FOOD VS BIO-FUEL AND ITS IMPACT ON THE FOOD COMMODITY MARKET IN INDONESIA

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Abstract

The increase in demand and price of fuel has made renewable fuel as an alternative energy including the bio-fuel. Bio-fuel, especially bio-ethanol and bio-diesel, are produced from food stocks. In world market, the process of conversion from corn to ethanol and soybean to bio diesel is becoming prevalent. This process can endanger food safety, primary for those in under-developed and developing countries. For Indonesia, the case is highly relevant as both corn and soybean are imported commodities. The present study aims at: (1) demonstrating the impact analysis of corn and soybean conversion to bio-fuel in the world market upon corn and soybean market in Indonesia, and (2) proposing the formulation policies to increase corn and soybean domestic production in Indonesia. Using time series data of 1983-2006 as well as econometric model of simultaneous equations that was estimated through the 2SLS procedure, the study found that: (1) the conversion of corn and soybean to bio-fuel in the world market have a relatively low impact (less than 5 percent) for increasing/decreasing price, production and demand of corn and soybean in Indonesia, and (2) policy about fertilizer subsidy and import tarif increased production of corn and soybean in Indonesia.

Keywords*: corn, soybean, bio-fuel, policy*

Introduction

Biofuel is a one of a kind renewable fuel, which can reduce the greenhouse effect and dependency to fossil fuel. Recently, there are three kinds of biofuel, they are bio-ethanol, bio-diesel and bio-gas. Biofuel, especially bio-ethanol and bio-diesel, are produced from food stocks. In the world market, the process of conversion from corn to ethanol and soybean to bio diesel is becoming prevalent. This process can endanger food safety, primarily for those who live in under-developed and developing countries.

Indonesia imports food stocks like corn and soybean. They are strategic food stocks in Indonesia. Corn is a second source of carbohydrate after rice and raw material for animal food. A soybean has a role to supply vegetable proteins for a low income community. Also, a raw materials can provide for a food home industry. This is the second most important raw material after corn for animal food. It means corn and soybean have a

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role indirectly to support the availability of animal protein. Between 1997-2006, the average import of corn was 0.988 million ton each year (8.7% from total demand) and soybean was 1.056 million ton each year (50.39% from total demand) (Hapsari, 2009).

At the farm level, both commodities indicate field competition. Corn is one of the rival plants to soybean in land use. The real price for soybean from 1991 to 2002 decreased about 3.21% each year, meanwhile the real price for corn increased by 0.98% each year (Simatupang, etc., 2005). Sarono, etc. (2001) stated that corn was more profitable than soybean, based on the cost of pesticides that they used. When soybean are harvested in the rainy season, it has a higher risk rather than corn because soybean need time to dry.

Soybean and corn imports can cause a connection between the domestic market and the world market. The countries who export corn and soybean to make bio-fuel can cause a fear within the Indonesia market. Based on those conditions, this research will indicate the impact of using soybean and corn to bio-fuel in world market upon corn and soybean market in Indonesia Also, this will assess the government policy to increase the domestic production of corn and soybean.

Problem Statement

1. How does the impact of corn and soybean conversion to bio-fuel in the world market upon the corn and soybean market in Indonesia ?
2. Which government policies can increase the corn and soybean production in Indonesia ?

Objective

1. To demonstrate the impact of corn and soybean conversion to bio-fuel in the world market upon the corn and soybean market in Indonesia.
2. To propose the formulation policies to increase the corn and soybean production in Indonesia.

Research Benefit

1. Government reference in proposing the formulation policies of corn and soybean.
2. Reference of associated research.

Research Method

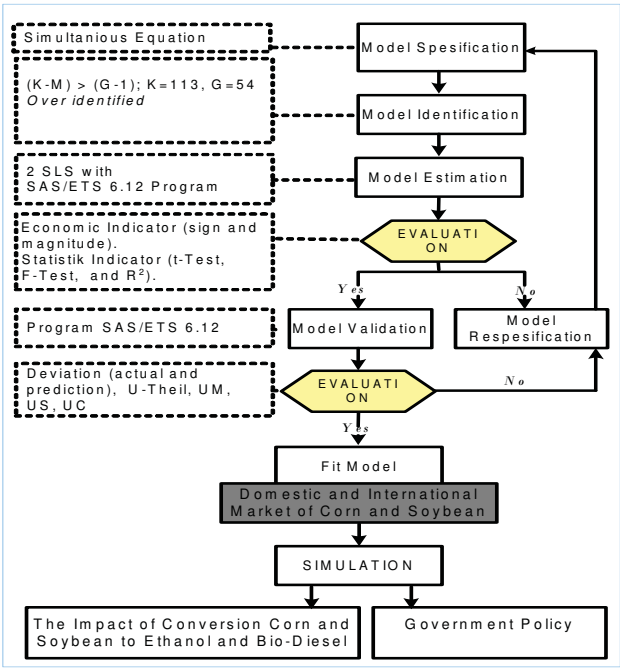
The Research Data

This research used secondary time data of 1983-2006. The data were taken from : APPI (The Association of Indonesian Fertilizer Producer), BPS (The Center of Statistic), FAO, NASS USDA (National Agriculture Statistic Service – United States Department of Agricuigurelture), ERS USDA (Economics Research Service – United States Department of Agriculture) dan IMF.

To construct the model of the corn and soybean world market, it is determined 4 biggest corn and soybean exporter country between 1983-2006, they are USA, Argentina, Brazil and China. The importer countries of corn are Japan, South Korea and Indonesia. The importer countries of soybean are Japan, Netherlands and Indonesia.

The Research Steps

There are many steps we must do in this research, as shown in Figure 1.



Model Specification

Model specification is the first step in this research. The models were analyzed with simultaneous equations, those consist of four blocks : the model of domestic markets of corn and soybean, and the model of world markets of corn and soybean.

