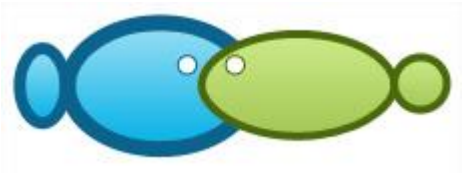

The impact of increasing fuel prices on the sustainable marine economy in Central Java, Indonesia

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Abstract. The fisheries sector has a significant economic potential in Central Java. The purpose of this study was to examine the relationship between the fishery sector and other sectors of the Central Java economy, the economic impact of rising fuel prices on the fishery sector, and the impact of rising fuel prices due to the elimination of diesel subsidies on output, employment, and household income in the Central Java fisheries sector. Input-output analysis was used in this study to classify the economic activity into a matrix of 36 sectors from a total of 88 sectors for Central Java input-output data. The analysis' findings show that the fisheries sector's backward linkage is greater than that of the future; the economic impact of 0,035 USD increase in fuel prices as a result of the elimination of diesel subsidies causes the price of diesel to rise to 0.021 USD L^{-1}, raising the operational costs of a fishing motorbike per trip. The increase in fuel prices due to the reduction in diesel subsidies also caused the sector's output to decrease and caused the absorption of labor in the fisheries sector to decrease. So that in the end, the increase in fuel prices resulted in the household income of the fishery sector of Central Java to decrease.
Key Words: fisheries sector, fuel price increase, input output, back linkage.

Introduction. Central Java is one of the provinces in Indonesia with great potential for fishing, due to its location: it faces two sides of the ocean, namely the Java Sea in the north and the Indian Ocean in the south, and to the length of its coastline, of up to 828.82 km (KKP 2013). In 2017, the volume of fishery production was of 737,816 tons, consisting of 275,469 tons from capture fisheries and 462,347 tons from aquaculture, and the value of fishery production reached 1,316 billion USD nationally (KKP 2018). More specifically, in Central Java Province, the fisheries sector contributed with 590 million USD or around 0.91% of GDRP in 2018 (BPS 2019).

The fish catch in capture fisheries is determined by the intensity of the fishermen going to sea. Capture fishermen need large amounts of fuel to drive their boat engines (Putra & Aqimuddin 2014). Fuel has an important role in increasing fisheries productivity (Suryawati & Apriliani 2015). This study aims to analyze the economic impact of the rising fuel prices on the marine sector in Central Java Province. This study uses diesel price data, because diesel is used as fuel for fishing motor boats. The government has set diesel subsidies in 2020 at USD 103.58 L^{-1}, which is lower than in 2019. Reducing the subsidies for diesel in 2020 will lead to an increase in the diesel prices. A fuel price increase will reduce the frequency of fishing so that the profits earned will decrease (Mira et al 2014) and the operating costs will increase, for the fishermen. Fuel may represent 70% of the total operating costs (Saptanto et al 2016). According to Hariati et al (2015), up to 40 to 50% of the operating costs are fuel costs. The most affected by the increase in fuel prices are small fishermen with vessels less than 5 GT (Saptanto et al 2016). Based on a research carried out by Mira et al (2014), an increase in the fuel prices by 17.94% resulted in a decrease in the output of tuna, skipjack and tuna fishing by -0.132 and -0.125% for other marine caught fish. In addition, the increase in the fuel prices by 17.94% resulted in a decrease in the labor absorption in the fishery business by -0.346% and -0.333% in other capture fishery businesses. The results of research by Carvalho et al (2011) found that reducing or eliminating fuel subsidies will affect the performance of

the fisheries sector and of other sectors related to that sector. The reduction in fuel subsidies resulted in an increase in fishing production costs, reduced fishing output and decreased fishermen's income. Cheilari et al (2013) also found that the increase in fuel prices resulted in increased operating costs for fishing.

The fisheries sector has forward and backward linkages with other sectors. The results of the research conducted by Dault & Suherman (2008) show that the fisheries sector in Central Java has greater backward linkages than forward linkages. The backward linkage value is 1.1401 and the forward linkage value is 1.0214. One of the appropriate methods to describe the linkages between sectors, to evaluate the economic impact of changes in fisheries regulations and to determine the role of the marine sector in the economy is to use the input-output method (Cai et al 2005; Nurkholis et al 2016). The input-output analysis is an analytical tool that can analyze the economy of a region in a comprehensive manner, because it can see the relationship between economic sectors of a region as a whole. If there is a change in the level of production in a certain sector, the impact on other sectors will be seen (Tarigan 2005). This study uses the Central Java input-output Table 2013. The purpose of this study was to analyze the impact of rising fuel prices on the fishery sector in Central Java Province.

