

Mechanism Design for Foreign Producers of Unique Homogeneity Product

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Abstract. Paper concerns to impact on custom receipts of duty rate changing from single to differentiated ones by customs house for foreign producers. To get maximal custom receipts for achieving of social goal state may introduce differentiated duty rates for foreign producers of unique product. Success of this state policy will depend on effectiveness of incentive compatibility conditions for these producers.

Keywords. Mechanism design, single duty, differentiated duty, custom policy, social choice function

Key terms. MechanismDesign, RevelationPrinciple, SocialGoal, MathematicalModel, IncentiveCompatible

1 Introduction

Mechanism is a mathematical structure, modeling an institute and determining the set of rules, regulating actions accessible to the participants and determining as participants strategies in given communication system are transformed in results. In the absence of co-operation mechanism between participants the final result can substantially differ from social optimal one. A mechanism implements given objective function, realizing it on participants types space [2; 8].

Mechanism structure includes [7]:

1. Social choice function (SCF is a final result demanded by the society)
2. Implementation mechanism (realization of SCF by the payoffs and distributive functions of product and money);
3. Revelation mechanism of participants types (by a social planner);
4. Motivating mechanism (it is intended to make conditions for revelation of true information by participants about their types θ [6]).

Objective function F is a composition of messages μ and result h (fig.1).

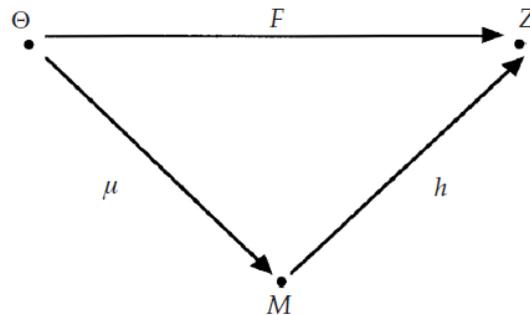


Fig. 3. Mechanism M and objective function F

Mechanism can enforce to cooperation rules, when participants accomplish actions, violating set rules [4]. Two extremes of mechanisms' types are centralized (planned system) and decentralized (such as competition market), between them are continuum numbers of other mechanisms.

The decentralized mechanism (saving confidentiality mechanism) implies the private expenditure (for collection and verification of information reliability) [1]. Existent mechanisms can be complemented or substituted by the new ones, for example, by the means of legislation changes.

Reasons of new mechanism introduction:

- Revelation of unsatisfactory aspects activity of existent economic systems or institutes (market failures)
- Established economic system gives advantage only for certain participants

Mechanism tasks:

- To ground social choice function with the desirable characteristics for society
- To develop compatible conditions for participants to reveal their true types (reservation price, costs etc.)
- To make implementation process of social choice function by the help of chosen mechanism (direct or indirect)

The *direct mechanisms* provide direct transfer of the truthful private information about their types by the agents to the public planner (not realistic mechanism). The *indirect mechanisms* create motive, under which to the agents more profitable to open true information, than to conceal or to distort it (more realistic mechanism) [10].

During organizing of customs mechanism, as well as any other, to the participants concerns of social planner (government) and agents (payers of the customs tax). The agent is selfish person, who has private information only about him or her own type (for example, personal income, costs, profit).

Economic environment is exogenous variable, given by nature or received from the last periods (competition type, technology, rule of custom policy). In model neither the agents, nor mechanism designer do not know prevailing environment. Mechanism designer knows: (i) class of environments, for which should be developed the mechanism; (ii) desired criterions for SCF [5; 9].

SCF represents criteria for result estimation, but not a means of goal achievements as mechanism does.

For customs house SCF mapping types space (average costs of production for importers) in results space (custom receipts). The participant type (average costs) defines its message (invoice cost of the goods), which causes final result (custom receipts).

So the purpose of customs mechanism can be maximization of receipts from customs taxes in the state budget under creation of the appropriate motivating system for the importers (increase of the invoice price, preferential duty rates regime).