The Domestic Market of Corn

The model of corn in the domestic market are constructed by 12 equations (endogenous variables), consist of : 3 identity equations and 9 structural equations.

$$SJIN_t = QJIN_t + IMJIN_t - EXJIN_t + \Delta GJIN_t \quad \text{.....(1)}$$

$$QJIN_t = AJIN_t * YJIN_t \quad \text{.....(2)}$$

$$AJIN_t = b_{11}(PJP_t / PKP_t) + b_{12}PFIN_t + b_{13}LAJIN + e_t \quad \text{.....(3)}$$

$$YJIN_t = b_{21}PJP_t + b_{22}PFIN_t + b_{23}TEK_t + b_{24}LYJIN + e_t \quad \text{..(4)}$$

$$IMJIN_t = b_{30} + b_{31}PMJIN_t + b_{32}DJIN_t + b_{33}QJIN_t + b_{34}LIMJIN + e_t \quad \text{.....(5)}$$

$$EXJIN_t = b_{40} + b_{41}PJW_t + b_{42}ERIN_t + b_{43}QJIN_t + e_t \quad \text{...(6)}$$

$$DJIN_t = DJFOIN_t + DJFEIN_t + DJSIN_t \quad \text{.....(7)}$$

$$DJFOIN_t = b_{51}PJIN_t + b_{52}IIN_t + b_{53}POPIN_t + b_{54}LDJFOIN + e_t \quad \text{..... (8)}$$

$$DJFEIN_t = b_{61}PJIN_t + b_{62}UNGIN_t + e_t \quad \text{.....(9)}$$

$$PMJIN_t = b_{70} + b_{71}PJW_t + b_{72}NPRJIN_t + b_{73}ERIN_t + e_t \quad \text{.....(10)}$$

$$PJIN_t = b_{80} + b_{81}SJIN_t + b_{82}DJIN_t + b_{83}PMJIN + b_{84}PJIN_{t-1} + e_t \quad \text{.....(11)}$$

$$PJP_t = b_{91}PJIN_t + b_{92}LPJP + e_t \quad \text{.....(12)}$$

Hyphotesis :

- $b_{11}, b_{21}, b_{23}, b_{31}, b_{32}, b_{41}, b_{42}, b_{43}, b_{52}, b_{53}, b_{61}, b_{71}, b_{72}, b_{73}, b_{81}, b_{82}, b_{83}, b_{91} > 0$.
- $b_{12}, b_{22}, b_{33}, b_{41}, b_{51}, b_{62}, b_{81} < 0$.
- $0 < b_{13}, b_{24}, b_{34}, b_{54}, b_{84}, b_{92} < 1$.

Explanation :

SJIN	:	Indonesia corn supply	(Ton)
QJIN	:	Indonesia corn production	(Ton)
AJIN	:	Indonesia corn area	(Ha)
YJIN	:	Indonesia corn productivity	(Ton/Ha)
IMJIN	:	Indonesia corn import	(Ton)
EXJIN	:	Indonesia corn export	(Ton)
GJIN	:	Indonesia corn stocks	(Ha)
DJIN	:	Indonesia corn demand	(Ton)
DJFOIN	:	Indonesia corn demand for food	(Ton)
DJFEIN	:	Indonesia corn demand for feed	(Ton)
DJSIN	:	Indonesia corn demand for another	(Ton)

PMJIN	:	Indonesia corn impor price	(Rp/Ton)
PJIN	:	Indonesia corn price	(Rp/Ton)
PJP	:	Indonesia corn price at farm level	(Rp/Ton)
PKP	:	Indonesia soybean price at farm level	(Rp/Ton)
PFIN	:	Indonesia corn fertilizer	(Rp/Ton)
TEK	:	Technology	
PJW	:	World corn price	(US$/Ton)
NPRJIN	:	Indonesia corn impor tarif	(%)
ERIN	:	Indonesia exchange rate	(Rp/US$)
LAJIN	:	Lag of Indonesia corn area	(Ha)
LDJFOIN	:	Lag of Indonesia corn demand for food	(Ton)
LDJFEIN	:	Lag of Indonesia corn demand for feed	(Ton)
LPJIN	:	Lag of Indonesia corn price	(Rp/Ton)
LPJP	:	Lag of Indonesia corn price at farm level	(Rp/Ton)

The Domestic Market of Soybean

The model of soybean in the domestic market are constructed by 12 equations (endogenous variables), consist of : 3 identity equations and 9 structural equations.

$$SKIN_t = QKIN_t + IMKIN_t - EXKIN_t + \Delta GKIN_t \quad \text{.....(13)}$$

$$QKIN_t = AKIN_t * YKIN_t \quad \text{.....(14)}$$

$$AKIN_t = a_{10} + a_{11}PKP_t + a_{12}PJP_t + a_{13}PFIN_t + a_{14}AKIN_{t-1} + e_t \quad \text{.....(15)}$$

$$YKIN_t = a_{21}(PKIN_t / PFIN_t) + a_{22}TEK_t + e_t \quad \text{.....(16)}$$

$$IMKIN_t = a_{31}PMKIN_t + a_{32}DKIN_t + a_{33}QKIN_t + a_{34}IMKIN_{t-1} + e_t \quad \text{.....(17)}$$

$$EXKIN_t = a_{41}GKIN_t + a_{42}EXKIN_{t-1} + e_t \quad \text{.....(18)}$$

$$DKIN_t = DKTP_t + DKTH_t + DKSIN_t \quad \text{.....(19)}$$

$$DKTP_t = a_{51}(PTP_t / PKIN_t) + a_{52}DKTP_{t-1} + e_t \quad \text{.....(20)}$$

$$DKTH_t = a_{61}(PTH_t / PKIN_t) + a_{62}DKTH_{t-1} + e_t \quad \text{.....(21)}$$

$$PMKIN_t = a_{70} + a_{71}PKW_t + a_{72}NPRKIN_t + a_{73}ERIN_t + e_t \quad \text{.....(22)}$$

$$PKIN_t = a_{80} + a_{81}IMKIN_t + a_{82}DKTPTH_t + a_{83}PMKIN + e_t \quad (23)$$

$$PKP_t = a_{91}PKIN_t + a_{92}PKP_{t-1} + e_t \quad \text{.....(24)}$$

Hyphotesis :

- $a_{11}, a_{21}, a_{22}, a_{32}, a_{41}, a_{51}, a_{52}, a_{71}, a_{72}, a_{73}, a_{82}, a_{83}, a_{91} > 0$.
- $a_{12}, a_{13}, a_{31}, a_{33}, a_{81} < 0$.

