ENERGY REGULATORY ECONOMICS

CONTRACT THEORY

CONTRACT THEORY

- Mechanism Design

  - Social choice function : mapping from a vector of characteristiscs to a feasible social state

$$\theta \in \Theta \xrightarrow{\quad f \quad} A$$

  - A mechanism is a couple $M=(M^1,\ldots,M^I)$ and a function $g(\bullet)$ such that

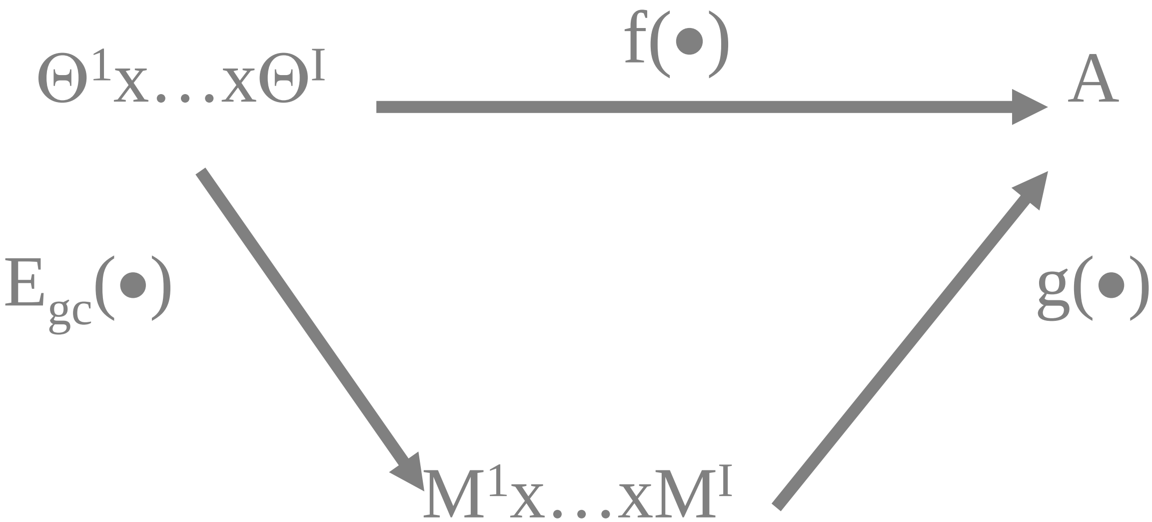
$$m=(m^1,\ldots,m^I) \xrightarrow{\quad g \quad} A$$

  - $E_{gc}(\bullet)$ is a mapping from θ to m

CONTRACT THEORY

- Mechanism Design

  -A mechanism implements a social choice function, for a certain equilibrium concept, if:



  - Two concepts of equilibrium (c): Dominant and Nash.

CONTRACT THEORY

- Mechanism Design

    - Mechanism:

        * Direct if $M_i = \Theta_i, \forall i=1,\ldots,I$

        * Revealing if $\theta \in E_{gc}(\theta), \forall \theta \in \Theta$

        * Implemented by revelation if it is direct and $g(\theta)=f(\theta), \forall \theta \in \Theta$

CONTRACT THEORY

- Mechanism Design
  - The Revelation Principle:

    "Let (g,M) be a mechanism that implements the social choice function f(•) for the dominant equilibrium concept. Then there exists a direct mechanism (Ψ,Θ) that implements by revelation f(•) in dominant equlibria"

CONTRACT THEORY

•Principal-agent model. Adverse selection example:

- Perfect information:

$$\max\ (t_i - c(q_i))$$

$$\theta_i\, q_i - t_i \geq 0$$

CONTRACT THEORY

- Complete information:

f. o. c.

