CHAPTER 11

Household Implications of Production and Price Shocks in Indonesian Agriculture*

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1. Introduction

The various economies of East Asia differ considerably in whether they are net importers or exporters of staple foodstuffs. Partly as a consequence, agricultural policies also differ widely. Generalizing broadly, major net exporters of food, such as Thailand, typically intervene only moderately in the markets for these commodities, but countries that are both net importers and substantial producers of food, such as Indonesia, have increasingly tended to intervene more heavily. In particular, they look for ways to promote "food security" by limiting food imports.[1] Critics of these policies interpret "food security" as code for politically driven protection of the import-competing agricultural sector. Whatever the motive for the protection, its existence has important economic consequences. When the agricultural sectors of these two groups of countries are affected by price or production shocks, the effects on the agricultural sectors themselves and the subsequent effects on rural

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[1] Importers that are not significant producers, such as Singapore and Hong Kong, view "food security" quite differently. For them, there is no possibility of producing all the food they require.

and urban households may be quite different because the policy environment in which the agricultural sector operates is so different.

As interpreted here, a price shock means an exogenous international price change like the international food price crisis of 2007—08. Obviously, such a shock can be positive or negative. A production shock means an exogenous positive or negative shock to domestic supply conditions. It may be a temporary negative shock, such as drought, floods, crop diseases, or pest outbreaks, but it can also be a more permanent positive shock such as a change in technology that shifts production functions or a permanent (positive or negative) change in climatic conditions.

This study focuses on Indonesia, a net importer of virtually all of its staple foods, including rice and sugar, but a net exporter of several nonstaple agricultural commodities, such as rubber and palm oil. The Indonesian government intervenes actively in pursuit of its goal of food security, which is overwhelmingly interpreted to mean avoiding imports of rice. Indonesia has been a major importer of rice for many decades, but it officially prohibited imports of rice in 2004.[2] This feature of its trade policy will clearly affect the way that production shocks on the one hand, and externally induced price shocks on the other hand impact rural and urban households in Indonesia, compared with what those impacts would be under free trade. This study attempts to clarify these differences.

The method of analysis used is a very simple general equilibrium model of the Indonesian economy to study the way these two kinds of shocks affect households under different agricultural trade policies. The model is indeed simple, but it is based on empirical Indonesian data. The research first simulates the effects of both production and price shocks under free trade, then under a binding restriction on food imports, and then compares the results. The reason for using a very simple model is to isolate the economic issues that are most important for the effects on households of agricultural price and production shocks. The paper begins by summarizing the case for a general equilibrium treatment. Then it

[2] The "ban" is only partially effective in the sense that some imports still enter the country, and imported rice can still be found in the Jakarta retail market. In effect, the "ban" is more like an import quota where the quantity of imports permitted is about one-tenth of the previous level. The permitted quantity of imports is apparently variable and has changed with market conditions. Exports of rice were already banned since at least the early 1990s to eliminate the possibility that a surge in international prices could produce a similar price surge within Indonesia.

presents a summary of the multihousehold general equilibrium model to be used followed by a description of the simulations performed. The study then discusses the implications of the findings.

2. A Simple General Equilibrium Framework

2.1 The case for a general equilibrium treatment

Suppose we are interested in the economic consequences on households of changes in international agricultural prices similar to what happened in 2007—08. The effect on the welfare of individual households involves both changes in household expenditures (operating through consumer goods prices) and changes in household incomes (operating through changes in factor returns). The effect on consumer goods prices is obvious. On the income side, factor returns will also be affected. In the case of a large increase in agricultural prices, the agricultural sector can be expected to respond to higher prices with increased output, increasing the demand for the factors of production that it uses. Returns to agricultural land will increase. Since agriculture is a large employer of labor, the equilibrium wage may rise throughout the economy, thereby influencing returns to fixed factors used elsewhere. These changes in factor returns will in turn affect the structure of household incomes, depending on the factor ownership characteristics of individual households.

Alternatively, consider the effect on agricultural production of shocks such as natural disasters or pest outbreaks on the one hand, or improvements to agricultural technology on the other. These shocks will affect households via changes in factor incomes and perhaps through changes in commodity prices as well.

Clearly, an analysis of the way large external price shocks or shocks to production conditions affect the structure of household welfare (and thus poverty) is inherently a general equilibrium problem. The objective of this study is to employ the *simplest* general equilibrium structure that is capable of capturing the essence of the phenomena under study. The model is called *Indonesia-Dua*. Most of its structural features are very conventional. Its distinctive feature is its disaggregated household structure, designed to facilitate analysis of

the way exogenous shocks affect poverty and inequality. Despite its simplicity, the model is empirically based. On the production side, it draws upon the Indonesian *Social Accounting Matrix* and on the household side, it draws upon the Indonesian household income and expenditure survey called *Susenas*.

The advantage of working with a general equilibrium model with a disaggregated household sector is that it becomes possible to conduct controlled experiments that focus on the consequences on household incomes, expenditures, poverty, and inequality resulting from different economic shocks, taken one at a time.

2.2 Model structure

Consider a very simple two-sector economy in which agricultural commodities are net imports and nonagricultural commodities like manufactured goods are net exports. There is one factor of production—labor—which is mobile between the two industries and one specific factor used in each of the two industries. The agricultural factor can be called land and the nonagricultural factor, capital. There are 100 rural households of varying income levels, which derive their incomes primarily, but not exclusively, from ownership of factors used in agriculture. There are also 100 urban households whose incomes also vary and which derive their incomes primarily, but not exclusively, from factors used in the nonagricultural industry. The rural and urban households are each arranged by expenditure per person into 100 subcategories of equal population size.

The theoretical structure of *Indonesia-Dua* is conventional for static general equilibrium models and includes the following major components:

- Cobb-Douglas household consumption demand systems for each of the 200 households, for each of the two consumer goods
- The household supplies of each of the three factors of production are exogenously given
- A factor demand system, based on the assumption of constant elasticity of substitution (CES) production technology, which relates the demand for each primary factor to industry outputs and prices of the primary factors used in that industry. Factors of production may therefore be substituted for one another in ways that depend on factor prices and on the elasticities of substitution between the factors. Elasticities of

substitution in both industries are initially set at 0.5.

- Rates of import tariffs and excise taxes across commodities based on data from the Indonesian Ministry of Finance
- A set of macroeconomic identities ensuring that standard macroeconomic accounting conventions are observed
- A set of equations determining the incomes of the 200 households from their exogenous ownership of factors of production and their endogenously determined rates of return, 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. 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 on the income side (through changes in the returns to factors of production that they own).
- The nominal exchange rate between the Indonesian currency (the rupiah) and the US dollar can be thought of as being exogenously fixed. The role of the exogenous nominal exchange rate within the model 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.

The demand-and-supply equations for private-sector agents are derived from the solutions to these agents' microeconomic optimization problems (utility maximization for households and cost minimization for firms). All households and firms are assumed to be price-takers, with producers operating in competitive markets with zero-profit conditions, reflecting the assumption of constant returns to scale. Both agricultural and nonagricultural goods are traded internationally at exogenously given prices. The nominal exchange rate is exogenously fixed. Wage adjusts endogenously to clear the labor market.

The general equilibrium properties of this simple model can be understood with the aid of figure 1. The fixed total supply of labor is indicated by the horizontal axis. Labor can be allocated between the two sectors subject to this restriction on its total supply. Given the prices of the two goods, the marginal value product of labor in the agricultural and

nonagricultural sectors corresponds to the demand for labor in these two sectors, respectively, as given by the schedules D_{LA} and D_{LN}.

When the demand for labor in agriculture is D_{LA}^0, the full employment equilibrium gives a wage of w^0 and an allocation of labor between the two sectors of L^0. If the demand for labor in agriculture shifts to the right, say to D_{LA}^1 (as for example, with an increase in the price of the agricultural good or due to some particular forms of technical change, discussed further below), the equilibrium real wage increases to w^1, employment in agriculture increases to L^1 and employment in the nonagriculture sector declines. A larger increase in labor demand, say to D_{LA}^2, increases these effects, while a reduction in the demand for labor in agriculture, say to D_{LA}^3, reduces the real wage and shifts employment from agriculture to nonagriculture.

2.3 Social accounting matrix and equation set

Table 1 summarizes the social accounting matrix that describes the initial state of this economy, based on the Indonesian *Social Accounting Matrix* for 2003. Obviously, many simplifying assumptions were required to reduce the input-output structure for Indonesia to a two-sector framework without intermediate inputs. The expenditures, incomes, and sources of income of the 100 rural and 100 urban households are based on household survey data for Indonesia, derived from the 2006 *Susenas* survey. The full equation set for the model is provided in the appendix.

