

The Efficient Mechanism for Downsizing the Public Sector

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This article analyzes the efficient mechanism for downsizing the public sector, focusing on adverse selection in productive efficiency. Each worker is assumed to have two type-dependent reservation utilities: the status quo utility in the public sector before downsizing and the utility that the worker expects to obtain by entering the private sector. The efficient mechanism consists of a menu of probability (of remaining in the public sector) and transfer pairs that induces self-selection. A worker's full cost is defined by the sum of production cost in the public sector and reservation utility in the private sector. It is optimal to start by laying off the agents with higher full cost. When the public sector before downsizing is discriminating as the differential of private information about productive efficiency suggests, there are countervailing incentives. This makes the size of downsizing smaller under asymmetric information than under complete information.

Inefficient public sectors in developing countries exhibit considerable labor redundancy. Hence, downsizing constitutes a natural step for every public sector reform in developing countries. However, downsizing is subject to adverse selection problems (Diwan 1994 and Rama 1997). For example, consider a simple downsizing mechanism that gives generous severance pay to every worker who leaves the public sector. Suppose that efficient workers have better job opportunities in the private sector than inefficient workers. Then, it may happen that only the efficient workers leave the public sector. If the consequence of this brain drain is so serious that it disrupts the public sector, downsizing may result in an increase rather than a decrease of inefficiency in the public sector.

In this article, we consider adverse selection in workers' productive efficiency. The type of worker, which represents the worker's production cost in the public sector, is the worker's private information. Alternatively, the type can be interpreted as disutility of effort. We assume that there are two types of workers, those with high and those with low production cost in the public sector. We call the type with low production cost efficient and the type with high production

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cost inefficient. We analyze mechanisms for voluntary downsizing when each worker has two type-dependent reservation utilities. The first represents the worker's status quo utility level in the public sector before downsizing; the second represents the worker's expected utility on entering the private sector. Thus our work is closely related to the literature on mechanism design under type-dependent reservation utility (see Lewis and Sappington 1989, Maggi and Rodriguez-Clare 1995, and Jullien 1997).

Because we focus mainly on downsizing public sectors in developing countries, we assume that monitoring in the public sector is so inefficient that the quantity produced by a worker cannot be a controllable instrument. We do not envision a reform of the incentive system in the public sector. Indeed, it is often the political unfeasibility of such a reform that leads to downsizing. Hence the principal, the benevolent regulator of the public sector, or the government has two instruments: the probability that a worker will remain in the public sector and the monetary transfer to the worker. In our model, the stochastic element of the mechanism is the key feature that allows the government to induce self-selection. After analyzing the efficient downsizing mechanism, we show how the government can implement it through a menu of probability, wage, and severance pay triplets without causing any worker to regret having participated in the downsizing procedure.

Kahn (1985) analyzes optimal severance pay when there is asymmetric information about a worker's outside productivity. His framework is different from ours, however, in that he assumes complete information about on-the-job productivity. Lazear (1995) studies efficient severance pay and efficient layoff rule in a context in which concerns about firm-specific human capital make firms adopt upward-sloping age-earnings profiles. But he does not consider adverse selection.

Our work is more closely related to studies about downsizing under adverse selection. Diwan (1994) studies adverse selection in workers' productivity. He does not consider self-selection mechanisms and thus proposes randomization as the optimal response. By contrast, we show that self-selection can be achieved, and that, as a consequence, randomization is, in general, a suboptimal solution. Levy and McLean (1996) consider adverse selection in workers' disutility of effort. They assume that workers' productivity in the public sector and their alternative wages are type-dependent. However, they restrict the government's instrument to one severance pay that is a scalar multiple of the status quo wage. In our work, we do not restrict the government's instruments: it can use a menu of probability and transfer pairs. Furthermore, we show that the government can implement an efficient downsizing mechanism that will not cause regret on the part of the workers.

Rama (1997) studies adverse selection in workers' aversion to effort. He considers a self-selection mechanism that combines a fixed-term contract with severance pay such that hard-working employees want to switch to the fixed-term contract, whereas lazy ones prefer severance pay. But he does not analyze the

efficient downsizing mechanism. Moreover, as we discuss in section VII, fixed-term contracts can be regarded as an alternative to stochastic mechanisms if concerns about favoritism on the part of public officials make a transparent implementation of the latter difficult.

Section I gives a self-contained summary of the main results derived in this article. Section II presents our model of an efficient mechanism for downsizing the public sector. Section III analyzes the benchmark case of the efficient downsizing mechanism when there is complete information about workers' productive efficiency. Section IV analyzes the efficient downsizing mechanism when there is asymmetric information about workers' productive efficiency. Section V shows how the efficient mechanism derived in section IV can be implemented without regret through a menu of probability, wage, and severance pay triplets. Section VI relaxes some of the main assumptions and describes extensions of the analysis. Section VII discusses the relevance of key assumptions and suggests directions for further research.

I. MAIN RESULTS

The efficient downsizing mechanism consists of a menu of contracts that induces self-selection. Each contract, composed of a probability of staying in the public sector and a monetary transfer, is conceived such that all the efficient workers (respectively, all the inefficient workers) choose the contract designed for the efficient type (respectively, the inefficient type). Self-selection can be achieved because each worker attaches a different value to the possibility of keeping a job in the public sector according to the worker's productive efficiency in the public sector and job opportunities in the private sector.

Whether the regulator should start to lay off the efficient workers or the inefficient workers depends on each type's full cost of staying in the public sector. Each type's full cost is equal to the production cost in the public sector plus the opportunity cost. The opportunity cost is given by the utility that the worker expects to obtain by leaving the public sector and trying to find a job in the private sector. For example, if the probability of finding employment in the private sector is low and the cost of searching for a job is high, the opportunity cost will be small. It is always optimal to start laying off the workers with high full cost. This implies that there may exist cases in which it is optimal to start laying off the efficient workers.

To determine which type has high full cost, we need information about the differential in terms of productive efficiency between the efficient type and the inefficient type, in the public sector and in the private sector. We also need information about the nature of the incentive schemes that map efficiency levels into informational rents in both sectors. For example, if workers' efficiency is general (that is, not specific to a sector) and if the private sector's reward structure is more sensitive to workers' efficiency, then it is optimal to start laying off the efficient workers.

The extent of downsizing is determined by comparing the social marginal gain with the social marginal cost of keeping a worker in the public sector. When the social value of public production is low, it is optimal for the regulator to lay off all the workers with high full cost and to keep only a proportion of the workers with low full cost. When the social value is high, it is optimal to keep all the workers with low full cost and to lay off a proportion of the workers with high full cost.

Under complete information, the social marginal cost of keeping a worker is equal to the private marginal cost (given by the full cost defined above) multiplied by $1 + \lambda$, where $\lambda (> 0)$ represents the shadow cost of public funds. Thus the higher is the negative impact of distortionary taxation, the larger the size of downsizing should be.

