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IMPACT OF AGRICULTURE TRADE AND SUBSIDY POLICY ON THE MACROECONOMY, DISTRIBUTION, AND ENVIRONMENT IN INDONESIA: A STRATEGY FOR FUTURE INDUSTRIAL DEVELOPMENT

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I. INTRODUCTION

THE crisis in Asia has entered its third year. While neighboring East Asian economies such as the Republic of Korea and Thailand are showing signs of significant economic recovery, the prospects for the Indonesian economy in the short term remain the subject of conjecture and controversy, despite the major economic reform undertaken by the government with the help of multilateral agencies such as the International Monetary Fund (IMF), World Bank, and Asian Development Bank (ADB). Progress in various aspects of reform such as on banking, corporate restructuring, and legal reform has been very slow. Uncertainty over Indonesian economic prospects appears to influence not only the business community engaged in assessing specific business risks and opportunities, but large multilateral lenders as well.

Recently, the IMF went as far as to state that the estimate for this year's (2000) economic growth of over 3 per cent should be interpreted with caution, since this anticipated growth in GDP is based on a consumption-driven recovery. There are, as yet, few signs of a turnaround in investment. Fortunately, the Indonesian economy survives due to the agricultural output and the performance of agricultural exports.

The agricultural sector continues to play an important role in production and exports in Indonesia. Before the crisis, the value of exports of agriculture-related products doubled from around U.S.$6,500 million in 1988 to more than U.S.$15,000 million in 1997. This sector also plays a role in generating employment, supplying basic foods and inputs for industrial goods, and providing a substantial source of

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foreign currency. Moreover, the agriculture-related sector contributes significantly to stimulating business development and maintaining the stability of the industrial sector. Being less dependent on imports, relying more on traditional financial support, and being heavily dependent on government subsidies, the agricultural sector has been less hardly hit by the crisis than other sectors.

Sustaining agricultural output is becoming increasingly problematic, however, since the crisis indirectly affects both the government budget and the implementation of trade liberalization. In part due to a decrease in the development budget, the government is now reducing subsidies for energy and food, while aggressively promoting non-oil exports. Trade liberalization in the agricultural sector involves the implementation of a market deregulation policy, such as reduced import duties and tariffs, and other forms of export deregulation, such as tax incentives and export free zones. In essence, import policies aimed at protecting domestic producers and at helping stabilize prices are justifiable only on a very selective, temporary, and case-by-case basis.

Trade liberalization has both positive and negative impacts on the economy. Besides the economic and social implications, it is also worth considering the impact of export promotion and trade liberalization on environmental pollution. Although agricultural exports should benefit from the depreciation of the rupiah, this natural incentive for primary product–based activities could lead to the exploitation of Indonesia's natural resources.

On the other hand, extensive trade flows could result in a flood of *cheap but dirty products* from other countries to the domestic market. This situation may be exacerbated should there be relocation of industries from countries with relatively strict environmental standards to those with relatively lax standards (pollution havens). Should this situation occur, the recipient country (in this case Indonesia) would be flooded with environment-polluting industries, in turn giving rise to social problems. Therefore, trade liberalization is associated not only with economic problems, but also undoubtedly gives rise to social and environment-related problems, which, of course, need to be attended appropriately and judiciously.

In this paper, attempts are made to examine these issues within this suggested literature framework, and to analyze the interdependence among trade liberalization, the agricultural sector production activities, and environmental pollution, and hence to evaluate the policy impacts on the economy and industrial development.

This study employs the computable general equilibrium (CGE) model, which analyzes the wide economic, social, and environmental consequences of reducing import tariffs on agricultural inputs and increasing government subsidies to the agricultural sector as part of the strategy for economic recovery. At the sectoral/industry and regional levels, this study examines changes in several indicators, such as output level, product/commodity base price, output per input price, exports, imports, employment, and other micro indicators. The effect on various pollutant emissions such as dust (SPM), air (CO_2, NO_x), and water (BOD and COD) is also estimated. Furthermore, at the macro level this study examines macroeconomic performance changes in real GDP, real aggregate consumption, real investment, inflation, exchange rates, and other macro indicators. The extent of the impact is indicated by the percentage parameter change from the initial condition following trade liberalization.

II. TRADE LIBERALIZATION, INDUSTRIAL POLICY, AND ENVIRONMENTAL IMPACT: LITERATURE REVIEW

Concern over economic output, trade liberalization, and environmental impact has been growing for decades. In the mid-1970s, several researchers (Siebert 1977; Pethig 1976; Blackhurst 1977) conducted studies to identify the possible contaminating impact of international trade flow, particularly from the United States, Western Europe, and Canada. Their results suggested that trade flow does not give rise to negative impacts such as pollution.

In the 80s, a number of researchers conducted in-depth research into the foreign direct investment (FDI) by the United States and Western European high-polluting industries in East Asian countries. Butler (1992) concluded that the results sufficiently supported the existence of a negative impact, yet these results were not significant. Nevertheless, cross-country direct investment reallocations of highly polluting industries were found to be increasing, presumably due to the difference in pollution standards. Tight pollution standards in developed countries were one of the several reasons for relocating to, and implementing foreign direct investment in, countries that have more lenient environmental standards. It was also claimed that the developing countries deliberately set lower environmental standards in order to promote the influx of FDI and multinational corporations (MNCs) (the industrial flight hypothesis).

Lucas et al. (1992) suggested three causes of changes in pollution intensity: (i) development giving rise to change in private sector comparative advantage, (ii) environmental regulations, and (iii) economic policy differences. In their research, Lucas and others used pollution intensity data for thirty-seven manufacturing industries in eighty countries between 1960 and 1988. The findings suggested that pollution intensity in developing countries is increasing faster in the development process associated with major structural changes. Also, tighter regulations stimulate the relocation of industries, thus giving rise to pollution in developing countries.

Low and Yeats (1992) conducted research using trade flow data as a proxy for the shift in the pattern of dirty industry locations. The data employed comprised trade flows for forty-three polluting industries during the period 1965–88. The polluting extent of these dirty industries is indicated by their expenditure on controlling and reducing pollution. The higher the expenditure on pollution control, the more polluting the industry is. The results suggested that dirty industries tended to be distributed in developing countries. Apparently, dirty industries in developing countries grow faster than those in developed countries due to the intensive use of natural resources in the early stage of industrial development.

A study conducted by Perroni and Wigle (1994) employed a world economy general equilibrium model incorporating local and global environmental externalities. This model was used to examine the relationship between international trade and environmental quality. The results suggested that international trade exerts a negligible effect on environmental quality.

The impact of trade on the environment, as far as Indonesia is concerned, has remained largely unexplored. Abimanyu (1996) analyzed the dirty product flow from developed countries in the APEC region and in the ASEAN4 (Indonesia, Malaysia, Philippines, and Thailand) region. He stated that there is evidence of an increase in imported products considered to give rise to excessive pollution from Australia, Korea, Canada, and ASEAN4 nations, for instance, while the percentage of dirty imported products from the United States, Japan, and Western European countries decreased. Key factors contributing to the existence of dirty products include macroeconomic and trade variables: commodity exports, foreign currency reserves, exchange rates (macroeconomic variables), and import tariffs (trade variable).