2.4 Factors of production

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

Two types of factors are identified: those mobile between the two industries, called "labor,"

and those specific to the industry concerned within the period of adjustment implicit in the model. These specific factors are called “land” in agriculture and “capital” in nonagriculture, but it should be recognized that these are really just labels of convenience.

2.5 Households

Table 2 summarizes the characteristics of urban and rural households to the extent that 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. The poverty lines used for each category replicate the official levels of poverty incidence reported in the 2003 *Susenas* survey, using official poverty lines. These rates of poverty incidence are summarized in the final column of table 2. Significant numbers of poor people are found in both categories: 13.6 percent of the urban population and 20.2 percent of the rural population. These numbers, together with the urban/rural population shares, imply that 65 percent of all poor people within Indonesia reside in rural areas.

Figure 3 shows the cumulative distribution of expenditures for urban households (left panel) and rural households (right panel). The solid lines show these distributions as given by the data *ex ante*, that is, before any simulations are performed. The dashed lines, to be discussed later, show the estimated distributions *ex post*, or calculated from a particular simulation. The vertical intersection of the distribution with the poverty line indicates poverty incidence as a percentage of the population concerned.

2.6 Analyzing distributional impacts

Several approaches have been adopted in analyzing income distribution within a CGE context. The approach used in this study is the *integrated multihousehold method*, which consists of disaggregating households and arranging them by the size of expenditure or income per capita. If the categories are detailed enough, distributional impacts such as effects on poverty incidence or standard inequality indicators can be estimated with any desired level of accuracy. As the number of household categories is increased, greater accuracy can be achieved. For example, Warr (2008) used this approach in assessing the

effects that the 2007—08 international food price crisis had on poverty incidence in Thailand.

Poverty incidence is calculated as follows. Let y_c be real expenditure per capita of a household of the c-th centile where c = 1, 2, …, 100. The initial (*ex ante*) level of poverty incidence is calculated using

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

(1)

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

The change in poverty incidence after a policy shock (simulation) is calculated as

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

(2)

The distribution y_c^{**} is calculated by first computing the distribution of *ex post* levels of real expenditures from

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

(3)

where $\ddot{y}_c$ is the percentage change in real per capita expenditure of household of centile c produced from the simulation of the computable general equilibrium (CGE) model. The distribution y_c^{*} is then *re-sorted* to obtain the distribution y_c^{**}, such that $y_{c+1}^{**} \geq y_c^{**}$ for all c. This re-sorting is necessary to re-establish a well-behaved cumulative distribution because the ordering of households within the distribution y_c^{*} may have changed from the original distribution, y_c. It is therefore not necessarily the case that $y_{c+1}^{*} \geq y_c^{*}$ for all c.

Returning to figure 3, the dashed lines show the *ex post* distributions of real expenditures, calculated at base-period prices using household-specific consumer price deflators. Thus, their intersections with the poverty line indicate the estimated *ex post* level of poverty incidence. The difference between this and the *ex ante* levels is therefore the estimated change in poverty incidence resulting from the shocks concerned.

3. Simulations and Results: Agricultural Price Shocks

3.1 Model closure

Since the real expenditure of each household is to be 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 intertemporal 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 multiperiod 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). In addition, all government revenue raised from taxes is distributed to households in lump sum form in proportion to their incomes. 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. In addition, the structural features of the model mean that there is no government spending, no investment, and no household saving. In macroeconomic terms, any change in GDP is matched by an identical change in household consumption expenditure. The effect of this closure is that the full effects of the shocks concerned on policy are channeled into

household expenditures and not into effects that are not captured within the single-period focus of the model.

3.2 Shocks to the international price of the agricultural good

Table 2 summarizes the simulated effects of shocks to the international price of the agricultural good. The effects on rural and urban poverty incidence are summarized in figures 1 and 2. We analyze a range of price shocks ranging from a price reduction of 24 percent to a price increase of 24 percent. The simulated effects are described in table 2.

The distributional effects of the simulated shocks to prices can be clarified further by decomposing the change in real expenditure within each socioeconomic group as follows. As above, uppercase Roman letters like Z will denote levels of variables and lowercase Roman letters like z will denote their proportional change. Let the proportional change in the nominal income of household h be given by $y_h = \tilde{y}_h + p_h$, where $\tilde{y}_h$ is the proportional change in the household's real income and $p_h = \sum_{i=1}^{I} S_h^i p^i$ is the proportional change in a consumer price index (CPI) specific to household h, with $S_h^i = E_h^i / Y_h$ denoting that household's expenditure share on commodity i, E_h^i denoting its nominal expenditure on commodity i, and p^i denoting the proportional change in the consumer price of commodity *i*. The absolute change in this household's nominal income is now

$$dY_h = Y_h y_h = Y_h \tilde{y}_h + Y_h p_h. \quad (4)$$

Now, noting that the base levels of nominal and real expenditures are equal ($Y_h = \tilde{Y}_h$)[3], the change in the nominal income of the household is given by the change in its real income plus the change in its true cost of living, the latter an expenditure weighted sum of the changes in the consumer prices that household actually faces, where the expenditure weights pertain to that particular household:

$$dY_h = d\tilde{Y}_h + \sum_{i=1}^{I} E_h^i p^i. \quad (5)$$

[3] Real expenditures means expenditures measured at constant prices, defined here to mean base period prices. Thus, the levels of nominal and real expenditures in the base period are identical.

Disregarding any changes in transfer income or direct taxes for simplicity, the change in nominal income is equal to the change in factor income, Y_h^f. Thus

$$d\tilde{Y}_h = dY_h^f - \sum_{i=1}^{I} E_h^i p^i. \quad (6)$$

The change in the household's real income is decomposable into the change in its nominal factor income minus the change in its true cost of living. Clearly, the change in nominal factor income is itself directly decomposable into its factor components.

Tables 4 and 5 apply this decomposition to the results of the simulations described in table 3. The calculations refer to the particular household within the set of urban households (table 4) and rural households (table 5) with a base level of expenditures closest to the respective poverty line. If the real expenditure of that household increases, we expect poverty incidence within that socioeconomic category to decline and vice versa. The decomposition makes it possible to explain the reason for the estimated change in poverty. This feature of the analysis helps overcome the "black box" feature of so many general equilibrium studies.

3.3 Shocks to agricultural productivity

The effects of shocks to agricultural productivity are analyzed in a similar manner to the price shocks above. The meaning of the shocks can be seen from the equation set provided in the appendix. A factor-neutral deterioration in agricultural productivity is represented by the shock shown in the first column of table 6, $a_A^L = a_A^K = -1$. This shock *increases* the requirements of both labor and capital in producing one unit of output by 1 percent and is therefore a negative productivity shock. A factor-neutral improvement is given by the fourth column where $a_A^L = a_A^K = 1$ indicated a 1 percent *reduction* in the requirements of both labor and capital in producing one unit of output. Factor-biased technological change is covered in table 7. The first column, reporting the shock $a_A^L = 1$ depicts a 1 percent *reduction* (technological improvement) in the unit requirement of labor to produce one unit of output and so on.

Figure 2 illustrates the possibility of factor-biased technical change. An initial isoquant (combinations of labor and capital producing a particular level of output, $\overline{Q}$) is given by $f^0(L,K) = \overline{Q}$. Relative factor prices are given by the slope of the line *CC,* with a slope equal to $-(r/w)$, where r is the rate of return to capital and w is the wage, implying a cost-minimizing combination of factors producing output $\overline{Q}$, given by point A. Now consider the possibility of technical change that reduces the cost of producing output $\overline{Q}$ at these factor prices to CC. The new isoquant is given by $f^1(L,K) = \overline{Q}$ and the point of tangency between it and CC is point B. Under factor-neutral technical change, point B will lie on the ray $(L/K)^0$, the same ratio of factor usage as point A. The definition of labor-saving technical change is that point B lies on a ray with a lower ratio of labor to capital than $(L/K)^0$, say $(L/K)^1$, with a combination of factors used equal to B^1. Capital-saving technical change has the opposite characteristic as shown in figure 3. The new isoquant ($f^2(L,K) = \overline{Q}$) produces a point of tangency along a ray with a ratio of labor to capital than $(L/K)^0$.

4. Results under Free Trade

4.1 Shocks to the international price of the agricultural good

Tables 3 to 5 summarize the results. We shall consider the effect of an exogenous decline in the international price of the agricultural good, holding the price of the nonagricultural good constant.[4] These effects of a lower agricultural price are shown in the left half of tables 3 to 5, and it is helpful to focus on the first column (a 24 percent reduction in the agricultural price). The effects of a price increase are the opposite of these and are shown on the right half of the same tables. The price decline reduces real wages by reducing the domestic price of the agricultural good and thereby reducing the demand for labor in agriculture, leaving the demand schedule for labor in nonagriculture unaffected. Despite this decline in the real wage, the decline in food prices makes a higher level of aggregate real consumption possible.

