What would happen to the economy when energy crops replace food crops? A case of gasohol production in Thailand

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ABSTRACT

This thesis studies the effects of gasohol production and gasohol consumption on changes of consumer's real income. It is divided into two parts. First, the price elasticity of demand for energy crops, major crops and some related goods were calculated by using Single demand equation model which has three methods ,i.e.; Seemingly Unrelated Regression, Ordinary Least Squares (OLS), and Point Elasticity. The data from 2000 to 2011 were used in this calculation. Second, the price elasticity of demand from first part were used to construct a partial equilibrium model of the need of expansion of planting areas for sugarcane and cassava by using the data in year 2009 to be the base year. This model will be using to analyze the real income from the reduction of paddy fields and corn fields due to the replacement of sugarcane or cassava in order to produce gasohol. This study found that the case which decreased the paddy fields for gasohol plant fields; the real income will increase when gasohol production from sugarcane or cassava was found to increase not over than 30% as compared to the plant field in 2009. For the both cases of corn field reduction for gasohol plants cultivation and no changed plant area, will result in the increase of gasohol production as can be assumed that the income will increase. Therefore, it can be concluded that the increment of gasohol production can enhance the consumer's real income.

Keywords: Gasohol, Energy crops, Food crops, Real income, Elasticity of demand

JEL Classification: Q41, Q43, C63

1. Introduction

Energy price is keep rising in world market. It encourages many countries to set strategies for the reduction of usage of fossil energy and promote renewable energy. In Thailand, the energy demand increases along with the increasing Gross Domestic Product (GDP). The country imports energy heavily. Transportation consumed 35.5 % of all energy and 69.3% of refined fuels in 2010. The ground transportation was 80 % of all transportation. In the same year, the import of crude oil and refined fuels were over 731,566 million baht and 3,368 million baht respectively. The summation of both numbers is around 7.3% of the Thai GDP.

The production of gasohol can affect real income by two ways, the increase of food price and the decrease of energy price. Gasohol can substitute Benzene. It can be produced from sugarcane and cassava. There are two cases in the first channel, the increase of food price. In the first case, if gasohol production used sugarcane and cassava when the planting area of those crops are fixed, then the prices of sugar, flour and molasses would increase and raise the food price. In the second case, if the country expanded the planting area of sugarcane and cassava by replacing rice or corn, then prices of rice or corn would also increase which also affect the food price. For the second channel, energy price would drop because of the substitution of gasohol to Benzene. Totally, the real income change is still unanswered whether it would increase or decrease. Figure 1 illustrates the conceptual linkages between gasohol production, sugarcane, cassava, rice, corn, other food crops, transportation, food price, energy price and real income.

The objectives of this study are to investigate the effect of gasohol production on changes of food price, energy price and real income. It will answer whether the promotion of gasohol production and consumption would raise the real income of people in Thailand.

2. Literature review

Somporn Isvilanonda (1999) searched for price elasticity of sugarcane relative to sugarcane planting area, efficiency of sugarcane production and rice price. If rice price was lower than sugarcane, farmers would shift from growing rice to sugarcane. Kanching Devahastin Na Ayudhaya (2001) studied costs of ethanol production of local ethanol plants at different sizes using raw materials comparing between the use of cassava roots, sugarcane and molasses. The ethanol plant which used tapioca as raw materials was found to come up with the lowest unit cost. Kingkarn Photiwat (2001) suggested that cassava was suitable for ethanol production due to its stable price and demand. Paitoon Kraipornsak (2006) studied energy consumption of Thailand in long term using Almost Ideal Demand System (AIDS) which separated commodities into energy, foods and other products. The results revealed that elasticities calculated by Static AIDS using Seemingly Unrelated Regression and Dynamic AIDS with Cointegration were a little bit different. Jaturun Tongthainan (2007) studied factors affecting ethanol production. The study found that ethanol price produced by molasses