Examining Japanese and Indonesian trade, Lee and Roland-Holst (1993) proposed the use of the concept "embodied effluent trade" (EET), which is applied to gauge the waste arising from production aimed at the export market. In their study they concluded that domestic parties were principally responsible for environmental damage.

Azis (1992) also analyzed the impact of trade liberalization on the Indonesian economy. He identified the interdependence between external factors, internalization, and macroeconomic structure both explicitly and quantitatively. The simulation used pollution tax (or retribution) to identify the total pollution tax and the optimal rate of pollution. The results of the simulation showed that further trade liberalization led to a high level of welfare rate (measured by their utility).

III. CGE INDORANI MODEL

In this study a computable general equilibrium model was used as a basic framework for analysis since it is capable of examining broad-spectrum problems, such as trade liberalization. The CGE model can provide a comprehensive analysis of the impact of a change in, or a particular scenario of, policy implementation. The output of the application of the CGE model can be used to identify how much gain and how much pain an economy sustains as a result of a change in policy or implementation of a new policy. The trade-off arising from a change in policy or implementation of a new policy can also be identified.

The CGE INDORANI[1] model is a typical comparative-static model that reflects the economic conditions at a certain time. Basically, INDORANI involves a simulation equation that shows the linkage between economic activities. This simulation equation analyzes:

1. producers' demand for intermediate and primary input (capital, labor, and land),
2. producers' demand for investment goods for generating capital,
3. the supply of commodities offered by producers,
4. household consumption demand,
5. export demand,
6. government expenditure,
7. relationship between production value and production cost and selling price,
8. market clearing[2] conditions for commodity and primary input, and
9. other macro indicators and price index.

The equation for agents of demand and supply in the private sector is based on the principle of optimization (minimizing cost, maximizing utility, etc.). The agents are assumed to be price takers. The producers operate in a competitive market and are therefore unable to determine the price. Additionally, this assumption can be adapted according to the market conditions of the industry.

A. *Database*

Figure 1 is a schematic representation of the model's input-output database. It reveals the basic structure of the model. The column headings in the main part of the figure (an absorption matrix) identify the following demand categories:

(1) domestic producers divided into *I* industries;
(2) investors divided into *I* industries;
(3) a single representative household;
(4) aggregate foreign purchase of exports;
(5) an "other" demand category, broadly corresponding to government; and
(6) changes in inventories.

[1] Generally, the applied general equilibrium model being constructed will be renamed to preserve the uniqueness of the model. INDORANI is an economic-wide and sector-level model of an applied general equilibrium model for the Indonesian economy. This model is derived from the AGE ORANI model first developed by the IMPACT Project at Monash University, Australia (see Dixon et al. 1977, 1982; Powell 1991). INDORANI has been modified in terms of equations, closures, parameters, and data according to the current Indonesian economic conditions and behavior, which are unique in nature, for example, in the labor market, household breakdown, energy sectors, and regional breakdown. For further details of the model please visit INDORANI homepage at: http://paue.or.id/indorani/.

[2] Market clearing is an assumption of each market equilibrium condition that can be adjusted according to actual conditions.

Fig. 1. INDORANI Database Flow

		Absorption Matrix					
		1	2	3	4	5	6
		Producers	Investors	Households	Exports	Govern-ment	Changes in Inventories
	Size	← I →	← I →	← I →	← I →	← I →	← I →
Base transaction flow	↑ $C \times S$ ↓	*V1BAS*	*V2BAS*	*V3BAS*	*V4BAS*	*V5BAS*	*V6BAS*
Margins	↑ $C \times S \times M$ ↓	*V1MAR*	*V2MAR*	*V3MAR*	*V4MAR*	*V5MAR*	n.a.
Taxes	↑ $C \times S$ ↓	*V1TAX*	*V2TAX*	*V3TAX*	*V4TAX*	*V5TAX*	n.a.
Labor	↑ O ↓	*V1LAB*					
Capital	↑ I ↓	*V1CAP*					
Land	↑ I ↓	*V1LND*					
Other cost/ subsidies	↑ I ↓	*V1OCT*					

Notation:
C = commodity
I = industry
S = domestic and imports
M = commodities used as a margin
O = occupation categories

The entries in each column show the structure of the purchases made by the agents identified in the column heading. Each of the C commodity types identified in the model can be obtained locally or imported from overseas. The source-specific commodities are used by industries as inputs to current production and capital formation, consumed by households and governments, exported, or are added to or subtracted from inventories. Only domestically produced goods appear in the export column. M of the domestically produced goods is used as margin services (wholesale and retail trade, and transport) which are required to transfer commodities from their sources to their users. Commodity taxes are payable on the purchase. As well as intermediate inputs, current production requires inputs of three categories of primary factors: labor (divided into O occupations), fixed capital, and agricultural land. The "other costs" category covers various miscellaneous industry expenses.

Each cell in the illustrative absorption matrix in Figure 1 contains the name of the corresponding data matrix. For example, *V2MAR* is a four-dimensional array showing the cost of M margin services in the flow of C goods, both domestically produced and imported (S), to I investors. In principle, each industry is capable of producing any of the C commodity types.

B. *Equation Systems*

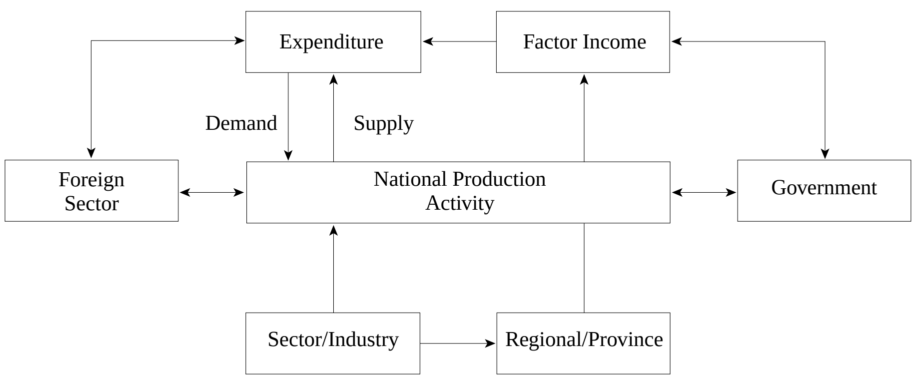
To understand the behavior of the linkage between variables in the INDORANI model, the economy can be simplified into several block equations, as shown in Figure 2. The first block shows the production activity at the producer level, the second block shows the household income from production factors sold to the producer, and the last block shows the household consumption expenditure. There is a linkage between each of these blocks.

In the production activity block, the producer absorbs inputs (capital, land, and labor) from the household sector, while producing output to supply both the household sector and the production sector (as intermediary input, inventory, or capital goods). Any excess supply in domestic trade goods will be exported, and conversely, any shortage will be met by imports. The Walrasian neoclassical general equilibrium theory, in which there is an equilibrium between demand and supply, is used as a basis for constructing the CGE model.

