31E12100 Microeconomics policy

Lecture 3: Regulation theory

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Motivating illustrations

Motivating example I: Electricity distribution

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There are close to 80 companies that are local monopolies: their pricing and investments are regulated *Link*. The government objective:

- regulated prices that are reasonable and fair and give enough incentives for investments to maintain and improve the quality of the service

The government problems:

- regulations have led to price increases that are not deemed "reasonable and fair". Similarly, investments are not deemed optimal: some companies over-invest while others may invest too little.

This illustration highlights two challenges for regulations: **companies know privately their current costs and investment options**.

Motivating example II: Railways

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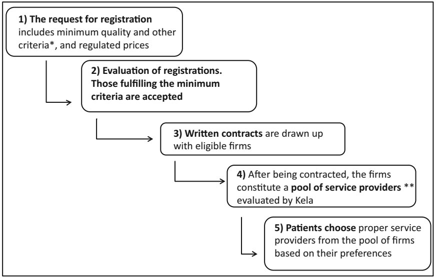
The government has decided to open rail passenger services to competition in stages to be completed by 2026 (Aug. 10, 2017, Ministry of Transport and Communications). The plan raises a number of questions:

- The government has to find a way to procure the service from private producers: contractual arrangement between the government and the producers. How should we design such contracts (i) to create incentives for good quality service and (ii) to save on costs?
- Different routes have different social values
- All routes use the same underlying infrastructure.

This illustration highlights one basic challenge: **How to share the cost of the infrastructure between firms, consumers, and the government?**.

Motivating example III: Procurement of physiotherapy services

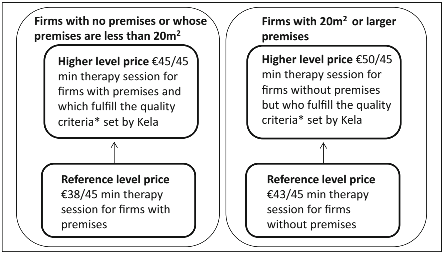
The Social Insurance Institution of Finland (Kela) procures the services from private providers. For example, in 2011, approximately 87 300 persons received rehabilitation services through Kela, the budget was approximately 339 million euros. See Pekola et al. (2017):



* The minimum criteria (registration criteria) include several issues, e.g. firms must be registered for prepayment, their businesses need to be insured, their premises and equipment must be safe for disabled individuals, they must accept regulated prices and declare not to charge any extra fees from the patients, they need to inform the SII on any changes in their business, therapists must have professional practice rights, they must have first aid skills and must get acquainted with Kela's quality standards
** All the firms that received a contract with Kela form a pool of therapists from which patients may choose one to provide the physiotherapy

Illustration: Prices and service

Prices fixed but also dependent on quality. See Pekola et al. (2017):



* The quality criteria for higher level prices are the following:

- 30 study credit of further education after graduation (a combination of longer and shorter courses)
- Work experience of 8 years or more

Illustration: A recent procurement by Kela, Oct. 30, 2018

Here is a link to the final outcomes of this procurement. And *Here* is a link to economists' report on the procurement.