[4] The nonagricultural good may be considered the *numeraire*.

The effects on urban households on the border of the urban poverty line are summarized in table 4. Income from labor and land both decline (urban households derive some income from ownership of land) but the reduction in real wages increases the return to capital. Nevertheless, total income, measured in terms of the nonagricultural good (third row from the bottom), declines. However, the cost of living (second row from the bottom) declines even more. Real expenditure (final row), therefore, rises. For the poor rural household (table 5), these effects are qualitatively similar, although the decline in income from land (second row) is larger (because poor rural households derive more of their income from this source). The reduction in the cost of living is also larger because of the larger share of food in the budget of the rural poor than the urban poor. The rise in real income of both urban and rural households near the poverty line means that poverty incidence *falls* in both categories of households (table 3).

An increase in the agricultural price (right side of tables 3 to 5) reverses all of these effects, and poverty incidence *rises* in both categories of households. A crucial point is that under free trade, a change in the international price is transmitted to both domestic producer prices (leading to income side effects) and domestic consumer prices (leading to expenditure side effects).

4.2 Shocks to agricultural productivity

The effects of factor-neutral productivity shocks in agriculture, holding international prices constant, are summarized in tables 6, 8, and 9. Factor-neutral technical *progress*–reducing the unit requirement of both labor and land–is shown on the right side of table 6 where $a_A^L = a_A^H > 0$ and where *H* denotes land. To illustrate, we can focus on the case $a_A^L = a_A^H = 4$. This form of technical change reduces the unit cost of producing agricultural output at constant factor prices, raising the profitability of agricultural production, inducing an expansion of agricultural output with subsequent effects on factor prices. It is helpful to focus on the final column of table 6. Agricultural output increases, the real wage rises, along with the real return to land.

The effects on urban households on the border of the urban poverty line are summarized on the left side of table 8. Income from both labor and land increases, outweighing the

reduction in the return to capital. Nominal income rises. The cost of living is unchanged because commodity prices are unchanged and real expenditure therefore rises. Urban poverty incidence falls (table 6). For rural households (table 9), the effects are again qualitatively similar, except that the effects on land income are higher than for urban households. Poverty incidence declines in both urban and rural areas. Productivity-reducing technical change (left side of table 6) produces the opposite of these effects, raising poverty incidence in both urban and rural areas.

Factor-biased technical change is analyzed in table 7. A reduction in the unit requirement of labor alone corresponds to labor-saving technical change. We can focus on the example of $a_A^L = 4$ given by the last column in table 7. Agricultural output increases and the real wage rises.[5] Land-saving technical change (e.g., $a_A^H = 4$) also induces an increase in agricultural output and real wage. The return per unit of land rises as a consequence of its higher productivity.[6] In the case of both labor-saving and land-saving technical change, poverty incidence declines in both rural and urban areas.

5. Results under Restricted Food Imports

As background to the simulations to be reported below, the effect of restricting imports of the agricultural good was simulated by exogenously reducing food imports by 90 percent. This solution was then used to produce a new database, summarized in table 10. This database was then used in all subsequent simulations, with the quantity of food imports exogenously fixed at this new, lower level. The import quota on food means that the domestic price of food is no longer determined by the international price but by domestic supply-and-demand conditions. As the international price varies, the quantity of food imported does not respond but the rent associated with the import quota is affected because it is determined by the difference between the domestic price and the international price. When the international price rises, the rent declines. In the simulations below, this rent is assumed to accrue to the richest one percent of urban households. In what follows, the focus is on the difference between the results obtained under free trade as discussed above and those arising with a

[5] We discuss below the role of the assumption that the elasticity of substitution is 0.5 in driving this result.

[6] The elasticity of substitution again plays an important role in this outcome.

fixed volume of food imports.

5.1 Shocks to the international price of the agricultural good

When the international price declines, the rent associated with the quota rises. Quota owners experience increased incomes, but the domestic price of food is not directly affected. There is a small effect arising from the small increase in the demand for food from the now-wealthier quota owners. This induces a small increase in agricultural output, which, in turn, induces a small increase in real wages. The result is a small reduction in urban and rural poverty. A price increase has the opposite result: a small, negative effect on the urban and rural poor, arising from a decline in agricultural income.

The restriction on food imports shields domestic markets from the effects of these international price changes. This, in turn, shields domestic poor households from almost all of the otherwise beneficial effects of an international price decline and the otherwise harmful effects of a price increase. In assessing these effects, it must be recalled that the imposition of the quota in itself imposes a substantial domestic price increase and negatively affects urban and rural poor households in much the same way that an international price increase does under free trade. Unlike the effects of temporary international price increases, however, the negative effects of the quota last as long as the quota remains in place.

5.2 Shocks to agricultural productivity

Tables 14 to 17 now summarize the effects of agricultural productivity shocks under a food import quota. Table 14 may be compared with table 6 above. Again, it is convenient to focus on the last column of table 14 ($a_A^L = a_A^H = 4$). Whereas agricultural output expands vigorously under free trade, the expansion is smaller under an import quota because the price of food is forced down. Output rises, imports remain the same, and the increased output must be consumed domestically. The increase in agricultural consumption (table 14, last column), therefore, far exceeds that under free trade (table 6, last column). This can occur only with a lower price of food. Under free trade, most of the increase in output is reflected in reduced imports. However, a comparison between tables 16 and table 8 shows that the final effect on the real expenditures of urban households is almost the same. Under

free trade, there is a larger income effect but no cost-of-living effect from reduced food prices. Under the quota, there is almost no income effect but a substantial cost-of-living effect. Comparison between tables 17 and table 9 shows that the outcome for rural households is slightly more favorable under the quota than under free trade. The higher share of food in the consumption basket of rural households means that the decline in the price of food has greater value for them, on average, than for urban households.

An expansion of agricultural output occurs under both labor-saving and land-saving technical change, again forcing down the price of food. Nominal wages fall because of the decline in agricultural prices. However, this is outweighed by the decline in the CPI caused by declining food prices while real wages rise slightly. Returns to land rise under labor-saving technical change but fall under land-saving technical change. Under free trade, returns to land rise in all cases. The paradoxical effect of the existence of an import quota is that land owners lose from land-saving technical change because of the resulting decline in agricultural prices.

Overall, both the urban and rural poor benefit from technical progress in agriculture under free trade and under an import quota on food. The magnitude of the benefits is surprisingly similar under the two trade policy regimes. Under free trade, the benefits mainly take the form of increased incomes. Under restricted food imports, the benefits arise mainly from a lower price of staple foods.

6. Sensitivity of the Results to the Elasticity of Substitution

It has been known since Hicks that the elasticity of substitution can play an important role in determining the distributional effects of factor-biased technical change. For example, the lower is the elasticity of substitution, the greater is the likelihood that labor-saving technical change will lower the real wage. The preceding results were computed under the assumption that the elasticity of substitution in both industries is 0.5. Suppose this elasticity was 0.25 in agriculture. How would the results be affected? Tables 18 and 19 show the results.

The lower elasticity of substitution results in a smaller decline in the price of food under labor-saving technical change but a larger decline when the technical progress is land-

saving. The decline in labor income that occurs under labor-saving technical change is accentuated by a low elasticity of substitution. Overall, both urban and rural households still gain from technical change under a lower elasticity of substitution, but the gain is smaller in the case of labor-saving technical change and larger in the case of land-saving technical change. Significantly, whether the technical change is labor-saving or land-saving and regardless of the trade policy regime, both urban and rural households benefit from productivity growth in agriculture, at least within the range of the elasticity assumptions considered in this study.

7. Conclusions

This paper used a simple general equilibrium framework to analyze the effects of agricultural price shocks and production shocks under two different policy environments. A restriction on food imports reduces welfare in a static sense and raises poverty incidence but it shields poor households from the effects of fluctuations in international agricultural prices. The effects of production shocks are also influenced by trade policies. When imports are restricted, production shocks affect poor households to a greater extent on the expenditure side (through the price of food rather than through income changes). The elasticity of substitution within agriculture has been found to affect the magnitude of these outcomes but not their signs. The results of this study show that the rural and urban poor benefit from technical progress in agriculture and lose from negative shocks, regardless of whether the shock is labor-saving or land-saving and regardless of the nature of the trade policy regime.

This study also found that whether the existing policy objective of "self-sufficiency" in staple foods is maintained or not, productivity-enhancing investments in agriculture have strong poverty-reducing effects. Unfortunately, Indonesia's public investment in agricultural research relative to total value-added in agricultural production (a measure known as research intensity) has declined alarmingly (by about two-thirds) over the past three decades since the late 1970s even though agricultural research in Indonesia has been found to enhance productivity growth with a high economic rate of return.[7] The trend of declining research intensity should therefore be reversed.

[7] Warr (2011) available from the author upon request.

