Tradeoff between marginal welfare costs

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resumo

Este artigo estuda as implicações de um dilema entre os custos sociais de financiamento público e os custos sociais de monopólio num esquema conceptual de aquisições governamentais e de regulação, ambos sob informação incompleta. O sentido das distorções de custo, esforço e nível de produção são determinadas com referência ao padrão de informação completa.

résumé / abstract

Cet article étudie les implications d'un dilemme entre les coûts sociaux de financement public et les coûts sociaux de monopole dans un schéma conceptuel d'acquisitions gouvernementales et de régulation, tous deux sous information incomplète. Le sens des distorsions de coût, d'effort et de niveau de production se trouve déterminé selon une référence au modèle d'information complète.

This paper studies the implications of a tradeoff between the social costs of public funding and the social costs of monopoly in a framework of government procurement and a framework of regulation both under incomplete information. The directions of cost, effort and output distortions are determined with reference to the complete information benchmark.

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1. Introduction*

The literature on the subject of government procurement and regulation generally assumes that there is no alternative to raising revenue generated through distortionary taxes in order to spend on public goods and make public expenditures. If government could use distortion-less transfers then it would always implement the first-best outcome, even under adverse conditions such as the existence of incomplete information.

The first theme of my analysis is to explore an alternative financing scheme that a rational government might be interested in. As a way of being paid for its effort in the production of some public good, the firm awarded with a procurement contract is allowed by the government to operate some segment of a final product market and keep the market demand revenue there generated. The consideration of financing options in alternative to raising revenue through distortionary taxes apparently seems such a sound principle that any government concerned with minimizing the cost society has to pay per each euro or dollar spent in public expenditure must follow.

Eventually the government decides to exercise external control of this firm through regulation of prices in the final product market. Again the regulator's concerns with minimizing overall social distortions are entirely justified. The final product market consumers are therefore subject to price discrimination for redistributive purposes. Cross-subsidization from price discrimination occurs between the firm supplier of the public good and some segment of the final product market. Cross-subsidization allows a firm to supply a good without having to receive extra funds from the government, simply by covering the monetary counterpart of its procurement effort entirely through charges to its new customers.

There is some literature on the topic of government favoritism of domestic firms. The rationale for foreign firms being discriminated against relative to domestic firms in procurement contract or final production licensing awards underlies in a profit shifting argument. Because the profits of domestic firms enter the objective function of a utilitarian government and the foreign firms' profits do not, the widespread practice of discrimination in favor of domestic firms is therefore justified. The second theme of my analysis is to explore government favoritism in a framework of regulation under incomplete information. Would a rational regulator award production licenses to a less efficient domestic firm?

The empirical literature on the deadweight losses of public funds and of imperfect competition is not very conclusive. The calculations of the deadweight loss of public funds have been made by Ballard et al. (1985) and Hausman and Poterba (1987). A reasonable mean estimate for the U.S. economy seems to be 30% per each dollar raised through distortionary taxes. Government can finance public goods and public enterprise deficits by increasing taxes, say commodity taxes. Such taxes will normally increase existing differences between price and marginal cost for these commodities. Browning (1987) found that, on the margin, the resulting welfare losses of taxation lie in the wide range of 10% and 500% of the collected tax revenues.

The social costs of monopoly have been estimated by Harberger among others. Harberger (1954) estimated that monopoly welfare losses in the U.S. were very small in relation to U.S. national income, less than 0.1% of the U.S. GNP in the 1920s. Almost all of the early estimates of the deadweight welfare loss triangle suggest that these were insubstantial relative to the U.S. national income. Commenting on observed behavior that involves market power, Reder (1982), concludes that measurements of social welfare loss stemming form the exercise of market power have generally been found to be small.

Some authors though, like Cowling and Mueller (1978), suggest that the deadweight losses of imperfect competition may be fairly large. The U. S. estimates of Cowling and Mueller range

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between 4 and 13 % of Gross Corporate Product (for their preferred econometric model). These authors also level several objections against the Hargerger-type approach (namely, the partial equilibrium formula for welfare loss) and then use several procedures derived to meet these objections. Scherer and Ross (1990), however, assert that the method used by Cowling and Mueller gives rise to much larger welfare estimates than the Harberger method and advance with their own estimates. Scherer and Ross estimate of the deadweight welfare loss attributable to monopolistic resource misallocation in the U.S. lies between 0.5 and 2 % of GNP.

The definition of the «monopoly problem», according to these authors, lies in the height of monopoly prices and profits *per se*. This traditional view of the «monopoly problem», however, fails to recognize other inefficiencies such as the costs involved in attempts to gain and retain monopoly power. The definition of social cost of monopoly of Posner (1975) is different and includes the resources wasted in the creation and protection of monopoly rents.

Government favoritism in the award of procurement contracts under incomplete information have been studied in McAfee and McMillan (1989) and Branco (1994). McAfee and McMillan showed that if there are cost advantages of foreign firms, then an expected procurement cost minimizing government should discriminate in favor of the domestic firms. The argument of profit shifting used in Branco is similar to the one used by Brander and Spencer (1981), as the optimal discrimination procurement policy can be implemented through a price preference rule which is equivalent to a tariff.

The rest of this paper is organized as follows. Section 2 develops the general principal-agent model of the strategic procurement game between the government and the firm. Section 3 deals with the solution of the government's procurement problem. Section 4 includes an element of government regulation in the original problem. Section 5 establishes a circumstance where financing structure proposed by us is better than the standard financing of the firm activity through public funds alone. Section 6 introduces the details of a regulation model. Section 7 establishes optimally the endogenous market structure of our regulation model of last section. Section 8 compares the analytic results of two models with utilitarian regulators which favor domestic firms, our regulation model and a procurement model with incomplete information. Last, Section 9 gathers concluding remarks, prospects for further research and policy implications.

2. Procurement Model

We develop a principal-agent model under the incomplete information scenario. This model with a benevolent principal follows closely the set up in Rasmusen (2001) and extends it with regard to the financing options available to the principal. The regulator's objective is then assumed to be the maximization of total surplus (consumers' plus firm's plus taxpayers') in society. It is also assumed that the firms and the regulator are risk neutral with respect to income. That is, the players are assumed to ignore the riskiness or variance of income, and take account of only the mathematical expectation of income.