firm price observable quality measures quantity

Palveluntuottajan nimi/toimipiste	Valitaan palveluntuottajaksi	Tarjottu hinta €/45 min	Hinnan vertailupisteet	Pisteet koulutuksesta	Pisteet työkokemuksesta	Pisteet tiloista	Laadun pisteet yht.	Laadun vertailupisteet	Vertailupisteet yhteensä	Tarjottu asiakasmäärä	Asiakasmäärän kertymä
Saukkolan fysikaalinen hoitolaitos Juha Pennanen Ky	x	44,00	80,00	25,00	15,00	10,00	50,00	20,00	100,00	7	7
Fysioterapeutti Eveliina Nummelin	x	42,90	82,05	25,00	10,00	0,00	35,00	14,00	96,05	10	17
Fysioeka Tmi/ Lohja	x	46,75	75,29	25,00	15,00	10,00	50,00	20,00	95,29	18	35
Fysioeka Tmi/ Helsinki	x	47,25	74,50	25,00	15,00	10,00	50,00	20,00	94,50	10	45
Diplomiosteopaatti-Fysioterapeutti Vesa-Pekka Rantala D.O	x	45,00	78,22	25,00	15,00	0,00	40,00	16,00	94,22	23	68
Fysiopoint Aapo Riila	x	49,00	71,84	25,00	15,00	10,00	50,00	20,00	91,84	10	78
Anjalankosken Kuntopiste Oy	x	50,00	70,40	25,00	15,00	10,00	50,00	20,00	90,40	75	153
Fysioterapia Kirkkonummi/ Kirkkonummi	x	50,00	70,40	25,00	15,00	10,00	50,00	20,00	90,40	35	188
Tmi Fysioterapeutti Eija Lehtinen, Martinlaakson Kuntoapu	x	50,00	70,40	25,00	15,00	10,00	50,00	20,00	90,40	6	194
Suvelan Fysikaalinen Hoitolaitos Oy	x	51,50	68,35	25,00	15,00	10,00	50,00	20,00	88,35	5	199

Plan

First part of the lecture

- Natural monopoly regulation with complete information: Ramsey Pricing

Second part of the lecture

- Private information and regulatory contracts

We leave regulation of investments for the last week of course.

The possibility to use transfers is important in both parts of the lecture

1. **Transfers to the firm are feasible**. Public funds can be used to subsidize the firm. Transfers can be included in the following:

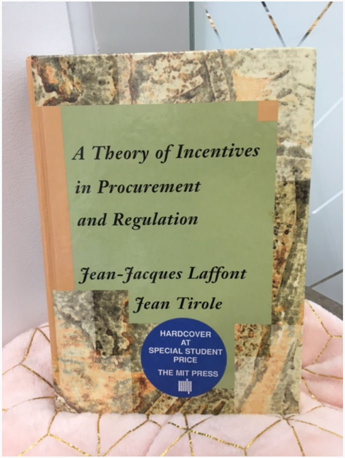
- Two-part tariffs
- Incentive contracts (rate adjustments depending on performance)
- Cost-plus contracts (e.g.,procurement and defence)

2. **Transfers not allowed**. Could be because of competition issues, or because funds are costly.

- Price caps (electricity)
- Incentive regulation (profit or cost sharing)
- Cost-of-service regulation (evaluation of fixed costs and revenues)

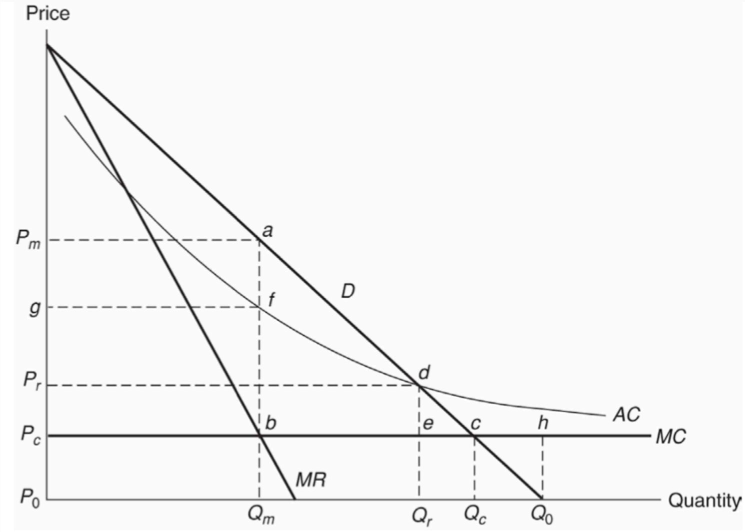
3. **Transfers are possible but they are costly**: How much to subsidize? Leads us to Ramsey pricing.

Encyclopedic source on the topic:



Natural monopoly regulation with complete information

Refreshment: Natural Monopoly under economies of scale



What are the policy options? To be covered in the class.