was affected by both prices of sugarcane and sugar. Moreover, the expansion of ethanol production from sugarcane caused the increase of molasses price. This was because sugarcane supply and molasses supply were not enough for domestic demand. Mark W. Rosegrant (2008) also studied the effect of policy on energy crops and crop prices. The results showed that prices of both energy and food crops prices increased along with the increasing production of energy crop. Weerasak Kongrithi and Somporn Isvilanonda (2009) studied effects of energy crops' prices on supply of rice in Thailand. Their results showed that rice supply was affected (as a negative response) by price of energy crops in the long run than in the short run.
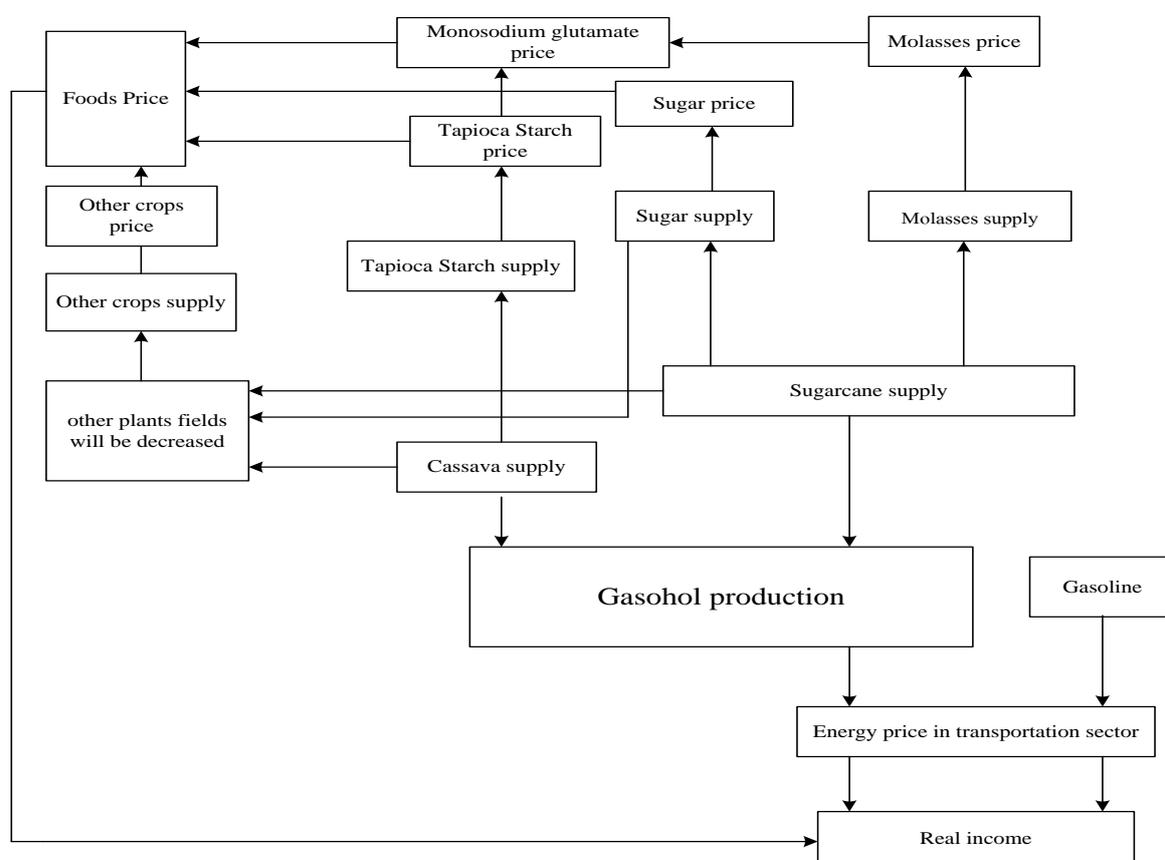

Figure 1. Economic Linkages between gasohol production and Thai Economy

Barney Foran and David Crane (2009) studied the transition to a biofuel economy in Australia using OzEcco Embodied Energy Model in the case of promotion of gasohol usage. It revealed that the use of fossil energy decreased with declining per capita income. Santhiti Thongchuang and Srisuda Thungsuwan (2009) studied gasohol E20 consumption in Thailand using Multiple Regression Analysis. It was found that the most influential factors of E20 consumption are gasohol E20 price, gasohol E10 price and Benzene price. Jun Jie Wu (2010) studied interactions between food prices, energy markets, and biofuel policies using General Equilibrium analysis. This study presented

that bio-energy subsidy directly affected the reduction of bio-energy price. It indirectly affected the increase of crops' prices. The policy did not affect crude oil price. Conversely, crude oil price affected prices of crops and food.

