unemployment is  $U_1^*$  and  $U_2^*$ .

### 3.3 Comparative Statics

We conclude this section by examining the comparative statics of the two types of contracts when  $z > 0$  and  $w > \tilde{w}$ . Using equations (4) and (5), the concavity of  $F$ , and the facts that  $K > I$  and  $w > \tilde{w}K$  [from equation (3)], we note that the surplus-maximizing contract results in more labor in the unionized sector, relative to the profit-maximizing contract (Figure 2). Also, since the amount of unemployment is proportional to the

amount of employment (with a factor of  $K-1$ ), there is more unemployment under the surplus-maximizing contract.

An increase in  $w$  shifts the demand curves  $C(w,s)$  and  $D(w,s)$  to the left and thus decreases the equilibrium level of employment. Under profit maximization, an increase in  $w$  increases the private cost of hiring workers. Under surplus maximization, an increase in  $w$  increases  $K$  and thus increases the industry opportunity cost of employment. However, an increase in  $w$  also causes the supply curve to rotate counter-clockwise, so the equilibrium effects on  $L$  and  $U = L - e$  are ambiguous. Using the equilibrium conditions for  $e$ , the definition of  $K$ , and the relation  $L = Ke$ , we obtain the comparative statics.

$$\begin{aligned} \text{surplus maximizing : } \frac{dU}{dw} &= \frac{\partial K}{\partial w} \left[ e + \frac{(K-1)\tilde{w}}{(p+s)F''} \right] \\ \text{profit maximizing : } \frac{dU}{dw} &= \frac{\partial K}{\partial w} e + \frac{K-1}{(p+s)F''}. \end{aligned} \tag{7}$$

Unemployment is non-monotonic in the wage, because a higher wage reduces both labour supply and demand in the unionized sector. Using equation (7) and the fact that  $e$  is a decreasing function of  $w$ , we see that for both types of contracts, for sufficiently low  $w$  (high  $e$ ), an increase in the wage increases the amount of unemployment, as we would expect. (As  $w \rightarrow \tilde{w}$ ,  $K \rightarrow 1$ , so both derivatives in equation (7) are positive.) The wage increase attracts workers to the unionized sector despite the decrease in employment, thus increasing unemployment. However, for sufficiently high  $w$ , the equilibrium  $e$  approaches 0, and both derivatives in equation (7) become negative. When the wage is initially high, the probability of getting a unionized job is small. A further increase in the wage reduces the probability of getting a job by enough to offset the increased value of the job. As a result, the decline in the number of workers in the unionized sector exceeds the decline in employment there, and unemployment falls.

For both types of contracts, an increase in the subsidy increases labor demand in the unionized sector, without changing the labor supply curve (since  $K$  is independent of  $s$ ). Consequently, an increase in the subsidy increases *both employment and unemployment* in the unionized sector. For a fixed wage, increased unemployment is the price that the government pays to improve the allocation of labour, i.e., to bring more workers into the unionized sector.

In summary, we have

Proposition 1: (i) For given  $s$  and  $w$ , the surplus-maximizing contract results in more unemployment and unionized employment than the profit-maximizing contract. (ii) An increase in the unionized wage increases (respectively, decreases) the amount of unemployment if the initial wage is sufficiently low (respectively, high). (iii) For both types of contracts, an increase in the subsidy increases unemployment and unionized employment and shrinks the competitive sector. •

#### 4. The Wage and Subsidy (Stages 2 and 1)

This section studies the selection of the wage and the subsidy. We show that the subsidy depends on the wage, but does not depend directly on the choice of employment-setting contracts. We discuss the case where there is no unemployment ( $z = 0$ ) in order to illustrate the "labour-management conspiracy" in the simplest manner, and to highlight the role of unemployment in the general model. Here we reproduce Matsuyama's (1990) results when there is no deadweight cost of raising government funds for the subsidy. We derive the Pareto frontiers under the two employment-setting contracts. Finally, we consider the case where the government chooses a wage rather than an output subsidy, and we study more general employment-setting rules.

4.1 The Government's Objective and the Industry Bargain The government's objective is to maximize social surplus (the value of output)  $Y \equiv pF(e) + (\bar{L} - L)\tilde{w} = pF(e) - K(w)e\tilde{w} + \bar{L}\tilde{w}$ , where  $\bar{L}$  is the total amount of labor in the economy. The government recognizes that  $e = C(w,s)$  if employment in the third stage maximizes surplus, and  $e = D(w,s)$  if employment in the third stage maximizes profits. The government also understands that the social cost of increasing union employment is an increase in unemployment: The government is able to choose the socially optimal point on the labour supply constraint (equation 1), but it is not able to alter this constraint.

For both contracts  $\partial e/\partial s \neq 0$  (when  $e > 0$ ), so the optimal level of  $s$  satisfies the first order condition

$$pF'(e(w,s)) - K(w)\tilde{w} = 0. \quad (8)$$

The value of marginal product of a unionized worker must equal the opportunity cost of her employment. Equation (8) shows that the equilibrium  $e$ , which we denote  $e^*(w)$ , depends on  $w$  but not on whether employment is subsequently chosen to maximize industry surplus or firms' profits. Substituting  $e^*(w)$  into either equation (5) or (6) gives the equilibrium subsidy as functions of  $w$ :  $s^{*p}(w)$  ("p" when employment maximizes profits) and  $s^{*s}(w)$  ("s" when employment maximizes surplus).

We now consider the industry bargain. Equations (2) and (3) define the firm and union payoffs. To describe the union-firm bargain we adopt

Assumption (A1) The equilibrium wage is Pareto Optimal, given the employment-setting contract. (A2) If a move to a higher Pareto frontier benefits either agent, it harms neither agent.