• $0 < a_{14}, a_{34}, a_{42}, a_{52}, a_{62}, a_{84}, a_{92} < 1$.

Explanation :

$SKIN_t$	:	Indonesia soybean supply	(Ton)
$QKIN_t$	:	Indonesia soybean production	(Ton)
$AKIN_t$	:	Indonesia soybean area	(Ha)
$YKIN_t$	:	Indonesia soybean productivity	(Ton/Ha)
$IMKIN_t$	:	Indonesia soybean import	(Ton)
$EXKIN_t$	:	Indonesia soybean export	(Ton)
$GKIN_t$	:	Indonesia soybean stocks	(Ha)
$DKIN_t$	:	Indonesia soybean demand	(Ton)
$DKTP_t$	:	Indonesia soybean demand for tempeh	(Ton)
$DKTH_t$	:	Indonesia soybean demand for tofu	(Ton)
$DKSIN_t$	:	Indonesia soybean demand for another	(Ton)
$PKIN_t$	:	Indonesia soybean price	(Rp/Ton)
$PMKIN_t$	:	Indonesia soybean import price	(Rp/Ton)
PKP_t	:	Indonesia soybean price at farm level	(Rp/Ton)
PKW_t	:	World soybean price	(US$/Ton)
$NPRKIN_t$	:	Indonesia soybean import tarif	(%)
$AKIN_{t-1}$	:	Lag of Indonesia soybean area	(Ha)
$DKTP_{t-1}$	:	Lag of Indonesia soybean demand for tempeh	(Ton)
$DKTH_{t-1}$	:	Lag of Indonesia soybean demand for tofu	(Ton)
$PKIN_{t-1}$	:	Lag of Indonesia soybean price	(Rp/Ton)
PKP_{t-1}	:	Lag of Indonesia soybean price at farm level	(Rp/Ton)
$EXKIN_{t-1}$	:	Lag of Indonesia soybean ekspor	(Ton)

The World Market of Corn

The model of corn in the world market are constructed by 16 equations (endogenous variables), consist of : 5 identity equations and 11 structural equations.

$$EXJW_t = EXJAS_t + EXJAR_t + EXJBR_t + EXJCI_t + EXJSW_t \quad \text{.....(25)}$$

$$EXJAS_t = QJAS_t - DJAS_t + \Delta GJAS_t \quad \text{.....(26)}$$

$$QJAS_t = AJAS_t * YJAS_t \quad \text{.....(27)}$$

$$AJAS_t = d_{10} + d_{11}PJW_t + d_{12}PKW_t + d_{13}PET_t + e_t \quad \text{.....(28)}$$

$$YJAS_t = d_{21}PJW_t + d_{22}TEK_t + e_t \quad \text{.....(29)}$$

$$DJAS_t = DJFOAS_t + DJFEAS_t + DJETAS_t + DJSAS_t \quad \text{.....(30)}$$

$$DJFOAS_t = d_{30} + d_{31}PJW_t + d_{32}LDJFOAS_t + e_t \quad \text{.....(31)}$$

$$DJFEAS_t = d_{40} + d_{41}PJW_t + d_{42}UNGAS_t + e_t \quad \text{....(32)}$$

$$DJETAS_t = d_{51}PJW_t + d_{52}PET_t + e_t \quad \text{.....(33)}$$

$$EXJAR_t = d_{60} + d_{61}(PJW_t * ERAR_t) + d_{62}QJAR_t + \\ + d_{63}EXJAS + d_{64}LEXJAR_t + e_t \quad \text{.....(34)}$$

$$EXJBR_t = d_{70} + d_{71}PJW_t + d_{72}QJBR_t + d_{73}LEXJBR_t + e_t \quad \text{...(35)}$$

$$EXJCI_t = d_{81}(PJW_t * ERCI_t) + d_{82}QJCI_t + \\ + d_{83}EXJAS + d_{84}LEXJCI_t + e_t \quad \text{.....(36)}$$

$$IMJW_t = IMJJE_t + IMJKO_t + IMJIN_t + IMJSW_t \quad \text{.....(37)}$$

$$IMJJE_t = d_{90} + d_{91}PJW_t + d_{92}DJJE_t + d_{93}NPRJJE_t + \\ + d_{94}ERJE_t + d_{95}LIMJJE_t + e_t \quad \text{.....(38)}$$

$$IMJKO_t = d_{100} + d_{101}PJW_t + d_{102}QJKO_t + \\ + d_{103}NPRJKO_t + + d_{104}ERKO_t + \\ + d_{105}LIMJKO_t + e_t \quad \text{.....(39)}$$

$$PJW_t = d_{100} + d_{101}EXJW_t + d_{102}IMJW_t + \\ + d_{103}LPJW_t + e_t \quad \text{.....(40)}$$

Hyphotesis :

- $d_{11}, d_{13}, d_{21}, d_{22}, d_{42}, d_{61}, d_{62}, d_{71}, d_{72}, d_{81}, d_{82}, d_{92}, d_{112} > 0$.
- $d_{12}, d_{32}, d_{41}, d_{62}, d_{63}, d_{83}, d_{91}, d_{93}, d_{94}, d_{101}, d_{102}, d_{103}, d_{104}, d_{111} < 0$.
- $0 < d_{23}, d_{32}, d_{73}, d_{84}, d_{95}, d_{105}, d_{113} < 1$.

EXJAS	:	USA corn export	(Ton)
QJAS	:	USA corn production	(Ton)
AJAS	:	USA corn area	(Ha)
YJAS	:	USA corn productivity	(Ton/Ha)
DJAS	:	USA corn demand	(Ton)
DJFOAS	:	USA corn demand for food	(Ton)
DJFEAS	:	USA corn demand for feed	(Ton)
DJETAS	:	USA corn demand for ethanol	(Ton)
DJSAS	:	USA corn demand for another	(Ton)
GJAS	:	USA corn stocks	(Ton)
EXJW	:	Corn export total in world market	(Ton)
EXJAR	:	Argentina corn export	(Ton)
EXJBR	:	Brazil corn export	(Ha)
EXJCI	:	China corn export	(Ton)
EXJSW	:	Corn export from another country	(Ton)

Explanation :

