THE DISTRIBUTIONAL IMPACTS OF FOOD SECURITY POLICIES IN INDONESIA: RESULTS FROM A STOCHASTIC SIMULATION MODEL OF THE AGRICULTURAL SECTOR

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Introduction

In the past 15 years, the Indonesian economy has grown rapidly, and, since 1973-1974, increased oil revenues have reduced foreign exchange constraints and allowed rapid increases in capital and consumer goods imports. Despite growth in the industrial sector, the subsistence oriented farm sector is still the largest employer in the country. About 80 percent of the present population of 150 million live in rural areas. The food security of both the urban and rural populations has been a prime goal of the government. It has been achieved principally through the regulation of the domestic rice market by the National Logistics Agency (BULOG), the total cost of which fluctuates considerably from year to year, depending on world price movements and domestic production performance. The prospect that domestic energy demand may erode oil export revenues suggests that food policies which focus less on the level and stability of rice prices need to be evaluated.

Since food consumption patterns and preferences differ markedly between income groups, changes in policies affecting relative rice prices have different impacts on the quality and stability of the food intake within each group. This paper describes results from a stochastic simulation model which disaggregates consumers into two urban and two rural income groups, and food production and consumption into five staple food crops. Results from the model support the hypothesis that higher and less stable rice prices would have their most deleterious impact on the urban poor; however, less severe regulation of the domestic rice market is shown to lead to significant increases in the food risk faced by all groups.

Consumer Tastes and Consumption Patterns in Indonesia

Data from Indonesia's National Socioeconomic Surveys (Susenas) of 1969-1970, 1976, and 1978 were analyzed by several researchers to identify patterns of food consumption and to estimate expenditure and price elasticities of demand (Dixon, a). Much of the work concentrated on the 1976 Susenas and on the major starchy staples: rice, wheat, maize, cassava, and sweet potatoes, which provide three quarters of Indonesia's average food energy consumption. Susenas data disaggregate consumption patterns into urban and rural groups, and into income classes within these groups. Briefly, the pattern of consumption is as follows: urban staple food consumption consists almost entirely of rice, with a little wheat included. Rural staple food consumption is more diversified, with maize and cassava (in both the fresh root and dried forms) being very important. While there is little variability in staple food consumption patterns in urban areas, rural consumption patterns show major variations seasonally, and by income groups.

Our analysis divides the Indonesian population into four groups: high and low income urban dwellers and high and low income rural dwellers. Estimates are made of the distributions of total population, income, and stable food consumption between these four groups (see table 1). The estimates of income shares are based on the 1976 Susenas and reflect the percentage of total income accounted for by each group. The staple food consumption shares are based on the 1976 population share in each group and the 1978 Susenas data on per capita consumption. Matrices of own price, cross price, and income elasticities of demand are assembled separately for each of the four groups (see table 2). The

Table 1. Subdivision of Consumers into Four Income Groups[a]

Income Group	Share of Population	Share of Personal Income	Share of Total Consumption				
			Rice	Wheat	Maize	Cassava	Sweet Potato
	Percent						
Urban high	8	20	9	30	0	5	4
Urban low	12	10	11	20	0	5	4
Rural high	28	42	37	30	25	30	44
Rural low	52	28	43	20	75	60	48

[a]The group characteristics shown are derived from the results of the 1976 and 1978 National Socioeconomic Surveys (Susenas). See Dixon, (a).

values adopted for the income elasticities are based on data from the several studies surveyed by Dixon and modified based on 1978 Susenas results. They are lower than some of the expenditure elasticity estimates based on cross sectional data, though higher than the time series estimates of Squire and others. The own price and cross price elasticity matrices were the most difficult to specify and represent a compilation of empirical results and qualitative insights. Weak cross elasticity estimates (typically those relating rice consumption to the prices of other foods) have occasionally been adjusted so that these matrices, combined with the corresponding vectors of income elasticities, conform approximately to the conditions imposed by consumption theory.

