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RICE POLICY, TRADE, AND EXCHANGE RATE CHANGES IN INDONESIA: A GENERAL EQUILIBRIUM ANALYSIS

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ABSTRACT

This paper presents an agriculture-focused computable general equilibrium model that can be used to analyze the economy-wide impacts of changes in technology, market structure, and the foreign exchange rate on resource allocation, production, and trade in Indonesia. The model includes a specification of the rice market and the government price-support, stocking, and trade policies for rice. Using a mixed complementarity approach, the model incorporates inequalities and changes in policy regime as prices and/or stocks move within specified bands. The model is used to examine the impact on the Indonesian economy of changes in rice yield and exchange rates given different assumptions about the operations of BULOG (National Logistic Agency). An important result is that there is inefficient allocation of resources within agriculture and the rest of the economy if BULOG operates to maintain the rice price when there are significant increases in rice productivity or changes in the exchange rate. With increased productivity in rice, the price support scheme retains resources in rice production that would be better used in other, high value, agriculture. With devaluation, maintaining a low rice price discriminates against rice producers and hence slows the process of structural adjustment. In addition, the price support program is costly and strains the government accounts, even if the administrative costs of operating the program are ignored.

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Table of Contents

List of Tables and Figures

I. INTRODUCTION

Food policy in Indonesia aims to achieve food security by increasing food production, raising farm income, improving nutritional status of the people, and ensuring the availability of food supplies at affordable prices (BULOG 1996). For the last 27 years, Indonesian food policy has centered on rice, the most important staple crop. Since the early 1970s, rice policy in Indonesia has sought to attain food self sufficiency through price support, price stabilization, and public investment policies (Pearson et al., 1991). Indonesia's state monopoly, BULOG (national logistic agency), is in charge of carrying out the state's current rice policies, which center around four main objectives: (1) setting a "high enough" floor price to stimulate production; (2) establishing a ceiling price which assures a reasonable price for consumers; (3) maintaining sufficient range between these two prices to provide traders and millers a reasonable profit after holding rice between crop seasons; and (4) keeping an "appropriate" price relationship between domestic and international markets. BULOG's implementation of these price support and price stabilization policies for rice involves setting a floor price and a ceiling price, procuring paddy or milled rice, managing stocks, and controlling quality and distribution, as well as importing and exporting. BULOG's efforts to achieve commodity price stabilization has been acclaimed for its contribution to Indonesia's political stability and development (Timmer 1989).

With an unparalleled record in achieving rice self sufficiency during the late 1980s and early 1990s, Indonesia-- in the middle of the current Asian crisis-- is suffering from a prolonged drought and unsuccessful recent harvests. It has been estimated that Indonesia will need to import between 4.4 million and 8.0 million tonnes of rice in 1998, which amounts to about 25 to 40 percent of world trade in rice (*Economist* 1998: 39). To meet this considerable challenge, the government will need to provide BULOG with foreign exchange reserves to finance rice imports to provide enough food to support consumer prices. These developments have fueled the ongoing debate in Indonesia regarding BULOG interventions in the rice market.

In order to assess the economy-wide impacts of commodity market interventions, this study presents an agriculture-focused computable general equilibrium (AG-CGE) model for Indonesia. This analytical framework focuses on agriculture and on links between the agricultural and non-agricultural sectors. The model can be used for analyzing the impacts of changes in production technology, protection, subsidies, and the exchange rate on resource allocation, production, employment, and trade. The model incorporates a specification of the rice market and the role of BULOG, and is used to examine how changes in rice yield affect the economy under different scenarios concerning BULOG's management of the rice market. We also consider the impact of changes in the exchange rate.

II. THE MODEL

Table 1 presents an aggregate "macro" SAM (Social Accounting Matrix) for Indonesia for the benchmark year 1990, while Table 2 shows the level of disaggregation of the macro SAM underlying our AG-CGE model.[1] Specifying a complete model requires that the market, behavioral, and system relationships embodied in each account in the SAM be represented in the model structure. The *activity*, *commodity*, and *factor* accounts all require the specification of market behavior (supply, demand, and clearing conditions). The *households*, *enterprise*, and *government* accounts embody the private and public sector budget constraints (income equals expenditure). Finally, the *capital* and *world* accounts represent the macroeconomic requirements for internal (saving equals investment) and external (exports plus capital inflows equal imports) balance.[2]

Our AG-CGE model for Indonesia is a static general equilibrium model of a small, open economy of the type discussed in Dervis, de Melo, and Robinson (1982) and Devarajan, Lewis, and Robinson (1994). The model structure is designed with an emphasis on the agriculture sector and an explicit modeling of BULOG price support behavior formulated as a mixed complementarity problem (MCP).[3] Table 3 lists the equations describing the behavior of BULOG as part of the AG-CGE model. The remaining model equations are reported in Appendix Tables 1-6.[4]

In the AG-CGE model, BULOG is assumed to support producer and consumer prices within a plus-or-minus price band that is set exogenously. Inequalities (1) and (2) in Table 3 describe the producer and consumer price support scheme, respectively. In (1), the producer price of rice (*PX*) is not allowed to fall below an exogenously set level determined by a floor price (*pxtarg*) and an allowed price band (*dpxtarg*). Similarly, the consumer price of rice (*PC*) cannot exceed a pre-determined ceiling price (*pctarg*) and an allowed price band (*dpctarg*). There is a complementary slackness relationship between the producer-price and consumer-price inequalities and the BULOG stocking and de-stocking variables. For example, if *PC* hits the ceiling price plus the allowed band, say because of poor harvest, BULOG will start selling rice from its existing stocks, (BUL_i^{stk}) as defined in equation (5). The stock equals initial stocks (stk^o) plus the net of BULOG's domestic and international trade activities. When stock levels are low and hit the lower bound, BULOG will experience a period of stock accumulation by purchasing from domestic and international sources.

Equation (6) and inequality (7) introduce a policy tool to maintain a ceiling on fertilizer price. Equation (6) distinguishes the consumer price of a composite good (*PC*) and the price for composite goods (*PQ*) by including a fixed consumption subsidy/tax parameter (*tc*) and a subsidy variable (*SPC*)-- in stead of a quantity demand variable, as in the case of rice. Inequality (7) imposes a ceiling on *PC* by exogenously setting $pcup_i$ – the ceiling level – as a proportion of *PC*. If *PQ* goes up, pushing the consumer price (*PC*) to exceed the ceiling price level, the subsidy variable, *SPC*, which is initially set to zero, adjusts by assuming a positive value, and thus maintains the consumer price at a level that satisfies the inequality in (7). Again, there is a complementary slackness relationship between *SPC* and *PC*. If the *PC* inequality is strict, *SPC* is zero. Otherwise, *SPC* will be positive.

The model solves for domestic commodity and factor prices that equate supply and demand in all goods and factor markets. Traded and non-traded goods are assumed to be distinct by sector, with imports and exports being imperfect substitutes for goods produced in Indonesia and sold on the domestic market. The model incorporates a realistic degree of insulation of domestic commodity markets from world markets, but the links are still important. The model specifies an equilibrium relationship between the balance of trade (in goods and non-factor services, or the current account balance) and the real exchange rate (which measures the average price of traded goods — exports and imports — relative to the average price of domestically produced goods sold on the domestic market).

The aggregate consumer price index is the "numeraire" price index for the model, which means that the model base solution is a "no inflation" benchmark. All solution prices should be seen as relative to the consumer price index. The equilibrium exchange rate in the model can be interpreted as the real effective exchange rate, deflated by the Indonesian consumer price index. The exchange rate variable in the model is not a financial exchange rate, since the model has no assets, asset markets, or inflation.

III. BASE SOLUTION, POLICY EXPERIMENTS, AND RESULTS

The base run of the model starts from the benchmark SAM for 1990, and then updates indirect tax rates and tariff rates to 1995 values (see Robinson et al., 1997). We assume a 30 percent wedge between world export and import prices of rice facing BULOG when it operates in world markets, or plus and minus 15 percent, relative to the initial domestic price. The new base solution of the AG-CGE model is thus an updated 1990 base, with some data from 1995. This base solution provides the benchmark against which results from various experiments are compared. Table 4 presents this base solution and is organized to focus on the agriculture sector. The table lists sectoral value added, output, trade, trade ratios, and values of various elasticity parameters. According to Table 4, agriculture value added is 26.4 percent of total value added, of which, 16.2 percent is from Food crops, 3.5 percent from Other agriculture, 2.6 percent from Livestock, 1.9 percent from Forestry, and 2.1 percent from Fishery. The table also shows how value added is distributed among other non-agriculture sectors.

