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Authors

Lewis, Tracy R.
Ware, Roger
Feenstra, Robert

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UNIVERSITY OF CALIFORNIA, BERKELEY

Department of Economics

Berkeley, California 94720

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OPTIMAL EXCLUSION AND RELOCATION OF WORKERS
IN OVERSUBSCRIBED INDUSTRIES

Tracy R. Lewis, Roger Ware and Robert Feenstra

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Abstract

This paper characterizes informationally and politically constrained government programs for eliminating overemployment and overproduction in certain industries. The issues which we examine in this model include (i) To what extent is it possible to reduce the size of oversubscribed industries in light of the information and political constraints that exist? (ii) which "type" of workers (as characterized by their skill levels and outside employment opportunities) remain in the industry? (iii) Does the average skill level in the industry increase or decrease once the industry is reorganized? (iv) Which type of worker is harmed by the relocation program? Which coalitions of workers will oppose the reorganization?

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May 1988.

Tracy R. Lewis

Department of Economics
UC Davis

Roger Ware

Department of Economics
UC Berkeley
University of Toronto

Robert Feenstra

Department of Economics
UC Davis

OPTIMAL EXCLUSION AND RELOCATION OF WORKERS IN OVERSUBSCRIBED INDUSTRIES

1. Introduction

There are many industries in which productive inputs are widely perceived to be excessively employed. Such distortions can arise when subsidies in the industry have encouraged too much entry, when property rights are ill defined as in the exploitation of a common property resource, or when there is a sudden change in technology which allows for some elimination or consolidation of inputs employed in a particular enterprise.

Examples of this abound. Government incentives for overproduction in agriculture have escalated into a worldwide crisis in recent years.¹ Steel, automobiles, textiles, footwear and other industries routinely receive protection in the U.S. and abroad through tariffs and import quotas.² Overexploitation of common access fisheries is a common problem.³ In a bureaucratic context, budget cuts in many professional institutions, including universities have forced management to consider downsizing and layoff programs. Finally as a result of mergers, a rationalized industry may be oversupplied with workers of various types.

In theory, the restoration of these industries to efficient operation poses no problems for the government or social planner. So long as relocation costs are minimal and distributive effects are ignored, the government can redeploy productive resources efficiently with little information through decentralized taxation and subsidization. In practice such schemes are politically unviable and as such they are rarely implemented. Typically, insufficient funds are allocated to compensate displaced workers, or to pay for their relocation costs.

Potentially displaced workers thus have a strong incentive to maintain the status quo, and they usually lobby vigorously, and often successfully, to do so.⁴

In this paper we consider politically viable programs for the exclusion and relocation of workers from overemployed industries. We imagine that the workers are characterized by two attributes, their skill level on the job, as well as their ability to earn income in other industries. These characteristics are private information known only to the worker himself. A first best or efficient scheme for relocation would select the workers who could be bribed most inexpensively to leave, net of their productivity in the industry. However, without information of the workers characteristics, such first-best relocation would not be implementable, because of incentives created for the workers to exploit their private information. In addition political realities will dictate that any plan that is implemented must be acceptable to at least some proportion of those who are to be affected by the program.

This paper characterizes second best programs which account for information asymmetries and political acceptance constraints. Formally these programs are derived as a mechanism in which workers are confronted with a menu of employment options to choose from. For example, one option allows for compensation to workers who voluntarily leave the industry. Another set of options stipulates a schedule of payments to be received as a function of the work performed for all of those workers who choose to remain in the industry. The issues which we examine in this model include (i) To what extent is it possible to reduce the size of oversubscribed industries in light of the information and political constraints that exist? (ii) Which "type" of workers (as characterized by their skill levels and outside employment opportunities) remain in the industry? (iii) Does the average skill level in the industry increase or decrease

once the industry is reorganized? (iv) Which type of worker is harmed by the relocation program? Which coalitions of workers will oppose the reorganization?

The paper is organized as follows. In section 2 we present our model and assumptions. Initially we assume that the industry is receiving a production subsidy. The government now wishes to remove the subsidy which may have been appropriate at one time, but is deemed to be unnecessary now.⁵ Production and employment conditions are characterized for the status quo, which is the original free entry equilibrium in the subsidized industry. The status quo is compared with the first best or efficient organization of the industry in the absence of the subsidy. The task of reorganizing the industry subject to informational and political constraints is modelled as a mechanism design problem in the spirit of Mirrlees (1971) and more recently Baron and Myerson (1982) Guesnerie and Laffont (1984) and Lewis and Sappington (1988). Workers are allowed to choose from a menu of employment options. The menu is designed to select out workers who can leave the industry at lowest social cost while minimizing the government's cost of reorganization. To insure political viability the menu must provide enough compensation so that a sufficient percentage of workers benefit from the reorganization. The resultant policy is second best because of informational and political constraints facing the government.

Section 3 characterizes these second best policies for two cases which characterize the degree to which industry skills transfer to outside employment. In one case (N) higher skilled workers are unable to transfer their skill advantage to earn higher income on the outside. All workers command the same income outside the industry. In the other case (T) a worker's industry skills are highly transferable to the outside. The main results reported in section 3 indicate that political and information constraints prevent the government from removing all production distortions and restoring the industry to efficiency. This is

manifested in there being an inefficiently small number of workers employed in the industry after reorganization. In addition output distortions exist where inefficiently high levels of output may be induced from lower skilled workers, and inefficiently low levels of output may be induced from high skilled workers. The output policy is also inflexible, affording some workers little discretion in choosing a level of production to correspond with their relative skills.

Section 4 concludes the paper with a discussion of some applications and suggestions for further research. For expositional ease, proofs of our formal results are collected in the appendix.

2. The Model

The model we propose is quite simple, abstracting from several real world complexities associated with worker displacement, political processes and administrative procedures. Yet it does capture the salient features of formulating industrial policy under informational and political constraints.⁶ We envision an industry consisting of a large number of independent producing units. The example of an agricultural industry fits our analysis best although our discussion readily applies to other examples. For simplicity we assume that each worker is a single producing unit such as an independent farmer or firm. Each worker is characterized by a variable θ . The cost of producing output, q , to a worker of type θ is given by $(k-\theta)c(q|\theta)$ with $c(0) = 0$. $c(\cdot)$ is an increasing convex function of output, and $k > \theta$.⁷ Higher θ workers are more skilled and can produce at lower cost.

Let p be the constant market price for industry output. Initially, the industry receives a government subsidy of s per unit produced. Each worker chooses output to maximize profits, inclusive of the subsidy. Let $\pi^0(\theta)$ be the profit of a type θ worker or enterprise. It is defined by

$$\pi^0(\theta) = \max_{q(\theta)} (p+s)q(\theta) - (k-\theta)c(q(\theta)) \quad (1a)$$

where the optimal output, $q^0(\theta)$, satisfies

$$(p+s) - (k-\theta)c'(q^0(\theta)) = 0, \quad (\text{provided } q^0(\theta) > 0). \quad (1b)$$

Notice that $(p+s)$ is the perceived market price including the subsidy.

Each worker has employment opportunities outside this industry. The worker's outside reservation level of income (or profit) is $v(\theta)$. Our results hinge on certain properties of this reservation schedule. We distinguish between two cases.

Low transferability of skills, $v(\theta) = v$ Higher skilled workers [N]

have limited ability to transfer their skills to earn more on the outside.

High transferability of skills $v'(\theta) \geq \pi^0'(\theta)$ Higher skilled [T]

workers can readily transfer their skills to earn more on the outside.

For expositional ease we assume that $v(\theta) = v$ for [N]. The results to follow continue to hold when $v'(\theta)$ is sufficiently small. In the [T] case we assume that the transference of skills is sufficiently high that $v'(\theta) \geq \pi^0'(\theta)$. This ensures that the reservation utility schedule is steeper than the equilibrium profit schedule which is significant to our analysis.⁸

To motivate these two cases, we can consider different skills which a worker may possess: (a) firm specific human capital possibly received from on the job training which cannot be transferred outside the industry (the [N] case); (b) skills from education and observable abilities, which can lead to wage offers highly correlated across industries (the [T] case). Hamermesh (1987) documents the importance of firm specific human capital in a sample of displaced workers,

while Weiss (1980) considers a model where the reservation wages of workers are an increasing function of their productivity. A further distinction between the two cases is that firm specific capital may be unobservable, leading to a flat schedule of outside wage offers ($v(\theta)=v$), whereas education is observable and may be rewarded in outside offers ($v'(\theta) > 0$). However, notice that in our model workers receive payment within the industry which fully reflects their skill level (by virtue of self employment), but that the government cannot observe skills in either the [N] or [T] cases.

For our purposes there is little harm in assuming that workers of type θ are uniformly distributed over the unit interval $[0,1]$.⁹ Workers can produce in the subsidized industry or they can work outside. A type θ worker's income is thus determined by the max $[v(\theta), \pi^0(\theta)]$. We shall refer to the workers optimal choice of quantity in (1) and the set of employed workers with the subsidy as the status quo [SQ] equilibrium. Given our assumptions we can define the set of workers employed under [SQ] in the two cases [N] and [T] by, $I_N^0 = \{\theta | \theta \in [\hat{\theta}^0, 1]\}$ and $I_T^0 = \{\theta | \theta \in [0, \hat{\theta}^0]\}$, respectively, where $\hat{\theta}^0$ satisfies $\pi^0(\hat{\theta}^0) = v(\hat{\theta}^0)$. We shall assume that $\hat{\theta}^0 \in (0,1)$, so that there are some workers employed on the outside in the status quo.

