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Abstract

Indonesia is a net importer of almost all of its staple foods. National self-sufficiency in food, especially the main staple, rice, is a core objective of economic policy. Poverty reduction is also a core policy objective. Since the 1970s, Indonesia has used agricultural input subsidies, especially on fertilizer, to stimulate agricultural production, largely in pursuit of its self-sufficiency goals. Recently, it has also used output protection, especially in rice, for the same purpose. This paper utilizes a multi-sectoral, multi-household general equilibrium model of the Indonesian economy to study the trade-offs between the goals of self-sufficiency and poverty reduction when two alternative means are used to achieve them: a fertilizer subsidy, on the one hand, and output protection, on the other. It does this by analyzing the aggregate and distributional effects of these two sets of policies and by comparing their effects with non-intervention. The analysis shows that, in terms of its effects on poverty, a fertilizer subsidy can be a more effective instrument for achieving the goal of rice self-sufficiency than final product import restrictions.

Key words: Indonesia; fertilizer subsidies; food self-sufficiency; general equilibrium modeling.

JEL classification: D58, I32, F14

Fertilizer subsidies and food self-sufficiency in Indonesia

1. Introduction

Most Asian countries intervene actively in agricultural input markets (Timmer, Pingali and McCulloch 2011). Indonesia is no exception. Irrigation, seed, fuel, credit, agricultural research, transport and marketing infrastructure all receive some form of public subsidy, but fertilizer subsidies have been politically the most contentious and the most costly in budgetary terms.

A central policy objective in subsidizing agricultural inputs, as in almost all aspects of Indonesian agricultural policy, is the goal of food self-sufficiency – or more precisely rice self-sufficiency. The importance of this deeply held goal in the formulation of Indonesia's agricultural policies could hardly be over-stated. Indonesia is a net importer of almost all of its staple foods, including rice, maize, cassava, soybeans, sugar and wheat.[1] Agricultural exports have tended to be non-staples produced on estates, such as rubber, copra, coffee and tea, rather than staple foods produced by smallholders. Successive Indonesian governments have been increasingly unhappy with their country's need to rely on thin and volatile world food markets to supplement their domestic food supplies – especially in the case of rice.

The paper's contention is that the evolution of Indonesia's agricultural policies can be understood fully only in relation to the goal of rice self-sufficiency. The analysis treats the goal of increasing self-sufficiency in rice, meaning reducing the volume of rice imports, as a given. It compares output market protection for rice with fertilizer input subsidies as alternative means of achieving this goal. Since poverty reduction is also a strongly held policy goal within Indonesia, the analysis looks in particular at the way these two alternative policy instruments affect poverty incidence, in both rural and urban areas. Section 2 of the paper briefly reviews the history of both output pricing policy in rice and fertilizer subsidization since the 1960s. Section 3 argues the case for a general equilibrium analytical treatment of these issues and describes the model to be used. Section 4 sets out the results and Section 5 concludes.

[1] Indonesia is now the world's largest single importer of wheat, having recently surpassed Egypt. Wheat is used in producing many processed foods but is barely grown at all within Indonesia.

2. Indonesia's rice and fertilizer pricing policies

Rice is the staple food of most of the Indonesian population and the main source of income for millions of small farmers. For some decades, ending in the early 2000s, Indonesia was the world's largest rice importer. Figure 1 shows Indonesia's rice production and imports since 1961 and Figure 2 shows rice imports as a percentage of total consumption over the same period. From the mid-1980s to the early-1990s rice imports reached almost zero levels. President Suharto, who led the country from 1968 to 1997, is said to have described the attainment of self-sufficiency in rice during that period as his proudest single achievement.[2] Self-sufficiency proved to be temporary. Imports subsequently increased as production failed to keep pace with domestic consumption.

Rice prices were stabilized relative to international prices and at about the same average level from the 1960s until the Asian Financial Crisis of 1997–99. In the case of rice, output protection was accordingly not significant during that period (Figure 3). The collapse of the Indonesian exchange rate during the chaos of 1998 temporarily meant that domestic food prices would have surged and most agricultural commodities, including rice, would have been exported if it were not for export prohibitions that were imposed at that time (Fane and Warr 2008).

Overt output market protection of the domestic rice industry became important only from about 1999 onwards. With the country's transition to a more democratic form of government, the lobbying power of pro-farmer political groups, combined with parliamentary rhetoric about rice self-sufficiency, led first to heavy tariffs on rice imports and then, in 2004, to an official ban on rice imports. Despite the prohibition, limited quantities of imports were and are still occasionally permitted (Warr 2005, 2011) to stabilize domestic rice prices in times of domestic shortage. By 2006 this policy had restricted imports to an average of about one fourth of their previous volume and had increased domestic wholesale rice prices relative to world prices by about 40 per cent (Figure 3). The surges in international rice prices in 2007–08 eroded the protective effect of the quantitative import restrictions but the quotas avoided transmission of the temporary price surges to domestic rice prices. For the purpose of the present discussion the restrictions on rice can be thought of as variable import quotas that normally restrict imports, but to an extent that depends on international rice prices. Their effect is to stabilize

[2] The statement was reportedly made when President Suharto was awarded the FAO Gold Medal in 1985.

domestic rice prices but at levels well above those that would have applied in the absence of the protection.

Indonesia has subsidized fertilizer use since 1971, at varying rates. These subsidies were part of a broad range of agricultural policies designed to take advantage of the possibilities offered by the new green revolution technologies of the time. The subsidies, under a scheme called HET (Table 1), have been applied particularly to urea, a nitrogenous by-product of natural gas production, although other fertilizers have also received subsidies, notably NPK, which provides plant-available phosphorus and potassium as well as nitrogen. In recent years, organic fertilizers have also been subsidized significantly through the BLP scheme (Table 1). Maximum retail prices were set for urea in relation to the minimum procurement price for unmilled rice (paddy). The ratio of the paddy floor price to the urea price varied from 1.3 to 1.5 until 1997 and increased to 2.2 in 1998.

By the 1990s the budgetary cost of these subsidies had become a serious problem. Over the seven years 1984 to 1990 fertilizer subsidies cost the government an annual average of US$440 million. Because of this, the program was gradually phased out during the 1990s by tightening eligibility for the scheme. From 1990 to 1997 the average annual budgetary cost of the subsidies was reduced to US$160 million, about 17 per cent of annual budgetary expenditure supporting agriculture. Fertilizer subsidies were abandoned during the fiscal tightening that followed the Asian Financial Crisis, but were resumed in 2002 (Figure 4). Between then and 2009 the paddy/urea price ratio increased from 1.5 to 2.5 (OECD 2012), reflecting the combination of rice market protection and fertilizer subsidies that was then operative. The budgetary cost of the scheme increased significantly between 2003 and 2009, due partly to the increased price of energy and partly to an increase in the quantities of subsidized fertilizer being distributed, especially NPK. In 2009 the budgetary cost of the fertilizer subsidies was 37 per cent of total budgetary support for agriculture, 13.2 per cent of the cost of all subsidies (petroleum product subsidies are by far the largest) and 1.9 per cent of total government expenditures.

3. The modeling framework

3.1 The case for a general equilibrium treatment

Consider a quantitative restriction on imports, on the one hand, and a fertilizer subsidy, on the other, each set at rates that have the same exogenously specified effect in reducing rice imports. A partial equilibrium analysis would proceed as follows. The import restriction operates on domestic consumers and producers by raising both domestic consumer and producer prices sufficiently to produce a combination of reduced consumption, through a movement *along* the demand schedule, and increased production, through movement *along* the supply schedule, equal to the exogenously specified import reduction. An input subsidy induces a *shift* in the supply schedule to the right, increasing production at the previous price and leaving consumption unchanged. Imports again decline. If the commodity was a perfect substitute for imports, the latter available at an exogenously given international price, the domestic product price would not change. If it was an imperfect substitute there would be some reduction in the domestic price.

This analysis is helpful, as far as it goes. But how would these two scenarios affect poverty? These effects will depend on what happens to the incomes, living costs and tax burdens of households with real expenditures close to the poverty line. The changes in incomes depend on changes in factor returns and the changes in living costs depend on changes in consumer prices. Consider first the effect of import restrictions. When rice prices rise, demand shifts to other commodities, influencing their prices as well. The final effect on the composition of consumer good prices depends on the detailed structure of commodity demands and supplies. The effect on the welfare of individual households then depends on these changes in consumer goods prices as well as the structure of expenditures of those households.

