Analysis on the Policy for Reduction of NOx in Developing Cities

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ABSTRACT

This research addressed about the policy to reduce the nitric oxides pollutant in developing cities. The model was developed based on the balance between development of domestic automobile industry and improvement of urban environment so as to simulate the nitric oxides pollutant level and the domestic economic level through the alternative policies. The result shows difficulty to reduce pollutant with economical development in developing cities.

INTRODUCTION

The reduction on the nitric oxides (NOx) pollutant has became one of most pressing problem in developing cities. Since the pollutant is mainly discharged from automobiles, particularly old truck and bus, the reduction of these old automobiles or/and replace with regulated new one would alleviate this pressing problem. However, the truck and bus used to play an important role on the economical development of developing cities as only one available transport mode, because of the lack of railway system and thus, it is rather difficult to reduce the number of them directly. It seems that the reduction of NOx trades off with the economical development.

Also, there is another trade-off relationship between the environment and the economical development. To replace the old automobiles, users have to pay the highly cost, which mainly come from the situation that the most of automobiles is imported or knock down and so imposed highly tax to protect the domestic product market. Thus it will bring the pressure on the economics of these cities.

Bangkok as a capital city of Thailand is one of the typical cities facing said conflict between development on economic and preservation of the environment. Thus, the model was applied in Thailand and the possible measurements was tested to find the available solution.

STATEMENT OF PROBLEM

(1) The automobile industry

The automobile industry in Thailand has been protected through the policy to foster the import substitution as same as in other developing countries during these three decades and now, it is one of the few Thai industries.

The history of automobile industry in Thailand was opened by Thai Motor Industry Inc., when it started to assemble the automobile in 1961. In accordance with revision of the law for an encouragement of industrial investment by Thai government in next year, the automobile assemble enterprises could enjoy tax privilege. As this result, foreign assemblers have branched out and set up joint corporations. By 1970, their number increased up to 10 and the number of registered automobile has soared from 525 in 1962 to 6.5 millions in 1989.

During this period, the number of local suppliers have also been increased because Guidelines for local content has been provided by Automobile Development Committee (ADC) from 1962 and they have been raised. The industry contribution to the manufacturing value added was 6.14% in 1989. At present, the local content of pick-up trucks reached 66.5 %, but production of facility-intensive and high technological parts, such as transmission, engine, etc. is so difficult for local suppliers that they still have to be imported from foreign countries. Thus, plain structure of Thai automobile industry can be depicted like as Figure 1. In 1989, 132,340 units of chassis fitted with engines of motor vehicles (19.1 million Baht; including parts) and 69,033 units of accessaries of the motor vehicles (10.2 million Baht; for all kinds of motor vehicles) were imported and 208,141 cars assembled within domestic, while 2,831 vans and pickup trucks, 6,956 motor vehicles for the transport of goods and 70,544 motor cars for the transport of persons were imported.

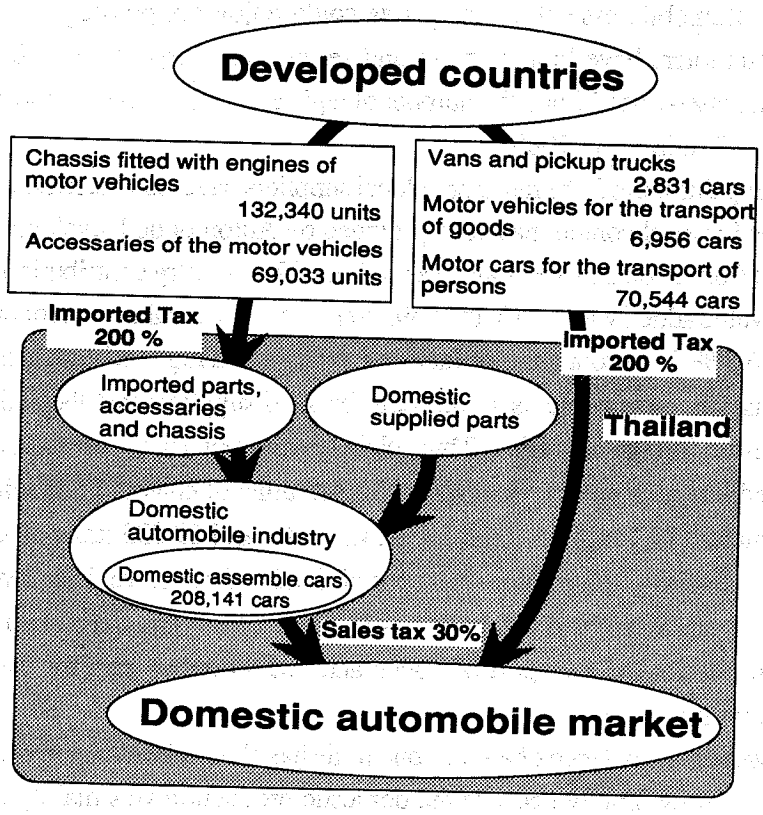
However, the balance of automobile trade has always been negative and its deficit continues to grow rapidly because the domestic production was mainly for local consumption and the industry had to pay remitter of royalties and technical assistance fees