Producer expenditure on primary input is a primary input to household income. Sources of income include the government (transfers and subsidies) and tax from households. Consequently, the government affects the level of household welfare and income, and this can be used as a basis for analyzing the impact of government policies on the level of household income. In addition, household income levels can indicate household expenditure patterns on commodities produced by the production sector.

Production activity at the national level is an aggregate of national or regional sector production activities. The national production activity box shows GDP (gross domestic product) from the production side, while the factor income box shows GDP from the income side, and the expenditure box, GDP from the expenditure side. The aggregate of sector output makes up the production side GDP. If produc-

Fig. 2. INDORANI Model Scheme



tion activities at the regional level are aggregated, they make up the sector output and GDP. In other words, the economy is assumed to be always in equilibrium, and this can be used as a basis for an applied general equilibrium model.

1. *Structure of production*

INDORANI allows each industry to produce several commodities, using as inputs domestic and imported commodities, labor of several types, land, capital, and "other costs." In addition, commodities destined for export are distinguished from those for local use. The multi-input, multi-output production specification can be managed by a series of separability assumptions, illustrated by the nesting shown in Figure 3. For example, the assumption of *input-output separability* implies the existence of a generalized production function for some industries:

$$F(\text{inputs, outputs}) = 0 \tag{1}$$

may be written as:

$$G(\text{inputs}) = X1TOT = H\,(\text{outputs}), \tag{2}$$

where *X1TOT* is an index of industry activity. Assumptions of this type reduce the number of estimated parameters required by the model. Figure 3 shows that the *H* function in (2) is derived from two nested CET (constant elasticity of transformation) aggregation functions, while the *G* function is broken into a sequence of nests. At the top level, commodity composites, a primary-factor composite, and "other costs" are combined using a Leontief production function. Consequently, the demand for all the composites is directly proportional to *X1TOT*. Each commodity composite is a CES (constant elasticity of substitution) function of a domestic good and the imported equivalent. The primary-factor composite is a CES aggregation of land, capital, and composite labor. Composite labor is a CES aggregation of occupational labor types. Although all the industries share this common production structure, input proportions and behavioral parameters may vary between industries.

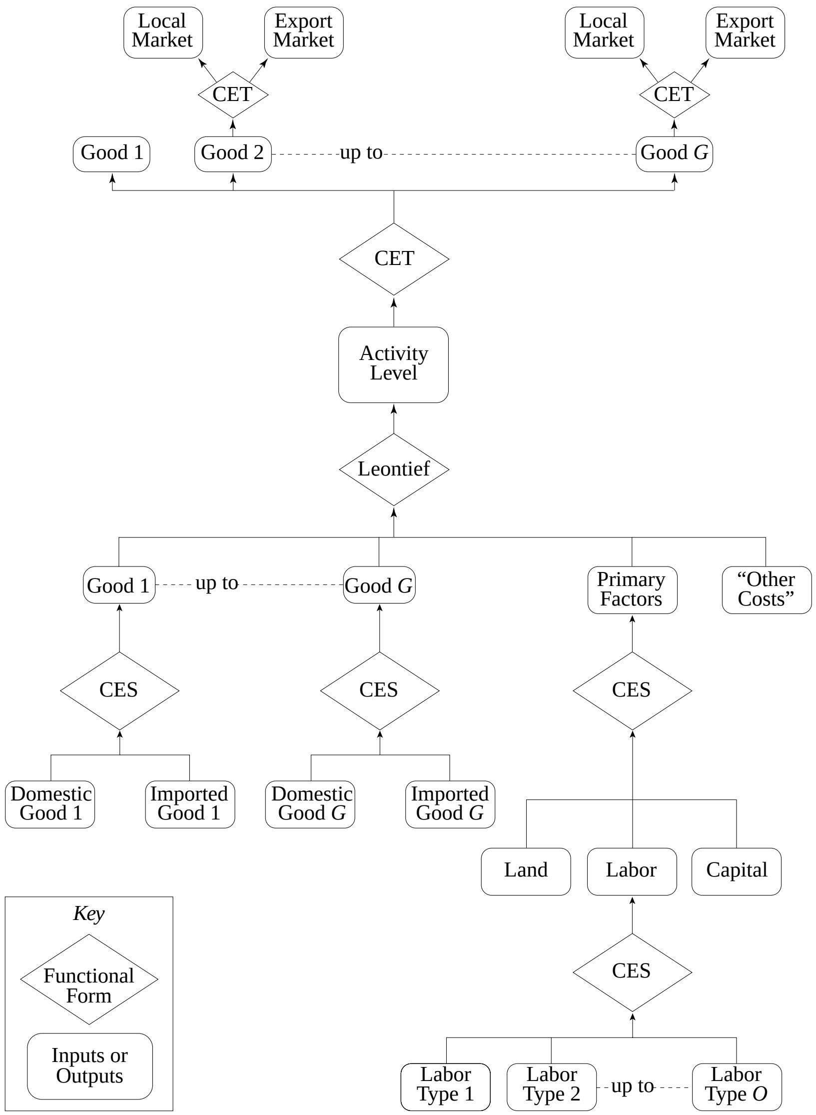
Production function covers the topmost input-demand nest of Figure 3. Commodity composites, the primary-factor composite, and "other costs" are combined using a Leontief production function, given by:

$$X1TOT(i) = \frac{1}{A1TOT(i)} \times \text{MIN}\left[All, c, COM: \frac{X1\_S(c,i)}{A1\_S(c,i)}, \frac{X1PRIM(i)}{A1PRIM(i)}, \frac{X1OCT(i)}{A1OCT(i)}\right], \tag{3}$$

where

X1TOT = total of intermediate inputs used for production,
A1TOT = augmenting technical coefficient,
[*All*, *c*, *COM*] = over the whole range of commodities,
PRIM = primary input (land, labor, and capital), and

Fig. 3. Structure of Production



OCT = other costs (e.g., subsidies).

Consequently, the demand for each of these three categories of inputs identified at the top level is directly proportional to *X1TOT*(*i*).

The Leontief production function is equivalent to a CES production function with the substitution elasticity set at zero. Hence, the demand equations resemble those derived from the CES case but lack price (substitution) terms. The *a1tot*(*i*) are Hicks-neutral technical-change terms, affecting all inputs equally.

INDORANI allows for each industry to produce a mixture of all the commodities. For each industry, the mix varies according to the relative prices of commodities. The first two equations, (3) and (4), determine the commodity composition of industry output—the final nest of Figure 3. Here, the total revenue from all outputs is *maximized*, subject to the production function:

$$X1TOT(i) = \mathrm{CET}[All, c, COM: Q1(c, i)]. \quad (4)$$

The CET (constant elasticity of transformation) aggregation function is identical with CES, except that the transformation parameter in the CET function has the opposite sign to the substitution parameter in the CES function. In equation (4), an increase in a commodity price *Q1*, relative to the average, induces transformation in favor of that output.