On the income side, a change in rice producer prices will also affect factor returns. The rice industry is very large and can be expected to respond to higher producer prices with increased output, increasing demand for the factors of production that are important for the rice (paddy) industry. Returns to paddy land will increase. Since paddy is a large employer of unskilled labor, the equilibrium price of unskilled labor may rise throughout the economy, affecting other industries and thereby influencing returns to capital and fixed factors in these industries, as well as the return to skilled labor. These changes in factor returns will in turn affect the structure of household incomes, depending on the factor ownership characteristics of individual households. A reduction in the quantity of permitted rice imports will also affect the rents received by the holders of quota licenses, raising the value of those licenses that remain usable and eliminating the value of those that are not, in turn affecting the structure of final demands among the owners of these licenses.

Now consider the effect of the fertilizer subsidy. The magnitude of the required subsidy depends on the elasticity of substitution between fertilizer and other inputs. The lower the elasticity the larger the required subsidy. When the price of fertilizer changes, the demands for other factors also change, affecting their returns., Household incomes are thereby affected, depending on the structure of household factor ownership. If the consumer price of rice falls, this will affect consumer welfare and will also affect other consumer goods prices, impacting on household welfare in a way that again depends on the structure of household demands. Finally, the budgetary cost of the subsidy must be met in some way. Sooner or later, taxes must be raised or other expenditures reduced, compared with what they would otherwise have been and the effect on household net incomes depends on the tax or expenditure reduction that is used and its effects on the structure of consumer and producer prices.

There will be both gainers and losers from all of this. Detailed, quantitative economic analysis is needed to sort out the net effects on the structure of household welfare, and thus poverty, this analysis is an inherently general equilibrium problem. Working with an applied general equilibrium model makes it possible to capture all of the economic relationships alluded to above in a way that is internally consistent and which uses all quantitative economic information that is available. Moreover, it is possible to conduct the analysis through controlled experiments, focusing on the consequences for household incomes, expenditures, poverty and inequality that arise from different policy shocks, taken one at a time, holding all other exogenous variables constant.

3.2 Model structure

The analysis uses an applied general equilibrium model of the Indonesian economy called INDONESIA-E3, designed specifically for the analysis of this type of economic problem. The model is described in detail in Yusuf (2006), except for some differences outlined below. Most structural features are standard. Its distinctive characteristic is its disaggregated household structure, designed to facilitate analysis of the way exogenous shocks affect poverty and inequality. The model identifies two categories of households, rural and urban, each of which is divided into 100 sub-categories of equal population size, with the sub-categories arranged by expenditures per capita.

As well as disaggregating households, INDONESIA-E3 also has a disaggregated industry and commodity structure, with 41 industries and 41 corresponding commodities. The microeconomic behavior assumed within it is competitive profit maximization on the part of firms and competitive utility maximization on the part of consumers. In the simulations reported in this paper, the markets for final outputs, intermediate goods and factors of production are all assumed to clear at prices that are determined endogenously within the model. The nominal exchange rate between the Indonesian currency (the rupiah) and the US dollar can be thought of as being fixed exogenously. The role within the model of the exogenous nominal exchange rate is to determine, along with international prices, the nominal domestic price level. Given that prices adjust flexibly to clear markets, a 1 percent increase in the rupiah/dollar exchange rate will result in a 1 percent increase in all nominal domestic prices, leaving all real variables unchanged.

Of the 41 industries, 10 are in agriculture (paddy, maize, cassava, beans, wheat, other food crops, estate crops, livestock, forestry, fishery). In addition 2 are in mining, 4 in food processing, 14 in other manufacturing and 9 in services. The structure of the model is based on the ORANI-G model (Horridge, 2000) with several modifications, of which the most important is multi-household feature mentioned above. This feature is fully integrated within the general equilibrium structure and enables the model to capture the way that changes in the economy affect households on the expenditure side, through changes in the prices of goods and services that they buy, and also on the income side, through changes in the returns to factors of production that they own.

The theoretical structure of INDONESIA-E3 is conventional for static general equilibrium models. It includes of the following major components:

- Household consumption demand systems for each of the 200 households, for each of the 41 categories of consumer goods. These demand functions are derived from the linear expenditure system.
- The household supplies of skilled and unskilled labor are assumed to be exogenous. A factor demand system, based on the assumption of CES production technology, relating the demand for each primary factor to industry outputs and prices of each of the primary factors. This reflects the assumption that factors of production may be substituted for one another in ways that depend on factor prices and on the elasticities of substitution between the factors. For the purposes of this study, factors of production include fertilizer, which is substitutable with a CES nest of land, labor and capital. Figure 5 summarizes the farm-level production structure assumed within the model.
- A distinction between two kinds of labor: skilled and, which are ‘nested’ within the industry production functions. In each industry, both kinds of labor enter a CES production function to produce ‘labor’, which itself enters a further CES production function for industry output.
- Leontief assumptions for the demand for intermediate goods, except for fertilizer. Each intermediate good in each industry is demanded in fixed proportion to the gross output of the industry.

- Demands for imported and domestically produced versions of each good, incorporating Armington elasticities of substitution between the two.
- A set of export demand functions, indicating the elasticities of foreign demand for Indonesia's exports.
- A set of equations determining the incomes of the 200 households from their (exogenous) ownership of factors of production, reflecting data derived from the 2003 *Social Accounting Matrix*, the (endogenous) rates of return to these factors, and any net transfers from elsewhere in the system.
- Rates of import tariffs and excise taxes across commodities, rates of business taxes, value added taxes and corporate income taxes across industries, and rates of personal income taxes across household types which reflect the structure of the Indonesian tax system, using data from the Indonesian Ministry of Finance.
- A set of macroeconomic identities ensuring that standard macroeconomic accounting conventions are observed.

The demand and supply equations for private-sector agents are derived from the solutions to these agents' microeconomic optimization problems (cost minimization for firms and utility maximization for households). The agents are assumed to be price-takers, with producers operating in competitive markets with zero profit conditions, reflecting the assumption of constant returns to scale.

3.3 Social accounting matrix

The multi-household feature of the model required significant modifications to the database used for constructing the CGE model. In contrast to other ORANI-G based CGE models, which are based solely on an Input-Output table, this model requires many pieces of additional information, which are available only from a Social Accounting Matrix. For example, in the Indonesian Social Accounting Matrix (SAM), constructed by the Government of Indonesia's Central Bureau of Statistics, the corporate or enterprise sector owns a great deal of undistributed earnings, and the values of transfers among institutions such as from government to households, are also recorded. These important features, essential for a multi-household model, cannot be captured from an I-O based model alone. Accordingly, INDONESIA-E3 incorporates inter-institution transfers, most importantly from the government to households.

The Indonesian Social Accounting Matrix 2003 serves as the core database for the INDONESIA-E3 model. Analyses of the distributional impact of policies have in the past been constrained by the absence of a Social Accounting Matrix (SAM) with disaggregated households. Since Indonesia's official SAM does not distinguish households by income or expenditure size, this fact has impeded accurate estimation of the distributional impact of exogenous shocks to the economy or policy changes, such as calculation of inequality or poverty incidence. The SAM used in this paper, is aggregated from a specially constructed SAM, representing the Indonesian economy for the year 2003, with 181 industries, 181 commodities, and 200 households (100 urban and 100 rural households sorted by expenditure per capita). This SAM (768×768 accounts) is the most disaggregated yet constructed for Indonesia at both the sectoral and household levels. Its structure is summarized in Table 3, but its detailed composition will not described fully in this paper. Interested readers may refer to Yusuf (2006).

3.4 Factors of production

The mobility of factors of production is a critical feature of any general equilibrium system. 'Mobility' refers here to mobility across economic activities (industries), rather than geographical mobility. The greater the factor mobility that is built into the model, the greater is the economy's simulated capacity to respond to changes in the economic environment. It is clearly essential that assumptions about the mobility of factors of production be consistent with the length of run that the model is intended to represent.

Two types of labor are identified, ‘unskilled labor’ and ‘skilled labor’, based on the educational characteristics of the workforce. Skilled labor is defined as those workers with lower secondary education or more. The way that these two kinds of labor are aggregated from the 16 categories of labor identified in the Indonesian SAM is summarized in Table 4. Table 5 summarizes the importance of the factors of production discussed above within the context of the cost structure of major industry categories. It notable that ‘skilled’ labor is unimportant in agriculture. The simulations assume that both categories of labor are mobile across all sectors while capital and land are immobile across industries. These features imply an intermediate-run focus for the analysis, of about two years duration. The focus is neither very short-run, or else labor would be less than fully mobile, nor long-run, or else capital and land would be more mobile.