$$q_i = q_i^*$$

$$c'(q_i^*) = \theta_i \; (\Rightarrow q_2^* > q_1^*)$$

$$t_i^* = \theta_i \, q_i^*$$

CONTRACT THEORY

- Assymetric information:

$$\max_{t_1,q_1,t_2,q_2} \{\Pi\ [t_1 - c(q_1)] + (1-\pi)[t_2 - c(q_2)]\}$$

subject to:

$$\theta_1 q_1 - t_1 \geq \theta_1 q_2 - t_2 \qquad (IC_1)$$

$$\theta_2 q_2 - t_2 \geq \theta_2 q_1 - t_1 \qquad (IC_2)$$

$$\theta_1 q_1 - t_1 \geq 0 \qquad (IR_1)$$

$$\theta_2 q_2 - t_2 \geq 0 \qquad (IR_2)$$

CONTRACT THEORY

- Assymetric information:

f.o.c:

$t_1 = \theta_1 q_1$ (IR$_1$ binding)

$t_2 - t_1 = \theta_2 (q_2 - q_1)$ (IC$_2$ binding)

$q_2 \geq q_1$

$q_2 = q_2^*$

$q_1 < q_1^*$

CONTRACT THEORY

Common properties:

- The highest type gets an efficient allocation
- Each type is indifferent between his contract and that of the immediately lower contract (with the exception of the lowest type)
- All types get an informational rent that increases with the type (with the exception of the lowest type)

CONTRACT THEORY

Common properties:

- All types obtain a subefficent allocation (with the exception of the highest type)
- The lowest type obtains a zero surplus

THE CANONICAL

MODEL OF REGULATION

THE CANONICAL MODEL OF REGULATION

- Assumptions:

  1.- Regulation is subject to adverse selection and moral hazard

  2.- Costs, products and prices are verifiable. However, the regulator can’t differentiate the different cost components

  3.- The firm can refuse to produce if the regulatory contract doesn’t guarantee a minimum expected utility

THE CANONICAL MODEL OF REGULATION

- Assumptions:

  4.- The regulator can make monetary transfers to the firm

  5.- The firm and the regulator are risk neutral with respect to income

  6.- The firm only cares about its income and effort ($U = t - \varphi(e)$, $t = t + R(q) - \hat{c}(\bullet)$)

  7.- The regulator faces a shadow cost of public funds ($\lambda > 0$)

THE CANONICAL MODEL OF REGULATION

- Assumptions:

  8.- The regulator’s objective is to maximize social welfare (benevolent-regulator assumption)

  9.- The regulator designs the regulatory contract

THE CANONICAL MODEL OF REGULATION

$$W = S(\theta, s, q) - R(q) - (1+\lambda)\hat{t} + EU$$

$$EU = \hat{t} + R(q) - C(\beta, e, q) - \psi(e, s) = t - \psi(e, s)$$

$$W = S(\theta, s, q) + \lambda R(q) - (1+\lambda)(C(\beta, e, q) - \psi(e, s)) + \lambda EU$$

THE CANONICAL MODEL OF REGULATION

- Expected social welfare:

$$W = S(\theta, s, q) - R(q) - (1+\lambda)\hat{t} + EU$$

- Menu of linear contracts:

$$S(\theta, s, q) = S$$

$$c = \beta - e + \tilde{\varepsilon}$$

$$U = t - \varphi(\beta - c)$$

THE CANONICAL MODEL OF REGULATION

- Menu of linear contracts:

  - Under complete information:

$$\varphi'(e)=1 \text{ ó } e=e^{*}$$

$$t=\varphi(e^{*}) \text{ ó } U(\beta)=0 \quad (\forall\beta)$$

THE CANONICAL MODEL OF REGULATION

- Menu of linear contracts:

  - Revelation Principle (revealing direct mechanism: $\{t(\beta), c(\beta)\}$): $\beta \in \underset{\tilde{\beta}}{Arg\max}\left\{t(\tilde{\beta}) - c(\tilde{\beta})\right\}$

