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Overview of the Indonesian rice economic model

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Abstract

The increasing demand for rice from year to year is the main problem in maintaining Indonesia's food security. This research aims to analyze factors that affected the rice economy in Indonesia toward riceself-sufficiency. The data used in the study are secondary data based on time series from 1961 - 2018. The model used in this study is a simultaneous equations model. The rice supply blocks models consist of paddy production, rice production, rice area, rice productivity, paddy fields, labor, N fertilizer, P fertilizer, K fertilizer, pesticides, rice supply, loss of rice, rice supply, rice imports, rice exports, prices of domestic rice, and world rice prices. The result shows that all the explanatory variables that make up the 11 models significantly affect the endogenous variables (level of significance of 1%). In contrast, the explanatory variable of the rice import equation can not explain the model

Keywords: economic model, rice, import, self-sufficient

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INTRODUCTION

Rice is a staple food source of carbohydrates and is a strategic commodity in Indonesia (Sa'diyah et al., 2019). In various income quintiles, households in Indonesia consume rice as a staple food (Nikmatul et al., 2020). Indonesia's population grow this relatively high (1.3% per year). The Indonesian people's average per capita rice consumption is the highest globally (139 kg/capita/year). It is the biggest problem in maintaining food security (Maraseni et al., 2018; Van der Eng, 2000). Related to the Indonesia population prediction in 2045 (Indonesian Golden Era), with the projection that Indonesia's population will experience declining grow that a rate of 0.27 percent per year, then the population of Indonesia will amount to 321 million (Bapuelve et al. 2013). In 2015, the consumption figure assumed 124.89 kg capita per year, with a population of 255.46 millionpeople, so that the total consumption of rice is 31.9 milliontons. In 2020 the need for rice consumption is projected to be 33.60 milliontons, and in 2025 it will be 35.34 milliontons. In 2030, rice consumption is estimated at 36.70 milliontons, and in 2035 it is estimated at 37.8 milliontons (Arifin et al., 2018).

The prediction of rice demand for consumption in 2016 based on the forecast figure for rice consumption per capita in 2015 is 124.89 kilograms/capita/year. The share of expenditure on grains, including rice by households in Indonesia in urban and rural, reaches 20% of total food expenditure (Khoiriyah et al., 2020).With a 258.71 million population, it is estimated that the need for rice for direct consumption by the Indonesian people will reach 32.31 milliontons. Meanwhile, rice production prediction in 2017-2019 is estimated to reach 80.93 milliontonnes or an increase of 2.68% in the next three years. This production will be achieved through the estimated achievement of rice productivity, which will reach 5.46 tons per hectare or an increase of 1.19% per year, with an increase in the harvested area expected to reach 1.62% (land area of 14.86 millionhectares). The forecast for rice demand for 2017-2019 for direct consumption is estimated at 124.89 kg/capita/year, with an assumed population growth of 1.20% per year. Thus, the total demand for rice for direct consumption by the Indonesian people in 2017 was 32.71 milliontons and 33.47 milliontons in 2019.

Research has been carried out on the rice policy scenario in several countries, including Korea(Soon et al., 2019), thePhilippines(Balié & Valera, 2020; Pradesha et al., 2019), inEcuador(Akita & Lukman, 1999), andalso in Indonesia for (Díaz González & Morales-Opazo, 2020), in India (Jha et al., 2020). These studies generally use simultaneous equational model approach. The research data uses secondary data in timeseries data from the period 1961-2018 of seven data sources. The data analys is used a simultaneous equations model (simultaneous equations model). This

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study's results can be used to compile an economic model of Indonesian rice, which will then be used for the preparation of rice policys cenarios in the golden age of Indonesia in 2045. This research aims to analyze factors that affected the rice economy in Indonesia toward riceself-sufficiency

RESEARCH METHODS

Data

The data used in the study are secondary data based on timeseries from 1961 - 2018. The data collected are from 1. Central Bureau of Statistics (BPS) 2. Ministry of Agriculture/ Pusdatin, 3. Food AgricultureOrganization (FAO)) 4. International Rice Research (IRR) 5. Ministryof Trade 6. United States Department ofAgriculture (USDA) 7. ASEAN Food Security Information System (AFSIS).

Model Specification

The model simplifies the real world, where all the activities of the agricultural economy are analyzed. The formulation of the model is the initial and most fundamental stage in studying the relationship between economic variables related to the built model. The model used in this study is a simultaneous equations model. It is a set of equations where the dependent variable in one or more equations becomes an independent variable in several other equations (Gujarati Damodar, 2012; Rendón, 2012). The simultaneous equation model has several equations that describe the relationship between the dependent variable and the independent variable, where at least one equation has one of the endogenous independent variables (Hult et al., 2018; Sarwar et al., 2017; Ullah et al., 2019).