2. *Demand for primary factors*

Equation (5) determines the composition of the demand for primary factors. Their derivation follows a pattern similar to that underlying the previous nest in Figure 3. In this case, total primary factor costs are minimized subject to the production function:

$$X1PRIM(i) = \mathrm{CES}\left[\frac{X1LAB\_O(i)}{A1LAB\_O(i)}, \frac{X1CAP(i)}{A1CAP(i)}, \frac{X1LND(i)}{A1LND(i)}\right], \quad (5)$$

where *LAB* = labor, *CAP* = capital, and *LND* = land.

Because we may wish to introduce factor-saving technical changes, we include explicitly the coefficients *A1LAB_O*(*i*), *A1CAP*(*i*), and *A1LND*(*i*). This means that the demand for each input is proportional to the primary input demand, *X1PRIM*.

In Figure 3, labor demand has several branches that show the work composition of each industry. The equation is:

$$X1LAB\_O(i) = \mathrm{CES}[All, o, OCC: X1LAB(i, o)], \quad (6)$$

where *OCC* = occupations.

Equation (6) determines the occupational composition of the labor demand in each industry. For each industry *i*, the equations are derived from the following optimization problem. The first of the equations indicates that the demand for labor type *o* is proportional to the overall labor demand, *X1LAB_O*, and to a price term. In change form, the price term is composed of an elasticity of substitution, *SIGMA1LAB*(*i*), multiplied by the percentage change in a price ratio [*p1lab*(*i*, *o*) − *p1lab_o*(*i*)] representing the wage of occupation *o* relative to the average wage for labor in industry *i*. Changes in the relative prices of the occupations induce substitution in favor of relatively cheaper occupations.

3. *Demand for intermediate inputs*

INDORANI adopts the Armington (1969, 1970) assumption according to which imports are imperfect substitutes for domestic supplies. Equation (7) determines the import/domestic composition of intermediate commodity demand. Commodity demand from each source is proportional to the demand for the composite, *X1_S*(*c*, *i*), and to a price term. It follows a pattern similar to the previous nest. Here, the total cost of imported and domestic goods *i* is minimized subject to the production function:

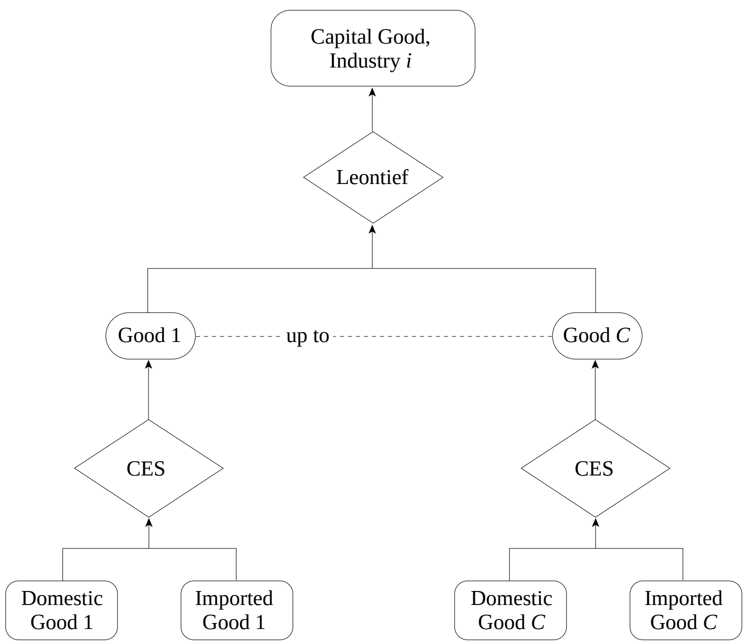
$$X1\_S(c, i) = \text{CES}[All, s, SRC: \frac{X1(c, s, i)}{A1(c, s, i)}], \qquad (7)$$

where *X1_S* = total intermediate input by sources (domestic and import).

4. *Demand for investment goods*

Figure 4 shows the nesting structure for the production of new units of fixed capital. Capital is assumed to be produced with inputs of domestically produced and imported commodities. The production function has the same nested structure as that which governs intermediate inputs to current production. No primary factors are used directly as inputs to capital formation.

Fig. 4. Structure of Investment Demand



The investment demand equations are derived from the solutions to the investor's two-part cost-minimization problem. At the bottom level in Figure 4, the total cost of imported and domestic good *i* is minimized subject to the CES production function:

$$X2\_S(c, i) = \text{CES}[All, s, SRC: \frac{X2(c, s, i)}{A2(c, s, i)}], \tag{8}$$

where *X2_S* = investment by source (domestic and foreign), while at the top level the total cost of commodity composites is minimized subject to the Leontief production function:

$$X2TOT(i) = \frac{1}{A2TOT(i)} \text{MIN}[All, c, COM: \frac{X2\_S(c, i)}{A2\_S(c, i)}], \tag{9}$$

where the total amount of investment in each industry, *X2TOT*(*i*), is exogenous to the cost-minimization problem and determined by other equations. Equation (9) describes the demand for source-specific inputs and for composites. Thus, this equation is very similar to the corresponding intermediate demand equations. The source-specific demand equation requires an elasticity of substitution, *A2TOT*(*i*).

5. *Demand for margins*

Demand for margins (trade and transportation) is proportional to the commodity flows with which the margins are associated. But, following the pattern of nested production function, a technical change element is included in the margin equation. Margins are divided into five categories: margin for producer (*X1MAR*), margin for investor (*X2MAR*), household margin (*X3MAR*), export margin (*X4MAR*), and government margin (*X5MAR*).

$$XnMAR(c, s, i, m) = \frac{Xn(c, s, i)}{AnMAR(c, s, i, m)} . \tag{10}$$

The "*n*" variables allow for technical change in margin usage, margin transaction (*Xn*), and technology changes (*AnMAR*).

To model export demand, commodities in INDORANI were divided into two groups: the traditional exports, mostly primary products, which comprise the bulk of exports; and the remaining, nontraditional exports. Exports accounted for a large share of the total output for most commodities in the traditional export category but for only a small share of the total output for nontraditional export commodities.

Equation (11) specifies downward-sloping foreign demand schedules for traditional exports:

$$X4(c) = F4Q(c)\left[\frac{P4(c)}{PHI*F4P(c)}\right]^{EXP\_ELAST(c)}, \tag{11}$$

where *EXP_ELAST*(*c*) is a negative parameter—the constant elasticity of demand. That is, export volumes, *X4*(*c*), are declining functions of their prices in foreign currency, (*P4*(*c*)/*PHI*). The exchange rate *PHI* converts local to foreign currency units. The variables *F4Q*(*i*) and *F4P*(*i*) allow for horizontal (quantity) and vertical (price) shifts in the demand schedules.

C. *Computation Method and Interpretation of Model Results*

Like the majority of the CGE models, INDORANI was originally designed for comparative-static simulations. Its equations and variables all refer implicitly to the economy in some future time period.