  - Under assymetric information

$$Max \int_{\underline{\beta}}^{\overline{\beta}} \left\{S - (1+\lambda)(\beta - e + \varphi(e)) - \lambda U(\beta)\right\} dF(\beta)$$

subject to:

$$\dot{U}(\beta) = -\varphi'(e(\beta)), \forall \beta$$

$$U(\beta) \geq 0, \forall \beta$$

THE CANONICAL MODEL OF REGULATION

- Menu of Linear Contracts:

  - Under assymetric information

    f.o.c.

$$\varphi'(e^*(\beta)) = 1 - \frac{\lambda}{1+\lambda}\frac{F(\beta)}{f(\beta)}\varphi''(e^*(\beta))$$

$$U^*(\beta) = \int_{\underline{\beta}}^{\overline{\beta}} \varphi'(e^*(\overline{\beta}))\, d\tilde{\beta}$$

THE CANONICAL MODEL OF REGULATION

- Menu of linear contracts:

  - Transfer function:

$$t(\beta) = U^*(\beta) + \varphi(e^*(\beta)) = t(\beta(c)) = T(c)$$

$$t(c,c^a) = a(c^a) - b(c^a)(c - c^a)$$

THE CANONICAL MODEL OF REGULATION

- The dichotomy between Pricing and Cost Reimbursement Rules:

$$W = S(q) + \lambda \sum_k p_k(q) q_k - (1+\lambda)(C + \psi(e)) - \lambda U$$

subject to

$$\dot{U} = -\psi(E(\beta, C, q))$$

$$U \geq 0$$

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THE CANONICAL MODEL OF REGULATION

- The dichotomy between Pricing and Cost Reimbursement Rules:

f.o.c.

$$L_k = \frac{p_k - C_k}{p_k} = -C_e - \frac{\lambda}{1+\lambda}\frac{1}{\hat{\eta}_k} + \left[\frac{\lambda F(\beta)\psi'(e)}{(1+\lambda)f(\beta)}\right]\frac{d}{dq_k}(E_\beta) \quad k = 1, \ldots, n$$

$$\psi'(e) = -C_e - \frac{\lambda}{1+\lambda}\frac{F(\beta)}{f(\beta)}\frac{d}{de}\left[\psi'(e)E_\beta\right]$$

THE CANONICAL MODEL OF REGULATION

- The dichotomy between Pricing and Cost Reimbursement Rules:

  $C = c(\beta,e,q)$ can be re-written as

  $$C = c(\zeta(\beta,e),q)$$

- Pricing rule: Ramsey-Boiteux

- Cost rule:

  * Price-cap regulation for the most efficient firm
  * Cost-of-service regulation for the least efficient firm

PRICE REGULATION

PRICE REGULATION

- Introduction

- Price level regulation

- Price structure regulation

- Regulation of electricity transmission

INTRODUCTION

- History of the optimal prices:

  - First best: marginal cost (70´s)
  - Second best: Ramsey pricing (80´s)
  - Third best: Revelation Principle/ Laffont-Tirole (93)
  - Fourth best: Theoretical models under practical constraints

PRICE REGULATION

INTRODUCTION

- "Desirable" properties of applied mechanisms:
  - Pareto superiority
  - Efficiency improvements

- Few niches of legal and natural monopolies. (e.g.:transmission and distribution of gas and electricity)

PRICE REGULATION

INTRODUCTION

- Regulation of monopolies is important since they are vertically related with competitive sectors.

- Two basic concepts:

  - Price level

  - Price structure

REGULATION OF PRICE LEVEL

- Alternatives:

  - Cost-of-service regulation
  - Price caps: adjustment factors (RPI, X, etc.)
  - "Yardstick" regulation
  - Profit sharing
  - Hybrid regulation

REGULATION OF PRICE STRUCTURE

- Total-cost distribution
- Price bands
- Restricted flexibility
    - Tariff basket
    - Average revenue

REGULATION OF ELECTRICITY TRANSMISSION

- Types of weights:

    * Laspeyres chain
    * Paasche
    * Fixed Laspeyres
    * Ideal weights (Laffont-Tirole)
    * Flexible (average revenue)

REGULATION OF PRICE STRUCTURE

- Disputes regarding consumer groups and the regulated-firm competitors.