Material and Method. Secondary data were used in this study. The data used are the 2013 Central Java Province's input-output tables, plus the labor, agricultural census and fuel price time series. The data used were obtained from the Central Java Province Statistics Agency. This study uses the domestic transaction input-output table based on the producer price classification from 88 sectors, which are then aggregated into 36 sectors for the Central Java input-output data in 2013.

This study will analyze: (1) the economic impact of the fuel price increase on the fisheries sector, (2) the inter-sectorial linkages that have a both forward and backward effect in the fisheries sector, (3) the multiplier effect of the fuel price increase on the output of the fishery sector in Central Java (4) the multiplier effect of the fuel price increase on sector workforce creation, (5) the impact of the fuel price increase on the fisheries' weight in the economy of Central Java and (6) the multiplier effect of the fuel price increase on household income in the fisheries sector in the economy of Central Java. The main concepts of the analysis are:

1. The backward linkage is the ability of a sector to stimulate the growth of the output of other sectors, whose input uses the output of that sector (Morrissey & O'Donoghue 2013). The total backward linkage effect is obtained by adding up the direct backward linkage value with the indirect backward linkage value. The total backward effect can be written mathematically as follows (Firmansyah 2006):

$$B^{d+id}=\sum_{i=1}^{n} \propto_{ij}$$

Where:
B^{d+id} - the index of direct and indirect backward linkages;
$\propto_{ij}$ - the Leontief inverse matrix.

2. The forward linkage is an increase in the level of output of the economy due to an increase in the output of the production sector through the supply of output (Seung & Waters 2009). The total forward effect is the sum of the Leontief inverse matrices. The total forward effect can be written mathematically as follows (Firmansyah 2006):

$$F^{xd+id}=\sum_{j=1}^{n} \propto_{ij}$$

Where:
F^{xd+id} - the index of direct and indirect forward linkages;
$\propto_{ij}$ - the Leontief inverse matrix.

3. The output multiplier is the total value of output produced in the economy due to changes in the final demand for a sector. The output multiplier number formula can be written as follows (BPS 2014):

$$O_j = \sum_{i=1}^{n} \propto_{ij}$$

Where:
Oj is output multiplier of sector;
j and $\propto_{ij}$ - an element of the Leontief inverse matrix.

4. The household income multiplier is the change in the amount of household income received by a sector due to an additional unit of money at the end of the request (Suryahadi et al 2009). The household income multiplier figure can be written mathematically as follows (Perwitasari 2019):

$$H_j = \sum_{i=1}^{n} \propto_{n+1j} \propto_{ij}$$

Where:
Hj - multiplier income sector;
j, $\propto_{n+1j}$ - income coefficient sector;
j, $\propto_{ij}$ - an open leontief inverse matrix.

5. The employment multiplier is the total effect of changes in employment in the economy due to changes in one unit of final demanded money in a sector (Perwitasari 2019). The employment multiplier can be formulated mathematically as follows (Perwitasari 2019):

$$E_j = \sum_{i=1}^{n} W_{n+1i} \propto_{ij}$$

Where:
Ej - labor multiplier of sector;
j, W_{n+1i} - labor coefficient;
$\propto_{ij}$ - open Leontief inverse matrix.

Results and Discussion

Scenario of diesel subsidies for the fishery sector. The reduction of the fuel subsidies provided by the government(in particular the diesel fuel) by 0.035 USD L^{-1}, in 2020, would lead to price increases and it is feared that it will affect fishermen's fishing activities at the sea. Table 1 shows the difference between the reduced and the previous subsidy levels, in terms of magnitude of the change in fuel prices.

Table 1

Scenario calculation

Type of diesel distribution	*Total consumption (kL)*	*Previous subsidy/ scenario I (USD L^{-1})*	*Total subsidies/ scenario I (USD)*	*Reduced subsidy/ scenario II (USD L^{-1})*	*Total subsidies/ scenario II (USD)*
Gas station/SPBU	0	0.14	0	0.11	0
Agent of premium and diesel fuel/APMS	0	0.14	0	0.11	0
Bunker refueling station/SPBB	13.723	0.14	1,901,423.20	0.11	1,426,378.23
Solar packed dealer/SPDN	32.160	0.14	4,456,005.98	0.11	3,342,732.91
Gas station for fishery/SPBN	54.528	0.14	7,555,257.91	0.11	5,667,678.49
Fishery	0	0.14	0	0.11	0
Sea freight	3.007	0.14	416,642.10	0.11	312,549.68
Total	103.418		14,329,329.19		10,749,339.31

Economic impact of increase in fuel prices. Based on Table 2, in 2020 diesel fuel subsidies will decrease by 0.035 USD L^{-1}, which results in an increase in diesel prices by 0.021 USD L^{-1}.