Rice Productivity Experiments

We consider three sets of experiments where rice productivity shocks are introduced: (1) an adverse productivity shock, (2) a favorable productivity shock, and (3) a favorable productivity shock where BULOG does not intervene in the rice market. To simulate rice productivity changes, we change the shift parameter in the production function for rice. Such changes can be interpreted as resulting from a temporary shock (e.g., weather, drought) or a permanent change (e.g., adopting new technology). In either case, we assume that the economy adjusts to the change, achieving a new market equilibrium.

For the first set of experiments, an adverse production shock, rice productivity is decreased in a series of five cumulative experiments. In each, rice productivity falls 5 percent, for a cumulative total of 25 percent decline in experiment 5. The second and the third set of experiments are similar, with sets of five cumulative experiments.

In the first two sets of experiments, BULOG is assumed to stabilize producer and consumer prices within a plus-or-minus band of five 5 percent.[5] The nature of BULOG intervention depends on the direction of the price change.[6] In the first set, with rice productivity falling (by 5 to 25 percent), there will be excess demand for rice and consumer prices will tend to rise. When the consumer price of rice hits the ceiling of the price band, BULOG intervenes by selling enough quantities of rice in the domestic market to satisfy the excess demand. BULOG first sells rice from its buffer stocks. In the model's stylization of BULOG behavior, once the buffer stock hits its lower limit, BULOG starts importing, buying rice on the international market at the prevailing spot price.[7] The productivity increase experiments are symmetric. The productivity increase generates an excess supply of rice, which should cause producer prices to fall. When the producer price hits the floor value, BULOG intervenes by purchasing rice from the domestic market to maintain the market price at the floor value. As BULOG purchases rice, it first replenishes its buffer stock. When stocks are at maximum target levels, BULOG starts exporting at the spot world export price (which is assumed to be 30 percent below the spot world import price).

Devaluation Experiments

We consider two sets of experiments where real exchange rate depreciation is introduced with and without intervention by BULOG in the rice market. In these experiments, the real exchange rate is fixed and the model solves endogenously for the equilibrium value of the balance of trade. In the first set, there is no BULOG intervention and the real exchange rate is devalued in a series of five steps of 3 percent each, for a cumulative total of 15 percent devaluation in experiment 5. The second set is similar, but BULOG does intervene in the rice market. The model's stylization of BULOG behavior follows the same assumptions adopted in the rice productivity experiments: a 5 percent plus or minus price band around producer and consumer prices, and a 3.5 percent buffer stocks of the initial level of rice production.

In these experiments, which explore the impact on Indonesia of major devaluation under different adjustment scenarios, we assume that producers and consumers react to changes in prices following supply and demand functions (derived from profit and utility maximization) in the medium run. During and after the Rupiah crisis in 1997-1998, there was a widespread hoarding of rice and other commodities by consumers. We can model this phenomenon as exogenously specified increases in inventory accumulation, but have not done so in the experiments reported below. We do some sensitivity analysis of our results to changes in inventory accumulation of rice, and report the qualitative results in the next section.

Results

Rice Productivity Decline

When rice productivity declines, the consumer price of rice tends to increase, prompting BULOG intervention to maintain the price within the 5 percent band. Tables 5, 6, and 7 list the results of this policy experiment. Table 5 shows the effect of the productivity decline on the government account. Initially, when rice productivity drops by 5 percent, there is a decline in government expenditure, because BULOG is earning money by selling from its buffer stock. However, as rice productivity continues to decline and BULOG intervenes more, net government expenditure rises as BULOG is forced to purchase imports (at spot world prices) to maintain the buffer stock at its minimum target level. The information on BULOG purchases/sales and BULOG imports/exports indicate how BULOG is intervening in the rice market. As rice productivity declines by 5 percent, BULOG sales increase from zero in the base year to 0.25 billion Rp., and BULOG imports remain unchanged since sales from existing buffer stocks are sufficient to maintain the consumer price for rice within the band. However, as rice productivity falls by 10 percent, or more, the volume of BULOG intervention in the rice market increases. BULOG sales cause buffer stocks to hit their lower limit, and BULOG starts importing. Below 10 percent, BULOG operations involve only increasing imports, which is reflected in the net government expenditure figures. Imports increase and the program becomes more costly.

consumer price of rice (*PC*) hits the price ceiling when productivity falls by 5 percent. Since a 5 percent price band on rice prices is maintained (consumer and producer prices), the percentage change in *PC* from its base value remains the same with further declines in rice productivity. Price stabilization becomes more costly as rice productivity falls. BULOG has to pay for imports at fixed world prices, but the domestic price increases as the exchange rate depreciates in reaction to the increased aggregate imports. The domestic output of rice (X) falls with the productivity decline. The supply of rice (Q) falls by less, as BULOG sells stocks and imports.

At the macro level, the aggregate effects of an adverse rice productivity shock, shown in Table 7, include a significant contraction in real GDP (-4.3 percent with a 25 percent decline in rice productivity), as rice output falls. Government consumption net of BULOG sales fall, while imports increase. The increase in real imports leads to a significant depreciation of the real exchange rate (2.8 percent). The depreciation has required to generate additional exports to pay for the additional imports. Both aggregate exports and imports increase. The macro impact of this scenario is significant, even though rice has a relatively small share of value added (about 8.4 percent). BULOG operations matter at the economy-wide level.

Rice Productivity Improvement

When rice productivity improves, the fall in the producer price of rice prompts BULOG intervention to maintain the 5 percent price band. Tables 8, 9, and 10 present the results of this policy experiment. Similar to the productivity decline experiment, Table 8 shows the impact of a favorable productivity shock in the rice market on the government accounts, Table 9 provides detailed results for the rice sector, and Table 10 lists the aggregate effects.

This experiment is the reverse of the first one, but the results are not perfectly symmetrical. In this case, BULOG operations will be reversed. Instead of selling rice to reduce excess demand, BULOG will have to purchase it to reduce the excess supply. Production of rice increases by 39 percent under a 25 percent increase in productivity (Table 9). Instead of importing rice to support its sales, BULOG will export surplus rice in excess of its stocking needs. Given that import prices of rice are much higher than export prices, when BULOG intervenes by selling rice on the world market, the export earnings are less than the corresponding import costs for the same amount of rice when BULOG imported rice in the first experiment. Table 8 shows how BULOG purchases and exports increase as rice productivity improves.

BULOG operations lose money (see the first two rows of Table 8) – more than under the productivity decline scenario. In supporting the domestic price, BULOG purchases rice at the support price and sells at a lower price to world markets. After a 5 percent productivity improvement, BULOG starts exporting, which causes a real appreciation of the exchange rate and changes in the structure of production. Total government revenue falls, largely because indirect tax revenue falls. The shift in the structure of production is towards activities with lower indirect tax rates (*e.g.*, agriculture). As a result, the government deficit increases (government savings fall in the expenditure account).

The asymmetry of response between experiments 1 and 2 is shown by the exchange rate effect (Table 10). In the first experiment, the exchange rate depreciates by 2.8 percent with productivity decline of 25 percent, while in the second the exchange rate appreciates by 2.5 percent when productivity increases 25 percent. The difference is due to the fact that the export price of rice is well below the import price. Increased exports generate smaller increase in earnings, and less exchange rate appreciation is required to generate the additional imports financed by the export earnings.

Rice Productivity Improvement Without BULOG Intervention

This experiment is the same as experiment 2 except that there is no BULOG intervention. Prices are free to adjust to changed market conditions. The absence of BULOG is assumed to preclude rice export, and the domestic market is assumed to absorb all the increased supply of rice.[8] The results, focusing on the differences from experiment 2, are shown in Figures 1, 2, and 3. Figure 1 shows what happens to agricultural and non-agricultural production. With BULOG intervention, the rice sector draws resources (capital and labor) away from other sectors, forcing more resources into agriculture than the free market would justify. For example, with a 25 percent increase in productivity, rice output increases by only 17 percent (not tabulated), compared to 39 percent with BULOG intervention (Table 9). Also, without BULOG intervention, net government revenue increases (not tabulated), while in the BULOG intervention case net government revenue falls.

Figure 2 shows the changes in agriculture and non-agriculture imports. With BULOG intervention, the exchange rate appreciates. Without BULOG intervention, there is no increase in rice exports (by assumption) and a slight depreciation of the exchange rate, as increased income leads to higher demand for imports. The difference is that, with BULOG intervention, all imports rise and there is displacement of domestic non-agricultural production – the Dutch disease. The same effect is seen in Figure 3, which shows the comparative effects on exports. They mirror the import effects except that, of course, agricultural exports (which include BULOG rice exports) rise while non-agricultural exports fall.