This model is called the rice supply and demand econometric model, arranged in two blocks, namely the Supply Block and the Demand Block(Pathak & Shi, 2020). The model built can be developed for each subsector according to the available variables. The rice supply blocks consist of paddy production, rice production, rice area, rice productivity, paddyfields, labor, N fertilizer, P fertilizer, K fertilizer, pesticides, rice supply, loss of rice, rice supply, rice imports, rice exports, prices of domestic rice and world rice prices.

In detail the econometrica model of Indonesia's rice economic toward 2045 is described as **Fig. 1**.

Based on **Fig. 1**, the Indonesian rice economy model in 2045 is built using an econometricrice supply and rice demand model, which is arranged in two blocks, consisting of the Supply Block and the Demand Block. The rice supply block consists of 10 equation models, while the rice demand block consists of 5 equations. Based on the model built, it can be developed to analyze each sub sector according to the objectives and available variables. It is hoped that the 2045 Indonesian rice econometric model that makes up each equation can meet the economic criteria. This model has 12 equations consisting of 4 identity equations (equations 1, 2, 10, and 11) and 8 structural equations (equations 3, 4, 5, 6, 7, 8, 9, and 12).

RESULTS AND DISCUSSION

In general, the econometric model constructed is representative enough to describe the economic phenomenon of rice commodities in the domestic market and the world market, particularly regarding the performance of the Indonesian rice commercial economy. It is deduced from the evaluation of economic criteria, and the values of the statistical indicators obtained, namely the coefficient of determination (R^2), the F test, and the Durbin Watson test (DW). The results of the calculation of the value of the statistical indicators are shown in **Table 1**.

Evaluating the economic criteria for all estimation parameters in each of the equations used to build the Indonesian rice economy's econometric model has a sign and a magnitude that coincide with the expected economic criteria. So the coefficient of determination in most equations has a high value. **Table 2** shows that of the 12 equations that makeup the model, four equations have an R^2 value greater than 90%, five equations have an R^2 value between 60-90%, one equation has an R2 value between 60-70%, and three, the equation has an R2 value between <60%. It means that the explanatory variables included in the equations can describe the behavior of the endogenous variables.

The F-test (simultaneoustest/model test) of all the equations used to build the econometric model of the Indonesian rice economy shows that in the 11 equations, all the explanatory variables that makeup the equation together have a significant effect on the endogenous variables (level of significance of 1%). While an equation (rice import), the explanatory variable cannot explain the model. It indicates that if the t-test (partial test) is performed on each equation, then at least one explanatory variable has a significant effect (it has a high level of confidence in its endogenous variables).

The autocorrelation test results for all equations used to build the econometric model of the rice economy using the Durbin Watson test (DW test) show that there is only one equation out of the 12 structural equations used to buildt he model that has autocorrelation symptoms. According to Koutsoyiannis (1997), as a result of the autocorrelation symptom, the estimates of the regression coefficient obtained are still unbiased predictors, but the variants of the disorder variable are less efficient compared to the absence of autocorrelation symptoms. Therefore, the estimation model results in this study are still good enough to describe the economic phenomenon of rice in Indonesia.