Natural monopoly: theory solutions

no transfers

Linear pricing: the firm is allowed to charge one linear price P per unit of consumption. Leads to price $P_r = AC$ in Figure above. The welfare loss? Non-linear pricing: Set fixed fee, F, plus the linear price P. Consumer's expenditure is $F + PQ$. The optimal two-part tariff: $P = MC$ and F covers the losses. Problems:

- pricing requires knowledge of the full consumer surplus: how do we know that the value of the natural monopoly is positive? See Coase for survey (1970)
- How to share the total cost between consumers? Suppose n consumers, so F/n is the fixed fee per consumer. But this fixed cost may not exceed the value of consumption for all consumers. Optimal design leads to a trade-off between efficiency and exclusion of consumers from the market

Transfers to the firm feasible

- Let us assume $C(q) = cq + c_0$, cost of producing quantity q where c_0 is fixed cost and c is marginal cost
- $U(q)$, consumer utlity
- $p = P(q) = U'(q)$, inverse demand
- $\lambda > 0$, shadow cost of public funds: if regulator uses 1€ for subsidies, the society pays $(1 + \lambda) > 1$€

The regulator would like to choose quantity produced to balance consumer surplus and the losses of the firm:

$$\max_q \{[U(q) - P(q)q] - (1+\lambda)[cq + c_0 - P(q)q]\}$$
$$\Rightarrow \frac{p-c}{p} = \frac{\lambda}{1+\lambda}\frac{1}{\eta}$$

where $\eta = -(dq/dp)/(q/p)$ is the elasticity of demand.

Note that the regulation pays no attention to the average cost and that:

- $\lambda = 0$: funds can be transferred to the firm without costs $\Rightarrow$ marginal cost pricing!
- $\lambda = \infty$: funds from the firm extremely valuable $\Rightarrow$ monopoly pricing!

Frank Ramsey, 1903-1930.

Multiproduct monopoly. For example, the Railway company provides multiple services using the same basic infrastructure. How to set the prices if all costs have to be covered with revenues from the consumers. The answer is provided by Ramsey pricing (Frank Ramsey, 1927, Economic Journal). The allocation problem is now:

$$\max_{q_1,\ldots,q_n}\{\sum_{i=1}^{n} U_i(q_i) - C(q_1, ..., q_n)\}$$
$$s.t. \sum_{i=1}^{n} P_i(q_i)q_i \geqslant C(q_1, ..., q_n)$$

Solution is simple:

$$\frac{p_i - \frac{\partial C(.)}{\partial q_i}}{p_i} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_i}$$

where is λ is now the shadow cost of the budget constraint.

Ramsey pricing: Check your understanding using the following example:

$$C(q_1, c_2) = 1800 + 20q_1 + 20q_2$$
$$q_1 = 100 - p_1$$
$$q_2 = 120 - 2p_2$$

Consider: (i) marginal cost pricing; (ii) one price policy covering costs; (iii) differentiated price, i.e., the optimal policy.
Check that you can solve (i)-(iii) in this case.

Ramsey pricing: problems

- All transfers excluded: prices must exceed marginal costs
- Formidable information requirements (applies to all solutions so far)
- Cost function is exogenous while in reality regulated firms can influence their costs

Loeb and Magat Incentive Scheme:

- Regulator knows only demand in Figure "Natural Monopoly"
- Monopolist knows the cost structure
- Let the firm choose the price freely and subsidize the firm by the amount that is between the demand curve and the chosen price.
- How will the monopoly choose the price?

The lesson: efficiency can be obtained even with private information if the firm receives enough surplus

Asymmetric information

Introduction:

- In reality, the regulated firms report accounting costs
- The regulators designs reimbursement rules: costs are paid back plus typically some incentive payment
- The key problem: costs are endogenous (effort, innovation) to the firm, and the conditions and actions influencing costs are not observed by the regulator
- How to provide correct incentives for cost reductions?