- A non-constrained monopoly establishes an efficient price structure but at an inefficient level

- Contractual prices must coexist with regulated prices together with quality regulation so as to avoid cross subsidies

REGULATION OF TRANSMISSION

- Objectives:

  - Incentives to reduce the distance between the generating plants and demanding centers

  - Reliability of the frequency and the voltage of the system

  - Coordination of the generating stations and provision of solutions in cases of emergency

REGULATION OF TRANSMISSION

- Main Problems:

  - Capacity use (short-run).
  - Optimal investment (long-run).

- Proposal to regulate price level:

  - Price cap
  - RPI-X; $0\% \leq X \leq 5\%$.
  - Regulatory lag (5 years)
  - Cost of service during each five-year tariff revisions

REGULATION OF TRANSMISSION

- Proposal to regulate price structure:
  - It considers congestion problems (short-run) as well as capacity problems (long-run).
  - Two-part tariff:
    * Usage charge: it solves congestion problems.
    * Capacity charge: recovering of capital costs.
    * Rebalancing between charges: investment incentives
    * Transmissions quantities are used as weights

REGULATION OF TRANSMISSION

- Proposal to regulate price structure:

  - Model (Vogelsang, 1999):

$$max \prod^t = p^t q^t + F^t N - c(q^t, k^t)$$

subject to:

$$\sum_i p_i^t q_i^w + \sum_j F_j^t \delta_j^w \le \left(\sum_i p_i^{t-1} q_i^w + \sum_j F_j^{t-1} \delta_j^w\right)(1 - X)$$

$$F^t \le F^{t-1} + \left(p^{t-1} - p^t\right) q^w / N$$

$$q^t \le k^t$$

REGULATION OF TRANSMISSION

- Proposal to regulate price structure:

  - f.o.c.:

$$\left(\frac{\partial q^t}{\partial p^t}\right)\left(p^t + \mu^t - \frac{\partial c}{\partial q^t}\right) = q^w - q^t$$

$$\mu^t = 0 \Rightarrow \left(p^t - \frac{\partial c}{\partial q^t}\right) = -\left(\frac{q^w}{q^t - 1}\right) \Big/ \varepsilon$$

  - Under chained Laspeyres weights there is convergence to Ramsey prices

REGULATION OF TRANSMISSION

- Proposal to regulate price structure :

    - Principles:

        * Efficient operation of the energy market
        * Efficient investment in the system
        * Sign-posting of locational advantages in generation and distribution
        * Asset costs recovery
        * Simplicity and transparency
        * Political feasibility