Agricultural liberalization also enhances poverty reduction because it reduces the cost of staple foods, generating significant gains for poor households. Since 2004, Indonesia has adopted the opposite policy—tighter import controls on food, directed at achieving food self-sufficiency. It is a myth that poverty incidence is reduced by protecting the agricultural sector through import controls. Some poor farmers do indeed benefit from these import restrictions. However, many other small farmers are net purchasers of staple foods and they are harmed by import controls. Overall, the number of poor households within Indonesia that are net *sellers* of staple foods is greatly exceeded by the number of poor people who are net *purchasers*. This statement is true even within rural areas.

The policy recommendations consistent with these findings are that the interests of poor households within Indonesia, both rural and urban, are best served by gradual liberalization of import controls on staple foods, especially rice, combined with substantially increased levels of productivity-enhancing agricultural investments, particularly in research and development.

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Tables and Figures

Table 1. Social Accounting Matrix without Protection

		Industries		Commodities		Factors		HH	Govern-ment	ROW	
	Category	1	2	3	4	5	6	7	8	9	Total
Industries	Agriculture 1			342,077							342,077
	Nonagric. 2				1,665,920						1,665,920
Commodities	Agriculture 3							375,778			375,778
	Nonagric. 4							1,624,427		41,492	1,665,920
Factors	Labor 5	230,649	718,856								949,505
	Capital 6	111,429	947,063								1,058,492
Households	7					949,505	1,058,492		160	-7,951	2,000,205
Government	Taxes/Tariffs 8			160							160
Rest of the world (ROW)	9			33,541							33,541
	Total	342,077	1,665,920	375,778	1,665,920	949,505	1,058,492	2,000,205	160	33,541	

***Note*:** Data based on Indonesia input-output tables for 2005.

Table 2. 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 3. Agricultural Price Shocks under Free Trade: Simulation Results

	Shock: Change to international price of agricultural good								
	Variable	Unit	-24 %	-12 %	-8 %	-4 %	4 %	8 %	12 %	24 %
Output agric.	x_A	% Δ	-19.52	-8.75	-5.65	-2.74	2.58	5.01	7.31	13.53
Output non agric.	x_N	% Δ	3.49	1.69	1.11	0.55	-0.54	-1.07	-1.59	-3.09
Wage	w	% Δ	-9.00	-4.40	-2.91	-1.45	1.43	2.84	4.23	8.32
Rent on land	r_A	% Δ	-50.77	-26.74	-18.10	-9.18	9.43	19.09	28.97	59.83
Rent on capital	r_N	% Δ	7.11	3.40	2.24	1.10	-1.08	-2.13	-3.15	-6.09
CPI	*cpi*	% Δ	-5.02	-2.37	-1.55	-0.76	0.74	1.46	2.15	4.13
GDP	*gdp*	% Δ	-3.69	-1.94	-1.32	-0.67	0.69	1.39	2.11	4.35
Real GDP	*rgdp*	% Δ	0.035	-0.016	0.011	0.005	-0.005	-0.009	-0.014	-0.027
Real wage	*w-cpi*	% Δ	-3.98	-2.02	-1.36	-0.68	0.69	1.38	2.08	4.19
Total consumption	*cons*	% Δ	1.38	0.43	0.24	0.09	-0.05	-0.06	-0.04	0.23
Real consumption	*cons-cpi*	% Δ	6.40	2.80	1.79	0.86	-0.79	-1.52	-2.19	-3.90
Total exports	*e*	% Δ	282.54	142.81	95.52	47.91	-48.19	-96.65	-145.35	-292.85
Total imports	*m*	% Δ	493.76	215.42	137.79	66.22	-61.46	79.86	-176.14	-190.10
Price of Food	p_A	% Δ	-24.00	-12.00	-8.00	-4.00	4.00	8.00	12.00	24.00
Price of Non food	p_N	% Δ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abs.ch. agr. output	ΔX_A	Δ	-58,200	-28,104	-18,535	-9,171	8,989	17,807	26,463	51,542
Abs.ch. agr. cons'n	ΔQ_A	Δ	85,863	39,643	25,786	12,590	-12,033	-23,552	-34,596	-65,203
Abs.ch. agr.	ΔM_A	Δ	144,063	67,747	44,320	21,761	-21,022	-41,359	-61,059	-116,745
Δ Poverty rural	ΔP_R	Δ	-2.1652	-0.9259	-0.5559	-0.2508	0.1781	0.2962	0.3667	0.3804
Δ Poverty urban	ΔP_U	Δ	-0.8211	-0.1145	-0.0439	-0.0091	-0.0101	-0.0348	-0.0708	-0.2256
Δ Poverty total	ΔP	Δ	-1.5531	-0.5563	-0.3228	-0.1407	0.0924	0.2962	0.1674	0.1044
Δ Gini – rural	ΔG_R	Δ	-0.0029	-0.0015	-0.0010	-0.0005	0.0005	0.0011	0.0017	0.0034
Δ Gini – urban	ΔG_U	Δ	-0.0010	-0.0005	-0.0003	-0.0002	0.0001	0.0003	0.0005	0.0011
Δ Gini – total	ΔG	Δ	-0.0029	-0.0014	-0.0009	-0.0004	0.0004	0.0008	0.0013	0.0024

***Note*:** Units expressed as Δ are measured in billions of IDR, 2005 prices.

Table 4. Agricultural Price Shocks under Free Trade: Welfare Decomposition for Poor Urban Household

Price Shocks	**-24 %**	**-12 %**	**-8 %**	**-4 %**	**4 %**	**8 %**	**12 %**	**24 %**
Labor income	-344.6	-168.5	-111.5	-55.4	54.7	108.7	162.1	318.8
Land income	-211.0	-111.1	-75.2	-38.2	39.2	79.3	120.4	248.6
Capital income	315.0	150.8	99.1	48.9	-47.7	-94.2	-139.7	-269.9
Tax revenue	1.8	0.9	0.6	0.3	-0.3	-0.6	-0.9	-1.8
Transfer	0	0	0	0	0	0	0	0
Nominal total income	-290.9	-147.7	-99.0	-49.7	50.1	100.6	151.5	306.3
Cost of living	-355.8	-167.8	-109.9	-54.0	52.3	103.1	152.4	292.5
Real income = expend.	64.9	20.1	11.0	4.3	-2.2	-2.4	-0.8	13.8

***Note*:** Units expressed in billions of IDR, 2005 prices.

Table 5. Agricultural Price Shocks under Free Trade: Welfare Decomposition for Poor Rural Household

Price Shocks	**-24 %**	**-12 %**	**-8 %**	**-4 %**	**4 %**	**8 %**	**12 %**	**24 %**
Labor income	-283.2	-138.4	-91.6	-45.5	44.9	89.3	133.2	261.9
Land income	-286.1	-150.7	-102.0	-51.7	53.1	107.6	163.2	337.1
Capital income	286.8	137.3	90.3	44.5	-43.4	-85.8	-127.1	-245.8
Tax revenue	1.5	0.8	0.5	0.3	-0.3	-0.5	-0.8	-1.6
Transfer	0	0	0	0	0	0	0	0
Nominal total income	-281.3	-144.3	-97.0	-48.8	49.5	99.7	150.4	306.0
Cost of living	-409.8	-193.6	-126.8	-62.4	60.5	119.2	176.3	338.9
Real income = expend.	128.5	49.2	29.9	13.5	-10.9	-19.5	-25.8	-32.9

***Note*:** Units expressed in billions of IDR, 2005 prices.

Table 6. Factor-Neutral Agricultural Productivity Shocks under Free Trade: Simulation Results

