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A National Food Crops Policy Model for Indonesia

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From the implementation of the New Order government's first five-year development plan (Repelita I) in 1969 until the mid-1980's, the overriding objective of Indonesian food policy was to increase rice production so as to be self-sufficient, at a relatively high level of consumption, in the nation's basic staple food. The goal of rice self-sufficiency was pursued through a centrally directed program of production and area targets, subsidized distribution of inputs with extension services, investments in irrigation and marketing infrastructure, and a remunerative floor price to farmers. With the achievement of rice self-sufficiency in 1985, the focus of Indonesia's food policy was broadened somewhat to include the promotion of secondary food crops production. But the basic mechanism of centrally directed supply targets and input distribution remained as the means to encourage diversification of the food crops sector.

Today, Indonesia is pursuing economic reforms directed at moving away from an administered economy to one more responsive to domestic and international market forces. At the national level for the agricultural sector, these reforms suggest a reduction in agricultural input subsidies, a relaxation of commodity production targets, and a better integration of the agricultural sector both with international commodity markets and with other sectors of the economy. This liberalization of

the agricultural economy will occur against the backdrop of two conflicting sectoral realities: 1) rice self-sufficiency, still Indonesia's preeminent food policy objective, is very tenuous and must be pursued vigorously if the trend in domestic production is to meet an even lower than historical trend in domestic consumption in the future; and 2) rising Indonesian incomes are changing the structure of consumer demand and creating different food crop requirements, in particular, the derived demand for secondary crops as animal feeds resulting from increased consumer demand for livestock products. More broadly, although agriculture's share of GDP was halved to about 25 percent in 1988, the sector still remains the largest source of employment for unskilled labor, providing incomes to more than half of the population. Continued growth in the agricultural sector, therefore, is necessary to absorb Indonesia's ever increasing labor force and to promote a stable transition to an industrialized economy.

What is necessary for Indonesia's food policymakers at this time is flexible analytical tools to provide guidance in managing the transition of the agricultural economy to a more market oriented structure. To be useful in this regard, a set of planning tools which explicitly, and consistently, take into account the inter-commodity and inter-sectoral effects of economic interventions and their removal on the food sector is required. In what follows, a simulation model of Indonesia's food crops sector is introduced and described. The simulation

uses a demand system to model consumption and an area and productivity (yield) model to determine food crops supply. Through a supply-driven link to national income formation, the sector model is linked simultaneously to the determination of national income. The simulation model is used to derive a baseline scenario for the Repelita V period (1989-93) to be used as a benchmark for conducting subsequent policy analysis. The potential impact of policy changes can then be assessed as percentage changes from the baseline.

A National Food Crops Policy Model

Model Overview

The national model is built on a spreadsheet (Lotus 123) and is in a format that easily accommodates changes in behavioral parameter estimates and even in assumed economic behavior itself. This feature of flexibility is incorporated to reflect Indonesia's rich accumulation of applied econometric research on commodity and input markets and the consequent range of parameter estimates available (Ellis, 1988). It is not unusual for econometric estimation models with differing structures, specifications, and underlying data sources to generate different behavioral parameters. The problem for policy analysts and policymakers is to discern what reliable projections can be made of undertaking certain courses of action from a wide range of behavioral parameter estimates. Flexibility of analytical tools is key in such an environment.

The present version of the National Food Crops Policy Model (NFCPM) for Indonesia is a price-exogenous adaptation of a multi-commodity, multi-sector, real-price driven econometric simulation model developed by Altemeier, Tabor, and Daris (1989). Demand for eight food crops, rice, wheat, corn, cassava, soybeans, mungbeans, peanuts, and sugar is estimated as a function of private expenditures and real food crop prices. Agricultural commodity supply is also for eight food crops (wheat is not grown in Indonesia but rice is separated into dryland and wetland production) and is defined as the product of area-harvested and yields. Area-harvested is estimated as a function of current or previous period crop prices and previous-period area achievements. Yields are derived from a profit-maximizing relationship between output prices and input prices. Supply available from production is adjusted for intermediate use (seed use, waste, feed, and industrial use) and human consumption to determine a domestic market deficit or surplus. Market deficits or surpluses are closed by trade and/or changes in stock levels.

The model is simultaneous in that agricultural sector income is linked to the determination of private consumption expenditures, which in turn drive staple food demand. The value of food crop sector income is endogenously calculated by the model as the value of food crop sector product at wholesale prices less expenditures on fertilizer. Food crop sector income is added to product from other sectors of the economy to give total GDP which then determines private consumption expenditures.

A flowchart of the model can be found in Figure 1.