Figure 4 shows the differential impact of experiments 1 and 2 on the structure of agricultural production. The effect of BULOG intervention is dramatic, keeping agricultural resources in rice that would otherwise move to other crops, especially high-value crops such as fruits and vegetables. Other crops are also affected significantly.

Table 11 compares changes in GDP deflators with and without BULOG intervention with a 25 percent increase in rice productivity. With base values equal to 100 and the consumer price index being the numeraire, there is no effect on consumption deflators. With BULOG intervention, consumers are relatively worse off as the deflators for all non-consumption categories fall relative to consumer goods. Without BULOG intervention, the effects are reversed. The prices of non-consumer goods rise relative to consumer goods, so consumers are much better off.

Table 12 gives more detail on the changes in the real and nominal value added shares with a 25 percent rice productivity improvement with and without BULOG. BULOG operations do not allow large price changes, as evident from Table 11, and the gains from the rice productivity improvement do not spread to other sectors of the economy. Without BULOG market intervention, part of the productivity gain is spread across the rest of the economy as the output increases and associated productivity gain leads to lower rice prices, the nominal share of rice falls while real share rises. In other words, the impact of BULOG intervention on the real share of value added is favorable only to the rice sector. Without BULOG intervention, gains from rice productivity improvement spread across the Indonesian economy.

Devaluation

The results from these experiments are summarized in Figure 5. Devaluation of the real exchange rate leads to a shift of resources into the tradable good sectors — exports and import substitutes (see Table 4) — and leads to both increased exports and lower imports. Figure 5a shows the changes in aggregate real exports and imports, and Figure 5b shows the changes in the balance of trade in goods and non-factor services (the current account balance) in 1990 U.S. dollars. Changes in the value of agricultural production are shown in Figure 5c.

Without BULOG intervention, changes in the exchange rate cause changes in border prices that are passed through to the domestic market. With BULOG intervention, the government prevents the domestic price of rice from rising along with the devaluation. If rice were not exported or imported, it would act as a non-traded good, and the devaluation would lead to a relative fall in its price (since the price of traded goods would rise). With BULOG intervention, the price of rice is maintained at its current level, which is higher than that of non-traded goods but much lower than the border price of rice (which equals the world price times the exchange rate).

From Figure 5a, without BULOG intervention, rice is traded and the devaluation leads to a larger effect on both exports and imports relative to the effect when BULOG controls the price of rice. Figure 5b shows the effect on the balance of trade. With BULOG intervention, a given devaluation leads to a smaller improvement in the balance of trade. For example, with a 15 percent real devaluation, the trade balance improves by $39 billion without BULOG intervention and by $27 billion when BULOG intervenes. In effect, BULOG intervention hinders the process of structural adjustment, preventing price changes that would lead to needed changes in demand and reallocation of factors in response to the devaluation.

Figure 5c shows the impact of devaluation on agricultural production. With BULOG intervention to keep the price down, rice production falls, leading to a slight decline in aggregate agricultural production.[9] Without BULOG intervention, rice behaves as a tradable good and the devaluation leads to a significant increase in price and production. Total agricultural production rises, and there is some reallocation of resources away from lightly-traded agricultural goods (such as fruits and vegetables) toward rice and other traded goods (e.g., coconut and palm oil).

V. CONCLUSION

Starting from an agriculture-focused computable general equilibrium model of Indonesia, we have modeled the behavior of Indonesia's rice policy as implemented by BULOG. We use a mixed complementarity approach that allows the specification of inequalities and shifts of policy regime as prices and/or stocks move within specified bands. We use this model to explore the impact on the Indonesian economy of changes in the productivity of rice production under different assumptions about the operation of BULOG, and changes in the real exchange rate. Our empirical results support a few conclusions.

BULOG operations have significant impact on government accounts and macro variables. Policy intervention in the rice market reverberates throughout the Indonesian economy, which is not surprising given that rice production accounts for about 8.4 percent of value added (in 1990). The links between rice and the rest of agriculture, and between agricultural and non-agricultural sectors, are important.

If BULOG operates to maintain the rice price when there are significant increases in rice productivity, the results are:

- Rice production goes up dramatically, and the price support scheme attracts more resources into rice production. Instead of releasing resources to other high-value agricultural uses (*e.g.*, production of fruits and vegetables), the policy draws resources away from them. The result is an inefficient allocation of resources within agriculture and the rest of the economy.

- With increased rice production, BULOG price-support operations would lead to significant subsidized rice exports. The result is an appreciation of the real exchange rate, which leads to increased imports and a bias against other exports, especially of non-agricultural products. The result is an inefficient allocation of resources between agriculture and non-agriculture sectors.

- The prices of non-consumer goods (intermediate and capital goods) fall relative to the prices of consumer goods, especially food. Consumers are relatively worse off.

- The price-support program is expensive and strains the government accounts, even if the administrative costs of operating the program are ignored.

Without BULOG intervention, productivity increases in rice lead to different results, as follows;

- Rice production increases, but by significantly less. Resources are released from the rice sector to other higher-value agricultural and non-agricultural uses. The benefits of the productivity increase are spread across the economy, following market linkages.

- The price of rice falls to the world price. The relative prices of consumer goods fall, and consumers are better off.

- There is some depreciation of the real exchange rate and no bias against non-agricultural exports.

- Net government revenue increases as increased non-agricultural output generates increased tax revenue.

Finally, devaluation of the real exchange rate should lead to an improvement in the balance of trade, with increased production of tradable goods— both exports and import substitutes.

However, with BULOG intervention, rice does not behave like a tradable good. With BULOG intervention, compared to a situation where the rice market is free, the results are:

- Aggregate exports rise less and imports fall less.

- The impact of the devaluation on the balance of trade is weakened.

- Aggregate agricultural output falls instead of rising.

Intervention in the rice market thus hinders the process of structural adjustment that would normally take place with a major devaluation of the exchange rate.

NOTES

1. For a complete listing of the corresponding "Micro" SAM, see Appendix 3 in Robinson et al., (1997). Basic data from BPS (1994a) were used in constructing the benchmark SAM in the present study.

2. See Pyatt and Round (1985) and Robinson and Roland-Horst (1989) for perspectives on SAM based modeling.

3. For an introduction to complementarity problems applied to economic analysis that uses GAMS see Rutherford (1995) or Lofgren and Robinson (1997).

4. For a complete description of the model equations, the reader is referred to Chapter 4 in Robinson et al. (1997).

5. Note that we can specify more or less than 5 percent ceiling on consumer prices for rice.

6. BULOG behavior is modeled by specifying different “regimes” defined by inequalities in prices and buffer stocks. The regime switches are modeled using a mixed complementarity programming model.

7. BULOG's buffer stock amounts to 3.5 percent of the initial level of rice production. The buffer stock is set exogenously, and can be varied. Policy experiments can be implemented to test the effect of varying BULOG stocking capacity in response to a productivity shock.

8. In fact, the domestic price falls below the export price after the third step (15 percent productivity increase). At that point, the free market should start exporting. The last two steps thus overstate the displacement of resources out of rice.

9. This result is qualified and even reversed if one assumes that there is significant hoarding of rice as observed recently. Sensitivity experiments indicate that for every percentage point of gross rice output that is hoarded (i.e., an increase in inventory accumulation), the price of rice goes up by roughly a percentage point.