IMJW	:	Corn import total in world market	(Ton)
IMKJE	:	Japan corn import	(Ton)
IMJKO	:	South Korea corn import	(Ton)
IMJSW	:	Corn import from another country	(Ton)
PJW	:	World corn price	(US$/Ton)
PKW	:	World soybean price	(US$/Ton)
PET	:	USA ethanol price	(US$/Gallon)
UNGAS	:	A number of USA chicken	

QJAR	:	Argentina corn production	(Ton)
QJBR	:	Brazil corn production	(Ton)
QJCI	:	China corn production	(Ton)
QJKO	:	Japan corn production	(Ton)
NPRJJE	:	Japan corn import tarif	(%)
NPRJKO	:	South Korea corn import tarif	(%)
DJJE	:	Netherlands corn demand	(Ton)
ERAR	:	Argentina exchange rate	(Pesos/US$)
ERCI	:	China exchange rate	(Yuan/US$)
ERJE	:	Japan exchange rate	(Yen/US$)
ERKO	:	South Korea exchange rate	(Won/US$)
LDJFOAS	:	Lag of USA corn demand for food	(Ton)
LEXJAR	:	Lag of Argentina corn export	(Ton)
LEXJBR	:	Lag of Brazil corn export	(Ton)
LEXJCI	:	Lag of China corn export	(Ton)
LIMJJE	:	Lag of Japan corn import	(Ton)
LIMJKO	:	Lag of South Korea corn import	(Ton)
LPJW	:	Lag of world corn price	(US$/Ton)

The World Market of Soybean

The model of soybean in the world market are constructed by 12 equations (endogenous variables), consist of : 3 identity equations and 9 structural equations.

$$EXKW_t = EXKAS_t + EXKAR_t + EXKBR_t + \\ + EXKCI_t + EXKSW_t \quad \text{.....(41)}$$

$$EXKAS_t = c_{11}PKW_t + c_{12}QKAS_t + e_t \quad \text{.....(42)}$$

$$QKAS_t = AKAS_t * YKAS_t \quad \text{.....(43)}$$

$$AKAS_t = c_{21}PKW_t + c_{22}PET_t + + c_{23}LAKAS_t + e_t \quad \text{.....(44)}$$

$$YKAS_t = c_{30} + c_{31}TEK_t + e_t \quad \text{.....(45)}$$

$$EXKAR_t = c_{40} + c_{41}PKW_t + c_{42}QKAR_t + \\ + c_{43}EXKAS_t + c_{44}LEXKAR_t + e_t \quad \text{.....(46)}$$

$$EXKBR_t = c_{51}QKBR_t + c_{52}NPRKBR_t + c_{53}EXKAS_t + e_t \quad (47)$$

$$EXKCI_t = c_{61}PKW_t + c_{62}QKCI_t + c_{63}EXKAS_t + e_t \quad \text{.....(48)}$$

$$IMKW_t = IMKJE_t + IMKBE_t + IMKIN_t + IMKSW_t \quad \text{.....(49)}$$

$$IMKJE_t = c_{70} + c_{71}PKW_t + c_{72}QKJE_t + \\ + c_{73}NPRKJE_t + c_{74}LIMKJE_t + e_t \quad \text{.....(50)}$$

$$IMKBE_t = c_{80} + c_{81}PKW_t + c_{82}DKJE_t + c_{83}ERBE_t + \\ + c_{84}LIMKBE_t + e_t \quad \text{..(51)}$$

$$PKW_t = c_{91}(IMKW_t / EXKW_t) + e_t \quad \text{.....(52)}$$

Hyphotesis :

- $c_{11}, c_{12}, c_{21}, c_{31}, c_{41}, c_{42}, c_{51}, c_{62}, c_{71}, c_{82}, c_{91} > 0$.
- $c_{22}, c_{43}, c_{52}, c_{53}, c_{63}, c_{71}, c_{72}, c_{73}, c_{81}, c_{83} < 0$.
- $0 < c_{23}, c_{44}, c_{74}, c_{84} < 1$.

Explanation :

$EXKAS_t$	:	USA soybean export	(Ton)
$QKAS_t$	:	USA soybean production	(Ton)
$AKAS_t$	:	USA soybean area	(Ha)
$YKAS_t$	:	USA soybean productivity	(Ton/Ha)
$EXKW_t$	:	Soybean export total in world market	(Ton)
$EXKAR_t$	:	Argentina soybean export	(Ton)
$EXKBR_t$	:	Brazil soybean export	(Ha)
$EXKCI_t$	:	China soybean export	(Ton)
$EXKSW_t$	:	Soybean export from another country	(Ton)
$IMKW_t$	:	Soybean export total in world market	(Ton)
$IMKJE_t$	:	Japan soybean import	(Ton)
$IMKBE_t$	:	Netherlands soybean import	(Ton)
$IMKIN_t$	:	Indonesia soybean import	(Ton)
$IMKSW_t$	:	Soybean import from another country	(Ton)
$QKAR_t$	:	Argentina soybean production	(Ton)
$QKBR_t$	:	Brazil soybean production	(Ton)
$QKCI_t$	:	China soybean production	(Ton)
$QKJE_t$	:	Japan soybean production	(Ton)
$NPRKBR_t$	:	Brazil soybean import tarif	(%)
$NPRKJE_t$	:	Japan soybean import tarif	(%)
$DKBE_t$	:	Netherlands soybean demand	(Ton)
$ERBE_t$	:	Netherlands exchange rate	(Euro/US$)
$AKAS_{t-1}$	:	Lag of USA soybean area	(Ha)
$EXKAR_{t-1}$	:	Lag of Argentina soybean export	(Ton)
$IMKJE_{t-1}$	:	Lag of Japan soybean import	(Ton)

Model Identification, Estimation, Evaluation and Validation

One of the requirement to identify the equations is $(K - M) \geq G - 1$ (Koutsoyiannis, 1975). In this research, K (total amount of variables, endogeneous and *predetermined*) is 111 variables, consist of 52 equations or endogeneous variables, 36 exogeneous variables and 23 lag-endogeneous variables. M is the amount of variables endogeneous dan exogeneous on the identification equation; and G is the total amount of equations (endogeneous variables) on the model (G=52). The result of identification for each equation is over identified, so 2SLS/Two Stage Least Square method can be applied for estimation (Gujarati, 1995).