	Shock: Change in agricultural productivity parameter							
	Variable	Unit	$a_A^L = a_A^H = -1$	$a_A^L = a_A^H = -2$	$a_A^L = a_A^H = -4$	$a_A^L = a_A^H = 1$	$a_A^L = a_A^H = 2$	$a_A^L = a_A^H = 4$
Output agric.	x_A	% Δ	-1.65	-3.26	-6.37	1.68	3.40	6.96
Output non agric.	x_N	% Δ	0.14	0.27	0.53	-0.14	-0.28	-0.56
Wage	w	% Δ	-0.36	-0.71	-1.39	0.36	0.73	1.49
Rent on land	r_A	% Δ	-2.30	-4.53	-8.83	2.36	4.78	9.83
Rent on capital	r_N	% Δ	0.27	0.54	1.06	-0.27	-0.55	-1.12
CPI	*cpi*	% Δ	0	0	0	0	0	0
GDP	*gdp*	% Δ	-0.17	-0.33	-0.64	0.17	0.35	0.71
Real GDP	*rgdp*	% Δ	-0.17	-0.33	-0.64	0.17	0.35	0.71
Real wage	*w-cpi*	% Δ	-0.36	-0.71	-1.39	0.36	0.73	1.49
Total consumption	*cons*	% Δ	-0.17	-0.33	-0.64	0.17	0.35	0.72
Real consumption	*cons-cpi*	% Δ	-0.17	-0.33	-0.64	0.17	0.35	0.72
Total exports	*e*	% Δ	11.89	23.52	46.07	-12.14	-24.55	-50.21
Total imports	*m*	% Δ	14.77	29.24	57.27	-15.09	-30.52	-62.40
Price of Food	p_A	% Δ	0	0	0	0	0	0
Price of Non food	p_N	% Δ	0	0	0	0	0	0
Abs.ch. agr. output	ΔX_A	Δ	-5,628	-11,135	-21,800	5,754	11,636	23,806
Abs.ch. agr. cons'n	ΔQ_A	Δ	-673	-1,329	-2,592	691	1,400	2,875
Abs.ch. agr. imports	ΔM_A	Δ	4,955	9,806	19,208	-5,063	-10,236	-20,931
Abs.ch. Poverty rural	ΔP_R	Δ	0.22289	0.43925	0.84286	-0.22896	-0.45587	-0.90499
Abs.ch. Poverty urban	ΔP_U	Δ	0.12889	0.25918	0.43954	-0.12755	-0.25386	-0.50303
Abs.ch. Poverty total	ΔP	Δ	0.18008	0.35725	0.65919	-0.18278	-0.36387	-0.72194
Abs.ch. Gini – rural	ΔG_R	Δ	0.00009	0.00018	0.00037	-0.00009	-0.00018	-0.00035
Abs.ch. Gini – urban	ΔG_U	Δ	0.00017	0.00034	0.00067	-0.00017	-0.00034	-0.00069
Abs.ch. Gini – total	ΔG	Δ	0.00017	0.00035	0.00069	-0.00018	-0.00035	-0.00071

***Note*:** Units expressed as Δ are measured in billions of IDR, 2005 prices.

Table 7. Factor-Biased Agricultural Productivity Shocks under Free Trade: Simulation Results

	Shock: Change in agricultural productivity parameter							
	Variable	Unit	$a_A^L = 1$	$a_A^L = 2$	$a_A^L = 4$	$a_A^H = 1$	$a_A^H = 2$	$a_A^H = 4$
Output agric.	x_A	% Δ	0.91	1.82	3.68	0.76	1.54	3.13
Output non agric.	x_N	% Δ	-0.05	-0.09	-0.19	-0.90	-0.18	-0.37
Wage	w	% Δ	0.12	0.25	0.49	0.24	0.48	0.97
Rent on land	r_A	% Δ	1.83	3.69	7.51	0.52	1.04	2.10
Rent on capital	r_N	% Δ	-0.09	-0.19	-0.37	-0.18	-0.36	-0.73
CPI	*cpi*	% Δ	0	0	0	0	0	0
GDP	*gdp*	% Δ	0.12	0.23	0.47	0.06	0.11	0.23
Real GDP	*rgdp*	% Δ	0.12	0.23	0.47	0.06	0.11	0.23
Real wage	*w-cpi*	% Δ	0.12	0.25	0.49	0.24	0.48	0.97
Total consumption	*cons*	% Δ	0.12	0.23	0.47	0.06	0.11	0.23
Real consumption	*cons-cpi*	% Δ	0.12	0.23	0.47	0.06	0.11	0.23
Total exports	*e*	% Δ	-6.39	-12.82	-25.84	-5.69	-11.48	-23.31
Total imports	*m*	% Δ	-7.94	-15.94	-32.12	-7.08	-14.26	-28.97
Price of Food	p_A	% Δ	0	0	0	0	0	0
Price of Non food	p_N	% Δ	0	0	0	0	0	0
Abs.ch. agr. output	ΔX_A	Δ	3,111	6,248	12,604	2,613	5,265	10,696
Abs.ch. agr. cons'n	ΔQ_A	Δ	448	902	1,830	239	481	977
Abs.ch. agr. imports	ΔM_A	Δ	-2,663	-5,346	-10,775	-2,374	-4,784	-9,718
Abs.ch. Poverty rural	ΔP_R	Δ	-0.13192	-0.26503	-0.54295	-0.09573	-0.19490	-0.37977
Abs.ch. Poverty urban	ΔP_U	Δ	-0.06337	-0.12677	-0.25381	-0.06452	-0.12840	-0.25426
Abs.ch. Poverty total	ΔP	Δ	-0.10070	-0.20206	-0.41128	-0.08152	-0.16462	-0.32261
Abs.ch. Gini – rural	ΔG_R	Δ	0.00006	0.00013	0.00028	-0.00015	-0.00031	-0.00063
Abs.ch. Gini – urban	ΔG_U	Δ	-0.00002	-0.00004	-0.00007	-0.00015	-0.00030	-0.00062
Abs.ch. Gini – total	ΔG	Δ	-0.00004	-0.00007	-0.00013	-0.00014	-0.00028	-0.00057

***Note*:** units expressed as Δ are measured in billions of IDR, 2005 prices.

Table 8. Agricultural Productivity Shocks under Free Trade: Welfare Decomposition for Poor Urban Household

	Factor-neutral						**Factor-biased**					
Productivity shock	$a_A^L = a_A^H$ = -1	$a_A^L = a_A^H$ = -2	$a_A^L = a_A^H$ = -4	$a_A^L = a_A^H$ = 1	$a_A^L = a_A^H$ = 2	$a_A^L = a_A^H$ = 4	a_A^L = 1	a_A^L = 2	a_A^L = 4	a_A^H = 1	a_A^H = 2	a_A^H = 4
Labor income	-13.6	-27.1	-53.2	13.9	28.0	56.9	4.8	9.5	18.8	9.0	18.2	37.1
Land income	-9.5	-18.8	-36.7	9.8	19.9	40.8	7.6	15.3	31.2	2.2	4.3	8.7
Capital income	12.0	23.8	47.0	-12.2	-24.5	-49.6	-4.2	-8.3	-16.5	-7.9	-16.0	-32.4
Tax revenue	0.1	0.1	0.3	-0.1	-0.2	-0.3	0.0	-0.1	-0.2	0.0	-0.1	-0.1
Transfer	0	0	0	0	0	0	0	0	0	0	0	0
Nominal total	-12.3	-24.4	-47.8	12.6	25.5	52.2	6.4	12.9	26.0	6.1	12.3	25.1
Cost of living	0	0	0	0	0	0	0	0	0	0	0	0
Real expenditure	-12.3	-24.4	-47.8	12.6	25.5	52.2	6.4	12.9	26.0	6.1	12.3	25.1

***Note*:** Units expressed in billions of IDR, 2005 prices.

Table 9. Agricultural Productivity Shocks under Free Trade: Welfare Decomposition for Poor Rural Household

	Factor-neutral						**Factor-biased**					
Productivity shock	$a_A^L = a_A^H$ = -1	$a_A^L = a_A^H$ = -2	$a_A^L = a_A^H$ = -4	$a_A^L = a_A^H$ = 1	$a_A^L = a_A^H$ = 2	$a_A^L = a_A^H$ = 4	$a_A^L = 1$	$a_A^L = 2$	$a_A^L = 4$	$a_A^H = 1$	$a_A^H = 2$	$a_A^H = 4$
Labor income	-11.2	-22.2	-43.7	11.4	23.0	46.8	3.9	7.8	15.5	7.4	15.0	30.4
Land income	-12.9	-25.5	-49.8	13.3	26.9	55.4	10.3	20.8	42.3	2.9	5.9	11.8
Capital income	10.9	21.7	42.8	-11.1	-22.3	-45.2	-3.8	-7.6	-15.0	-7.2	-14.5	-29.5
Tax revenue	0.1	0.1	0.2	-0.1	-0.1	-0.3	0.0	-0.1	-0.1	0.0	-0.1	-0.1
Transfer	0	0	0	0	0	0	0	0	0	0	0	0
Nominal total	-12.2	-24.0	-47.0	12.4	25.2	51.6	7.1	14.3	29.0	5.2	10.6	21.5
Cost of living	0	0	0	0	0	0	0	0	0	0	0	0
Real expenditure	-12.2	-24.0	-47.0	12.4	25.2	51.6	7.1	14.3	29.0	5.2	10.6	21.5

***Note*:** Units expressed in billions of IDR, 2005 prices.

Table 10. Updated Social Accounting Matrix with Protection

			Industries		Commodities		Factors		HH	Govern-ment	ROW	
	Category		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
Industries	Agriculture	1			376,233							376,233
	Nonagric.	2				1,652,569						1,652,569
Commodities	Agriculture	3							379,953			379,953
	Nonagric.	4							1,641,113		11,459	1,652,572
Factors	Labor	5	249,033	720,622								969,655
	Capital	6	127,200	931,947								1,059,147
Households		7					969,657	1,059,148		213	-7,952	2,021,066
Government	Taxes/Tariffs	8			212							212
Rest of the world (ROW)		9			3,550							3,550
	Total		**376,233**	**1,652,569**	**379,995**	**1,652,569**	**969,657**	**1,059,148**	**2,021,066**	**213**	**3,507**	