It is instructive to compare [SQ] with the efficient industry equilibrium when the government subsidy, s , is removed. This reveals the misallocative effects of the subsidy. The efficient, no subsidy equilibrium [E] involves an output level $q^*(\theta)$ and corresponding profits $\pi^*(\theta)$ which are defined by

$$\pi^*(\theta) = \max_{q(\theta)} pq(\theta) - (k-\theta)c(q(\theta)) \quad (2)$$

$$p - (k-\theta)c'(q^*(\theta)) = 0, \quad (\text{whenever } q^*(\theta) > 0).$$

Denote by I_j^E the set of workers employed in the industry for $j = [N], [T]$. Efficient worker participation is then defined by $I_N^E = \{\theta \mid \theta \in [\hat{\theta}^*, 1]\}$ and $I_T^E = \{\theta \mid \theta \in [0, \hat{\theta}^*]\}$ where $\hat{\theta}^*$ satisfies $v(\hat{\theta}^*) = \pi(\hat{\theta}^*)$. A comparison of [SQ] and [E] is summarized in the following proposition which we state without proof.

Proposition 1: Compared with [E], [SQ] involves

- a. Excessive production, $q^0(\theta) > q^*(\theta)$
- b. Excessive worker participation. For [N] $\hat{\theta}^0 < \hat{\theta}^*$, and for [T] $\hat{\theta}^0 > \hat{\theta}^*$.

Any move towards efficiency in this industry requires both a reduction in the size of the industry work force as well as output supplied by each worker. The literature on externalities and their correction would suggest two traditional approaches to mitigating the inefficiency. First a taxation scheme would involve reversing or eliminating the original subsidy. This would of course make all workers worse off, and would not satisfy our political implementation constraint. Weitzman(1974) obtains a similar result in the context of a common property resource, where he shows that the restoration of efficient pricing to the resource would leave the workers worse off than under common access, unless income is redistributed. Second, the bargaining approach to externalities would argue that the excessive workers can profitably be bribed to leave by the government or by those remaining. Our analysis has similarities to both these approaches. As we shall see efficiency and implementability could be satisfied even with private information by eliminating the subsidy (or redefining the property right) and paying out a sufficiently large sum in compensation to all workers independent of type. The analysis to follow indicates that such a policy

would, however, be too expensive for the government to fund. We characterize optimal second best mechanisms to improve efficiency, taking appropriate account of the cost of public funds, and of the constraints imposed by private information.

The government's problem is to design policies which are efficient and politically acceptable when only the distribution of workers' types is known. The government can identify workers in I_j^0 prior to the industry reorganization.¹⁰ Our analysis shows that workers who are employed on the outside under [SQ] remain outside the industry once the industry is reorganized. The government is empowered to act as a Stackelberg leader who presents workers in I_j^0 with a menu of different options. Each option stipulates a (q, T) pair where q is the level of output that the worker supplies and T is total compensation that the worker receives. T includes the market value of output pq , plus a transfer τ from the government to the worker in the form of a subsidy or tax. One possible option is that the worker produces zero, and it receives compensation for exiting the industry as well as its reservation income, $v(\theta)$.¹¹

In order for the government to implement a particular policy where worker type θ chooses $\{q(\theta), T(\theta)\}$, an incentive compatibility restriction (IC) must be satisfied,

$$\pi(\theta) \equiv \pi(\theta|\theta) \geq \pi(\tilde{\theta}|\theta) \quad \text{for all } \tilde{\theta}, \theta \in I_j^0, j = N, T \quad (\text{IC})$$

where

$$\pi(\tilde{\theta}|\theta) \equiv T(\tilde{\theta}) - (k-\theta)c(q(\tilde{\theta})) + \delta(\tilde{\theta})v(\theta),$$

and δ is an indicator function which equals one whenever the worker is assigned to work on the outside with $q=0$ and it equals zero otherwise. $\pi(\tilde{\theta}|\theta)$ is the profit for worker type θ when it choose the quantity-compensation pair intended for worker of type $\tilde{\theta}$. (IC) simply requires that worker type θ must prefer

$\{q(\theta), T(\theta)\}$ to all other options offered in the menu. Also implicit in this formulation is the assumption that the government can observe and monitor the output of individual workers when arranging for their compensation.¹²

The government also operates under an additional constraint that the reorganization be politically acceptable, and can therefore be implemented. We choose to model this as a constraint that some prespecified proportion of incumbent workers remain at least as well off under the reorganization. One interpretation is that a violation of this constraint would create sufficient political pressure to prevent the reorganization. Another interpretation is that a favorable vote of the workers is necessary in order to affect the change. Specifically let $M \in (0, 1]$ be the proportion who must be made at least as well off under reorganization. The set of θ types who are not harmed by the reorganization is referred to as the set \tilde{M} which is defined by $\tilde{M} = \{\theta \mid \pi(\theta) \geq \pi^0(\theta)\}$. For a policy to be politically implementable (PI) we require that

$$\int_{\theta \in \tilde{M}} dF^0(\theta) \geq M \quad (\text{PI})$$

where $F^0(\theta)$ is the cumulative density for $\theta \in I_j^0$.¹³

The government wishes to maximize the net surplus from industry production. Let $W(q(\theta), \theta) = pq(\theta) - (k-\theta)c(q(\theta)) + \delta(\theta)v(\theta)$. For each type θ , net government surplus is given by

$$W(q(\theta), \theta) - \lambda(T(\theta) - pq(\theta))$$

To interpret the expression above, note that $W(q(\theta), \theta)$ represents the market value (net of costs) of industry output plus the reservation income generated by

workers employed outside the industry. Recall that each worker receives $T(\theta)$ which consists of the market value of his production plus a subsidy (or tax) from the government. The difference between $T(\theta)$ and $pq(\theta)$ is the subsidy (or tax) which the worker receives from the government. (When $q = 0$, workers still receive a subsidy even though they are employed outside the industry.) Such funds are usually financed with some sort of distortionary tax. The variable $\lambda > 0$ measures the marginal social cost (in terms of efficiency loss) of raising these funds. Substituting for $T(\theta)$ from the statement of (IC) in the expression above, and rearranging and renormalizing terms yields an alternative expression for net government surplus,

$$W(q(\theta), \theta) - \alpha \pi(\theta)$$

where $\alpha = \lambda / (1 + \lambda) > 0$.

The government's problem can now be formally stated as [GP]

$$\begin{array}{ll} \text{maximize} & \int_{\theta \in I_j^0} \{W(q(\theta), \theta) - \alpha \pi(\theta)\} dF^0(\theta) \\ q(\theta), T(\theta) & \end{array} \quad \text{[GP]}$$

subject to (IC), (PI).

3. Analysis

As a preliminary step in solving the government's problem, we record two properties that must hold to satisfy incentive compatibility (IC). Define I_j to be the set of all types who continue to be employed in the industry after reorganization.

Lemma 1: Necessary and sufficient conditions for (IC) to hold are that $\pi(\theta)$ be continuous and piecewise differentiable with:

(i) $\pi'(\theta) = c(q(\theta))$ and $q(\theta)$ is nondecreasing, for all $\theta \in I_j$;

(ii) $\pi'(\theta) = v'(\theta)$ for all $\theta \notin I_j$.

Condition (i) and the definition of $\pi(\theta)$ imply that $T'(\theta) = (k-\theta)c'(q(\theta))q'(\theta)$. This implies that T goes up with output q at the rate of marginal costs, $(k-\theta)c'$. The marginal rate of substitution of T for q for type θ is also equal to $(k-\theta)c'$. Hence, (i) is simply a tangency condition indicating that workers choose their most preferred (T, q) pair from the compensation-output schedule which the government offers. Part (ii) implies that $T'(\theta) = 0$ for $\theta \notin I_j$. Thus all workers who exit the industry receive the same government transfer. If instead, transfers varied by type for $\theta \notin I_j$, all workers leaving the industry would claim to be the type receiving the largest transfer.

Notice that Lemma 1 implies that we could implement [E] by simply transferring a constant sum T to each worker who would be allowed to maximize its own profits, $(pq - (k-\theta)c(q))$. One would choose T to satisfy the political implementation constraint. We shall see below, however, that this policy would transfer too much income to the workers.

