Bidding for the Unemployed: An Application of Mechanism Design to Welfare-to-Work Programs*

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Abstract

This paper applies the theory of mechanism design to welfare-to-work programs. When procuring welfare-to-work projects to employment service providers, governments face the problems of adverse selection (the winning provider is not the most efficient one) and moral hazard (the winning provider shirks in its responsibility to reintegrate unemployed people). We compare the constant-reward second-price auction with the socially optimal mechanism and show that the auction generates social welfare that is close to the optimal mechanism, while requiring less information and weaker commitment.

Keywords: Adverse selection; Auctions; Incentive contracts; Moral hazard; Welfare-to-work programs

JEL classification: D44; D82; J68

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1 Introduction

In several countries, the government procures welfare-to-work programs as part of their active labor market policy.[1] In doing so, the government allocates welfare-to-work projects to private employment service providers. A welfare-to-work project typically consists of a number of unemployed people. The winning provider is usually rewarded for the number of unemployed people who find a job within a specified time period.[2]

In reaching their targets, the government may be confronted with adverse selection and moral hazard. Adverse selection occurs if the procurement does not select the "best" employment service provider, i.e., the provider that, relative to all other providers, is able to help the unemployed back to work in the most cost efficient way. Moral hazard may occur if the winner has no incentive to expend effort on the welfare-to-work project.

Finn (2005) describes how the UK has implemented *Employment Zones* in which the government allocates the long-term unemployed to private employment service providers. Like many governments worldwide, the UK government uses a beauty contest to select providers. The selection criteria are quality and feasibility of the provider's business plan. The payment rules are as follows. The winning providers pay the social benefits for the unemployed during a 26 weeks period. More precisely, if a person finds a job for w weeks in this period, then the provider has to pay social benefits during $(26-w)$ weeks. The government rewards the provider with the social benefits for 21 weeks plus a bonus for each placement.

In this paper, we study auctions, which are simpler mechanisms than beauty contests, and compare these with the socially optimal mechanism. In an auction, several providers submit a bid for a welfare-to-work project, and the winner is chosen according to a well-defined and

[1] See OECD (2001) and Productivity Commission (2002) for Australia, and OECD (2003) for the Netherlands. Bruttel (2004) and SEO and TNO (2004) provide a comparison of welfare-to-work procurement mechanisms in Australia, the Netherlands, and the UK. In addition, SEO and TNO (2004) investigate procurement mechanisms in Denmark, Sweden, and the US.

[2] CPB (2004) gives an impression of the volume of this market: In the Netherlands in 2002, about 160,000 unemployed people were matched to employment service providers (1% of the total population and 2% of the labor force). The Dutch government transferred about 800 million euros to the providers (around 0.2% of Dutch GDP, and more than 10% of total active labor market policy expenditures).

anonymous allocation rule which is universal in that it does not depend on the details of the project.[3] Several economists claim that auctions perform better than beauty contests as they are more transparent, less prone to favoritism, and give rise to less administration for both bidders and the government.[4]

In particular, we study the constant-reward auction, which the OECD (2001) proposes as an alternative means to procuring welfare-to-work projects. The government sells the project to the highest bidder, for instance in the second-price sealed-bid auction (the constant-reward second-price auction). The winner is paid a fixed reward for each unit of its output. Observe that this payment scheme resembles that of the Employment Zones in the UK. More specifically, if the reward is equal to the savings on unemployment benefits, there is a one-to-one relationship between the payment schemes of both mechanisms: for both, the marginal benefits for a provider of a person finding a job of a week equals one week's social benefits. The only difference is that competition in the auction may drive down the fixed amount the government pays to the provider (the unemployment benefit for 21 weeks). The OECD (2001) argues that the constant-reward auction is optimal provided that the government awards the winner of the auction the marginal social value for each placement. However, the OECD's claim is based on McMillan (1992), who assumes that the government is completely informed about the efficiency of the providers, and who ignores the positive impact on government finances of a decrease in unemployment benefit.