***Note*:** Data based on Indonesia input-output tables for 2005.

Table 11. Agricultural Price Shock under Restricted Food Imports: Simulation Results

	Shock: Change to international price of agricultural good								
	Variable	Unit	-24 %	-12 %	-8 %	-4 %	4 %	8 %	12 %	24 %
Output agric.	x_A	% Δ	0.0173	0.0087	0.0058	0.0029	-0.0029	-0.0058	-0.0087	-0.0174
Output non agric.	x_N	% Δ	-0.0039	-0.002	-0.0013	-0.0007	0.0007	0.0013	0.002	0.004
Wage	w	% Δ	0.0102	0.0051	0.0034	0.0017	-0.0017	-0.0034	-0.0051	-0.0102
Rent on land	r_A	% Δ	0.0626	0.0313	0.0209	0.0104	-0.0104	-0.0209	-0.0313	-0.0626
Rent on capital	r_N	% Δ	-0.0079	-0.004	-0.0026	-0.0013	0.0013	0.0026	0.004	0.0079
CPI	*cpi*	% Δ	0.0053	0.0026	0.0018	0.0009	-0.0009	-0.0018	-0.0026	-0.0053
GDP	*gdp*	% Δ	0.0447	0.0224	0.0149	0.0075	-0.0075	-0.0149	-0.0224	-0.0447
Real GDP	*rgdp*	% Δ	0	0	0	0	0	0	0	0
Real wage	*w-cpi*	% Δ	0.0049	0.0025	0.0016	0.0008	-0.0008	-0.0016	-0.0025	-0.0049
Total consumption	*cons*	% Δ	0.0396	0.0198	0.0132	0.0066	-0.0066	-0.0132	-0.0198	-0.0396
Real consumption	*cons-cpi*	% Δ	0.0343	0.0172	0.0114	0.0057	-0.0057	-0.0114	-0.0172	-0.0343
Total exports	*e*	% Δ	-6.991	-3.4955	-2.3303	-1.1652	1.1652	2.3303	3.4955	6.991
Total imports	*m*	% Δ	0	0	0	0	0	0	0	0
Price of Food	p_A	% Δ	0.0279	0.014	0.0093	0.0047	-0.0047	-0.0093	-0.014	-0.0279
Price of Non food	p_N	% Δ	0	0	0	0	0	0	0	0
Abs.ch. agr. output	ΔX_A	Δ	65.3	32.6	21.8	10.9	-10.9	-21.8	-32.6	-65.3
Abs.ch. agr. cons'n	ΔQ_A	Δ	65.3	32.6	21.8	10.9	-10.9	-21.8	-32.6	-65.3
Abs.ch. agr. imports	ΔM_A	Δ	0	0	0	0	0	0	0	0
Δ Poverty rural	ΔP_R	Δ	-0.03853	-0.01928	-0.01285	-0.00643	0.00643	0.01286	0.01930	0.03862
Δ Poverty urban	ΔP_U	Δ	-0.02418	-0.01209	-0.00807	-0.00403	0.00403	0.00807	0.01211	0.02422
Δ Poverty total	ΔP	Δ	-0.03200	-0.01601	-0.01067	-0.00534	0.00534	0.01068	0.01603	0.03206
Δ Gini – rural	ΔG_R	Δ	6E-06	3E-06	2E-06	1E-06	-1.1E-06	-2.1E-06	-3.1E-06	-6.1E-06
Δ Gini – urban	ΔG_U	Δ	2.3E-06	1.2E-06	8E-07	4E-07	-4E-07	-7E-07	-1.1E-06	-2.3E-06
Δ Gini – total	ΔG	Δ	4.7E-06	2.3E-06	1.6E-06	8E-07	-8E-07	-1.6E-06	-2.3E-06	-4.7E-06

***Note*:** units expressed as Δ are measured in billions of IDR, 2005 prices.

Table 12. Agricultural Price Shocks under Restricted Food Imports: Welfare Decomposition for Poor Urban Household

Price Shocks	**-24 %**	**-12 %**	**-8 %**	**-4 %**	**4 %**	**8 %**	**12 %**	**24 %**
Labor income	0.400	0.200	0.133	0.067	-0.067	-0.133	-0.200	-0.400
Land income	0.297	0.149	0.099	0.050	-0.050	-0.099	-0.149	-0.297
Capital income	-0.344	-0.172	-0.115	-0.057	0.057	0.115	0.172	0.345
Tax revenue	2.493	1.247	0.831	0.416	-0.416	-0.831	-1.247	-2.493
Transfer	0	0	0	0	0	0	0	0
Nominal total income	2.869	1.435	0.956	0.478	-0.478	-0.956	-1.435	-2.869
Cost of living	0.376	0.188	0.125	0.063	-0.063	-0.125	-0.188	-0.376
Real income = expend.	2.493	1.247	0.831	0.416	-0.416	-0.831	-1.247	-2.494

***Note*:** Units expressed in billions of IDR, 2005 prices.

Table 13. Agricultural Price Shocks under Restricted Food Imports: Welfare Decomposition for Poor Rural Household

Price Shocks	**-24 %**	**-12 %**	**-8 %**	**-4 %**	**4 %**	**8 %**	**12 %**	**24 %**
Labor income	0.329	0.164	0.110	0.055	-0.055	-0.110	-0.164	-0.329
Land income	0.403	0.202	0.134	0.067	-0.067	-0.134	-0.202	-0.403
Capital income	-0.314	-0.157	-0.105	-0.052	0.052	0.105	0.157	0.314
Tax revenue	2.170	1.085	0.723	0.362	-0.362	-0.723	-1.085	-2.170
Transfer	0	0	0	0	0	0	0	0
Nominal total income	2.543	1.272	0.848	0.424	-0.424	-0.848	-1.272	-2.543
Cost of living	0.435	0.217	0.145	0.072	-0.072	-0.145	-0.217	-0.435
Real income = expend.	2.109	1.054	0.703	0.351	-0.351	-0.703	-1.054	-2.109

***Note*:** Units expressed in billions of IDR, 2005 prices.

Table 14. Factor-Neutral Agricultural Productivity Shocks under Restricted Food Imports: Simulation Results

	Shock: Change in agricultural productivity parameter							
	Variable	Unit	$a_A^L = a_A^H = -1$	$a_A^L = a_A^H = -2$	$a_A^L = a_A^H = -4$	$a_A^L = a_A^H = 1$	$a_A^L = a_A^H = 2$	$a_A^L = a_A^H = 4$
Output agric.	x_A	% Δ	-0.994	-1.968	-3.860	1.014	2.048	4.181
Output non agric.	x_N	% Δ	0.001	0.002	0.003	-0.001	-0.002	-0.003
Wage	w	% Δ	-0.002	-0.004	-0.008	0.002	0.004	0.008
Rent on land	r_A	% Δ	-0.013	-0.026	-0.051	0.013	0.026	0.051
Rent on capital	r_N	% Δ	0.002	0.003	0.006	-0.002	-0.003	-0.006
CPI	*cpi*	% Δ	0.186	0.371	0.736	-0.188	-0.377	-0.760
GDP	*gdp*	% Δ	0.001	0.002	0.003	-0.001	-0.002	-0.003
Real GDP	*rgdp*	% Δ	-0.184	-0.367	-0.724	0.187	0.375	0.760
Real wage	*w-cpi*	% Δ	0.015	0.029	0.059	-0.015	-0.029	-0.059
Total consumption	*cons*	% Δ	-0.994	-1.968	-3.860	1.014	2.048	4.181
Real consumption	*cons-cpi*	% Δ	0.001	0.002	0.003	-0.001	-0.002	-0.003
Total exports	*e*	% Δ	-0.002	-0.004	-0.008	0.002	0.004	0.008
Total imports	*m*	% Δ	0	0	0	0	0	0
Price of Food	p_A	% Δ	0.994	1.988	3.976	-0.994	-1.989	-3.978
Price of Non food	p_N	% Δ	0	0	0	0	0	0
Abs.ch. agr. output	ΔX_A	Δ	-3757	-7476	-14807	3795	7628	15415
Abs.ch. agr. cons'n	ΔQ_A	Δ	-3757	-7476	-14807	3795	7628	15415
Abs.ch. agr. imports	ΔM_A	Δ	0	0	0	0	0	0
Abs.ch. Poverty rural	ΔP_R	Δ	0.27100	0.52958	0.98679	-0.28139	-0.55635	-1.08807
Abs.ch. Poverty urban	ΔP_U	Δ	0.12612	0.25082	0.43302	-0.12757	-0.25663	-0.51935
Abs.ch. Poverty total	ΔP	Δ	0.20502	0.40263	0.73460	-0.21134	-0.41986	-0.82907
Abs.ch. Gini – rural	ΔG_R	Δ	0.00022	0.00044	0.00087	-0.00022	-0.00045	-0.00090
Abs.ch. Gini – urban	ΔG_U	Δ	0.00021	0.00042	0.00084	-0.00021	-0.00043	-0.00087
Abs.ch. Gini – total	ΔG	Δ	0.00028	0.00056	0.00111	-0.00028	-0.00057	-0.00115