Nature plays first and chooses the firm's cost parameter β. This is a technological parameter that enters the cost function of the firm at the date of contracting. By convention, a low (high) β corresponds to an (in)efficient technology. The low cost $\beta = L$ has probability θ and the high cost $\beta = H$ has probability $(1 - \theta)$.

The procurement contract offered by the government to the firm takes the form of a direct mechanism $\{n(\hat{\beta}), c(\hat{\beta})\}$ based on type announcements $\hat{\beta}$, where n is the number of identical final product market consumers assigned to the firm and c is the cost of producing the public good. The contract that implements in practice the optimal regulatory outcome is based on the observables n and c. The assumption of an economy populated by representative consumers is often observed in economic analysis. To simplify notation, we make $n(\beta) = n_\beta$ and $c(\beta) = c_\beta$ whenever useful.

This model assumes that the regulatory activity is subject to moral hazard and to adverse selection. Whereas the moral hazard parameter e represents the effort or cost-reducing effort of a firm, β is a technological parameter and also an adverse selection parameter. The firm's payoff if it accepts the procurement contract is given by

$$(1) \qquad \pi_f = s - d(e),$$

where s is the subsidy paid contingent on the cost type reported by the firm and $d(e)$ is the disutility of effort level e, expressed in monetary terms, with $d' > 0$ and $d'' > 0$. The subsidy is

$$(2) \qquad s = u\,n,$$

where $u = u(\beta)$ is the (positive) unit profit the firm receives for supplying a single final product market consumer, which is contingent on the true cost type β. If the firm rejects the contract its payoff is 0. The net surplus of consumers/taxpayers is $B - (1 + \lambda_t)c - (1 + \lambda_m)s$.

The utilitarian government's payoff if the firm accepts the contract is (after accounting for the disutility inflicted by distortionary taxation and by the exercise of market power)

$$(3) \qquad W_g = B - (1 + \lambda_t)c - \lambda_m s - d(e),$$

or, after replacing $s = un$,

$$(4) \qquad W_g = B - (1 + \lambda_t)c - \lambda_m(un) - d(e),$$

where B is the social benefit of the public good, λ_t is the marginal deadweight loss of taxation and λ_m is the marginal deadweight loss of exerting monopoly power in the final product market. Otherwise, the government's payoff if the firm rejects the contract is 0.

The standard deadweight welfare loss attributable to monopoly is, on the margin,

$$(5) \qquad \lambda_m = DWL/u,$$

where $DWL = B_i - b - u$, with B_i being the benefit a final product market consumer derives from a competitive supply source and $b = b(q)$ the individual consumer surplus derived from the equilibrium output level sold by the firm awarded with the procurement contract, which is expected to change with the firm cost parameter β. Whenever judged necessary we replace b by $b(q)$.

We assume that

$$(6) \qquad \lambda_m > 0,$$

as we expect $B_i - b - u > 0$ (the standard marginal pricing welfare outcome) and $u > 0$.

3. Noncontractible Output

Government procurement of a public good with alternative financing options is considered first. Under complete information, β is observed by the government, which can assign different contracts $\{n(\beta), c(\beta)\}$ to the two types of firms. It must be individually rational for the firm to accept the contract offered, as we show next after inverting the cost equation $c = \beta - e$ and setting $e = \beta - c$.

The firm's participation constraints for both types are, respectively:

(7A) $n_L u(L) - d(L - c_L) \geq 0$ (Low type)

(7B) $n_H u(H) - d(H - c_H) \geq 0$ (High type).

Binding constraints to both types should be expected to obtain in so far as transfers reduce government welfare due to deadweight loss. Thus, $n_L = d(L - c_L)/u(L)$ and $n_H = d(H - c_H)/u(H)$.

A partial cross subsidization effect is clearly observed here, since the disutility of effort $d(e)$ is financed by profits generated in the final product market where the firm operates.

Substituting these values into the government's payoff function, we get

(8) $W_g = B - (1 + \lambda_t)\, c_L - (1 + \lambda_m(L))\, d(L - c_L)$

for the low cost firm, where $\lambda_m(L) = DWL(L)/u(L)$ and $DWL(L) = B_i - b - u(L)$.

The first-order condition for the optimal cost level c_L is given by

(9) $\partial W_g / \partial c_L = -(1 + \lambda_t) + (1 + \lambda_m(L))\, d'(L - c_L) = 0,$

so that

(10) $d'(L - c_L) = (1 + \lambda_t) / (1 + \lambda_m(L)).$

The same procedure applies for the high cost firm and similar result obtains:

(11) $d'(H - c_H) = (1 + \lambda_t) / (1 + \lambda_m(H)),$

where $\lambda_m(H) = DWL(H)/u(H)$ and $DWL(H) = B_i - b - u(H)$.

Clearly, the standard result in the literature of government procurement that $d'(\beta - c_\beta) = 1$ implying the same efficient effort e^* in equilibrium for both types β can no longer hold. The equilibrium conditions derived above (equations (10) and (11)) show that the efficient effort levels for both types β are dependent on the alternative sources of financing available and the extent of their deadweight losses. In any such expression, the marginal disutility of effort is equal to one if and only if $\lambda_t = \lambda_m$; otherwise, it is greater (lesser) than one if $\lambda_t > (<) \lambda_m$. However, they cannot be equal to one at the same time as most likely $\lambda_m(L)$ is different from $\lambda_m(H)$.