Under asymmetric information, workers may obtain an informational rent. This makes downsizing more costly than under complete information and affects the social marginal cost of keeping a worker in the public sector. In this article, we consider the case in which the public sector before downsizing is discriminating as the differential of information suggests: the differential in terms of status quo utility between the two types is equal to the differential in terms of productive efficiency in the public sector. In this case, there are always countervailing incentives. In particular, when the social value of public production is low, the efficient downsizing mechanism requires that all the workers with high full cost leave the public sector, obtaining a positive informational rent, while the workers with low full cost stay with a positive probability and do not obtain any rent. An important consequence of countervailing incentives is that the social marginal cost of laying off a worker with low full cost is higher under asymmetric information than under complete information. Hence, asymmetric information reduces the size of downsizing when the social value of public production is low.

The efficient mechanism can be implemented through a menu of probability, wage, and severance pay triplets without causing regret on the part of the workers. The government proposes a menu composed of two triplets, and each worker chooses one triplet after having accepted the offer. By choosing a triplet, a worker is committed to respect the random outcome associated with the probability specified in the triplet. If the outcome is to stay in the public sector (respectively, to leave the sector), the worker should stay (respectively, leave), receiving the wage (respectively, the severance pay) specified in the triplet. The menu can be designed in such a way that each worker will choose the triplet designed for that worker's type and that none of the workers will regret having participated in the downsizing procedure regardless of whether they stay or get laid off.

II. THE MODEL

We consider an economy composed of two sectors: the public sector and the private sector which represents the rest of the economy. The government (the

benevolent regulator of the public sector) wants to downsize the public sector. There is a continuum of workers of mass 1 employed in the public sector before downsizing. We denote the set of workers in the public sector by I . A worker in the public sector who gets laid off after downsizing may try to find a job in the private sector.

We consider voluntary downsizing in the sense that downsizing should be done through a process that induces voluntary participation of the workers in the public sector. In other words, workers have the right to stay in the public sector with their current status and cannot be laid off against their will. This situation corresponds to reality because most countries forbid mandatory layoffs in the public sector by law.

We assume that monitoring in the public sector is so inefficient that the quantity produced by a worker cannot be a controllable instrument. In particular, we assume that the quantity produced by each worker is normalized to 1 both before and after downsizing. In other words, the government does not revise the incentive schemes within the public sector simultaneously with downsizing. Thus the efficient downsizing mechanism that we analyze is conditional on not changing incentive schemes in the public sector. The production level of the public sector after downsizing will equal the mass of workers remaining in the sector.

To focus on adverse selection in productive efficiency, we assume that all the workers are homogeneous except in terms of their production cost. In reality, discrimination based on some observable and verifiable characteristics is possible. The efficient downsizing mechanism will be discriminatory if there exists some correlation between the characteristics and productive efficiency. The model denotes worker A_i 's type, with $i \in I$, by θ_i , which represents the worker's marginal cost of production in the public sector. θ_i is independently and identically distributed. It takes the value $\underline{\theta}$ with probability v and the value $\bar{\theta}$ with probability $1 - v$. We denote the difference between the two values by $\Delta\theta \equiv \bar{\theta} - \underline{\theta} > 0$. θ_i is private information known only by A_i . The distribution of θ_i is common knowledge. We call type $\underline{\theta}$ the efficient type and type $\bar{\theta}$ the inefficient type.

A_i has two type-dependent reservation utilities. The first is the utility that A_i obtains by staying in the public sector, rejecting the government's offer of the downsizing mechanism. This reservation utility is expected to be high because, in general, public sector wages are large in view of the workers' productivity and because nonwage benefits are generous in public sectors. We denote it by $U^p(\theta_i)$, where the superscript p indicates the public sector. In particular, \underline{U}^p denotes the efficient type's reservation utility and \bar{U}^p denotes the inefficient type's reservation utility.

The second reservation utility is the one that A_i expects to obtain by leaving the public sector and entering the private sector. We denote it by $U^m(\theta_i)$, where the superscript m indicates market. When laid off by the public sector, a worker may either find a job in the private sector (probably after incurring some search cost) or remain unemployed. $U^m(\theta_i)$ is an expected type-dependent utility that takes into account various factors reflecting labor market conditions. In particu-

lar, \underline{U}^m denotes the efficient type's reservation utility and \bar{U}^m denotes the inefficient type's reservation utility. Without loss of generality, \bar{U}^m is normalized to 0.

A_i has two choices: stay in the public sector, rejecting the government's offer, or accept the offer. Hence, A_i 's utility, denoted by U_i , is given as follows:

$$U_i = \begin{cases} U^p(\theta_i) & \text{if staying in the public sector and rejecting the government's offer} \\ U(\theta_i) & \text{if accepting the offer.} \end{cases}$$

The government maximizes social welfare, denoted by W , defined as follows:

$$W \equiv S(q) - (1 + \lambda) \left(\sum_{i \in I} t_i \right) + \sum_{i \in I} U_i$$

where $S(\cdot)$ represents the social surplus generated by public production, which is a function of the total quantity produced by the public sector, denoted by q ; $\lambda (> 0)$ represents the shadow cost of public funds; and t_i is the monetary transfer from the government to worker A_i . $S(\cdot)$ is increasing and strictly concave with $S'(0) = \infty$. λ is strictly positive because distortionary taxation inflicts a cost of $(1 + \lambda)$ dollars on taxpayers in order to levy 1 dollar for the government.

According to the revelation principle, we can restrict our attention to the set of direct revelation mechanisms (see, for example, Gibbard 1973, Green and Laffont 1977, and Myerson 1979). A downsizing mechanism is then defined by:

$$\{p_i(\hat{\theta}), t_i(\hat{\theta})\} \quad \text{with} \quad \hat{\theta}_i \in \{\underline{\theta}, \bar{\theta}\}$$

where $p_i(\cdot)$ represents the probability of keeping A_i in the public sector, $t_i(\cdot)$ is the monetary transfer from the government to A_i , and $\hat{\theta}_i$ is A_i 's report to the government about A_i 's type. We note that because there is no aggregate uncertainty about type, the probability and the transfer for A_i depend only on A_i 's report.

The government offers to each worker the opportunity to participate in a random exercise that entails a payment and a probability of remaining in the public sector. The worker may or may not participate. A worker who does not participate keeps the reservation utility $U^p(\cdot)$. A worker who does participate makes a commitment to respect the outcome of the random exercise. In particular, if the outcome tells the worker to leave the public sector, the worker must try to find a job in the private sector, expecting the reservation utility $U^m(\cdot)$.

For expositional simplicity, we introduce the following notations:

$$\begin{aligned} p_i(\underline{\theta}) &= \underline{p}, \quad p_i(\bar{\theta}) = \bar{p} \\ t_i(\underline{\theta}) &= \underline{t}, \quad t_i(\bar{\theta}) = \bar{t}. \end{aligned}$$

Given a total quantity produced by the public sector q , we denote the social marginal cost of keeping a worker in the sector under complete information by $MC^c(q)$.