***Note*:** Units expressed as Δ are measured in billions of IDR, 2005 prices.

Table 15. Factor-Biased Agricultural Productivity Shocks under Restricted Food Imports: Simulation Results

	Shock: Change in agricultural productivity parameter							
	Variable	Unit	$a_A^L = 1$	$a_A^L = 2$	$a_A^L = 4$	$a_A^H = 1$	$a_A^H = 2$	$a_A^H = 4$
Output agric.	x_A	% Δ	0.547	1.100	2.226	0.462	0.929	1.877
Output non agric.	x_N	% Δ	0.027	0.055	0.111	-0.028	-0.056	-0.113
Wage	w	% Δ	-0.070	-0.141	-0.286	0.072	0.145	0.292
Rent on land	r_A	% Δ	0.576	1.160	2.348	-0.562	-1.129	-2.278
Rent on capital	r_N	% Δ	0.054	0.109	0.221	-0.056	-0.112	-0.225
CPI	*cpi*	% Δ	-0.097	-0.194	-0.391	-0.090	-0.181	-0.364
GDP	*gdp*	% Δ	0.027	0.054	0.109	-0.027	-0.055	-0.110
Real GDP	*rgdp*	% Δ	0.123	0.248	0.499	0.063	0.126	0.253
Real wage	*w-cpi*	% Δ	0.027	0.053	0.105	0.162	0.326	0.656
Total consumption	*cons*	% Δ	0.124	0.249	0.502	0.063	0.127	0.255
Real consumption	*cons-cpi*	% Δ	0.221	0.443	0.892	0.154	0.308	0.619
Total exports	*e*	% Δ	-0.008	-0.015	-0.030	-0.007	-0.014	-0.028
Total imports	*m*	% Δ	0	0	0	0	0	0
Price of Food	p_A	% Δ	-0.515	-1.029	-2.060	-0.480	-0.961	-1.923
Price of Non food	p_N	% Δ	0	0	0	0	0	0
Abs.ch. agr. output	ΔX_A	Δ	2,052	4,117	8,287	1,735	3,479	6,995
Abs.ch. agr. cons'n	ΔQ_A	Δ	2,052	4,117	8,287	1,735	3,479	6,995
Abs.ch. agr. imports	ΔM_A	Δ	0	0	0	0	0	0
Abs.ch. Poverty rural	ΔP_R	Δ	-0.15752	-0.31777	-0.64946	-0.12324	-0.24765	-0.47596
Abs.ch. Poverty urban	ΔP_U	Δ	-0.06106	-0.12327	-0.25133	-0.06615	-0.13192	-0.26231
Abs.ch. Poverty total	ΔP	Δ	-0.11359	-0.22920	-0.46815	-0.09724	-0.19495	-0.37866
Abs.ch. Gini – rural	ΔG_R	Δ	5.3E-06	1.14E-05	2.59E-05	-0.00023	-0.00046	-0.00092
Abs.ch. Gini – urban	ΔG_U	Δ	-3.35E-05	-6.67E-05	-0.00013	-0.00018	-0.00036	-0.00073
Abs.ch. Gini – total	ΔG	Δ	-8.49E-05	-0.00017	-0.00034	-0.00020	-0.00040	-0.00080

Note: Units expressed as Δ are measured in billions of IDR, 2005 prices.

Table 16. Agricultural Productivity Shocks under Restricted Food Imports: Welfare Decomposition for Poor Urban Household

	Factor-neutral						**Factor-biased**					
Productivity shock	$a_A^L = a_A^H$ = -1	$a_A^L = a_A^H$ = -2	$a_A^L = a_A^H$ = -4	$a_A^L = a_A^H$ = 1	$a_A^L = a_A^H$ = 2	$a_A^L = a_A^H$ = 4	a_A^L = 1	a_A^L = 2	a_A^L = 4	a_A^H = 1	a_A^H = 2	a_A^H = 4
Labor income	-0.08	-0.16	-0.33	0.08	0.15	0.31	-2.74	-5.19	-10.52	2.82	5.32	10.73
Land income	-0.06	-0.12	-0.24	0.06	0.12	0.23	2.73	5.34	10.82	-2.67	-5.20	-10.49
Capital income	0.07	0.14	0.28	-0.07	-0.14	-0.27	2.36	4.62	9.37	-2.43	-4.73	-9.53
Tax revenue	0.11	0.22	0.44	-0.10	-0.21	-0.42	-0.06	-0.11	-0.22	-0.05	-0.10	-0.20
Transfer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nominal total income	0.03	0.07	0.13	-0.03	-0.07	-0.13	-0.25	-0.32	-0.64	0.22	0.25	0.51
Cost of living	13.30	26.48	52.44	-12.73	-25.59	-51.70	-6.94	-13.18	-26.51	-6.47	-12.29	-24.73
Real expenditure	-13.27	-26.41	-52.30	12.70	25.52	51.57	6.69	12.86	25.87	6.69	12.55	25.24

***Note*:** Units expressed in billions of IDR, 2005 prices.

Table 17. Agricultural Productivity Shocks under Restricted Food Imports: Welfare Decomposition for Poor Rural Household

	Factor-neutral						**Factor-biased**					
Productivity shock	$a_A^L = a_A^H$ = -1	$a_A^L = a_A^H$ = -2	$a_A^L = a_A^H$ = -4	$a_A^L = a_A^H$ = 1	$a_A^L = a_A^H$ = 2	$a_A^L = a_A^H$ = 4	$a_A^L = 1$	$a_A^L = 2$	$a_A^L = 4$	$a_A^H = 1$	$a_A^H = 2$	$a_A^H = 4$
Labor income	-0.07	-0.13	-0.27	0.07	0.13	0.25	-2.25	-4.54	-9.19	2.32	4.65	9.37
Land income	-0.08	-0.16	-0.31	0.08	0.16	0.38	3.71	7.46	15.10	-3.62	-7.26	-14.65
Capital income	0.06	0.13	0.24	-0.06	-0.13	-0.28	2.15	4.33	8.78	-2.21	-4.44	-8.94
Tax revenue	0.10	0.19	0.38	-0.10	-0.19	-0.39	-0.05	-0.10	-0.20	-0.05	-0.09	-0.18
Transfer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nominal total income	0.02	0.04	0.08	-0.02	-0.04	-0.09	0.63	1.26	2.56	-0.64	-1.29	-2.60
Cost of living	15.39	30.63	56.14	-15.55	-31.25	-59.26	-8.03	-16.10	-32.39	-7.49	-15.02	-30.20
Real expenditure	-15.37	-30.59	-56.07	15.53	31.21	59.18	8.65	17.36	34.95	6.84	13.72	27.59

***Note*:** Units expressed in billions of IDR, 2005 prices.

Table 18. Factor-Biased Agricultural Productivity Shocks under Restricted Food Imports (σ= 0.25): Simulation Results