3. Methodology

First, the price and quantity of food crops, energy crops and related products were used for the calculation of elasticities by using Almost Ideal Demand System (AIDS). The AIDS model is as follows:

$$S_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln\left(\frac{x}{P}\right) \tag{1}$$

Where ; S_i is the expenditure share of the goods consumed

$\dfrac{x}{P}$ is the totol per capita real expenditure on all goods

P is Stone'geometric price index as in Equation:

$$\ln P^* = \sum_i^j s_i \ln p_i$$

3.1   Calculation of elasticities of demand using AIDS model
(Greene and Alston, 1990 cited in Wiboonpongse, n.t.)

Own price elasticity

$$\varepsilon_{ii} = -1 + \frac{\gamma_{ii}}{s_i} - \beta_i \qquad \text{(Masrhallian Own-Price Elasticity)} \tag{2}$$

Cross price elasticities

$$\varepsilon_{ij} = \frac{\gamma_{ij}}{s_i} - \beta_i \frac{s_j}{s_i} \qquad \text{(Masrhallian Cross-Price Elasticity)} \tag{3}$$

Income elasticity

$$\varepsilon_{ii} = 1 + \frac{\beta_i}{s_i} \qquad \text{(Expenditure Elasticity)} \tag{4}$$

Equation (4) is expenditure elasticity for goods (i) or income elasticity of demand.

Because of the lack of data and statistical significant of some results, there are three methods as follows:

1) Seemingly unrelated regression (SURE):

$$\ln Q_1 = c_1 + \beta_1 \ln P_1$$
$$\ln Q_2 = c_2 + \beta_2 \ln P_2$$
$$\vdots$$
$$\ln Q_N = c_3 + \beta_N \ln P_N$$

(5)

where; Q_i is demand for goods i

P_i is price for goods i

β is price elasticity of demand

2) Point elasticity

$$E_d = \frac{Q_{t2} - Q_{t1}}{P_{t2} - P_{t1}} \times \frac{P_{t1}}{Q_{t1}}$$

(6)

where; E_d is price elasticity of demand

Q is demand

P is price level

3) Ordinary least squares (OLS)

$$\ln Q = C + \beta \ln P$$

(7)

where; Q is Consumption of goods

P is price lavel

β is price elasticity of demand

Price elasticity of demand was used to make the model of demand:

$$Q_d = e^c P^\beta$$

(8)

To calculate c form equation:

$$c = \ln \frac{Q}{P^\beta}$$

where; β is price elasticity of demand

Q is Consumption of goods in 2009

P is price level in 2009

Assume that the demand of gasohol has elasticity of zero, find the equilibrium price by changing supply as shown in Fig. 2.
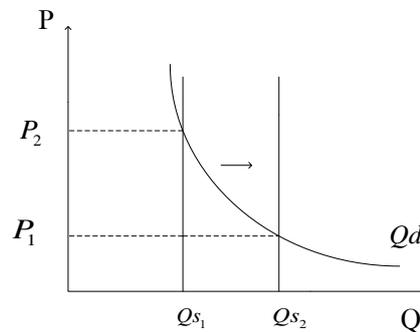

Figure 2. The equilibrium price by changing supply

3.2 The calculation of land use for gasohol plants

The increments of gasohol have to use more input that is cassava or sugarcane. Therefore, two cases for increasing gasohol were used; the first case is only cassava and the second case is only sugarcane. After that, the changes of cassava land field or sugarcane land field were then calculated by data as follows.

Case 1:   Gasohol 1 liter uses 1/10 liter of ethanol.

               Ethanol 1 liter uses 1/70 tons of sugarcane

               Sugarcane 1 ton uses land use 1/average output (ton per rai)

Case 2:   Gasohol 1 liter uses 1/10 liter of ethanol.

               Ethanol 1 liter uses 1/180 tons of cassava

               Cassava 1 ton uses land use 1/average output (ton per rai)

3.3 Model for the effect of gasohol consumption on changing real income

The changed price was calculated by the Eq. as below.

$$P = \left[\frac{Q_s}{e^c} \right]^{\frac{1}{\beta}} \qquad\qquad (9)$$

where;

Q_s is supply

β is price elasticity of demand

Nominal income was fixed in Partial Equilibrium Model for calculation changing of price level.

$$\frac{P_{t2} - P_{t1}}{P_{t1}} \times 100 = A\% \tag{10}$$

The changing of price level was carried out from the effect of gasohol production on changing of land use including gasohol price and food price which taken place by gasohol plants.