Supply

Food crop production for wetland rice, dryland rice, soybeans, corn, cassava, peanuts, mungbeans, and sugar is represented in the model. Farmers are assumed to follow a two-stage decision making process. In the first stage, they choose which commodity to produce by allocating their land to various crops. In the second stage, farmers apply variable factors of production such as labor and fertilizer to determine a yield per hectare for the chosen commodity. For each commodity, then, domestic production is defined as the product of area and yield (see appendix for variable definitions):

$$(1) \quad \ln X_{wi} = \ln Y_i + \ln A_i.$$

Area allocated to food crops production is a function of real own-crop prices, real prices of other land-competing crops, and previous period area achievements. The area allocation process is thus modeled to behave like a Nerlovian stock adjustment process. The typical form of the area-response equation used is with a single-period lagged expectation as follows:

$$(2) \quad \ln A_i = a(t) + \sum_{j=1}^{m} b_{ij} \cdot \ln P_{j(t,t-1)} + bb_i \cdot \ln A_{i(t-1)}.$$

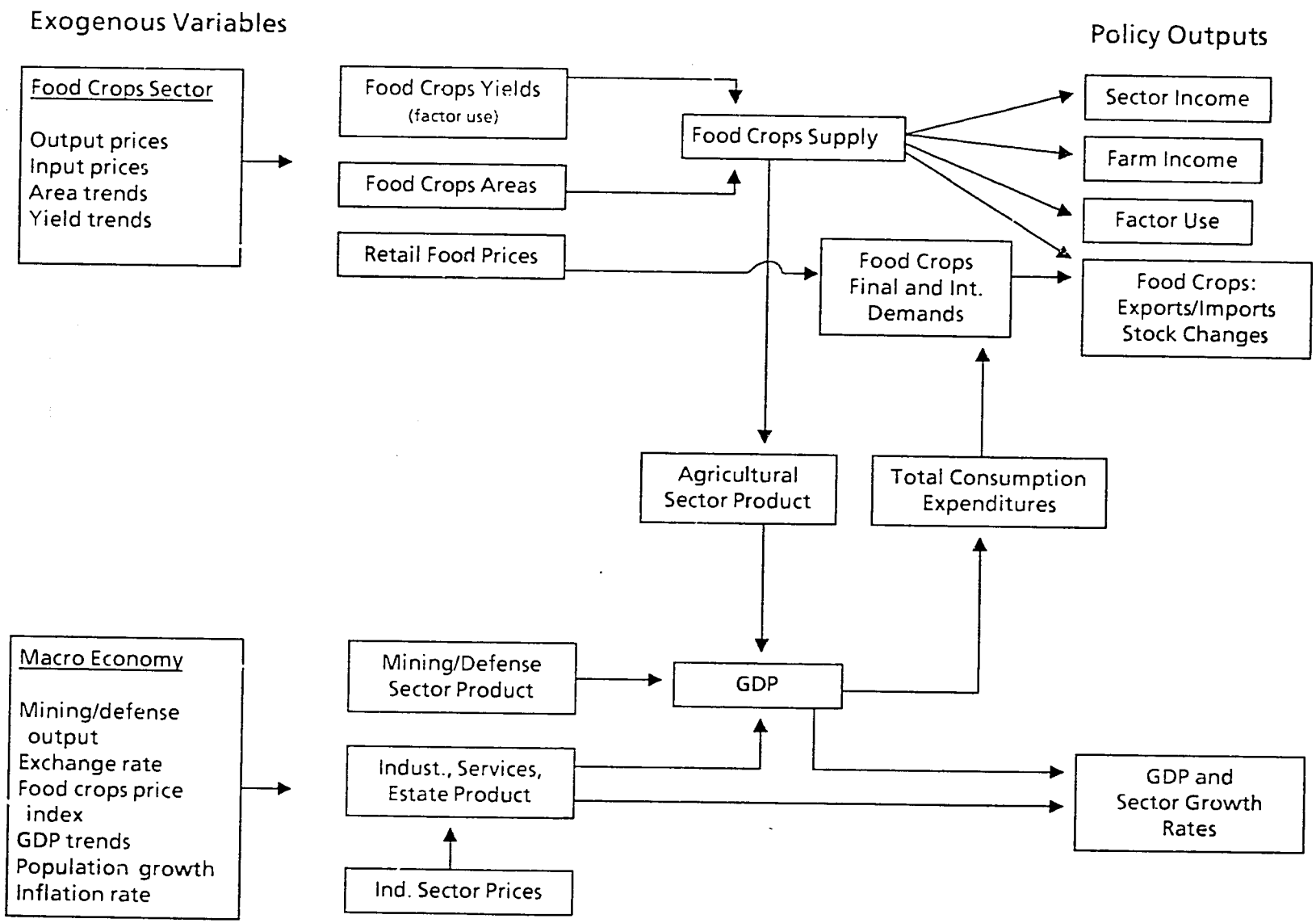

Figure 1. Model Structure

Whether current one-period lagged prices are used depends upon when in the calendar year the main planting time occurs and the duration of the crop cycle. For example, the main rice planting period is October and November with the main harvest occuring in April. Lagged prices are used in the rice equations. The main corn planting period is September\October with the main harvest in January. Lagged prices are used in the corn equation as well. Equations for longer duration crops such as sugarcane and cassava employ lagged prices also. Soybeans, on the other hand, have a growing time of only three months and are harvested continuously throughout the year. Current period prices are therefore used for soybeans. The lagged area variable is highly collinear with government area targets and must be interpreted accordingly. Finally, the intercepts are functions of time and shift according to non-price factors such as public investments in new irrigation systems and rehabilitation.