This interpretation is illustrated by Figure 5, which depicts the values of some variables, i.e., employment, against time. *A* is the level of employment in the base period (period 0) and *B* is the level which it would attain in *T* years time if some policy—i.e., a tariff change—were *not* implemented. With the tariff change, employment would reach *C*, all other things being equal. In a comparative-static simulation, INDORANI might generate the percentage change in employment $100(C - B)/B$, showing how employment *in period T* would be affected by the tariff change alone.

Many comparative-static INDORANI simulations have analyzed the short-term effects of policy changes. For these simulations, capital stocks have usually been held at their pre-shock levels. Econometric evidence suggests that a short-term equilibrium will be reached in about two years, i.e., $T = 2$ (Cooper, McLaren, and Powell 1985). Other simulations have adopted the long-term assumption according to which capital stocks will have adjusted to restore (exogenous) rates of return—this might take ten or twenty years, i.e., $T = 10$ or 20. In either case, only the choice of closure and the interpretation of the results affect the timing of changes: the model only specifies the values of two dates. Consequently there is no information about adjustment paths, shown as dotted lines in Figure 5.

D. *Internalization of Environmental Factors*

To determine the effect of economic activity (trade or government spending) on environmental cost, we need to identify the emission intensity, defined as the quantity of pollutant emitted when a production activity takes place. Specifically, this is defined by the environmental output by industry divided by the value of production. In this study, abatement costs will be quantified in the short term. The environmental output and emission rate equations will be as follows:

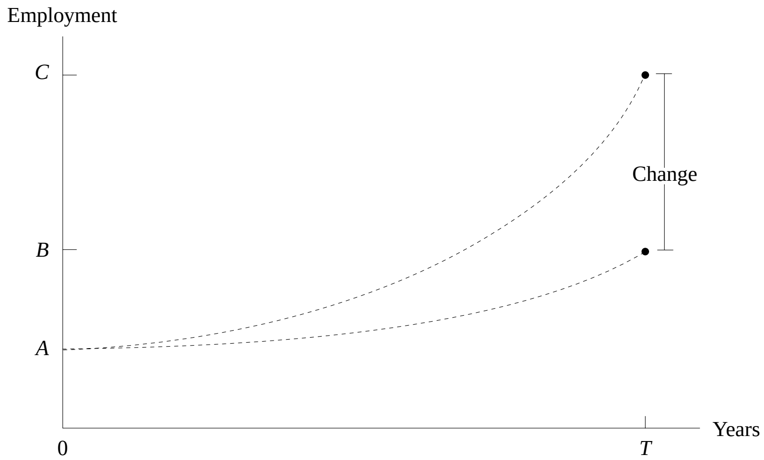
Environmental outputs (by industry):

$$(all, i, IND)(all, e, ENV11) bads(i, e) = x1tot(i) + badsrate(i, e);$$

Environmental outputs (by emission):

$$(all, e, ENV11) BAD\_i(e) * bads\_i(e) = \text{Sum}\{i, IND, BAD(i, e) * bads(i, e)\};$$

Fig. 5. Comparative-Static Interpretation of Results



Emission rate:

$$(all,\ i,\ IND)(all,\ e,\ ENV11) badsrate(i,\ e) = badsrate\_i(e) + badsrate\_e(i);$$

where

bads refers to the environmental outputs (air, water, and solid pollution) based on data given by Lee and Roland-Holst (1993),

bads_i(*e*) refers to all-industries environmental outputs,

badsrate(*i, e*) refers to the rate of emission = environmental output per unit of output,

badsrate_i(*e*) refers to all-industries emission shifter,

badsrate_e(*i*) refers to all types (of pollutants) emission shifter,

BAD(*i, e*) refers to total environmental outputs,

BAD_i(*e*) refers to all-industries environmental outputs, and small letters stand for percentage changes and capital letters for levels.

IV. SIMULATIONS

The main issues to be investigated through the simulations are the economic, social, and environmental implications of three different scenarios: first, a decrease in import tariffs on agriculture-related inputs; second, an increase in fertilizer subsidies; and third, a combination of a reduction in import tariffs and an increase in government transfer to poor farmers. We restrict ourselves to projecting the short-term comparative-static effects since this is the purpose to achieve economic recovery. The main features common to all the short-term comparative-static closures used for the simulations are as follows:

- capital stock fixed in each industry;
- slack labor market for all labor categories, or real wage is fixed and exogenous;
- aggregate private investment and government expenditure exogenous;
- the exchange rate is exogenous; and
- pollution abatement is exogenous and remains fixed (no policy to tighten the environmental standards).

Features of the closures specific to individual simulations are given in the table below. To simplify, we concentrate on the case of a 10 per cent decrease in import tariffs on agricultural inputs (fertilizer, chemicals, and pesticides), a 10 per cent increase in fertilizer subsidies, and a 10 per cent increase in government transfer to poor farmers.

There are two stages or steps in the simulation. The first stage is based on pre-crisis conditions which take into consideration crisis scenarios in the model to produce an updated version of 1999/2000 figures. The second stage incorporates the scenario of post-crisis strategy, such as further decreases in import tariffs and increased subsidies to support agriculture.

The table below shows detailed simulation scenarios, shocks, and major exogenous variables. We conducted four simulations, three of which are described in this paper. The first simulation was conducted as a basis for post-crisis simulations (SIM-A, SIM-B, and SIM-C).

Simulations	Shock	Fixed Exogenous Variables
1. Crisis simulation (1998–2000)	• 10% increase in real exports • 5% increase in household consumption shifter • 10% decrease in fuel subsidies • 35% decrease in electricity subsidies • 10% increase in civil servants' salary • 20% increase in development spending	• Real private investment • Exchange rate • Real wages • Real government demand
2. SIM-A: import tariffs	• 10% reduction in import tariffs on fertilizer, pesticides, and chemicals	• Real private investment • Exchange rate • Real wages
3. SIM-B: fertilizer subsidies	• 10% increase in fertilizer subsidies	• Real private investment • Exchange rate • Real wages

4. SIM-C: import tariffs plus direct subsidies	• 10% reduction in import tariffs on fertilizer, pesticides, and chemicals • 10% increase in targeted subsidies to landless and poor farmers	• Real private investment • Exchange rate • Real wages

A. *Macroeconomic Results*

With our data, a 10 per cent decrease in import tariffs on agricultural inputs (SIM-A) is a shock equivalent to a 0.336 per cent increase in GDP. A 10 per cent increase in fertilizer subsidies leads to a 0.250 per cent growth in GDP (SIM-B), and a mixed policy of trade liberalization and increased government transfer induces a moderate outcome of 0.342 per cent growth in GDP (Table I). Since private investment was fixed, the growth in GDP is primarily consumer-driven.