Assumption (A2) implies that if the union and firm have a choice of two bargaining games, they choose the game with the higher frontier (unless they are indifferent between the two).<sup>8</sup> This assumption seems reasonable, since when agents bargain they should be able to find a way of sharing the surplus associated with the move to a higher Pareto frontier, so that neither agent blocks the move.<sup>9</sup>

4.2 Zero Unemployment If  $z = 0$ , there is no unemployment regardless of  $w$  and  $e$ :

$K(w; z)_{|z=0} = 1$ . This equality and equation (8) imply that equilibrium union employment, which we denote as  $e^{**}$ , is a constant which satisfies  $pF'(e^{**}) = \tilde{w}$ . With no unemployment, the government can achieve the first best outcome using a subsidy, for any wage.

Under surplus maximization, the firm and the union choose  $e^{**}$  in stage 3 if and only if  $s = 0$ . Therefore, whatever wage was chosen in stage 1, the government uses no subsidy when the industry maximizes surplus in stage 3. The industry surplus is  $pF(e^{**}) - \tilde{w}e^{**}$ , which is independent of  $w$ . The bargaining problem in stage 1 determines how this constant surplus is shared. A higher wage gives the union a larger share of the surplus.

If the firm maximizes profits in stage 3, the government chooses the subsidy

$s^{*p}(w)_{|z=0} = [w - \tilde{w}] / F'(e^{**})$  [obtained using equations (6) and (8)], which is linearly increasing in

$w$ . The union surplus,  $(w - \tilde{w})e^{**}$ , is increasing in  $w$ . The derivative of equilibrium firm profits,

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<sup>8</sup> If a point of intersection of two Pareto frontiers maximizes one agent's payoff (under both frontiers), as occurs in Figure 3a below, and if in addition that agent has all of the bargaining power, the equilibrium is the same under the two frontiers.

<sup>9</sup> Although reasonable, Assumption (A2) is not vacuous. For example, in a generalized Nash bargaining game with *fixed bargaining weights and a fixed threat point*, the move to a higher frontier might make one agent worse off, if the growth in the frontier is sufficiently "unbalanced". In that situation, Assumption (A2) requires that either the threat point or the bargaining weights be adjusted, to induce both agents to be willing to move to the higher frontier.

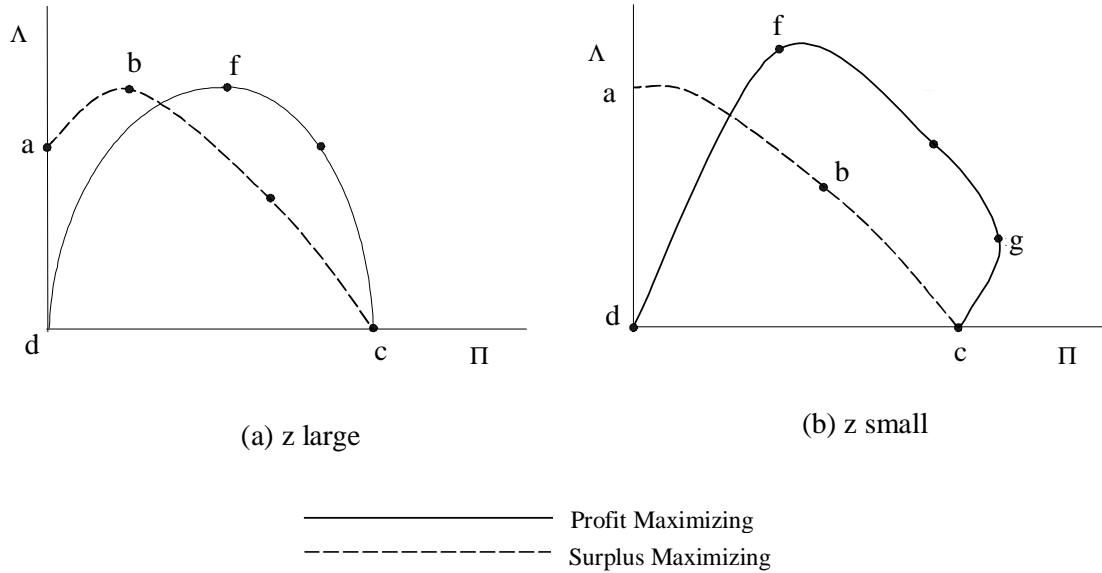


with respect to the wage, is  $d\Pi/dw = [e^{**}/F'(e^{**})][F(e^{**})/e^{**} - F'(e^{**})]$  which is positive because of the concavity of  $F$ . Both the union and the firm want to choose the highest feasible wage.

When  $z = 0$  there is no conflict of interest between the union and firm. They both prefer the inefficient, profit-maximizing contract; in addition, they both want to set the wage as high as possible. These are the two aspects of the labour-management conspiracy.

4.3 The Pareto Frontiers with Unemployment When  $e$  is chosen to maximize industry surplus, the government does not subsidize the industry even with unemployment. The purpose of the subsidy, to ensure that the amount of employment in the unionized sector maximizes social surplus, is achieved if and only if  $s^{*s}(w) \equiv 0$  (see equations (5) and (8)).

The optimal subsidy when employment maximizes profits [using (6) and (8)] is  $s^{*p}(w) = p[w/K\tilde{w} - 1] \geq 0$ . The inequality is strict if  $w > \tilde{w}$ . The subsidy is increasing and concave in  $w$ , so higher wages generate higher subsidies, but at a decreasing rate. In addition,  $\partial s^{*p}/\partial z < 0$  and  $\partial^2 s^{*p}/\partial w \partial z < 0$ . An increase in  $z$  decreases the subsidy at a given wage, and it decreases the wage's marginal effect on the subsidy.