3.5 Fertilizer and fertilizer subsidies

In the context of this paper, the special features of fertilizer as a factor of production and fertilizer subsidies, as captured in the model, require explanation. In all industries using fertilizer as an input, it is unique among intermediate inputs in that it substitutes with a nest of the primary factors land, labor and capital, with an elasticity of substitution that is varied in the analysis that follows. All other intermediate inputs are used in fixed proportions to output. In paddy production fertilizer accounts for 15.4 per cent of total intermediate input cost and only 2.7 per cent of total costs. Fertilizer subsidies constitute 15.9 per cent of the value of total sales of fertilizer. But if the rate of subsidy was 100 per cent this would reduce the cost of producing paddy by only 2.7 per cent. Clearly, a fertilizer subsidy is at best a relatively blunt instrument for reducing farmers' costs.

3.6 Households

The sources of income of the various households are of particular interest for this study because of their central importance for the distribution of income. These data are summarized in Table 6. Urban and rural households vary considerably in the composition of their factor incomes, particularly as regards skilled and unskilled labor. However, there is considerable variation within each of the urban and rural categories and Figures 6 and 7 summarize this information. This variation, between and within the rural and urban categories is fully captured by the database used for INDONESIA E-3. The principal source of the factor ownership matrix used in the model is Indonesia's SAM for the year 2003, but this is supplemented by additional data as described in Yusuf (2006).

Table 7 summarizes the characteristics of urban and rural households in so far as they relate to poverty incidence. Mean consumption expenditures per capita differ widely between urban and rural households. In the simulations conducted below, poverty incidence is calculated for each of these two household categories, using poverty lines for each category replicating the official levels of poverty incidence reported from the 2003 *Susenas* survey, using official poverty lines. These rates of poverty incidence are summarized in the final column of Table 7. Significant numbers of poor people are found in both categories: 13.6 per cent of the urban population and 20.2 per cent of the rural population. These numbers, together with the urban/rural population shares, imply that 65 per cent of all poor people within Indonesia reside in rural areas.

3.7 Analyzing distributional impacts

Several approaches have been adopted in analyzing income distribution within a CGE context. The traditional one is the *representative household method*, where it is assumed that the distribution of household incomes or expenditures follow a particular functional form, assumed to remain constant after the shock. Obviously, this assumption could be untrue, potentially affecting the results (Decaluwé *et al.* 1999). Studies on Indonesia by Sugema *et al.* (2005) and Oktaviani *et al.* (2005), among others, belong to this approach.

The second approach is the *socioeconomic class method*. Several CGE studies for Indonesia use this approach, based on the official household classification of the SAM, which divides the population into 10 socioeconomic classes. Like the representative household method, fixed intra-category income distribution is assumed. The distributional impact is analyzed by comparing the effects of policies among these socioeconomic classes. Studies for Indonesia by Resosudarmo (2003), Azis (2000), and Azis (2006), follow this approach.

A third approach is the *top-down method*, in which two models are combined, but imperfectly. Price changes produced by a CGE model, normally containing only a single representative household, are transferred as exogenous shocks to a separate micro-simulation model, such as a demand system model or an income-generation model, but without feedback from the micro-model to the CGE model. A high level of household heterogeneity can be incorporated with this approach, but data reconciliation between the two models is a major problem. Studies for Indonesia by Bourguignon et al. (2003), Ikhsan et al. (2005), Robilliard and Robinson (2006) and Robilliard *et al.* (2008) adopt this approach.

The fourth approach, adopted in this paper, is the *integrated multi-household method*, which consists of disaggregating households into a discrete number of categories, arranged by expenditure or income per capita.[3] These households are then fully integrated into the general equilibrium structure of the model. This approach has the strong methodological advantage of internal model consistency that is the essential feature of true general equilibrium analyses. Distributional impacts of external shocks, including effects on poverty incidence or standard inequality indicators can be estimated with any desired degree of accuracy by increasing the fineness of disaggregation of the household categories.

Poverty incidence is calculated in this study as follows. The number of household categories is 100 for rural households and 100 for urban households. The calculation of poverty incidence *ex ante* (before the shock) will be described first. Households are divided into rural and urban categories. For each of these categories the raw data on household expenditures per capita are sorted according to expenditures per capita, from the poorest to the richest, creating a smooth cumulative distribution of expenditures per capita. These data are then divided into centile groups, with equal population in each of the 100 categories. Let y_c be expenditure per capita of a household of the *c*-th centile where $c = 1,2, \ldots, 100$. That is,

[3] Warr (2008) uses this approach in studying the effects on poverty incidence in Thailand of the 2007–08 food price crisis.

y_1 is the poorest centile group and y_{100} is the richest and by construction, $y_{i+1} \geq y_i$. Poverty incidence is now

$$P(y_c, y_P) = \max\left\{c \middle| y_c < y_P\right\} + \frac{y_P - \max\left\{y_c \middle| y_c < y_P\right\}}{\min\left\{y_c \middle| y_c > y_P\right\} - \max\left\{y_c \middle| y_c < y_P\right\}} \tag{2}$$

where y_P is the poverty line. The first term is simply the highest centile for which expenditure per capita is below the poverty line. The second term is the linear approximation to where poverty incidence lies between centiles *c* and *c*+1.

The general equilibrium simulation of the impact of a particular shock generates estimated percentage changes in the distribution of real per capita expenditures. The meaning of 'real' is that the deflators used to obtain the distribution of real expenditures from the distribution of nominal expenditures are indices of consumer prices specific to the household centile categories concerned. They are calculated using the budget shares corresponding to each individual centile group. Let $\hat{y}_c$ denote the estimated percentage change in the real expenditure per capita of centile group *c*, The estimated *ex post* (after the shock) level of real expenditure per capita, as estimated by the general equilibrium model is given by y_c^*, where

$$y_c^* = \left(1 + \frac{\hat{y}_c}{100}\right).y_c\,. \tag{3}$$

It is important to note that different centile categories may be affected differently by the project, as captured by the simulation results. This means that the ordering of centile groups according to their *ex post* real expenditures per capita may have changed from their *ex ante* ordering. The distribution y_c^* is not necessarily smooth in that it is not necessarily the case that $y_{i+1}^* \geq y_i^*$. Accordingly, the method of equation (2) above cannot be applied directly to the distribution y_c^*. The 100 household categories in the ex post distribution y_c^* are now *re-sorted* according to real expenditures per capita in the same way as described above, to obtain a new distribution y_c^{**} such that $y_{i+1}^{**} \geq y_i^{**}$. The distribution y_c^{**} differs from the distribution y_c^* only by this re-sorting. It is notable that because of the re-sorting the *i*-th centile group in the re-sorted *ex post* distribution y_c^{**} does not necessarily correspond to the *i*-th centile group in the *ex ante* distribution y_c.

The re-sorted *ex-post* distribution y_c^{**} of real expenditures per capita is then used as the basis for recalculating poverty incidence in the same manner as in equation (2), substituting y_c^{**} for y_c to obtain $P(y_c^{**}, y_P)$. The poverty line is held constant in real terms and so the same poverty line y_P can be used to calculate poverty incidence in the *ex ante* and *ex post* distributions. Both distributions represent *real* household expenditures per capita. The estimated change in poverty incidence after a policy shock (as captured by a simulation of the model) is now

$$\Delta P = P(y_c^{**}, y_P) - P(y_c, y_P). \qquad (4)$$

That is, the same method is used to calculate the level of poverty incidence in the sorted *ex ante* and the re-sorted *ex post* distributions. The estimated change in poverty incidence is the difference between them.

4. Simulations and results

4.1 Model closure

Since the real expenditure of each household is used as the basis for the calculation of poverty incidence and inequality, the macroeconomic closure must be made compatible with both this measure and with the single-period horizon of the model. This is done by ensuring that the full economic effects of the shocks to be introduced are channeled into current-period household incomes and do not 'leak' in other directions, with real-world inter-temporal welfare implications not captured by the welfare measure. The choice of macroeconomic closure may thus be seen in part as a mechanism for minimizing inconsistencies between the use of a single-period model to analyze welfare results and the multi-period reality that the model depicts.