We examine to which extent the OECD proposal holds true in the case of incomplete information and distortionary taxes. We show that the constant-reward auction is "close" to the optimal mechanism in terms of welfare. The auction has an advantage over the socially optimal mechanism in that (1) it is "detail free": the government need not acquire information about the distribution of the efficiency levels of the providers and (2) it is less demanding with respect to the government's commitment. This result supports the OECD's claim that the constant-reward auction is a good alternative to the beauty contests that are currently used.

[3] Krishna (2002).

[4] See e.g. Binmore and Klemperer (2002).

Several branches of the literature are related to our paper. There is comprehensive literature on welfare-to-work programs, which focuses on the effects of specific programs such as financial stimuli, training and skill development, and work support subsidies.[5] The role of intermediation has been virtually ignored in this literature.[6] The main goal of this paper is to fill this gap.

In addition, there is substantial literature on optimal auction design[7] and on incentive contracts.[8] McAfee and McMillan (1986, 1987) and Laffont and Tirole (1987, 1993) build a bridge between auction and incentive theory. Laffont and Tirole study a model in which the government auctions an indivisible project to one of several risk neutral firms. The government wishes to incentivize the selected firm to reduce the costs of the project. McAfee and McMillan (1986) investigate a similar setting, assuming risk averse bidders. The optimal contract in their model is usually an incentive contract, i.e., a contract that shares risk between the government and the winning bidder. McAfee and McMillan (1987) is the most closely related to our paper. The most substantial difference is that they maximize the principal's profit, whereas we maximize social welfare, taking into account costs incurred by the winning agent. Qualitatively, we derive the same results with respect to the optimal mechanism: optimally, the government screens out all providers below a fixed threshold, and gives the winner incentives to provide less output then in the full-information optimum.

The remainder of this paper is organized as follows. In the next section, we describe our model. In Section 3, we construct the socially optimal mechanism while in Section 4, we study the second-price constant-reward auction. In Section 5, we compare the socially optimal mechanism and the auction. Section 6 contains a discussion about several other auction formats. Section 7 includes a conclusion, in which we propose several applications of our study to situations other than welfare-to-work procurement, and in which we describe avenues for further

[5] See Heckman et al. (1999), Martin and Grubb (2001), Kluve and Schmidt (2002), and Boone and Van Ours (2004) for overviews.

[6] Two notable exceptions can be found in the work of James Heckman and Al Roth. Heckman et al. (1996) investigate the incentives for case workers in job training programs. Roth (2002) studies computer algorithms that implement the intermediation between workers and employers. Some of these algorithms have been applied in the US to match young doctors with hospitals.

[7] See Klemperer (1999) and Krishna (2002).

[8] See Laffont and Tirole (1993) and Laffont and Martimort (2002).

research.

2 The model

A risk neutral government wishes to procure a welfare-to-work project. We assume that n risk neutral employment service providers participate in the procurement. Each provider i, $i = 1, ..., n$, upon winning the project, is able to produce output e_i at the cost $C(e_i, \alpha_i)$ where α_i is provider i's efficiency level. The output level e_i is observable,[9] or the relevant output is the sum of e_i and a disturbance term with mean 0. The latter is irrelevant as by assumption, both the government and the providers are risk neutral. In the specific context of welfare-to-work programs, we interpret output as the savings on social benefits when people in the project find a job. C is strictly increasing and strictly convex in e_i, with $C(0, \alpha_i) = 0$. In other words, the marginal costs of output are strictly increasing in output. The reason for this is not diseconomies of scale, but that some people are easier to place than others. If economies of scale played an important role, the government would have good reason to split up the program into smaller programs, and have several providers do the job. Moreover, C is strictly decreasing in α_i, with $C_{\alpha e}(e, \alpha) < 0$ and $C_{\alpha\alpha}(e, \alpha) \geq 0$.