to foreign mother company.

(2) Trucks

National transport network in Thailand has been started by constructing the railways late eighteen century under the assistance of European countries. Until this period, water way was only one available transportation to coalesce Kingdom because of geographic characteristics.

Full-scale development of modern road network has brought by the US government so as to support Vietnam war and high standard for road structure was adapted so that weighted tanks could be driven on it from camp to camp. This made freight transport by truck available rapidly and now it plays the main role of freight transport. Population of road transport in 1987 was around 84 % of total freight (that was 26.7 Billion Ton-Km).



Figuer 1 plain structure of Thai automobile industry

Another remarkable thing on truck transport in Thailand is its long life. Generally, most of trucks in Thailand were used more than 20 years and some time over 30 years by replacing a worn-out engine with a second hand which was mainly imported from Japan as industrial waste. This keeps cost in low level and make possible to hold trucks by croppers. Actually, most of trucks are occupied by not track transporter but croppers. However, this makes the problem seriously.

(3) Air Pollution

Since data of air pollutant is very limited, it is impossible to confirm the level of air pollutant in Bangkok or Thailand. The Science and Technology Agency of Japan estimated amount of discharged NOx in Thailand was increased from 182 thousand tons in 1975 to 384 thousand tons in 1987 depending on the energy consumption. Especially, NOx from land transport sector was estimated 46.0 % of amount of NOx in 1987 (177 thousand tons).

Thai government has provided the standards and restricted a car which discharge over these standards officially. However, this standards seems to do not work enough to alleviate air pollutant.

MODEL

Figure 2 shows the main causal diagram which consists of two positive and two negative loops.

First positive loops represents the economical growth. Even though some part of revenue from car sales would drain to abroad as rimitter for mother company, repercussion effect would grow domestic parts supplier and increase GDP.

Second positive loop is the price cutting caused by productivity gain. At the beginning, production capacity of domestic parts supplier is negligible and guide line for substitution so as to increase capacity would be provided by government. Thus most of parts must be imported and cost could not be reduced. If capacity will be increase, productivity would be gain and cost could be cut. This could makes price decrease and easy to buy automobile. However, increment of automobile sales over this production capacity would be increase the price because required huge cost for rapid investment would be charged on the price or vacant of parts would be replenished with imported parts.

On the other hand, an increment of vehicles over the service level of road network used to bring traffic congestion. In developing countries in which infrastructure is very poor, this means not only increment of transport cost but also reduction of productivity. This is first negative loop.

Second negative loop has never been respected in actual world and this used to make environmental problem. An increment of vehicles increase air pollution together with traffic jam. But, both manufacture and government have never taken action until problem became seriously.