**Figure 3** The Pareto Frontier

Figure 3 graphs the Pareto frontiers when  $z$  is "large" (panel a) or "small" (panel b). (Appendix B derives these frontiers.) The union surplus depends on the wage but not the type of employment-setting contract, since the equilibrium level of employment is the same under both. At  $w = \tilde{w}$ , where union surplus is 0, profits are positive and equal under the two contracts (since the subsidy is zero in both cases). For a wage greater than  $\tilde{w}$ , firm profits are higher under stage-three profit maximization (where the firm receives the subsidy  $s^*p(w) > 0$ ) than under surplus maximization (where the firm receives a zero subsidy). Therefore, the Pareto frontier under profit maximization lies above the frontier under surplus maximization for  $w > \tilde{w}$ .

The only notable feature of Figure 3 is that for small  $z$  the Pareto frontier is increasing in the region of  $w = \tilde{w}$  (i.e., when  $\Lambda$  is small) under profit maximization. From the discussion in section 4.2 it is easy to see that for  $z = 0$  the frontier under profit maximization is a line through point  $c$  with positive slope. The frontier in Figure 3b is thus an intermediate case of the frontiers where  $z = 0$  or  $z$  is large.

#### 4.4 Different Specifications

The model is robust to changes in the government policy and to generalizations of the employment-setting contract. If the government wants to alter the

inter-sectoral allocation of labour, an employment subsidy is a more efficient instrument than an output subsidy. If the government uses a unit employment subsidy of  $\sigma$  instead of the output subsidy  $s$ , industry profits are

$$\Pi(e, \sigma, w) = pF(e) - (w - \sigma)e. \quad (9)$$

Appendix C establishes

Proposition 2 (i) For a given wage, the equilibrium *employment subsidy* induces the same amount of employment,  $e^*(w)$  as the output subsidy, under either profit or surplus-maximizing employment-setting contracts. (ii) The equilibrium employment subsidy is identically 0 under surplus maximizing. (iii) Under profit maximizing, the equilibrium transfer to firms with the employment subsidy is positive but smaller than with the output subsidy. (iv) With the employment subsidy, the Pareto frontier is monotonically decreasing in the neighborhood of  $\Lambda = 0$  for all  $z > 0$ . •

Proposition 2.ii implies that the industry Pareto frontier under the surplus-maximizing contract is the same when the government chooses either an employment or output subsidy - since in both cases the subsidy is zero. Proposition 2.iii implies that the Pareto frontier under the profit-maximizing contract, when the government chooses an employment subsidy, lies between the two Pareto frontiers (under profit and under surplus maximizing in stage 3) for the output subsidy. Proposition 2.iv implies that (with profit maximization) the Pareto frontier under the employment subsidy has the shape of the solid curve in Figure 3a: there can be no upwardly sloping portion in the neighborhood point  $c$ , as in Figure 3b.

We now briefly consider the case where the firm and union can choose a more general employment setting contract; the government again chooses an output subsidy. For a given wage and subsidy, firms would never want to choose less than the profit-maximizing level of

employment,  $D(w,s)$ , and the union would always want a higher level of employment. Thus,  $D(w,s)$  is a reasonable lower bound for  $e$ . For a given wage, the union is always better off with higher  $e$ . The firm always prefers a lower level of employment than the surplus-maximizing level  $C(w,s)$ . The union recognizes that it cannot raise  $e$  above the level  $e^*(w)$ , and therefore has no incentive to insist on a contract that attempts to set  $e > C(w,s)$ . Thus,  $C(w,s)$  is a reasonable upper bound for the employment-setting contract.

Instead of assuming that at stage 0 the industry chooses either contract  $D$  or  $C$ , we can allow them to choose a convex combination of the two, indexed by the parameter  $0 \leq \alpha \leq 1$ :  $B(w,s;\alpha) \equiv \alpha D(w,s) + (1-\alpha)C(w,s)$ . It is easy to show (and not at all surprising) that the Pareto frontier associated with the contract  $B(\cdot;\alpha)$  is a continuous function of  $\alpha$  and that for  $0 < \alpha < 1$  the Pareto frontier lies between the solid and dashed curves in Figure 3.

## 5. Comparing Equilibria (Stages 1 and 0)

We compare the equilibrium wage and payoff levels under the two contracts in order to determine how unemployment effects the equilibrium. Government intervention decreases social welfare, and the output subsidy does more damage than the employment subsidy. If the firm is sufficiently powerful at the wage-setting stage of bargaining, government intervention also increases equilibrium unemployment. To illustrate plausible magnitudes and to show that our results are robust, we then discuss numerical examples. Finally, we consider changing the timing of moves.

### 5.1 The Effect of Unemployment on the "Conspiracy"

Section 4.2 showed that with no unemployment, the firm and union choose the inefficient contract and a high wage: they "conspire" at both stages of bargaining, i.e. over both instruments. We first consider the firm and union incentive to choose a high wage in stage 1 if they previously chose the profit-maximizing

contract, and  $z > 0$ . We then consider their incentive to choose the profit-maximizing contract. That is, we examine separately the incentives to conspire at the different stages, in the presence of unemployment.