Yields per hectare are defined as a function of output price, input prices for labor and fertilizer variable inputs, and time:

$$(3) \quad \ln Y_i = a(t) + C_i \cdot \ln p_i + \sum_{j=1}^{r} d_{ij} \cdot \ln q_j$$

The yield elasticities are derived from a profit function approach modeling the crop productivity relationship. Under the

assumption of profit maximization, farmers apply labor and fertilizer so as to maximize profits. This second stage of the production process is thus modeled as the yield that results per hectare if farmers, having already allocated their lands to various commodities, maximize profits. The inclusion of a trend relationship in the yield equations allows explicit treatment of exogenous efficiency gains that can result from, for example, dissemination of new technology and enhanced human capital.

Factor demands per hectare are also defined as a linear function of input and output prices and time:

$$(4) \quad \ln r_{ij} = a(t) + \sum_{k=1}^{m} \mu_{ik} \cdot \ln q_{jk} + \eta_{ij} \cdot \ln p_i .$$

The factor demand elasticities, like the yield elasticities, are derived from a profit function model. The inclusion of a trend relationship allows for the impact of behavioral changes in input use due to new technology and enhanced human capital. In the future, labor use per hectare is likely to fall for most crops as the mechanization of agricultural tasks spreads, but fertilizer use per hectare is likely to increase due to exogenous factors.

Demand

Food crop demand per capita is modeled as a linear function of own and other staple foods prices and an endogenously

determined estimate of real total expenditures:

$$(5) \quad \ln X_{di} = a(t) + e_i \cdot \ln \widehat{TEXPC} + \sum_{j=1}^{m} f_{ij} \cdot \ln p_j .$$

Elasticity values are derived under the assumption of a sub-utility maximizing, two-stage (staple foods and everything else) expenditure budgeting. That is, in the parameter estimations, household consumption is assumed done first by allocating the budget between staple foods and other goods, then within each class of commodities. Private consumption expenditures per capita, which together with prices drive demand, are defined as a function of an endogenously defined estimate of GDP (described further below):

$$(6) \quad \ln \widehat{TEXPC} = a + g \cdot \ln \widehat{GDP} - \ln POP.$$

Macro-Component

Agricultural production is linked directly to national income formation. In the macro-component of the model, the economy is partitioned into three sectors. National income is defined as the sum of income generated in (1) the food crops sector, (2) the mining and defense sectors, and (3) the other industrial and services sectors:

$$(7) \quad GDP = GDP_1 + GDP_2 + GDP_3 .$$

The food crops sector income is derived directly from the supply side of the model. Food crops sector product is defined as the value of food crops sector output valued at real wholesale crop prices less the cost of fertilizer:

$$(8) \quad GDP_1 = \left[\sum_{i=1}^{m} p_i \cdot X_{wi} - q_j \cdot \sum_{i=1}^{m} r_{ij} \cdot A_i \right] \cdot CORR \ (j = \text{fertilizer}).$$

The endogenously determined sector income thus includes all rents, profits, and interest generated from farm production minus the cost of chemical fertilizers, the predominant agricultural input used from outside the sector. The parameter CORR is a constant correction factor that accounts for differences between the endogenously determined food crops sector product and figures from national statistical yearbooks. This parameter reflects, largely, the value of horticultural production which is not accounted for in the model but is included as part of food crops sector income in the national accounts. National product generated from estates and livestock production is not included in the CORR parameter.

The "mining and quarrying" and "administrative services and defense" subsectors from the national accounts are added together to comprise a sector labeled mining and defense. The value of extractive earnings and thus mining sector output depends very heavily on world petroleum prices, as does the budgetary funds

available to undertake administrative and defense activities. For this reason, the GDP from this sector is defined exogenously in the model.