The Price level was calculated by weighted arithmetic mean:

$$\frac{\beta * A\% + \alpha * B\%}{\beta + \alpha} \tag{11}$$

where; β is share Consumption of gasohol

α is share Consumption of foods

A is changed price of gasohol

B is changed price of foods

4. Data

The secondary data for elasticity calculation was obtained from various resources as follows:
1. Gasohol price was obtained from Bank of Thailand
2. Sell quantity and gasoline price were obtained from Ministry of Energy.
3. Data of economic plants and energy plants was obtained from Office of Agricultural Economics.
4. Sugar price was obtained from of Agricultural Economics and
5. Sugar volume was obtained from Bank of Thailand
6. Data of molasses (price and volume) was obtained from of Agricultural Economics
7. Data of Tapioca Starch (price and volume) was obtained from The Thai Tapioca Trade Association
8. Ethanol volume from various input was obtained from Energy Research and Development Institute-Nakornping Chiang Mai University

5. Results

5.1 Elasticities of demand

The cross elasticity of demand and the income elasticity of demand of energy crops, major economic crops and transportation which were calculated from AIDS can be interpreted that gasoline consumption increased along with the increase of income and sugarcane price. It would decrease when molasses price increased. The consumption of coconut, longan, onion and durian decreased when gasoline price increased.

TABLE 1. Elasticities from AIDS model

Categories	Elasticities
Average elasticity of Benzene to sugarcane price	0.66
Average elasticity of Benzene to molasses price	-0.40
Average elasticity of Benzene to income	2.70
Average elasticity of coconut to gasoline price	0.89
Average elasticity of longan to gasoline price	-0.14
Average elasticity of onion to gasoline price	-7.46
Average elasticity of durian to gasoline price	-0.76

Source: Calculation

5.2 The effect of gasohol consumption on the real income

The increase of gasohol production without the expansion of sugarcane and cassava planting area would increase the real income of people. This is because the increase of gasohol production would decrease energy price which lead to the increase of real income.

TABLE 2. Effects on real income from increasing gasohol supply by using sugarcane as raw materials with no change in land use (switching the use of sugarcane from food to gasohol).

Increase of gasohol supply (%)	Price increase (%)
10	-16.47
20	-25.75
30	-31.2
40	-34.48
50	-36.48

Source: Calculation

TABLE 3. Effects on real income from increasing gasohol supply by using cassava as raw materials with no change in land use (switching the use of cassava from food to gasohol).

Increase of gasohol supply (%)	Price increase (%)
10	-17.45
20	-27.34
30	-33.2
40	-36.79
50	-39.03

Source: Calculation

In case of the increase of gasohol production by replacing paddy filed, the model reveals that when gasohol production increased by 20 percent, its price would decrease and this would cause the increase in real income. When the production increased by 30 percent compared to the total production in 2009, both in case of sugarcane and cassava, it would cause the decrease in real income.

TABLE 4. Effects on real income from increasing gasohol supply by using sugarcane as raw materials in case of the replacement of paddy field.

Increase of gasohol supply (%)	Price increase (%)
10	-0.61
20	-0.38
30	0.10
40	0.73
50	1.44

Source: Calculation

TABLE 5. Effects on real income from increasing gasohol supply by using cassava as raw materials in case of the replacement of paddy field.

Increase of gasohol supply (%)	Price increase (%)
10	-0.45
20	-0.06
30	0.59
40	1.38
50	2.26

Source: Calculation

In case of the increase of gasohol production by replacing corn filed, the increase of gasohol production would reduce the price index and raise the real income.

TABLE 6. Effects on real income from increasing gasohol supply by using sugarcane as raw materials in case of the replacement of corn field.

Increase of gasohol supply (%)	Price increase (%)
10	-17.68
20	-27.39
30	-32.80
40	-35.75
50	-37.21

Source: Calculation

TABLE 7. Effects on real income from increasing gasohol supply by using cassava as raw materials in case of the replacement of corn field.

Increase of gasohol supply (%)	Price increase (%)
10	-17.53
20	-27.05
30	-32.24
40	-34.94
50	-36.11

Source: Calculation

6. Discussions

Consumption of Benzene would increase when income and the price of sugarcane increased, and it would decrease when the price of molasses increased. The change of Benzene consumption may not be related to molasses price. This is because the use of molasses from sugarcane in gasohol production is still small and molasses has been used in other industries. Its production is not enough for domestic consumption. The study found that when income increased, gasohol consumption would increase while Benzene consumption would also increase. Other parts of the analysis are the consumption of longan, onion and durian. The consumption of these crops would decrease when Benzene price increased.

This study has limited data, only 9 years of time series. It also assumes fixed external factors which might be unrealistic. Therefore, in further studies, when other factors such as energy subsidy policy, international trade, income of farmers, and environmental cost were included, it is still unanswered whether the promotion of gasohol consumption is the right choice for the future of Thailand or not. Moreover, the question of the optimal portion between food crops and energy crops should be further investigated.

7. Concluding remarks

This study reveals that the income elasticity of demand can be calculated from SURE, OLS and Point Elasticity even though the data used in this study are only 9 years. AIDS might not be suitable for the calculation with such the short time series. The results show that the price elasticity of gasohol is small compared to major economic crops. The elasticity is also less than those of molasses, sugarcane and cassava. It means that the price change of gasohol does not affect its consumption much.