Suppose that the industry adopts the profit-maximizing contract and the government uses an output subsidy. If  $z$  is small but positive, both agents benefit from a wage increase when  $w$  is close to  $\tilde{w}$  (Figure 3b). If the wage is high enough, the usual conflict arises and the firm wants to reduce the wage. If  $z$  is large (so that "potential unemployment" is important) wage reductions always increase equilibrium firm profits (Figure 3a). The possibility of unemployment reduces, and may eliminate, the range of wages over which the firm and union payoffs are both increasing. Unemployment thus reduces or eliminates the harmony of interests between the union and firm, and thus reduces or eliminates their incentive to conspire in setting high wages. The equilibrium wage occurs on the non-positively sloped portion of the utility possibility frontier; there, a higher wage reduces the firm's profits.

If the government uses an employment rather than an output subsidy, firms always want to drive the wage to  $\tilde{w}$  (Proposition 2.iv). Thus, there is never an incentive to conspire at the wage-setting stage when the government uses an employment subsidy.

If either of the following two conditions hold, the equilibrium wage under profit maximization is strictly greater than  $\tilde{w}$ :

(S1) The union has some bargaining power at the wage-setting stage.

(S2)  $z$  is small and the government uses an output subsidy.

Condition (S1) implies that the equilibrium does not occur at point  $c$  in Figure 3a, and (S2) implies that the Pareto frontier is as shown in Figure 3b. Hereafter we assume that either (S1) or (S2), and Assumption (A), hold.

The following two propositions summarize our main results. Proposition 3 restates the observation that unemployment may affect the industry incentive to conspire at the wage setting, but not at the contract setting stage of bargaining. Proposition 4 (proven in Appendix C) describes the effect of government intervention on wages and welfare.

Proposition 3. (i) Both an output and an employment subsidy cause the industry to choose the inefficient profit-maximizing contract. (ii) When the government uses an employment subsidy, the union and firm have no incentive to conspire at the wage-setting stage. The possibility of unemployment ( $z > 0$ ) reduces or eliminates the incentive for the union and firm to conspire at the wage-setting stage when the government uses an output subsidy. •

Proposition 4 (i) Government intervention increases the equilibrium wage and decreases social welfare. (ii) The reduction in social welfare and the increase in the wage are greater under the output subsidy than under the employment subsidy. (iii) If the union bargaining power at the wage setting stage is sufficiently low, government intervention increases the amount of unemployment. (iv) With an output subsidy, and increase in  $z$  can cause a decrease in the equilibrium amount of unemployment. •

Proposition 4.i and 4.ii establish that government intervention reduces social welfare. In line with the Principle of Targeting, the employment subsidy causes a smaller distortion, and therefore a smaller welfare loss.

Proposition 1.iii established that a subsidy increases the amount of unemployment at a given wage. However, anticipation of the subsidy increases the equilibrium wage, which has an ambiguous effect on unemployment. Proposition 4.iii gives a sufficient condition for government intervention to increase unemployment. For example, if the union has little bargaining power, then absent government intervention the equilibrium wage is in the neighborhood of  $\tilde{w}$  and the amount of unemployment is negligible. The anticipation of

government intervention creates the conspiracy at stage 0, changes the equilibrium wage, and leads to high unemployment.

Proposition 4.iv shows that an increase in  $z$  can be associated with a decrease in the equilibrium amount of unemployment, because an increase in  $z$  can lead to a large decrease in the equilibrium wage when the government intervenes. If the government *does not intervene*, the industry would choose the surplus-maximizing contract. In that case, the direct (positive) effect of  $z$  on unemployment would tend to dominate the indirect effect (via the change in the equilibrium wage). Thus, without government intervention, an increase in  $z$  is more likely to be associated with an increase in the equilibrium amount of unemployment. Consequently, the parameter  $z$  may be positively or negatively associated with unemployment. The OECD Employment Outlook (1997) notes that the empirical relation between turnover rates and unemployment is ambiguous, a finding consistent with our result.

We saw in section 4.4 that all "reasonable" employment-setting contracts can be constructed as convex combinations of  $C(\cdot)$  and  $D(\cdot)$ . In view of the results of this section, it is clear that the industry always prefers contract  $D(\cdot)$  over any convex combination when the government intervenes, and it always prefers contract  $C(\cdot)$  when the government does not intervene. Thus, there is no loss in generality in assuming that the choice is restricted to the two extreme contracts.

5.2 Examples. Propositions 3 and 4 establish the qualitative effects of government intervention in our model. Numerical examples help to determine whether the effects are likely to be significant. These examples also show that the assumption of small union bargaining power (used in parts of Proposition 4) is not essential. In addition, the analytic results rely on Assumption (A2). Although this assumption seems innocuous, it is not necessarily satisfied in bargaining games (footnote 9). For our numerical examples we assume that firms and the union

solve a Nash bargaining game with equal bargaining weights. Given our parameterization, we confirm that Assumption A2 is satisfied. Assumption A1 is, of course, satisfied by construction.

Appendix D describes the numerical experiments for the case of an output subsidy; here we summarize the results. In the absence of government intervention, the industry chooses the surplus-maximizing contract; the equilibrium level of unemployment is increasing in  $z$ .

Government intervention induces the industry to adopt the profit-maximizing contract and changes the equilibrium wage. When the government uses employment subsidies, the relation between  $z$  and equilibrium unemployment is unchanged, but the use of output subsidies reverses this relation. Thus, the relation between the turnover rate and equilibrium unemployment depends on whether the government intervenes, and the form of intervention.

When  $z$  is small (.1), output subsidies cause unemployment to increase from 3% to 5% and social welfare to fall by 2.4%. When  $z$  is large (.6), output subsidies cause a small increase in unemployment (from 4.5% to 4.8%) a small decrease in social welfare (-.5%). For large  $z$ , output subsidies would be socially expensive, because they would lead to high unemployment. The industry recognizes that the government is unwilling to intervene strongly in an economy with large  $z$ . This recognition leads to moderate wages at stage 1 bargaining, which lower the cost of government intervention. The employment subsidy has qualitatively similar, but weaker, effects.