We introduce the following assumptions.

ASSUMPTION 1: $S'(1) < MC^c(1)$

ASSUMPTION 2: $\underline{U}^p - \bar{U}^p = \Delta\theta$.

Assumption 1 says that, under complete information, if the government keeps all the workers in the public sector, the social marginal surplus of keeping a worker is smaller than the social marginal cost of keeping a worker. Thus assumption 1 justifies the necessity of downsizing. Assumption 2 states that the reservation utility that a worker obtains by staying in the public sector (refusing the government's offer) is higher for the efficient type than for the inefficient type and that the difference between the two reservation utilities is exactly equal to the cost differential between the two types. Assumption 2 implies that the public sector before downsizing is discriminating as the differential of information suggests. Thus asymmetric information about workers' efficiency also exists within the public sector. In fact, $U^p(\theta)$ is determined by three factors: nonwage benefits, wages, and production costs. Suppose that every worker in the public sector before downsizing receives the same nonwage benefits and the same wage regardless of type. Then, the difference between $U^p(\theta)$ and $U^p(\bar{\theta})$ should be equal to the cost differential between the two types ($\Delta\theta$) because we normalized the quantity produced by each worker to 1.

We define A_i 's full cost as $\bar{\theta}_i^f \equiv \theta_i + U^m(\theta_i)$. The efficient type's full cost is $\underline{\theta}^f = \underline{\theta} + \underline{U}^m$; the inefficient type's full cost is $\bar{\theta}^f = \bar{\theta}$. The difference in full cost between the inefficient and efficient types is $\Delta\theta^f \equiv \bar{\theta}^f - \underline{\theta}^f$. The efficient type becomes the low-cost type if $\Delta\theta - \underline{U}^m = (\Delta\theta^f) > 0$; it becomes the high-cost type if $\Delta\theta - \underline{U}^m < 0$. Whether the efficient type is the low-cost type depends crucially on the opportunity cost \underline{U}^m . Because we normalized the inefficient type's opportunity cost to 0, \underline{U}^m represents the difference in terms of opportunity cost between the two types. In the following sections, we distinguish three cases depending on the value of $\Delta\theta - \underline{U}^m$: $\Delta\theta > \underline{U}^m$, $\Delta\theta < \underline{U}^m$, and $\Delta\theta = \underline{U}^m$.

III. BENCHMARK: THE COMPLETE INFORMATION CASE

As a benchmark, we consider the case in which there is complete information about cost parameter θ_i . For downsizing to be an issue, it is natural to assume that $U^p(\theta) \geq U^m(\theta)$ for all $\theta \in \{\underline{\theta}, \bar{\theta}\}$. For the downsizing mechanism to induce participation, it should satisfy the following individual rationality constraints:

- (1) $U(\underline{\theta}) \equiv \underline{t} - \underline{p}\underline{\theta} + (1 - \underline{p})\underline{U}^m \geq \underline{U}^p$ for the efficient type
- (2) $U(\bar{\theta}) \equiv \bar{t} - \bar{p}\bar{\theta} \geq \bar{U}^p$ for the inefficient type.

Expected social welfare, denoted by EW , is defined as follows:

$$EW \equiv S[v\underline{p} + (1 - v)\bar{p}] - (1 + \lambda)[v\underline{t} + (1 - v)\bar{t}] + v\underline{U} + (1 - v)\bar{U}$$

where $\underline{U} \equiv U(\theta)$ and $\bar{U} \equiv U(\bar{\theta})$. Hence, the government's program under complete information, denoted by P^c , is given by:

$$P^c \left\{ \begin{array}{l} \max_{\underline{p}, \bar{p}, \underline{t}, \bar{t}} EW \\ \text{subject to constraints 1 and 2.} \end{array} \right.$$

It is useful to rewrite the equation for expected welfare in terms of workers' utilities and full costs as follows:

$$EW = S[v\underline{p} + (1 - v)\bar{p}] - \lambda[v\underline{U} + (1 - v)\bar{U}] \\ - (1 + \lambda)[v\underline{p}\underline{\theta}^f + (1 - v)\bar{p}\bar{\theta}^f] + (1 + \lambda)v\underline{U}^m.$$

From this expression, it is costly for the government to give positive utility levels to workers (beyond the utility derived from the public sector) as long as the shadow cost of public funds is positive.

Using the above expression for expected welfare, the government's program in terms of full costs can be written as follows:

$$P^{c'} \left\{ \begin{array}{l} \max_{\underline{p}, \bar{p}, \underline{t}, \bar{t}} EW \\ \text{subject to} \\ \underline{t} - \underline{p}\underline{\theta}^f \geq \bar{U}^p + \Delta\theta^f \\ \bar{t} - \bar{p}\bar{\theta}^f \geq \bar{U}^p \end{array} \right.$$

From the efficient type's individual rationality constraint in $P^{c'}$, we can reinterpret the efficient type as the type whose marginal cost is equal to $\underline{\theta}^f$ and whose reservation utility in the public sector is equal to $\bar{U}^p + \Delta\theta^f$, ignoring the reservation utility in the private sector. And we can do the same for the inefficient type.

From the first-order conditions with regard to the probabilities, we can define the following social marginal costs of keeping a worker in the public sector under complete information:

$$\underline{MC}^c \equiv (1 + \lambda)\underline{\theta}^f \quad \text{for the efficient type}$$

$$\bar{MC}^c \equiv (1 + \lambda)\bar{\theta}^f \quad \text{for the inefficient type}$$

where the superscript c indicates complete information. The social marginal cost of keeping a worker is equal to the worker's private marginal cost (given by the worker's full cost) multiplied by $(1 + \lambda)$. The shadow cost of public funds inter-

venes because the government must resort to distortionary taxation in order to raise the necessary money. The social marginal cost of keeping an efficient worker is smaller than that of keeping an inefficient worker if and only if $\Delta\theta - \underline{U}^m = \Delta\theta^f > 0$ holds.

We characterize the optimal downsizing mechanism under complete information in proposition 1.

PROPOSITION 1. Under assumptions 1 and 2, the efficient downsizing mechanism under complete information $\{p^*, \bar{p}^*, t^*, \bar{t}^*\}$ is characterized as follows.