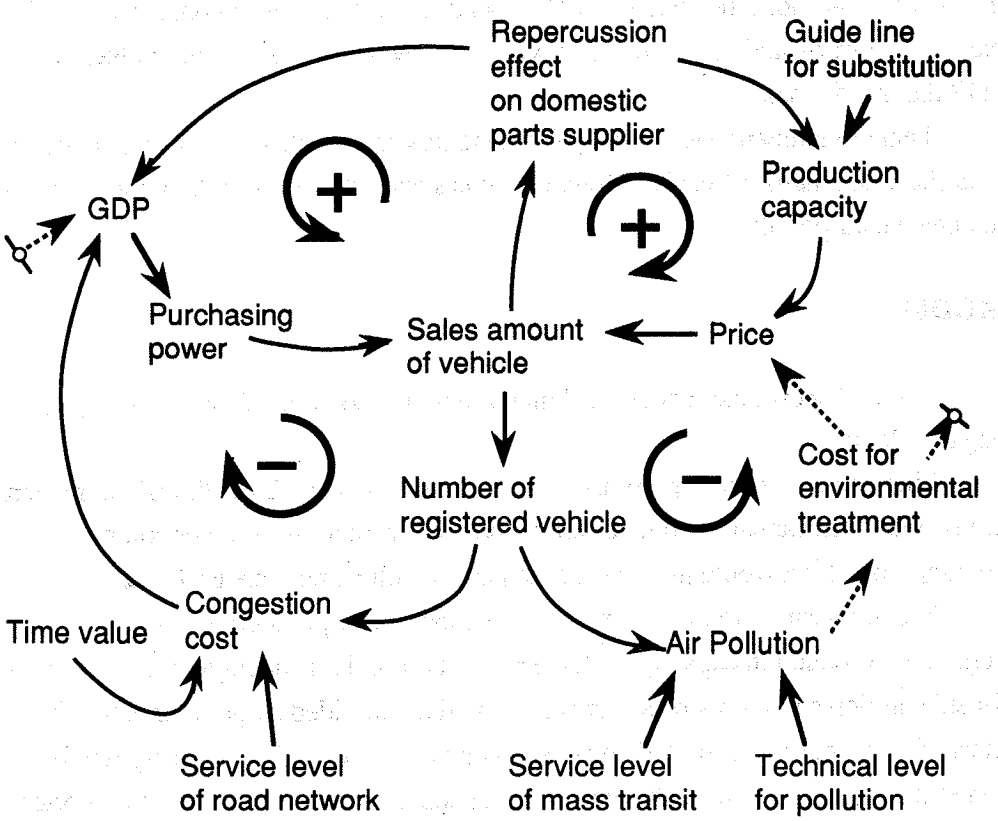


Figure 2 The causal diagram

HYPOTHESES

We had to assume following hypothesis to make system dynamics model;

(1) The population of registered automobile by operating year was actually unknown in time series because dealing data in second hand market was not available. Thus we have to estimate the distribution of registered automobile by using difference on year registered numbers.

(2) The relationship between operating year and discharged NOx could not be investigated because replacement of engines. We assumed that during first three years an engine may not be replaced, in net ten years it may be replaced several times with a second hand but condition be stable and after that, condition of car may be getting worse. Thus we classified registered cars into three groups by operating age, namely New Car; 3 years or less, Middle Car; less than 13 years and more than 3 years and Old Car; 13 years or more and adapted the average value of discharged NOx by operating years.

(3) The model didn't have any constraint for the capacity of foreign parts production.

(4) we assumed that damage on the environment should pay as the cost to treat it. This cost may be included in the price of car and the average production cost of an enterprise.

POLICY

In spite of a lot of alternatives exist to reduce air pollutant, it is considered that taxation concerning an automobile and modal change by providing rail system are only practical measures.

Therefore, in this paper the following measures regarding to taxation were proposed.

(1) Increase or decrease the tariff rate for imported automobile;

Tariff rate imposed on imported automobile should be increased from 200 % up to 400 % so as to increase local content, or decreased up to 100 % so as to increase capacity of automobile assemble.

(2) Cut down the sales tax for new car;

Sales tax imposed on new car should be cut down from 30 % until 20 % so that the cost of enterprise and consumers will diminish.

(3) Increase the sales tax for secondhand car;

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(3) Increase the sales tax for secondhand car;

Sales tax imposed on secondhand car should be increased from 30 % until 100 % so as to hasten replacement of a worn-out car.

(4) Regulate old automobile using;

The law which obliges users to have an automobile inspection will be provided in order to hasten replacement of a worn-out car, also.

Figure 3. shows the relationship between these taxations and automobile production process.

Another practical measure may be a replacement of transport of goods from truck to railway system. This research did not tackled this measure because we must have another research to find out a solution of financial problem for the implementation of railway construction. It seems to be out of this research. Moreover, even if we could have a solution to get fund for the construction of railway, it will take time until a system will open. Thus this measure did not tested in this paper.

