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Impact of Fuel Subsidies on Level of Fishing Effort in South Korea

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Abstract Fuel subsidies impact on fishing has fluctuated considerably among fisheries and countries. Also, a lack of basic data necessary to monitor the development and impact of fuel subsidies and availability in different regions makes it difficult to find a single model for simulating the impact of fuel prices on fisheries. In this paper we use the Fox model to analyse the fuel subsidies effect on inshore and offshore fisheries. Overcapacity with high fishing efforts and depletion of stocks are the main reasons to scrutinizefuel subsidies. As the result in accordance to E_{MEY} , the subsidies have negative affects when fishing effort level passes E_{MEY} and positive when the fishing effort is below this level. In order to have good policies for fuel subsidies to control overfishing, governments should closely look for the level of fishing efforts.

Keywords Overcapacity, Fuel Subsidies, Economic Loss, Economic Overfishing, Fishing Effort

1. Introduction

The most important motivator in fisheries in profit, all other part of fisheries in different countries considered equal the only factor that makes a fundamental different is price of fuel. Fuel constitutes a substantial component of the cost of fishing. The actual proportion varies by fishery, but can reach up to 60% in cases such as the commercial fisheries of Hong Kong[27] and for canoe purse-seiners in NW Africa[6]. Subsidies are given directly to fishers in various forms, including grants, loans and loan guarantees, equity infusions, tax preferences or exemptions, and price or income support programmers[15,20,13,26,2,10] (UNEP, 2004). It is important to understand that the fuel subsidies are not only used in the fisheries sector but also it can be given to other economic sectors as well. (FAO 2000) identified subsidies: The experts defined this as government financial transfers that reduce costs and/or increase revenues of producers in the short term.

Here by subsidies we commonly mean first set of subsidies.

Fuel as one of the important factors in fisheries sector can have enormous effect on increasing fishing costs. In order to support fisherman many countries give fuel subsidies to increase fisherman revenue.

In this paper we will try to show the situation of South Korea inshore and offshore fishery and the amount of fuel they consume over the past 10 years, also the amount of subsides that they pay for fisheries sector. In the second part we use Fox model to analyse the effort level of South Korea fisheries while defining effort as amount of fuel these sectors used in one year, and in the end we analyse the situation that South Korea offshore and inshore is in right now and whether the fuel subsidies are needed for these sectors or not.

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In Korea, tariff and fossil fuel import levies are imposed on fuel fishing vessel. Thanks to the Korean government's implementation of efficient and enforceable fisheries management system and strengthened monitoring, control and surveillance despite the tax concessions fish stocks are showing sign of recovery. Also the enactment of the fisheries resources management Act in 2009 made it possible for the government to manage the fisheries resources more systematically.

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<Figure1> we can see the Catch Per Unit of Effort (CPUE) in offshore and inshore fisheries in Korea.

As we can see CPUE decreased but this can be for two reasons first catch can increase, second effort can decrease. As we consider fishing effort the amount of fuel consumption of inshore and offshore fisheries the Korean government set fix level of subsidies on fuel no matter how much the price of a drum increase in world markets; so the amount is got direct relation with fisherman profit. Next part we will analyse the Fox model in order to understand the situation in inshore and offshore fisheries of South Korea.

2. Model

To analyse the effect of fuel subsidies in South Korean fisheries we will use Fox(1970) exponential model. The exponential growth model is given by

$$\frac{dB}{dt} = G = rBln\left(\frac{k}{B}\right) \quad (1)$$

where r is the intrinsic growth is rate and k is carrying capacity of the environment. B also determine Biomass in this model. Assuming that Catch per unit of effort (U) is proportional to the biomass equation (1) can be specified as

$$G = \frac{r\,U}{q}\left[\ln\left(\frac{U_\infty}{q}\right) - \ln\left(\frac{U}{q}\right)\right] \quad (2)$$

where U_∞ is the catch per unit of effort that would occur if the stock was at an unexploited level and $\overline{U}$ is mean catch per unit of effort. Also q is catchability coefficient. Expanding out the right hand sight results in the cancellation of the $\ln(q)$ terms so that equation (2) can be simplified as