1. Utility. Every worker accepts the government's offer and obtains a utility level equal to the status quo utility level in the public sector [$U(\theta_j) = U^p(\theta_j)$].
2. Probability. We can distinguish five cases according to the value of $\Delta\theta - \underline{U}^m$ and the social value of public production:

<i>Social value of public production</i>	$\Delta\theta > \underline{U}^m$	$\Delta\theta < \underline{U}^m$	$\Delta\theta = \underline{U}^m$
Low	$0 < \underline{p}^* \leq 1$ $\bar{p}^* = 0$	$\underline{p}^* = 0$ $0 < \bar{p}^* \leq 1$	$v\underline{p}^* + (1 - v)\bar{p}^*$
High	$\underline{p}^* = 1$ $0 < \bar{p}^* < 1$	$0 < \underline{p}^* < 1$ $\bar{p}^* = 1$	$= \underline{p}^* < 1$

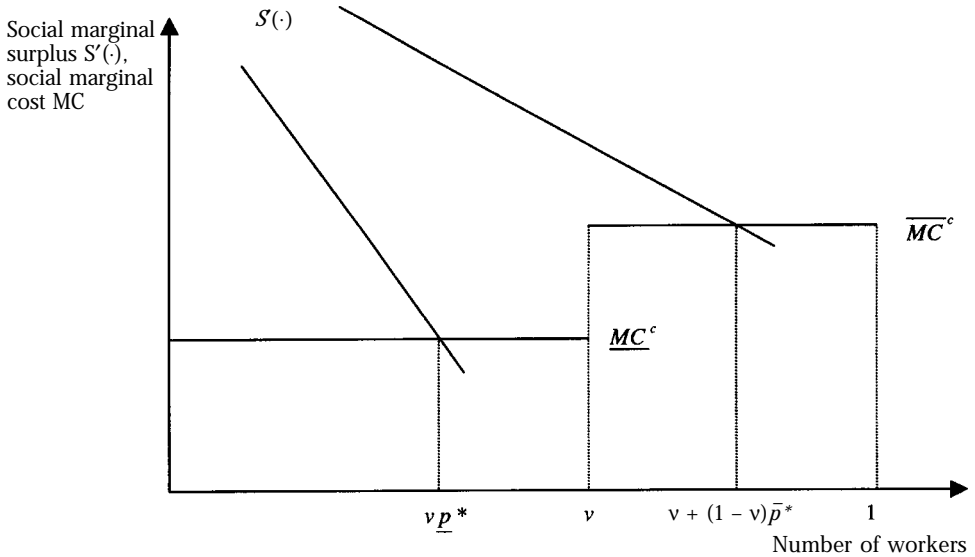
PROOF. The proof is trivial and is omitted. For the formal exposition, see appendix A.

Under complete information, the government offers the minimal utility levels necessary to induce the workers to accept the downsizing mechanism, that is, the status quo utility levels in the public sector.

Figure 1 shows how to determine the optimal number of workers to keep in the public sector when $\Delta\theta > \underline{U}^m$. If the social value of public production is low—that is, if $S(\cdot)$ is small—the number is determined by the point where the social marginal surplus of keeping a worker is equal to \underline{MC}^c . If the social value of public production is high— $S(\cdot)$ is large—the number is determined by the point where the social marginal surplus is equal to \bar{MC}^c .

In the general case in which $\Delta\theta$ is different from \underline{U}^m , if the social value of public production is low, the government lays off all the high-cost workers and keeps, with a random mechanism, a proportion of the low-cost workers. In practice, secondary personal characteristics known to the government may be used to choose the set of workers laid off, rather than using a random mechanism. If the social value of public production is high, the government keeps all the low-cost workers and lays off a proportion of the high-cost workers. In the special case in which $\Delta\theta$ is equal to \underline{U}^m , the social marginal cost of keeping an efficient worker is equal to that of keeping an inefficient worker. Hence, the government is only interested in the total number of workers to keep. Given the total num-

Figure 1. *The Optimal Number of Workers under Complete Information, $\Delta\theta > \underline{U}^m$*



ber, the government does not care about the choice between the efficient and inefficient workers. Hence, in this case, randomization within the whole set of workers ($\underline{p}^* = \bar{p}^* = p^*$, $\underline{t}^* = \bar{t}^*$) is an optimal solution.

Appendix A gives a formal characterization of the efficient downsizing mechanism, including the optimal transfers. If the government keeps a worker, it pays the status quo utility level plus the production cost. If it lays off the worker, it pays the status quo utility level minus the worker's reservation utility in the private sector.

IV. THE ASYMMETRIC INFORMATION CASE

In this section, we assume that there is asymmetric information about cost parameter θ_i . We distinguish three scenarios, depending on the value of $\Delta\theta - \underline{U}^m$: $\Delta\theta > \underline{U}^m$, $\Delta\theta < \underline{U}^m$, and $\Delta\theta = \underline{U}^m$. Because $\Delta\theta \neq \underline{U}^m$ is generic and the second scenario is perfectly symmetric to the first one, we will focus on the first scenario.

For the downsizing mechanism to induce truth telling, it should satisfy the following incentive compatibility constraints:

- (3) $\underline{t} - \underline{p}\underline{\theta} + (1 - \underline{p})\underline{U}^m \geq \bar{t} - \bar{p}\underline{\theta} + (1 - \bar{p})\underline{U}^m$ for the efficient type
- (4) $\bar{t} - \bar{p}\bar{\theta} \geq \underline{t} - \underline{p}\bar{\theta}$ for the inefficient type.

The government’s program under asymmetric information, denoted by P^a , is given by:

$$P^a \begin{cases} \max_{p, \bar{p}, t, \bar{t}} EW \\ \text{subject to constraints 1, 2, 3, and 4.} \end{cases}$$

There is no loss of generality in considering full participation. Any mechanism that induces the participation of only one type is equivalent to the mechanism with full participation in which the contract for the excluded type, denoted by θ^e , is given by $\{p(\theta^e) = 1, t(\theta^e) = U^p(\theta^e) + \theta^e\}$. P^a can be written equivalently in terms of full costs as in the following program, denoted by $P^{a'}$:

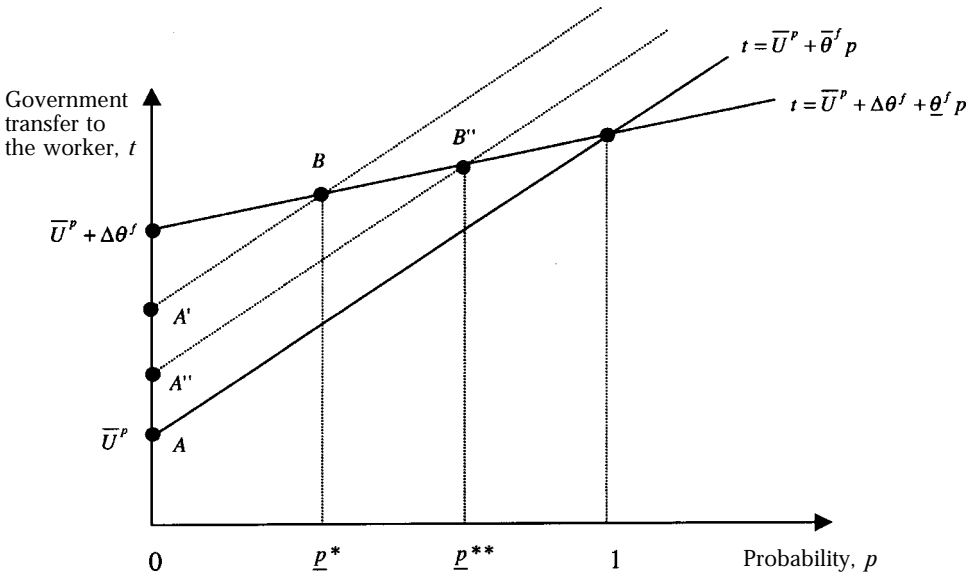
$$P^{a'} \begin{cases} \max_{p, \bar{p}, t, \bar{t}} EW \\ \text{subject to} \\ t - p\theta^f \geq \bar{U}^p + \Delta\theta^f \\ \bar{t} - \bar{p}\bar{\theta}^f \geq \bar{U}^p \\ t - p\theta^f \geq \bar{t} - \bar{p}\bar{\theta}^f \\ \bar{t} - \bar{p}\bar{\theta}^f \geq \underline{t} - \underline{p}\bar{\theta}^f. \end{cases}$$