Before characterizing optimal government programs we introduce one further restriction, the strong subsidy [SS] assumption:

$$s > (\alpha / (k-1-\alpha))p \quad \text{[SS]}$$

If the initial subsidy s is very small then the status quo equilibrium will be nearly efficient. In that case the (IC) and (PI) constraints bind in such a way that the government can do little better than to maintain the status quo. [SS] is

a technical assumption which specifies a lower bound on s insuring that the solution to [GP] differs significantly from [SQ]. Of course, from a policy perspective we are interested in those cases where the initial subsidy is sufficiently large so that there are large potential benefits from industry reorganization. Simple calculations reveal that for our model [SS] will typically be satisfied for subsidies which are equal to or greater than 15 per cent of the market price.¹⁴

Government Policies When Workers' Skills Are Not Transferable

Political implementation requires that M percent of the workers benefit from industry reorganization. Given $M \in (0,1)$, for any feasible solution to [GP] there will exist some $\theta' \in I_N^0$ such that $\pi(\theta) = \pi^0(\theta')$.¹⁵ From Lemma 1 (and recalling that $v'(\theta) = 0$ for $[N]$) we can represent $\pi(\theta)$ by:

$$\pi(\theta) = \begin{cases} \pi^0(\theta') - \int_{\theta}^{\theta'} c(q(z)) dz, & \theta \leq \theta' \\ \pi^0(\theta') + \int_{\theta'}^{\theta} c(q(z)) dz, & \theta > \theta' \end{cases} \quad (3)$$

Substituting this expression for $\pi(\theta)$ into [GP] and integrating by parts we can rewrite the government's problem as [GP]'

$$\text{maximize}_{q(\cdot), \theta'} \int_{\theta \in I_N^0} AW(q(\theta), \theta) dF^0(\theta) \quad \text{s.t. (IC), (PI)}$$

where

$$\begin{aligned}
 W(q(\theta), \theta) &= \alpha[\pi^0(\theta') - (F^0(\theta)/f^0(\theta)) c(q(\theta))] &< \\
 AW(q(\theta), \theta) &= W(q(\theta), \theta) - \alpha[\pi^0(\theta')] &\theta = \theta' \quad (4) \\
 W(q(\theta), \theta) &= \alpha[\pi^0(\theta') + (1 - F^0(\theta))/f^0(\theta) c(q(\theta))] &>
 \end{aligned}$$

The AW expression in (4) is the "adjusted welfare" function which includes the conventional welfare measure, W as well as a second term which accounts for the rents or profits which must be afforded the firm. To interpret this second term in square brackets, note that for $\theta > \theta'$, profits must rise at the rate of $c(q(\theta))$ to satisfy (IC). Thus if type θ is assigned costs $c(q(\theta))$, all types higher than θ , (which includes $1 - F^0(\theta)$ of the population) have their profits increase by $c(q(\theta))$. The total increase in profits which the government must pay is thus $(1 - F^0(\theta)) c(q(\theta))$. (We divide this term by $f^0(\theta)$ since AW is multiplied by $f^0(\theta)$ in [GP]'). There is a similar explanation for the second term appearing in AW for $\theta < \theta'$.

In the analysis to follow, $\tilde{q}(\theta)$ denotes the quantity that maximizes $AW(q, \theta)$. In general, \tilde{q} will differ from q^* because of the government's desire to limit the workers' profits. The major qualitative properties of the solution to [GP]' for the [N] case are summarized in the Proposition 2 and illustrated in Figures 1 and 2.

Proposition 2: Given [N], and [SS]

$$(a) \quad I_N = \{ \theta \mid \hat{\theta} \leq \theta \leq 1 \}, \quad I_N \subset I_N^E \subset I_N^0$$

$$\hat{\theta} \text{ satisfies } pq(\hat{\theta}) - (k - \hat{\theta})c(q(\hat{\theta})) = v$$

$$(b) \text{ For } \theta \in I_N, \quad q(\theta) < q^0(\theta) \text{ and}$$

$$\begin{aligned}
q(\theta) &> q^*(\theta), & \hat{\theta} \leq \theta < \theta_1 \\
q(\theta) &= \bar{q}, & \theta_1 \leq \theta \leq \theta_2 \\
\tilde{q}(\theta) &\leq q^*(\theta), & \theta_2 \leq \theta \leq 1 \text{ (with strict inequality for } \theta = 1 \text{)}
\end{aligned}$$

where \bar{q} maximizes expected adjusted welfare over (θ_1, θ_2) and

$$\hat{\theta} \leq \theta_1 \leq \theta' < \theta_2 \leq 1$$

(c) $\tilde{M} = \{ \theta \mid \hat{\theta}^0 \leq \theta \leq \theta' \}$, with θ' satisfying $M = \int_{\hat{\theta}^0}^{\theta'} dF^0(\theta)$

(d) $q(\theta)$ and θ' are increasing in M .

The integral of net government surplus is decreasing in M .

Figure 1 shows the constant outside income level, v , profits, $\pi^0(\theta)$ under [SQ] and profits, $\pi(\theta)$ under [GP]. The lowest skilled worker employed under [SQ] is $\hat{\theta}^0$, satisfying $\pi^0(\hat{\theta}^0) = v$. After reorganization, workers in the interval $[\hat{\theta}^0, \hat{\theta}]$ are paid a transfer, denoted by \hat{T} , which is sufficient to induce them to leave the industry. As indicated in part (a) of Proposition 2, this exceeds the set of workers who would exit under the efficient equilibrium. The reason for this is that under [GP] employment is determined at the point where the industry surplus $p q(\hat{\theta}) - (k - \hat{\theta}) c(q(\hat{\theta}))$ generated by the marginal worker is equal to its opportunity income, v . This condition also determines employment under [E]. Generally, however, workers don't maximize surplus in the solution to [GP] as indicated in part (b). Thus the contribution of each worker is less than under efficient conditions and less workers are retained under [GP] than are employed under efficient conditions.

The output profile is described in part (b) and illustrated in Figure 2 by the $q(\theta)$ curve. Efficient output is denoted by the $q^*(\theta)$ curve. Under [SQ] output is excessive. This inefficiency is partially corrected under reorganization as $q(\theta) < q^0(\theta)$. However, as shown by the comparison with $q^*(\theta)$, $q(\theta)$ is generally not efficient; inefficiently high levels of output are induced for low skill types and inefficiently low output levels are induced for high skilled workers. The choice of $q(\theta)$ involves a tradeoff between efficiency and the limitation of workers' profits which is described as follows: (PI) requires that $\pi(\theta') = \pi^0(\theta')$. For $\theta > \theta'$ we know from (3) that a worker's income increases with its type at the rate of $c(q(\theta))$. Over this range the government will tend to induce lower than efficient levels of output in order to limit the rate which higher type workers earn income. This is reflected in Figure 2. For $\theta < \theta'$ income declines with lower type workers at the rate of $c(q(\theta))$. In this instance the government tends to induce higher than efficient levels of output, in order to increase the rate which income falls with lower type workers.

In Figure 2 there is an interval, (θ_1, θ_2) , of pooling where all agents are induced to choose the same terms involving an output level \bar{q} . To explain this we note that for types $\theta < \theta'$ the government would like to continue to induce output above the efficient level along the extension of the segment AB in Figure 2 in order to increase the decline in workers' profits as θ decreases. And to limit the workers' increase in profits, the government would like to continue to induce output below the efficient level for all $\theta > \theta'$ along the extension of segment CD in Figure 2. To do so however, would require that for some range of θ around θ' that output would decrease with higher θ 's. But this would violate (IC) according to Lemma 1.

Consequently, the government can do no better than to induce the same level of output, \bar{q} in the interval (θ_1, θ_2) that surrounds θ' . In this case we

obtain quite a simple policy, where all agents in (θ_1, θ_2) are forced to abide by the same production rule, and receive the same compensation, T . Figure 2 shows that \bar{q} is clearly not ex post efficient except for a single realization of θ . However, given that output must be constant over (θ_1, θ_2) , \bar{q} is chosen efficiently to maximize expected adjusted welfare over (θ_1, θ_2) .¹⁶

To summarize, the output policy $q(\theta)$ chosen by the government has a very simple interpretation. The government selects a single production level \bar{q} which workers must supply, with some exceptions. \bar{q} is efficient ex ante, given the set of workers who supply it. Exceptions to this production rule are granted to the relatively low skilled workers who are allowed to supply less than \bar{q} , and to the relatively high skilled workers who are instructed to supply more than \bar{q} .¹⁷

Part (c) of the Proposition and Figure 1 reveal that \tilde{M} the set of types who benefit from reorganization consist of an interval $[\hat{\theta}^0, \theta^*]$ of the lower skilled workers. Political implementation requires that the high skilled types be taxed to make some group of low skilled workers better off. Some tax revenues will be used as a bribe to induce some workers out of the industry. The preferential treatment of low skilled workers is not explained by a government preference for these workers. Rather it follows from the fact that the [SQ] income profile, $\pi^0(\theta)$ is steeper than $\pi(\theta)$. To see this, note that (IC) requires that the slope of $\pi(\theta)$ is $c(q(\theta))$ for $\theta \in I_H$, and it is zero otherwise. By (1) the slope of the $\pi^0(\theta)$ is $c(q^0(\theta))$. Since $q(\theta) < q^0(\theta)$ and $c(\cdot)$ is increasing, $\pi(\theta)$ is flatter than $\pi^0(\theta)$. Hence the rate at which income increases with type is less and income is more equally distributed across types under reorganization. To achieve this more even distribution of income, some low skilled workers must benefit at the expense of high skilled workers.

Part d implies that as M increases, so that reorganization requires the consent of a greater percent of workers, that the set \tilde{M} must grow and that the integral of net government surplus decreases. A less obvious result is that $q(\theta)$ is weakly increasing in M . Recall that rent limitation calls for inducing higher than efficient levels of output for all types $\theta < \theta'$. As M grows, θ' the type for which (PI) binds increases. This means that more workers will be induced to supply higher levels of output with increases in M . In the limit where $M = 1$, $q(\theta) > q^*(\theta)$ for all $\theta \in I_N$ and $\tilde{M} = I_N^0$.