The efficient effort levels decrease in β if $\lambda'_m(\beta) > 0$ as $d''(e) > 0$. Under reasonable assumptions, the deadweight loss of market power $\lambda_m(\beta)$ increases in β. Let denote $DWL(q, \beta) = B_i - b(q) - u(q, \beta)$, where q is the equilibrium output level sold to an individual consumer by the β cost firm. We need to determine the sign of the total derivative

$$(12) \quad \frac{\partial}{\partial\beta}\left(\frac{DWL}{u}\right) = \frac{\partial}{\partial q}\left(\frac{B_i - b(q)}{u(q, \beta)}\right)\frac{dq}{d\beta} + \frac{\partial}{\partial\beta}\left(\frac{B_i - b(q)}{u(q, \beta)}\right)1.$$

The first-order condition for the monopoly equilibrium output level is $u'_q = 0$. Totally differentiating this equation, yields $dq / d\beta = - u''_{q\beta} / u''_{qq} < 0$, as $u''_{q\beta} < 0$ and $u''_{qq} < 0$ (the concavity of the profit function). Also $\frac{\partial}{\partial q}\left(\frac{B_i - b(q)}{u(q, \beta)}\right) < 0$, as $b'_q > 0$ (the consumer surplus effect), and $\frac{\partial}{\partial q}\left(\frac{B_i - b(q)}{u(q, \beta)}\right)$ as $u'_\beta < 0$ (the production inefficiency effect). Therefore, $\lambda_m(\beta)$ increases in β and effort levels in equilibrium decrease in c.

A judicious selection of sources of financing makes possible that effort levels increase beyond e^*, the equilibrium effort level under a single source of financing, and that financing welfare distortions diminish. Consider the low cost type for a moment. If $\lambda_t > \lambda_m(L)$, then the effort level chosen by the low cost firm increases at the margin beyond e^* as $d''(e) > 0$, therefore further reducing c and the welfare distortion of taxation $\lambda_t c_L$. Obviously n_L, the alternative source of financing, increases beyond that just required to compensate the firm for the disutility of effort e^*.

We are ignoring so far the integer number problem arising in the calculation of n. To tackle this problem now under the complete information scenario, denote by $[y]$ the smallest positive integer in excess of the real number y. Then we choose $n = [n_\beta]$ as the number of consumers of the final product market supplied by the firm of type β.

Under incomplete information, the true type β is not observed by the government, which must therefore offer the firm a separating contract $\{n(\hat{\beta}), c(\hat{\beta})\}$ based on type announcements $\hat{\beta}$ providing incentives to truth-telling, and inducing the low cost firm to produce the procured good at a lower cost than the high cost firm. The contract must satisfy participation constraints and incentive-compatibility constraints.

The firm's participation constraints for both types are, respectively:

(13A) $n_L u(L) - d(L - c_L) \geq 0$ (Low type)

(13B) $n_H u(H) - d(H - c_H) \geq 0$ (High type).

The incentive-compatibility constraints for both types are, respectively:

(14A) $n_L u(L) - d(L - c_L) \geq n_H u(L) - d(L - c_H)$ (Low type)

(14B) $n_H u(H) - d(H - c_H) \geq n_L u(H) - d(H - c_L)$ (High type).

The participation constraint for the high cost firm and the incentive-compatibility constraint for the low cost firm will be binding in equilibrium, in order to avoid deadweight loss. Knowing that these two constraints are satisfied as equalities, we can write

(15) $n_H = d(H - c_H)/u(H)$

and, using this result,

(16) $n_L = d(H - c_H)/u(H) + (d(L - c_L) - d(L - c_H))/u(L)$.

The government's maximization problem under incomplete information is

(17) $Max\ \theta[B - (1 + \lambda_t)\, c_L - \lambda_m(L)\, u(L)\, n_L - d(L - c_L)]$
$+ (1 - \theta)[B - (1 + \lambda_t)\, c_H - \lambda_m(H)\, u(H)\, n_H - d(H - c_H)]$

with respect to n_L, n_H, c_L and c_H. Once we substitute for the values of n_L and n_H derived above, we get the simplified problem

(18) $Max\ \theta[B - (1 + \lambda_t)\, c_L - \lambda_m(L)\, (u(L)\, d(H - c_H)/u(H) - d(L - c_H) + d(L - c_L))$
$- d(L - c_L)] + (1 - \theta)[B - (1 + \lambda_t)\, c_H - (1 + \lambda_m(H))\, d(H - c_H)]$

with respect to c_L and c_H.

The first-order condition with respect to c_L is

(19) $\theta[-(1 + \lambda_t) + (1 + \lambda_m(L))\, d'(L - c_L)] = 0$,

or, after simplification,

(20) $d'(L - c_L) = (1 + \lambda_t) / (1 + \lambda_m(L))$.

The efficient effort level is selected in equilibrium under incomplete information and therefore c_L takes exactly the same value as under complete information. Moreover, incomplete information increases n_L, which is necessary to induce truth-telling by the low cost firm and so allowing the firm to earn informational rents. From the right-hand-side of the equation (16) establishing n_L under incomplete information, $d(L - c_L)/u(L)$ equals n_L under complete information but $d(H - c_H)/u(H) - d(L - c_H)/u(L) = 1/u(H)\ (d(H - c_H) - d(L - c_H)\ u(H)/u(L)) > 0$ as $d'(e) > 0$ and $u'(\beta) < 0$.

The first-order condition with respect to c_H is

(21) $\theta[\lambda_m(L)\, (d'(H - c_H)u(L)/u(H) - d'(L - c_H))]$
$+ (1 - \theta)[-(1 + \lambda_t) + (1 + \lambda_m(H))\, d'(H - c_H)] = 0$,

or, after simplification,

$$(22) \quad d'(H - c_H) = \frac{1 + \lambda_t}{1 + \lambda_t(H)} - \frac{\theta}{1-\theta} \frac{\lambda_m(L)}{1 + \lambda_t(H)} \left(d'(H - c_H)\frac{u(L)}{u(H)} - d'(L - c_H) \right).$$

The equilibrium effort level exerted by the high cost firm lowers under incomplete information since the right-hand-side of this equation (22) is less than $(1 + \lambda_t)/(1 + \lambda_m(H))$ as $d''(e) > 0$ and $u'(\beta) < 0$. Moreover, the lower the monopoly market distortion $\lambda_m(L)$, the lower the equilibrium effort level distortion exerted by the high cost firm.