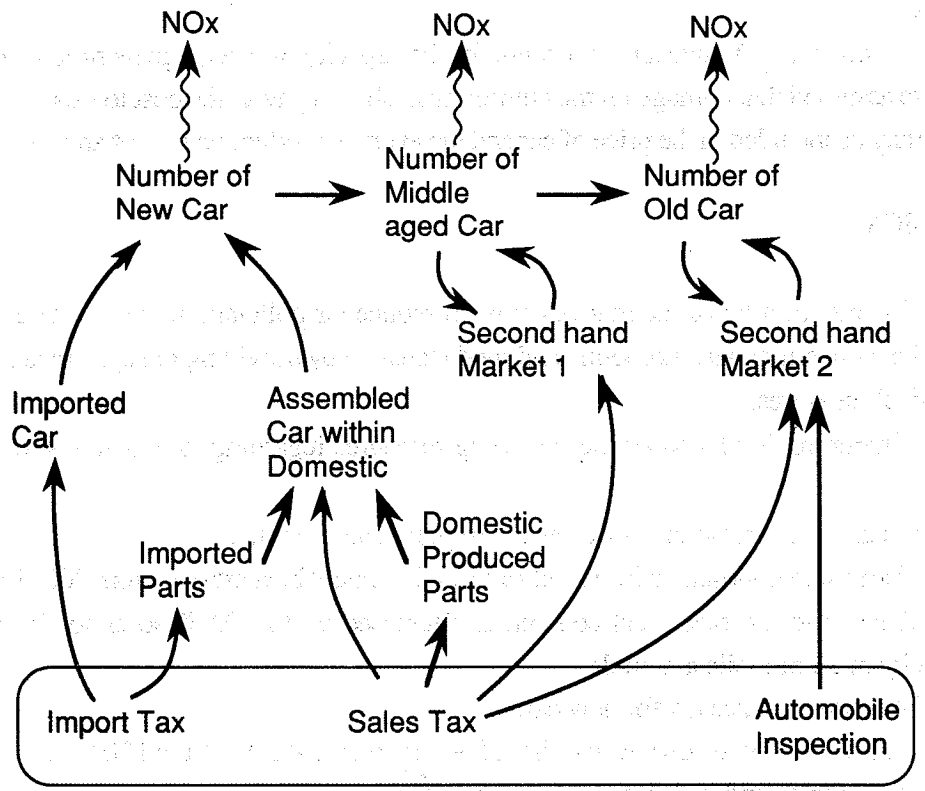

Figure 3 Relationship between automobile production process and taxation

RESULTS OF SIMULATIONS

The model of the automobile industry and air pollution has been used in several simulation experiments for studying the effects of the proposed policies.

Figure 4 and 5 show comparisons of the number of registered New Car and Old Car under selected tax rate combination and the automobile inspection. Actually, the annual automobile sales used to draw the jagged locus because it is very sensitive to economic situation. In this model, however, economic change in short term was not elucidated. Thus, locus shows registered cars in long term and became smooth.

This results shows that revise of taxation may affect on the number of registered New Car more directly than Old Car. Also this shows for reduction of Old Car, an automobile inspection is more effective than revise of taxation.

Figure 6 shows the amount of discharged NOx. Since an average discharged NOx from Old Car is quite large, the locus of NOx seems to be parallel with Old Car.

On the other hand, the effect on the domestic production was rather small because the increment of the production capacity of the parts supplier and assembler was kept in low rate and the consumption level is in balance with the price of a car.

CONCLUSIONS

In this simulation, the feasibility of the policy was appraised by comparing the estimated amount of NOx and impact on economy. The results of simulation shows possibility to eliminate air pollutant by applying the revision of the taxation and an automobile inspection. Thus to sustain the economical development, the policy on the taxation is required.

However, the current position of economic situation and demand for transport in Thailand is the standing up part of the demand curve. The model seems to include the tendency to grow strongly. Under like this situation, even if the taxation would be revised, the amount of NOx will increase rapidly.