Government Policies When Workers' Skills Are Transferable

As in the (N) case, it proves useful to rewrite [GP] in terms of the adjusted welfare expression. In the Proposition below we establish that $I_T = \{\theta \mid \theta \in [0, \hat{\theta}]\}$. From Lemma 1, we can represent worker's income, $\pi(\theta)$ as

$$\pi(\theta) = \begin{cases} \pi(\hat{\theta}) - \int_{\hat{\theta}}^{\theta} c(q(z)) dz, & \theta \leq \hat{\theta} \\ \pi(\hat{\theta}) + \int_{\hat{\theta}}^{\theta} v'(z) dz, & \theta > \hat{\theta} \end{cases} \quad (5)$$

where we have used $\hat{\theta}$, the marginally employed worker after reorganization, as our reference point. Substituting this expression for $\pi(\theta)$ into [GP] and integrating by parts we can rewrite the government's problem as [GP]'

$$\text{maximize}_{q(\theta), \hat{\theta}} \int_{\theta \in I_T^0} AW(q(\theta), \theta) dF^0(\theta) \quad \text{s.t. (IC), (PI)}$$

where

$$\begin{aligned}
 W(q(\theta), \theta) - \alpha[\pi^0(\hat{\theta}) - (F^0(\theta)/f^0(\theta)) c(q(\theta))] &< \\
 AW(q(\theta), \theta) = W(q(\theta), \theta) - \alpha\pi^0(\hat{\theta}) & \theta = \hat{\theta} \quad (6) \\
 W(q(\theta), \theta) - \alpha[\pi^0(\hat{\theta}) + (1-F^0(\theta))/f^0(\theta)] v'(\theta) &>
 \end{aligned}$$

As before, the adjusted welfare expression in (6) includes the conventional welfare measure, W , as well as a term which accounts for the rents which must be afforded the firm. We continue to let $\tilde{q}(\theta)$ denote the quantity which maximizes $AW(q, \theta)$ defined by (6). There can now be two skill types for which $\pi(\theta) = \pi^0(\theta)$ and these are denoted by θ' and θ'' with $\theta' < \theta''$. The major qualitative properties of the solution to [GP]' for the [T] case are summarized in Proposition 3

Proposition 3: Given [T] and [SS]

$$(a) \quad I_T = \{ \theta \mid 0 \leq \theta \leq \hat{\theta} \}, \quad I_T \subset I_T^E \subset I_T^0,$$

$$\hat{\theta} \text{ satisfies: } pq(\hat{\theta}) - (k - \hat{\theta})c(q(\hat{\theta})) = v(\hat{\theta})$$

(b) For $\theta \in I_T$, $q(\theta) < q^0(\theta)$ and

(i) If (PI) is not binding, $q(\theta) = \tilde{q}(\theta) > q^*(\theta)$

(ii) If (PI) is binding,

$$\begin{aligned}
 \tilde{q}(\theta) > q^*(\theta), & \quad \hat{\theta} \leq \theta < \theta_1 \\
 q(\theta) = \bar{q}, & \quad \theta_1 \leq \theta \leq \theta_2 \\
 \tilde{q}(\theta), & \quad \theta_2 < \theta \leq \hat{\theta}
 \end{aligned}$$

where \bar{q} maximizes expected adjusted welfare over (θ_1, θ_2) and

$$0 \leq \theta_1 < \theta' < \theta_2 \leq \hat{\theta}$$

$$(c) \tilde{M} = \{\theta \mid \theta \in [0, \theta^*] \text{ or } \theta \in [\theta^*, \hat{\theta}^0]\}, \theta^* \leq \hat{\theta} \leq \theta^*$$

In Figure 3 we illustrate the reservation income $v(\theta)$, profits, $\pi^0(\theta)$ under [SQ], and profits, $\pi(\theta)$ under the government policy, for the case $M < 1$ and (PI) is binding. Under [SQ] workers with skill level above $\hat{\theta}^0$ work outside the industry, whereas under [GP] workers above $\hat{\theta}$ exit.

Propositions 2 and 3 reveal some interesting similarities and differences between the [N] and [T] cases. First we note from part a of Proposition 3 that like the [N] case employment is inefficiently small under [T]. Less than the efficient number of workers is retained because production distortions reduce each worker's contribution to the industry. An apparent difference between [N] and [T] lies in the employment sets I_N and I_T . When skills are not transferable, workers are equally productive on the outside, so the higher skilled workers are employed in the industry. However, with [T] the higher skilled workers are also more productive on the outside and it is not obvious which types should remain in the industry. According to part (a) of Proposition 3, the less skilled workers are retained in the industry. Intuitively this arises because (IC) constraints make it too costly for the government to employ higher skilled workers if lower skilled workers have been excluded from the industry. The reason is that opportunity income rises very fast with skill level in the [T] case. Thus any severance payment which induces a lower skilled worker to exit looks even more attractive to a higher skilled worker. The compensation required to retain higher skilled workers exceeds the value of the output they produce. Thus only lower skilled workers are retained.

Another interesting difference between the [N] and [T] cases is political implementability. (PI) always binds in the [N] case. In contrast political implementability may not bind in the [T] case when M is sufficiently small. This situation is depicted in Figure 4 where M is such that (PI) just requires that types $\theta < \tilde{\theta}$ benefit from the reorganization whereas all types $\theta < \theta'$ actually benefit from the reorganization. This occurs because the restriction that workers must receive at least $v(\theta)$ to remain in the industry turns out to be binding constraint in this case. Satisfying this employment constraint is more than sufficient to insure political implementability.

There continue to be differences between the [N] and [T] cases when (PI) is binding. In the [N] case the π schedule intersects π^0 at a single point θ' and all lower skilled workers $\theta < \theta'$ support reorganization. In the [T] case there is a "kink" in the $\pi(\theta)$ schedule at $\hat{\theta}$ as indicated by equation (5). This means that π may intersect π^0 at two points, θ' and θ'' as we have depicted in Figure 3. This implies that reorganization will be supported by a subset $(0, \theta')$ of the lower skilled workers as well as by a subset $(\theta'', \hat{\theta}^0)$ of the higher skilled workers. The higher skilled workers benefitting from reorganization, will be the ones induced to leave the industry.¹⁸

Part (b) of Proposition 3 describes the output induced under reorganization. Roughly the same results emerge here as in the [N] case; inefficient levels of output will generally be induced in order to limit the rents which workers accrue from their private information. Also there may be a region of pooling around θ' when pointwise maximization of adjusted welfare, violates the monotonicity condition of (IC).

We indicated earlier (see fn. 8) that our characterization of optimal policies is incomplete for situations where $\pi^*(\theta) \leq v(\theta) \leq \pi^0(\theta)$. These are interesting but difficult cases to analyze since the employment sets and worker

coalitions supporting reorganization may consist of disjoint intervals of worker types. Characterization of these cases will have to await further analysis.

To summarize, Propositions 2 and 3, reveal that political and information constraints prevent the government from removing all production distortions and restoring the industry to efficiency. Second best policies for reorganization are characterized by:

(1) *Underemployment of workers:* Reorganization will involve a reduction in employment, relative to the status quo. However there will also be underemployment of workers relative to the first best. The reason is that incentive compatibility constraints will require a distortion of workers output away from efficiency. Each worker's contribution will be less than it would be under first best conditions, so that fewer workers will be employed in the industry.

(2) *Workers' Output will be inefficient:* Each worker's output will be reduced under reorganization as production subsidies are removed. However workers will be induced to supply inefficiently high or low levels of output in order to reduce the rents they command from their superior information. This inefficiency will be further reflected in the "pooling" regions where workers have no discretion in choosing quantities to supply in accord with their relative skill levels. Such inflexible production rules may be relatively attractive in their ease of administration, however.

(3) *Excluded Workers:* In case [N], when skills aren't transferable, lower skilled workers will be excluded. In case [T], when skills are highly transferable, higher skilled workers will be induced to leave the industry.

(4) *Political Implementation:* The coalition of workers benefitting from reorganization will typically include some of the workers who are "bribed" to

leave the industry. Whether or not particular workers who remain in the industry support reorganization will vary by case, [N] or [T].

While our analysis is normative certain predictions of our model correspond, at least in spirit, with certain real world observations. Our model primarily demonstrates how effectively (PI) constraints impede the removal of production subsidies. This is consistent with the observation that special interest groups have managed to block the removal of agricultural price support programs in several countries including the United States.

4. Summary and Extensions

So far as we know the application of our techniques to study politically constrained public policy is new. At this stage our analysis is necessarily simple as we abstract from several complications associated with political processes and administrative procedures. Despite this we believe that there are three important general conclusions emerging from our analysis, which are likely to hold in richer environments than the one we have modelled. Some of these results point to the attractiveness of our analysis, while others reveal certain weakness in our approach which will need to be remedied in future research. Our first general result is:

1. With informational and political constraints, efficient reorganization may be possible, but it is generally undesirable.

By Lemma 1 it's possible to induce efficient reorganization, provided that worker's profits increase with type at the rate $c(q^*(\theta)) + \delta^*(\theta) v'(\theta)$, where $\delta^*(\theta)$ is an indicator variable which equals one when $q^*(\theta) = 0$, and the worker is excluded from the industry. Notice that total surplus increase with worker type at the rate,

$$W'(q(\theta), \theta) = W_q q'(\theta) + W_\theta$$

When the efficient policy is implemented with $q(\theta) = q^*(\theta)$, so that $W_q q' = 0$, the rate of increase in total surplus becomes

$$W'(q^*(\theta), \theta) = W_\theta(q^*(\theta), \theta) = c(q^*(\theta)) + \delta^*(\theta) v'(\theta) = \pi'(\theta) \quad (7)$$

According to (7) all of the differential rents arising from workers of increasing skill, are captured by the workers themselves when the industry is run efficiently. Since there is a shadow cost to transferring public funds to pay workers, the government wants to limit the workers' rents to reduce transfer payments. Thus while it is possible to achieve production efficiency it is not desirable.

This result is an application of the Theory of the Second Best. It is because there is a distortion elsewhere in the economy from raising government revenue that industry reorganization is inefficient. Also given that there is a distortion in workers output, less than the efficient number of workers are retained in the industry.¹⁹ By usual second best arguments, an adjustment in industry employment towards the optimal level would only make things worse.