The providers draw the α_i's independently from the same distribution with a cumulative distribution function F and density function f with $f(\alpha_i) > 0$ for all α_i. F is common knowledge. Without loss of generality, we assume that F has all its mass on the interval $[0, 1]$. Provider i has the utility function

$$U_i = t_i - C(e_i, \alpha_i) \tag{1}$$

where t_i is the monetary transfer that it receives from the government.

Let S denote the net social welfare of the project. We follow Laffont and Tirole (1987) in that the social cost of one unit of money is $1 + \lambda$, where $\lambda \geq 0$.[10] Ballard et al. (1985) estimate deadweight losses of raising taxes to lie between 17 and 56 cents for every extra \$1 raised, so

[9] The government can perfectly observe output if output equals the savings on social benefits because the government pays the social benefits to each unemployed person who participates in the project.

[10] Jacobs et al. (2004) show in an optimal taxation model that $\lambda = 0$ under certain conditions.

that in practice, $\lambda \approx 0.37$. Net social welfare is given by:

$$\begin{aligned} S &= e_i - (1+\lambda)t_i + t_i - C(e_i, \alpha_i) \\ &= e_i - \lambda U_i - (1+\lambda)C(e_i, \alpha_i) \end{aligned} \tag{2}$$

where i is the winner of the procurement. The marginal social benefits of each unit of the provider's output is normalized to 1.[11] The social benefits include all effects on the economy associated with people finding a job, and may be positively related to increased production, a decrease in social benefits (so that the government has to levy less distortionary taxes), and diminishing intergenerational welfare dependency. The benefits may be negatively related to the placement of one person detracting from the employment possibilities of others.[12] In other words, the model allows for the possibility that the micro-economic effect of a person finding a job may be quite different than the macro-economic effect, as stressed by e.g. Heckman et al. (1999).[13]

An optimal mechanism maximizes S under the restriction that the providers play a Bayesian Nash equilibrium, and that it satisfies a participation constraint (each participating provider should at least receive zero expected utility). The first-best optimum (the social optimum under complete information) has the following properties. First of all, the government selects the most efficient provider, i.e., the provider with the highest type α_i, as he has the lowest C_i for a given output level. Secondly, the government induces this provider to produce output $e^{**}(\alpha_i)$ for which

$$C_e(e^{**}(\alpha_i), \alpha_i) = \frac{1}{1+\lambda}. \tag{3}$$

Finally, the government covers the costs $C(e^{**}(\alpha_i), \alpha_i)$ exactly.

[11] Suppose instead that $S = s(e_i) - \lambda U_i - (1+\lambda)C$ for some continuous and strictly increasing function s. Then this model is equivalent to one in which e is replaced by $\tilde{e}_i \equiv s(e_i)$, C by $\tilde{C}$ for which $\tilde{C}(\tilde{e}_i, \alpha) = C(s^{-1}(\tilde{e}_i), \alpha)$, and S by $\tilde{S} = \tilde{e}_i - \lambda U_i - (1+\lambda)\tilde{C}$.

[12] See e.g. Calmfors (1994).

[13] Mirrlees' (1971) analysis of optimal taxation indicates that it is optimal that the persons with the lowest abilities remain unemployed. An implication of this result is that under some circumstances, the marginal social benefits are zero. We ignore this possibility in this paper.

3 The socially optimal mechanism

What is the socially optimal mechanism in a setting with incomplete information? We use the techniques developed by Laffont and Tirole (1987) and McAfee and McMillan (1987) to answer this question. According to Myerson (1981), we may, without loss of generality, restrict our attention to incentive compatible and individually rational direct revelation mechanisms. Let $\tilde{\boldsymbol{\alpha}} = (\tilde{\alpha}_1, ..., \tilde{\alpha}_n)$ be the vector of announcements by provider $1, ..., n$ respectively. We consider mechanisms $M = (x_i, e_i, t_i)_{i=1,...,n}$ that induce a truthtelling Bayesian Nash equilibrium, where, given the announcement $\tilde{\boldsymbol{\alpha}}$, $x_i(\tilde{\boldsymbol{\alpha}})$ is the probability that provider i wins the contract, and, given that provider i wins the contract, $e_i(\tilde{\boldsymbol{\alpha}})$ is its output and $t_i(\tilde{\boldsymbol{\alpha}})$ is the monetary transfer it receives from the government.