When sugarcane and cassava replaced corn fields for gasohol production, price index would decrease which would lead to the increase of real income. In another case, when gasohol production replaced paddy fields, the real income would increase but only until the expansion of gasohol production by 20% compared to 2009 level. The expansion beyond this level, e.g. 30%, the real income would decrease.

When switching sugarcane and cassava from being food to energy without the expansion of these crops' planting area, the price index would decrease. It would also raise the real income of the society. The size of the increasing real income in this case would not so different from the case of the replacement of corn fields.

REFERENCES

Deaton, Angus and John Muellbauer. 1980. *An Almost Ideal Demand System* . Available: http://pages.stern.nyu.edu/~rslee/teaching/io/papers.demand/ Deaton%20Muellbauer%20(1980%20AER)%20%20An%20Almost%20Ideal% 20Demand%20System.pdf(March 30,2012)

Devahastin Na Ayudhaya, Kanching. 2001. *A Cost Analysis of Ethanol Production in Thailand.* Thesis Mater of Economics:Dhurakijpundit University**.** (In Thai)

Foran, Barney and David Crane. 2009. *Modelling the Transition to a Biofuel Economy in Australia.* Available:http://www.cse.csiro.au/publications/2000/biofuel-00-10.pdf (January 27,2012)

Greene, W.H. 2000. *Econometric Analysis.* 4thed. New Jersy,prentice-Hall, lnc.

Isvilanonda, Somporn. 1999 "*Analysis of sugarcane supply response* "Applied Economics Journal 6,1 (January-June):22-28.(In Thai)

Kraipornsak, Paitoon. 2006. Long Run Energy Consumption of Thailand:Static and Dynamic Systems of Demand Equations. Available:http://www.ecomod.org/files/ papers/1461.pdf (March 30, 2012)

Kongrithi, Weerasak and Somporn Isvilanonda. 2009. *Supply Response of Thailand's Rice to the Price of Biofuel Crops*. Kasetsart University Journal of Economics 16.1: 1-25.

Ministry of Energy. 2010. *Thailand Energy Statistics 2010*. Available: http://www.emco.or.th/ UserFiles/File/downloaddata/1301117872.pdf (January 21, 2012)

Mittelhammer, R., G. Judge, and D. Miller. 2000. Econometric Foundations. Cambridge: Cambridge University Press.

Photiwat, Kingkarn. 2001. *The Impact of Fuel-Ethanol Production on Production,Consumption and Trade of Cassava.* Thesis Mater of Economics:Dhurakijpundit University**.** (In Thai)

Rosegrant, Mark W. 2012. Biofuels and Grain Prices. *Impacts and Policy Responses*. Available: http://oldweb.econ.tu.ac.th/archan/rangsun/EC%20460/EC%20460%20 Readings/Global%20Issues/Food%20Crisis/Biofuels%20and%20Food%20Price/Biofue ls%20and%20Grain%20Prices.pdf (March 30,2012)

Sriboonchitta, Songsak. 2004. *Econometrics:Theory and Applications.* Faculty of Economics: Chiang Mai University. (In Thai)

Stewart, J. and L. Gill. 1998. Econometrics. 2nded. London,prentice Hall Europe. Zellner, A. 1962. "*An Efficient Method of Estimating Seemingly Unrelated Regression andTests for Aggregation Bias.*" J. Amer. Stat. Assoc., 57,pp348-368.

Thai Tapioca Trade Association. 2011. *Tapioca Products Price*. Available: www.ttta-tapioca.org (January 22, 2012)

Thungsuwan, Srisuda. 2009. *The Quantity Analysis of Gasohol E20 Consumption in Thailand*. Available: http://www.bu.ac.th/knowledgecenter/epaper/july_dec2010/pdf/P_47-55.pdf (In Thai)

Tongthainan, Jaturun. 2007. *Factors Affecting The Ethanol Price Produced from sugarcane*. Thesis Mater of Economics:Naresuan University**.** (In Thai)

Wiboonpongse, Aree. n.t. *Applied Ecomometrics for Agricultural Marketing*. Division of Agricultural Economics:Chiang Mai University. (In Thai)

Wu, Jun Jie. 2010. *Interactions between Food Prices, Energy Markets, and Biofuel Policies:* A General Equilibrium Analysis. Available: http://www.webmeets. com /files/papers/WCERE/2010/1438/Ethanol%20Subsidies%20World%20 Congress.pdf(January 28,2012)