We have established that a separating contract, as the one stated at the beginning of the formulation of the government problem under incomplete information, is optimal. A pooling contract, which would allow the low cost firm to exert less effort in equilibrium than the high cost one, is therefore not optimal, as we have not found that $c_L = c_H$.

The integer number problem is ignored so far under the incomplete information scenario. We need now to make sure that the incentive-compatibility constraint for the high cost firm is satisfied with positive integers computed from the binding constraints of participation for the high cost firm and the incentive-compatibility for the low cost firm. Set $n_H = [d(H - c_H)/u(H)]$ first and then $n_L = n_H + [(d(L - c_L) - d(L - c_H))/u(L)]$. This is the solution if $(d(H - c_L) - d(H - c_H))/u(H)$ is not smaller than $[(d(L - c_L) - d(L - c_H))/u(L)]$.

4. Contractible Output

Government intervention in production for the final product market is considered now. The optimal incentive mechanism between the government and the firm under complete information now includes the form of a fixed-output contract with contractible output to the final product market contingent on the observed cost types. The social-welfare-maximizing principal reduces the social welfare loss of financing by changing the agent's behavior and payoff with output--contingent rules.

Return to the government's objective function under complete information (equation (8)). The first-order conditions for the optimal cost level c_L and the optimal output level q_L are $\partial Wg/\partial c_L = 0$ (already established in (9)) and

$$(23) \quad \frac{\partial Wg}{\partial q_L} = -\frac{\partial}{\partial q_L}(\lambda_m(L)d(L - c_L)) = 0,$$

which simplifies to

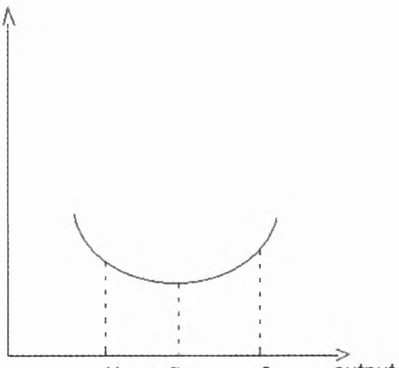
$$(24) \quad -\frac{\partial Wg}{\partial q_L}(\lambda_m(L)) = 0,$$

This is equivalent to finding a local minimum for $\lambda_m(L)$. The second-order condition for the minimization problem, $\partial^2(\lambda_m(L))/\partial q^2_L \geq 0$ (convexity), is satisfied at the critical point if we have $[-b''u - (B_i - b)u''_{qq}]/u^2 \geq 0$. That is, if $|b''|$ is sufficiently close to $|u''_{qq}|$ and/or $B_i - b(q)$ is sufficiently large, as $b'u + (B_i - b))\, u'_q = 0$ (the first-order condition) and $DWL(L) > 0$. In what follows, we shall assume the convexity of $\lambda_m(L)$. Therefore we can restrict our attention to local minima to derive results.

The optimal output level q_L is greater than the standard monopoly equilibrium output level q^M and smaller than the perfectly competitive equilibrium output level q^C or, which amounts to the same, the output level that solves the standard market welfare maximization problem $b + u$, q^S. From the first-order condition for the standard monopoly output level, $u'_q = 0$, which implies that

$\partial(\lambda_m(L))/\partial q_L < 0$. From the first-order condition for the standard social welfare output level, $b' + u'_q = 0$, which implies that $\partial(\lambda_m(L))/\partial q_L > 0$.

The same procedure for local conditions applies for the high cost firm and similar result obtains with regard to optimal levels of c_H and q_H. The following picture illustrates these results.



Thus we can now assert that $\lambda_m(\beta)$ increases in β as long as the government sets optimal output levels q_β (or for that matter output levels q^M). The sign of $\lambda'_m(\beta)$ however is indeterminate for output levels q^C.

The optimal incentive mechanism between the government and the firm under incomplete information, which as we know includes the form of a fixed-output contract with contractible output to the final product market, now is contingent on the reports of cost types by the firm. The principal strategically manipulates the agent's incentive and contractible output with a forcing contract in order to induce the most desirable social outcome.

From the government's objective function under incomplete information (equation (18)), we can derive the first-order conditions with respect to optimal output levels q_L and q_H, in addition to the other local conditions with respect to optimal cost levels.

$$\text{(25A)} \quad \frac{\partial W_g}{\partial q_L} = -\frac{\partial}{\partial q_L}\left(\theta\lambda_m(L)(u(L)d(H-c_H)\,/\,u(H) - d(L-c_H) + d(L-c_L))\right) = 0,$$

$$\text{(25B)} \quad \frac{\partial W_g}{\partial q_H} = -\frac{\partial}{\partial q_H}\left(\theta\lambda_m(L)(u(L)d(H-c_H)\,/\,u(H) + (1-\theta)\lambda_m(H)d(H-c_H)\right) = 0.$$

These constraints simplify respectively to

$$\text{(26A)} \quad \frac{\partial}{\partial q_L}\left(\lambda_m(L)(u(L)d(H-c_H)\,/\,u(H) - d(L-c_H) + d(L-c_L))\right) = 0,$$

and

$$\text{(26B)} \quad \frac{\partial}{\partial q_H}\left(\theta\lambda_m(L)(u(L)/u(H) + (1-\theta)\lambda_m(H)\right) = 0.$$

The output distortion introduced by incomplete information is such that its direction changes with cost types, implying that $\lambda_m(\beta)$, for any β, is never minimized in equilibrium. While incomplete information increases q_L as $\partial(u(L))/\partial q_L < 0$ and $\partial(\lambda_m(L))/\lambda q_L > 0$, it decreases q_H as $\partial(1/u(H))/\partial q_H > 0$ and $\partial(\lambda_m(H))/\lambda q_H < 0$.

Clearly, the standard result regarding output distortions in the literature of incentive contracts with contractible outputs, whether taking the form of forcing contracts or linear contracts, can no longer hold. The standard result states that we should expect a lower output level under incomplete information than under the complete information equilibrium except for the lowest cost type, which is the 'no distortion' outcome of the model. In our model, on the other hand, q_L increases under incomplete information as compared to the benchmark model of complete information.