The Simulation Model

The model adopted simulates the short and medium run responses of Indonesia's staple food sector to changes in food trade and pricing policies. The interacting domestic markets for rice, wheat, maize, cassava, and sweet potatoes are simulated stochastically over the period 1979-1990. Exogenous variables driving the model (Tyers and Dixon) include: (1) the long run trend in national income and its distribution between identified income groups; (2) growth in the population of each group; (3) the trends in the international trading prices of rice, wheat, maize, and cassava, and correlated random deviations from these price trends; (4) the component of production growth due to cost reducing technological advance; and (5) additional random disturbances to the level of production of each commodity, resulting in year to year fluctuations in both domestic food output and the incomes of rural groups.

The consumption behaviour of each income group is assumed to be linear. Substitution due to changes in relative prices depends on a Slutsky matrix, derived from the elasticities of table 2 in each year of the simulation. The exogenous trend in per capita income is modified in each year in accordance with fixed elasticities of group income to crop output.[2] Changes in consumption resulting from the trend in income and short run production changes are then derived, based on fixed income elasticities of demand. On the supply side, a lagged and adjustment framework is used. The remainder of the model comprises equations determining the level of rice, wheat, and maize ending stocks, as they depend on expected profits from storage by the private sector and year to year fluctuations in total grain availability, and price transmission

Table 2. Price and Income Elasticities of Demand[a]

Income Group and Crop	Price Elasticity					Income Elasticity
	Rice	Wheat	Maize	Cassava	Sweet Potato	
Urban high						
Rice	-0.40	0.05	0.0	0.02	0.0	0.10
Wheat	0.30	-0.60	0.0	0.0	0.0	0.30
Maize	0.0	0.0	0.0	0.0	0.0	0.0
Cassava	0.10	0.0	0.0	-0.40	0.07	-0.10
Sweet Potato	0.0	0.0	0.0	0.30	-0.50	0.10
Urban low						
Rice	-0.50	0.02	0.0	0.003	0.0	0.35
Wheat	0.20	-0.80	0.0	0.0	0.0	0.60
Maize	0.0	0.0	0.0	0.0	0.0	-0.10
Cassava	0.10	0.0	0.0	-0.40	0.08	0.10
Sweet Potato	0.0	0.0	0.0	0.50	-0.90	0.40
Rural high						
Rice	-0.40	0.01	0.03	0.015	0.004	0.25
Wheat	0.20	-1.20	0.01	0.0	0.0	0.40
Maize	0.50	0.01	-0.80	0.46	0.046	-0.40
Cassava	0.20	0.0	0.30	-1.0	0.56	-0.10
Sweet Potato	0.10	0.0	0.10	0.20	-0.80	0.40
Rural low						
Rice	-0.80	0.004	0.11	0.10	0.006	0.60
Wheat	0.20	-1.00	0.05	0.05	0.0	0.60
Maize	0.90	0.01	-0.90	0.50	0.024	-0.50
Cassava	0.80	0.01	0.50	-1.20	0.053	-0.20
Sweet Potato	0.20	0.0	0.10	0.30	-1.20	0.50

[a]Elasticity values adopted for this study are based on a variety of estimates from the 1976 National Socioeconomic Survey (Susenas). Most values are based on the estimates for Java (Madura) by Dixon (a). The approaches adopted in the derivation are described in Dixon (b). Special account is also taken of the estimates by Timmer and Alderman.

equations which summarize the government's policies affecting the relationship between the domestic and border prices of traded goods. The production, storage, and price transmission components of the model have been described previously (Tyers and Chisholm; and Tyers and Rachman).