$$G = \frac{r\,U}{q}\left[lnU_\infty - ln\overline{U}\right] \quad (3)$$

Dividing equation (3) though by $\overline{U}$ results in

$$E = \frac{r}{q}\left[lnU_\infty - ln\overline{U}\right] \quad (4)$$

where E is, again, the level of effort expended the fishery. This can be rearranged to produce

$$ln\overline{U} = lnU_\infty - \left(\frac{q}{r}\right)E \quad (5)$$

The catch can be expressed as0

$$C = qkEe^{-\left(\frac{q}{r}\right)E} \quad (6)$$

The level of effort that maximizes catch in the Fox model is given by the first order condition

$$\frac{dC}{dE} = qkEe^{-\left(\frac{q}{r}\right)E}\left(1 - \frac{q}{r}E\right) = 0 \quad (7)$$

Dividing both sides by $qkEe^{-\left(\frac{q}{r}\right)E}$ and solving the resulting for E gives

$$E_{msy} = r/q \quad (8)$$

The Fox model can be written as below:

$$\frac{\overline{U_{t+1}} - \overline{U_{t-1}}}{\overline{U_t}} = rln(qk) - rln\overline{U_t} - q\overline{E_t} \quad (9)$$

Also we can calculate E_{MEY} with the below formula:

$$E_{MEY} = \frac{r}{q}\left(1 - \left(\frac{c*CPUE}{pqk}\right)e^{\left(\frac{q}{r}\right)E_{MEY}}\right) \quad (10)$$

where c is the cost per unit of catch and p is the market price per unit of harvest.

3. Analysis

Fuel-tax exemptions for fishing vessels are given when taxing on such fuel does not conform to the propose or when there is a need to protect the socially and economically vulnerable groups. These exceptions are legitimate in line with Korea's tax legislation system. Therefore, it is reasonable to exempt such taxes for fuels for fishing vessels.

There are two scenarios in every fisheries sector that can occur. First is when the fishing effort is less than theE_{MEY}, in this case usually the fishing effort should increase and this will make fisherman earn more benefit. Considering Fuel consumption as effort level, giving fuel subsidies can help fishermen increase their benefits. The second scenario is when the fishing effort is more than E_{MEY}. In this case the fuel subsidies will have negative effect because the fisherman will look for new fishing grounds while the stock is declining. An increase in effort level will move fisheries sector and fisherman toward economic lost.

<Figure 2> shows the increase in fuel prices due to global issues and government policies while the effect of these sudden changes decreased the fuel consumption in fisheries sector of South Korea. In South Korea the government set the certain amount of subsidies no matter how much the prices change. It means if the fuel prices increase the government pay the certain amount of subsidies so that fisherman can survive but fisherman himself should manage the amount of fuel he uses. Accordingly when the fuel prices increase even though half of the amount is paid the fisherman will try to manage his/her fuel consumption cause of high cost. As we can see the fuel consumption decreased dramatically from the year 2000. We can reach to this conclusion that changes in fuel prices can reduce the fuel consumption since the fisherman think logically and try to maximize his/her benefit