TABLE I

MACROECONOMIC EFFECTS OF A 10% TARIFF REDUCTION ON AGRICULTURAL INPUTS AND A 10% INCREASE IN GOVERNMENT SUBSIDIES

Symbols	Variables	SIM-A	SIM-B	SIM-C
DelB	BOT/GDP	–0.006	–0.009	–0.006
Delsgovsav	GOS/GDP	–0.009	–0.012	–0.009
Employ_I	Employment	0.944	1.159	0.952
P0realdev	Competitiveness	–0.446	–1.690	–0.565
P0toft	Terms of trade	0.023	0.328	0.056
P3tot_h	Inflation	0.487	1.727	0.608
Realgovsav	Real GOS/GDP	–12.620	–18.151	–13.262
W0tar_c	Nominal tariffs	–215.222	2.686	–214.351
W1oct_I	Nominal subsidies	–1.261	202.696	–1.688
Wgovexp	Nominal gov. expenditure	–0.851	0.457	–0.251
Wincgov	Nominal gov. revenue	–6.033	–7.333	–5.920
x0cif_c	Real imports (c.i.f.)	3.241	2.772	3.358
x0gdpexp	Real GDP	0.336	0.250	0.342
x3tot_h	Real household consumption	1.138	1.423	1.197
x4tot	Real exports	0.499	–1.075	0.440

Source: INDORANI simulation results.
Note: BOT = balance of trade; GOS = government saving.

A reduction in import tariffs stimulates imports more than exports in the short term (SIM-A). Since an increase in government spending (subsidies) primarily affects domestic goods, real appreciation is required to cover the deficit in the trade balance. This reduces exports and stimulates imports. Because exports fall, the terms of trade improve (SIM-B).

Inflation is the crucial factor when a policy is implemented to increase fertilizer subsidies. In contrast, targeted subsidies to landless and poor farmers (SIM-C) appear to be a suitable policy for simultaneously meeting targets for inflation, GDP growth, and generating more employment. In addition, a combination of trade liberalization of agricultural inputs and targeted subsidies to poor farmers is likely to alleviate the budget deficit.

B. *Aggregate Sectoral and Industry Results*

The INDORANI model includes sixty-eight industries and seventy-three commodities, but for ease of presentation we have aggregated the industry results to the seven-sector classification shown in Table II-A. In Table II-B, all the sixty-eight industries have been presented. As expected, almost all the agricultural sectors benefit from these policies, with the exception of the rubber and forestry sectors which are adversely affected by subsidies on fertilizer, pesticides, and chemicals. There are two possible reasons for this: first, rubber and forestry production does not require a large use of fertilizer, pesticides, and chemicals; and second, labor for the production of these two commodities is absorbed by other agricultural sectors. Trade policy, i.e., a reduction in import tariffs, on the other hand, exerts a beneficial effect on all the agricultural commodities, particularly export-oriented (or -related) products such as fisheries, forest products, and rubber. Reducing import tariffs boosts the competitiveness of these products, and the results of the simulation show that given their relatively low level of competitiveness, Indonesian agricultural products are able to make some adjustment to the global market.

Manufacturing sectors related to fertilizer, pesticides, and chemicals, such as food, beverage, and tobacco (ISIC 31), enjoy the benefit of cheaper inputs. Most of the manufacturing sectors other than fertilizer, pesticides, and chemicals are adversely affected by an increase in subsidies, but remain competitive as barriers to trade are reduced. Subsidy policy exerts a beneficial effect on large fertilizer manufacturers, much more so than on small chemical manufacturers, who benefit only moderately. A subsidy policy therefore should be implemented carefully.

Small manufacturing businesses benefit more than the agricultural sector from a reduction in import tariffs on agricultural inputs (SIM-A and SIM-C). Since the primary agricultural input is labor, small businesses can increase the output as a result of cheaper inputs of fertilizer and other chemical-related products.

Fertilizer subsidies exert a beneficial effect on the agricultural sector and large fertilizer manufacturers (SIM-B). In SIM-B, exports declined because of the real

TABLE II

SECTORAL EFFECTS OF A 10% TARIFF REDUCTION ON AGRICULTURAL INPUTS AND A 10% INCREASE IN GOVERNMENT SUBSIDIES

A. By Aggregate Sector

Aggregate Sectors	SIM-A	SIM-B	SIM-C
Agriculture	0.706	1.042	0.718
Mining	0.090	–0.691	0.032
Crude oil	–0.007	0.005	–0.009
Refinery	0.095	–1.600	0.073
Large manufacturing	0.224	0.894	0.216
Small manufacturing	0.875	0.478	0.881
Services	0.372	0.329	0.380

B. By Sector

Sectors	SIM-A		SIM-B		SIM-C	
	Employment	Output	Employment	Output	Employment	Output
Agriculture:						
Paddy	0.605	0.491	0.869	0.704	0.617	0.501
Root crops	1.677	1.292	2.650	2.036	1.735	1.337
Soybean	0.775	0.620	1.261	1.006	0.774	0.619
Vegetables	1.964	1.547	3.663	2.872	2.028	1.595
Fruits	1.754	1.379	2.724	2.135	1.818	1.428
Other food crops	1.478	1.165	2.834	2.225	1.474	1.161
Rubber	2.190	1.805	–0.580	–0.480	2.142	1.766
Sugarcane	0.581	0.437	0.815	0.613	0.586	0.441
Coconut	1.438	0.962	2.207	1.472	1.489	0.996
Oil palm	0.150	0.101	0.805	0.541	0.149	0.101
Tobacco	1.250	0.992	4.505	3.547	1.261	0.999
Coffee	0.733	0.495	1.131	0.763	0.741	0.501
Tea	0.748	0.543	1.117	0.810	0.762	0.553
Clove	0.598	0.413	0.890	0.615	0.603	0.416
Other agriculture	0.693	0.470	1.088	0.736	0.616	0.418
Livestock	1.002	0.350	1.222	0.426	0.992	0.346
Other livestock	1.652	0.402	1.991	0.483	1.720	0.418
Forestry	0.909	0.267	–1.530	–0.458	0.813	0.239
Other forestry	0.468	0.122	–0.363	–0.096	0.430	0.112
Sea fish	1.363	0.290	1.613	0.342	1.412	0.300
Land water fish	1.524	0.324	1.928	0.408	1.597	0.339
Dry salt fish	1.587	0.286	1.962	0.352	1.675	0.301
Crude oil:						
Crude oil	–0.195	–0.007	–0.788	–0.049	–0.258	–0.010
Mining:						
Natural gas	–0.116	–0.005	4.369	0.182	–0.122	–0.005
Mining	0.256	0.148	–1.387	–0.807	0.145	0.083
Coal mining	–0.102	–0.075	–0.659	–0.362	–0.200	–0.116
Manufacturing:						
Food, bev., tobacco L	1.468	0.412	2.035	0.568	1.477	0.414

TABLE II (Continued)