Table 2

Increase in fuel prices due to reductions in subsidies

Year	*Non-subsidized solar prices*	*Subsidy*	*Prices after subsidies*
2019	USD 0.67	USD 0.14	USD 0.53
2020	USD 0.65	USD 0.11	USD 0.55

Table 3 shows that the increase in fuel prices due to lower diesel subsidies led to an increase in the fishing operational costs per trip by 1.22%, equivalent to 35.77 USD. According to from the studies of Samuelson & Nordhaus (1992) and Yuranda et al (2016), this increase in the fishing operational costs will increase the production costs and will reduce the operator's income.

Table 3

Fishing cost structure using motor boat per trip*

Structure of cost	*Before the price increase*		*After the price increase*	
	Motor boat		*Motor boat*	
	Volume (kL)	*Value (USD)*	*Volume (kL)*	*Value (USD)*
1. Production	4,103.49	3,106.30	4,103.49	3,106.30
2. Expenditure	-	2,925.73	-	2,962.00
a. Wage	-	826.41	-	826.41
b. Fuel	4.59	2.08	4.59	2.08
c. Diesel	1,720.66	906.09	1,720.66	942.01
d. Kerosene	0	0	0	0
e. Oil	17.32	33.67	17,32	33.67
f. Salt	0.31	0	0,31	0
g. Ice	2,471.79	97.84	2,471.79	97.84
h. Bait	0.67	0.42	0.67	0.42
i. Stores		475.74		475.74
j. Transport of catches		32.91		32.91
k. Rent		263.30		263.30
l. Maintenance		109.00		109.00
m. Cost permit		7.41		7.41
n. Indirect cost		18.09		18.09
o. Operational support cost		1.80		1.80
p. Depreciation of capital goods		101.44		101.44
q. Fishery services		26.68		26.68
r. Other costs		22.87		22.87
Total income		180.58		144.84

* Average days per trip: 8 days.

Forward linkage and backward linkage. Table 4 shows that the fisheries sector in Central Java, which is represented by the marine fish and other marine products sector, has a backward linkage value that is greater than its forward linkage. The backward linkage value is 1.23878 and the forward linkage value is 1.01122. The results of this study are in accordance with Syarief et al (2014). This means that the fisheries sub-sector uses production inputs from the output of other sectors more than producing inputs for other sectors. The forward and backward linkages are obtained from the sum of the numbers in the output multiplier matrix or the Leontief inverse matrix. Forward

linkage is obtained by adding up the numbers in the output multiplier matrix or the leontief reciprocal matrix horizontally. Backward linkage is obtained by adding up the numbers in the output multiplier matrix or the leontief inverse matrix vertically.

Table 4

Forward linkage and backward linkage fishery sector

New code	*Sector*	*Backward linkage*			*Forward linkage*		
		26	*27*	*28*	*26*	*27*	*28*
1	Paddy	0.01188	0.00835	0.03286	0.00008	0.00005	0.00441
2	Corn	0.00098	0.00760	0.00903	0.00008	0.00005	0.00377
3	Cassava	0.00021	0.00040	0.00067	0.00004	0.00002	0.00178
4	Other tubes	0.00010	0.00011	0.00029	0.00003	0.00002	0.00042
5	Shallot	0.00000	0.00000	0.00000	0.00004	0.00002	0.00001
6	Vegetables	0.00023	0.00025	0.00047	0.00009	0.00006	0.00033
7	Banana	0.00000	0.00000	0.00000	0.00005	0.00003	0.00003
8	Fruits	0.00050	0.00049	0.00072	0.00007	0.00004	0.00018
9	Peanut	0.00007	0.00005	0.00011	0.00005	0.00004	0.00210
10	Other nuts	0.00034	0.00024	0.00049	0.00008	0.00005	0.00227
11	Other food ingredients	0.00022	0.00016	0.00030	0.00013	0.00007	0.00033
12	Rubber	0.00017	0.00012	0.00023	0.00012	0.00007	0.00041
13	Sugarcane	0.00007	0.00005	0.00010	0.00013	0.00007	0.00012
14	Coconut	0.00000	0.00000	0.00000	0.00011	0.00006	0.00046
15	Tobacco	0.00042	0.00030	0.00056	0.00023	0.00013	0.00022
16	Coffee	0.00008	0.00006	0.00010	0.00013	0.00008	0.00019
17	Clove	0.00024	0.00017	0.00032	0.00010	0.00006	0.00016
18	Fiber crop yield	0.00021	0.00014	0.00027	0.00062	0.00005	0.00016
19	Tea plantation	0.00002	0.00001	0.00002	0.00012	0.00006	0.00009
20	Other plantations	0.00053	0.00037	0.00079	0.00011	0.00006	0.00118
21	Other agricultural products	0.00002	0.00002	0.00007	0.00023	0.00013	0.00025
22	Livestock and their products	0.00018	0.00019	0.02201	0.00033	0.00018	0.00108
23	Poultry and their products	0.00056	0.00101	0.00054	0.00057	0.00029	0.00038
24	Wood	0.00045	0.00037	0.00056	0.00011	0.00007	0.00131
25	Other forest products	0.00069	0.00026	0.00026	0.00010	0.00006	0.00057
26	Fish and other seafood	1.00222	0.00018	0.00031	1.00222	0.00024	0.00022
27	Land fish and inland Water products	0.00024	1.02957	0.00026	0.00018	1.02957	0.00017
28	Agricultural Services	0.00022	0.00017	1.00019	0.00031	0.00026	1.00019
29	Mining and excavation	0.00046	0.00053	0.00056	0.00015	0.00008	0.00003
30	Processing industry	0.13653	0.09593	0.18098	0.00196	0.00085	0.00047
31	Electricity, gas and drinking water	0.00324	0.00937	0.00704	0.00035	0.00017	0.00008
32	Building	0.00417	0.00665	0.00441	0.00060	0.00033	0.00015
33	Trade, restaurant and hospitality	0.04705	0.05963	0.03978	0.00066	0.00084	0.00007
34	Transportation and communication	0.01620	0.01908	0.01953	0.00059	0.00030	0.00013
35	Financial institutions, real estate and corporate services	0.00660	0.00700	0.01177	0.00009	0.00006	0.00002
36	Services	0.00369	0.00363	0.02316	0.00035	0.00032	0.00006
	Total	1.23878	1.25248	1.35876	1.01122	1.03484	1.02380