Under asymmetric information, workers may obtain informational rents in the downsizing mechanism. A_i ’s informational rent is defined as the difference between the utility level when the worker accepts the government’s offer [$U(\theta_j)$] and the worker’s status quo utility level [$U^p(\theta_j)$]. Because rents are costly to the principal, the optimal probabilities under asymmetric information will be determined by the best tradeoff between efficiency and rent extraction.

We examine now the government’s program ($P^{a'}$) in the case in which the efficient type is the low-cost type: $\Delta\theta > \underline{U}^m$. Figure 2 shows intuitively which constraints are binding in $P^{a'}$. The solid line starting from point A is the inefficient type’s indifference curve keeping utility equal to \bar{U}^p . The other solid line, with a less steep slope, is the efficient type’s indifference curve keeping utility equal to $\bar{U}^p + \Delta\theta^f$. Suppose that the social value of public production is low, such that under complete information the optimal probabilities are given by $0 < p^* < 1$ and $\bar{p}^* = 0$. Thus the efficient downsizing mechanism under complete information consists of two contracts represented by points A and B for the inefficient and efficient types, respectively.

Suppose now that there is asymmetric information and that the government still offers contracts A and B . Then the inefficient type will choose B instead of A because utility is greater than \bar{U}^p with contract B . Thus the offer of (A, B) is not incentive compatible. Restoring incentive compatibility is possible by offering A' instead of A . The inefficient type is now indifferent between A' and B . How-

Figure 2. *Countervailing Incentives under Asymmetric Information, $\Delta\theta > \underline{U}^m$*



ever, this result requires a high transfer to the inefficient type. Thus the government can improve social welfare by increasing a little bit the probability of keeping the efficient type in order to reduce the inefficient type's informational rent. Therefore, the efficient downsizing mechanism under asymmetric information will consist of A'' for the inefficient type and B'' for the efficient type. The inefficient type is indifferent between the two contracts and obtains a positive rent. The efficient type strictly prefers B'' to A'' and obtains no rent. Hence, there are countervailing incentives: the inefficient type's incentive compatibility constraint and the efficient type's individual rationality constraint are binding.¹

From the first-order conditions with regard to the probabilities, we can define the following social marginal costs of keeping a worker in the public sector under asymmetric information:

$$\begin{aligned} \underline{MC}^a &\equiv (1 + \lambda)\underline{\theta}^f - \frac{\lambda(1 - v)}{v} \Delta\theta^f < \underline{MC}^c && \text{for the efficient type} \\ \overline{MC}^a &\equiv (1 + \lambda)\overline{\theta}^f = \overline{MC}^c && \text{for the inefficient type} \end{aligned}$$

where the superscript a indicates asymmetric information. Asymmetric information makes downsizing more costly because of the rent that the government

1. The problem differs from a classical principal-agent model with adverse selection in which the status quo utility levels are identical for the two types, leading to a nonnegative rent for the efficient type. Here, the efficient type's status quo utility level is higher by $\Delta\theta^f$, making any contract ensuring this level attractive for the inefficient type.

gives up to the inefficient type.² The fact that this rent is decreasing in \underline{p} makes the social marginal cost of keeping an efficient worker smaller under asymmetric information than under complete information. In fact, the difference between \underline{MC}^c and \underline{MC}^a is equal to $[\lambda(1 - v)]/v\Delta\theta^f$, implying that the rent extraction effect is increasing in the shadow cost of public funds (λ), in the proportion of the inefficient workers to the efficient workers $(1 - v)/v$, and in the marginal impact of the increase of \underline{p} on the inefficient type's rent ($\Delta\theta^f$). However, asymmetric information does not change the social marginal cost of keeping an inefficient worker because \bar{p} does not affect rent extraction.

We characterize the efficient downsizing mechanism under asymmetric information in proposition 2.

PROPOSITION 2. Suppose that $\Delta\theta > \underline{U}^m$ holds. Under assumptions 1 and 2, the efficient downsizing mechanism under asymmetric information $\{\underline{p}^{**}, \bar{p}^{**}, \underline{t}^{**}, \bar{t}^{**}\}$ is characterized as follows.

1. When the social value of public production is low:
 - a. Utility. Every worker accepts the government's offer. The efficient type's utility level is equal to the status quo utility level, while the inefficient type's utility level is greater than the status quo utility level.
 - b. Probability. All the inefficient workers get laid off, and a proportion of the efficient workers is retained. The size of downsizing is smaller under asymmetric information than under complete information.
2. When the social value of public production is high, the optimal complete information outcome characterized in proposition 1 can be achieved.

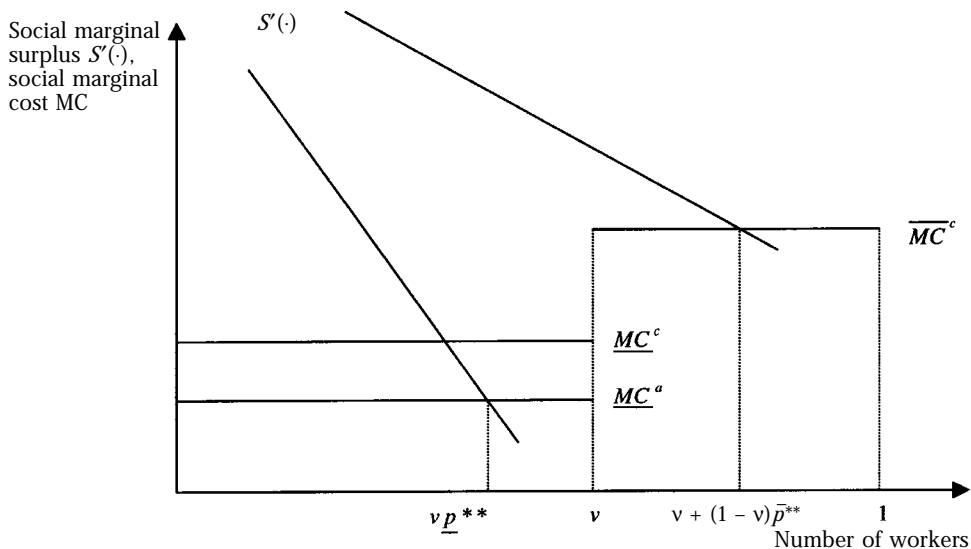
PROOF. For the formal exposition and proof, see appendix B.