2. Optimal Reorganization depends on the status quo equilibrium

Propositions 2 and 3 reveal that reorganization is quite sensitive to the status quo equilibrium. This implies that our analysis is unlikely to yield many general results. Rather the details of industry reorganization need to be specified on a case by case basis depending on the [SQ] equilibrium. More generally, this suggests that history matters in formulating industrial policy. The correction of market imperfections is limited by political constraints, and the coalition of workers

who support changes in their industry depends on the original state of the industry. Also, it suggests that some industry changes like the imposition of a temporary production subsidy are hard to undo. Once a subsidy is introduced, there is political opposition to removing it. In addition a policy which is advertised as being only temporary may be time inconsistent, as pointed out by Matsuyama (1987), Staiger and Tabellini (1987) , and Tornell (1988). in the context of industry protection. The same problems exist on a larger scale when trying to shift government expenditure from ,say, defense to welfare and education. Reductions in defense expenditures will be opposed by the industrial military complex. Anticipating this, the government will want to devise policies for industry change which can be implemented with the support of the minimal political constituency, since this same constituency will oppose the government later on if it wants to reverse the policy.

3. How Stable are Reorganized Industries?

Our analysis models the government as a Stackelberg leader who commits to a take it or leave policy for industrial change. Workers react to this taking the commitment of the government to this policy as given. Of course policies don't last forever, and the ability of governments to commit to policies over the long term is questionable. Ironically, it is the fact that Congress and the regulatory agencies are potentially so powerful, which prevents them from credibly committing themselves (and especially their successors) not to change industrial policy in accord with information they obtain over time. In theory there is a good reason why industries which have recently been reorganized by the government may be subject to further change in the future. After the reorganization, the government may have more information about the workers' characteristics, as revealed by their decisions. With this new information, the government may want

to institute further changes in order to tax away some of the workers excess income. It may also want to renegotiate terms to correct the ex post inefficiencies in the industry. Of course, if workers can anticipate these eventual changes, they will act differently in the original reorganization to protect themselves against further policy changes.²⁰

In contrast to this, our model is cast in an environment in which government policy changes are long lasting. In reality major industrial and commercial policy changes like elimination of agriculture price supports and restructuring of tax codes occur infrequently. There are several reasons for this. In practice it may be too costly for the government to track the individual decisions and behavior of all industry workers during reorganization. The advantages from further policy changes are diminished without this information as the ability of the government to collect additional payments and to correct inefficiencies in the industry is reduced. In addition once the industry becomes more efficient through reorganization, the incentives for further policy changes in order to enhance efficiency are diminished. Finally the ability to commit is a valuable asset for governments. Carrying out policies which are ex post undesirable helps governments to establish a reputation for policy commitment which can be useful in affecting future policy.

We recognize, however, that if governments can not commit to certain policies, their ability to improve industry performance is diminished. An important direction for further research is to investigate the types of industrial policies which can be implemented in an environment in which government commitment to future policies is imperfect.²¹

APPENDIX

Proof of Lemma 1: The proof of Lemma 1 follows directly from arguments presented in Baron and Myerson (1982) and Guesnerie and Laffont (1984) and so is omitted.

Proof of Proposition 2: Before proceeding to the proof of Proposition 2 we need to establish some preliminary results.

Lemma A1: Given [N] and [SS] $\pi(\theta)$ intersects $\pi^0(\theta)$ once and from above at some $\theta' \in (\hat{\theta}^0, 1]$

Proof: Since all workers are equally productive on the outside, the employment set I_N will consist of some interval $[\hat{\theta}, 1]$ of higher skilled workers. Clearly the continuous schedules $\pi(\theta)$ and $\pi^0(\theta)$ must touch or intersect at least once, otherwise (PI) would be violated, or it would not bind which must be suboptimal for the government.

Suppose, contrary to our assertion, that the $\pi(\theta)$ schedule intersects $\pi^0(\theta)$ from below at some θ' . Clearly $\theta' > \hat{\theta}$ since $\pi(\theta)$ is flat for $\theta \leq \hat{\theta}$. Now consider the subproblem of maximizing net government surplus over the interval $[\hat{\theta}^0, \theta']$ holding $\hat{\theta}$ constant and subject to (IC) and the restriction that $\tilde{\pi}(\theta') = \pi^0(\theta')$ where $\tilde{\pi}$ is the resulting income schedule. According to Lemma 1,

$$\tilde{\pi}(\theta) = \pi^0(\theta') - \int_{\hat{\theta}}^{\theta'} c(q(z)) dz, \quad \theta < \theta'$$

Substituting this expression for $\pi(\theta)$ into [GP] and integrating by parts we can express this subproblem as

$$\text{maximize}_{q(\theta)} \int_{\theta < \theta'} AW(q(\theta), \theta) dF^0(\theta)$$

where

$$AW(q(\theta), \theta) = W(q(\theta), \theta) - \alpha[\pi^0(\theta') - (F^0(\theta)/f^0(\theta)) c(q(\theta))]$$

The solution to this problem is partially characterized by

$$dAW(\tilde{q}(\theta), \theta)/dq = 0, \theta \in [\hat{\theta}^0, \theta'], \tilde{q}(\theta) = 0, \theta < \hat{\theta}^0$$

where $\tilde{q}(\theta)$ is optimal output. Given [SS] it's easy to show that $\tilde{q}(\theta) < q^0(\theta)$ for all $\theta \in [\hat{\theta}^0, \theta']$. Since the slopes of $\tilde{\pi}(\theta)$ and $\pi^0(\theta)$ are both given by $c(q)$, and since $\tilde{q}(\theta) < q^0(\theta)$, the $\tilde{\pi}(\theta)$ schedule is flatter than the $\pi^0(\theta)$ schedule. Thus $\tilde{\pi}(\theta) > \pi^0(\theta)$ for $\theta \in [\hat{\theta}^0, \theta']$. It follows that if [PI] was satisfied originally, it is also satisfied by the solution to this subproblem. Hence $\tilde{q}(\theta)$ is implementable and it also maximizes net surplus over the interval $[\hat{\theta}^0, \theta']$. But notice $\tilde{\pi}(\theta)$ intersects $\pi^0(\theta)$ from above, thus contradicting our original supposition.

The argument above has demonstrated that if $\pi(\theta') = \pi^0(\theta')$ then $\pi(\theta) > \pi^0(\theta)$ for $\theta \in [\hat{\theta}^0, \theta']$. To conclude the proof we must show that $\pi(\theta)$ and $\pi^0(\theta)$ can not touch at some point θ' with $\pi(\theta) > \pi^0(\theta)$ for $\theta \in (\theta', 1]$. If this were true then [PI] would not be binding for $\theta \in (\theta', 1]$. In that case the subproblem of maximizing net government surplus over $(\theta', 1]$ would be

$$\text{maximize}_{q(\theta)} \int_{\theta'}^1 AW(q(\theta), \theta) dF^0(\theta)$$

where

$$AW(q(\theta), \theta) = W(q(\theta), \theta) - \alpha[\pi^0(\theta') + (1 - F^0(\theta)/f^0(\theta)) c(q(\theta))]$$

The expression for AW is obtained as before by using Lemma 1 to substitute for $\pi(\theta)$ in [GP]. The solution to this problem is partially characterized by

$$dAW(\tilde{q}(\theta), \theta)/dq = 0, \quad \theta \in (\theta', 1),$$

where $\tilde{q}(\theta)$ is optimal output. Given [SS] it's easy to show that $\tilde{q}(\theta) < q^0(\theta)$. By previous arguments this implies that the corresponding income schedule $\tilde{\pi}(\theta)$ lies below $\pi^0(\theta)$ for $\theta > \theta'$ thus violating our original assumption. This completes the proof of Lemma A1.

By Lemma A1 we know that [GP] can be rewritten as [GP]' in the text. We can now proceed directly to prove Proposition 2. For convenience some parts of the Proposition are proved in a different order from which they appear in the text.

Proof of part c: Since π intersects π^0 once from above, it follows that $\tilde{M} = \{\theta \mid \hat{\theta}^0 \leq \theta \leq \theta'\}$ where $\pi(\theta') = \pi^0(\theta')$. To satisfy (PI) θ' must satisfy,

$$M = \int_{\hat{\theta}^0}^{\theta'} dF^0(\theta)$$

Proof of part b (sketch): Let $\tilde{q}(\theta)$ be the output which pointwise maximizes $AW(q(\theta), \theta)$ in [GP]'. $\tilde{q}(\theta)$ is characterized by

$$dAW(\tilde{q}(\theta), \theta)/dq = 0, \quad \theta \in I_N \quad (a1)$$

It's clear from the definition of AW in the text and from (a1) that $\tilde{q}(\theta)$ decreases discontinuously at $\theta = \theta'$. Thus it is not possible to implement $\tilde{q}(\theta)$ since it would violate (IC). Borrowing from Baron and Myerson (1982), Guesnerie and Laffont (1984) and Lewis and Sappington (1987), standard arguments can be applied to show that the optimal policy involves pooling with $q(\theta) = \bar{q}$ in some

neighborhood $[\theta_1, \theta_2]$ of θ' where $\tilde{q}(\theta)$ is not monotonically increasing. Outside of this neighborhood, $q(\theta) = \tilde{q}(\theta)$. The characterization of the pooling region and the optimal output policy are described as follows:

$$q(\theta) = \begin{cases} \min [\tilde{q}(\theta), \bar{q}] & , \theta \leq \theta' \\ \max [\tilde{q}(\theta), \bar{q}] & , \theta > \theta' \end{cases}$$

where $\tilde{q}(\theta)$ satisfies: $dAW(\tilde{q}(\theta), \theta)/dq = 0$

$$\bar{q} \text{ satisfies: } \int_{\theta_1}^{\theta_2} \{dAW(\bar{q}, \theta)/dq\} dF^0(\theta) = 0$$

and $q = \tilde{q}(\theta_i)$ for $i = 1, 2$ when $\theta_1, \theta_2 \in (\hat{\theta}, 1)$

From this characterization it's easy to verify that $q(\theta)$ satisfies the properties of part b. Since the complete proof and derivation of this characterization is straightforward but long, the reader is referred to Proposition 1 of Lewis and Sappington (1988) for details. (This paper is available upon request).