We remarked in Section 3.1 that the parameter  $z$  can be viewed as an indicator of labour market flexibility. With this interpretation, our results imply that government intervention is likely to do more damage where labour markets are inflexible. In such markets, the *apparent* cost of government intervention (given the wage) is small. The *real* cost of government intervention, which takes into account the endogeneity of the wage, is high.



5.3 Changing the timing of moves. Here we consider how the equilibrium changes when the output subsidy is chosen before the wage. The simplest case is where employment maximizes industry surplus in stage 3. When the wage is set before the subsidy, we saw that the equilibrium subsidy is identically 0. However, if the subsidy is chosen first, the optimal subsidy is generally not 0. The (industry-)surplus-maximizing contract chooses the socially optimal point on the labour supply constraint,  $L = K(w)e$  when the subsidy is 0. A small subsidy (or tax) therefore has only a second order effect on welfare for a given value of  $K$ . However, the subsidy has a first order effect on the equilibrium  $w$ , and thus has a first order effect on the constraint and on welfare. Consequently, if industry employment maximizes industry surplus in stage 3, and the subsidy is chosen before the wage, the optimal subsidy is not zero.

The government would like to relax the labor supply constraint, i.e. to reduce  $K$ . It is able to do this by decreasing the endogenous wage. Karp and Paul (1997) show that with a quadratic specification of  $F$  and a cooperative Nash game, a small tax decreases the equilibrium wage and increases welfare when the union has almost all of the bargaining power at stage 2. The effect of a tax is ambiguous when the bargaining power is more evenly shared, but even in that case a tax decreases the amount of employment and reduces the benefit to the union of a marginal wage increase. The tax therefore is likely to reduce the equilibrium wage, and improve welfare. The same forces are at work when the firm maximizes profits in stage 3, but there they are weaker because the level of unionized employment is suboptimal for the given wage. A small subsidy has a positive first order effect on welfare, so the net effect is uncertain.

This comparison suggests that if the government is able to make commitments, which influence wage-setting decisions, we are more likely to observe the unionized industry being taxed. If, on the other hand, the government lacks the ability to make commitments, and reacts to industry wages, we are more likely to observe the industry being subsidized. An equilibrium

in which the unionized sector is taxed seems empirically less important, and therefore we do not analyze further the model in which the subsidy is chosen before the wage. However, it is worth noting that this change in timing may remove the industry's incentive to choose an inefficient contract at stage 0 of the game.

Another critical assumption is that the wage and employment *level* (as distinct from the employment-setting rule) are chosen sequentially. Suppose instead that these decisions are made simultaneously in a bargaining stage. If the government moves second, it would choose a zero subsidy. When the government takes  $w$  and  $e$ , and therefore  $L = K(w)e$ , as fixed, it has no incentive to intervene. If the government moves first it intervenes in order to change the bargaining equilibrium.

## 6. Conclusion

We investigated the effect of unemployment on the incentives for the union and firm to sign inefficient contracts with high wages, i.e., to "conspire" against the government. We viewed the (possible) conspiracy as consisting of two stages. At stage 0, the firm and the union conspire if they both want a socially inefficient contract. At stage 1 they conspire if they both want the highest feasible wage, even though social welfare decreases with the wage.

Unemployment does not eliminate the industry preference for the inefficient contract. However an increase in the importance of unemployment, which in our model is equivalent to an increase in  $z$ , shrinks the set of wages over which both agents' payoffs are increasing. For a sufficiently large value of  $z$ , the firm always wants to reduce the wage to the competitive level, and the union wants to increase it. Thus, unemployment weakens or eliminates the conspiracy at the wage setting stage, but not at the stage which determines the employment-setting contract.

The government uses the subsidy to choose the optimal allocation of labour, and thus the optimal amount of unemployment, given the wage. However, government intervention actually causes the conspiracy at both stages. Without government intervention, the two agents would not both prefer the inefficient contract at stage 0. At stage 1, whatever contract is chosen, the two agents would not both prefer the socially damaging high wage. A numerical example showed that government subsidies might cause a sufficiently large increase in the wage that the equilibrium amount of unemployment is higher, *and the intersectoral allocation of labour is worse*, than in the equilibrium without government intervention. The same result holds for general functional forms whenever the firm has sufficient bargaining power and the turnover rate in the unionized sector is sufficiently small. This result is another example of where the ability to act, without the ability to make commitments, makes an agent worse off.

The loss in social welfare due to government intervention, whether measured by the change in unemployment or the change in national income, is especially great in economies where the turnover rate in the protected sector is small. Economies that display this kind of rigidity in the labour market are especially likely to be harmed by a government's willingness to use subsidies. Numerical examples showed that in the absence of government intervention, an increase in this kind of rigidity lowers unemployment. Thus, without the expectation of government subsidies, labour rules that decrease turnover rates in unionized sectors can decrease unemployment, as unions hope. However, when the union and firm expect government subsidies, the same sort of labour rules increase the equilibrium amount of unemployment.

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### Appendix A: The Steady State Labor Supply

The total number of workers in the unionized sector is  $L$ , and the number of workers in that sector is  $e$ . The number of unemployed workers in  $U=L-e$ . The probability—per unit of time—of losing a job in the unionized sector, if currently employed in the unionized sector, is the exogenous constant  $z$ . The probability—per unit of time—of getting a job, if currently unemployed in the unionized sector, is  $\rho$  which is endogeneously determined by the system but taken as given by workers.