Statistical test is used to examine the model, they are: i) F-test (to examine what the endogeneous variable is significantly influenced by the all of exogeneous variables), ii) R^2 (to know the goodness of the model), and iii) t-test (to examine what the endogeneous variable is individually significantly influenced by the exogeneous variables). The indicators to examine validation of model are : i) the deviation between prediction and actual value, ii) U-Theil, with value between 0 dan 1, if U=0 it means that model is perfect, dan iii) decomposition of U-Theil, they are U^M (proportion biased), U^S (variance biased) dan U^C (covariance biased). The good model is if the model has U^M, U^S value close to zero, and U^C value close to one, so : $U^M + U^S + U^C = 1$.

Simulation

There are two kinds of simulations that were conducted to solve the problem in this research. The first simulation was to know the impact of corn and soybean conversion to biofuel in the world market with the corn and soybean price, production and demand in Indonesia. The simulation were : 1) the increasing demand of corn for ethanol in USA 350%, the decreasing of USA corn export 50% and there is no corn export from Argentina, Brazil and China, 2) the increasing demand of corn for ethanol in USA 350%, the decreasing of USA corn export 50% and there is no corn export in world market, 3) the increasing demand of corn for ethanol in USA 350%, the increasing of corn land in USA 30%, the decreasing soybean land in USA 10%, meanwhile the decreasing soybean export from USA, Argentina, Brazil and China 10%, and 4) the increasing demand of corn for ethanol in USA 350%, the increasing of corn land in USA 30%, the decreasing soybean land in USA 10%, meanwhile the decreasing soybean export from USA, Argentina, Brazil and China 30% and the decreasing soybean export from USA 50%.

The second simulation was to know the influence of implemented policy of corn and soybean production in Indonesia. The simulation were : 1) policy of fertilizer subsidy 25%, 2) policy of floor price of soybean 10%, 3) corn import tarif 10% and soybean import tarif 20%, 4) integrated policy of corn import tarif 10%, soybean import tarif 20%, fertilizer subsidy 25%, and 5) integrated policy of fertilizer subsidy 25% and soybean floor price 10%.

Result and Discussion

Model Evaluation

The model evaluation shows that 6 equations (9.26%) have R^2 value less than 60% and all of the equations significantly influence the endogeneous variables together.

The Model of Domestic Corn Market

The model of corn supply consists of 2 identity equations (corn supply, corn production) and 4 structural equations (corn area, corn productivity, corn import and export).

$AJIN_t$ = 2659696 (PJP_t - 2.996335 $PFIN_t$ + 0.731275 $AJIN_{t-1}$ / PKP_t)
(1.095) (-0.067) (3.357)
R^2 = 0.9994 F-hitung = 7645.890

$YJIN_t$ = 0.000006631 - 0.000000105 PFINt + PJINt
(11.57) (7.803)
+ 0.004214 + 0.971689 YJINt-1 TEKt
(0.927) (16.634)
R^2 = 0.9868 F-hitung = 474.154

$IMJIN_t$ = -80675 - 18.729238 + 0.375677 $DJIN_t$ + $PMJIN_t$
(-0.218) (-0.871) (3.592)
-0.290012 + 0.074608
$QJIN_t$ $IMJIN_{t-1}$
(-2.235) (0.349)
R^2 = 0.7295 F-hitung = 12.138

$EXJIN_t$ = -888883 + 242974 + 4692.00479 $ERIN_t$ PJW_t
(-3.688) (2.872) (5.857)
+ 0.021938
$EXJIN_{t-1}$
(1.735)
R^2 = 0.6467 F-hitung = 11.594

The corn area is significantly influenced by the ratio of soybean and corn price, and the lag of corn area. The corn productivity is significantly influenced by the lag of corn productivity. The corn import is significantly influenced by the corn demand and productivity. The corn export is significantly influenced by the world price of corn, the exchange rate of Rp/US$ and the domestic production of corn.

The model of corn demand is determined by corn demand for food, feed and another. The corn demand for food is significantly influenced by the corn domestic price, a number of people, and the lag of corn demand. The corn demand for feed is significantly influenced by the corn price and the number of chicken. Corn has many advantages as a raw material of animal feed, likewise, the corn price is more cheaper than the other, corn has a high calorie and is a protein source with amino acids (Erwidodo, dkk., 2003).

$DJF = - 109.822855 + 4.132879\ IIN_t + PJIN_t + OIN_t$

(-1.785) (0.768)

$+ 0.019295\ POPIN_t + 0.671622\ DJFOIN_{t-1}$

(2.295) (3.726)

$R^2 = 0.9930$ F-hitung = 673.004

$DJF = - 65.10547 + 2.477873\ UNGIN_t + PJIN_t + EIN_t$

(-2.907) (6.796)

$R^2 = 0.8411$ F-hitung = 55.593

The model of corn price consists of three equations, they are import price of corn, domestic price of corn and corn price at farm level. The import price of corn is significantly influenced by the world price of corn (is approximately the same like the price used in the USA), the import tarif of corn and the exchange rate of Rp/US$. The corn domestic price is significantly influenced by the corn import price. The corn price at farm level is significantly influenced by the domestic price of corn.

$PM = -3844.19478 + 2024.038832\ PJW_t + JIN_t$

(-1.242) (1.649)

$+ 59.821463\ NPRJIN_t + 118.688961\ ERIN_t$

(7.09)

(3.98)

R^2 = F-hitung = 27.320

0.8118

PJI = 8899.429266 - 0.00058 $SJIN_t$ + .000558 $DJIN_t$ · N_t

(3.915) (-1.126) (1.115)

+0.378263 + 0.269478 $PJIN_{t-1}$ $PMJIN_t$

(4.722) (1.727)

R^2 = F-hitung = 11.847

0.7247

PJP_t = - 1203.817042 + 0.404088 $PJIN_t$ + .549914 $PJIN_{t-1}$

(-0.525) (3.319) (4.309)

R^2 = F-hitung = 23.159

0.6984

The Model of Domestic Soybean Market

The model of soybean supply consists of 2 identity equations (soybean supply and production) and 4 structural equations (soybean area, productivity, import and export). The area of soybean is significantly influenced by the domestic price of corn. The productivity of soybean is significantly influenced by the ratio of price of soybean and price of urea, and technology. The import of soybean is significantly influenced by demand and productivity of soybean.