5. Choosing Financing Strutures

We ask now a fundamental question: Under what circumstances the proposed financing structure will be better than the standard financing scheme of public funding? In order to provide only a particular answer to this question we will conduct a comparative statics analysis and the implicit function theorem will be the approach used there.

Take any $\lambda_m(L)$, $\lambda_m(H)$ and λ_t possible. Let $W^*_{ci}\ \lambda_m(L), \lambda_m(H), \lambda_t)$, equal to $\theta\,[B-(1+\lambda_t)\,c_L-(1+\lambda_m(L))\,d(L-c_L)]+(1-\theta)[B-(1+\lambda_t)\,c_H-(1+\lambda_m(H))\,d(H-c_H)]$, denote the maximum for the expected welfare function of the government under complete information for these λ's. Set $W^*_{ci}\ \lambda_m(L), \lambda_m(H), \lambda_t) = \bar{W}$. Let $W^*_{ii}\ \lambda_m(L), \lambda_m(H), \lambda_t)$ denote the maximum of the government's expected welfare payoff under incomplete information for the same λ's.

We rephrase the original question now as: Which particular values taken by the financing structure $\{\lambda_m(L), \lambda_m(H)\}$ given λ_t achieve the highest possible W^*_{ii} assuming that $W^*_{ci} = \bar{W}$? In particular, it may happen that $\bar{W} = W^*_{ci}\,(\lambda_t, \lambda_t, \lambda_t)$ which denotes the optimal expected welfare payoff for the government under complete information with the standard financing scheme through public funding. In such case the original question can still be rephrased once more as: Which financing structure $\{\lambda_m(L), \lambda_m(H)\}$ given λ_t achieves the highest W^*_{ii} assuming that the government is indifferent as to which one to choose under complete information?

We treat $\lambda_m(L)$ as the exogenous variable and $\lambda_m(H)$ as the endogenous variable on what follows and we assess the impact of only small changes in $\lambda_m(L)$ and $\lambda_m(H)$ on W^*_{ii} given W^*_{ci}.

Define $\tilde{\Psi}\,(\lambda_m(L), \lambda_m(H), \lambda_t) = W^*_{ci}\,(\lambda_m(L), \lambda_m(H), \lambda_t) - \bar{W} = 0$. Thus $\lambda_m(H)$ can be defined implicitly as a function of $\lambda_m(L)$ given λ_t : $\lambda_m(H) = \Psi\,(\lambda_m(L))$. What do we know about $\Psi\,(\lambda_m(L))$? Consider the particular case where $W^*_{ci}\,(\lambda_t, \lambda_t, \lambda_t) = \bar{W}$ to obtain an answer. It can be shown that if $\lambda_m(L) \neq \lambda_m(H)$ then $\lambda_m(L) < \lambda_t < \lambda_m(H)$. And if it were the case that $\lambda_m(L) = \lambda_m(H)$ then we would have $\lambda_m(L) = \lambda_m(H) = \lambda_t$.

The comparative statics multiplier is

$$(27) \qquad \frac{\partial\psi(\lambda_m(L))}{\partial\lambda_m(L)} = -\frac{\partial\tilde{\Psi}/\partial\lambda_m(L)}{\partial\tilde{\Psi}/\partial\psi(\lambda_m(L))} = -\frac{\theta d(L-c_L)}{(1-\theta)d(H-c_H)} < 0.$$

We need to compute $\dfrac{\partial W^*_{ii}}{\partial\lambda_m(L)}$ and determine its sign but in order to do that we hypothesise first

what are the effects of a small exogenous variation $\partial\lambda_m(L)$. We assume that $\partial\lambda_m(L)$ can be plausibly related to a small variation ε in either b or $u(L)$, elements of $\lambda_m(L)$. Thus, either $\partial\lambda_m(L) = -\varepsilon\,/\,u(L)$ or $\partial\lambda_m(L) = -\varepsilon(B_i - b)\,/\,(u(L))^2$. The same reasoning applies to $\beta = H$. The envelope theorem and $\lambda_m(B)$ when the government chooses the final product market output q optimally, that is, $q_\beta = q^s_\beta$, under complete information implies that we should ignore further marginal effects on q due to these parametric changes. We proceed along these very lines on what follows.

Consider first the case where $\varepsilon = db$. Then

$$(28) \quad \frac{\partial W^{*}_{ii}}{\partial \lambda_m(L)}\bigg|_{b \text{ changes, } u \text{ fixed}} = -\theta\,(d(H - c_H)u(L) \,/\, u(H) - d(L - c_H)).$$

We are ready to establish our first proposition.

PROPOSITION 1: For every $\lambda_m(L) > 0$, $\lambda_m(H) = \psi(\lambda_m(L))$ and $0 \in (0,1)$,

$$(29) \quad \frac{\partial W^{*}_{ii}}{\partial \lambda_m(L)}\bigg|_{b \text{ changes, } u \text{ fixed}} < 0 \text{ and } \frac{\partial^2 W^{*}_{ii}}{\partial \lambda_m(L)\partial\theta}\bigg|_{b \text{ changes, } u \text{ fixed}} < 0.$$

PROOF: $d(H - c_H)u(L) \,/\, u(H) - d(L - c_H) > 0$. Hence we prove our claim.

Additional small decreases in $\lambda_m(L)$ always increase the government's welfare payoff under incomplete information, no matter what is the level of $\lambda_m(L)$. Social welfare increases by lowering on the margin the deadweight loss for every euro spent in subsidizing the low-cost firm while increasing in a pre-designated way the welfare loss associated to each euro paid as subsidy to the high-cost firm. This net effect is explained by the fact that the low-cost firm's subsidy is higher under incomplete information than under complete information to satisfy the incentive--compatibility constraint, and that shows in the expression of $\frac{\partial W^{*}_{ii}}{\partial \lambda_m(L)}$ computed above (equation(28)). Moreover the increments in social welfare are higher the higher the θ. That is to say, marginal social welfare gains due to lower $\lambda_m(L)$'s are higher on expected terms the more likely is Nature to draw a low-cost firm. We replicate next these results for variations of u although under a restricted set of values for $\lambda_m(L)$ and θ.