Let  $q^e$  and  $q^u$  denote the present-discounted value of, respectively, being employed and being unemployed in the unionized sector. Employed workers receive the wage  $w$  and become unemployed at the rate  $z$ . At the stationary equilibrium and with a perfect capital market, the values of  $q^e$  and  $q^u$  must satisfy:

$$rq^e = w - z(q^e - q^u) \quad (\text{A1})$$

$$rq^u = \rho(q^e - q^u) \quad (\text{A2})$$

where  $r$  is the interest rate. The present value of being employed in the competitive sector, is:

$$q^0 = \frac{\tilde{w}}{r}. \quad (\text{A3})$$

The present value of being employed in the competitive sector rather than unemployed in the unionized sector,  $q$ , is therefore:

$$q \equiv q^0 - q^u \quad (\text{A4})$$

Instead of waiting for a job in the unionized sector, an unemployed worker can also migrate to the competitive sector. In the absence of search cost, the migration decision is such that:

$$q \equiv 0 \quad (\text{A5})$$

At a steady state:

$$\rho(L - e) = ze. \quad (\text{A6})$$

The probability of  $\rho$  is such that, in the unionized sector, the flow of workers into unemployment is exactly equal to the flow of newly employed workers.

Rewriting equations (A1), (A2), and (A6), we get :

$$q^e = \frac{w + zq^u}{r + z}. \quad (\text{A7})$$

$$q^u = \frac{\rho q^e}{r + \rho}. \quad (\text{A8})$$

$$\rho = \frac{ze}{L - e} \quad (\text{A9})$$

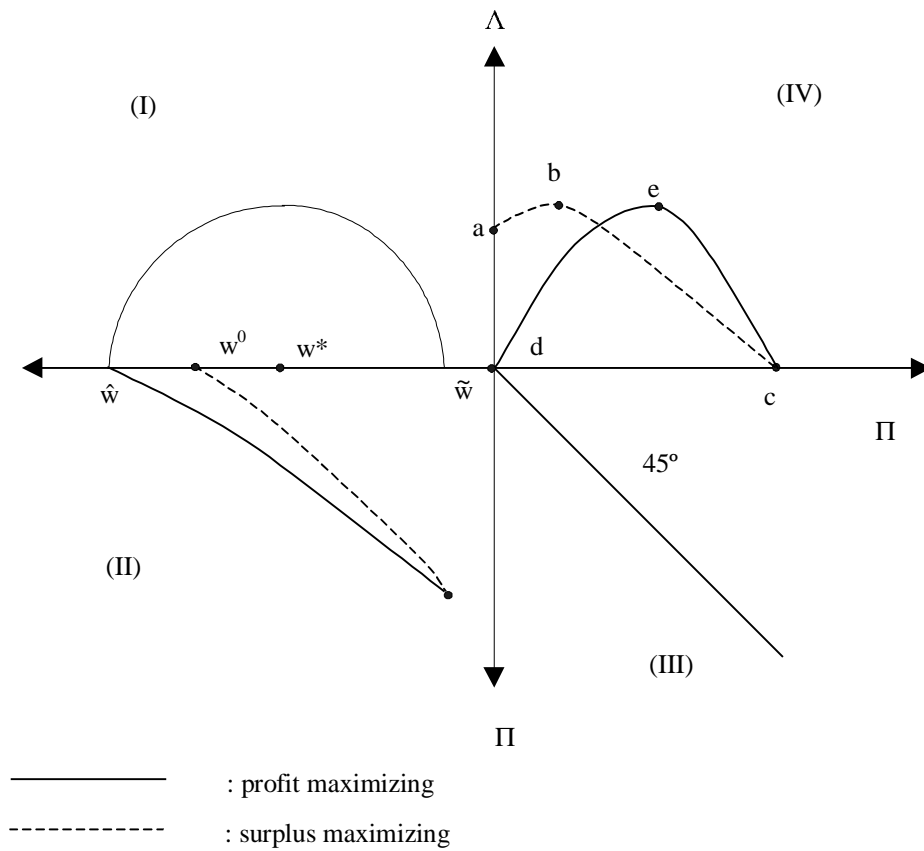
Substituting (A7) and (A9) into (A8) and then using (A5), we obtain the following relationship between  $e$  and  $L$  for fixed  $w$ :

$$\frac{\tilde{w}}{r} - \frac{zew}{r(r(L - e) + Lz)} \equiv 0 \quad (\text{A10})$$

We rearrange equation (A10) to obtain equation 1 of the text.