When the social value of public production is low, the government lays off all the inefficient workers and keeps a proportion of the efficient workers. But the government keeps more efficient workers under asymmetric information than under complete information. Figure 3 illustrates how asymmetric information reduces the size of downsizing when the social value of public production is low: $\underline{p}^* < \underline{p}^{**}$. When the social value of public production is high, the government keeps all the efficient workers and lays off a proportion of the inefficient workers. In this case, the proportion of the inefficient workers being laid off is not affected by asymmetric information. In fact, the government achieves the optimal complete information outcome because the inefficient type obtains no rent when $\underline{p}^{**} = 1$.

The transfer to the efficient type is the same as under complete information, while the transfer to the inefficient type is equal to the transfer under complete information plus the worker's informational rent. Of course, the transfers are functions of $(\underline{p}^{**}, \bar{p}^{**})$ instead of $(\underline{p}^*, \bar{p}^*)$; see appendix B.

2. The inefficient type's rent is given by $(1 - p)\Delta\theta^f$.

Figure 3. *The Optimal Number of Workers under Asymmetric Information, $\Delta\theta > \underline{U}^m$*



Because the case in which the inefficient type is the low-cost type ($\Delta\theta < \underline{U}^m$) is perfectly symmetric to the case $\Delta\theta > \underline{U}^m$, we just state the results for this case in proposition 3. For a more detailed analysis of this case and the proof of proposition 3, see Jeon and Laffont (1999).

PROPOSITION 3. Suppose that $\Delta\theta < \underline{U}^m$ holds. Under assumptions 1 and 2, the efficient downsizing mechanism under asymmetric information is characterized as follows.

1. When the social value of public production is low:
 - a. Utility. Every worker accepts the government's offer. The inefficient type's utility level is equal to the status quo utility level, while the efficient type's utility level is greater than the status quo utility level.
 - b. Probability. All the efficient workers get laid off and a proportion of the inefficient workers is retained. The size of downsizing is smaller under asymmetric information than under complete information.
2. When the social value of public production is high, the optimal complete information outcome characterized in proposition 1 can be achieved.

PROOF. The proof is omitted because of the perfect symmetry with the case $\Delta\theta > \underline{U}^m$.

Consider now the special case in which $\Delta\theta = \underline{U}^m$ holds. In this case, there is no difference between the efficient type and the inefficient type, not only in terms of

the full cost but also in terms of the reservation utilities both in the public sector and in the private sector. Because there is only one type, asymmetric information about θ_i does not matter and the optimal complete information outcome can be achieved, as stated in proposition 4.

PROPOSITION 4. Suppose that $\Delta\theta = \underline{U}^m$ holds. Suppose that there is asymmetric information about θ_i . Under assumptions 1 and 2, the optimal complete information outcome characterized in proposition 1 can be achieved.

PROOF. The proof is trivial and is omitted.

We note that the randomization analyzed in the complete information case is still an optimal solution in the asymmetric information case.

V. IMPLEMENTATION WITHOUT REGRET

The optimal revelation mechanism obtained in section IV can be implemented with a nonlinear transfer mechanism $t(p)$ as usual, offering different transfers for different probabilities of remaining in the public sector. In this section, we show that the efficient downsizing mechanism can be implemented through a menu of probability, wage, and severance pay triplets. Indeed, we are interested in the implementation in which no worker regrets having participated in the downsizing procedure, regardless of whether the worker stays or gets laid off. We denote the triplet of probability, wage, and severance pay designed for type θ by $[p(\theta), w(\theta), s(\theta)]$, with $\theta \in \{\underline{\theta}, \bar{\theta}\}$.

The sequence of implementation is as follows. The government offers each worker the menu of triplets $[p(\theta), w(\theta), s(\theta)]$. For those workers who have accepted one of the triplets, the outcome of the random mechanism associated with the probability specified in the triplet gets realized. If the outcome is to leave the public sector, the worker should leave, receiving the severance pay specified in the triplet. If the outcome is to remain in the sector, the worker should remain in the sector, receiving the wage specified in the triplet. The wage should be interpreted in a broad sense; it comprises all the monetary and nonmonetary benefits that a worker obtains by working in the public sector.

The optimal menu for implementing the efficient downsizing mechanism characterized in section IV is given by:

$$\begin{aligned} p(\theta) &= p^{**}(\theta), \quad w(\theta) = w(\bar{\theta}) = U^P(\theta) + \theta \\ s(\theta) &= U^P(\theta) - U^m(\theta) + R(\theta) \quad \text{with} \quad \theta \in \{\underline{\theta}, \bar{\theta}\} \end{aligned}$$

where $R(\theta)$ represents type θ 's informational rent under the efficient mechanism.

In the equilibrium under the optimal menu, each worker will accept the offer and choose the triplet designed for that worker's type. Moreover, the menu sat-

ifies ex post individual rationality in the sense that every worker obtains at least the status quo utility level in the public sector. Hence, no worker will regret having participated in the downsizing procedure regardless of whether the outcome is to stay or to get laid off. This result can be achieved because type-dependent wages and severance payments give the government more degrees of freedom than do transfers that are not conditional on the outcome of the random mechanism.

We observe from the optimal menu that only those leaving the public sector may obtain an informational rent and that those remaining in the sector receive the same wage regardless of type. Moreover, this wage is equal to the wage before downsizing. The wage before downsizing, denoted by w^p , is defined implicitly from the status quo utility level by the following equation: $U^p(\theta) = w^p - \theta$ for all $\theta \in \{\underline{\theta}, \bar{\theta}\}$.

Here we show how the efficient downsizing mechanism can be implemented through the optimal menu. (See Jeon and Laffont 1999 for a complete case-by-case analysis.) Consider the case in which the efficient type is the low-cost type: $\Delta\theta > \underline{U}^m$. Suppose that the social value of public production is low such that the optimal probabilities are given by $0 < \underline{p}^{**} < 1$ and $\bar{p}^{**} = 0$. In this case, the optimal menu is given by:

$$\begin{aligned} w(\underline{\theta}) &= \underline{U}^p + \underline{\theta}, \quad s(\underline{\theta}) = \underline{U}^p - \underline{U}^m \\ s(\bar{\theta}) &= \bar{U}^p + (1 - \underline{p}^{**})(\Delta\theta - \underline{U}^m). \end{aligned}$$

Because $\bar{p}^{**} = 0$, $w(\bar{\theta})$ can take any value. A proportion of the efficient workers remains in the public sector, receiving a wage equal to their status quo utility level in the public sector plus their production cost. The rest of the efficient workers leave the sector and are offered a severance pay equal to their status quo utility level in the public sector minus their reservation utility in the private sector. Hence, every efficient worker gets zero ex ante and zero ex post rent. The inefficient workers always get laid off and are offered a severance pay larger than their status quo utility level in the public sector. Hence, they obtain a positive informational rent. We note that the severance pay for the efficient type is larger than the one for the inefficient type: $s(\underline{\theta}) - s(\bar{\theta}) > 0$.