The difference between total GDP and the sum of food crops sector product and the mining and defense sector product equals, by definition, the value of goods and services produced in other sectors of the economy. This other or residual sector is comprised mainly of industrial, services, and estates production. In a real price model with an exogenous inflation rate, price changes in agriculture must be offset by price movements for products in this other goods sector. The price relationship between agricultural and non-agricultural sectors affects the real growth potential in either sector. Further, since many products in the other sector are tradeable, the real exchange rate will have an impact on non-agricultural production. Production in the industrial and services sector, then, is defined as a function of exogenous technical change, relative inter-sectoral prices, and the real Rp/US$ exchange rate:

$$(9) \quad GDP_{\Xi} = a(t) + h \cdot \ln (\hat{P}_{\Xi} / \hat{P}_{+}) + \epsilon \cdot \ln EXC + \ln \hat{P}_{\Xi}.$$

Intersectoral, real price relationships are formed by determining nonagricultural prices as a function of an index of agricultural prices. The agricultural price index is defined as a share-weighted sum of commodity prices:

$$(10) \quad \ln \hat{p}_f = \sum_{j=1}^{m} \hat{W}_j \cdot \ln(p_{j(t)} / p_{j(\text{base year})}),$$

with $\hat{w}(j)$ being:

$$(10a) \quad \hat{W}_j = X_{Bj} \cdot P_j / FEXP_{(t-1)}.$$

Nonagricultural prices are defined as a Lapashe index of food and non-food prices:

$$(10b) \quad \ln \hat{p}_x = \hat{V} \cdot \ln \hat{p}_f$$

determined by the relative share of food expenditures (FEXP) in total expenditures:

$$(10c) \quad \hat{V} = -S_f/(1-\hat{S}_f)$$

$$\hat{S}_f = [FEXP/TEXP]_{(t-1)}.$$

Model Closure

In a model such as the one described above, either agricultural output prices or trade quantities can be set exogenously, in addition to the exchange rate, input prices, population growth rates, and mining/defense sector output. In the present version of the model, trade and/or stocks changes are

allowed to adjust and clear commodity markets. Agricultural production yields an amount available for domestic use. Human consumption and intermediate uses (seed, waste, and other non-food uses) are subtracted off to yield a domestic market surplus or deficit, which is closed by trade and stock adjustments.

The nature of the adjustment process varies by commodity and reflects crop-specific trade policies. Wheat imports, although controlled by BULOG, is physically conducted by private flour mills that hold stocks for inventory purposes. These levels historically have been about twenty-five percent of annual flour production. Rice trade policy during the Repelita V period is likely to be one of non-entry into world markets as long as domestic stock levels are within BULOG's operational bounds, between one and 2.5 million metric tons. When stock levels fall out of this range, BULOG will either import or export until stocks are back within an acceptable range. Sugar production is now consistently below domestic consumption so imports are necessary every year. Stock levels are quite high at present and are assumed to be reduced by 25,000 metric tons per year over the Fifth Plan period to keep imports at a reasonable level. Stock levels are far less significant for other crops and trade is assumed to clear all other markets.

The intermediate use of agricultural commodities is modeled very simply. Feed and other non-food use (waste and industrial use) are fixed percentages of annual production. The use rates

employed in the model are those found in the food balance sheets published by the Central Bureau of Statistics (CBS). (Further development of the model will include a more sophisticated specification of feed-use behavior.) Seed use is determined by average per-hectare application rates and cultivated area. Per-hectare seed application rates are taken from the annual cost of production surveys published by CBS.

Data and Assumptions

The model described above is in constant elasticity form. The NFCPM is tuned to the 1986 National Accounts but 1988 is the base year for model projections. Both 1986 and 1988 are considered normal years for agricultural production. The food crops sector is defined as production and consumption of rice, wheat, corn, cassava, soybeans, peanuts, and mungbeans measured at wholesale prices. Sugar is also included in the model because it is an important competitor with food crops but is not included in the calculation of sector product. Agricultural area parameters are based on time-series analysis of area and price developments. Yield and factor demand elasticities are based on econometric estimation of profit function relations using farm survey data from 1986. The estimation of supply parameters is discussed more fully in Altemeier et al., (1988). Commodity demand parameters are derived from an Almost Ideal Demand System (AIDS) model estimated from 17 years of expenditure and wholesale price data. The demand results are reported in Tabor

et al., (1989). Non- agricultural sector output is defined as total GDP less petroleum/defense sector output and agricultural sector output. A time series of (deflated) exchange rates and the consumer price indices reported by CBS were used in the estimation of non- agricultural GDP. The elasticity values used in the present model are reported in Table 1.

In the parameter estimations, homogeneity in production factor demand and aggregation as well as homogeneity and symmetry of commodity demands were imposed. These restrictions do not hold exactly for the demand parameters in Table 1 because wheat was not included in the AIDS estimation model. Demand parameters for wheat are taken from Meyers (1988) and added to the demand system without making adjustments to the other parameters. Therefore, own- and cross-price elasticities of demand no longer sum to zero. These changes should not affect significantly model simulation results, or the usefulness of the model, especially if it is used properly as an analytical tool rather than as a basis for forecasting.