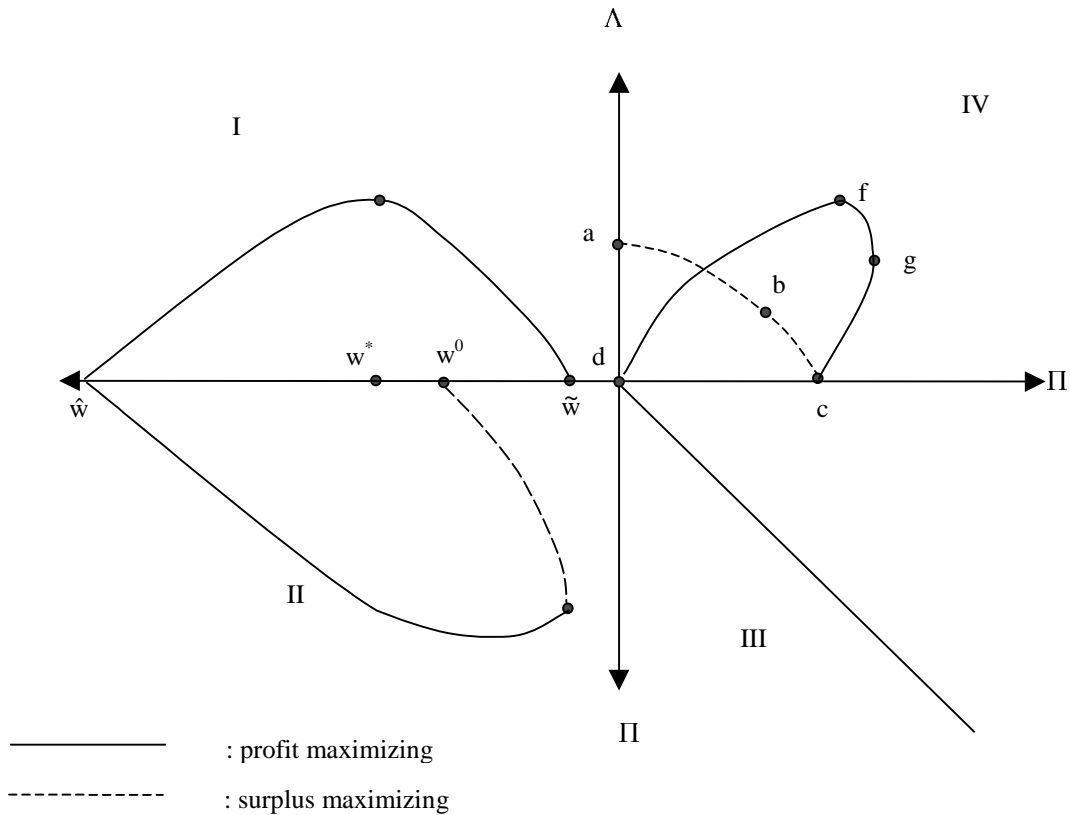
Appendix B: Derivation of Figure 3

**B1: Surplus maximization** Quadrant I (in both Figures B1 and B2) shows the graph of  $\Lambda$  as a function of  $w$ , using the derivative  $\Lambda_w = e^* (1 - \tilde{w} \partial K/\partial w) + (w - \tilde{w} K) de^*/dw$ , where  $de^*/dw = [\tilde{w} \partial K/\partial w]/F'' < 0$ . At  $\tilde{w}$ ,  $\Lambda$  is increasing in  $w$ . At a sufficiently high wage ( $\hat{w}$ ) employment and union surplus equal 0. There must then be an intermediate wage,  $w^*$ , that maximizes union surplus.



**Figure B1:** Utility Possibility Frontier for Large  $z$





**Figure B2:** Utility Possibility Frontier for Small  $z$

The dashed curve in quadrant II (in both Figures) graphs industry profits. The slope of this graph is  $\Pi_w = -e^* + (pF'(e^*) - w)de^*/dw$ . At  $w = \tilde{w}$ ,  $K = 1$ , and  $pF'(e^*(\tilde{w})) - w = 0$ ; therefore  $\Pi_w(\tilde{w}) = -e^*(\tilde{w}) < 0$ . Moreover,  $\Pi(\tilde{w}) > 0$ . For sufficiently high  $w$ ,  $\Pi < 0$ . We define  $w^0$  as the wage that drives profits to 0. If  $\Pi$  is concave (as is the case for quadratic  $F$ )  $\Pi_w \leq 0$  at least over the interval  $(\tilde{w}, w^0)$ . For the quadratic case<sup>10</sup> when  $z$  is large,  $\hat{w} > w^0 > w^*$ , as shown in Figure B1. When  $z$  is small,  $w^0 < w^*$ , as shown in Figure B2.

<sup>10</sup> For the quadratic case,  $F = e - e^2/2$ , we can calculate  $\hat{w} = [r + z - \tilde{w}r]/z$ ,  $w^0 = [r + z + \tilde{w}r]/(z + 2r)$ , and  $w^* = (\tilde{w} + \hat{w})/2$ . From these formulae we see that  $w^0 > w^*$  if and only if  $z$  is sufficiently large.

We use the graphs of  $\Pi$  and  $\Lambda$  and the  $45^\circ$  line in quadrant III to construct the utility possibility frontier, the dashed curve through  $abc$  in quadrant IV, Figures B1 and B2. The negatively sloped region of this curve is the Pareto frontier.

B2: Profit Maximization The relation between  $\Lambda$  and  $w$  is the same under both profit and surplus maximization in stage 3, since the function  $e^*(w)$  is the same under both contracts. The solid curves in quadrant I of Figures B1 and B2 show the graph of  $\Lambda(w)$  for both contracts.

The solid curves in quadrant II show the graph of profits when employment maximizes profits. (See the discussion in the text.) Profits are positive whenever employment is positive, i.e., when  $w < \hat{w}$ . The derivative of profits with respect to the wage is

$$\frac{d\Pi}{dw} = \frac{e^*}{F'} \left[ \frac{r}{(r+z)K} \left( \frac{F}{e^*} \right) - F' \right].$$

If  $z$  is large,  $\Pi_w(\tilde{w}) < 0$ , as in Figure B1. When  $z$  is small,  $\Pi_w(\tilde{w}) > 0$ , as in Figure B2.<sup>11</sup> For both cases, the utility possibility frontier is the solid curve in the quadrant IV. Only the negatively sloped portion, giving the Pareto frontier, is relevant.

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<sup>11</sup> For  $F = e - e^2/2$ ,  $\Pi_w(\tilde{w}) \leq 0$  if and only if  $z \geq (1 - \tilde{w})/2$ .