Important for this paper is the model's representation of goverment price policy. Producer prices are a fixed fraction of retail prices, the difference being due to a constant marketing margin and producer taxes (subsidies). The retail prices of rice and wheat are assumed to be regulated, through BULOG supply management, between a ceiling of p^{max} and a floor of $(1-b)p^{max}$.[3] The ceiling price is then assumed to be influenced by the level of the border price via a fixed price transmission elasticity, ϕ. In the reference projection, against which the results of alternative price policies are compared in later sections, the gap between the ceiling and floor prices of rice and wheat is collapsed to zero and no transmission of international price movements is permitted ($\phi = 0$). Thus, domestic rice and wheat prices are assumed to be held constant in real terms.

By contrast, the prices of maize and cassava are determined assuming perfect transmission of international price movements (ϕ=1). The price of nontraded sweet potatoes is set endogenously to clear the domestic market.

The Impact of Changes in Price Policy

Three alternative policy scenarios are examined and compared with the reference projection. The resulting changes in consumers' surplus[4] and food energy consumption[5] are evaluated for each income group (table 3). The alternative policy scenarios and their results are as follows:

1. A graduated increase in the regulated price of rice to a total of 10 percent by 1985 the price remaining constant thereafter. This policy change results in a 6-percent decline in expected total rice consumption in 1985 and in all subsequent years up to 1990. The expected welfare and food energy consumption impacts of this change are mitigated, however, by low price and income elasticities of demand among urban groups, and by high maize rice and cassava rice cross elasticities of demand among rural groups. These results indicate that the welfare and consumption impacts of such a rice price increase would be greatest among the urban poor. With such a policy change, however, the government deficit position from the regulation of the rice and wheat markets would improve by about Rp (1980) 34 million in 1985 and the decline in the coefficient of variation of this deficit from 0.39 to 0.24 would significantly reduce government exposure to financial risk.

2. The separation of the ceiling and floor prices through a graduated increase in the ceiling price to a total of 10 percent by 1985. In this scenario, rice prices are permitted to fluctuate across the acceptable price band. This is achieved by first evaluating the closed economy domestic price in each year, then comparing this price with the predetermined floor and ceiling prices. If it is within the acceptable range, it is permitted to stand and no imports or public stock releases are required. If it is above the ceiling, imports or stock releases are initiated which will return the price to ceiling level. The results again indicate that the urban poor would be the most seriously affected. In this case, however, the expected declines in economic surplus and consumption are smaller, while all four income groups bear greater risk from price fluctuation. The increases in the coefficients of variation and hence in the exposure to food risk of urban groups are markedly higher than for rural groups. This is partly because their exposure to risk in the reference case had been relatively small, since they consume little of the nonregulated commodities--maize, cassava, and sweet potatoes. It is also due to their small cross elasticities of demand between these commodities and rice; the reverse being true for rural groups which thereby are buffered against rice price risk. The adoption by the government of this price policy would improve its financial position by Rp (1980) 15 million in 1985 and reduce the coefficient of variation of its deficit from rice and wheat market regulation to 0.28.

3. An immediate increase in the elasticity of transmission of international rice price movements, from zero to 0.2. In this scenario, the floor and ceiling prices are united, as in the reference case, and the resulting regulated price is permitted to fluctuate slightly, following changes in the international price.[6] The result is a coefficient of variation of domestic rice prices of 5 percent--about double that occurring under policy scenario 2. In this case, the mean rice price remains roughly constant. Thus, the changes in the expected welfare or consumption measures stemming from

Table 3. The Effects of Alternative Price Policies on Consumer Welfare[a]