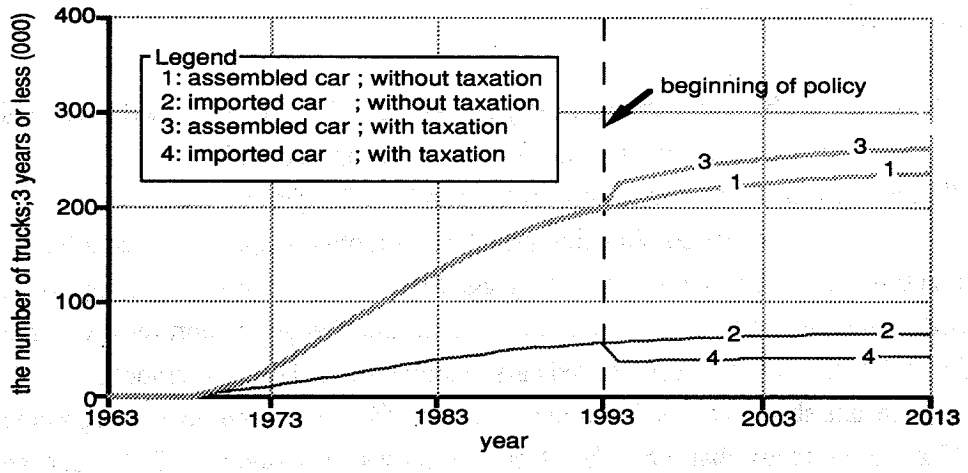

Figure 4 Result on New Car

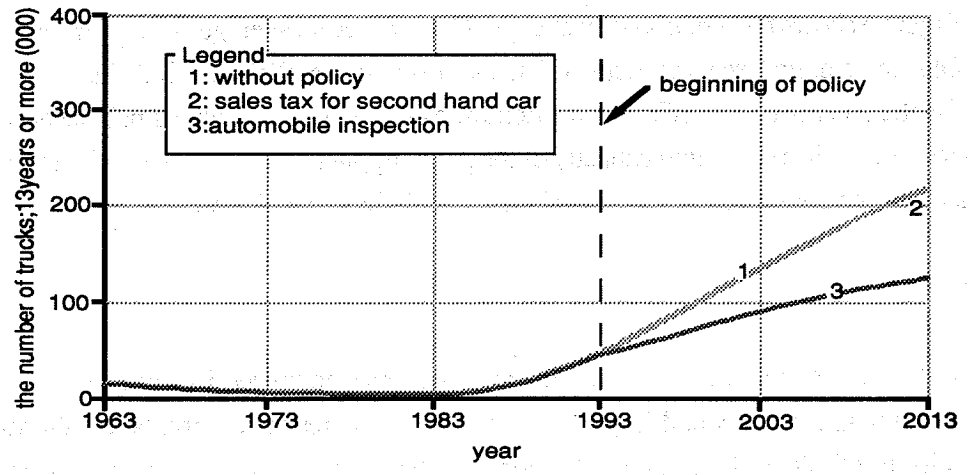

Figure 5 Result on Old Car

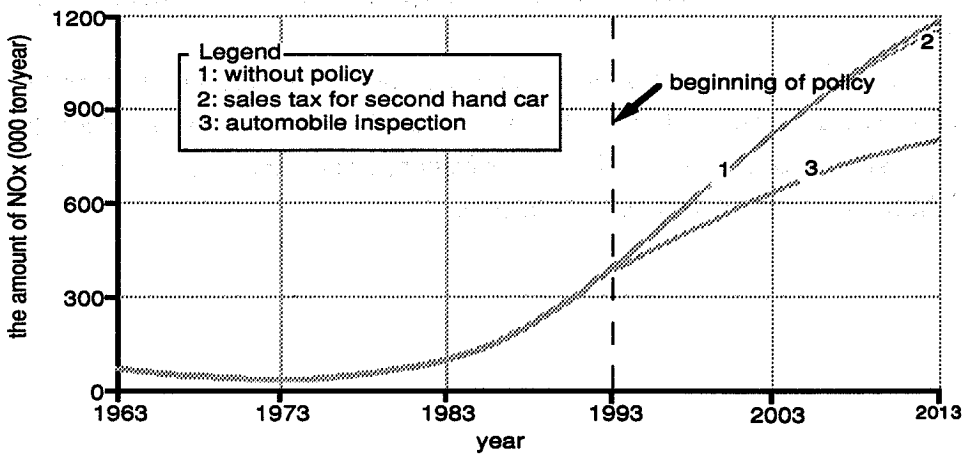

Figure 6 Result on amount of NOx

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