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TABLE 1. Indonesia: A Macro SAM for 1990 (Rp. billion)

		Expenditures										
		Value Added			Suppliers		Institutions					
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	Total
Receipts	**Value Added**											
	(1) Labor				94027							94027
	(2) Capital				90616							90616
	(3) Land				13953							13953
	Suppliers											
	(4) Activity					355053					53288	408341
	(5) Commodity				200540		127330		15502	64790		408163
	Institutions											
	(6) Household	94027	35855	13953			4616	242	5723		3612	158030
	(7) Enterprise		54761								-4272	50489
	(8) Government				9204	3064	1997	23059			-4090	33236
	(9) Capital Account						24086	19667	12010		9026	64790
	(10) World					50045		7519				57565
	Total	94027	90616	13953	408341	408163	158030	50489	33236	64790	57565	

TABLE 2. SAM Disaggregation (Activities, Commodities, Factors, and Institutions)

Activities/Commodities (set i/j)

Agricultural (set iag; 13 sectors)

1. Rice
2. Soybeans
3. Maize
4. Cassava
5. Fruits and vegetables
6. Other food
7. Rubber
8. Sugarcane
9. Coconut
10. Palm Oil
11. Other non-food
12. Livestock
13. Forestry

Non-agricultural (set iagn; 21 sectors)

1. Fishery
2. Oil
3. Mining
4. Food processing
5. Furniture
6. Textiles
7. Paper
8. Fertilizer
9. Chemical
10. Petroleum refinery
11. Cement
12. Steel
13. Other manufacturing
14. Construction
15. Electricity-gas-water
16. Trade
17. Restaurant and hotels
18. Transport and communication
19. Services
20. Public administration
21. Other services

Factors of Production (set f)

Labor (10)

1. Rural paid agriculture labor
2. Urban paid agriculture labor
3. Rural unpaid agriculture labor
4. Urban unpaid agriculture labor
5. Rural production, transport equipment operator, and manual labor
6. Urban production, transport equipment operator, and manual labor
7. Rural clerical sales, and services labor
8. Urban clerical sales and services labor
9. Rural professional and managerial labor
10. Urban professional and managerial labor

Land
Capital

Institutions

Households (set hh; 8 sectors)

1. Agricultural worker
2. Small farmer
3. Medium farmer
4. Large farmer
5. Rural lower level
6. Rural higher level
7. Urban lower level
8. Urban higher level

Companies
Government
Rest of the World

TABLE 3. Mixed Complementary Equations of BULOG Market Intervention

#	Equation		Complementary variable	Description
1.	$PX_i - pxtarg_i + dpxtarg_i \geq 0$	($i \in$ itarg)	$BULOG_i^{pur}$	Producer price target floor
2.	$pctarg_i + dpctarg_i - PC_i \geq 0$	($i \in$ itarg)	$BULOG_i^{sal}$	Consumer price target ceiling
3.	$stk_i^o + dstk_i \geq BUL_i^{stk}$	($i \in$ itarg)	$BULOG_i^E$	Upper bound on BULOG's stocks
4.	$BUL_i^{stk} \geq stk_i^o - dstk_i$	($i \in$ itarg)	$BULOG_i^M$	lower bound on BULOG's stocks
5.	$BUL_i^{stk} = stk_i^o + BULOG_i^{pur} - BULOG_i^{sal} + BULOG_i^M - BULOG_i^E$	($i \in$ itarg)		BULOG's stocks
6.	$PC_i = PQ_i\,(1 + tc_i - SPC_i)$	($i \in$ I)		Consumer prices of composite goods
7.	$pcup_i - PC_i \geq 0$	($i \in$ itop)	SPC_i	Fertilizer price ceiling

Notation

Sets

$i \in I$	Productive activities
$i \in itarg\ (\subset I)$	Target price sectors (rice sector)
$i \in itop\ (\subset I)$	Subsidized consumption sector (fertilizer sector)

Parameters

$dpctarg_i$	Target price band for consumer prices
$dpxtarg_i$	Target price band for producer prices
$dstk_i^o$	Target band on stocks
$pctarg_i$	Target consumer price
$pcup_i$	Consumer price ceiling
$pxtarg_i$	Target producer price
stk_i^o	Target stock level
tc_i	Consumption tax (+) or subsidy (-) rates

Variables

BUL_i^{stk}	BULOG stocks
$BULOG_i^E$	BULOG exports
$BULOG_i^M$	BULOG imports
$BULOG_i^{pur}$	BULOG purchases
$BULOG_i^{sal}$	BULOG sales
PC_i	Consumer price of composite goods
PQ_i	Price of composite good
PX_i	Average output price
SPC_i	Variable subsidy

TABLE 4. Structure of the Indonesian Economy, 1990

	Sectoral composition (%)					Ratios (%)		Elasticities		
	Value Added (VA)	Output (X)	Domestic supply (Q)	Exports (E)	Imports (M)	Exports/ output (E/X)	Imports / domestic supply (M/Q)	Substitution elasticity (rohc)	Transformation elasticity (rhot)	Production elasticity (rhop)
Agriculture	26.4	19.0	19.5	3.2	2.0	-	-			
Food crops										
Rice	8.4	8.2	7.8	0.0	0.0	0.0	0.0	0.75	1.25	0.75
Soybeans	0.6	0.3	0.4	0.0	0.5	0.0	8.9	0.75	1.25	0.75
Maize	0.8	0.4	0.4	0.1	0.0	1.0	0.1	0.75	1.25	0.75
Cassava	1.1	0.5	0.6	0.0	0.0	0.0	0.0	0.75	1.25	0.75
Fruits and vegetables	4.2	2.1	2.5	0.0	0.2	0.1	0.6	0.75	1.25	0.75
Other	1.1	0.6	0.7	0.3	0.6	3.9	5.4	0.75	1.25	0.75
Total	16.2	12.2	12.3	0.4	1.4					
Other agriculture										
Rubber	0.4	0.2	0.2	0.1	0.0	4.1	0.1	0.75	1.25	0.75
Sugarcane	0.4	0.3	0.3	0.0	0.0	0.0	0.0	0.75	1.25	0.75
Coconut	0.7	0.3	0.3	0.0	0.0	0.2	0.0	0.75	1.25	0.75
Palm oil	0.5	0.3	0.2	0.6	0.0	17.5	0.0	0.75	1.25	0.75
Other	1.6	0.9	0.8	1.3	0.2	11.4	1.6	0.75	1.25	0.75
Total	3.5	2.1	1.8	2.0	0.2					
Livestock	2.6	2.4	2.5	0.1	0.1	0.2	0.2	0.75	1.25	0.75
Forestry	1.9	1.0	1.2	0.2	0.3	1.3	1.6	0.75	1.25	0.75
Fishery	2.1	1.3	1.6	0.6	0.0	3.6	0.0	0.75	1.25	0.75
Non-agriculture	73.6	81.0	80.5	96.8	98.0	16.7	14.7			
Oil	13.5	6.8	3.5	22.9	4.5	27.7	8.0	0.50	1.50	0.50
Mining	2.8	1.5	1.4	2.9	0.8	15.4	3.8	0.50	1.50	0.50
Food processing	6.1	6.3	6.4	7.5	2.5	9.7	2.5	1.50	2.00	1.50
Furniture	2.8	2.9	1.3	13.7	0.1	39.5	0.5	1.50	2.00	1.50
Textiles	2.6	3.7	2.9	10.5	4.6	23.5	9.9	1.50	2.00	1.50
Paper	0.7	0.9	1.0	0.6	1.1	5.5	6.8	1.50	2.00	1.50
Fertilizer	0.5	0.8	0.7	0.9	0.5	9.5	4.6	0.50	2.00	0.50
Chemical	1.1	1.6	3.6	1.6	14.1	8.3	24.4	0.50	2.00	0.50
Petroleum refinery	4.5	5.4	3.5	18.5	2.9	28.0	5.1	0.50	1.50	0.50
Cement	0.6	0.7	1.1	0.8	1.9	8.9	10.8	0.50	2.00	0.50
Steel	1.1	1.4	2.0	2.7	5.3	15.4	16.9	0.50	2.00	0.50
Other manufacturing	4.2	5.9	13.1	6.6	46.1	9.3	22.2	0.50	2.00	0.50
Construction	7.0	10.6	9.8	0.0	0.0	0.0	0.0	1.50	2.00	1.50
Electricity, gas, and water	0.9	1.2	1.1	0.0	0.0	0.0	0.0	0.50	2.00	0.50
Trade	-1.8	9.3	8.3	0.4	0.6	0.3	0.4	2.00	0.50	2.00
Restaurants and hotels	4.2	4.1	3.7	2.0	2.0	4.0	3.4	1.25	0.50	1.25
Transportation and communication	1.9	5.4	5.1	1.6	2.3	2.4	2.9	0.50	0.50	0.50
Services	9.7	5.9	5.5	3.3	4.5	4.6	5.2	1.25	0.50	1.25
Public administration	9.6	5.2	5.1	0.5	3.3	0.8	4.1	1.25	0.50	1.25
Other services	1.6	1.4	1.4	0.0	0.9	0.2	3.9	1.25	0.50	1.25
Total	100.0	100.0	100.0	100.0	100.0					

TABLE 5. Government Accounts: Rice Productivity Decline (Rp. trillion, 1990 prices)