$AKIN_t$ = 271408 + 12.99094 PKP_t - 37.178702 PJP_t +
(0.620) (1.289) (-1.867)
-37.178702 $PFIN_t$ + 0.789814 $AKIN_{t-1}$
(-0.481) (7.757)
R^2 = 0.8668 F-hitung = 29.283

$YKIN_t$ = 0.187128 ($PKIN_t$ / $PFIN_t$) + 0.033027 TEK_t
(11.57) (7.803)
R^2 = 0.9807 F-hitung = 533.626

$IMKIN_t$ = -0.42367 $PMKIN_t$ + 0.885372 $DKIN_t$ - 0.83896 $QKIN_t$ +
(-0.249) (14.396) (-11.371)
+0.024582 $IMKIN_{t-1}$
(0.347)
R^2 = 0.9940 F-hitung = 783.538

$EXKIN_t = 0.003503\ GKIN_t + 0.05791\ EXKIN_{t-1}$
(3.437) (0.215)
$\chi^2 = 0.4482$ F-hitung = 8.530

The model of soybean demand is an identity equation, consisting of an equation for soybean demand for tempeh and tofu. The soybean demand for tempeh/tofu are significantly influenced by the ratio of tempeh/tofu price with soybean price and the lag of soybean demand for tempeh/ tofu.

$DKTP_t = 104114\ (PTP_t / PKIN_t) + 0.902479\ DKTP_{t-1}$
(1.66) (12.376)
$R^2 = 0.9765$ F-hitung = 436.531

$DKTH_t = 119085\ (PTH_t / PKIN_t) + 0.900977\ DKTH_{t-1}$
(1.723) (12.621)
$R^2 = 0.9764$ F-hitung = 434.983

The model of price consists of three equations, they are import price of soybean, domestic price of soybean and soybean price at farm level. The import price o soybean is significantly influenced by world price of soybean, import tarif of soybean and exchange rate of Rp/US$. The domestic price of soybean is significantly influenced by the import price of soybean. The soybean price at farm level is significantly influenced by domestic price of soybean.

$PMKIN_t = -3336.074896 + 1488.561799\ PKW_t + 214.558348\ ERIN_t$
(-0.621) (1.574) (6.904)
$R^2 = 0.8004$ F-hitung = 25.395

$PKIN_t = 6135.127002 - 0.001004\ IMKIN_t + 0.39567\ PMKIN_t$
(0.664) (-0.348)
$R^2 = 0.5309$ F-hitung : 5.092

$PKP_t = 0.16664 PKIN_t + 0.835928\ PKP_{t-1}$
(1.457) (7.255)
$R^2 = 0.9952$ F-hitung : 2193.181

The Model of World Corn Market

The export of corn in world market is an identity equation, determined by corn export from USA, Argentina, Brazil, China and another country. The USA export of corn is an identity equation, determined by the deviation between production and demand of

corn in USA. The USA production of corn is an identity equation, determined by area and productivity of corn.

$AJAS_t = 29373799 + 1057889\ PJW_t +$
(21.454) (0.549)
$2597404\ PKW_t + 307848464\ PET_t$
(-3.096) (2.245)
$R^2 = 0.4868$ F-hitung = 6.008

$YJAS_t = 3.140721 PJW_t + 0.299083\ TEK_t$
(10.554) (11.05)
$R^2 = 0.9785$ F-hitung = 477.468

The corn area is significantly influenced by USA price of ethanol and soybean. Fortenbery and Park's research (2008), concluded that the corn demand for ethanol had the biggest effect to USA price of corn, compare with corn demand for export and feed. The corn productivity is significantly influenced by USA price of corn and technology. Between 1997-2006, the average productivity of corn in USA was 8.88 million ton/ha, almost three times higher from the average productivity of corn in Indonesia, 3.01 ton/ha (Hapsari, 2009).

The USA demand of corn is an identity equation, determined by demand of corn for food, feed, ethanol and another. The demand of corn for food is influenced by the lag of demand of corn for food in USA. The demand of corn for feed is influenced by the price of corn and by the number of chicken. The demand of corn for ethanol isn't influenced by the price of corn and ethanol. That is because of the conversion of corn to ethanol in USA was supported by USA subsidy. Demand of corn for ethanol increased from 7% in 1997 to 23% in 2006 (Hapsari, 2009).

$DJFOAS_t = 2958963 - 16011\ PJW_t + .\ 910356\ DJFOAS_{t-1}$
(2.099) (-0.038) (25.572)
$R^2 = 0.9905$ F-hitung = 1042.677

$DJFEAS_t = 120161741 - 23991148 PJW_t + 0.025941\ UNGAS_t$
(8.934) (-5.352) (4.912)
$R^2 = 0.9312$ F-hitung = 135.272

$DJETAS_t = -\ 3585837\ PJW_t + 1143695635\ PET_t$
(-0.263) (1.045)
$R^2 = 0.4920$ F-hitung = 10.168

The model of corn export from Argentina, Brazil, and China are a structural equation. The Argentina export of corn is significantly influenced by Argentina production of corn and USA export of corn. The Brazil export of corn is significantly

influenced by the Brazil production of corn and the lag of corn demand. The China export of corn is significantly influenced by the China production of corn.

$EXJAR_t$ = 5657207 (PJW_t * $ERAR_t$) + 0.744367 $QJAR_t$ +
(0.434) (8.765)
- 0.057775 $EXJAS_t$ + 0.128057 $EXJAR_{t-1}$
(-2.500) (1.330)
R^2 = 0.9871 F-hitung = 362.763

$EXJBR_t$ = - 4732551 PJW_t + 180064 PJW_t +
(-2.18) (0.208)
+ 0.170215 $QJBR_t$ 0.193817 $EXJBR_{t-1}$
(3.875) (1.124)
R^2 = 0.6486 F-hitung = 8.306

$EXJCI_t$ = 13918149 (PJW_t * $ERCI_t$) + 0.054655 $QJCI_t$ +
(0.706) (1.257)
-0.068775 $EXJAS_t$ + 0.274287 $EXJBR_{t-1}$
(-0.55) (1.17)
R^2 = 0.7048 F-hitung = 11.343

The world demand of corn makes an identity equation that consists of the import of corn from Japan, South Korea, Indonesia and the other countries. The Japan import of corn is significantly influenced by demand of corn, import tarif and exchange rate of Yen/US$. The South Korean import of corn is significantly influenced by world price of corn, import tarif, exchange rate of Won/US$, and the lag of South Korea import of corn.