Consider now the case where $\varepsilon = du$. Observe first that $u(L) = \frac{B_i - b}{1 + \lambda_m(L)}$ and that $u(H)$ is a function of $\lambda_m(H)$ defined in a similar fashion. Thus, after some simplifications, we obtain

$$\frac{\partial W^{*}_{ii}}{\partial \lambda_m(L)}\bigg|_{u \text{ changes, } b \text{ fixed}} = -\theta\,(d(H - c_H)u(L) \,/\, u(H) - d(L - c_H)).$$

$$(30) \quad + \,\theta\lambda_m(L)\left(d(H - c_H)\,\frac{u(L)}{u(H)} + \frac{1}{1 + \lambda_m(H)}\,\frac{u(L)}{u(H)}\,\frac{\theta}{1 - \theta}\,d(L - c_H)\right)$$

We add another element to the right-side of the expression of $\frac{\partial W^{*}_{ii}}{\partial \lambda_m(L)}$ computed in the first place (equation (28)). This second element is a multiplicative function of $\lambda_m(L)$ and is positive. To explain why this second parcel is positive observe that it is inversely proportional to $\frac{\partial W^{*}_{ii}}{\partial \lambda_m(L)}\left(\frac{u(L)}{u(H)}\right) < 0$ which means that small increases in $\lambda_m(L)$ seem to alleviate the incentive-compatibility constraint and for that reason increase social welfare, instead of decreasing it. The net effect of the two elements of the right-side of the equation (30) upon the marginal social welfare will depend among other things on the level of $\lambda_m(L)$.

PROPOSITION 2: If $\lambda_m(L) \to 0$ and $\lambda_m(H) = \psi(\lambda_m(L))$, then $\frac{\partial W^{*}_{ii}}{\partial \lambda_m(L)}\bigg|_{u \text{ changes, } b \text{ fixed}} < 0$.

PROOF: Let $\lambda_m(L) \to 0$. Then $\psi(\lambda_m(L)) \to C$, where C is some positive upper bound, as $-\infty < \frac{\partial\psi(\lambda_m(L))}{\partial\lambda_m(L)} < 0$. Let $+\infty > u(\beta) > 0$, for every β. Hence, as $d(H - c_H)u(L) / u(H) - d(L - c_H) > 0$, we prove our claim.

Small decreases in already small levels of $\lambda_m(L)$ have as effect an increase in social welfare under incomplete information.

PROPOSITION 3: If $\left.\frac{\partial W^*_{ii}}{\partial\lambda_m(L)}\right|_{u\ changes,\ b\ fixed} < 0$ for some $\lambda_m(L) > 0$ and $\lambda_m(H) = \psi(\lambda_m(L))$, then

$$(31)\qquad \left.\frac{\partial^2 W^*_{ii}}{\partial\lambda_m(L)\partial\theta}\right|_{u\ changes,\ b\ fixed} \text{ is } \begin{cases} <0 & if \quad \theta < \theta^* \\ 0 & if \quad \theta = \theta^* \\ >0 & if \quad \theta > \theta^*, \end{cases}$$

where $\theta^* = \arg\min \left.\frac{\partial W^*_{ii}}{\partial\lambda_m(L)}\right|_{u\ changes,\ b\ fixed}$.

PROOF: Let $\left.\frac{\partial W^*_{ii}}{\partial\lambda_m(L)}\right|_{u\ changes,\ b\ fixed} < 0$ for some $\lambda_m(L) > 0$. (From hereon in this proof we skip the heavy notation of partial derivative). $\frac{\partial W^*_{ii}}{\partial\lambda_m(L)}$ is a function of θ over the interval *(0, 1)*. Observe that $\frac{\partial W^*_{ii}}{\partial\lambda_m(L)} \to 0^-$ as $\theta \to 0^+$ and that $\frac{\partial W^*_{ii}}{\partial\lambda_m(L)} \to +\infty$ as $\theta \to 1^-$. The function $\frac{\partial W^*_{ii}}{\partial\lambda_m(L)}$ takes the generic form $\theta\,(-A + B\frac{\theta}{1-\theta})$, where $A > 0$ and $B > 0$ are independent of θ. This function is continuous and differentiable over its domain and therefore there exists a unique $\theta \in (0,1)$ that solves the problem *Min* $\frac{\partial W^*_{ii}}{\partial\lambda_m(L)}$. Call θ^* the interior solution for this problem.

Hence we prove our claim.

Every small decrease in $\lambda_m(L)$ when the level of $\lambda_m(L)$ happens to be sufficiently close to zero will have a magnified effect upon social welfare under incomplete information due to small increases in θ so long as the level of θ is close enough to zero as well. Therefore as we have referred to above we reproduce the same signs for the first- and second-order derivatives of social welfare but now under a more restricted set of values when we assume a different sort of parametric variations to explain $\partial\lambda_m(L)$.

6. Regulation Framework

We move now to another framework with a utilitarian regulator under incomplete information but no moral hazard. This time it is assumed that the regulatory activity is subject to adverse selection alone. Both the domestic firm and the foreign firm are assumed to have private information about their technology. A profit shifting argument will be used to explain the final outcome that foreign should be discriminated against by the optimal regulation policy.

Our concern however is still the understanding the implications of the same conceptual component of economic efficiency used in the government procurement framework presented above: allocative efficiency. Allocative efficiency concerns the relation between price and marginal cost, and is a function of market power. Basically, more competition or more potential competition reduces market power and increases allocative efficiency.

We introduce another private information cost parameter in the setting now. Let β_i denote the production efficiency of the foreign firm. Under incomplete information, the foreign firm might have an incentive to misrepresent its cost parameter and mimic a higher cost firm. Being taken by a low efficiency firm, it will deliver less individual benefit β_i to consumers in the domestic market and will rise its individual profit $u(\beta_i)$. Of course we need to explicitly rewrite λ_m as function of two technological parameters, $\lambda_m(\beta, \beta_i)$, and denote the function of one parameter $B_i = B_i(\beta_i)$. λ_m decreases in β_i and increases in β, the domestic firm production efficiency parameter.