This paper has a following structure. We make a literature review in this, first, part. Problem statement and basic assumptions of model are presented in the second part. Part 3 deals with main results for participants under fixed and differentiated duty rates. Last part concludes.

2 Problem Statement

Search of effective ways of state budget replenishment by the means of indirect taxes requires introduction of flexible duty customs for foreign producers foreseen by the proper government laws in relation to payment of custom payments. Criteria, after which the state aims to set the duty rate on import commodities, and to foresee protectionism principle for domestic producers, profitableness principle for the state and utility principle, for domestic consumers.

Peculiarity of optimization for import duty rate is that foreign producers, forming a competition domestic market, will maximize own profits, taking into account a market price [3], whereas for state size of custom rate depends on invoice cost of commodity, which can be corrected by a custom house in the direction of increase and have to corresponds to prevailing (equilibrium) market price.

Product invoice price indicates cost of commodity, which transfers through custom border of Ukraine. If the invoice price indicated in freight customs declaration below of average price in the base of Government custom service of Ukraine, there is the rise of product price to average level before getting customs clearance for product. From the customs value of product duty and VAT is counted, that countries are transferred in a budget.

Customs takes place as follows:

$$B = t \cdot TR_N,$$

where B – duty sum; TR_N – part of product invoice price, that exceeds an un-taxable size (in UAH); t – duty rate (in per cent) from the product invoice price, which now in Ukraine is equal 10%.

For construction of model, that describes co-operation of foreign producers and customs we assume:

- n foreign firms produce homogeneous product, which is supplied to the domestic market and has no domestic analogues;
- between firms there is quantitative Cournot competition;
- cost functions of all firms are linear on production quantities (constant scale return), and reverse domestic market demand function is linear on the quantity of foreign products;
- information about average costs of foreign firms and domestic market demand is uniformly (symmetrically) distributed between *all* participants (foreign producers, domestic consumers and government).

Participants' objective functions:

Foreign producers:

Total cost of producer i consists of variable cost (fixed cost we assume zero in long-run period, v_i is average (variable) cost of producer i) and duty sum:

$TC_i^F = v_i \cdot q_i + t \cdot P \cdot q_i$, where $P_f = P$ is invoice price of unit product.

Profit of producer i : $\pi_i^F = P \cdot q_i - (v_i \cdot q_i + t \cdot P \cdot q_i)$ or $\pi_i^F = (1-t) \cdot P \cdot q_i - v_i \cdot q_i \xrightarrow{q_i \geq 0} \max$, $i = 1, \dots, n$, t is endogenous variable, i.e. duty rate determined by government.

1. State (Ukrainian Income and Duty Ministry)

Tax proceeds to state budget is: $B = t \cdot P_f \cdot \sum_{i=1}^n q_i$.

2. Domestic market:

Reverse linear function of domestic demand is $P = b - c \cdot Q = b - c \cdot \sum_{i=1}^n q_i$,

where P is market price of product, b - maximal price of foreign product on domestic market (under zero import supply).

3 Results

3.1 Custom Receipts Model Construction for Fixed Duty Rate

3.1.1 Producer profit maximization

After substitution of market price to profit function of producer i we obtain:

$\pi_i^F = (1-t) \cdot \left(b - c \cdot \sum_{i=1}^n q_i \right) \cdot q_i - v_i \cdot q_i$, $i = 1, \dots, n$. First order condition (FOC)

of profit give us: $\frac{\partial \pi_i^F}{\partial q_i} = (1-t) \cdot \left(b - 2c \cdot q_i - c \cdot \sum_{j \neq i} q_j \right) - v_i = 0$. Similarly we get partial derivatives for profit function of all producers. Algebraic transformation yields:

$$\begin{cases} 2 \cdot q_1 + q_2 + \dots + q_n = b - \frac{v_1}{c \cdot (1-t)}, \\ q_1 + 2 \cdot q_2 + \dots + q_n = b - \frac{v_2}{c \cdot (1-t)}, \\ \dots, \\ q_1 + q_2 + \dots + 2 \cdot q_n = b - \frac{v_n}{c \cdot (1-t)}. \end{cases}$$