	Base Values	Rice Productivity Decline 5%	10%	15%	20%	25%
Expenditure						
BULOG imports / (exports)	0.00	0.00	1.41	3.04	4.70	6.37
BULOG purchases / (sales)	0.00	(0.25)	(1.74)	(3.16)	(4.56)	(5.93)
Fertilizer subsidy	0.00	0.00	0.00	0.02	0.05	0.08
Government consumption	15.07	14.94	15.08	15.22	15.37	15.51
Government savings	10.24	10.35	10.79	10.92	10.99	11.02
Government transfers	5.72	5.72	5.72	5.72	5.72	5.72
Total Expenditures	31.04	30.76	31.26	31.77	32.27	32.78
Revenue						
Consumption tax / subsidy	0.00	0.00	0.00	-0.02	-0.05	-0.08
Enterprise tax	21.75	21.56	21.84	22.14	22.44	22.74
Foreign borrowing	-4.09	-4.06	-4.12	-4.18	-4.24	-4.30
Household tax	2.02	2.00	2.00	2.00	2.00	2.00
Indirect taxes	8.25	8.17	8.43	8.69	8.95	9.21
Tariff revenue	3.11	3.09	3.10	3.11	3.12	3.14
Total Revenue	31.04	30.76	31.26	31.77	32.27	32.78

TABLE 6. Rice Prices and Quantities: Rice Productivity Decline

	Base Values	Rice Productivity Decline 5%	10%	15%	20%	25%
Percent change in:						
Domestic price of exports	0.85	-0.77	0.65	2.19	3.73	5.25
Domestic price of imports	1.15	-0.77	0.65	2.19	3.73	5.25
Average output price	1.00	5.19	5.15	5.12	5.08	5.05
Price of composite good	1.00	5.00	5.00	5.00	5.00	5.00
Domestic activity goods price	1.00	5.19	5.16	5.12	5.08	5.05
Domestic commodity goods price	1.00	5.00	5.00	5.00	5.00	5.00
Consumer price of composite good	1.00	5.00	5.00	5.00	5.00	5.00
Quantity of:						
Exports	0.00	0.00	0.00	0.00	0.00	0.00
Imports	0.02	0.02	1.42	2.99	4.54	6.06
Percent change in:						
Domestic output	29.71	-3.79	-12.35	-20.68	-28.8	-36.9
Composite goods supply	30.61	-3.00	-6.95	-10.87	-14.7	-18.4
Domestic activity sales	29.70	-3.79	-12.35	-20.69	-28.8	-36.9
Domestic commodity sales	30.59	-3.79	-12.35	-20.69	-28.8	-36.9

Note: For quantities, base values are in 1990 trillion Rp.

TABLE 7. Macro Results: Rice Productivity Decline

	Base Values	Rice Productivity Decline 5%	10%	15%	20%	25%
Percent change in real :						
GDP	209.0	-0.3	-1.3	-2.3	-3.4	-4.3
Private consumption	128.6	-0.7	-0.7	-0.8	-1.0	-1.1
Investment	55.6	0.8	-0.3	-1.4	-2.6	-3.7
Government demand	15.1	-1.6	-11.0	-20.0	-28.8	-37.5
Exports	57.4	0.0	1.8	3.7	5.7	7.6
Imports	-47.7	0.0	2.1	4.5	6.9	9.2
Exchange rate	1.7	-0.5	0.1	1.0	1.9	2.8

Note: Base values are in 1990 trillion Rp.
Government demand includes BULOG purchases/sales.
The real exchange rate is defined as the nominal exchange rate deflated by the domestic sales price index.

TABLE 8. Government Accounts: Rice Productivity Improvement (Rp. trillion, 1990 prices)

		Rice Productivity Improvement				
	Base Values	5%	10%	15%	20%	25%
Expenditure						
BULOG imports / (exports)	0.00	0.00	(0.99)	(2.20)	(3.39)	(4.57)
BULOG purchases / (sales)	0.00	0.13	1.53	2.90	4.28	5.68
Fertilizer subsidy	0.00	0.00	0.00	0.00	0.00	0.00
Government consumption	15.07	15.21	15.09	14.97	14.84	14.72
Government savings	10.24	10.27	9.55	9.07	8.56	8.02
Government transfers	5.72	5.72	5.72	5.72	5.72	5.72
Total Expenditures	31.04	31.34	30.90	30.46	30.02	29.58
Revenue						
Consumption tax / subsidy	0.00	0.00	0.00	0.00	0.00	0.00
Enterprise tax	21.75	21.94	21.72	21.48	21.24	21.00
Foreign borrowing	-4.09	-4.12	-4.08	-4.03	-3.98	-3.93
Household tax	2.02	2.03	2.03	2.03	2.03	2.02
Indirect taxes	8.25	8.35	8.11	7.87	7.63	7.39
Tariff revenue	3.11	3.13	3.12	3.11	3.10	3.09
Total Revenue	31.04	31.34	30.90	30.46	30.02	29.58

TABLE 9. Rice Prices and Quantities: Rice Productivity Improvement

	Base Values	Rice Productivity improvement				
		5%	10%	15%	20%	25%
Percent change in:						
Domestic price of exports	0.85	0.78	-0.30	-1.54	-2.79	-4.04
Domestic price of imports	1.15	0.78	-0.30	-1.54	-2.79	-4.04
Average output price	0.99	-5.00	-5.00	-5.00	-5.00	-5.00
Price of composite good	0.99	-4.82	-4.84	-4.87	-4.90	-4.93
Domestic activity goods price	0.99	-5.00	-5.00	-5.00	-5.00	-5.00
Domestic commodity goods price	0.99	-4.82	-4.85	-4.87	-4.90	-4.93
Consumer price of composite good	0.99	-4.82	-4.84	-4.87	-4.90	-4.93
Quantity of:						
Exports	0.00	0.00	0.99	2.24	3.49	4.76
Imports	0.02	0.02	0.02	0.02	0.02	0.03
Percent change in:						
Domestic output	30.14	3.36	12.09	20.81	29.64	38.56
Composite goods supply	31.05	3.35	12.08	20.80	29.63	38.57
Domestic activity sales	30.14	3.36	12.09	20.81	29.64	38.57
Domestic commodity sales	31.03	3.36	12.09	20.81	29.64	38.57

Note : For quantities, base values are in 1990 trillion Rp.

TABLE 10. Macro Results: Rice Productivity Improvement

	Base Values	Rice Productivity Improvement 5%	10%	15%	20%	25%
Percent change in real :						
GDP	209.0	0.3	1.1	2.0	3.0	3.9
Private consumption	128.6	0.8	0.6	0.5	0.5	0.5
Investment	55.6	-0.8	0.0	1.0	2.0	3.0
Government demand	15.1	0.9	10.6	20.2	29.9	39.7
Exports	57.4	0.0	0.5	1.1	1.8	2.5
Imports	-47.7	0.0	0.6	1.3	2.2	3.0
Exchange rate	1.7	0.4	-0.2	-1.0	-1.7	-2.5

Note: Base values are in 1990 trillion Rp.
Government demand includes BULOG purchases/sales.
The real exchange rate is defined as the nominal exchange rate deflated by the domestic sales price index.

TABLE 11. GDP Deflators With and Without BULOG Intervention: Rice Productivity Improvement

	GDP deflators		
	Base	With BULOG	Without BULOG
Consumption	100	100	100
Investment	100	97	104
Government	100	97	105
Exports	100	96	104
Imports	100	96	104
GDP	100	99	101

TABLE 12. Real and Nominal Value Added Shares: Rice Productivity Improvement (Percent)

	Base shares		Shares with BULOG		Shares without BULOG	
	Nomin	Real	Nominal	Real	Nominal	Real
Agriculture						
Rice	6.6	6.7	8.7	9.1	5.4	7.5
Fruits and	3.7	3.7	4.0	3.5	3.6	3.8
Other Crops	5.9	5.9	6.2	5.5	5.9	6.1
Livestock	2.3	2.3	2.5	2.3	2.4	2.4
Forestry	1.7	1.7	1.5	1.6	1.7	1.7
Fishery	1.8	1.8	1.9	1.8	1.9	1.9
Consumer goods	9.4	9.5	8.8	9.0	9.6	9.5
Intermediate capital	22.7	22.5	21.5	21.8	22.8	22.0
Services	45.4	45.5	44.4	45.2	46.3	45.0
Total	100	100	100	100	100	100

FIGURE 1a. Changes in the Value of Non-Agricultural Production: Rice Productivity Improvement

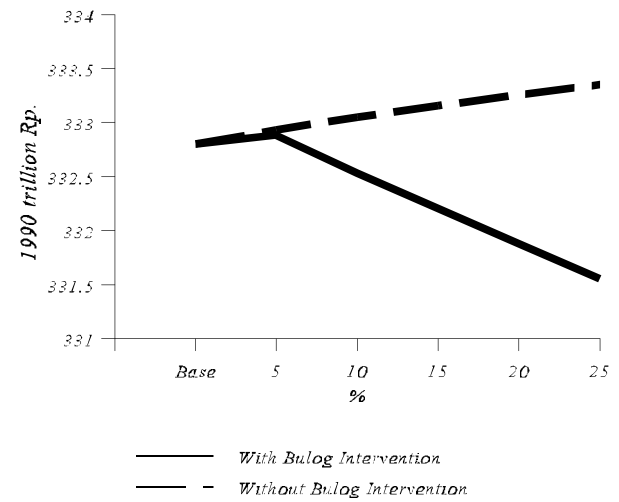


FIGURE 1b. Changes in the Value of Agricultural Production: Rice Productivity Improvement