Suppose that $e^*(\alpha)$ is a solution to

$$C_e(e^*(\alpha), \alpha) = \frac{1}{1+\lambda} + \frac{\lambda}{1+\lambda} \frac{1 - F(\alpha)}{f(\alpha)} C_{\alpha e}(e^*(\alpha), \alpha_i). \tag{4}$$

Let

$$A(e, \alpha) \equiv e - (1+\lambda) C(e, \alpha) + \lambda \frac{1 - F(\alpha)}{f(\alpha)} C_\alpha(e, \alpha).$$

Proposition 1 *The optimal mechanism $M^* = (x_i^*, e_i^*, t_i^*)_{i=1,...,n}$ has the following properties:*

$$\begin{aligned} x_i^*(\boldsymbol{\alpha}) &= \begin{cases} 1 & \text{if } \alpha_i > \max_{j \neq i} \alpha_j \text{ and } \alpha_i \geq \underline{\alpha} \\ 0 & \text{otherwise} \end{cases}, \\ e_i^*(\boldsymbol{\alpha}) &= e^*(\alpha_i), \text{ and} \\ t_i^*(\boldsymbol{\alpha}) &= C(e^*(\alpha_i), \alpha_i) - \int_{\underline{\alpha}}^{\alpha_i} C_\alpha(e^*(y), y) \left(\frac{F(y)}{F(\alpha_i)} \right)^{n-1} dy. \end{aligned}$$

where $\underline{\alpha}$ is the smallest solution to y in $A(e^*(y), y) \geq 0$.

Proof. Analogous to proofs in Laffont and Tirole (1987) and McAfee and McMillan (1987) for similar results. ■

Under the optimal mechanism M^*, the government chooses the most efficient provider, provided that its efficiency level exceeds $\underline{\alpha}$. This provider produces output according to e_i^*, and

t_i^* determines the payments it receives from the government. Observe that the desired output level $e_i^*(\boldsymbol{\alpha})$ and $\underline{\alpha}$ do not depend on the number of bidding providers.

Three types of inefficiency arise from this mechanism. First, the comparison between (3) and (4) reveals that $e^*(\alpha) < e^{**}(\alpha)$ for all $\alpha < 1$, i.e., output is lower than in the full-information optimum for all types apart from the most efficient one. Second, the government will not contract with any provider whose efficiency level is below $\underline{\alpha}$, whereas in the full-information world, the government would contract with any provider. The latter is analogous to a reserve price in an optimal auction (see Myerson, 1981 and Riley and Samuelson 1981). Third, as $t_i^*(\boldsymbol{\alpha}) > C(e_i^*(\boldsymbol{\alpha}), \alpha_i)$ for $\alpha_i > 0$, the government covers more than the costs that are actually born by the winning provider, which is inefficient as government finances are socially costly. These types of inefficiency allow the government to capture some of the informational rents that arise because of incomplete information.

4 The constant-reward second-price auction

The optimal mechanism that we discussed in the previous section has two practical drawbacks. First, the mechanism is context dependent: it depends on the providers' cost function and the signal distribution. The stand-point that the auction designer should restrict his attention to mechanisms that do not depend on the details of the environment is sometimes called "the Wilson doctrine", named after Robert Wilson, who is a well known advocate of this point of view (Wilson, 1987). Second, the optimal mechanism is demanding with regards the government's commitment: it (1) requires an ex post suboptimal level of effort from the winning agent, and (2) the government to withhold a welfare enhancing project when the efficiency parameter of all agents turns out to be below a certain threshold value.