VI. EXTENSIONS

In this section, we relax the main assumptions and investigate how our analysis can be extended.

When Discrimination before Downsizing is Less Than the Differential of Information

We have considered only the case in which the public sector before downsizing discriminates as the differential of information suggests. Even if this is a good benchmark, the public sector before downsizing is likely to discriminate less than the differential of information suggests: $\Delta\theta > \underline{U}^p - \bar{U}^p > \max\{0, \underline{U}^m - \bar{U}^p\}$.

This case corresponds to the stylized fact that low-ability workers tend to be overpaid and high-ability workers tend to be underpaid in public sectors of developing countries, compared with their peers in the private sector. Hence, it will be interesting to examine this more general case.

We fix the level of \bar{U}^p and investigate the impact of the variation in the level of \underline{U}^p on the efficient downsizing mechanism. The optimal probabilities under complete information are not affected by the change in the level of \underline{U}^p because the full costs are independent of it. We investigate below the impact on the optimal probabilities under asymmetric information in the case in which the efficient type is the low-cost type ($\Delta\theta > \underline{U}^m$). Suppose that the social value of public production is so low that the optimal probabilities under complete information are given by $0 < p^* < 1$ and $\bar{p}^* = 0$.

In figure 2, a decrease in the level of \underline{U}^p will shift the efficient type's indifference curve (which keeps the worker's utility equal to the status quo utility level) downward without affecting the slope. Thus there will be three cases. First, if \underline{U}^p is large enough, the inefficient type's incentive compatibility constraint is binding and the size of downsizing will be smaller under asymmetric information than under complete information: $p^* < p^{**}$. Second, if \underline{U}^p is small enough, the efficient type's incentive compatibility constraint will be binding. In this case, the efficient type obtains a positive informational rent, but the size of downsizing will not be affected by asymmetric information: $\underline{p}^* = \underline{p}^{**}$.³ Third, if \underline{U}^p is intermediate, both incentive compatibility constraints are slack, and the optimal complete information outcome can be implemented: $\underline{p}^* = \underline{p}^{**}$. Hence, countervailing incentives exist only when \underline{U}^p is large enough.

Mandatory Downsizing

Here we look at mandatory downsizing instead of voluntary downsizing. The latter may favor workers who have already been favored by entering the public sector because the government must compensate the workers for their status quo utility level in the public sector to induce their participation. Under mandatory downsizing, the utility that worker A_i expects to obtain by rejecting the government's offer is given by $U^m(\theta_i)$ instead of $U^p(\theta_i)$.

It is easy to see that the optimal probabilities under complete information are the same regardless of whether downsizing is voluntary or mandatory. We study the optimal probabilities under asymmetric information, maintaining the assumption that the public sector before downsizing is discriminating as the differential of information suggests. Consider the case in which the efficient type is the low-cost type ($\Delta\theta > \underline{U}^m$). Suppose that the social value of public production is high, such that the optimal probabilities under complete information are given by $\underline{p}^* = 1$ and $0 < \bar{p}^* < 1$. In figure 2, under mandatory downsizing, the indifference curves for the efficient and inefficient types have the same constant, given

3. However, if the social value of public production is high, such that the optimal probabilities under complete information are given by $\underline{p}^* = 1$ and $0 < \bar{p}^* < 1$, the size of downsizing will be larger under asymmetric information than under complete information: $\bar{p}^{**} < \bar{p}^*$.

by ($p = 0$, $t = 0$). Hence the efficient type's incentive compatibility constraint is binding, and the size of downsizing is larger under asymmetric information: $\bar{p}^{**} < \bar{p}^*$. Under mandatory downsizing, the monetary transfer is reduced for every worker by at least \bar{U}^p . However, the government gives up a positive rent to the efficient type and thus introduces a downward distortion in \bar{p}^{**} .⁴ Other cases can be analyzed in the same way.

Several Types

The analysis can be extended to the case in which there are several types: the cost parameter in the public sector θ can take several values. Consider the regular case in which full cost $[\theta + U^m(\theta)]$ is monotone in θ . Under complete information, the social marginal cost of keeping a worker in the public sector will be monotone in θ . Thus there will be a cutoff type such that the government will keep this type with a positive probability and will lay off (respectively, keep) with probability 1 all the types whose full cost is larger (respectively, smaller) than the cost of the cutoff type.

We analyze what happens under asymmetric information, maintaining the assumption that the public sector before downsizing is discriminating as the differential of information suggests. Consider the case in which $[\theta + U^m(\theta)]$ is increasing in θ . In figure 2, the indifference curve that keeps the individual rationality constraint binding will have an increasing slope and a decreasing constant in θ . Every curve will pass through the point $[p = 1, t = \theta + U^p(\theta)]$, where $[\theta + U^p(\theta)]$ represents the wage before downsizing and has the same value for all θ . Let θ^c denote the cutoff type under complete information.

Suppose that under complete information we have $0 < p^*(\theta^c) < 1$. Let $t^*(\theta^c)$ be the transfer that makes the cutoff type's individual rationality constraint binding. Then, under asymmetric information, every type whose cost parameter is larger than θ^c will have a strictly positive rent by taking the contract $[p^*(\theta^c), t^*(\theta^c)]$. Hence, there are countervailing incentives. Under certain regularity conditions, the social marginal cost of keeping a worker under asymmetric information will be increasing in θ , but it will be smaller than it would be under complete information. Consequently, under asymmetric information, the size of downsizing is smaller: either the cost parameter of the cutoff type under asymmetric information is larger than θ^c , or it is unchanged and the probability of keeping the same cutoff type under asymmetric information $p^{**}(\theta^c)$ is larger than $p^*(\theta^c)$.

Risk Aversion

We can relax the assumption of risk neutrality and incorporate risk aversion in our model. Then in the downsizing mechanism, the transfer to a worker should depend not only on type but also on whether the worker gets laid off. The utility

4. Under mandatory downsizing, rent is defined not with regard to $U^p(\cdot)$ but with regard to $U^m(\cdot)$.

that a worker expects to obtain by entering the private sector [$U^m(\cdot)$] should take into account the uncertainty related to finding a job.

In the special case in which risk aversion is represented by ex post individual rationality constraints, the efficient downsizing mechanism is given by the case analyzed in section V. In this case, risk aversion has an effect only on the individual rationality constraints and not on the incentive compatibility constraints. However, in general, if workers have risk aversion, they will have incentives to take the contract without randomness (for example, to stay with probability 1 in the public sector). Thus the government should pay a risk premium to induce workers to choose a random contract.