## Appendix C: Proof of Propositions 2 and 4

Proof of Proposition 2 (i) Changing the government's instrument from  $s$  to  $\sigma$  alters neither its objective nor constraint, and therefore does not change the equilibrium level of employment  $e^*(w)$ . (ii) Under surplus maximization at stage 3 the industry objective equals the government's objective if and only if  $\sigma^s(w) \equiv 0$ . (The superscript "s" denotes surplus maximization. (iii) Under profit maximization, the equilibrium output subsidy satisfies (6) with  $e = e^*(w)$  and the equilibrium employment subsidy satisfies  $pF'(e^*) = w - \sigma$ . These two equilibrium conditions imply that  $\sigma(w) = s(w)F'(e^*)$ . The government transfer to the firm with an output subsidy is  $sF(e^*)$  and the transfer with the employment subsidy is  $\sigma e^* = sF'(e^*)e^*$ . Concavity of  $F(e)$  implies  $sF(e^*) > sF'(e^*)e^*$  for all  $s > 0$ . (iv)  $\Lambda = 0$  for  $w = \tilde{w}$ , and  $\Lambda > 0$  for  $w > \tilde{w}$  but sufficiently small. Therefore  $d\Lambda/dw > 0$  in the neighborhood of  $w = \tilde{w}$ . Thus, we need only show that  $d\Pi/dw < 0$  in this neighborhood. Under the employment subsidy, firm profits are  $\Pi^\sigma(w) = pF(e^*) - (w - \sigma)e^* = pF(e^*) - pF'(e^*)e^*$  (which uses  $pF'(e^*) = w - \sigma$  from part (iii)). Taking the derivative of  $\Pi^\sigma(w)$ , using the concavity of  $F$  and the fact that  $de^*/dw < 0$  shows that  $d\Pi/dw < 0$ .

Proof of Proposition 4 (sketch) (i): Assumption (A2), the facts that government intervention shifts out the Pareto frontier and that union surplus depends only on the wage, imply that intervention increases the wage. An increase in the wage decreases social surplus, since  $dY/dw = -[\partial K/\partial w]e^* \tilde{w} < 0$ , where the equality follows from the envelope theorem. (ii): Assumption (A2) and the fact that the Pareto frontier is higher with the output subsidy than with the employment subsidy implies that the equilibrium wage is higher under the former. Again, since  $dY/dw = -[\partial K/\partial w]e^* \tilde{w} < 0$ , social welfare is lower with the output subsidy. (iii): When the union

bargaining power is low,  $A$  is close to 0 in the absence of government intervention, so  $w$  is close to  $\tilde{w}$ . Intervention increases  $w$ , and by Proposition 1.ii leads to an increase in unemployment.

(iv) If  $z$  is initially small, a sufficiently large increase in  $z$  eliminates the upwardly sloping portion of the Pareto frontier in Figure 3b (the interval from  $E^5$  to  $E^0$ ). (The point  $E^5$ , but not  $E^0$ , is independent of  $z$ .) If the union has little bargaining power, the increase in  $z$  causes the equilibrium to move from a point near  $E^0$  (where  $w \gg \tilde{w}$  and unemployment is non-negligible) to a point near  $E^5$  (where  $w \approx \tilde{w}$ ) and unemployment is negligible).

## Appendix D Numerical Examples

For the numerical examples we let  $F(e) = e - e^2$ ;  $\bar{L} = 1$ ;  $r = .1$ ; and  $\tilde{w} = .7$ . We set a unit of time equal to one year, and assume that the equilibrium wage solves the cooperative Nash bargaining problem with equal bargaining weights. The firms' threat point is zero profits, and the union's threat point is  $\tilde{w}L$ , the opportunity cost of labour. If the union wage were equal to the competitive wage, 60% of the labour force would be in the unionized sector and there would be no unemployment. [Nickell (1997) reports that for most European countries, over 70% of workers are covered by union bargaining at least indirectly, although the percent of unionized workers is typically much smaller.) The parameter  $z$  equals half the labour turnover rate. The average labour turnover rate among OECD countries is .67 (OECD 1997), which corresponds to  $z = .335$ . The following tables present results for three values of  $z$ : .1, .35, .6.

The output subsidy

	$z=0.1$	$z=0.35$	$z=0.6$
% of labour unemployed with SM	3.0	4.2	4.5
% of labour unemployed with PM	5.0	4.9	4.8

Table 1: Percentage Unemployment under the Two Contracts

	$z=0.1$	$z=0.35$	$z=0.6$
% Increase in unemployment	66.2	15.9	8.8
% increase in industry Surplus	31.8	7.9	4.6
% Decrease in national Income	2.4	0.9	0.5
% Decrease in union employment	15	6.1	3.8
% Decrease in union output	13.1	5.3	3.3
% Increase in wage	10	2.4	1.3

Table 2: Percentage Effects of Moving from SM to PM Contracts

The employment subsidy

	z=0.1	z=0.35	z=0.6
% of labour unemployed with SM	3.0	4.2	4.5
% of labour unemployed with PM	4.7	4.8	4.8

Table 3: Percentage Unemployment under the Two Contracts

	z=0.1	z=0.35	z=0.6
% Increase in unemployment	55.9	13.7	7.6
% increase in industry Surplus	20.5	4.9	2.8
% Decrease in National Income	2.0	0.7	0.4
% Decrease in union employment	12.1	5.2	3.2
% Decrease in union output	10.6	4.5	2.8
% Increase in wage	8	2.0	1.1

Table 4: Percentage Effects of Moving from SM to PM Contracts