There is an entry cost c for the foreign firm alone. It could be seen as foreign direct investment, like new plant and equipment, or as an infrastructure extension required for the operation of the foreign firm in the domestic market. This cost is assumed to be a fixed amount in this section. We will drop this assumption of cost constancy in the next section.

There are two candidates to supply the entire domestic market of size N in this setting. We will drop this assumption of single sourcing alternatives in the next section. The regulator will pick that alternative which maximizes the domestic social welfare. The domestic government welfare function if the foreign firm is selected (and paid by the government after raising distortionary taxes) is given by

(32) $$W_g = NB_i - (1 + \lambda_t)c.$$

If the domestic is the single firm selected instead, the domestic government welfare is given by

(33) $$W_g = N(B_i + (\lambda_t - \lambda_m)u(\beta)).$$

What is the optimal government policy concerning the selection of a firm to supply the domestic final consumer market? Is the rule for the selection of the firm that will be granted a production license biased toward the domestic firm outcome? Because the domestic firm's profits enter the government objective function and the foreign profits do not, that creates an asymmetry in the treatment of the two firms. This is the economic rationale for favoring less efficient domestic firms.

The next result clearly shows that the government discriminates in favor of the domestic firm even under complete information. The domestic firm is selected under certain circumstances even if $\lambda_m > 0$, which holds true only if $\beta_i < \beta$.

PROPOSITION 4: The regulator optimally selects under complete information the domestic firm outcome if $\lambda_t > \lambda_m$ and the foreign firm outcome if $\lambda_t < \lambda_m$ and either $\lambda_m \to +\infty$ or $\lambda_t \to 0^+$ and $N.DWL - c > 0$.

PROOF: Straightforward algebraic computations prove our claim.

A sufficient condition for the domestic firm to be selected by the regulator under complete information is $\lambda_t > \lambda_m$, as we have just seen. Note that this is not a necessary condition though because the domestic firm can still be selected by the regulator so long as the positive difference $\lambda_m - \lambda_t$ is sufficiently small (result taken from confronting (32) with (33)): $(\lambda_m - \lambda_t)Nu(\beta) < (1 + \lambda_t)c$.

Consider now the incomplete information case. This last inequality will be optimally distorted by the principal to limit the informational rent of the selected firm as shown next. Let the cost parameters be independently distributed according to the cumulative distribution functions $F(\beta) = F_i(\beta_i)$ on $[\underline{\beta}, \overline{\beta}] = [\underline{\beta}_i, \overline{\beta}_i]$. (This is the special case of symmetric bidders).

The virtual-welfare function for the domestic government in the case the foreign firm is selected is $W_g = NB_i - (1 + \lambda_t)c + (1 + \lambda_t)\frac{F_i(\beta_i)}{f_i(\beta_i)} u'(\beta_i)N$; the virtual-welfare function in the case the domestic firm is selected is $W_g = N(B_i + (\lambda_t - \lambda_m)u(\beta)) + \lambda_t \frac{F(\beta)}{f(\beta)} u'(\beta)N$.

By comparing the virtual-welfare functions for each possible selected outcome, and given truth-telling announcements of actual types β and β_i made by the two firms, it is easily established that the domestic firm is optimally selected under incomplete information if $(1 + \Delta(\beta, \beta_i))\lambda_t > \lambda_m$, where it is established by definition that $\Delta(\beta, \beta_i) \equiv \left(\frac{F(\beta)}{f(\beta)} u'(\beta) - \frac{1 + \lambda_t}{\lambda_t} \frac{F_i(\beta_i)}{f_i(\beta_i)} u'(\beta_i) \right) \frac{1}{u(\beta)}$, and $f(\beta)$ and $f_i(\beta_i)$ are probability density functions related respectively to domestic and foreign firms' types. This is a government preference rule which may be a more demanding one for the domestic firm than that of chosen under complete information. In order to determine exactly the sign of $\Delta(\beta, \beta_i)$ we need to specify particular cumulative distribution and unit profit functions. We proceed by presenting next a particular case by the way of illustration. Consider the symmetric and linear case, where by hypothesis the private information types of the domestic and foreign firms are independently distributed according to the same cumulative distribution function $F(.)$ on [0, 1], and the unit profit functions $u(.)$ are identical and linear in the private information types with $u' < 0$. We have in this particular case $\Delta(\beta, \beta_i) < 0$ so long as the foreign firm is considerably more efficient, $\beta_i << \beta$, and so we have $\lambda_m > 0$ too. The presence of incomplete information makes the regulator more selective in the choice of the domestic firm. A relatively less efficient domestic firm can still be selected by the regulator but that possibility becomes more difficult to take place under incomplete information.

7. Endogenous Market Structure

We consider now the possibility of an oligopoly-like market structure being optimally selected by the regulator. It can be shown that under certain circumstances such intermediate market outcome can only be chosen under incomplete information. The domestic regulator is therefore willing to allocate a share of a final product market to its relatively inefficient domestic firm as a device to increasing informational rent extraction from the foreign firm.

The domestic social welfare for this intermediate market structure under complete information can be written as

$$(34) \quad W_g = NB_i + (\lambda_t - \lambda_m)nu(\beta) - (1 + \lambda_t)c.$$

Under complete information or incomplete information and concave cost functions $c(N-n)$, the single firm selection outcome remains the only optimal market structure possible, that is, the optimal number of customers allocated to the domestic firm is $n^* \in \{0, N\}$. However under strictly convex cost function $c(N-n)$, it can be shown that intermediate market structures can be selected by the regulator, that is, $n^* \in \{0, N\}$. To find an interior solution to the government welfare problem under incomplete information

$$W_g = NB_i + (\lambda_t - \lambda_m)nu(\beta) - (1 + \lambda_t)c + (1 + \lambda_t)\frac{F_i(\beta_i)}{f_i(\beta_i)} u'(\beta_i)(N - n) + \lambda_t \frac{F(\beta)}{f(\beta)} u'(\beta)n,$$

if it exists at all, set

$$(35) \quad \partial W_g / \partial n = (\lambda_t - \lambda_m)u(\beta) + (1 + \lambda_t)c' + \lambda_t \Delta(\beta, \beta_i)u(\beta) = 0.$$

The regulator optimally trades off informational rent extraction, reduction in the entry cost of the foreign firm and allocative inefficiency of the domestic firm. For small enough n, both informational rents received by the foreign firm and entry cost may be high comparative to the measure of allocative inefficiency. For n sufficiently close to N on the other hand, allocative inefficiency and informational rents demanded by the domestic firm may high in relation to entry cost. Using a continuity argument we conclude that under such circumstances there exists an interior point where the government is indifferent between marginally changing n and not changing it all. It can also be easily checked that at that point $\partial^2 W_g / \partial n^2 < 0$ (second-order condition for local maximum).