In this section, we study the *constant-reward auction*, which does not suffer from these practical drawbacks. The OECD (2001) proposes this auction as an alternative to the beauty contests that are usually used in welfare-to-work programs. We focus on the constant-reward *second-price* auction. This mechanism consists of two stages. In the first stage, the project is

allocated in the second-price sealed-bid auction. All providers submit a bid (a non-negative amount of money). The highest bidding provider wins the project and pays the government the second highest bid. In the second stage, the winner chooses his effort level $e \geq 0$ in the project, for which the government pays him σe ($\sigma > 0$).

Proposition 2 *Let $L(\alpha)$ be the output of a provider with efficiency level α. Suppose*

$$L(\alpha) = \min\{e : C_e(e(\alpha), \alpha) \geq \sigma\}.$$

Moreover, suppose a provider with efficiency level α bids

$$B(\alpha) = \sigma L(\alpha) - C(L(\alpha), \alpha).$$

Then B and L constitute a symmetric Bayesian Nash equilibrium of the second-price constant-reward auction. This equilibrium is in weakly dominant strategies. B is constant in n and strictly increasing in α for all α for which $L(\alpha) > 0$.

Observe that the constant-reward second-price auction generates the first-best effort if $\sigma = \frac{1}{1+\lambda}$. Still, this auction fails to implement the optimal mechanism. First, types $\alpha < \underline{\alpha}$ can win the contract, which the socially optimal mechanism excludes. Of course, the government could impose a reserve price to make sure that only types $\alpha \geq \underline{\alpha}$ win, but this would create the same problems as for the optimal mechanism with respect to information requirements and commitment. Second, the socially optimal contract requires the winner to exert less effort than in the full-information optimum, unless the winner has type $\alpha = 1$. In other words, optimally, σ should depend on the winner's type, which is in contrast to the requirement for the constant-reward auction that σ is constant.

5 Auctions versus optimal mechanisms

In the previous section, we observed that the constant-reward second-price auction is suboptimal. In this section, we establish that this auction generates social welfare close to that which

the optimal mechanism generates. In order to simplify the comparison between the optimal mechanism and the auction, we assume

$$C(e_i, \alpha_i) = \frac{1}{2\beta} e_i^2 + \gamma e_i (1 - \alpha_i) \tag{5}$$

where $\beta, \gamma > 0$. Moreover, we define the inverse hazard rate as $h(\alpha_i) \equiv \frac{1-F(\alpha_i)}{f(\alpha_i)}$. Let $\check{\alpha}$ be the lower bound of the types that exert strictly positive effort in the equilibrium of the auction, i.e.,

$$\check{\alpha} = \max \left\{ 0, 1 - \frac{1}{\gamma (1 + \lambda)} \right\}.$$

Note that $\check{\alpha} \leq \underline{\alpha}$.

Let S^{opt} [S^{auc}] denote social welfare generated by the optimal mechanism [the auction where $\sigma = \frac{1}{1+\lambda}$]. Proposition 3 presents an upper bound to the difference in social welfare generated by the two mechanisms.

Proposition 3 $S^{opt} - S^{auc} \leq \frac{\beta\gamma^2\lambda^2}{2(1+\lambda)} \int_{\check{\alpha}}^{1} h(\alpha)^2 dF(\alpha)^n \equiv \bar{u}$.

Proposition 3 shows that the difference between the optimal mechanism and the auction is "not too large" if the tax distortion is "sufficiently small". The intuition behind this result is the following. If λ is small, the optimal effort level (given in (4)) is close to the first best optimum (defined in (3)). Because the auction generates the first-best effort, the output of both mechanisms is about the same. Moreover, because λ is small, payment differences between the two mechanisms hardly affect social welfare.

Another implication of Proposition 3 is that the auction converges to the optimal mechanism in terms of social welfare if the number of bidders increases. This follows from the observation that the difference in social welfare is proportional to the expectation of $h(\alpha)^2$ evaluated at the first order statistic of $\alpha_1, ..., \alpha_n$. This implies that the higher n is the more mass is close to 1. Because $h(1) = 0$, the difference converges to zero if n increases. The following example shows that this convergence can be very quick and that the upper bound $\bar{u}$ is a good approximation of $S^{opt} - S^{auc}$.