VII. CONCLUDING REMARKS

We have assumed that the quantity produced by each worker in the public sector is not a controllable instrument and is normalized to 1 regardless of type. This assumption can be relaxed if the public sector has some information about workers' productive efficiency. In this case, the quantities before downsizing may vary according to the information possessed by the public sector. This reinforces the relevance of the case in which the public sector before downsizing is discriminating less than the differential of information suggests. One important question is what is the optimal way to use this information for downsizing. In general, only direct superiors have information about their subordinates' productive efficiency. Moreover, those superiors might be engaged in favoritism or collusive behavior. Hence, it will be necessary to design an incentive scheme that induces superiors to reveal their information and deters them from engaging in favoritism or collusive behavior.

The stochastic element is a main feature of the efficient downsizing mechanism analyzed in our article. However, if the integrity of public officials is in doubt because of favoritism or corruption, the implementation of stochastic mechanisms may be difficult. In this case, we need to find an alternative that is more transparent and less prone to administrative arbitrariness. From this point of view, fixed-term contracts seem to have desirable features, but they will be much more costly.

Another interesting extension is to incorporate type-dependent externalities. For example, if the labor market is not competitive, the reservation utility in the private sector cannot capture all the social surplus that a worker generates in the private sector. Once we have type-dependent externalities, they will affect the first-order conditions. Hence, the conditions determining which type of workers the regulator should start to lay off will change.

In some countries, downsizing in the public sector is accompanied by retraining programs for laid-off workers. If the outcome of retraining depends on workers' productive efficiency in the public sector, retraining can be a useful supplementary instrument for solving the adverse selection problem. Hence, it

would be interesting to integrate retraining as an element of the downsizing mechanism.

Finally, although we mentioned the brain-drain effect in the introduction, we did not explicitly analyze it in our model. Explicit consideration of this effect will make it less likely that it is optimal to start laying off efficient workers.

APPENDIX A. THE EFFICIENT DOWNSIZING MECHANISM UNDER COMPLETE INFORMATION

The Formal Characterization

The efficient downsizing mechanism under complete information $\{p^*, \bar{p}^*, \underline{t}^*, \bar{t}^*\}$ is characterized as follows.

1. The two individual rationality constraints are binding.
2. The probabilities are given as in proposition 1.
3. The transfers are obtained from the binding individual rationality constraints:

$$\begin{aligned}\underline{t}^* &= \underline{p}^* (\underline{U}^P + \theta) + (1 - \underline{p}^*) (\underline{U}^P - \underline{U}^m) \\ \bar{t}^* &= \bar{p}^* (\bar{U}^P + \theta) + (1 - \bar{p}^*) \bar{U}^P.\end{aligned}$$

First-Order Conditions

The first-order conditions determining the optimal probabilities are given as follows.

CASE 1. When $\Delta\theta > \underline{U}^m$ holds.

a. If the social value of public production is low:

$$\begin{aligned}\underline{MC}^c &= S'(v\underline{p}^*) < \overline{MC}^c & \text{if } 0 < \underline{p}^* < 1 \\ \underline{MC}^c &\leq S'(v) \leq \overline{MC}^c & \text{if } \underline{p}^* = 1.\end{aligned}$$

b. If the social value of public production is high:

$$\underline{MC}^c < S'[v + (1 - v)\bar{p}^*] = \overline{MC}^c.$$

CASE 2. When $\Delta\theta < \underline{U}^m$ holds.

a. If the social value of public production is low:

$$\begin{aligned}\overline{MC}^c &= S'[(1 - v)\bar{p}^*] < \underline{MC}^c & \text{if } 0 < \bar{p}^* < 1 \\ \overline{MC}^c &\leq S'(1 - v) < \underline{MC}^c & \text{if } \bar{p}^* = 1.\end{aligned}$$

b. If the social value of public production is high:

$$\overline{MC}^c < S'[\nu \underline{p}^* + (1 - \nu)] = \underline{MC}^c.$$

Case 3. When $\Delta\theta = \underline{U}^m$ holds.

$$S'(p^*) = \underline{MC}^c = \overline{MC}^c.$$

APPENDIX B. THE EFFICIENT DOWNSIZING MECHANISM
UNDER ASYMMETRIC INFORMATION

The Formal Characterization

The efficient downsizing mechanism under asymmetric information $\{\underline{p}^{**}, \bar{p}^{**}, \underline{t}^{**}, \bar{t}^{**}\}$ is characterized by as follows.

1. Only the efficient type's individual rationality constraint and the inefficient type's incentive compatibility constraint are binding.
2. We can distinguish two cases depending on the social value of public production.
 - a. If the social value of public production is low, $0 < \underline{p}^* \leq \underline{p}^{**} \leq 1$ and $\bar{p}^* = \bar{p}^{**} = 0$.
 - b. If the social value of public production is high, the optimal complete information outcome is achievable: $\underline{p}^* = \underline{p}^{**} = 1$ and $0 < \bar{p}^* = \bar{p}^{**} < 1$.
3. The transfers are obtained from the two binding constraints:

$$\begin{aligned} \underline{t}^{**} &= \underline{p}^{**}(\underline{U}^p + \theta) + (1 - \underline{p}^{**})(\underline{U}^p - \underline{U}^m) \\ \bar{t}^{**} &= \bar{p}^{**}(\bar{U}^p + \theta) + (1 - \bar{p}^{**})\bar{U}^p + (1 - \underline{p}^{**})(\Delta\theta - \underline{U}^m). \end{aligned}$$

First-Order Conditions

After inserting the transfers given above into expected welfare, we find the following first-order conditions determining the optimal probabilities.

1. If the social value of public production is low:

$$\begin{aligned} \underline{MC}^a &= S'(\nu \underline{p}^{**}) < \overline{MC}^c & \text{if } 0 < \underline{p}^{**} < 1 \\ \underline{MC}^a &\leq S'(\nu) \leq \overline{MC}^c & \text{if } \underline{p}^{**} = 1. \end{aligned}$$

2. If the social value of public production is high, see appendix A.

Proof

It suffices to check whether the efficient mechanism described above satisfies the neglected constraints.

The inefficient type's individual rationality constraint is satisfied if the following inequality holds:

$$(1 - \underline{p}^{**})(\Delta\theta - \underline{U}^m) + \bar{U}^p \geq \bar{U}^p.$$

It is satisfied because we have $\Delta\theta - \underline{U}^m \geq 0$.

The efficient type's incentive compatibility constraint is satisfied if the following inequality holds:

$$\bar{U}^p + \Delta\theta \geq \bar{U}^p + (1 - \underline{p}^{**})(\Delta\theta - \underline{U}^m) + \bar{p}^{**}\Delta\theta + (1 - \bar{p}^{**})\underline{U}^m.$$

It is satisfied because we have $\underline{p}^{**} \geq \bar{p}^{**}$ and $\Delta\theta - \underline{U}^m \geq 0$.

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