To prevent these kinds of welfare leakages from occurring, the simulations are conducted with balanced trade (exogenous balance on current account). This ensures that the potential effects of the shock being studied do not flow to foreigners, through a current account surplus, or that increases in domestic consumption are not achieved at the expense of borrowing from abroad, in the case of a current account deficit. For the same reason, real government spending and real investment demand for each good are each fixed exogenously. The government budget deficit is held fixed in nominal terms. This is achieved by endogenous across-the-board adjustments to the *sales tax rate* so as to restore the base level of the budgetary deficit. The combined effect of these features of the closure is that the full impact of an exogenous shock is channeled into household consumption and not into effects that are not captured within the single period focus of the model.

4.2 The shocks

In analyzing the effects of a fertilizer subsidy, it seems likely that the elasticity of substitution between fertilizer and primary factors would be a central parameter in determining the amount of subsidy required to achieve a given output effect. Three values for this parameter were considered: 0.1, 0.25 and 0.5. For each value, three sets of shocks were applied:

1. Subsidy: a fertilizer subsidy that reduces rice imports, relative to the base, by 10 %.
2. Quota: a reduction in the permitted level of rice imports, relative to the base, of 10 %.
3. Tariff: imposition of a tariff that reduces rice imports, relative to the base, by 10%.

In each of these three scenarios the level of rice imports is specified exogenously – a 10 per cent reduction. In simulation 1 the level of the fertilizer subsidy is endogenously determined. In simulations 2 and 3 the difference between the international and domestic price of imported rice is determined endogenously. The difference between simulations 2 and 3 is that in simulation 2 the rent from the quota is collected by the quota owners, assumed to be the richest 5 per cent of urban households, whereas in simulation 3 the revenue from the tariff is collected by the government. This gives a total of nine simulations.

4.3 Results

Tables 8 to 14 summarize the results. The assumed value of the CES elasticity of substitution between fertililzer and a CES composite of primary factors, labelled ‘Sigma’, is repeated at the top row of each table (0.1, 0.25 and 0.5) and will subsequently be called ‘Sigma’ for brevity. The next row shows the three sets of simulations: Subsidy, Quota and Tariff conducted for each value of this elasticity.

Beginning with macroeconomic effects, shown in Table 8, large effects on real GDP do not occur and should not be expected, because neither technology nor factor supplies are changing. The tariff and quota shocks have no notable macroeconomic effects but the fertilizer subsidy distorts the allocation of resources sufficiently that real GDP declines by a small amount. The reason can be seen by jumping ahead to Table 10. At low values of Sigma a huge increase in the rate of fertilizer subsidy is required to achieve the 10 per cent reduction in rice imports. When Sigma = 0.1, the required subsidy rate increases by 68.6 per cent, from the base level of 15.9 per cent to 84.5 per cent, requiring 13.4 trillion Indonesian Rupiah (about US$14 billion) of tax revenue to finance it. As Sigma rises this budgetary cost declines, but it is still huge. In conventional efficiency terms, the fertilizer subsidy is a wasteful way of reducing rice imports.

Effects on factor returns, deflated by the consumer price index, are shown in Table 9. The fertilizer subsidy bids up the value of land and raises unskilled wages because cheap fertilizer raises the marginal product of unskilled labor in labor-intensive agriculture. Because of the mobility of labor, the effect on unskilled wages is economy-wide. Agriculture uses virtually no 'skilled' labor, but outside agriculture, where the fertilizer subsidy has no direct value, the increase in unskilled wages reduces the return to other factors, including skilled labor and capital. Protection of the rice industry, whether through a quota or a tariff has similar but much smaller effects.

Table 10 shows that paddy production rises more under the fertilizer subsidy than under rice industry protection. It must, because none of the reduction in imports is coming from reduced consumption. In fact, under the subsidy, production must rise by more than the amount of the import reduction beause the increased volume of rice output forces down the domestic price of rice, increasing further the amount by which production must rise to reduce imports by the required amount. The price of rice falls by even more when the value of Sigma rises, reflecting the lower budgetary cost of the subsidy and the smaller increase in the sales tax rate required to finance it.

The simulated effects on poverty incidence are shown in Table 11. While a quota and a tariff worsen poverty incidence, rural and urban, under all values of Sigma, the fertilizer subsidy does the opposite. Why? First, the fertilizer subsidy forces down the consumer price of food, including but not only rice. The quota and the tariff raise the consumer price of rice. Poverty incidence is highly sensitive to this because food, especially rice, accounts for a high share of the budgets of poor consumers. Poor farmers lose from the decline in the price of rice, but this effect is numerically outweighed by the larger number of poor net purchasers of ricewho gain, even – indeed, especially – in rural areas.

The reasons for the simulated changes in urban and rural poverty can be understood more deeply by decomposing the changes in real expenditures of households with real expenditures close to the poverty line. This is done in Tables 12 and 13. Consider a rural household on the threshhold of the rural poverty line (Table 13). Because the base level of poverty incidence in rural areas is 20.2 per cent, the poverty line roughly coincides with the expenditure level of the rural household in the 20th centile. If this poverty-borderline household becomes better off, we expect poverty incidence to decline, and vice versa. Under Sim-1, the real expenditure of this household centile category rises by 10.8 billion rupiah (bottom row of the table) consistent with rural poverty incidence decling. We can now study in detail why its real expenditure rises.

It can be shown that the change in real expenditure is equal to the change in nominal consumption minus the change in the cost of living (Warr 2008). The change in nominal consumption is itself equal to the change in total income minus the change in saving. By examining each of these components of the change in real expenditure, it is clear that the overwhelming source of the rise in real expenditures of this household is the increase in the real wage for unskilled labor. The cause is not a decline in living costs, because despite the decline in the price of rice, living costs rise, reflecting the large increase in the sales tax rate required to finance the fertilizer subsidy.

In constrast, the quota and tariff both raise rural poverty incidence, though by small amounts. The reason is clear from Table 13. Both instruments raise living costs relative to all other components of the cost of living. They do so because they raise the price of rice. This same sequence can be followed for the borderline-poor urban household (Table 12), although the changes in poverty incidence are very small.

The observation that the effect on unskilled wages dominates the effect on rural poverty suggests that the treatment of the labor market could be an important driver of the results. This is confirmed by Table 14, which repeats the analysis of effects on poverty but under the assumption that rural labor and unskiled urban labor (both skilled and unskilled) do not compete directly. Assuming immobility of labor between rural and urban areas means that their wages can move independently. Under this assumption a fertilizer subsidy is even more poverty reducing than under mobile labor assumptions but the quota and tariff both produce small reductions in rural poverty that outweigh the small inceases in urban poverty. Repeating the decomposition method shown in Tables 12 and 13 reveals the reason. The quota and tariff cause unskilled rural wages to rise enough to outweigh the increase in the cost of living through the price of rice.

Is the assumption of immobile unskilled labor realistic for Indonesia? Definitely not. Unskilled workers move back and forth between rural and urban areas continuously, partly reflecting the seasonality of rural labor demand. But in the short run mobility is presumably less than complete. Rice industry protection could reduce rural poverty temporarily, by increasing agricultural wages, but the effect would soon be eroded as labor mobility reduces this wage effect and the increase in the consumer price of rice comes to dominate the net effect on rural poverty.

5. Conclusions

Indonesia has actively used both fertilizer subsidies and protection of the rice industry, through quantitative restrictions on rice imports, as instruments for the pursuit of rice self-sufficiency. Fertilizer subsidies have limited power in this respect because the share of fertilizer in the cost of producing rice is surprisingly low. To achieve any given reduction in rice imports a very high rate of fertilizer subsidy is required, implying a high budgetary cost to the government. But fertilizer subsidies have two advantages over output protection. First, they do not raise the price of rice; indeed, they lower it. Second, fertilizer subsidies have large and positive effects on unskilled wages. For these reasons, they reduce poverty, rather than increasing it, as with the case of output protection. Whether a fertilizer subsidy is an efficient instrument for reducing poverty, aside from its effects on rice self-sufficiency, is another matter.

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Table 1: Quantity of subsidized fertilizer, 2003–10

	2003	2004	2005	2006	2007	2008	2009	2010
Distributed through the HET price subsidy system								
Urea	4,339	4,239	4,027	4,300	4,300	4,800	5,500	4,931
SP-36	1,000	800	600	700	800	800	1,000	850
ZA	715	600	400	700	700	700	923	850
NPK	300	400	230	400	700	900	1,500	2,100
Organic	0	0	0	0	0	345	450	750
Distributed through the BLP organic fertilizer subsidy system								
Organic - Granular	0	0	0	0	0	152	195	293
Organic - ('000 liters)	0	0	0	0	0	1,010	1,297	1,955
NPK	0	0	0	0	0	51	65	98

Source: OECD (2012), Ministry of Agriculture (2011).