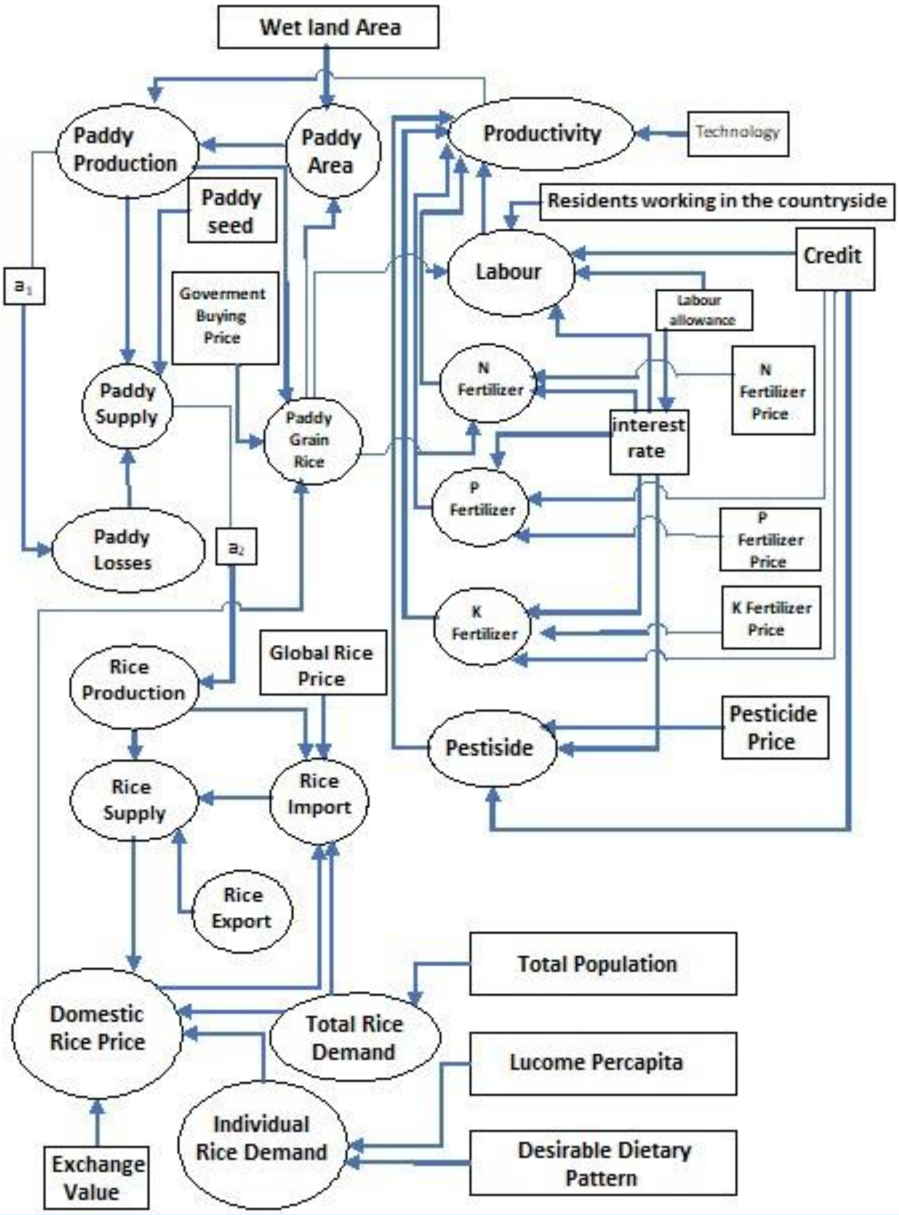

Fig. 1. Econometrica Model on Indonesia's Economic Rice Toward 2045

Table 1. Indonesia's Rice Economic Models

No	Model	Formulation/equation	Variables
1	Rice area	APt = ao + a1ASt + a2PPt + μ1	APt = paddy area (hectar) ASt = wet land area (hectar) PPt = paddy price (Rp/kg) Prediction mark of the expected parameters a1 >0, a2 >0, and a3 < 0
2	Rice production	QBt = a2*SPt	a2t = rice rendemen (percent) SPt = paddy supply (ton)
3	Rice productivity	YPt = bo + b1Lt + b2 FNt + b3 FPt + b4 FKt + b5 PESTt + b6 TEKt + μ2	YPt Paddy productivity (kwintal/hectar) Lt = labour usage (person) FNt = N Fertilizer usage (ton) FPt = P fertilizer usage (ton) FKt = K fertilizer usage (ton) Pestt = Pesticide usage (ton) Tekt = Level of technology application (Productivuty index) Prediction mark of the expected parameters b1 > 0, b2> 0, b3>0, b4>0, b5> 0, and b6> 0
4	Demand for Labour	Lt = c0 + c1PPt + c2 it + c3 KREt + c4 POPRt + μ3	Lt = Labour usage (person) PPt = paddy price (Rp/kg) it = rate of interest (percent) KREt = Total credit (rupiah) POPRt = agricultural sector labor wages (Rp/HOK) Prediction mark of the expected parameters c1>0, c2< 0, c3 > 0, and c4 > 0
5	Nitrogen fertilizer Usage	FNt = d0 + d1Pfnt + d2PPt + d3APt + d4 It + d5 KREt + μ4	FNt = N Fertilizer usage (ton) Pfnt = N Fertilizer price (Rp/kg) PPt = Paddy price (Rp/kg) APt = paddy area (hectar) It = rate of interest (percent) KREt = the amount of credit extended (Rp) Prediction mark of the expected parameters d1< 0, d2 > 0, d3 >0, c4 < 0,and d5 >0
6	Phosphat fertilizer usage	FPt = d0 + d1Pfpt + d2PPt + d3APt + d4 It + d5 KREt + μ5	FPt = P fertilizer usage (ton) Pfpt = P fretilizer price (Rp/kg) PPt = Paddy price (Rp/kg) APt = Paddy area (hectar) It = rate of interest (percent) KREt = the amount of credit extended (Rp) Prediction mark of the expected parameters d1 < 0, d2 > 0, d3 > 0, c4 < 0, and d5 >0
7	Kalium fertilizer usage	FKt = e0 + e1Pfkt + e2PPt + e3APt + e4 It + e5 KREt + μ6	FKt = K Fertilizer usage (ton) Pfkt = K fertilizer price (Rp/kg) PPt = Paddy price (Rp/kg) APt = luas areal padi (hectar) It = rate of interest (percent) KREt = the amount of credit extended (Rp) Prediction mark of the expected parameters e1 < 0, e2 > 0, e3 > 0, e4 < 0, and e5 >0
8	Pesticide usage	FPESTt = g0 + g1Ppestt + g2PPt + g3APt + g4 it+ d5 KREt + μ7	FKt = Pesticide usage (ton) Ppestt = Pesticide price (Rp/kg) PPt = Paddy price (Rp/kg) APt = Paddy area (hectar) It = interest rate (percent) KREt = the amount of credit extended (Rp) Prediction mark of the expected parameters g1 < 0, g2 > 0, g3 > 0, g4 < 0, and g5 >0