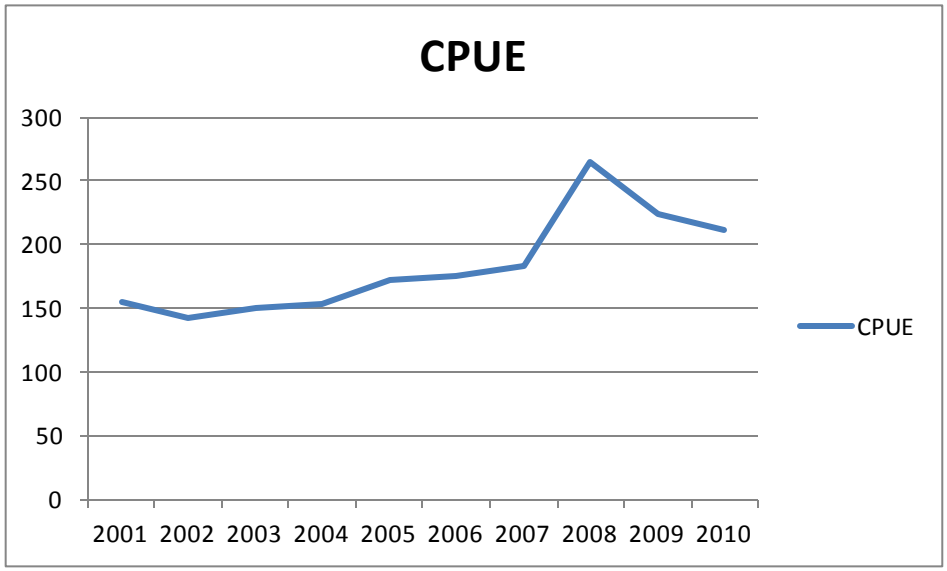
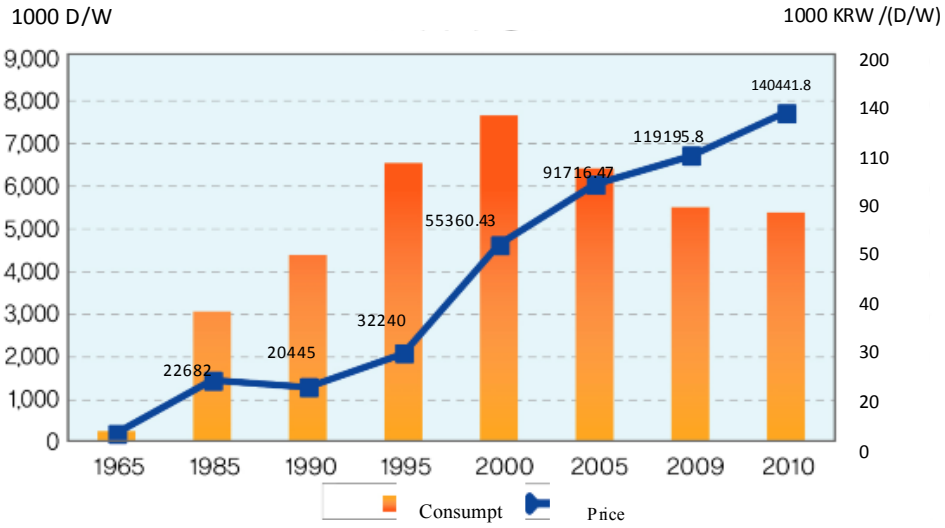