Example 1 *Suppose the α_i's are drawn from the uniform distribution on the interval $[0,1]$, i.e., $F(\alpha) = \alpha$ for all $\alpha \in [0,1]$. Then by Proposition 3,*

$$\begin{aligned} S^{opt} - S^{auc} &\leq \bar{u} = \frac{\beta\gamma^2\lambda^2}{2(1+\lambda)} \int_{\check{\alpha}}^{1} (1-\alpha)^2 d\alpha^n \leq \frac{\beta\gamma^2\lambda^2}{2(1+\lambda)} \int_{0}^{1} (1-\alpha)^2 d\alpha^n \\ &= \frac{\beta\gamma^2\lambda^2}{(1+\lambda)} \frac{1}{(n+1)(n+2)}. \end{aligned}$$

So, the difference between S^{opt} and S^{auc} is of the order n^{-2}. Recall that Ballard et al. (1985) estimate deadweight losses of raising taxes to lie between 17 and 56 cents for every extra \$1 raised. The following tables shows values for S^{opt}, S^{auc}, $S^{opt} - S^{auc}$, and $\bar{u}$ under the assumption that $\lambda = 0.56$, $\beta = 1 + \lambda$ and $\gamma = (1+\lambda)^{-1}$.

n	S^{opt}	S^{auc}	$S^{opt} - S^{auc}$	$\bar{u}$
1	0.12264	0.10683	0.01580	0.02148
2	0.20016	0.19017	0.00999	0.01074
3	0.25247	0.24615	0.00632	0.00644
5	0.31747	0.31440	0.00306	0.00307
10	0.39044	0.38947	0.00098	0.00098

Note that social welfare from the auction converges quickly to social welfare from the optimal mechanism (for two [five] bidders, the differences is less than 5% [1%] of social welfare generated by the optimal mechanism). Moreover, the upper bound $\bar{u}$ quickly approaches the actual difference.

6 Other auction formats

Do other auction formats perform better than the second-price constant-reward auction? Below, we briefly discuss the lowest-reward auction, the highest-output auction, and scoring auctions.

6.1 The lowest-reward auction

In the lowest-reward auction, providers submit non-negative bids on the payment they wish to receive per unit of output in the project. The provider submitting the lowest bid wins the project. If the winner submits a reward level equal to b, then the government rewards him with

be if his output in the project equals e. In Onderstal (2004), we show that in this auction, a "race to the bottom" emerges in the sense that the output converges to zero when the number of providers tends to infinity: more competition strengthens the moral hazard problem. This arises from the following trade-off. The more providers, the more efficient the most efficient provider is. However, the larger the number of providers in the auction, the more aggressively they bid. The winner, having submitted the lowest reward, then has little incentive to put much effort into the project as the marginal benefits from its output are very low. It turns out that the second effect dominates. In fact, social welfare converges to 0 if the number of bidders increases to infinity.

6.2 The highest-output auction

An alternative auction format is the highest-output auction. This auction allocates the project to the provider that promises the highest output level. The government pays the winner the following amount of money, depending on its actual output level e and the output level b that it promised in the auction: $t(e, b) = \sigma (e - b)$. Note that the highest-output auction is strategically equivalent to the constant-reward auction. A bid b in this auction is equivalent to a bid b/σ in the constant-reward auction. Therefore, the properties of the constant-reward second-price auction carry over to the highest-output auction if the winner of this auction is paid $\sigma \left(e - b^{(2)}\right)$ where $b^{(2)}$ is the second highest bid. Note that in the highest output-auction, the providers promise less than what they deliver ($e > b$). If they did not, they would end up with negative profits.

6.3 Scoring auctions

Che (1993) studies "scoring auctions" in which bidders submit bids on several dimensions. The auctioneer assigns the project to the bidder submitting the highest non-negative score (a well-defined function of these bids). In our setting, these dimensions could be the provider's output e and payment t. After the auction, the winner has to choose a payment t' and exert effort e' in order to fulfill his own score (in the first-score auction) or to match the highest rejected

score (in the second-score auction).