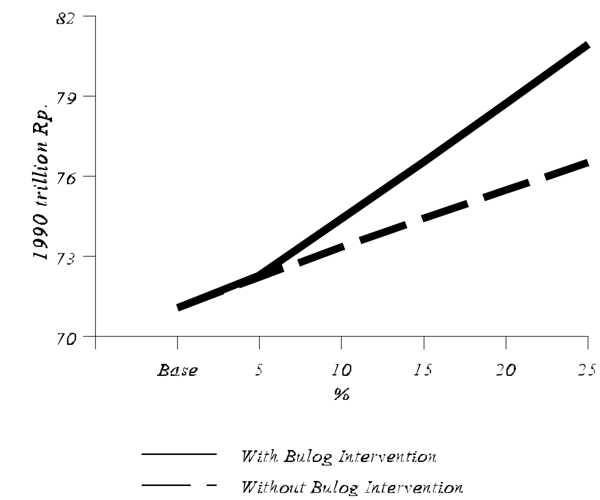


FIGURE 2a. Changes in the Value of Non-Agricultural Imports: Rice Productivity Improvement

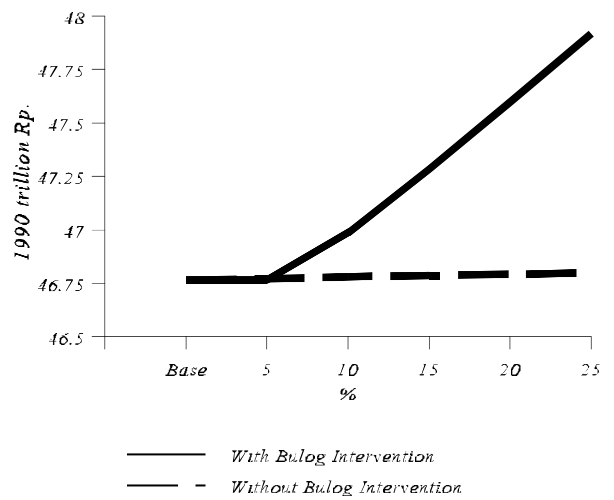


FIGURE 2b. Changes in the Value of Agricultural Imports: Rice Productivity Improvement

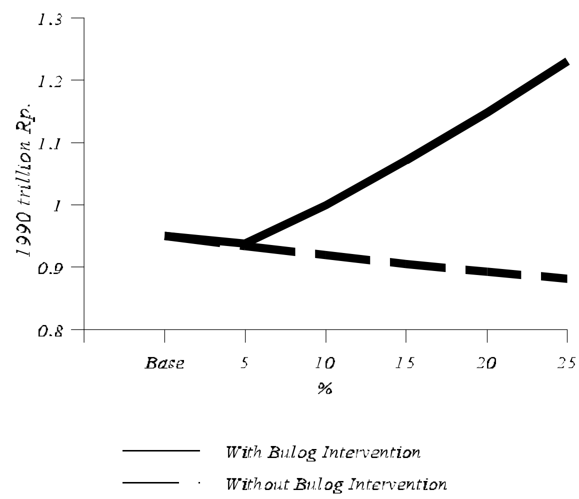


FIGURE 3a. Changes in the Value of Non-Agricultural Exports: Rice Productivity Improvement

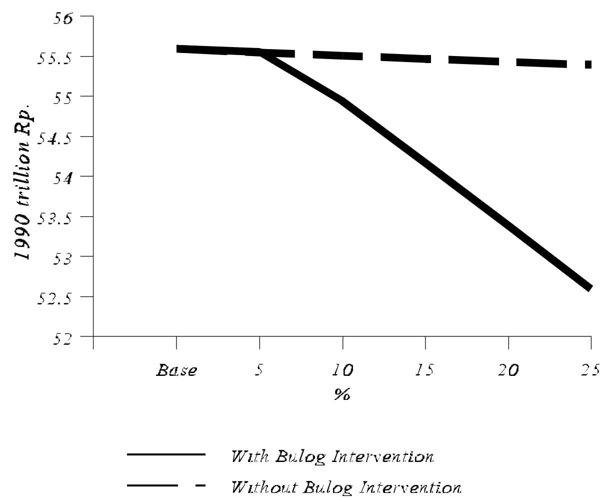


FIGURE 3b. Changes in the Value of Agricultural Exports: Rice Productivity Improvement

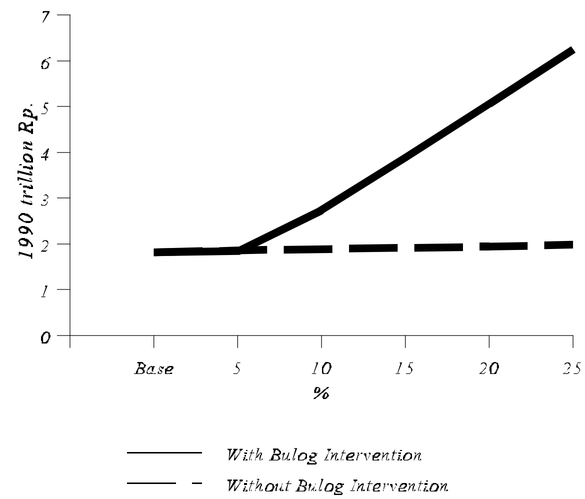


FIGURE 4a. Changes in the Value of Rice Production: Rice Productivity Improvement

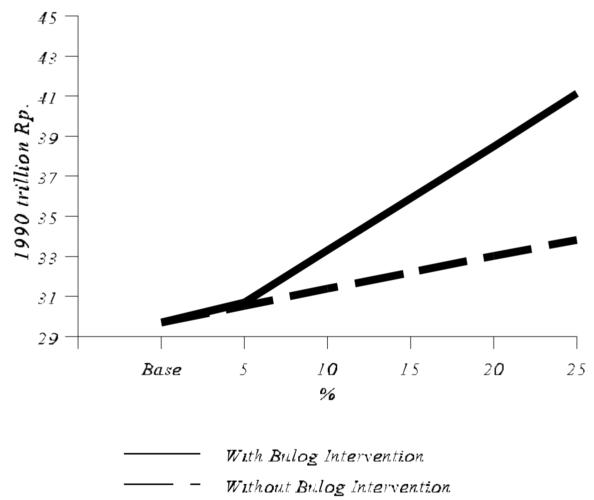


FIGURE 4b. Changes in the Value of Fruits and Vegetables Production: Rice Productivity Improvement

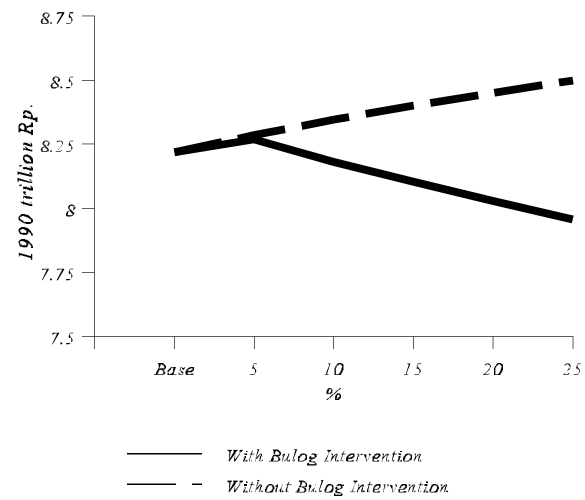


FIGURE 4c. Changes in the Value of Other Agriculture Production: Rice Productivity Improvement