Finally, although 1988 was considered a normal year for food crops production, adjustments were made to some of the intercepts in the area equations. The drought of 1987 affected corn, soybean, mungbean, and peanut production quite severely. Because of the impact of the one-period lagged area variable in the area equations, it was judged that the "below trend" cultivated areas in 1987 unduly raised equation intercepts for 1988, the model's projection base year. The 1987 lagged area figure was therefore

Table 1

Area Response Elasticities

Price/Crop	Wet Rice	Dry Rice	Corn	Cassava	Soybeans	Peanuts	M'beans	Sugar
Rice	0.157	0.475	0.000	0.000	0.000	0.000	0.000	-0.162
Corn	-0.079	0.000	0.687	-0.030	-0.157	-0.050	-0.674	0.000
Cassava	-0.004	0.000	-0.042	0.093	-0.149	0.000	0.000	0.000
Soybeans	-0.019	-0.006	-0.203	-0.069	1.106	-0.279	0.000	0.000
Peanuts	0.000	0.000	0.000	-0.121	-0.115	0.597	0.000	0.000
Mungbeans	0.000	-0.113	0.000	0.000	0.000	0.000	0.655	0.000
Sugar	-0.155	-0.259	-0.160	0.000	-0.059	0.000	-0.098	0.200
Lagged Area	0.000	0.000	0.680	0.870	0.290	0.770	0.750	0.500

Factor Demand Elasticities

Per ha. yields wrt	Wet Rice	Dry Rice	Corn	Cassava	Soybeans	Peanuts	M'beans	Sugar
Commodity price	0.30	0.29	0.60	0.27	0.19	0.09	0.19	0.30
Fertilizer price	-0.03	-0.01	-0.07	-0.05	-0.04	-0.01	-0.01	0.00
Wage rate	-0.27	-0.21	-0.53	-0.22	-0.15	-0.08	-0.18	0.00

Fertilizer demand wrt	All Rice	Corn	Cassava	Soybeans	Peanuts	M'beans	Sugar
Commodity price	0.63	0.96	1.28	1.09	0.26	0.52	
Fertilizer price	-0.47	-0.17	-0.66	-0.84	-0.74	-0.40	
Wage rate	-0.16	-0.78	-0.62	-0.25	0.48	-0.12	

Labor demand wrt	All Rice	Corn	Cassava	Soybeans	Peanuts	M'beans	Sugar
Commodity price	1.58	2.46	1.59	0.88	0.52	1.67	
Fertilizer price	0.00	-0.26	0.06	-0.05	0.07	-0.05	
Wage rate	-1.57	-2.20	-1.65	-0.83	-0.59	-1.61	

Demand Parameters

Price/Commodity	Rice	Corn	Cassava	Soybeans	Peanuts	Mungbeans	Sugar	Wheat
Rice	-0.1591	0.3865	0.4288	0.2139	0.4125	0.4055	0.1571	0.2000
Corn	0.0451	-0.2608	0.0556	0.0274	-0.1189	-0.1695	-0.0806	0.0500
Cassava	0.0356	0.0395	-0.3904	-0.0289	-0.1024	0.0904	-0.0005	0.0200
Soybeans	0.0230	0.0253	-0.0374	-0.7786	0.4828	-0.1391	0.2256	0.0200
Peanuts	0.0247	-0.0610	-0.0740	0.2690	-0.7379	0.4026	-0.0196	0.0000
Mungbeans	0.0069	-0.0245	0.0184	-0.0219	0.1136	-0.6799	0.0100	0.0000
Sugar	0.0239	-0.1049	-0.0010	0.3190	0.0497	0.0899	-0.2919	0.0200
Wheat	0.0300	0.0000	0.0200	0.0200	0.0000	0.0000	0.0200	-0.3800
Expenditure	0.2940	0.3880	0.2610	0.4580	0.6420	0.6140	0.5190	0.4750

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raised somewhat in the calculation of 1988 area intercepts for corn, soybeans, mungbeans, and peanuts. This change had the effect of making the 1988 intercept values for these crops lower than they would have been without adjustment.

Baseline Simulation

As discussed above, Indonesia has embarked on a program of economic liberalization. For a model like the one described above to be useful for analyzing economic policy reform during the Repelita V period, a baseline or benchmark from which the potential impact of policy changes can be judged must first be simulated. For a price-exogenous model, this involves making assumptions about domestic commodity prices in the future. Given the nature of the issues likely to confront Indonesia's policymakers during the Fifth Plan, an appropriate baseline would be one that reflects the consequences of a continuation of past agricultural policies and programs -- i.e., a high level of input subsidies, insulation of domestic markets from international markets, etc. -- in the pursuit of planned objectives and public investments for the sector.