Table 2: Trade shares and elasticity assumptions, agricultural, processed food and resource-based industries, 2003

		Import share (%)	Export share (%)	Armington elasticity of demand	Elasticity of substitution	Export demand elasticity
1	Paddy	0.00	0.00	5.05	0.24	10.10
2	Maize	4.85	0.02	1.30	0.24	2.60
3	Cassava	0.12	0.01	1.85	0.24	3.70
4	Beans	19.60	0.07	2.25	0.24	3.72
5	Other food crops	7.69	0.90	2.14	0.24	3.71
6	Estate crops	10.85	6.88	2.86	0.24	6.39
7	Livestock	5.56	1.65	1.65	0.24	3.81
8	Wood	2.14	1.17	2.50	0.20	5.00
9	Fishery	0.51	14.33	1.25	0.20	2.50
10	Coal mining	8.99	54.44	1.46	0.20	2.43
11	Oil and gas	26.12	67.99	10.50	0.20	12.33
12	Milled rice	1.14	0.00	12.00	1.12	24.00
13	Flour	2.01	0.25	2.00	1.12	4.00
14	Sugar	38.05	4.39	2.00	1.12	4.00
15	Other food	3.62	9.52	2.70	1.12	5.40
16	Fertilizer	1.44	6.45	2.25	1.12	5.74

Note: Import share means imports/domestic demand. Export share means exports/domestic production.
Source: Authors' calculations. Armington elasticities and export demand elasticities are derived from the GTAP database, as described in GTAP database, as in Hertel (1997).

Table 3: Structure of 768 × 768 Indonesian SAM

		Activities 1…181	Commodity		Factor		Ind. Tax	S-I	Households 1…200	Transfers	Enterprises	Gov't	ROW	TOTAL
			Domestic 1…181	Imported 1…181	Labor 1…16	Capital								
Activities	1 … 181		MAKE Matrix											Industry Sales
Domestic Commo-dities	1 … 181	_Domestic Intermediate Input						Domestic Invest-ment	Domestic Hou. Con-Sumption			_Domeatic Gov't Lon-sumption	Export	Total Dom. Demand
Imported Commo-dities	1 … 181	Imported Intermediate Input						Imported Invest-ment	Imported Hou. Con-Sumption			Imported Gov't Con-sumption		Total Import
labor	1 … 16	Salary and Wages											labor used abroad	Total labor Demand
Capital		Non-labor											Cap. used abroad	Capital Demand
Ind. Tax		Tax/ Subsidy		Tariff										Ind. Tax Reven.
Urban HH	1 … 100				Labor Income: Urban	Capital Income: Urban				Inter-Hous. Transfer			ROW transfer to HH	Total Hous. Income
Rural HH	1 … 100				labor Income: Rural	Capital Income: Rural				Inter-Hous.. Transfer			ROW transfer to HH	Total Hous. Income
Transfer									Transfer to HH					Int. Hous. Transter
S-I									Household Saving		Enterprise Saving	Gov't Saving		Total Saving
Govern-ment							Ind.Tax Revenue		Direct Tax		Ent. _Traps. to Gov t	Inter G Transfer	ROW Tans. to Gov t	Govt Revenue
Enter-prises						Enter- Enter-					Inter Ent. itans.		ROW Trans. to Enter.	Ente. Income
ROW				Import	Foreign labor	Foreign Capital			HH Transfer to abroad		Ent Trans. to abroad	G. Transfer to abroad		Forex Outflow
TOTAL		Industry Costs	Dom. Supply	Import Supply	Labor Supply	Capital Supply	Ind. Tax Revenue	Total Invest.	Household Spending	Int. Hou. Transfer	Enter. Spending	Govern. Spending	Forex Inflow	

Source: Yusuf (2006).

Table 4: Labor categories used in INDONESIA E-3 model

	16 SAM categories	2 skill categories
1	Urban, formal, agriculture	Unskilled
2	Rural, formal, agriculture	Unskilled
3	Urban, informal, agriculture	Unskilled
4	Rural, informal, agriculture	Unskilled
5	Urban, formal, production	Unskilled
6	Rural, formal, production	Unskilled
7	Urban, informal, production	Unskilled
8	Rural, informal, production	Unskilled
9	Rural, formal, clerical	Skilled
10	Rural, formal, clerical	Skilled
11	Urban, informal, clerical	Skilled
12	Rural, informal, clerical	Skilled
13	Urban, formal, professional	Skilled
14	Rural, formal, professional	Skilled
15	Urban, informal, professional	Skilled
16	Rural, informal, professional	Skilled

Source: 16 SAM categories from Central Bureau of Statistics, *Social Accounting Matrix, Indonesia, 2003*, Central Bureau of Statistics, Jakarta, 2003.

Table 5: Cost shares of major factors of production (2003)

	Unskilled labor	Skilled labor	Capital	Land	Total
Agriculture	62.2	2.0	17.6	18.2	100
Mining	10.5	4.5	85.0	0.0	100
Food Processing	35.1	9.7	55.2	0.0	100
Other manufacturing	24.0	9.1	66.8	0.0	100
Service	14.6	40.2	45.2	0.0	100
All industries	25.4	22.2	49.4	3.0	100

Source: Authors' calculations from Indonesia's official SAM and related data sources.

Table 6: Household factor income shares

	Unskilled labor	Skilled labor	Capital	Land	Total
Urban	26.57	38.97	31.20	3.27	100
Rural	45.60	15.57	33.74	5.09	100
Total	34.08	29.74	32.20	3.99	100

Source: Authors' calculations from Indonesia's official SAM and related data sources.

Table 7: Expenditure and poverty incidence by household group, 2005

	% of total population in this group	% of total households in this group	Mean per capita expenditure (Rp. /mo.)	% of population in this group in poverty
Urban	45.54	44.68	732,023	13.6
Rural	54.46	55.32	413,576	20.2
Total	100	100	558,597	17.19

Source: Authors' calculations from Indonesia's *Susenas* survey and related data sources.

Table 8: Macroeconomic effects

	Sigma = 0.1			Sigma = 0.25			Sigma = 0.5		
	Subsidy Sim-1	Quota Sim-2	Tariff Sim-3	Subsidy Sim-4	Quota Sim-5	Tariff Sim-6	Subsidy Sim-7	Quota Sim-8	Tariff Sim-9
GDP price index	0.353	0.014	0.014	0.219	0.014	0.014	0.137	0.014	0.014
Real devaluation	-0.351	-0.014	-0.014	-0.219	-0.014	-0.014	-0.137	-0.014	-0.014
Consumer price index	0.252	0.018	0.018	0.145	0.018	0.018	0.077	0.018	0.018
Real GDP	-0.058	0.000	0.000	-0.033	0.000	0.000	-0.021	0.000	0.000
Import volume index	-0.274	-0.009	-0.009	-0.136	-0.009	-0.009	-0.054	-0.009	-0.009
Export volume index	-0.237	-0.008	-0.008	-0.118	-0.008	-0.008	-0.047	-0.008	-0.008
Real household consumption	-0.069	0.000	0.000	-0.039	0.000	0.000	-0.026	0.000	0.000

Note:
'Subsidy' means a fertilizer subsidy that reduces rice imports by 10 per cent.
'Quota' means a quantitative reduction of rice imports of 10 per cent.
'Tariff' means a tariff on rice imports that reduces those imports by 10 per cent.
Source: Authors' calculations**.**

Table 9: Effects on real factor returns

	Sigma = 0.1			Sigma = 0.25			Sigma = 0.5		
	Subsidy Sim-1	Quota Sim-2	Tariff Sim-3	Subsidy Sim-4	Quota Sim-5	Tariff Sim-6	Subsidy Sim-7	Quota Sim-8	Tariff Sim-9
Unskilled Labor	0.439	0.015	0.015	0.161	0.015	0.015	-0.011	0.014	0.015
Skilled Labor	-0.276	-0.026	-0.026	-0.021	-0.026	-0.026	0.131	-0.026	-0.026
Capital	-0.049	-0.007	-0.007	0.000	-0.007	-0.007	0.028	-0.007	-0.007
Land	0.396	0.090	0.090	-0.155	0.089	0.089	-0.504	0.087	0.087

Note: See footnote to Table 8.
Source: Authors' calculations.