Solving of system by matrix approach give optimal value of foreign producer sales (duty rate $0 < t < 1$):

$$q_j = \frac{1}{(n+1) \cdot c} \cdot \left(b - \frac{(n+1) \cdot v_j - n \cdot \bar{v}}{1-t} \right), \quad j = 1, \dots, n, \tag{1}$$

where $\bar{v} = \frac{\sum_{i=1}^n v_i}{n}$ - average product cost of all foreign producers. If in equation

(1) average cost of producer j lower than average cost of all producers: $v_j < \bar{v}$, then after increasing of duty rate t , its optimal sales will rise. And vice versa: if $v_j > \bar{v}$, then optimal sale of producer j will decrease.

Total quantity of foreign producers with using of (1) will equal:

$$Q = \sum_{j=1}^n q_j = \frac{n \cdot ((1-t) \cdot b - \bar{v})}{c \cdot (n+1) \cdot (1-t)}. \tag{2}$$

Thus growth of duty rate always will lead to decreasing of total quantity of unique good for foreign producers at domestic market: $\frac{dQ}{dt} < 0$.

3.1.2 Budget Custom Receipts Maximization

The receipts from foreign producers' duty customs after substitution of total sales of import quantity in expression (2) will give:

$$B = t \cdot P_f \cdot Q \xrightarrow{t \geq 0} \max, \text{ where } P_f = \text{const} - \text{product unit invoice price.}$$

First order condition for maximization of custom receipts is determined by condition $\frac{dB}{dt} = 0$ or equivalent to following equation: $bt^2 - 2b \cdot t + b - \bar{v} = 0$, from here equilibrium duty rate will be equal:

$$t = 1 - \sqrt{\frac{\bar{v}}{b}} \tag{3}$$

Equilibrium single duty rate (3) will have inverse relation with average cost of all foreign producers and direct relation with maximal domestic product price.

Thus the invoice price of product will be set at a level $P = b - c \cdot Q$ or taking into account (2) and (3) we will get the equilibrium indexes of invoice price and sales accordingly:

$$P_f^* = \frac{\sqrt{b} \cdot (\sqrt{b} - n \cdot \sqrt{\bar{v}})}{(n+1)}, Q^* = \frac{n\sqrt{b} \cdot (\sqrt{b} - \sqrt{\bar{v}})}{c \cdot (n+1)}$$

Farther from expression $B = t \cdot P_f \cdot Q$ we will define that the equilibrium (maximal) custom sum will form:

$$B^* = \frac{n\sqrt{b} \cdot (\sqrt{b} - \sqrt{\bar{v}})^2 \cdot (\sqrt{b} - n\sqrt{\bar{v}})}{c \cdot (n+1)^2} \tag{4}$$

Consider dependence between equilibrium duty state and custom receipts on fig.2.