In our specific setting, the following scoring rule s implements the optimal mechanism for the first- and the second-score auction:

$$s(e,t) = \frac{1}{1+\lambda}e + \frac{\lambda}{1+\lambda}\int_0^e \frac{1-F((e^*)^{-1}(x))}{f((e^*)^{-1}(x))}C_{\alpha e}(e,(e^*)^{-1}(x))dx - t$$

if $e \in [0, e^*(1)]$, and $s(e,t) = -\infty$ otherwise.[14] These scoring auctions suffer from the same drawbacks as the optimal direct revelation mechanism of Proposition 1: context dependency and commitment problems. A scoring rule that generates the same outcome as the constant-reward second-price auction is

$$s(e,t) = \frac{1}{1+\lambda}e - t$$

if $e \in [0, L(1)]$, and $s(e,t) = -\infty$ otherwise.

7 Conclusion

In this paper, we have applied mechanism design theory to welfare-to-work programs. When procuring welfare-to-work projects to employment service providers, governments face the problems of adverse selection and moral hazard. As said in the introduction, several governments select providers in beauty contests and reward them for the number of unemployed people who find a job. The payment scheme in the Employment Zones in the UK probably gives firms the correct incentives: the moral hazard problem may be solved. Still, the government can be confronted with adverse selection. The reason is that the selection criteria in the beauty contest (quality and feasibility of the business plan) are not well-defined, so that it is unlikely that the most efficient provider always wins.

In contrast, we have shown that the constant-reward second-price auction (proposed by the OECD, 2001) does solve the adverse selection problem because the winner is always the most efficient provider. Moreover, the moral hazard problem is seemingly absent because the winning provider's output is exactly equal to the optimal output in a full-information world.

[14] See Che (1993) for a proof in a similar setting.

Although this output turns out to be excessive in our incomplete information setting, the auction approximates the socially optimal mechanism in terms of social welfare. The constant-reward auction is easy to implement and may revolutionize the way in which welfare-to-work projects are allocated.

Our conclusions are not limited to welfare-to-work programs. Other applications abound. For instance, in a large range of procurement settings, the buyer not only cares about the price, but also about the quality that the seller delivers. Consider the delivery date in road construction, the technical characteristics of weapons systems, and the quality of service in maternity care. In our paper, we have shown that the buyer of such services can rely fairly safely on simple auction formats, especially if the number of bidders is high.

More broadly, our analysis is relevant to any situation in which a principal wishes to select an agent from a set of agents and induce the winning agent to produce output in a task. For instance, it is quite common that employers pay their workers both a fixed salary and a bonus on the basis of their on-the-job performance. Our results show that the firm performs almost optimally if it selects the potential employee who is willing to accept the lowest fixed wage and sets the (marginal) bonus at the appropriate constant level.

There are several interesting avenues for future research. First of all, as far as we know, auctions are rarely used to allocate welfare-to-work projects. In some countries, beauty contests are employed (e.g. Employment Zones in the UK), and in others, the government (partly) awards contracts on the basis of the employment service providers' reputation (e.g. Job Network in Australia). The question that arises is whether there are circumstances in which beauty contests or reputation mechanisms outperform auctions. Secondly, from a theoretical point of view, it may be interesting to explore to what extent our "auctions versus optimal mechanisms" result generalizes to other settings. For instance, we have assumed that the agents' private information is one-dimensional. How does our result change in settings with multidimensional private signals?[15] Finally, the effect of the winner's curse and risk aversion among employment

[15] See Asker and Cantillon (2006) for the properties of scoring auctions in the case of multidimensional private information.

service providers are interesting topics for further research.