Figure 1. CPUE for offshore and inshore in South Korea



Source: Korea National Federation of Fisheries Cooperation

Figure 2. Fuel Consumption and Fuel Prices in Fisheries Sector

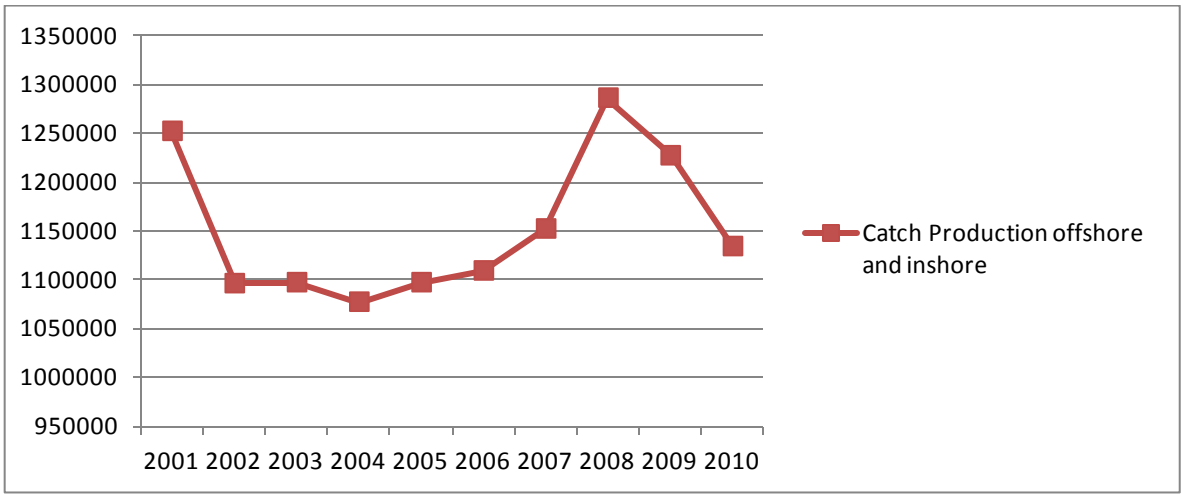


Figure 3. Catch Production in South Korea's Offshore and Inshore fisheries

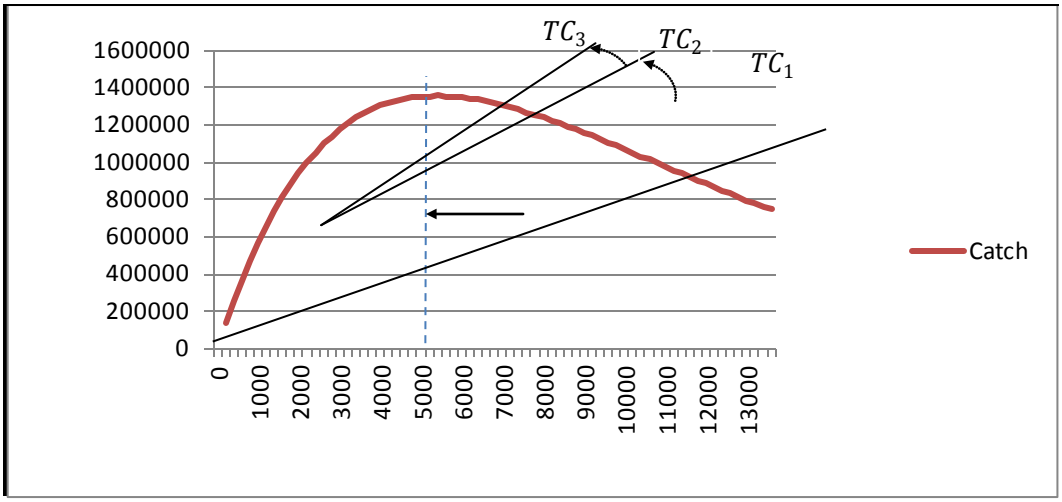


Figure 4. Fox Model Catch-Effort Graph

Looking at these changes we decided to consider fuel consumption of inshore and offshore fisheries as Effort level in these sectors. Before we use the Fox model we need to understand the catch level in offshore and inshore fisheries. Below Figure can show the level of catch from 2001 till 2010.

The catch dropped significantly from 2001 but in 2007 started to increase for a year but from 2008 again started the decrease.

Putting catch and the level of efforts beside each other in Fox model we will find the E_{msy} point of inshore and offshore fisheries of South Korea. Table below shows the Fox model variables:

Table 1. Fox Model Variables and Values

q	0.00005476
r	0.295
k	12501561.53
E_{MSY}	5,387
E_{MEY}	4,118

In this model we consider Effort the level of fuels that offshore and inshore fisheries consume every year. The E_{MSY} (the maximum level at which a stocks can be routinely exploited without long-term depletion) level is 5387 (1000 Drum (D/W)) and E_{MEY} is 4118 (1000 D/W). From here we divide Korean inshore and offshore fisheries in two parts and we analyze each part policies and tax subsidies.

<Figure 4 >shows the Fox Catch-Effort graph. Basically, fishermen try to increase their profit by reducing costs or catching more. Looking at <figure 2> we can see the total fuel cost increased due to changes in world prices. Showing this in <Figure 4> we can see TC_1 moves upward and so the fisherman needs to decrease his/her effort in order to reduce the cost and earn increase their rent. In this situation because government of South Korea always pay half of the fuel cost as in subsidies, the fisherman has no other choice to decrease their effort as much as possible. As most of the fisheries cases the stock is low so the fisherman needs to move around looking for more schools to harvest more, this will make fisherman consume more fuel. As government pay subsidies fisherman will not feel the pressure of increasing fishing cost as fuel cost is not increasing with the same speed of increasing fishing effort. This work shows when the world fuel prices increased because of high fuel prices the fisherman tried to reduce their fishing effort as much as possible. This had positive effect both on fishing catch and fishing effort.

Considering market prices fix the only way to increase the fisherman profit is to reduce cost. As we consider effort the amount of fuel drums fisherman consumes; the increasing fuel prices will make fisherman reduces his/her consumption as much as possible. This will have two effects: first on the stock and second on fisherman profit.

In this paper we consider only fisherman profit and we will not analyse the stock situation before and after.