Table 10: Selected microeconomic effects

	Sigma = 0.1			Sigma = 0.25			Sigma = 0.5		
	Subsidy Sim-1	Quota Sim-2	Tariff Sim-3	Subsidy Sim-4	Quota Sim-5	Tariff Sim-6	Subsidy Sim-7	Quota Sim-8	Tariff Sim-9
Paddy production	0.174	0.096	0.096	0.169	0.096	0.096	0.164	0.096	0.096
Rice consumption	1.223	-0.179	-0.178	0.987	-0.177	-0.176	0.818	-0.174	-0.173
Consumer price of rice	-0.568	0.230	0.231	-0.680	0.228	0.228	-0.745	0.225	0.225
Cost of fertilizer subsidy (Rp B)	13,460	0	0	8,733	0	0	5,873	0	0
Additional rate of subsidy (%)	68.58	0.00	0.00	43.70	0.00	0.00	28.95	0.00	0.00
Additional rate of tariff equiv. (%)	0.0	1.17	1.17	0.00	1.16	1.16	0.00	1.16	1.16

Note: See footnote to Table 8.
Source: Authors' calculations.

Table 11: Effects on poverty incidence

	Sigma = 0.1			Sigma = 0.25			Sigma = 0.5		
	Subsidy Sim-1	Quota Sim-2	Tariff Sim-3	Subsidy Sim-4	Quota Sim-5	Tariff Sim-6	Subsidy Sim-7	Quota Sim-8	Tariff Sim-9
Urban poverty incidence									
Ex-ante (%)	13.600	13.600	13.600	13.600	13.600	13.600	13.600	13.600	13.600
Ex-post (%)	13.596	13.602	13.602	13.596	13.602	13.602	13.598	13.602	13.602
Change	-0.004	0.002	0.002	-0.004	0.002	0.002	-0.002	0.002	0.002
Rural poverty incidence									
Ex-ante (%)	20.200	20.200	20.200	20.200	20.200	20.200	20.200	20.200	20.200
Ex-post (%)	20.045	20.205	20.204	20.111	20.205	20.204	20.153	20.204	20.204
Change	-0.155	0.005	0.004	-0.089	0.005	0.004	-0.047	0.004	0.004
Total poverty incidence									
Ex-ante (%)	16.914	16.914	16.914	16.914	16.914	16.914	16.914	16.914	16.914
Ex-post (%)	16.834	16.917	16.917	16.867	16.917	16.917	16.890	16.917	16.917
Change	-0.080	0.003	0.003	-0.047	0.003	0.003	-0.025	0.003	0.003

Note: See footnote to Table 8.
Source: Authors' calculations.

Table 12. Decomposition of changes in expenditure – urban poor household

	Sigma = 0.1			Sigma = 0.25			Sigma = 0.5		
	Subsidy Sim-1	Quota Sim-2	Tariff Sim-3	Subsidy Sim-4	Quota Sim-5	Tariff Sim-6	Subsidy Sim-7	Quota Sim-8	Tariff Sim-9
1 Unskilled	16.224	0.719	0.728	6.870	0.713	0.721	1.442	0.703	0.711
2 Skilled	-0.323	-0.108	-0.106	1.637	-0.106	-0.104	2.767	-0.102	-0.100
3 Capital	2.069	0.112	0.115	1.470	0.112	0.114	1.070	0.111	0.113
4 Land	0.815	0.135	0.136	-0.013	0.134	0.134	-0.534	0.131	0.132
5 Others	-0.181	-0.010	-0.010	-0.101	-0.010	-0.010	-0.050	-0.010	-0.010
6 Total	18.993	0.849	0.863	10.090	0.843	0.857	4.749	0.833	0.847
7 Saving	7.056	0.001	-0.001	4.084	0.001	-0.002	2.397	0.001	-0.002
8 Consumption	11.150	0.848	0.865	5.770	0.842	0.858	2.297	0.832	0.849
9 Living cost	11.498	1.098	1.099	5.732	1.089	1.091	2.344	1.076	1.078
10 Real expenditure	-0.312	-0.247	-0.232	0.036	-0.245	-0.230	-0.046	-0.241	-0.226

Note: See footnote to Table 8.
Source: Authors' calculations.

Table 13: Decomposition of changes in expenditure – rural poor household

	Sigma = 0.1			Sigma = 0.25			Sigma = 0.5		
	Subsidy Sim-1	Quota Sim-2	Tariff Sim-3	Subsidy Sim-4	Quota Sim-5	Tariff Sim-6	Subsidy Sim-7	Quota Sim-8	Tariff Sim-9
1 Unskilled	19.774	0.864	0.874	8.301	0.856	0.866	1.733	0.844	0.854
2 Skilled	-0.084	-0.028	-0.027	0.422	-0.027	-0.027	0.710	-0.026	-0.026
3 Capital	1.954	0.106	0.108	1.389	0.105	0.108	1.011	0.105	0.107
4 Land	0.770	0.128	0.129	-0.013	0.126	0.127	-0.504	0.124	0.124
5 Others	0.136	0.012	0.012	0.091	0.012	0.012	0.062	0.012	0.012
6 Total	23.119	1.084	1.098	10.354	1.074	1.088	3.033	1.060	1.074
7 Saving	6.436	0.006	0.003	3.654	0.006	0.003	2.075	0.005	0.003
8 Consumption	15.675	1.078	1.094	6.464	1.069	1.085	0.939	1.055	1.071
9 Living cost	4.397	1.376	1.379	0.285	1.365	1.367	-2.196	1.347	1.349
10 Real expenditure	10.802	-0.294	-0.281	6.161	-0.292	-0.278	3.205	-0.288	-0.275

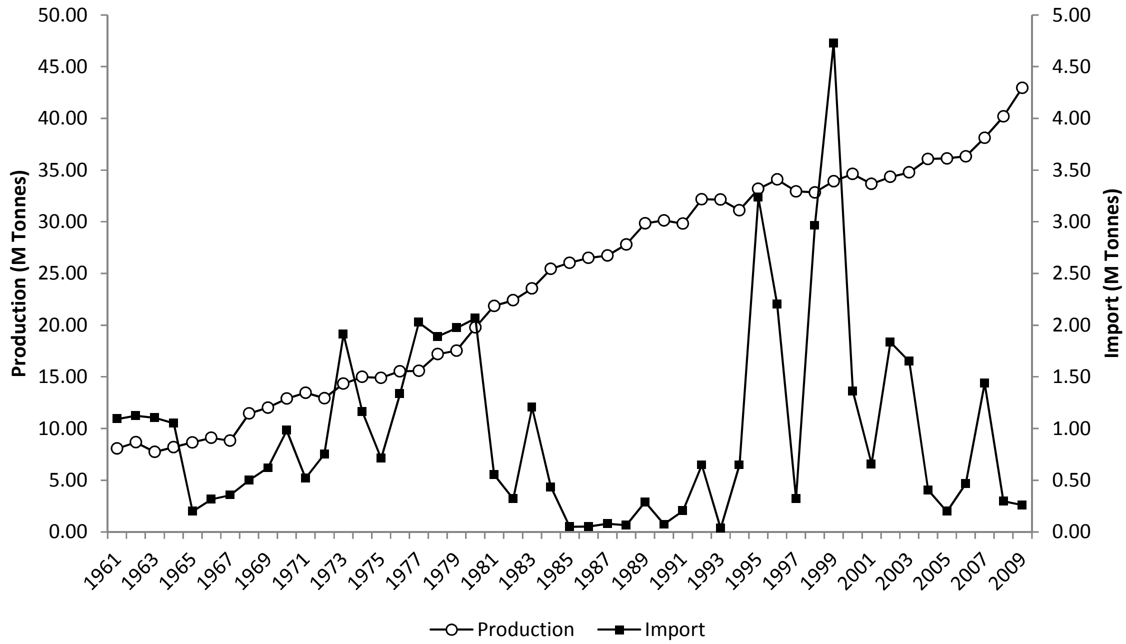
Note: See footnote to Table 8.
Source: Authors' calculations.