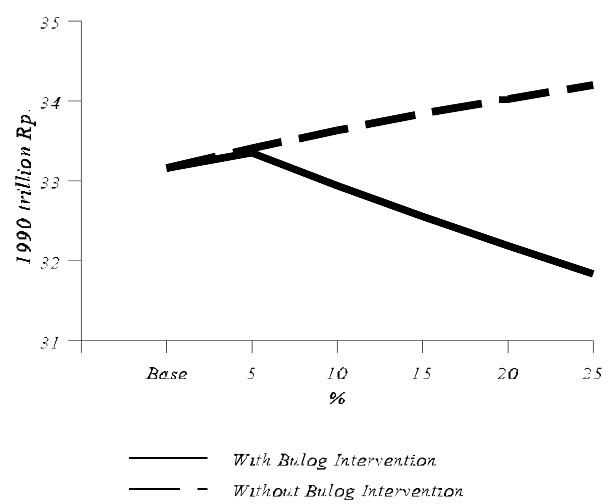


FIGURE 5a. Changes in Real Exports and Real Imports: Exchange Rate Devaluation

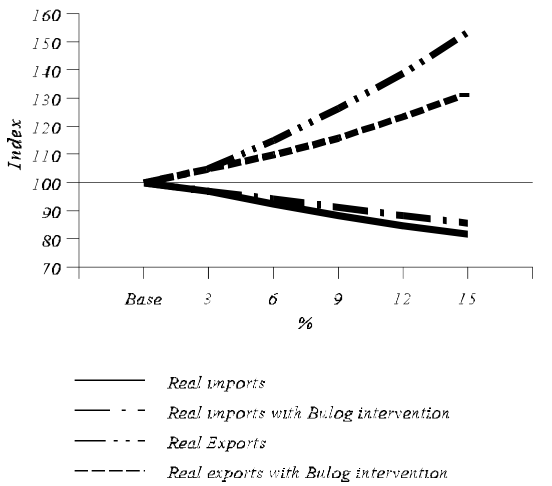


FIGURE 5b. Changes in the Trade Balance from Base Values: Exchange Rate Devaluation

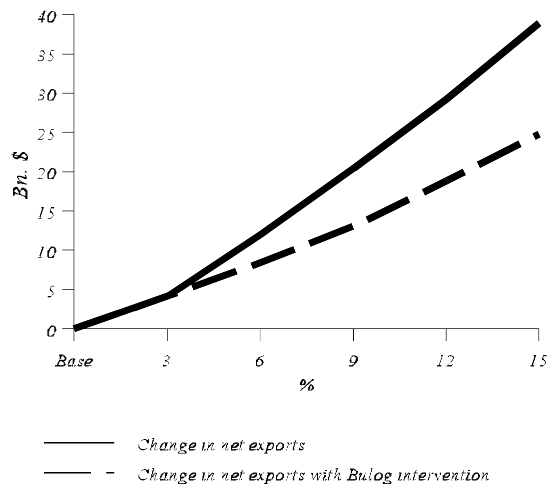
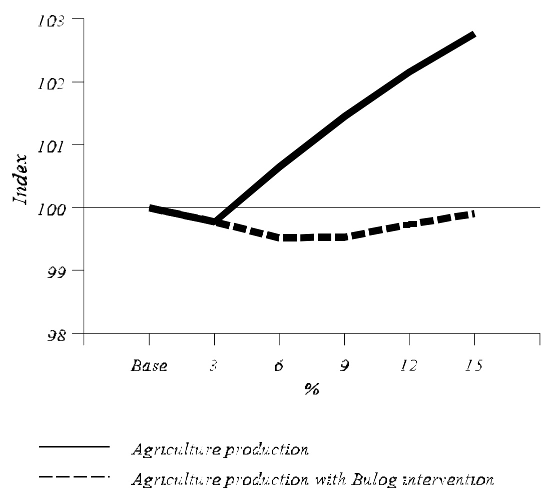


FIGURE 5c. Changes in the Value of Agricultural Production: Exchange Rate Devaluation



APPENDIX TABLE A.1. Definition of Parameters and Variables in the AG-CGE Model

Parameters

A	a_i^c	Armington function shift parameter
	a_i^d	CES shift parameter
	$\alpha_{i,f}$	CES factor share parameter
	a_i^T	CET function shift parameter
	$a_{i,j}$	Input-output coefficients
B	$b_{i,j}$	Capital composition matrix
C	$cwts_i$	Consumer price weights
D	δ_i	Armington function share parameter
	$depr_i$	Depreciation rates
	$dwts_i$	Domestic sales price weights
E	$econ_i$	Export demand constant
	η_i	Export demand price elasticity
	$exrb_i$	Base exchange rate
F	$fmap_{hh,f}$	Factors to household map
G	γ_i	CET function share parameter
	$gles_i$	Government consumption shares
K	$kshr_i$	Shares of investment by sector of destination
M	$make_{i,j}$	Make matrix coefficients
P	pvb_i	Base value added price
	$pwmb_i$	Base import price
	pwm_i	World market price of imports (in dollars)
	$pwse_i$	World price of export substitutes
	$pwts_i$	Price index weights
	pxb_i	Base output price
R	ρ_i^c	Armington function exponent
	ρ_i^P	CES production function exponent
	ρ_i^T	CET function exponent
S	$sremit_{hh}$	Remittance shares
	$strans_{hh}$	Government transfer shares
	$syenth_{hh}$	Share of enterprise income to households
	$syent_f$	Enterprise shares of factor income
	$sytr_{hh}$	Share of household income transferred to other households
T	tc_i	Consumption tax (+) or subsidy (-) rates
	te_i	Tax (+) or subsidy (-) rates on exports
	th_{hh}	Household tax rate
	tmb_i	Base tariff rate
	tm_i	Tariff rates on imports
	txb_i	Base indirect tax
	tx_i	Indirect tax rates
Y	$ymap_{h,hh}$	household to households map

Variables

B	$BULOG_i^E$	BULOG exports
	$BULOG_i^M$	BULOG imports
	$BULOG_i^{pur}$	BULOG purchases
	$BULOG_i^{sal}$	BULOG sales
	BUL_i^{stk}	BULOG stocks
C	CD_i	Final demand for private consumption
	CH_h	Household consumption
	$CONTAX$	Consumption tax revenue
D	DA_i	Domestic activity sales
	DC_i	Domestic commodity sales
	$DEPREC$	Total depreciation expenditure
	DK_i	Volume of investment by sector of destination
	DST_i	Inventory investment by sector
E	$ENTSAV$	Enterprise savings
	$ENTTAX$	Enterprise tax revenue
	$ENTTF$	Enterprise transfers abroad
	ESR	Enterprise savings rate
	ETR	Enterprise tax rate
	$EXPTAX$	Export subsidy payments
	EXR	Exchange rate (Rp. per $)
	E_i	Exports
F	$FBOR$	Government foreign borrowing
	$FDSC_{i,f}$	Factor demand by sector
	$FLABTF$	Labor transfers abroad
	$FSAV$	Net foreign savings
	FS_f	Factor supply
	$FXDINV$	Fixed capital investment
G	$GDPVA$	Value added in market prices
	$GDTOT$	Total volume of government consumption
	GD_i	Final demand for government consumption
	$GOVGDP$	Government to GDP ratio
	$GOVSAV$	Government savings
	$GOVTH$	Government transfers to households
	GR	Government revenue
H	$HHSAV$	Household savings
	$HHTAX$	Household tax revenue
I	ID_i	Final demand for productive investment
	$INDTAX$	Indirect tax revenue
	INT_i	Intermediates uses
	$INVEST$	Total investment
	$INVGDP$	Investment to GDP ratio
M	MPS_{hh}	Marginal propensity to save by household
	M_i	Imports
P	PC_i	Consumer price of composite goods
	PDA_i	Domestic activity goods price
	PDC_i	Domestic commodity goods price
	PE_i	Domestic price of exports
	$PINDCON$	Consumer price index
	$PINDDOM$	Domestic sales price index
	$PINDEX$	Producer price index
	PK_i	Price of capital goods by sector of destination
	PM_i	Domestic price of imports
	PQ_i	Price of composite good
	$PREMY$	Premium income
	PV_i	Value added price
	PWE_i	World price of exports
	PX_i	Average output price
Q	Q_i	Composite goods supply
R	$REMIT$	Remittances
	$REMITENT$	Enterprise remittances
	$RGDP$	Real GDP
S	$SAVING$	Total savings
	SPC_i	Variable subsidy
T	$TABSORB$	Total absorption
	$TARIFF$	Tariff revenue
	$TM2_i$	Import premium
W	$WFDIST_{i,f}$	Factor price sectoral proportionality ratios
	WF_f	Average factor price
X	X_i	Domestic output
Y	$YENT$	Enterprise income
	$YFCTR_f$	Factor income
	Y_h	Household income

APPENDIX TABLE A.2. Price Equations

#	Equation	Description
1	$PM_i = pwm_i \cdot (1 + tm_i + TM2_i) \cdot EXR$	Import prices (i ∈ im)
2	$PE_i = pwe_i \cdot (1 - te_i) \cdot EXR$	Export prices (i ∈ ie)
3	$PDA_i = PE_i$	Export Price
4	$PDC_j = \sum_i make_{if} \cdot PDA_i$	Definition of commodity prices
5	$PQ_i = \dfrac{PDC_i \cdot CD_i + PM_i \cdot M_i}{Q_i}$	Composite good prices
6	$PX_i = \dfrac{PDA_i \cdot DA_i + PE_i \cdot E_i}{X_i}$	Producer prices
7	$PV_i = PX_i \cdot (1 - tx_i) - \sum_j a_{ji} \cdot PC_j$	Value added prices net of indirect taxes
8	$PK_i = \sum_j b_{ji} \cdot PC_j$	Composite capital good prices
9	$PINDEX = \sum_i pwts_i \cdot PX_i$	Producer price index
10	$PINDCON = \sum_i cwts_i \cdot PC_i$	Consumer price index
11	$PINDDOM = \sum_i dwts_i \cdot PDA_i$	Domestic sales price index

Note: im/ie = tradable sectors with imports and exports, respectively.