The recently released Fifth Economic Development Plan calls for food self-sufficiency during the period 1989 to 1993. The price-endogenous model built by Altemeier et al., was used to simulate the domestic food crops prices resulting from pursuit of the stated goal of overall self-sufficiency during Replelita V. The food self-sufficiency objective was represented in the model

as a series of "feasible" target self-sufficiency ratios (domestic production over total demand) for individual food crops if stated policy goals are actively pursued. The trade ratios actually used represent a more modest set of goals than those found in the Fifth Plan. Setting trade ratios exogenously and simulating for prices allows movements of domestic prices different from world prices and thus a degree of protection for Indonesia's farmers as in the past. Exogenous growth rates in crop areas and yields were set also relative to the likely impact of planned levels of public investment and extension activities to be carried out over the period and historical trends. The assumptions used in this price simulation exercise are found in Table 2.

The resulting annual changes in real commodity prices for the Repelita V period are reported in Table 3. The price results indicate that steady increases in real food crops prices are necessary to achieve a somewhat more modest set of self-sufficiency targets than those implied in the Fifth Plan despite the very substantial run-up in prices that occurred during the 1986-88 period. In particular, rice prices must continue to rise if the tenuous self-sufficiency in Indonesia's basic staple food is to be maintained. Comparison of the domestic price projections with results from price projections found in the most recent CARD/FAPRI world agricultural outlook indicates that Indonesia's domestic prices could be increasing in the face of falling real agricultural commodity prices in world

Table 2

Simulation Scenario Assumptions for Repelita V Baseline

Exogenous Growth Parameters for:	Wetrice	Dryrice	Corn	Cassava	Soybeans	Peanuts	Mungbeans	Sugar
area(%/yr)	0.75	0.50	0.00	-0.50	2.50	0.50	0.50	1.00
yield (%/yr)	1.00	0.50	1.25	1.75	0.70	0.50	0.50	1.00
Trade Ratios	(all rice) 100%		100%	110%	80%	100%	100%	75%

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Table 3

Real Price Growth (%/year)

Commodity/Year	1989	1990	1991	1992	1993
Rice	2.5	2.1	2	2	1.9
Corn	1.2	1.3	1.2	1.2	1.2
Cassava	0.9	1.3	1.7	2.2	2.6
Soybeans	0.3	0.4	0.3	0.3	0.4
Peanuts	1.5	1.4	1.4	1.3	1.3
Mungbeans	0.1	0.1	0.2	0.2	0
Sugar	0	0.5	0.5	0.5	0.5
Wheat	1	-1	-1	-1	-1

markets. If so, Indonesia would have to continue insulating its domestic markets from international markets during the Repelita V period to achieve targeted production levels.

The next step in the analysis is to insert the price projections from the Altemeier model into the price-exogenous model described above to simulate a baseline for the Repelita V period. In theory, this could result in the same production and consumption levels as the price-endogenous model. However, the price-endogenous model employs a somewhat different parameter base, does not include wheat, and specifies cultivated area as a function of current real prices only. The exogenous growth rates in area and yields used in the baseline simulation are those in Table 2. In addition, population is projected to grow by 2.1% per annum during the period and real rural wages, fertilizer prices, and real exchange rates are assumed to remain unchanged after 1989; the petroleum and defense sector and the exogenous component of the industrial and services sector GDP equation are assumed to grow at 5% per annum.

The results of the baseline simulation along with base year data (1988) are summarized in Table 4. With real prices of all food commodities rising, and some help from slightly declining real wheat prices, production growth in the sector is fairly high and Repelita trade targets are attained or exceeded. For example, Indonesia becomes a net exporter of corn and is essentially self-sufficient in peanuts and mungbeans by the end of the plan period; the high level of cassava exports are

Table 4

Summary Table, Repelita V Baseline Simulation, 1988 - 1993

	Year	Rice	Corn	Cassava	Soybean	Peanut	Mungbean	Sugar	Total
Real Wholesale Price	1988	404	186	107	664	1429	970	621	
Real Farmgate Price		203	159	63	630	619	735		
(1986 Rp/kg)	1989	414	189	108	666	1450	971	621	
		208	161	64	632	573	736		
	1993	448	198	117	675	1530	976	634	
		225	169	69	641	663	740		
Growth Rate 1988-93, (%/year)		2.10	1.22	1.74	0.34	1.38	0.12	0.40	
Cultivated Area (1000 HA)	1988	10090	3203	1268	1143	582	316	326	16930
	1989	10443	3277	1292	1174	604	342	320	17452
	1993	10858	3573	1292	1326	715	393	309	18467
Growth Rate 1988-93, (%/year)		1.48	2.21	0.38	3.02	4.21	4.43	-1.15	1.75
Yields (MT/HA)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	3.03	2.25	13.31	1.14	1.01	0.79	6.09	
Growth Rate 1988-93, (%/year)		1.50	1.82	2.10	0.67	0.60	0.49	1.00	
Net Exports (1000 MT)	1988	-35	-33	1217	-373	-28	0	-256	
	1989	-275	-44	1239	-366	-25	8	-164	
	1993	0	92	1073	-438	5	-2	-476	