Proof of part a: Differentiating the integral of net government surplus in [GP]' with respect to $\hat{\theta}$ yields

$$\lambda(\hat{\theta}) = v - pq(\hat{\theta}) - (k - \hat{\theta})c(q(\hat{\theta}))$$

where $\lambda(\hat{\theta})$ measures the marginal change in net surplus from reducing employment in the industry. Let

$$\lambda^*(\hat{\theta}) = v - pq^*(\hat{\theta}) - (k - \hat{\theta})c(q^*(\hat{\theta}))$$

be the marginal change in net surplus in the efficient-first best case. Since $q^*(\theta)$ maximizes industry surplus, it follows that $\lambda(\hat{\theta}) \geq \lambda^*(\hat{\theta})$ for all $\hat{\theta}$ (with strict inequality whenever $q(\theta) \neq q^*(\theta)$). Note, the first best cutoff type, $\hat{\theta}^*$ satisfies

be the marginal change in net surplus in the efficient-first best case. Since $q^*(\theta)$ maximizes industry surplus, it follows that $\lambda(\hat{\theta}) \geq \lambda^*(\hat{\theta})$ for all $\hat{\theta}$ (with strict inequality whenever $q(\theta) \neq q^*(\theta)$). Note, the first best cutoff type, $\hat{\theta}^*$ satisfies

$$0 = \lambda^*(\hat{\theta}^*) \leq \lambda(\hat{\theta}^*)$$

This together with the fact that $\lambda(\hat{\theta}) \geq \lambda^*(\hat{\theta})$ for all $\hat{\theta}$ implies that $\hat{\theta} \leq \hat{\theta}^*$ (with strict inequality if $q(\theta) \neq q^*(\theta)$). Combining these results with part b of Proposition 1 serves to establish that $I_N \subset I_N^E \subset I_N^O$

Proof of part d: Differentiating the equation

$$M = \int_{\hat{\theta}^0}^{\theta^*} dF^0(\theta)$$

totally with respect to M establishes $d\theta^*/dM > 0$, which establishes that \tilde{M} is increasing with M .

Totally differentiating the expression which defines \bar{q} in part c of Proposition 2 with respect to M establishes that $d\bar{q}/dM > 0$. When $q(\theta) = \tilde{q}(\theta)$ there is not change in output, since $\tilde{q}(\theta)$ is independent of M . This establishes that output is weakly increasing in M .

The (PI) constraint is always binding in the solution to [GP]'. Hence an increase in M imposes a more severe (PI) constraint which reduces the integral of net government surplus.

Proof of Proposition 3: To establish Proposition 3 we first prove

Lemma B2: $I_T = \{\theta \mid \theta \in [0, \hat{\theta}]\}$

Proof: Let I_{T^c} be the complement of I_T ; it consists of all workers who are excluded from the industry. Assume, contrary to Lemma B2, that I_{T^c} contains an

interval $[\theta_1, \theta_2]$ and that $\theta \in (\theta_2, \theta_3)$ is contained in I_T where $0 \leq \theta_1 \leq \theta_2 < \theta_3$. By (IC) the transfer received by all excluded workers, say $T(\theta_2)$, is the same. Since any type worker can accept this transfer and exit the industry it follows that under reorganization, $\pi(\theta) \geq v(\theta) + T(\theta_2)$. Now consider an alternative policy which induces each worker $\theta \in [\theta_1, \theta_2]$ to produce a positive amount $q^Y(\theta)$ and pays each worker a profit $\pi(\theta) = v(\theta) + T(\theta_2)$ equal to what they would earn if they were unemployed. By (IC), $q^Y(\theta)$ must satisfy $c(q^Y(\theta)) = v'(\theta)$ For future reference we record the fact that [SS] and [T] imply that

$$q^Y(\theta) > q^*(\theta) \quad (b1)$$

Assuming I_T was chosen optimally, it follows that $v(\theta) \geq pq^Y(\theta) - (k-\theta)c(q^Y(\theta))$ for all $\theta \in [\theta_1, \theta_2]$ otherwise it would be optimal to employ some of these workers and have them produce $q^Y(\theta)$. In particular $v(\theta_2) \geq pq^Y(\theta_2) - (k-\theta_2)c(q^Y(\theta_2))$. Given [SS] and [T] it's easy to show that

$$v(\theta) > pq^Y(\theta) - (k-\theta)c(q^Y(\theta)) \text{ for all } \theta > \theta_2. \quad (b2)$$

The maximization of net government surplus with respect to the choice of θ_2 is simply characterized by (with the help of the Envelope Theorem)

$$pq^Y(\theta_2) - (k-\theta_2)c(q^Y(\theta_2)) = v(\theta_2) \text{ as } \theta \downarrow \theta_2 \text{ and} \quad (b3)$$

$$pq(\theta) - (k-\theta)c(q(\theta)) \geq v(\theta) \text{ in a neighborhood of } \theta_2,$$

But note that (IC) and the fact that $\pi(\theta) \geq v(\theta) + T(\theta_2)$ implies that $q(\theta) \geq q^Y(\theta)$ as $\theta \downarrow \theta_2$. But (b1) and (b2) imply $v(\theta) > pq^Y(\theta_2) - (k-\theta_2)c(q^Y(\theta_2)) \geq pq(\theta) - (k-\theta)c(q(\theta))$ in a neighborhood of θ_2 which violates (b3). Hence we have shown that it is not optimal to employ workers of higher type when workers of lower type are excluded from the industry, thus completing our proof.

We now proceed directly to the proof of Proposition 3. Again, for convenience some parts of the proposition are proved in a different order from which they appear in the text.

Proof of part c: It is possible to show that $\pi^0(\theta)$ and $\pi(\theta)$ touch at most once for $\theta \in I_T$. Suppose to the contrary that there exists $\theta^i \in I_T$ such that $\pi^0(\theta^i) = \pi(\theta^i)$ for $i = 1, 2$ with $\theta^1 < \theta^2$. Now consider the policy of maximizing government surplus over $(0, \theta^2)$ subject to $\pi(\theta) \geq \pi^0(\theta)$ over that interval. Using arguments presented in the proof of Lemma A1, one can show that the solution to this problem involves $q(\theta) = \tilde{q}(\theta)$ for $\theta \in [0, \theta^2]$ where $\tilde{q}(\theta)$ satisfies $dAW(\tilde{q}(\theta), \theta)/dq = 0$, and

$$AW(q(\theta), \theta) = W(q(\theta), \theta) - \alpha[\pi^0(\theta^2) - (F^0(\theta)/f^0(\theta))c(q(\theta))]$$

(This assumes that $\tilde{q}(\theta^2) \leq q(\theta)$ for $\theta > \theta^2$ so that (IC) is satisfied. If this condition is violated the same basic argument applies, but with some slight modification.) Given [SS] and the characterization for $\tilde{q}(\theta)$ it is easy to show that $\pi(\theta) > \pi^0(\theta)$ for all $\theta < \theta^2$, in particular for $\theta = \theta^1$. Assuming the original policy satisfied (PI), this policy does also. Hence since this policy is optimal it implies that π and π^0 touch at most once for $\theta \in I_T$.

Next we establish that π and π^0 touch at most once for $\theta \in I_T$. For $\theta \in I_T$, $\pi'(\theta) = v'(\theta) > \pi^0'(\theta)$. Hence π must intersect π^0 once and from below, if the two schedules intersect at all in $[\hat{\theta}, \hat{\theta}^0]$.

Combining these arguments we know there exists $\theta' \in [0, \hat{\theta}]$ and $\theta'' \in [\hat{\theta}, \hat{\theta}^0]$ such that $\pi = \pi^0$. (If π and π^0 don't touch for $\theta \in I_T$ we let $\theta' = 0$) Since π and π^0 are continuous it follows that π intersects π^0 from above at θ' (when $\theta' > 0$) and that π intersects π^0 from below at θ'' , whenever $\theta' \neq \theta''$. If $\theta' = \theta''$ then

$\pi(\theta) \geq \pi^0(\theta)$ for all θ with (strict inequality for $\theta = \theta'$) Summarizing we have $\pi(\theta) \geq \pi^0(\theta)$ whenever $\theta \in [0, \theta']$ or $\theta \in [\theta', \hat{\theta}^0]$.

Proof of part b: Given the characterization of \tilde{M} in part a, the solution to [GP] can be derived as follows:

(i) Pick a $\theta'' \leq \hat{\theta}^0$. The solution will require that $\pi \geq \pi^0$ for $\theta \in (\theta'', \hat{\theta}^0]$.