Incentive regulation: Laffont & Tirole (1994) A theory of incentives in procurement and regulation.
As an illustration of hidden information, consider the regulation of a public service (health care, etc.). There are two players:

- regulator, interested in the provision of a service q, generating a gross surplus $S(q)$ with $S'(q) > 0 > S''(q)$
- firm facing a cost given by θq where θ is a cost parameter, $\theta \in [\underline{\theta}, \overline{\theta}]$

The firm receives a transfer from the regulator, denoted by t. This transfer costs the regulator $(1 + \lambda)t$ where λ is the shadow cost of public funds (i.e. the cost of making one unit of transfer). Note that λ be thought of as arising from the excess burden of taxation that is needed elsewhere in the economy to cover the transfers

Complete information

Under complete information, the regulator knows the firm's cost parameter θ and can solve the following problem to determine the optimal service and transfer (we consider interior solutions):

$$\max_{q}\{S(q) - (1+\lambda)\theta q\}$$
$$\Rightarrow S'(q) = (1+\lambda)\theta = 0$$

The solution to this problem gives the first-best service $q = q^{FB}$, and the associated transfer $t = t^{FB} = \theta q^{FB}$.

Hidden information

In reality it is the firm, not the regulator who knows the cost. Think about the government's attempt to privatize the provision of certain health care or railway services. What is the cost of providing given service in a region? Only firms know their options for minimizing costs. The government has several options, including:

- offer a package deal to the firm (t, q) such that all firm types accept the deal. For example, pay $t = \overline{\theta} q$, and choose $q = q^{FB}$ for $\overline{\theta}$. What are the problems with this approach?
- Design $(t(\theta), q(\theta))_{\theta \in [\underline{\theta}, \overline{\theta}]}$ for each θ separately. Thus, ask firms to report their costs and thereby self-select the transfer-service pair.

We proceed now to describe such a menu of incentive contracts.

The regulator's problem under hidden information

Turn now to a more realistic incomplete-information situation, where the regulator no longer knows the firm's true type, but has a probabilistic assessment of the type. We assume two types now, the firm has either high cost or low cost, $\overline{\theta} > \underline{\theta}$. The relative probabilities for the types are $\overline{p}$ and $\underline{p}$ (here and below the overline and underline respectively refer to "high-type" and "low-type"). The regulator will seek to maximize the expected total surplus, taking into account the participation or "Individual Rationality" constraint ("IR" hereafter) as well as the "Incentive Compatibility" constraints ("IC" hereafter). The surplus maximization problem becomes:

$$\max_{(\overline{t},\overline{q}),(\underline{t},\underline{q})} \overline{p}[S(\overline{q}) - (1+\lambda)\overline{t}] + \underline{p}[S(\underline{q}) - (1+\lambda)\underline{t}]$$

IR constraints ensure that both types, when selecting the package designed for them, can participate:

$$\bar{t} - \bar{\theta}\bar{q} \geqslant 0 \qquad (\overline{IR})$$

$$\underline{t} - \underline{\theta}\underline{q} \geqslant 0 \qquad (\underline{IR})$$

IC constraints ensure that each type self-select the contract designed for the type:

$$\bar{t} - \bar{\theta}\bar{q} \geqslant \underline{t} - \bar{\theta}\underline{q} \qquad (\overline{IC})$$

$$\underline{t} - \underline{\theta}\underline{q} \geqslant \bar{t} - \underline{\theta}\bar{q} \qquad (\underline{IC})$$

Let us define the rent that the incentive compatible contracts leave for the firms as $\overline{R} = \overline{t} - \overline{\theta}\overline{q}$ and $\underline{R} = \underline{t} - \underline{\theta}\underline{q}$. Then, we can see that the regulator is effectively deciding how much rent R to leave for each firm type as a compensation for service q:

$$\max_{(\overline{R},\overline{q}),(\underline{R},\underline{q})} \overline{p}[S(\overline{q}) - (1+\lambda)(\overline{\theta}\overline{q} + \overline{R})] + \underline{p}[S(\underline{q}) - (1+\lambda)(\underline{\theta}\underline{q} + \underline{R})]$$

$$\overline{R} \geqslant 0 \qquad (\overline{IR})$$

$$\underline{R} \geqslant 0 \qquad (\underline{IR})$$

$$\overline{R} \geqslant \underline{R} + (\underline{\theta} - \overline{\theta})\underline{q} \qquad (\overline{IC})$$

$$\underline{R} \geqslant \overline{R} + (\overline{\theta} - \underline{\theta})\overline{q} \qquad (\underline{IC})$$

How to solve? Using economic reasoning, rather than brute force is a good route.