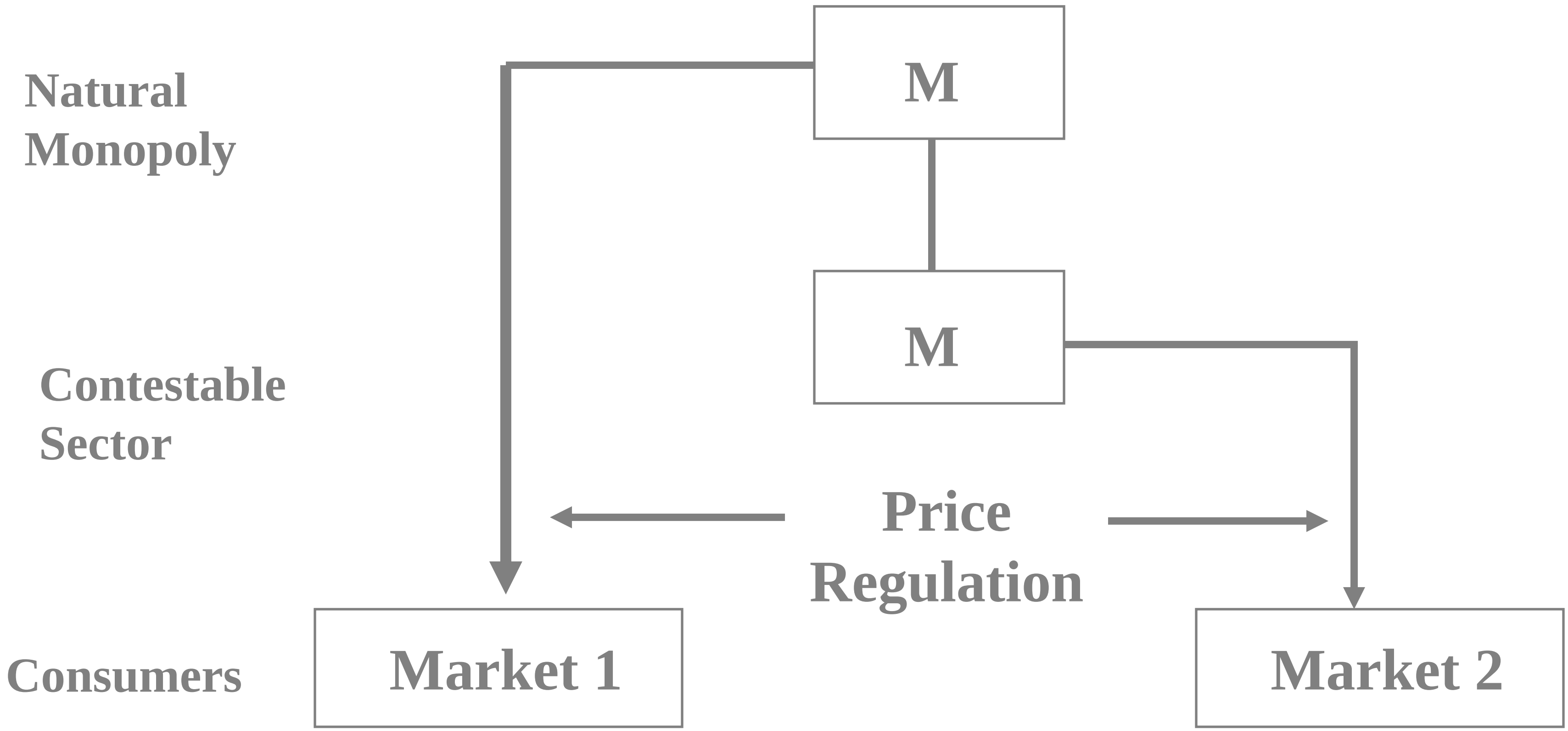
OTHER TOPICS

OTHER TOPICS

- Vertical Integration
- Liberalization
- Horizontal Structure
- Regional Structure
- Access-Price Regulation
- Quality and Environmental Regulation
- Ownership