4. Result and Discussion

To analyse the effect of fuel subsidies on inshore and offshore fisheries of South Korea we consider fuel drums as effort level in these sectors. In South Korea inshore and offshore fisheries the E_{MEY} (The effort level at maximum economic yield level)is 4118 D/W(Drum). The amount of fuel they used in 2010 in inshore and offshore fisheries sector is 5369 D/W that is 1251 D/W more than E_{MEY} which is called economic overfishing (overcapacity) of inshore and offshore fisheries of South Korea. In this case fuel subsidies which allow fisherman to buy the fuel cheaper than the market price do not help for reducing the effort. South Korean government fuel subsidies policies in fisheries sector will have negative effect since the fisherman will look for new fishing grounds and spend more fuel without considering fuel costs as an important factor.<Figure 5> shows cost and revenue of inshore and offshore fisheries sector of South Korea using Fox model.

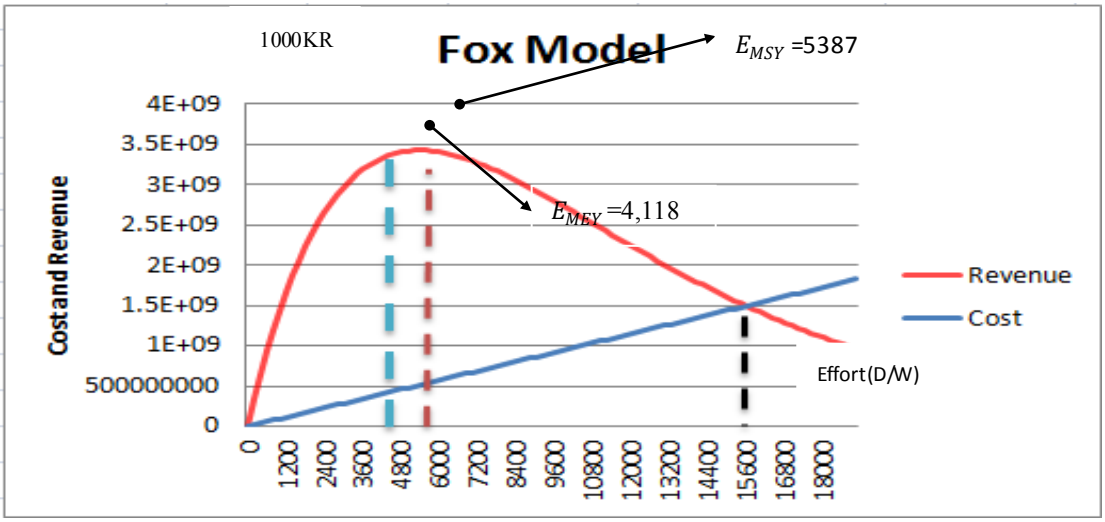


Figure 5. Fox Model Effort-Cost-Revenue Graph

The profit that South Korean inshore and offshore fisheries earned in 2010 is approximately 291 BillionKRW. Comparing this amount with the profit that they will earn on E_{MEY} level; we will see South Korea economic loss was 86.4 BillonKRW.