	1988	1989	1993	Growth Rate 1988-93, (%/year)
Food Crop Sector GDP (Billions 1986 Rp.)	19,682	20,962	25,252	5.11
Farm Income (Billions 1986 Rp.)	8,468	8,938	11,102	5.57
Other Sector GDP (Billions 1986 Rp.)	64,845	66,844	78,620	3.93
Overall GDP (Billions 1986 Rp.)	105,561	109,891	130,717	4.37

maintained, albeit at a lower level than at the beginning of the period; rice production stays in balance with rice consumption and imports are unnecessary. The sugar balance deteriorates as specified, with production levels falling to about 75 percent of domestic consumption.

What is disconcerting in the model results is that real price increases in food commodities constrain growth in overall GDP. The GOI's targeted GDP growth rate of 5% per annum is not attained on average over the period. Furthermore, the targeted growth rate of 10% per annum for the industrial and services sector is not even close to being reached. As long as Indonesia continues to pursue a high-price agriculture, high growth rates in other sectors of the economy will be difficult to achieve. This result points to a lack of consistency between agricultural production targets and the government's goal of attaining employment growth through industrial growth.

An Application

The baseline simulation described above suggests that high agricultural commodity prices are necessary to achieve even a more modest set of agricultural production targets than those implied by Repelita V. Results from the macro component of the model further suggest that high agricultural prices make attainment of policy goals in other sectors of the economy difficult to achieve. Therefore, a logical application of the model is a simulation of the implications of lower agricultural commodity prices during the Fifth Plan period. Two scenarios are

implemented. The first is a policy of no real price increases for food crops after 1989. The second consists of dropping all barriers to food crops trade after 1989, thus allowing world prices to become domestic prices. World agricultural commodity market price projections from the CARD/FAPRI models and the FAO are used in the second simulation. The results from the two simulations, respectively, are summarized in Tables 5 and 6.

The constant real price simulation indicates a deterioration in the agricultural trade position. Imports of rice, corn, soybeans, peanuts, and sugar increase significantly over the Plan period. Because of exogenous yield and area increases, food crop sector GDP and farm incomes grow at over 3 percent per year during Repelita V. The performance of the nonagricultural sectors improves over the baseline scenario though overall GDP growth remains about the same because higher industrial growth is offset by lower food crop sector growth.

The world price scenario results are quite interesting. Production of highly protected crops such as soybeans, peanuts, and sugarcane falls dramatically. On the other hand, performance of previously taxed crops, corn and cassava, is very strong. Although real output prices fall quite significantly, rice also does quite well once the relative price effects are sorted out. Rice production benefits at the expense of sugar and soybeans, and self-sufficiency is maintained, as in the baseline. Corn and cassava benefit also from the cross-effects of lower sugar and soybean prices, as well as from lower peanut and mungbean prices.

Table 5

Summary Table, Constant Real Price Simulation, 1988 - 1993

	Year	Rice	Corn	Cassava	Soybean	Peanut	Mungbean	Sugar	Total
Real Wholesale Price	1988	404	186	107	664	1429	970	621	
Real Farmgate Price		203	159	63	630	619	735		
(1986 Rp/kg)	1989	414	189	108	666	1430	971	621	
		208	161	64	632	573	736		
	1993	414	189	108	666	1450	971	621	
		207	161	63	632	628	736		
Growth Rate 1988-93, (%/year)		0.48	0.28	0.14	0.07	0.29	0.02	-0.01	
Cultivated Area (1000 HA)	1988	10090	3203	1268	1143	582	316	328	16930
	1989	10443	3277	1292	1174	604	342	320	17452
	1993	10787	3477	1296	1345	679	416	313	18313
Growth Rate 1988-93, (%/year)		1.34	1.65	0.45	3.32	3.12	5.64	-0.96	1.58
Yields (MT/HA)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	2.96	2.19	13.03	1.14	1.01	0.79	6.09	
Growth Rate 1988-93, (%/year)		1.04	1.25	1.66	0.61	0.50	0.47	1.00	
Net Exports (1000 MT)	1988	-35	-33	1217	-373	-28	0	-256	
	1989	-275	-44	1239	-366	-25	8	-164	
	1993	-1000	-154	833	-382	-42	27	-453	