$IMJJE_t$ = 14719997 · 194776 PJW_t + .154884 $DJJE_t$
(5.746) (-0.64) (3.082)
- 11684 $NPRJJE_t$ · 888929 $ERJE_t$ + .061421 $IMJJE_{t-1}$
(-3.451) (-2.766) (0.395)
R^2 = 0.8806 F-hitung = 25.072

$IMJKO_t$ = 8910753 · 1076521 PJW_t - .057212 $QJKO_{t-1}$
(3.109) (-1.244) (-0.288)
- 11771 $NPRJKO_t$ · 184968 $ERKO_t$ + .448311 $IMJKO_{t-1}$
(-1.302) (-2.099) (2.267)
R^2 = 0.8460 F-hitung = 14.648

The world price of corn is a structural equation, significantly influenced by the export total of corn and the lag of world price of corn.

PJW_t = 0.850526 - 9.33E-09 $EXJW_t$ - 5.23E-09 $IMJW_t$ + 0.548749 PJW_{t-1} +
(1.297) (-1.432) (0.664) (4.094)
R^2 = 0.6855 F-hitung = 13.806

The Model of World Soybean Market

The soybean export total in the world market is determined by USA, Argentina, Brazil, China export and soybean export from another country. USA is the biggest exporter of soybean in the world. At the farm level, both commodities indicate field competition. Corn is one of the rival plants to soybean in land use. So, this research needs to know the relationship of USA area, productivity and production of soybean. The Argentina export of soybean is significantly influenced by production of soybean. The Brazil export of soybean is significantly influenced by production of soybean, export tarif and USA export of soybean. The China export of soybean is significantly influenced by world price of soybean and USA export of soybean.

$EXKAS_t = 772403\ PKW_t + 0.313619\ QKAS_t$
(1.606) (13.426)
R^2 = 0.8118 F-hitung = 27.320

$AKAS_t = 460496\ PKW_t - 124094360\ PET_t + + 37.598\ AKAS_{t-1}$
(1.222) (-1.408) (37.598)
R^2 = 0.9988 F-hitung = 5766.882

$YKAS_t = 2.016285 + 0.033162\ TEK_t$
(23.561) (5.655)
R^2 = 0.6037 F-hitung = 31.984

$EXKAR_t = -150454 + 372858\ PKW_t - 0.065755 + .249019\ QKAR_t + EXKAS_t + 0.036282\ EXKAR_{t-1}$
(-0.062) (0.877) (- 0.783) (0.203) (4.571)
R^2 = 0.8370 F-hitung = 23.101

$EXKBR_t = 0.591128\ QKBR_t - 6688.517289 + NPRKBR_t - 334689\ EXKAS_t$
(12.182) (-2.085) (-4.633)
R^2 = 0.9741 F-hitung = 250.672

$EXKCI_t = 369401\ PKW_t + 0.00242\ QKCI_t - .023026\ EXKAS_t$
(7.175) (0.072) (-1.147)
R^2 = 0.8663 F-hitung = 43.197

The import of soybean in the world market makes an identity equation that consists of the soybean imports from Japan, Netherlands, Indonesia and the other countries. The Japan import of soybean is significantly influenced by the world price of soybean, impor tarif and lag of Japan import of soybean. The Netherlands import of soybean is significantly influenced by the world price of soybean and exchange rate of Euro/US$.

$$IMKJE_t = \underset{(-2.801)}{2549659} \cdot \underset{(-1.691)}{104941\ PKW_t} - \underset{(-0.938)}{.744697\ QKAR_t} \cdot \underset{(-3.904)}{10566\ NPRKJE_t} + \underset{(3.401)}{0.634435\ IMKSW_{t-1}}$$

$R^2 = 0.5575$ F-hitung = 5.670

$$IMKBE_t = \underset{(2.207)}{5424555} - \underset{(-2.011)}{535706\ PKW_t} + \underset{(0.928)}{0.363595\ DKBE_t} - \underset{(-1525)}{73750434\ ERBE_t} +$$

$R^2 = 0.6811$ F-hitung = 13.527

The world price of soybean is a structural equation, significantly influenced by the ratio of import total to export total.

$$PKW_t = \underset{(16.361)}{3.032087\ (IMKW_t / EXKW_t)}$$

$R^2 = 0.6811$ F-hitung = 13.527

The Model Validation

The validation showed that there are : a) 2 equations have a deviation more than 8%, b) 52 equations have a deviation less than 4%, c) 2 equations have an U-Theil value more than 40%, d) all of the equations have an UM-value close to zero, e) 50 equations have an US-value close to zero, and f) 50 equations have an UC-value close to one.

Pindyck and Rubinfield (1991) stated that some requirement to evaluate model didn't have consistency, primarily for a big model. Though, it need a compromize between statistical, mathematic and economic requirement. So, this model is valid for simulation.

The Simulation Result

Simulation Result Of The Impact Of Corn And Soybean Conversion To Biofuel Upon Corn And Soybean Market In Indonesia

Based on the simulation which is conducted in this research, the impact of corn and soybean conversion to biofuel in the world market upon corn and soybean market in Indonesia is shown in Figure 2 (price), Figure 3 (production) and Figure 4 (demand).