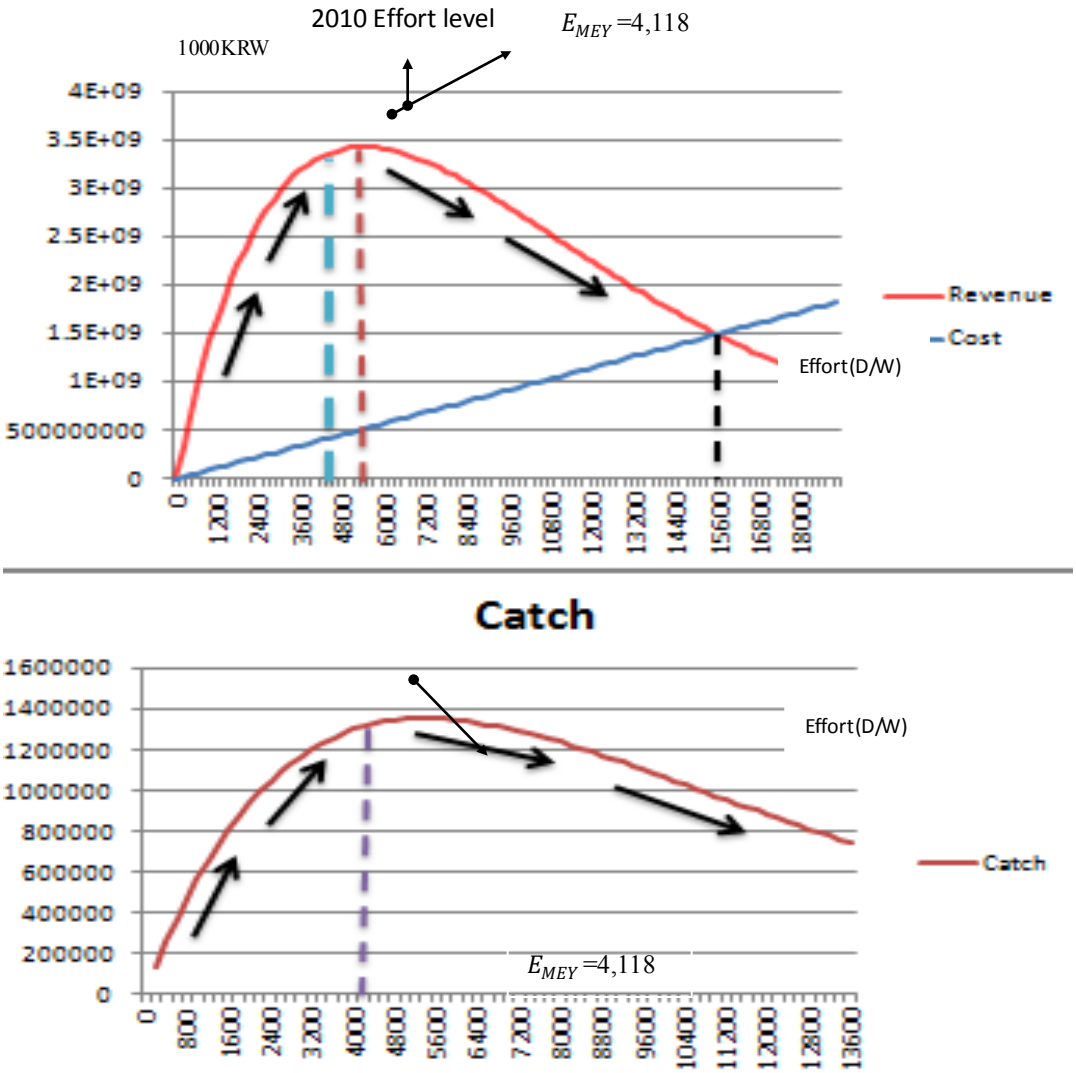


Figure 6. Catch and Revenue- Cost Graph for Fox Model in South Korean Inshore and Offshore Fisheries

5. Conclusions

Here we tried to show that the tax concession although it reduces the cost of fishing but somehow increases the fishing effort and this will lead to stock depletion but if the tax exemption on fuel on fishing vessels is repealed, many small-scale fishers would face difficulties due to decreased benefit. Also, repealing fuel-tax concessions might result in the fishers' resistance because it could hinder the fair and consistent distribution of taxes among primary production sectors, where the fisheries sector is left with a disproportionate burden, and put them in unfair competitive condition. In South Korea fishermen receive half of the value of fuel cost from subsidies. This helps fisherman to increase his profit but the data also shows that by increasing the world fuel prices the fisherman automatically control the amount of fuel they consume and reduce the fishing effort. South Korean government limited the amount of fuel subsidies that they pay every year no matter how much the world fuel prices increase or decrease. This will help fisherman to control the amount they use and reduce their effort.

There can be another way of looking at subsidies issues. Many economists might say governments should stop their subsidies support in fisheries sector. We need to look at world market prices as well as the amount of subsidies countries pay to fisherman. As we can see in this paper the world prices had more effect on fisherman behaviour despite the fact that government paid subsidies.

In Korean case as the world prices increased if the government has stopped the subsidies the fisherman would face serious problem and even would see better to leave the business.

We showed when the effort level is higher than E_{MEY} subsidies will have negative effect by decreasing fishing cost for fisherman and increasing effort level. The fuel subsidies in the Korean government budget have an important place and they should spend carefully so it won't increase the negative effect on environment.When fishing effort is below E_{MEY} the fuel subsidies have positive effect in the sense of developing fisheries but with increasing fishing effort and passing the E_{MEY} the fuel subsidies showed negative signs. In this case the government should carefully analyse the level of E_{MEY} .

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