Appendix

Proof of Proposition 2. We construct the equilibrium using backward induction, first deriving the output level by the winning firm, and then deriving the bids in the auction. The winner solves $\max_e \sigma e - C(e, \alpha)$ so that $L(\alpha) = \min\{e : C_e(e(\alpha), \alpha) \geq \sigma\}$. By the implicit function theorem, if $L(\alpha) > 0$,

$$L'(\alpha) = -\frac{C_{\alpha e}(L(\alpha), \alpha)}{C_{ee}(L(\alpha), \alpha)} > 0.$$

In the auction, each provider has a dominant strategy, which is to submit a bid B equal to its profits in the second stage, i.e. $B(\alpha) = \sigma L(\alpha) - C(L(\alpha), \alpha)$. These dominant strategies constitute a Bayesian Nash equilibrium. It is readily observed that B is constant in n. Finally, observe that for all α for which $L(\alpha) > 0$,

$$B'(\alpha) = [\sigma - C_e(L(\alpha), \alpha)]\, L'(\alpha) - C_\alpha(L(\alpha), \alpha) > 0.$$

Proof of Proposition 3. Let $\alpha^{(1)} \equiv \max_i \alpha_i$. For both the optimal mechanism and the auction it holds true that (1) firm i's effort only depends on its own signal α_i, and (2) if the project is allocated, it is always allocated to the firm with the highest signal. McAfee and McMillan (1987) show that for an incentive compatible and individually rational mechanism $(x_i, e_i, t_i)_{i=1,\ldots,n}$ with properties (1) and (2), social welfare equals $E\left\{A\left(e_i(\alpha^{(1)}), \alpha^{(1)}\right)\right\}$.

The auction has equilibrium effort

$$L(\alpha^{(1)}) = \max\left\{\frac{\beta}{1+\lambda} - \gamma\beta\left(1 - \alpha^{(1)}\right), 0\right\},$$

while in the optimal mechanism, equilibrium effort equals

$$e^*(\alpha^{(1)}) = \max\left\{\frac{\beta}{1+\lambda} - \gamma\beta\left(1 - \alpha^{(1)}\right) - \frac{\gamma\beta\lambda}{1+\lambda} h(\alpha^{(1)}), 0\right\}.$$

Social welfare from the auction is given by

$$\begin{aligned} S^{auc} &= \int_{\check{\alpha}}^{1} \left[L(\alpha) - (1+\lambda)\, C(L(\alpha),\alpha) - \lambda\gamma L(\alpha)h(\alpha)\right] dF(\alpha)^n \\ &= \int_{\check{\alpha}}^{1} L(\alpha)\left[1 - \frac{1+\lambda}{2\beta}L(\alpha) - (1+\lambda)\,\gamma\,(1-\alpha) - \lambda\gamma h(\alpha)\right] dF(\alpha)^n \\ &= \frac{1+\lambda}{2\beta}\int_{\check{\alpha}}^{1} L(\alpha)\left[L(\alpha) - 2\gamma\beta\frac{\lambda}{1+\lambda}h(\alpha)\right] dF(\alpha)^n. \end{aligned}$$

The second equality in the chain is derived by substituting (5).

Analogously, social welfare from the optimal mechanism equals

$$\begin{aligned} S^{opt} &= \frac{1+\lambda}{2\beta}\int_{\underline{\alpha}}^{1} \left[e^*(\alpha)\right]^2 dF(\alpha)^n \\ &= \frac{1+\lambda}{2\beta}\int_{\underline{\alpha}}^{1} \left[L(\alpha) - \frac{\gamma\beta\lambda}{1+\lambda}h(\alpha)\right]^2 dF(\alpha)^n \\ &\leq \frac{1+\lambda}{2\beta}\int_{\check{\alpha}}^{1} \left[L(\alpha) - \frac{\gamma\beta\lambda}{1+\lambda}h(\alpha)\right]^2 dF(\alpha)^n \end{aligned}$$

Therefore,

$$S^{opt} - S^{auc} \leq \frac{\beta\gamma^2\lambda^2}{2\,(1+\lambda)}\int_{\check{\alpha}}^{1} h(\alpha)^2 dF(\alpha)^n$$

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