Policy	Welfare Measure		Percent Change From Reference Projection			
			Urban High	Urban Low	Rural High	Rural Low
1. Graduated 10 percent increase in stabilized rice price[b]	Consumers' surplus	1985	-4.2	-6.0	-4.2	-2.3
		1990	-4.1	-6.1	-4.2	-2.9
	Food energy consumption	1985	-2.8	-4.2	-2.3	-2.7
		1990	-2.8	-4.2	-2.3	-3.2
2. Graduated 10 percent increase in ceiling rice price with floor price fixed	Consumers' surplus	1985	-1.9	-2.6	-1.8	-1.0
		1990	-1.1	-1.6	-1.1	-0.7
	Coefficient of variation	1985	263.0	387.0	78.0	45.0
		1990	192.0	292.0	65.0	66.0
	Food energy consumption	1985	-1.2	-1.9	-1.0	-1.2
		1990	-0.8	-1.1	-0.6	-0.8
	Coefficient of variation	1985	209.0	486.0	66.0	153.0
		1990	153.0	375.0	62.0	131.0
3. Increased transmission of border rice price movements: $\phi = 0.2$[c]	Consumers' surplus[d]	1985	0.1	0.3	0.1	0.1
		1990	-0.1	-0.2	-0.2	-0.2
	Coefficient of variation	1985	322.0	462.0	106.0	62.0
		1990	275.0	405.0	104.0	95.0
	Food energy consumption[d]	1985	0.1	0.1	0.0	0.1
		1990	-0.2	-0.1	-0.1	-0.2
	Coefficient of variation	1985	252.0	555.0	87.0	118.0
		1990	215.0	496.0	91.0	98.0

[a]Except where otherwise specified, entries are percentage changes in forecast means from simulations.

[b]Graduated increase in the rice price to a total of 10 percent by 1985, remaining constant thereafter. Floor and ceiling prices equal and no border price transmission.

[c]Floor and ceiling prices equal to regulated price. This price is permitted to fluctuate following border price movements, with transmission elasticity 0.2.

[d]Small changes in means are primarily due to randomness in the average over 200 simulations. International price disturbances result in a non-mean-preserving spread, though this effect is very small in this case.

this policy change are negligible. However, the increases in food risk among urban groups are even more dramatic than in policy scenario 2. The adoption of this policy would also improve the government's financial position--by reducing fluctuations in rice and wheat imports and thereby reducing foreign exchange risk. The government's financial position would improve by Rp (1980) 29 million in 1985, while the coefficient of variation would decline to 0.36.

Conclusion

We conclude that analysis of economic policy alternatives affecting the pattern of food production and consumption in Indonesia is greatly facilitated by the disaggregation of consumers by income group. Changes in food price policy which would result in higher and less stable rice prices would impair the average welfare position of all income groups--most seriously the urban poor--while they would expose all urban consumers to large increases in uncertainty. The greater preparedness of rural groups to substitute maize or cassava for rice when rice prices are raised tends to reduce their exposure to risk as prices become more unstable.

Notes

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[2]The link between short run changes in production and rural incomes is complex. Assuming changes in production are associated with weather and other factors not resulting from farm investment, the elasticity of farm income to crop production is simply the ratio of the trend value of crop revenue to total farm income. Taking this approach, and assuming that the rural poor and the rural wealthy incur equal proportional changes, the estimates of σ adopted for rural groups in the model are: rice 0.22, maize 0.022, cassava 0.024, and sweet potatoes 0.005.

[3]This conforms with the establishment by BULOG of fixed ceiling and floor prices as a guide to supply management operations. See Amat.

[4]Consumers' surplus, stemming from the consumption by each group of the five commodities included, is derived by evaluation of a line integral. See Tyers and Rachman.

[5]Conversion to kilocalories is at the rates: 3,660, 3,500, 3,490, 1,100 and 1,050 kcal/kg for rice, wheat flour, maize, fresh cassava, and sweet potatoes, respectively.

[6]No upward or downward trend is assumed in any of the international prices included. Stochastic disturbances are introduced around constant trends.

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OPENER'S REMARKS—V. Johansson

Perhaps the most interesting methodological point in Mukhebi's paper is the multiobjective function described by equation (1). However, the paper does not include any information on how the multiobjective goal function was constructed. What are the respective weights for income and employment? No information was given on the market situation, a very crucial point. If the most promising strategy were applied, it remains a question whether there is a market for the additional products.