Table 14:Effects on poverty incidence when labor is immobile between rural and urban areas

	Sigma = 0.1			Sigma = 0.25			Sigma = 0.5		
	Subsidy	Quota	Tariff	Subsidy	Quota	Tariff	Subsidy	Quota	Tariff
	Sim-1	Sim-2	Sim-3	Sim-4	Sim-5	Sim-6	Sim-7	Sim-8	Sim-9
Urban poverty incidence									
Ex-ante (%)	13.600	13.600	13.600	13.600	13.600	13.600	13.600	13.600	13.600
Ex-post (%)	13.657	13.607	13.607	13.589	13.607	13.607	13.576	13.607	13.607
Change	0.057	0.007	0.007	-0.011	0.007	0.007	-0.024	0.007	0.007
Rural poverty incidence									
Ex-ante (%)	20.200	20.200	20.200	20.200	20.200	20.200	20.200	20.200	20.200
Ex-post (%)	19.994	20.191	20.191	20.130	20.192	20.191	20.218	20.192	20.192
Change	-0.206	-0.009	-0.009	-0.070	-0.008	-0.009	0.018	-0.008	-0.008
Total poverty incidence									
Ex-ante (%)	16.914	16.914	16.914	16.914	16.914	16.914	16.914	16.914	16.914
Ex-post (%)	16.839	16.913	16.913	16.873	16.913	16.913	16.911	16.913	16.913
Change	-0.075	-0.001	-0.001	-0.041	-0.001	-0.001	-0.003	-0.001	-0.001

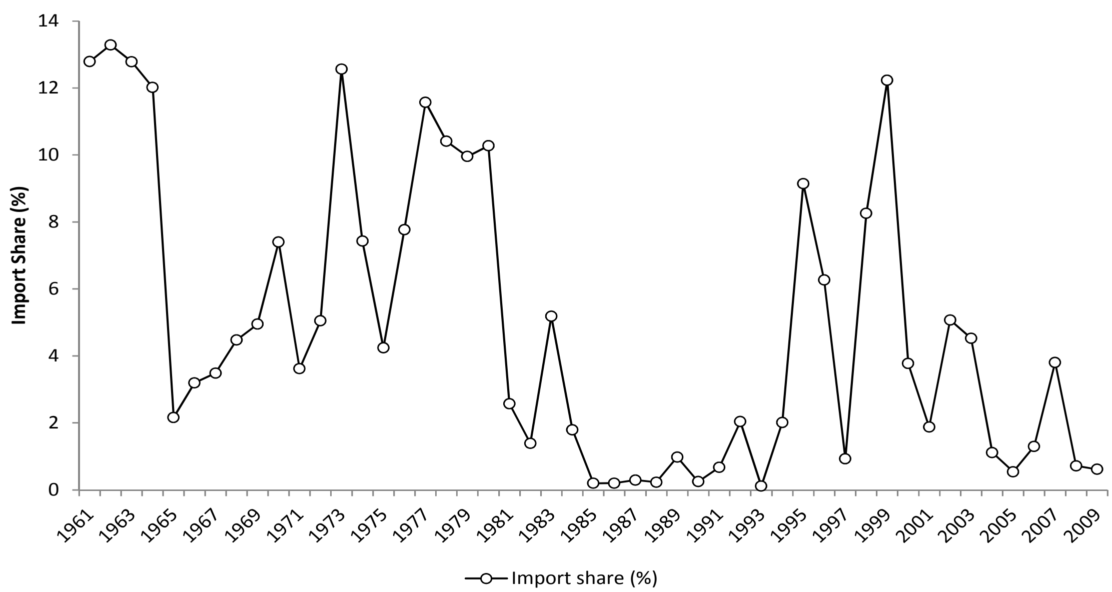
Note: See footnote to Table 8.
Source: Authors' calculations.

Figure 1: Indonesia: Rice production and imports (million tonnes)



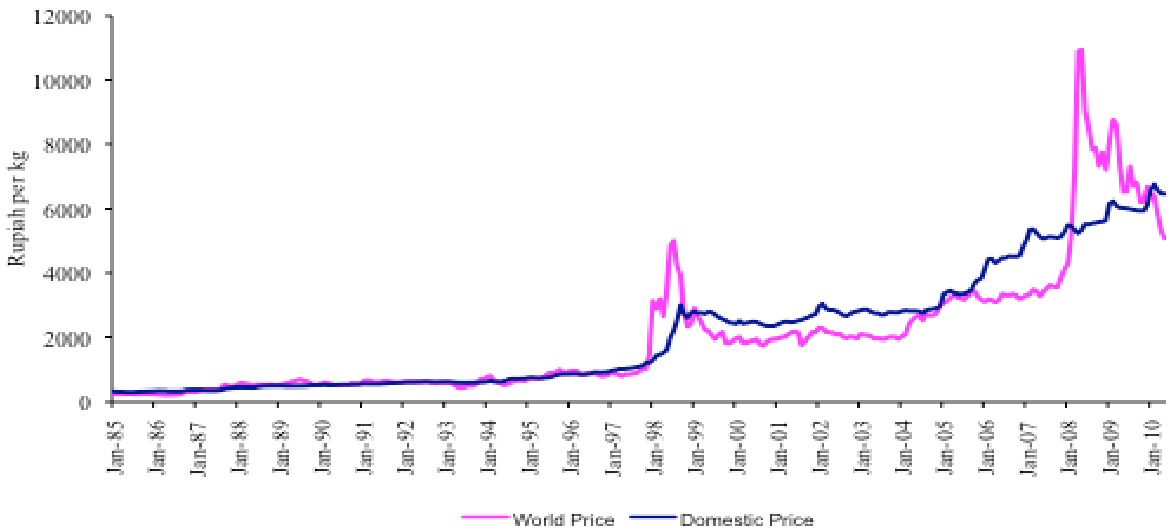
Source: Authors' calculations using data from FAO.

Figure 2: Indonesia: Share of imports in domestic rice supply (per cent)



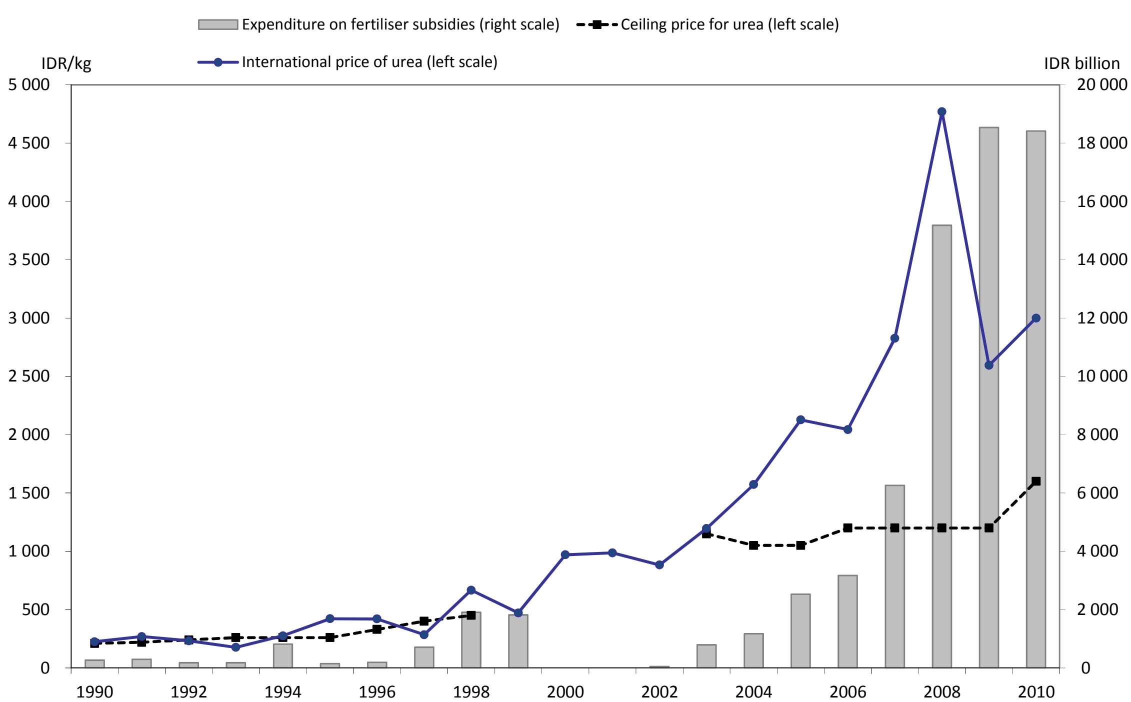
Source: Authors' calculations using data from FAO.