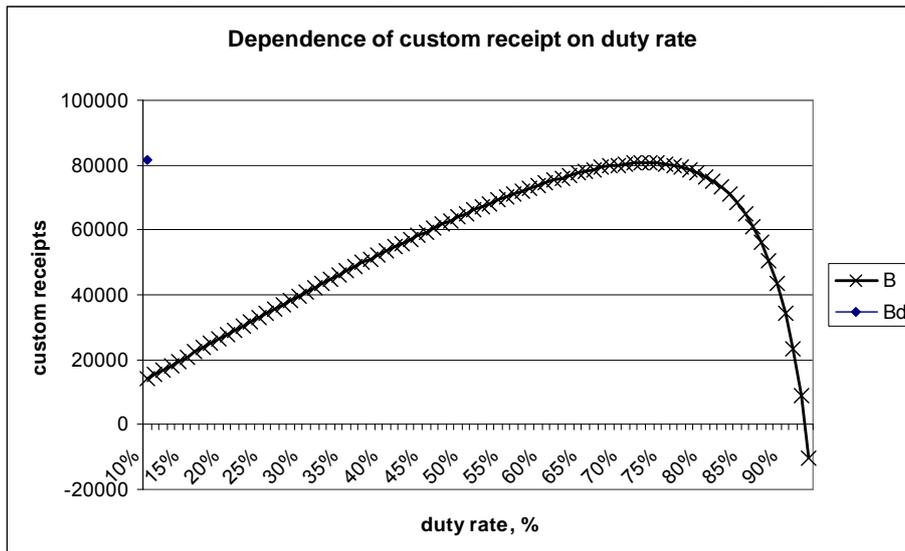


Fig. 2. Laffer curve – dependence between custom receipts and duty rate

$$(n=10, b=40, v=5,25, c=0,01, P=24,04) t=73\%.$$

3.2 Custom Receipts Model Construction for Differentiated Duty Rate

3.2.1 Producer profit maximization

Profit of foreign producer I is presented by next expression: $\pi_i^F = (1-t_i) \cdot P \cdot q_i - v_i \cdot q_i \xrightarrow{q_i \geq 0} \max$, where t_i is differentiated duty rate for foreign producer i. FOC for profit function gives ($i = 1, \dots, n$):

$$\frac{\partial \pi_i^B}{\partial q_i} = (1-t_i) \cdot \left(b - 2c \cdot q_i - c \cdot \sum_{j \neq i} q_j \right) - v_i = 0.$$

Similarly we obtain partial derivatives for profit functions of others foreign producers.

$$\begin{cases} 2 \cdot q_1 + q_2 + \dots + q_n = \frac{b}{c} - \frac{v_1}{c \cdot (1-t_1)}, \\ q_1 + 2 \cdot q_2 + \dots + q_n = \frac{b}{c} - \frac{v_2}{c \cdot (1-t_2)}, \\ \dots, \\ q_1 + q_2 + \dots + 2 \cdot q_n = \frac{b}{c} - \frac{v_n}{c \cdot (1-t_n)}. \end{cases}$$

System solving by matrix approach give optimal sales values for foreign producers on domestic market (duty rate $0 < t_i < 1, i = 1, \dots, n$):

$$q_j = \frac{1}{(n+1) \cdot c} \cdot \left[b - \frac{n \cdot v_j}{1-t_j} + \sum_{i \neq j} \frac{v_i}{1-t_i} \right], j = 1, \dots, n. \tag{5}$$

3.2.2 Budget custom receipts maximization

Receipts from taxation of differentiated duty rates for foreign producers of homogeneity products will equal:

$$B_d = P_f \cdot \sum_{i=1}^n t_i \cdot q_i \xrightarrow{t_i \geq 0, i=1, \dots, n} \max, \text{ where } P_f = \text{const} - \text{invoice price per}$$

unit product for foreign producers.

FOC for maximization of custom receipts is defined by following n conditions:

$$\frac{dB_d}{dt_i} = 0, \text{ where } i = 1, \dots, n. \text{ Obtained n-equation system with n unknown duty}$$

rates t_i after equivalent algebraic transformations define *reaction curves* (6) $t_i = f_i(t_{-i})$, which demonstrate dependence duty rate of i -th producer t_i and duty rates of all its rivals t_{-i} . In this function duty rates for foreign producers have to change in a same direction. Thus increasing optimal duty rate by one of the producers requires rising of duty rates for all others foreign producers.

$$t_i = 1 - \sqrt{\frac{v_i \cdot \sum_{j \neq i} (1 - t_j)}{b + \sum_{j \neq i} \frac{v_j}{1 - t_j}}}, \quad i = 1, \dots, n. \quad (6)$$

Such adjustment change of duty rates will proceed until the equilibrium size of each duty rates will not be set.