Sectors	SIM-A		SIM-B		SIM-C	
	Employment	Output	Employment	Output	Employment	Output
Food, bev., tobacco S	2.101	0.628	3.173	0.940	2.183	0.651
Textile, leather prod. L	4.312	1.320	–1.512	–0.482	4.213	1.292
Textile, leather prod. S	1.827	0.660	–0.489	–0.179	1.784	0.644
Plywood L	1.172	0.389	–3.010	–1.028	0.998	0.332
Wood product L	0.263	0.104	–1.362	–0.545	0.175	0.069
Wood product S	0.208	0.084	–0.886	–0.361	0.144	0.058
Paper product L	0.779	0.200	–0.690	–0.193	0.716	0.185
Paper product S	1.035	0.264	1.328	0.338	1.066	0.272
Fertilizer L	–3.911	–1.982	107.609	34.131	–2.706	–1.327
Fertilizer S	3.514	1.548	2.130	0.601	3.562	1.568
Pesticide L	–8.683	–1.719	3.759	0.668	–8.713	–1.719
Chemicals L	–15.340	–7.556	–0.990	–0.449	–15.404	–7.593
Chemicals S	3.403	1.575	0.052	0.025	3.369	1.559
Iron and steel L	4.261	1.283	–2.751	–1.069	4.104	1.239
Nonferrous metals L	0.928	0.393	–2.522	–1.107	0.783	0.332
Nonferrous metals S	1.118	0.551	–0.399	–0.206	1.062	0.523
Machinery L	0.861	0.311	–1.014	–0.372	0.790	0.286
Machinery S	0.545	0.251	–0.716	–0.332	0.491	0.226
Other manufacturing L	5.004	1.879	–1.222	–0.547	4.882	1.837
Other manufacturing S	7.502	1.837	1.460	0.366	7.532	1.843
Refinery:						
Petrol refined	0.342	0.346	0.006	0.243	0.301	0.348
LNG	–0.373	–0.155	–3.704	–3.476	–0.474	–0.204
Services:						
Electric PLN	1.437	0.419	2.069	0.231	1.475	0.434
Electric non-PLN	1.363	0.450	2.137	0.244	1.406	0.469
Gas, water	1.944	0.802	1.771	0.660	2.005	0.827
Construction	0.087	0.069	0.074	0.059	0.088	0.070
Agriculture construction	0.078	0.068	0.102	0.088	0.078	0.068
Public work construction	0.015	0.013	–0.025	–0.022	0.013	0.012
Gas, electric	0.052	0.045	0.037	0.031	0.053	0.046
Other construction	–0.018	–0.016	0.001	0.001	–0.019	–0.017
Trade	0.992	0.792	1.080	0.862	1.019	0.814
Restaurant, hotel	1.102	0.435	1.287	0.508	1.145	0.452
Rail transport	0.769	0.550	0.668	0.477	0.789	0.564
Road transport	0.916	0.357	0.655	0.256	0.912	0.356
Water transport	1.014	0.279	0.810	0.223	1.001	0.275
Air transport	0.637	0.130	0.520	0.106	0.648	0.133
Service transport	0.715	0.164	0.022	0.005	0.661	0.151
Communications	0.694	0.159	0.806	0.184	0.702	0.161
Finance	0.654	0.123	0.379	0.071	0.648	0.122
Government defense	–0.000	–0.000	0.000	0.000	0.000	0.000
Other services	1.385	0.935	1.047	0.707	1.428	0.963

Source: INDORANI simulation results.
Note: L stands for large/medium-sized manufacturing and S stands for small-sized manufacturing. PLN = public electricity companies.

appreciation of the real exchange rate, which resulted in a reduction in output for most traditional mining industries, such as coal mining.

C. *Employment Based on Occupational Results*

The simulations show very similar effects on employment. Each policy leads to an increase in economic activity, thus generating employment. With real wages assumed to be fixed and capital held constant, any activity generating employment should also contribute to the growth of GDP and vice versa. In SIM-A and SIM-C, trade liberalization of agricultural inputs exerted a beneficial effect on agricultural workers, even more so in SIM-B. As seen in Table III, the growth of large manufacturing industries generated more professional managers (SIM-B).

D. *Distributional Results*

Table IV shows that trade liberalization (reduction in import tariffs on agricultural inputs) in SIM-A exerts a relatively negligible effect on the distribution of nominal household consumption. Middle-income farmers benefit most from this policy, while the less privileged, including landless and poor farmers and those without permanent employment, suffer as a result. Meanwhile, increasing government subsidies for fertilizer on average raises nominal expenditure because this policy applies predominantly to domestic goods. But due to high inflation, real expenditure across households increases only moderately. In fact, the urban dweller without permanent employment struggles to keep up with the increase in inflation (SIM-B). A combination of trade and government subsidy policy (SIM-C) seems to be more effective, although direct subsidies will be needed to help the urban poor without permanent jobs. Finally, although the average households benefited from these policies, the supernumerary (approximately the 10 per cent richest) households enjoyed the most benefit. The gap between the supernumerary and the average households is relatively wide, and with the implementation of trade liberaliza-

TABLE III

OCCUPATION EFFECTS OF A 10% TARIFF REDUCTION ON AGRICULTURAL INPUTS AND A 10% INCREASE IN GOVERNMENT SUBSIDIES

Occupations	SIM-A	SIM-B	SIM-C
Civil servants	0.395	0.370	0.400
Managers	0.362	1.090	0.356
Clerical	0.699	0.641	0.697
Sales	0.973	1.092	0.998
Service	1.029	1.026	1.052
Agricultural	1.215	1.818	1.238
Manual	0.940	1.099	0.923

Source: INDORANI simulation results.

TABLE IV
DISTRIBUTIONAL EFFECTS OF A 10% TARIFF REDUCTION ON AGRICULTURAL INPUTS AND A 10% INCREASE IN GOVERNMENT SUBSIDIES

Household Groups	SIM-A			SIM-B			SIM-C		
	X1	X2	X3	X1	X2	X3	X1	X2	X3
Landless	2.659	1.051	0.536	8.555	3.408	1.625	6.760	2.119	1.475
Poor farmers	3.970	1.585	1.078	7.159	3.430	1.659	5.107	2.018	1.386
Middle-income farmers	3.788	1.906	1.417	6.044	3.587	1.835	4.005	2.071	1.458
Rich farmers	2.725	1.869	1.410	4.459	3.424	1.709	2.829	1.981	1.400
Rural nonagricultural poor	7.818	1.644	1.112	10.720	3.155	1.357	7.881	1.766	1.109
Rural nonagricultural undefined	2.960	1.221	0.712	4.372	2.523	0.761	3.032	1.332	0.699
Rural nonagricultural rich	2.827	1.898	1.437	4.619	3.482	1.762	2.946	2.020	1.436
Urban poor	5.579	1.684	1.164	7.800	3.164	1.379	5.665	1.804	1.159
Urban undefined	–0.741	0.101	–0.392	–0.468	1.018	–0.708	–0.594	0.233	–0.382
Urban rich	2.709	1.794	1.330	4.375	3.296	1.576	2.831	1.917	1.331

Source: INDORANI simulation results.
Note: X1 = nominal supernumerary household expenditure. X2 = nominal total household expenditure. X3 = real total household consumption.

tion, as we may expect, the gap will become wider. Targeted subsidies (SIM-C) appear to result in a narrower gap.