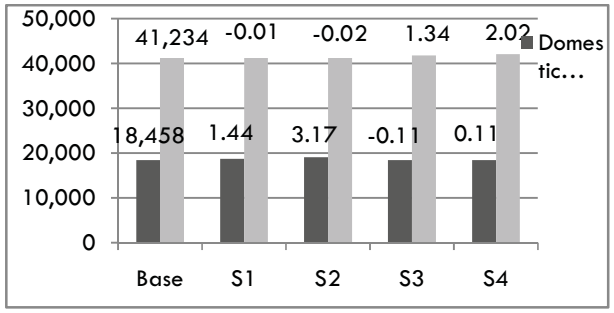


Figure 2. The Impact of Corn And Soybean Conversion to Biofuel In World Market Upon Corn and Soybean Price in Indonesia

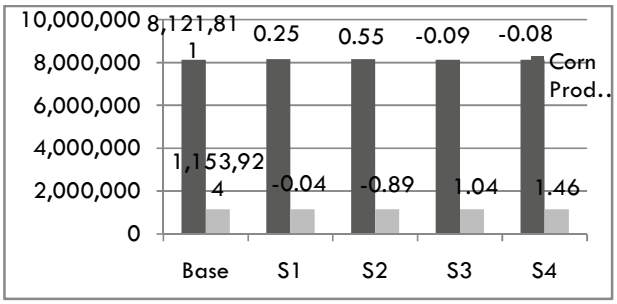


Figure 3. The Impact of Corn And Soybean Conversion to Biofuel In World Market Upon Corn and Soybean Production in Indonesia

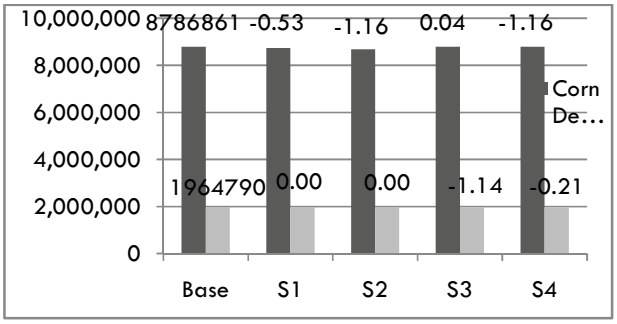


Figure 4. The Impact of Corn And Soybean Conversion to Biofuel In World Market Upon Corn and and Soybean Demand in Indonesia

The first simulation (S1) is increasing USA demand of corn for ethanol 350%, decreasing USA export of corn 50% and there is no export of corn from Argentina, Brazil and China. The impact of S1 to corn is increasing Indonesian price 1.44%, increasing Indonesian production 0.25%, and decreasing Indonesian demand 0.53%. The impact of S1 to soybean is increasing Indonesian price 0.01%, decreasing Indonesian production 0.04%, and Indonesian demand is constant.

The second simulation (S2) is increasing USA demand of corn for ethanol 350%, decreasing USA exports of corn 50% and there is no corn export in world market. The impact of S2 to corn is increasing Indonesian price 3.17%, increasing Indonesian production 0.55%, and decreasing Indonesian demand 1.16%. The impact of S2 to soybean is decreasing Indonesian price 0.02%, decreasing Indonesian production 0.89%, and Indonesian demand is constant.

The third simulation (S3) is increasing USA demand of corn for ethanol, increasing USA area for planting corn 30%, decreasing USA area for planting soybean 10%, decreasing export of soybean from USA, Argentina, Brazil and China 10%. The impact of S3 to corn is decreasing Indonesian price 0.11%, decreasing Indonesian production 0.09%, and increasing Indonesian demand 0.04%. The impact of S3 to soybean is increasing Indonesian price 1.34%, increasing Indonesian production 1.04%, and decreasing Indonesian demand 1.14%.

The forth simulation (S4) is increasing USA demand of corn for ethanol 350%, increasing USA area for planting corn 30%, decreasing USA area for planting soybean 10%, decreasing export of soybean from USA, Argentina, Brazil and China 30%, and decreasing USA export of soybean 50%. The impact of S4 to corn is increasing Indonesian price 0.11%, decreasing Indonesian production 0.08%, and decreasing Indonesian demand 1.16%. The impact of S4 to soybean is increasing Indonesian price 2.02%, increasing Indonesian production 1.46%, and decreasing Indonesian demand 0.21%.

Simulation Result of the Influence of Implemented Policy to Corn and Soybean Production in Indonesia

Based on the simulation which is conducted in this research, the influence of implemented policy to corn and soybean production in indonesia is shown in Figure 5. The first simulation (P1) is policy of fertilizer subsidy 25%. The second simulation (P2) is

policy of floor price of soybean 10%. The third simulation (P3) is policy of import tarif of corn 10% and soybean 20%. The forth simulation (P4) is integrated policy of import tarif of corn 10%, import tarif of soybean 20% and fertilizer subsidy 25%. The fifth simulation (P5) is integrated policy of fertilizer subsidy 25% and floor price of soybean 10%.

The influence of implemented policy to corn and soybean production in Indonesia, they are :

a) fertilizer subsidy increasing production of corn 0.14% and soybean 24.44%.
b) floor price of soybean decreasing production of corn 2.55% and increasing production of soybean 24.44%.
c) import tarif of corn less than import tarif of soybean decreasing production of corn 0.03% and increasing production of soybean 0.70%.
d) import tarif of corn less than import tarif of soybean and fertilizer subsidy increasing production of corn 0.22% and soybean 24.02%.
e) fertilizer subsidy and floor price of soybean decreasing production of corn 2.30% and increasing production of soybean 30.74%.

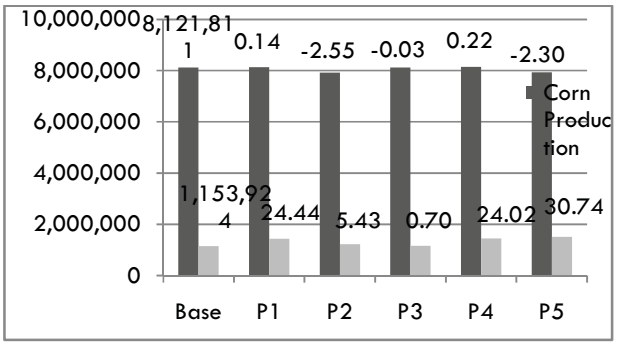


Figure 5. The the Influence of Implemented Policy to Corn and Soybean Production in Indonesia

Conclusion and Recomendation

Conclusion

1. The conversion of corn and soybean to biofuel in the world market has a relatively low impact (less than 5 percent) for increasing/decreasing price, production and demand of corn and soybean commodity in Indonesia.
2. The integrated policy of fertilizer subsidy and import tarif provided an increase in corn and soybean production in Indonesia.

Recommendation

1. The government should implement an integrated policy of fertilizer subsidy, floor price and import tarif for corn and soybean.
2. The government should support the research and provide funds in technological improvement to increase production.

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