Lee's paper on Taiwan is based on very straightforward approaches. It seems that the highly aggregated approach generates results that ought to be fairly well known from other sources. The main question is, therefore, whether it would have been possible to use disaggregated data in the model to gain more detailed information on the weak points in the economic system.

Tyers et al.'s paper on Indonesia indicates a fairly complicated system of price regulation. With more information it would have been easier to assess the probable effects on price policy of the discussed changes.

OPENER'S REMARKS—I. B. Teken

I have two comments on Mukhebi's findings. First, the attempt to incorporate more than one national objective in the analysis is greatly appreciated. Problems in model building usually cause one to take the easiest option and incorporate only a single objective, usually the income maximizing or employment maximizing objective. Mukhebi, however, tried both of these. Many developing countries try to attain more than two national objectives; such as increase farmers' net income, attain self-sufficiency in agricultural production (usually the subsistence level), increase consumers' welfare, stabilize the domestic market price of important consumer goods, or decrease government expenditure, which together probably make the decision model too intricate and unmanageable.

Secondly, I should like to comment on the implications of Mukhebi's finding that policies should place more emphasis on food crop than cash crop production, and on labour intensive and land saving rather than capital intensive technologies. If small farmers concentrate on food crops, with output from 0.8 ha. which is probably enough for their own consumption, they will face problems in obtaining enough cash income for household expenditures. This means very careful planning of off-farm employment, as is also the case in Indonesia. Labour intensive and land saving technologies would have a negative effect on labour productivity. This is the case with land preparation for rice production in Indonesia. The traditional hoeing by hand is becoming increasingly unpopular among the younger generation of farmers, who expect to use more equipment.

Lee's paper is an excellent description of how to achieve successful agricultural development within overall economic development. Many developing countries today are in the stage of labour intensive development, usually accompanied by low labour productivity. In trying to learn from Taiwan's experience, it would be interesting to hear from Lee what preconditions and conditions were required for the transition to be successful, and the implications of this kind of transition with respect to growth and equity, especially for smaller farmers, and policies implemented to induce the smooth transition.

RAPPORTEUR'S REPORT—D. J. Ansell

There are two principal areas of debate on Mukhebi's paper. The first concerned the definition of income used in his model. This was important in explaining the basis of the trade-off between income and employment. If increasing employment took the form of family labour, then increasing employment would raise family labour income, although it might reduce the share accruing to management. If family income was the definition, then there was no conflict in objectives. The second theme of the discussion was the extent to which one was trying to compare the objectives of two different groups. Policymakers may be concerned with employment, but the farmer would be uniquely concerned with income. Mukhebi suggested that policymakers would be able to influence farmers through, for example, the price mechanism so that they could be induced to respond to employment objectives.

Some difficulties were encountered in discussing Lee's paper because he was not present. Questions on his paper were confined to requests for further information on the form of specification used to capture the time-varying change in parameters. Concerning the basis for measuring capital in the model, the estimates were built up from disaggregated data, and fixed and working capital were measured separately. Concerning the nature of the policies used in order to guide the process of technological transformation, it was explained that these were three main phases in development policy since 1952. The first, lasting until 1964, was a period during which labour was surplus and hence labour intensive technologies had been encouraged. From about 1964, a rapidly growing industrial sector had increased the demand for labour and mechanization had been introduced. Since 1972 there had been a return to more employment related rural development policies.

The principal areas of discussion on Tyers et al.'s paper related to the fact that consumption was divided by income groups, and what the effect on the model would have been on changing, particularly toward more equitable, income distribution. The authors of the paper suggested that it would be possible to disaggregate into other income groups but the main intention at this stage had been to develop the methodology rather than to make prescriptions.

Participants in the discussion included C. W. Capstick (Session Chairman), M. G. Chandrakanth, D. R. Colman, Richard J. Foote, H. M. G. Herath, and W. H. Meyers.