(ii) Choose a $\hat{\theta} \leq \theta''$. Since $\theta'' \in I_T$, and $\pi(\theta'') = \pi^0(\theta'')$ it follows that

$$\pi(\theta'') = v(\theta'') + T(\theta'') \text{ or } T(\theta'') = \pi(\theta'') - v(\theta'').$$

(IC) implies that $T(\theta) = T(\theta'')$ for $\theta \in (\hat{\theta}, \hat{\theta}^0]$

(iii) Given θ'' , we choose θ' to satisfy (PI) so that the percent of types $\theta \in [0, \theta']$ or $\theta \in [\theta', \hat{\theta}^0]$ must equal or exceed M . When $\theta' > 0$, it satisfies $1 - F^0(\theta'') + F^0(\theta') = M$. Given θ'' we must select a policy to maximize net government surplus subject to (PI) which is equivalent to the restriction that

$$\pi(\hat{\theta}) = v(\hat{\theta}) + T(\hat{\theta}) = v(\hat{\theta}) + [\pi(\theta'') - v(\theta'')]$$

$$\pi(\theta) \geq \pi^0(\theta), \theta \in [0, \theta')$$

Using $\hat{\theta}$ as a reference point for representing worker profits, the government's problem can be written as [GP]' in the text.

The necessary conditions for pointwise maximization in [GP]' yields

$$dAW/dq - c' \mu(\theta) = 0, \theta \in I_T \tag{b4}$$

where $\mu(\theta)$ is the multiplier accompanying the constraint that $\pi(\theta') = \pi^0(\theta')$. This constraint binds only when (PI) is binding and only over the interval $[\theta', \hat{\theta}]$. Hence $\mu(\theta) = \mu \geq 0$ over $[\theta', \hat{\theta}]$, and it equals 0 otherwise. When (PI) is not binding so $\mu(\theta) = 0$, then $q(\theta) = \tilde{q}(\theta)$ where $dAW(\tilde{q}(\theta), \theta)/dq = 0$. When (PI) is binding then the $\tilde{q}(\theta)$ which satisfies (b4) will jump down discontinuously at θ' , thus violating (IC). As in the proof of part b of Proposition 2 we can employ standard arguments to show that the optimal policy involves pooling with $q(\theta) = \bar{q}$ in some neighborhood $[\theta_1, \theta_2]$ of θ' where $\tilde{q}(\theta)$ is not monotonically increasing. Outside of

this neighborhood, $q(\theta) = \tilde{q}(\theta)$. The characterization of the pooling region and the optimal output policy are:

(i) If (PI) is not binding, $q(\theta) = \tilde{q}(\theta)$

where $\tilde{q}(\theta)$ satisfies $dAW(\tilde{q}(\theta), \theta)/dq = 0$

(ii) If (PI) is binding,

$\min [\tilde{q}(\theta), \bar{q}] , \theta \leq \theta'$

$q(\theta) =$

$\max [\tilde{q}(\theta), \bar{q}] , \theta > \theta'$

where

$\tilde{q}(\theta)$ satisfies: $dAW(\tilde{q}(\theta), \theta)/dq - \mu(\theta) = 0$,

\bar{q} satisfies : $\int_{\theta_1}^{\theta_2} (dAW(\bar{q}, \theta)/dq - \mu(\theta)) dF^0(\theta) = 0$,

with $\bar{q} = \tilde{q}(\theta_i)$ for $i = 1, 2$ and

μ if $\theta \in [\theta', \hat{\theta}]$

$\mu(\theta) =$

0, otherwise

Given this characterization its easy to verify that $q(\theta)$ satisfies part b. The reader is referred to Proposition 1 of Lewis and Sappington (1988) for a derivation of this characterization.

Proof of part a: The characterization of I_T is proved in Lemma B2. The second part of a, is established using arguments identical to the proof of part (a) of Proposition 2

Footnotes

1. One measure of overproduction is the enormous stocks of unused surplus produce. World wheat stocks have risen nearly 70% since 198/81, world sugar stocks 45% and cotton stocks have doubled. For the U.S. many of these stocks are close to a year's consumption. See Rauser and Irwin (1987)
2. See Hufbauer, Berliner, and Elliot (1986) for case studies. Proposals to eliminate this protection have been advanced in Hufbauer and Rosen (1986) and Lawrence and Litan (1986).
3. The excessive use of factors of production in exploiting common property resources is well documented in Munro (1982)
4. The political power of the "farm lobby" in most western countries is widely documented.
5. Our analysis also extends to the case where factors of production are initially underemployed in some industry because of production taxes, externality or public goods problems.
6. To our knowledge there is little theoretical literature on this topic with the exception of the interesting paper by Roemer and Silvestre (1987) who analyze a model which differs significantly from ours.
7. A more general cost function could be employed, but it would only serve to unduly complicate the analysis.
8. We can obtain a complete characterization of optimal reorganization policies for cases [N] when $v'(\theta) < \pi^*(\theta)$, where $\pi^*(\theta)$ is the workers profit in the efficient first best case, and for cases [T] when $v'(\theta) > \pi^0(\theta)$. For the intermediate case where $\pi^*(\theta) < v'(\theta) < \pi^0(\theta)$, general results are difficult to obtain. Possible solutions for this case are discussed briefly in section 3.

9. A more general distribution could be assumed, but the uniform distribution saves on notation, and it satisfies a monotone hazard rate property which is usually imposed in models of this sort to avoid pooling.

10. The analysis remains basically unchanged even if the government can not observe I_j^0 prior to reorganization.

11. We are of course ignoring several possibly important costs that a worker incurs in changing jobs including loss of human capital, search costs and retraining and relocation costs. See Hamermesh (1987). In an expanded analysis we might also want to consider devices other than income transfers to induce workers to leave the industry. For example, transfers in kind, like offering relocation assistance may be more efficient in selecting workers to leave. (See Blackorby and Donaldson (1987))

12. This assumption is required if the government is to use nonlinear compensation schemes so as to discriminate between workers of different types. Of course this policy will suffer from the same problems as the implementation of nonlinear income taxes. Our assumptions about the power of the government to set compensation schemes may seem strong, but there are even stronger policies which could be used in theory to overcome informational problems. For example, the government could require each worker to report his type, and threaten to fine all workers a large amount if the distribution of reports did not coincide with the known distribution of worker types. If this threat of group punishment could be made credible, truth-telling would be a Nash equilibrium reporting strategy for all workers, and the government's information problem would disappear.

13. This treatment of political implementability is perhaps too simple in that it abstracts from the fact that the likelihood of any worker supporting or opposing reorganization may depend on the amount by which they gain or lose under the policy.

14. For our model, assuming $k = 3$ (so that there is a 50% cost differential between the lowest skilled and highest skilled worker) and adopting Shoven's

(1985) estimate that λ , the shadow cost of raising government revenue equals .3 we find that [SS] is satisfied provided s equals or exceeds 14% of p . This is a modest subsidy compared with several agricultural support programs. Estimates of average producer subsidy equivalents an estimate of the proportion of agricultural income generated by restrictions and subsidies of all kinds, are 72% for Japan, 33% for the European Community and 22% for the U.S. and Canada. Source: U.S. Department of Agriculture, Government Intervention in Agriculture: Measurement, Evolution and Implications for Trade Negotiations FAER-29 (April 1987)

15. If π and π^0 don't touch or intersect, then either (PI) is violated, or (PI) doesn't bind, which is never optimal.

16. Figure 2 corresponds to the case where M is moderately large. As M increases one can show that θ' increases towards 1, and the region of pooling includes only the highest skilled workers. In that case $q(\theta) > q^*(\theta)$ for all θ except $\theta = 1$.

17. Lewis and Sappington (1988) contain a more detailed discussion of these types of policies.

18. When $M = 1$, then one can show that π and π^0 touch once at single point, θ' , and that $\theta' = \theta'' = \hat{\theta}$.

19. Of course employment is efficient given the worker's output.

20. Another serious commitment problem concerns workers who are bribed to leave the industry and try to return later on. Richardson (1972) examines the extent to which this occurred under the U.S. Trade Adjustment Assistance program.