System solving of n equation formed from functions (6) gives the following sizes of equilibrium duty rates for foreign producers:

$$t_i = 1 - \sqrt{\frac{v_i}{b}}, \quad i = 1, \dots, n. \quad (7)$$

Obtained result shows *reverse* dependence between the average cost and size of duty rate for import product: $\frac{dt_i}{dv_i} < 0$ and shows *direct* dependence between maximal price of domestic market and duty rate.

From expression (7) follows that more effective producers (with average cost lower than industry average cost) will be assessed after the higher duty rate, than less effective ones for maximization of custom receipts. Now equilibrium invoice price and quantity sale with using of expression (7) and linear function of domestic demand will be set at the appropriate levels:

$$P_f^{d*} = \frac{\sqrt{b} \cdot \left(\sqrt{b} + \sum_{i=1}^n \sqrt{v_i} \right)}{(n+1)}, \quad Q^{d*} = \frac{\sqrt{b} \cdot \left(n\sqrt{b} - \sum_{i=1}^n \sqrt{v_i} \right)}{c \cdot (n+1)}.$$

It is important circumstance that after differentiation of duty rates for the foreign producers, import of product on domestic market will drop $Q^{d*} < Q^*$, that will result in rising of price for consumers. Additionally, possibility of charging lower duty rates for one producer and higher for another ones will generate corruption actions. To prevention it, necessary objective indexes for differentiation of these rates. Expedience of differentiated rate introduction will arise only after condition of increase of custom receipts $B_d > B$ in comparison with the fixed duty rate (fig. 3).

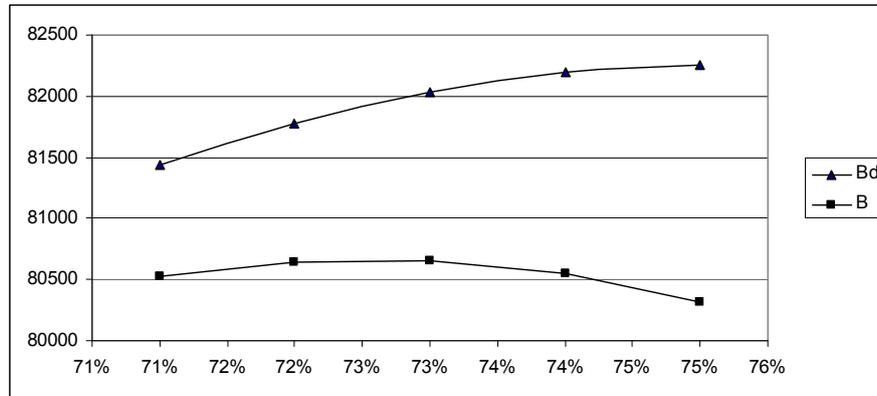


Fig. 3. Comparison of influencing of the differentiated and fixed duty rates on customs receipts ($n=10$, $b=40$, $v=5,25$, $c=0,01$, $P=24,04$)

4 Conclusions

So if as to differentiation of tariffs to take public accountant reports from the financial records audit of firm in part of total cost forming, it will decrease possibilities of realization of unfounded duty rates differentiation by custom house.

At the same time more effective producers will be interested not to disclosure information about true total cost with purpose to drop size of duty rates. Less effective producers vice versa will have motives to reveal its total cost, which below than average cost per unit.

Thus if less effective producers will prove that the effective ones gave false information, it will become foundation for the rise of duty rates to more effective producers and decrease of duty rate for less effective. Thus such custom policy will allow to the state will put information transaction cost about producers from itself on less effective producers. From one's part, more effective producers will have motives to prove that less effective producers set too high the size of its inefficiency.

Collusion between all foreign producers about non-disclosure information about own costs will be highly unlikely when number of foreign producers will be grow and collusion will be high-probability when firm concentration will be high.

To receive maximal custom receipts for achieving of social aim state may implement differentiated duty rates for foreign producers of unique product which depend from producers' cost. Success of this state policy will depend on effectiveness of incentive compatibility conditions for these producers, which mean extracting of true information about cost from foreign producers by the means of firms cross-sectional audit.

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