	1988	1989	1993	Growth Rate 1988-93, (%/year)
Food Crop Sector GDP (Billions 1986 Rp.)	19,682	20,962	22,835	3.02
Farm Income (Billions 1986 Rp.)	8,468	8,938	9,942	3.26
Other Sector GDP (Billions 1986 Rp.)	64,845	66,844	81,679	4.72
Overall GDP (Billions 1986 Rp.)	105,561	109,891	131,358	4.47

Table 6

Summary Table, World Price Simulation, 1988 - 1993

	Year	Rice	Corn	Cassava	Soybean	Peanut	Mungbean	Sugar	Total
Real Wholesale Price	1988	404	186	107	664	1429	970	621	
Real Farmgate Price		203	159	63	630	619	735		
(1986 Rp/kg)	1989	414	189	108	666	1450	971	621	
		208	161	64	632	573	736		
	1993	353	179	147	371	536	508	350	
		177	153	86	352	232	385		
Growth Rate 1988-93, (%/year)		-2.70	-0.79	6.47	-10.99	-17.81	-12.15	-10.84	
Cultivated Area (1000 HA)	1988	10090	3203	1268	1143	582	316	328	16930
	1989	10443	3277	1292	1174	604	342	320	17452
	1993	11667	4884	2164	633	206	170	270	19994
Growth Rate 1988-93, (%/year)		2.95	8.80	11.29	-11.16	-18.73	-11.71	-3.78	3.38
Yields (MT/HA)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	2.81	2.12	14.16	1.02	0.92	0.70	6.09	
Growth Rate 1988-93, (%/year)		0.00	0.61	3.36	-1.60	-1.28	-1.93	1.00	
Net Exports (1000 MT)	1988	-35	-33	1217	-373	-28	0	-256	
	1989	-275	-44	1239	-366	-25	8	-164	
	1993	0	1300	12711	-1149	-710	-181	-837	

	1988	1989	1993	Growth Rate 1988-93, (%/year)
Food Crop Sector GDP (Billions 1986 Rp.)	19,682	20,962	22,208	2.44
Farm Income (Billions 1986 Rp.)	8,468	8,938	9,263	1.81
Other Sector GDP (Billions 1986 Rp.)	64,845	66,844	88,053	6.31
Overall GDP (Billions 1986 Rp.)	105,561	109,891	137,106	5.37

Under the world price scenario, the performance of the industrial and services sector is very strong and overall GDP grows at over 5 percent per annum. The agricultural price index falls quite substantially, unleashing productive capacity in industry. A major drawback of a world price policy like the one simulated is the drastic drop in farm income that occurs in the first year of implementation. Although incomes do recover by 1993, the implied, short-run decrease in farm income resulting from such a policy change probably is unacceptable politically. But various measures, such as allowing rice prices to remain above world prices for one or two years, would cushion this short-run impact considerably. What is crucial to note, however, is the importance of the inter-commodity effects of price policy changes and the implication that a liberalization of agricultural trade must be sector-wide rather than crop-specific for desired outcomes, such as trend self-sufficiency in rice and increased corn production, to occur. From a methodological standpoint, this result shows the necessity of using multi-market analytical tools, such as the CARD National Food Crops Policy Model, when examining food price policy questions.

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Appendix: Symbols Used in Model Equations

GDP	Gross National Product (Rp. billions).
GDP_1	Gross Food Crops Sector product (Rp. billions).
GDP_2	Gross Mining and Defense Sector product (Rp. billions).
GDP_3	Gross Industrial, Services, and Estate sector product (Rp. billions).
p	Real food crop commodity wholesale prices (Rp/kg).
q	Real input prices.
EXC	Foreign exchange rate (Rp/US$).
x_s	Food crops supply (1000 MT).
x_d	Food crops demand (1000 MT).
A	Food crop harvested area (1000 HA).
r	Variable input demands (1000 MT).
Y	Yield per hectare (MT/HA).
TEXP	Total real consumption expenditures (Rp. billions)
TEXPC	TEXP per capita.
POP	Population growth rate.
P_f	Food crop commodity price index.
P_2	Other goods sector (GDP_3) commodity price index.
s	Food and non-food expenditure budget shares.
w	Single food crop commodity expenditure budget shares.
FEXP	Food crop consumption expenditures (Rp. billions).
a	Behavioral equation intercepts.
b	Area response own and cross price elasticities.
bb	Area response lagged area elasticity.
c	Yield response own price elasticities.

d	Yield response factor price elasticities.
u	Factor demand own and cross factor price elasticities.
n	Factor demand commodity price elasticities.
e	Food crop commodity expenditure (income) elasticities.
f	Compensated commodity demand own and cross price elasticities.
g	Expenditure income (GNP) elasticity.
h	Industrial sector product price ratio (food/non-food) elasticity.
v	Food/non-food expenditure ratio.
ε	Industrial sector ($GDP_{\neq}$) exchange rate elasticity.
^	Estimate.