9	Individual Rice demand	DB0t = mo + m1PBt + m2INCt + m3PPHt + μ9	DB0t = individual rice demand year-t (kg/capita/year) PBt = rice price year-t (Rp/kg) INCt = income per capita year-t (Rp/capita/year) PPHt = desirable food pattern (Pola Pangan Harapan/PPH) year-t (percent) Prediction mark of the expected parameters m1< 0, m2 > 0, m3 < 0 Prediction mark of the expected parameters p1 > 0, n2 < 0, and n3 > 0
10.	Domestic rice price	PBt = n0 + n1 DBt + n2SBt + n3 Excht + μ10	PBt = domestic rice price year-t (Rp/kg) DBt = domestic rice demand year-t (ton) SBt = rice supply year-t (ton) Excht = exchange rate year-t (Rp/US $) Prediction mark of the expected parameters n1 > 0, n2 < 0, and n3 > 0
11	Paddy price	PPt = p0 + p1PBt + p2QPt + p3HPPt + μ10	PPt = paddy price p0 =contant p1PBt = rice demand in year-t P2QPt = paddy production in year t P3HPPt = μ10 = Prediction mark of the expected parameters
12	Rice import	MBt = h0 + h1PBt + h2PWBt + h3QBt + h4DBt + μ8	MBt = The amount of rice imported in year t (ton) PBt = Domestic price rice year-t (Rp/kg) PWBt = world rice price year-t (US $/ton) QBt = rice production year-t (ton) DBt = rice total demand year-t (ton) Prediction mark of the expected parameters h1 > 0, h2 < 0, h3 < 0, h4 > 0 dan 0 < h5 < 1

Source: Authors modelling

Table 2. Statistical Indicator Value: R^2, F, Level of significance, and DW

No	Variabel Endogen	R^2	F	A	DW
1	Paddy Area	0,71866	68.97	<0.0001	0,196787
2	Rice Production (QB_t)	0.99164	6523,39	<0,0001	0,737162
3	Rice productivty (YPt)	0,9999	1000	<0,0001	2,6708
4	Demand for labor (Lt)	0,39360	8,44	<0,0001	0,725325
5	Nitrogen fertilizer usage(FNt)	0,93569	148,41	<0,0001	1,127026
6	Phosphat fertilizer usage (FPt)	0,94277	168,04	<0,0001	2,076095
7	Kalium fertizer usage (FKt)	0,88809	80,94	<0,0001	1,255317
8	Pesticide usage (PESTt)	0,22420	2,95	0,0206	0,803703
9	Individual rice demand (DBOt)	0,64286	31,80	<0,0001	0,434131
10	Domestic rice price (PBt)	0,83546	89,70	<0,0001	0,191623
11	Paddy price (PPt)	0,77908	62,30	<0,0001	0,744233
12	Rice import (MBt)	0,06166	0,85	0,4976	1,18559

α = level of significance

CONCLUSION

This research is a preliminary study of the Indonesian Rice Economic Model towards a golden Indonesia 2045 to strengthen food security and riceself-sufficiency. This study uses secondary data, using a simultaneous equation approach of 18 models. In this study, 12 models were tested. The results showed that of the 12 equation models analyzed, 11 models can be used to describe the economic behavior of Indonesian rice with the results of the actual F-test at the 1% level, where 75 percent of the independent variables in the model can explain the dependent variable with an average R^2 of 85%.

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