- Incentive compatibility implies that the more efficient firm should produce more:

$$(\overline{IC}, \underline{IC}) \Rightarrow (\bar{\theta} - \underline{\theta})\underline{q} \geqslant \underline{R} - \overline{R} \geqslant (\bar{\theta} - \underline{\theta})\overline{q} \Rightarrow \underline{q} \geqslant \overline{q}$$

- IR for the efficient firm will always hold. Low cost type must obtain more rent than the high cost type since it has the option of mimicking the other type. Thereby it must always be willing the participate if the high cost type is participating:

$$(\overline{IR}, \underline{IC}) \Rightarrow \underline{R} \geqslant (\bar{\theta} - \underline{\theta})\overline{q} \geqslant 0.$$

We can thus ignore $\underline{IR}$ constraint since it will always hold.

- Ignoring $\underline{IR}$ implies that $\underline{IC}$ must hold as equality: otherwise, the rent could be reduced without affecting incentives.
- The previous implies that $\overline{IC}$ always holds: $\underline{R} - \overline{R} = (\bar{\theta} - \underline{\theta})\overline{q} \leqslant (\bar{\theta} - \underline{\theta})\underline{q}$ (recall here that the efficient firm must produce more by incentive compatibility, $\underline{q} \geqslant \overline{q}$)
- Finally, $\overline{IR}$ must hold as equality. Otherwise, we could reduce both rents without affecting the incentives: see the IC constraints where the rents appear as constants.

We can now take the previous observations onboard and rewrite the regulator's problem:

$$\max_{(\overline{q},\underline{q})} \overline{p}[S(\overline{q}) - (1+\lambda)(\overline{\theta}\overline{q} + \overline{R})] + \underline{p}[S(\underline{q}) - (1+\lambda)(\underline{\theta}\underline{q} + \underline{R})]$$

$$\overline{R} = 0 \tag{$\overline{IR}$}$$

$$\underline{R} = \overline{R} + (\overline{\theta} - \underline{\theta})\overline{q} \tag{$\underline{IC}$}$$

$$\underline{q} \geqslant \overline{q} \tag{*}$$

Note that the last condition must be imposed for the incentive compatibility to hold.

To simplify further, we can write the problem as follows:

$$\max_{(\overline{q},\underline{q})} \overline{p}[S(\overline{q}) - (1+\lambda)\overline{\theta}\overline{q}] + \underline{p}[S(\underline{q}) - (1+\lambda)(\underline{\theta}\underline{q} + (\overline{\theta} - \underline{\theta})\overline{q})]$$

$$\underline{q} \geqslant \overline{q} \qquad (*)$$

We solve this by ignoring the constraint (*), and then verifying that the requirement will hold.

The solution to this simple example illustrates the basic properties of the incentive contracts:

- No distortion of efficiency for the low cost firm: the service required is the same as would be when there is full information of type $\underline{\theta}$

$$S'(\underline{q}) - (1+\lambda)\underline{\theta} = 0$$

  Thus, $\underline{q} = q^{FB}(\underline{\theta})$
- There is a distortion in the service requirement for the less efficient firm:

$$S'(\overline{q}) - (1+\lambda)\overline{\theta} = (\underline{p}/\overline{p})(1+\lambda)(\overline{\theta} - \underline{\theta})$$

  Thus, $\overline{q} < q^{FB}(\overline{\theta})$. Why is this? From $\underline{R} = \overline{R} + (\overline{\theta} - \underline{\theta})\overline{q}$ so that the output required from the less efficient firm determines the rent of the more efficient firm. It is optimal the reduce this rent by distorting the output.