However it may be case that, at the same time there is no interior solution to the government problem under complete information, the government problem under incomplete information may have a unique maximum. We are interested in analyzing the particular situation where the regulator discriminates in favor of the domestic firm due to incomplete information.

Proposition 5: An intermediate market structure outcome $n^* \in (0, N)$ involving discrimination in favor of the domestic firm relative to the foreign firm is achieved under incomplete information alone if and only if $\Delta(\beta, \beta_i) > 0$, $(\lambda_t - \lambda_m)u(\beta) + (1 + \lambda_t)c'(N) < 0$ under complete information, and $(\lambda_t - \lambda_m)u(\beta) + (1 + \lambda_t)c'(N) + \lambda_t \Delta u(\beta) > 0$ and $(\lambda_t - \lambda_m)u(\beta) + (1 + \lambda_t)c'(0) + \lambda_t \Delta u(\beta) < 0$ under incomplete information.

Proof: Straightforward calculations from the government's welfare functions under complete information and incomplete information prove our claim.

The nature of the solution changes drastically due to incomplete information in the terms set by this proposition: from a corner solution with $n^* = 0$, we move to an interior solution. As an immediate candidate of a $\Delta(\beta, \beta_i) > 0$ regarded as big enough by the regulator, let the parameter β_i alone be private information. The optimal mechanism designed by the regulator in this illustration concerns with inducing truth-telling on the part of the foreign firm alone at the same time it maximizes the *ex-ante* expected government welfare.

8. Regulatory Versus Procurement Outcomes

We show now the importance of the relation between λ_t and another conceptual component of economic efficiency: production efficiency. Production efficiency concerns the unit cost associated with production of goods and services, and is a function of factors such as economies of scale and cumulative technological change. Of course λ_m has to be defined in an appropriate way to deal with this new issue. We also establish comparisons between the optimal properties of our regulatory framework with a fixed entry cost and other frameworks with a utilitarian regulator.

In a government procurement framework under incomplete information, Branco (1994) establishes optimal rules for selecting firms. Once rephrased in terms of our notation, these optimal rules can be shown to present different biases in regard to the relation between λ_m and λ_t. To check this let us begin to define the deadweight welfare loss attributable to production in this procurement framework as

$$(36) \qquad \lambda_m(c_D, c_F) \equiv \frac{c_D - c_F}{c_F} ,$$

where c_D (c_F) is the cost of realizing a single indivisible project of social value S by a domestic firm (foreign firm). Each firm privately knows its costs of realizing the project (c_i), while the regulator knows that the c_i's are independently distributed according to the cumulative distribution F (according to which costs are uniformly distributed on [0, 1]). Branco establishes that the domestic firm should be selected if $\lambda_m < 0$ under complete information and if $\lambda_m < \theta$, with $\theta \equiv 1/(1 + 2\lambda_t)$, under incomplete information. The latter government rule therefore discriminates against foreign firms as $\theta > 0$.

There are three essential differences between the optimal government policy of our analysis and that of Branco just revised. First, we introduce discrimination in favor of the domestic firm right under complete information and that bias depends on the (relative) efficiency of the government in collecting taxes λ_t as well. Differently there is no discrimination whatsoever in Branco's framework under complete information. Second, the degree of discrimination in favor of the domestic firm – if there is any at all – changes due to the introduction of incomplete information in our model while any such degree of discrimination starts up right under incomplete information in Branco's framework. Finally, the degree of discrimination in favor of the domestic firm may increase with λ_t in our model while it necessary decreases in Branco's setting. In a sense a more inefficient State in Branco's setting requires more efficiency from a selected domestic firm. That outcome does not necessarily take place in our setting.

9. Conclusions, Prospects and PolicyImplications

We have derived in this paper several results concerning the determination of efficient levels of effort to be exerted by the firm and the direction of distortional effects due to incomplete information when the firm has several sources of financing available. We have also established a circumstance where the proposed financing is better than the standard financing scheme through public financing. Moving from a government procurement framework with incomplete information and moral hazard to a regulation framework with incomplete information, we have also studied the optimal discrimination policy to be adopted by the regulator when there are two candidates to supply a final consumer good: a domestic firm and a foreign firm.

A line of further research is certainly the determination of critical thresholds of financing modalities, so that we can find when generation of revenue through distortionary taxes in order to make public expenditures starts becoming non-attractive. We shall start research with a scenario of complete information and non-contractible output. We shall need then to establish the direction of financing distortions introduced either by incomplete information or by contractible output.

How looks like a sound regulatory policy recommendation for an emerging market economy in an era of globalization and economic integration? Suppose that the magnitude of the consumer surplus associated with a private good or service sold by some foreign company alone is strictly greater that the maximum social surplus (consumer surplus and firm surplus or profit) realized in a closed economy framework by following the optimal pricing in the presence of a shadow cost of public funds. Shall we conclude then that such an optimal variant of the marginal cost pricing policy is the best policy recommendation to offer when comes to regulating some final product market? Or shall the public regulator consider as top priority the entry of, and the option of market supply by, a foreign firm as part of the design of a regulatory mechanism conceived to improve economic performance of domestic markets?

We believe that a policy of regulation by duopoly seems the most appropriate for an emerging market economy because its monopoly suppliers normally operate at particularly low levels of efficiency.

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