21. Some promising research in this area includes the papers by Baron and Besanko(1987) and Laffont and Tirole(1988)

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FIGURE 1

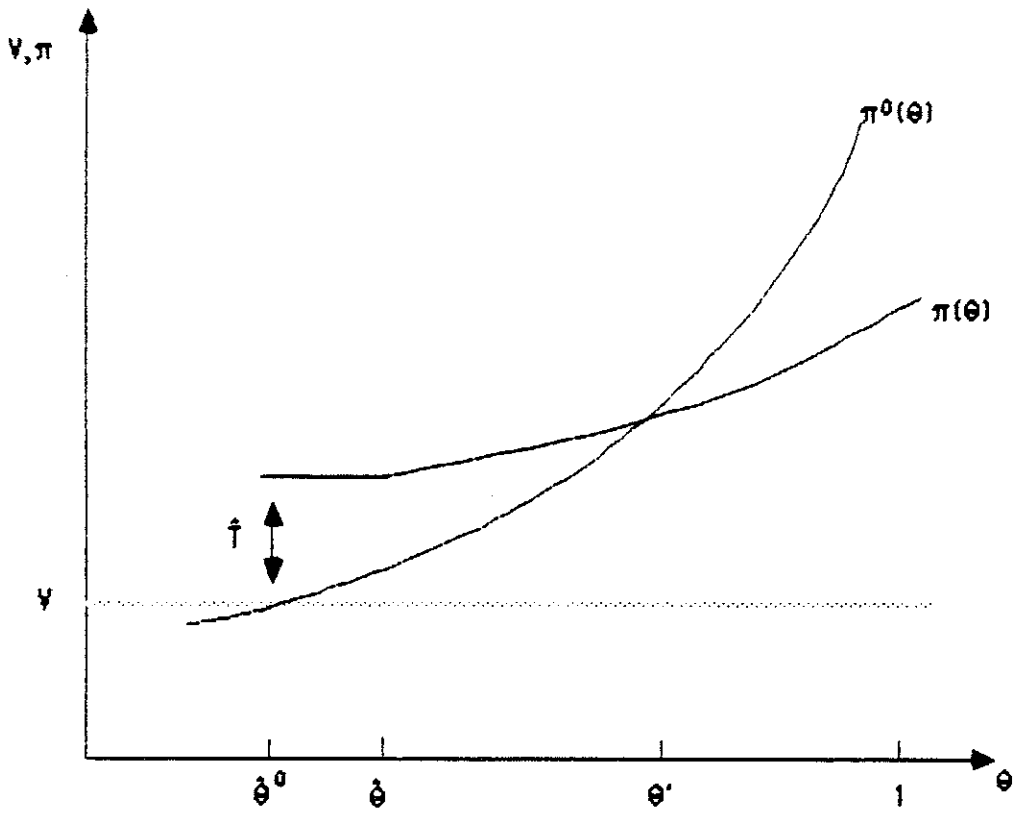


FIGURE 2

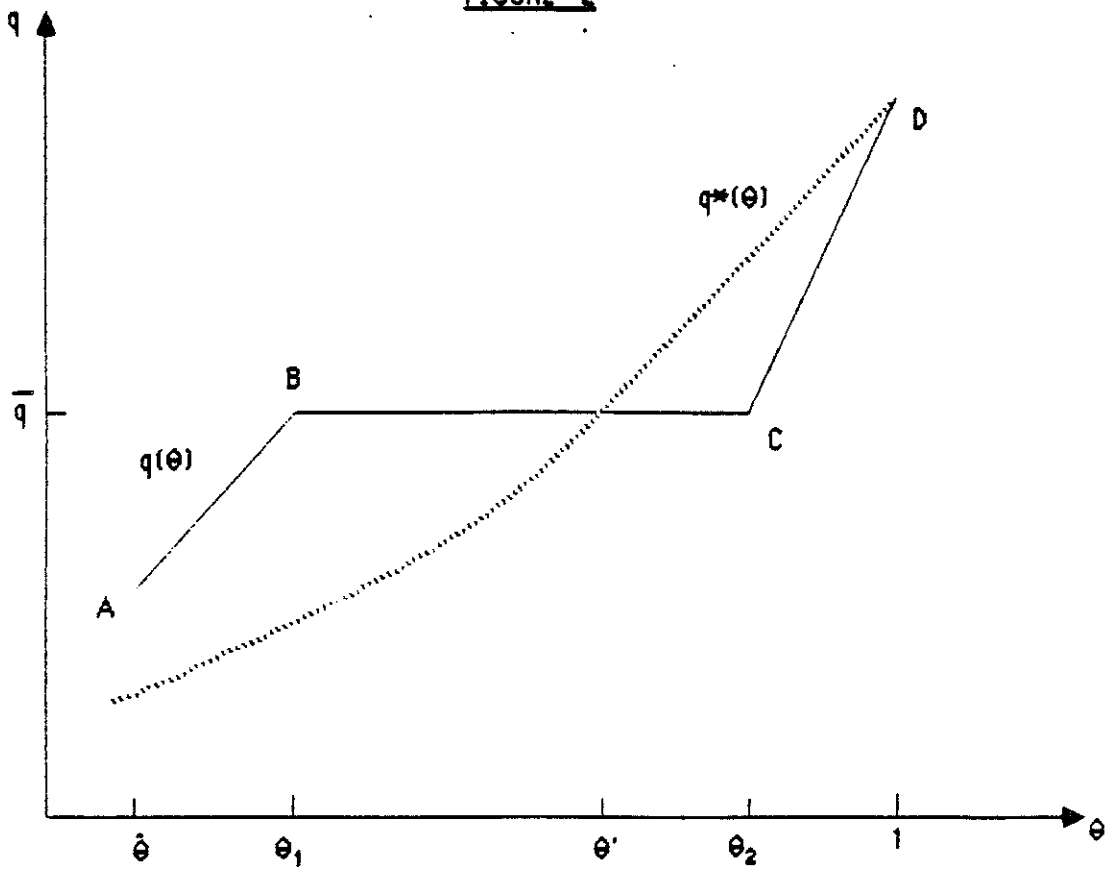


FIGURE 3

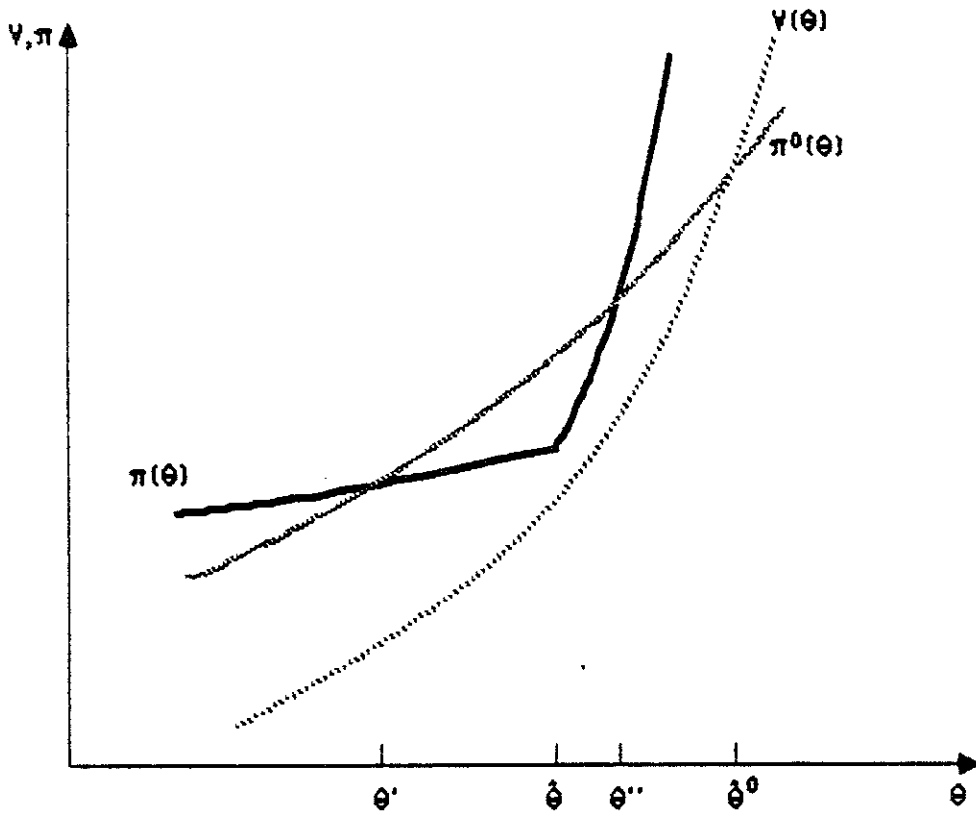
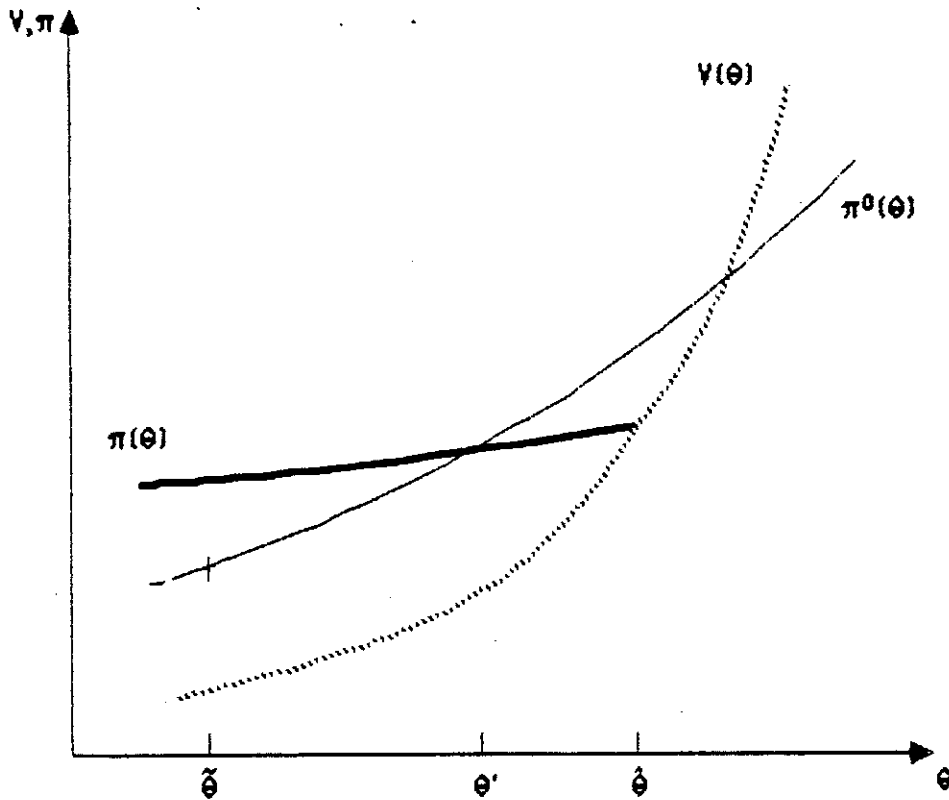


FIGURE 4



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