Figure 3. Indonesia: Domestic wholesale prices and world prices for rice, 1985 to 2010



Source: Authors' calculations using data from *Bulog*, Jakarta (rice prices) and Central Bureau of Statistics, Jakarta (exchange rates).

Figure 4: Indonesia: Fertilizer subsidies, 1990 to 2010



Source: FAO and OECD (2012).

Figure 5: Production structure of the model

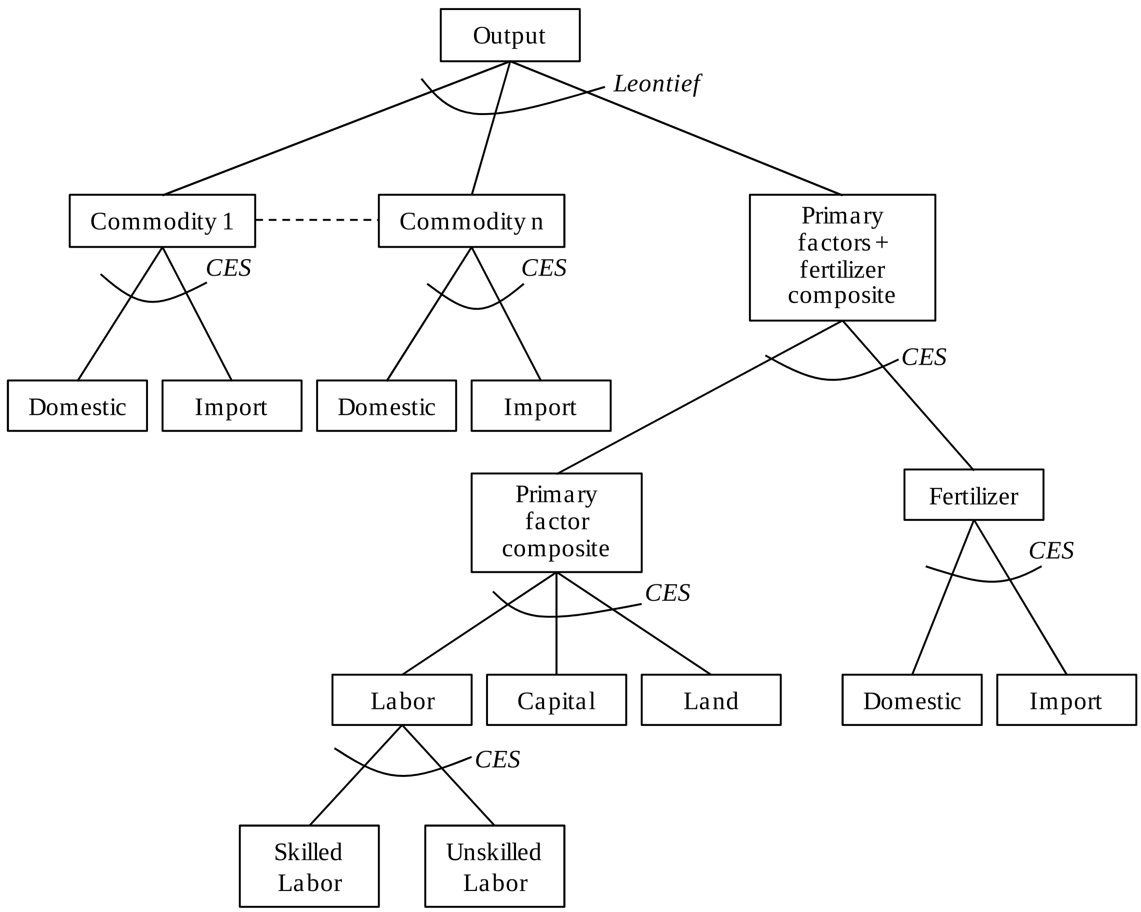
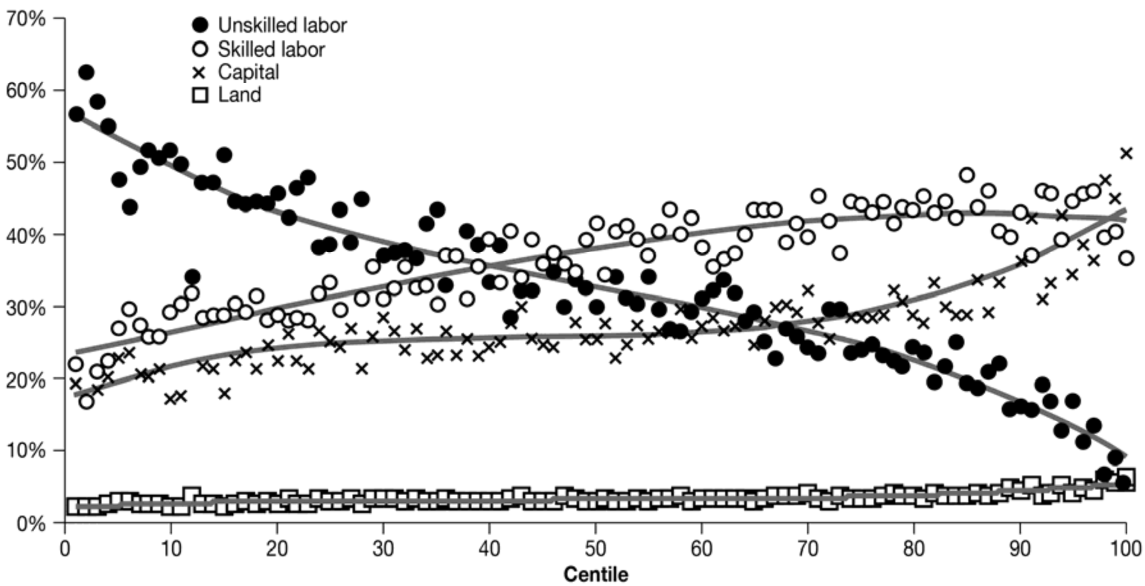
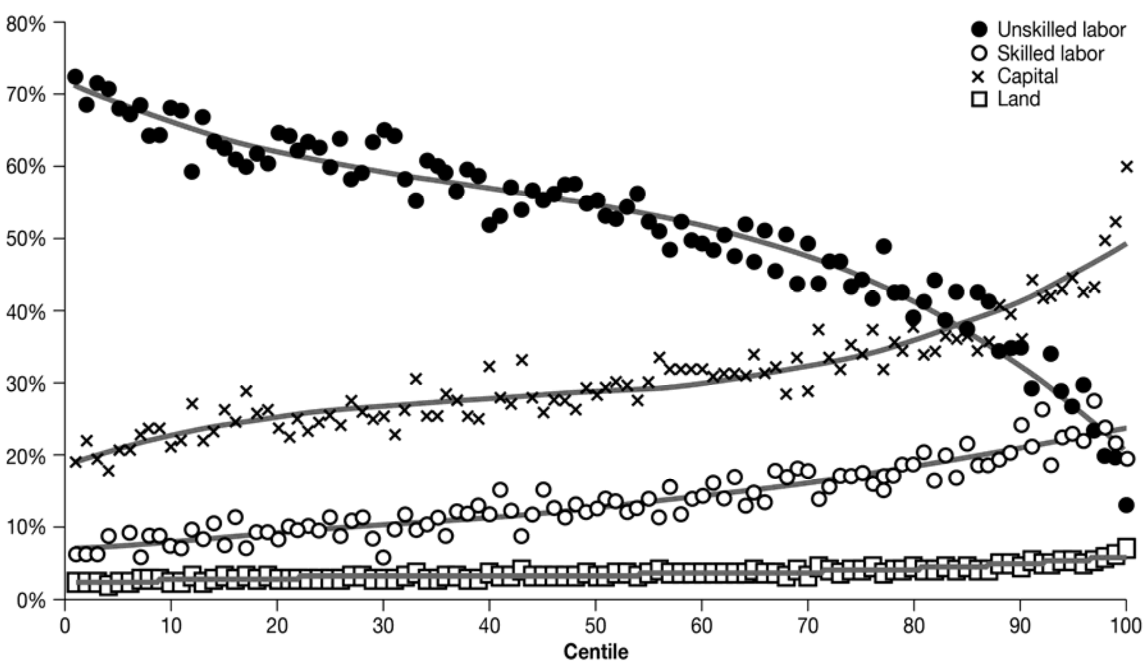


Figure 6: Factor shares in incomes of urban households



Source: Authors' calculations.

Figure 7: Factor shares in incomes of rural households



Source: Authors' calculations.

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