APPENDIX TABLE A.3. Quantity Equations

#	Equation	Description
12	$X_i = a_i^D \cdot \left[\sum_f \alpha_{i,f} \; FDSC_{i,f}^{-\rho_i^P} \right]^{-\frac{1}{\rho_i^P}}$	CES production function
13	$FDSC_{if} = X_i \cdot \left[\frac{\alpha_{if} \cdot PV_i}{(a_i^D)^{\rho_i^P} \cdot WF_f \cdot WFDIST_{if}} \right]^{\sigma_i^P}$	Demand function for primary factors (First order condition for profit maximization where $\sigma_i^P = \frac{1}{\rho_i^P + 1}$
14	$INT_i = \sum_j a_{ji} \cdot X_j$	Total intermediate use
15	$DA_i = \sum_j make_{ij} \cdot DC_i$	Commodity/activity relationship
16	$X_i = a_i^T \left[\gamma_i \, E_i^{\rho_i^T} + (1 - \gamma_i) \, D_i^{\rho_i^T} \right]^{\frac{1}{\rho_i^T}}$	Gross domestic output as a composite good $i \in ie1$
17	$X_i = E_i + D_i$	Gross domestic output $i \in ie2$
18	$X_i = D_i$	Gross domestic output for $i \in ien$
19	$E_i = D_i \left[\frac{PE_i \, (1 - \gamma_i)}{PDA_i \cdot \gamma_i} \right]^{\frac{1}{\rho_i^T - 1}}$	Export supply for $i \in ie1$
20	$E_i = econ_i \left[\frac{PW_i^e}{pwse_i} \right]^{-\eta_i}$	World export demand for $i \in ied$
21	$Q_i = a_i^C \left[\delta_i \, M_i^{-\rho_i^C} + (1 - \delta_i) \, D_i^{-\rho_i^C} \right]^{-\frac{1}{\rho_i^C}}$	Total supply for a composite good for $i \in im$
22	$Q_i = DC_i$	Total supply $i \in imn$
23	$M_i = D_i \left[\frac{P_i^d \cdot \delta_i}{P_i^m (1 - \delta_i)} \right]^{\frac{1}{1 + \rho_i^C}}$	First order condition for cost minimization of composite goods ($i \in im$)

Note: ie1 = export sectors with CET function
ie2 = sectors with no CET function (rice)
ien = non export sectors
ied = sectors with export demand
imn = non import sectors
For a listing of the sectors, factors, and institutions, see Table 2.

APPENDIX TABLE A.4. Income Equations

#	Equation	Description
24	$YFCTR_f = \sum_i WF_f \cdot FDSC_{if} \cdot WFDIST_{if}$	Factor income
25	$YENT = \sum_f syent_f \cdot YFCTR_f + REMITENT \cdot EXR + PREMY$	Capital income
26	$YH_{hh} = \sum_f fmap_{hh,f} \cdot (1 - syent_f) \cdot YFCTR_f + sremit_{hh} \cdot (REMIT - FLABTF) \cdot EXR + strans_{hh} \cdot GOVTH + \sum_h ymap_{hh,h} \cdot sytr_h \cdot YH_h + syenth_{hh} \cdot (YENT - ENTTAX - ENTSAV - ENTTF \cdot EXR)$	Household income
27	$CH_{hh} = (1 - th_{hh}) \cdot (1 - MPS_{hh}) \cdot YH_{hh} - \sum_h ymap_{hh,h} \cdot sytr_h \cdot YH_{hh}$	Household disposable income
28	$TARIFF = \sum_i tm_i \cdot PWM_i \cdot M_i \cdot EXR$	Tariff revenue i ∈ im
29	$PREMY = \sum_i tm2_i \cdot M_i \cdot pwm_i \cdot EXR$	Import premium i ∈ im
30	$CONTAX = \sum_i (tc_i - SPC_i) \cdot PQ_i \cdot Q_i$	Consumption taxes
31	$INDTAX = \sum_i tx_i \cdot PX_i \cdot X_i$	Indirect taxes
32	$EXPTAX = \sum_i te_i \cdot PWE_i \cdot E_i \cdot EXR$	Export subsidy i ∈ ie
33	$HHTAX = \sum_h th_h \cdot YH_h$	Household taxes
34	$DEPREC = \sum_i depr_i \cdot PK_i \cdot fdsc_{i,capital}$	Depreciation expenditure
35	$ENTTAX = ETR \cdot YENT$	Enterprise taxes
36	$ENTSAV = ESR \cdot YENT$	Enterprise savings
37	$HHSAV = \sum_h MPS_h \cdot YH_h \cdot (1 - th_h)$	Household savings
38	$GR = TARIFF + CONTAX + INDTAX + HHTAX + FBOR \cdot EXR + ENTTAX + EXPTAX$	Government revenue
39	$SAVING = HHSAV + ENTSAV + DEPREC + GOVSAV + EXR \cdot FSAV$	Total savings

Note: f = set of factors
hh = set of households

APPENDIX TABLE A.5. Expenditure Equations

#	Equation	Description
40	$PC_i \cdot CD_i = \sum_h PC_i \cdot \gamma_{i,h} + \beta_{i,h} \cdot (CH_h - \sum_j PC_j \cdot \gamma_{j,h})$	Private consumption
41	$GD_i = gles_i \cdot GDTOT + BULOGP_i - BULOGS_i$	Government consumption
42	$GR = \sum_i PC_i \cdot GD_i + GOVSAV + GOVTH - \sum_{itarg} BULOGE_{itarg}\ EXR\ PWE_{itarg} + \sum_{itarg} BULOGM_{itarg}\ EXR\ pwm_{itarg}$	Government savings
43	$FXDINV = INVEST - \sum_i PC_i \cdot DST_i$	Fixed investment
44	$PK_i \cdot DK_i = kshr_i \cdot FXDINV$	Real fixed investment by sector of destination
45	$ID_i = \sum_j b_{ij} \cdot DK_j$	Investment final demand by sector of origin

Note: itarg = target price sector (rice sector)

APPENDIX TABLE A.6. Market Clearing and Macro Economic Closures

#	Equation	Description
46	$Q_i = INT_i + CD_i + GD_i + ID_i + DST_i$	Goods market equilibrium
47	$FS_f = \sum_i FDSC_{i,f}$	Factor market equilibrium
48	$\sum_i pwm_i \cdot M_i + \sum_{itarg} BULOGM_{itarg}\ EXR\ pwm_{itarg} = \sum_i PWE_i \cdot E_i + FSAV + FBOR + REMIT + ENTTF - FLABTF + REMITENT + \sum_{itarg} BULOGE_{itarg}\ EXR\ PWE_{itarg}$	Current account balance
49	$SAVING = INVEST$	Saving- investment balance
50	$GDPVA = \sum_i PV_i \cdot X_i + INDTAX + TARIFF + CONTAX$	Value added including indirect taxes
51	$TABSORB = GDPVA + EXR(\sum_{im} pwm_{im} \cdot M_{im}) + \sum_{itarg} BULOGM_{itarg} \cdot pwm_{itarg} - \sum_{ie} PWE_{ie} \cdot E_{ie} - \sum_{itarg} BULOGE_{itarg} \cdot PWE_{itarg}$	Total absorption
52	$RGDP = \sum_i (pvb_i + txb_i) pxb_i \cdot X_i + tmb_i \cdot exrb \cdot pwmb_i \cdot M_i$	Real GDP
53	$GOVGDP = \frac{\sum_i PC_i \cdot GD_i}{TABSORB}$	Government to total absorption share
54	$INVGDP = \frac{\sum_i PC_i \cdot ID_i}{TABSORB}$	Investment to total absorption share