Source: Input output table of Central Java 2013, processed data.

The impact of the fuel price increase on the output of the fishery sector in Central Java. The impact of the fuel price increase on the output of the fishery sector in Central Java presented in the Table 5. The diesel subsidies decrease caused a diesel price increase so that the output of the marine fish and other marine products sector

decreased by 3,592,374.68 USD. This result is in line with the research of Mira et al (2014).

Table 5

Changes in output as a result of changes in primary input (USD)

Code	*Sector*	*Scenario I*	*Scenario II*
26	Marine fish and other marine products	14,365,124.80	10,773,843.60
27	Inland fish and inland aquatic products	7,235.85	5,426.89
28	Agricultural services	779.90	584.92
	Total	14,373,140.54	10,783,433.25

The impact of the fuel price increase on job creation in the fisheries sector in Central Java. The decrease in fuel subsidies resulted in an increase in fuel prices. Based on Table 2, employment opportunities in the fisheries sector have changed. When there is a subsidy, there are 6,867 job opportunities in the fisheries sector and when the subsidy decreases, the job opportunities are 5,150 people. It can be concluded that with the increase in fuel prices due to a decrease in subsidies, a decrease in job opportunities in the fisheries sector by 1,717 people is caused. The results of this study are in line with the approach of Muhardi (2005) and Mira et al (2014).

The impact of increasing diesel prices on fishery sector household income in Central Java. Table 6 shows that the increase in diesel prices due to reduced diesel subsidies resulted in a decrease of the household income in the marine fish and other marine products sector by 502,107.75 USD, assuming a fixed technology coefficient value. This is in accordance with the studies of Daiyuddin et al (2016), Lasut et al (2016) and Pasaribu (2008), where an increase in the fuel prices resulted in decreased incomes received by fishermen.

Table 6

Changes in household income (USD)

Code	*Sector*	*Scenario I*	*Scenario II*
26	Marine fish and other marine products	2,008,501.31	1,506,375.98
27	Inland fish and inland aquatic products	485.96	364.47
28	Agricultural services	438.70	329.02
	Total	2,009,425.96	1,506,840.63

Conclusions. The fisheries sector in Central Java, which is represented by the marine fish and other marine products sector, has a backward linkage value that is greater than the forward linkage value. The backward linkage value is 1.23878 and the forward linkage value is 1.01122. The reduction in diesel subsidies by 0.035 USD L^{-1} in 2020 has resulted in a diesel price increase. The impact of the increase of the diesel prices in the fisheries sector was determined by evaluating two scenarios: scenario I, before the price increase, with a total production valued at 14,335,835.43 USD and scenario II, after the price increase, with a total production valued at 10,751,883.40 USD. The increase of the diesel prices, caused by a reduction of the diesel subsidies by 0.035 USD L^{-1}, caused a decline of 3,592,348.77 USD in the fisheries sector and of 502,107.75 USD in the household income, and a loss of employment opportunities of 1,717 people, in the fisheries sector. Besides, the increase of the diesel prices due to a diesel subsidies decrease by 0.035 USD L^{-1} in 2020 has another economic impact on the fisheries sector, namely the diesel price increase by 0.021 USD L^{-1}, resulting in an increase by 35.77 USD $trip^{-1}$ of the operating costs of a fishing motorboat.

Conflict of interest. The authors declare no conflict of interest.

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