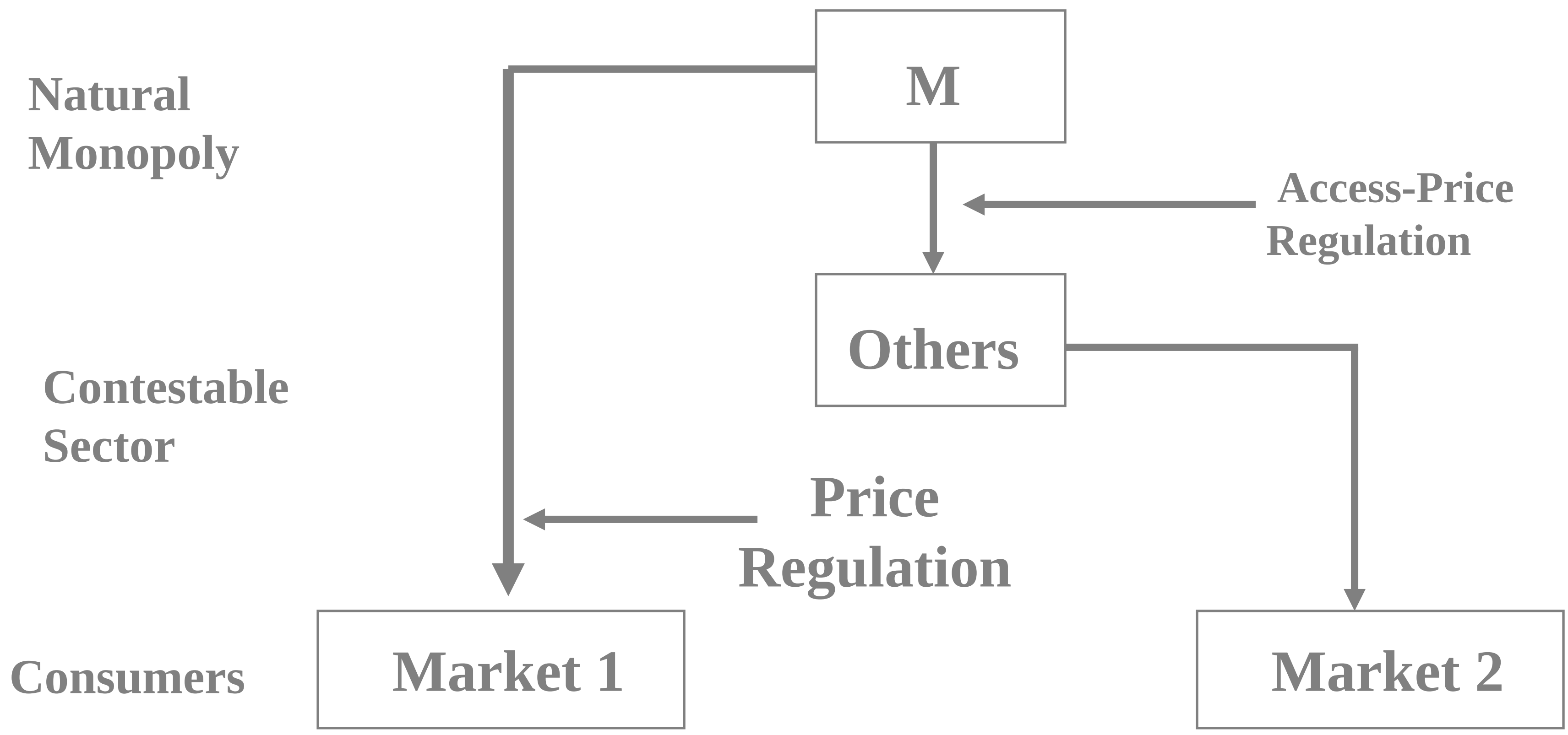
OTHER TOPICS

Vertically Integrated Monopoly

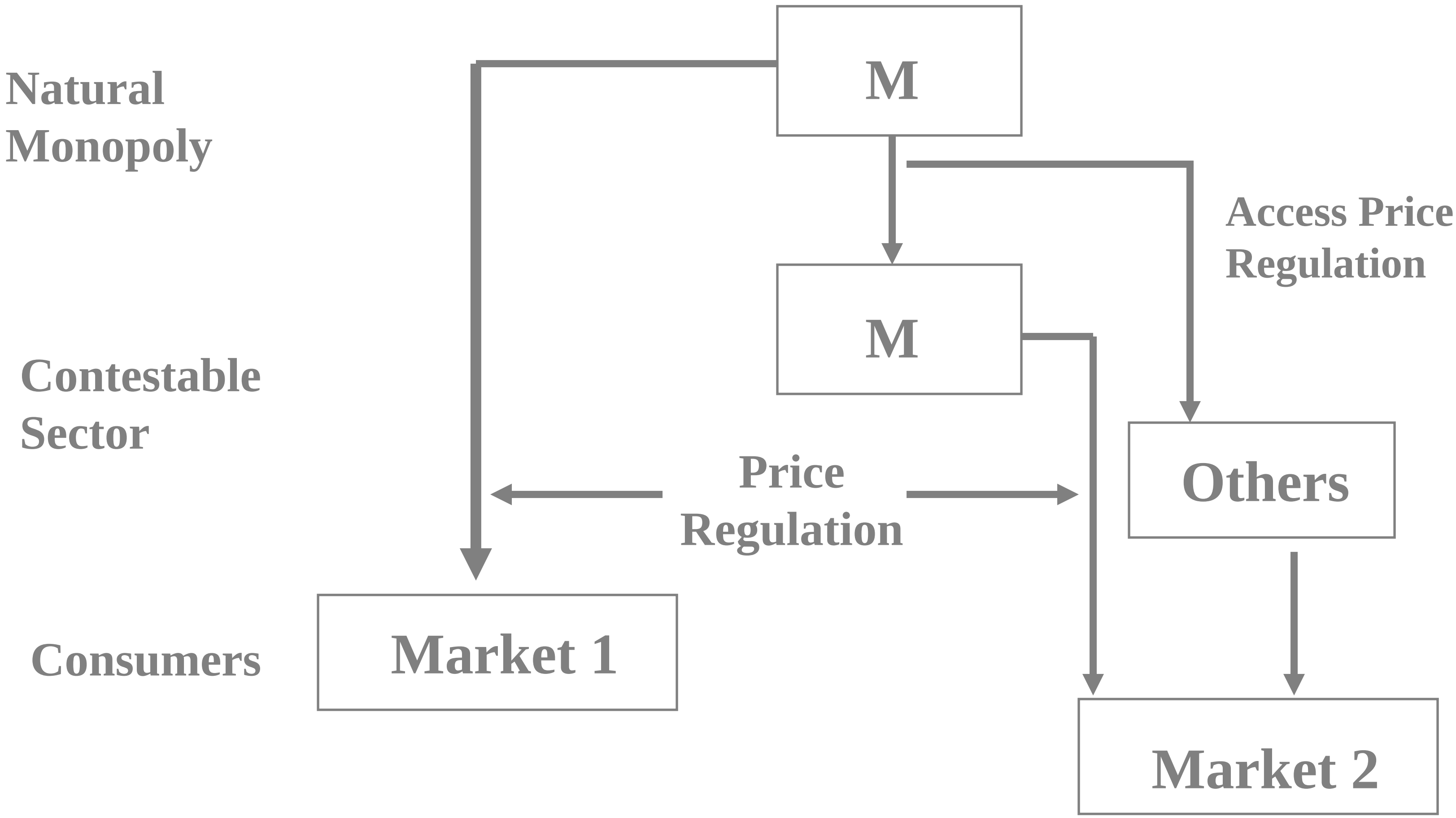


OTHER TOPICS

Vertical Separation



Vertical Integration with Liberalization



OTHER TOPICS

- Topics in Competition and Liberalization

  - “Cream Skimming”
  - Excess Entry
  - Competition for the Market
  - Entry Barriers
  - “Predatory Pricing”
  - Entry Assistance

OTHER TOPICS

- Access Pricing:

  - Under vertical separation: access price is equal to the marginal cost of access (as long as there is a transference)

  - Under vertical integration:

    * Final price regulation: access price is equal to the difference of the regulated final price less the marginal cost in the contestable market (ECPR: M's incremental cost for allowing access in terms of lost benefits)

OTHER TOPICS

- Access Pricing:

  - Under vertical integration:

    * Non/regulated final price: equal to the cost under vertical separation