E. *Environmental Impacts*

Among the pollutants included in the INDORANI model are SPM (suspended particulate matter), SO_2 (sulfur dioxide), NO_2 (nitrogen dioxide), CO (carbon monoxide), and BOD (biological oxygen demand). This study estimates the short-term environmental effects of trade liberalization of agricultural inputs, fertilizer subsidies, and a combination of trade liberalization and targeted subsidies to poor farmers (Table V). In general, reducing tariffs on agricultural inputs does not seem to adversely affect the environment (SIM-A). Conversely, increasing fertilizer input stimulates farmers to use domestic fertilizer, which, although cheaper, is inefficient, and environmentally unfriendly (SIM-B). The increased use of imported agricultural inputs due to a reduction in import tariffs, results in a decrease in emissions of water pollutants, such as BOD (SIM-A). These results seem to suggest that trade flow has a less negative impact on pollution than does domestic production. In a broader sense, it also suggests that international trade is less harmful to environmental quality. In other words, damage to the Indonesian environment has been inflicted primarily by the domestic sector.

Domestic production that makes use of primary or secondary environmental com-

TABLE V

ENVIRONMENTAL EFFECTS OF A 10% TARIFF REDUCTION ON AGRICULTURAL INPUTS AND A 10% INCREASE IN GOVERNMENT SUBSIDIES

Emissions	SIM-A	SIM-B	SIM-C
SPM	0.271	0.253	0.258
SO_2	0.189	0.358	0.178
NO_2	0.074	0.432	0.066
Lead	0.347	0.204	0.334
CO	0.113	0.275	0.099
BOD	–0.148	0.469	–0.155

Source: INDORANI simulation results.

modity inputs is considered to be harmful to the environment. These findings, however, need to be interpreted with caution. Lee and Roland-Holst (1993) analyzed Indonesia-Japan trade relations with respect to the environment. In this study it was found that in Indonesia pollution was six times higher than in Japan, and that Indonesia on average produces 29 per cent more waste than the rest of the world. Nevertheless, since Japanese exports to Indonesia far outstrip Indonesian exports to Japan, Japan produces more total waste.

V. CONCLUSION AND POLICY IMPLICATION

A. *Summary of the Results*

The objective of this study was to simulate the effects of trade liberalization of agricultural inputs and government subsidies on the economy, including social and environmental aspects using INDORANI, a CGE model for Indonesia based on ORANI, an Australian CGE model widely used for policy purposes.

The results of our simulations indicated that both trade liberalization and government subsidies—without constraints on government borrowing or external debt—enhanced GDP and real consumption. In the short term, reducing import tariffs on agricultural inputs should exert a beneficial effect on the economy by raising the agricultural output and employment, stimulating imports, and, subsequently, exports. Meanwhile, increasing government subsidies induces an appreciation in the real exchange rate, which restricts exports and promotes imports. Industries producing non-traded goods to meet the government demand expand compared to export- and import-competing industries.

With the constraint on foreign borrowing, which Indonesia is currently facing, any increase in spending not financed by taxation restricts private investment. Private investment is relatively import-intensive, implying that an appreciation in the real exchange rate will be required to preserve the trade balance.

As for tariff scenarios, generally, any trade liberalization will promote a decrease in capital cost because of the reduction in tariff barriers on imported capital goods. Industry expansion promoted by a decrease in capital cost is generally accompanied by only a minimal increase in employment. Indeed, since the wage rate in the short-term model is assumed to be fixed, there is no financial incentive for labor to work an extra hour. In the long term, however, there will be an incentive for professionals to work harder to sustain operations. Meanwhile, the industry will also have the option to use more efficient technology.

In general, trade liberalization policy, such as import tariff reduction, will also exert a beneficial effect on the industry and may strengthen the industrial structure in the long term. Industry will also benefit from competition, as many industries and sectors become more efficient. This is possible if three key policies are implemented: first, eliminate regulations and provide healthy competition; second, enable an industry to promote cooperation (networks) with other industries; and third, grant subsidies to protect the "small," in other words, provide targeted subsidies rather than price subsidies. Subsidies are justified only if they provide a sunset clause, indicating for how long they will be provided and when they will be withdrawn, since unlimited subsidies do not allow an industry to become established and form a strong basis for competition.

From the environmental perspective, imported agricultural inputs are relatively less harmful to the environment than domestically produced agricultural inputs. Our results indicate that trade liberalization stimulates the inflow of fewer dirty products (inputs) to the agricultural sector. This policy, however, provides disincentives for farmers, particularly those at the subsistence level, to maintain their level of production. Increased subsidies for fertilizer seem to be more beneficial to the large manufacturer and middle-income farmers, and therefore should be avoided. In the model, promoting trade openness along with providing targeted subsidies to landless and poor farmers enables to expand the economy and achieve social and environmental objectives. This policy, if applied in the Indonesian context, however, needs to be well coordinated because it involves a number of institutions as well as a detailed mechanism.

In the long term, industrialization strategy in Indonesia must address global issues such as competition and cooperation, and social issues such as inequality, human rights, and the environment. Since Indonesia is committed to becoming a global player, global economic issues cannot be ignored. Therefore, Indonesian industries are compelled to address these issues as a new challenge. Appropriate strategy to build a strong industrial sector with international networks and global vision are the key to success. In the context of development in general, globally oriented industrial policy must also take into account social responsibility. In cooperation with the government, industries must close the gap between the large (strong) and the small (and weak or left behind) types of industries that will result from increased competition. Therefore, multi-purpose policy, which boosts competitiveness while taking into account social responsibility, is the appropriate response to the global challenge, and the findings of this research confirm the hypothesis that economic growth, equity, and social responsibility are not necessarily conflicting objectives.

B. *Policy Relevance of Model Simulations*

This paper illustrates how a CGE model can provide a useful analysis of the likely impacts of particular policy shocks on many aspects of the economy, including the macroeconomy, industry, social aspects, and the environment. The study attempts to identify the mechanism in the model responsible for the results. The results should generate policy interests as well as alternative policies. It is considered that if properly understood by policymakers such results may enable to consider the impacts of policy changes and to estimate the broad magnitude of the impacts. By constructing a model, it may be possible to explain to policymakers why the model produces the results, how the results have been achieved, what factors are included in the analysis, and what is left out. It is the policymaker's responsibility to determine whether the analysis addresses key factors pertaining to the economic conditions.

The results should be interpreted with caution, and the empirical content of the model should be viewed with skepticism. For example, the user should bear in mind that the limitations of the empirical work on Indonesian data reflect on the elasticity of the INDORANI model. These limitations, however, should not discriminate CGE modeling from alternative methods of policy analysis. A formal modeling framework requires that the analyst be explicit about the empirical content of the analysis. Furthermore, the model at least provides a vehicle for further sensitivity testing of the conclusions to variations in the empirical input, and to the other aspects of the scenarios analyzed.

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