	Shock: Change in agricultural productivity parameter							
	Variable	Unit	$a_A^L = 1$	$a_A^L = 2$	$a_A^L = 4$	$a_A^H = 1$	$a_A^H = 2$	$a_A^H = 4$
Output agric.	x_A	% Δ	0.399	0.799	1.601	0.607	1.219	2.458
Output non agric.	x_N	% Δ	0.060	0.122	0.246	-0.061	-0.122	-0.246
Wage	w	% Δ	-0.156	-0.314	-0.636	0.157	0.316	0.637
Rent on land	r_A	% Δ	1.260	2.533	5.125	-1.241	-2.492	-5.027
Rent on capital	r_N	% Δ	0.121	0.243	0.493	-0.122	-0.244	-0.491
CPI	*cpi*	% Δ	-0.064	-0.128	-0.254	-0.123	-0.246	-0.492
GDP	*gdp*	% Δ	0.059	0.119	0.241	-0.060	-0.120	-0.241
Real GDP	*rgdp*	% Δ	0.123	0.247	0.496	0.063	0.125	0.250
Real wage	*w-cpi*	% Δ	-0.092	-0.186	-0.382	0.280	0.562	1.129
Total consumption	*cons*	% Δ	0.124	0.248	0.498	0.063	0.126	0.251
Real consumption	*cons-cpi*	% Δ	0.188	0.376	0.752	0.186	0.371	0.743
Total exports	*e*	% Δ	-0.005	-0.010	-0.020	-0.010	-0.019	-0.038
Total imports	*m*	% Δ	0	0	0	0	0	0
Price of Food	p_A	% Δ	-0.340	-0.678	-1.345	-0.651	-1.299	-2.588
Price of Nonfood	p_N	% Δ	0	0	0	0	0	0
Abs.ch. agr. output	ΔX_A	Δ	1,498	2,994	5,982	2,275	4,555	9,126
Abs.ch. agr. cons'n	ΔQ_A	Δ	1,498	2,994	5,982	2,275	4,555	9,126
Abs.ch. agr. imports	ΔM_A	Δ	0	0	0	0	0	0
Abs.ch. Poverty rural	ΔP_R	Δ	-0.12295	-0.24651	-0.52612	-0.15801	-0.30907	-0.57098
Abs.ch. Poverty urban	ΔP_U	Δ	-0.03257	-0.06580	-0.13438	-0.09335	-0.18464	-0.36120
Abs.ch. Poverty total	ΔP	Δ	-0.08179	-0.16422	-0.34772	-0.12856	-0.25240	-0.47545
Abs.ch. Gini – rural	ΔG_R	Δ	0.00019	0.00038	0.00077	-0.00041	-0.00082	-0.00166
Abs.ch. Gini – urban	ΔG_U	Δ	9.66E-05	0.00020	0.00040	-0.00031	-0.00062	-0.00124
Abs.ch. Gini – total	ΔG	Δ	3.93E-05	8.05E-05	0.00017	-0.00032	-0.00064	-0.00129

***Note*:** Units expressed as Δ are measured in billions of IDR, 2005 prices.

Table 19. Factor-Biased Agricultural Productivity Shocks under Restricted Food Imports (σ= 0.25): Welfare Decomposition for Poor Urban and Rural Households

	Urban household						**Rural household**					
Productivity shock	$a_A^L = 1$	$a_A^L = 2$	$a_A^L = 4$	$a_A^H = 1$	$a_A^H = 2$	$a_A^H = 4$	$a_A^L = 1$	$a_A^L = 2$	$a_A^L = 4$	$a_A^H = 1$	$a_A^H = 2$	$a_A^H = 4$
Labor income	-6.11	-12.29	-23.40	5.79	11.63	23.44	-5.02	-10.10	-20.44	5.06	10.16	20.48
Land income	5.97	12.02	23.61	-5.72	-11.48	-23.16	8.10	16.30	32.97	-7.98	-16.03	-32.33
Capital income	5.27	10.61	20.88	-5.15	-10.33	-20.80	4.80	9.66	19.57	-4.83	-9.69	-19.50
Tax revenue	-0.04	-0.07	-0.14	-0.07	-0.14	-0.27	-0.03	-0.07	-0.13	-0.06	-0.12	-0.25
Transfer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nominal total income	-0.53	-1.06	-1.29	0.29	0.58	1.19	1.40	2.81	5.70	-1.41	-2.82	-5.68
Cost of living	-4.58	-9.14	-17.25	-8.32	-16.65	-33.40	-5.30	-10.58	-21.08	-10.16	-20.34	-40.77
Real expenditure	4.05	8.09	15.96	8.61	17.24	34.59	6.70	13.39	26.78	8.75	17.52	35.09

***Note*:** Units expressed in billions of IDR, 2005 prices.

Figure 1. General equilibrium effect of technical change

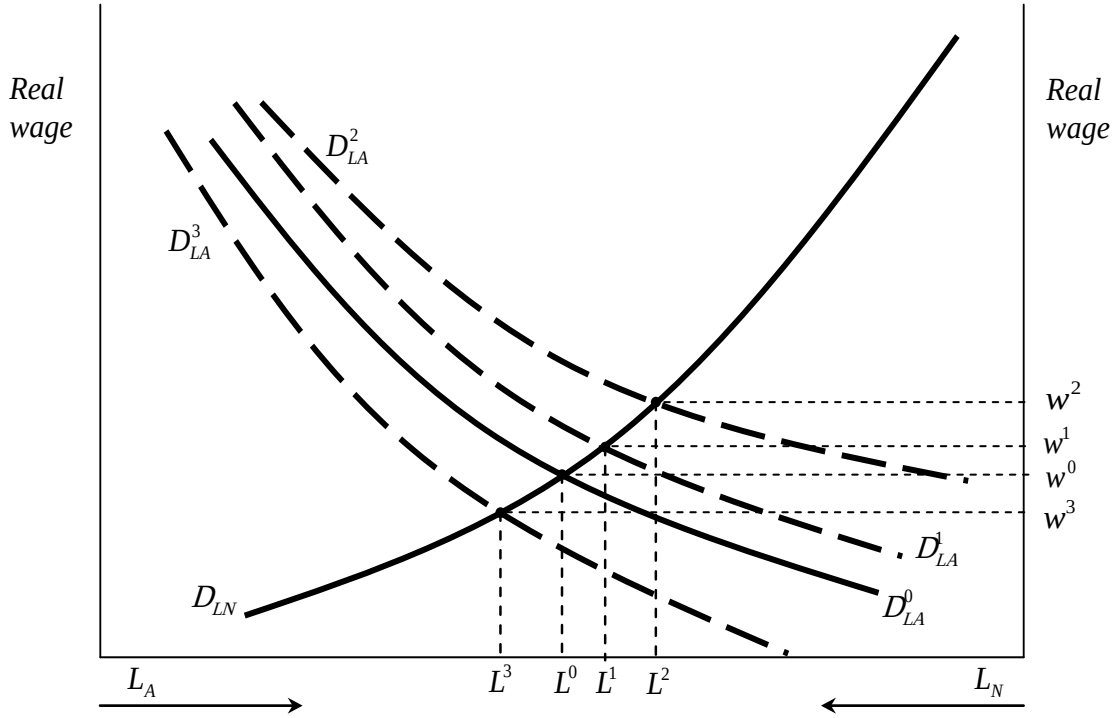


Figure 2. Labor-saving technical change

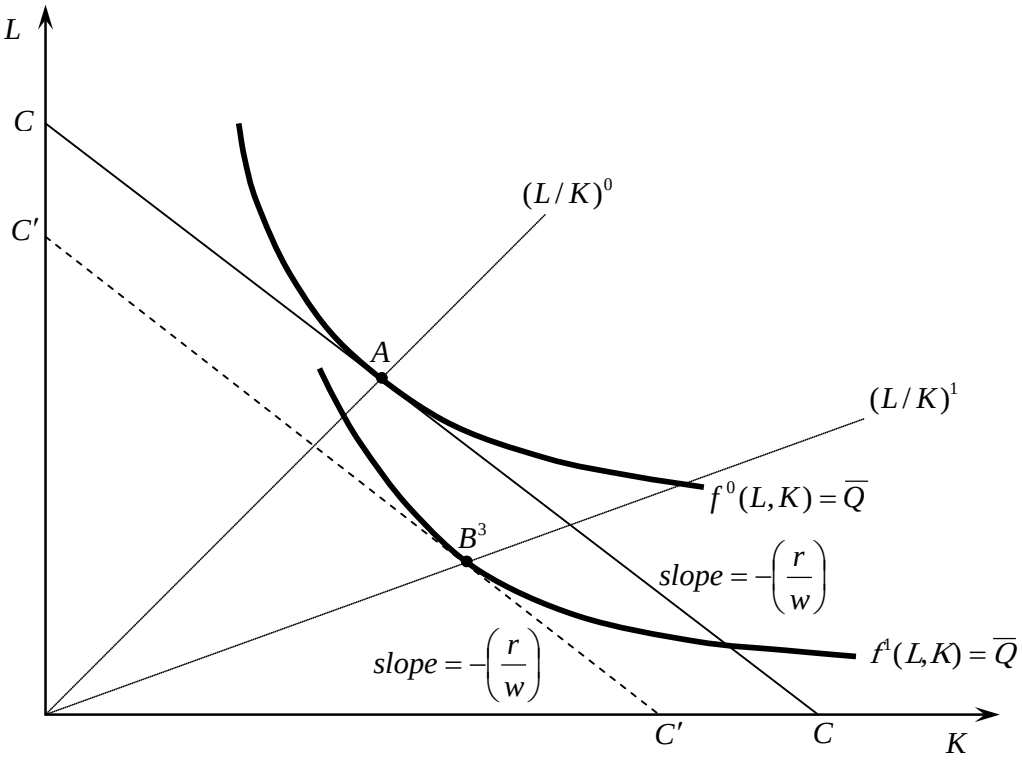


Figure 3. Calculation of poverty incidence for urban households (left panel) and rural households (right panel): -24% price shock

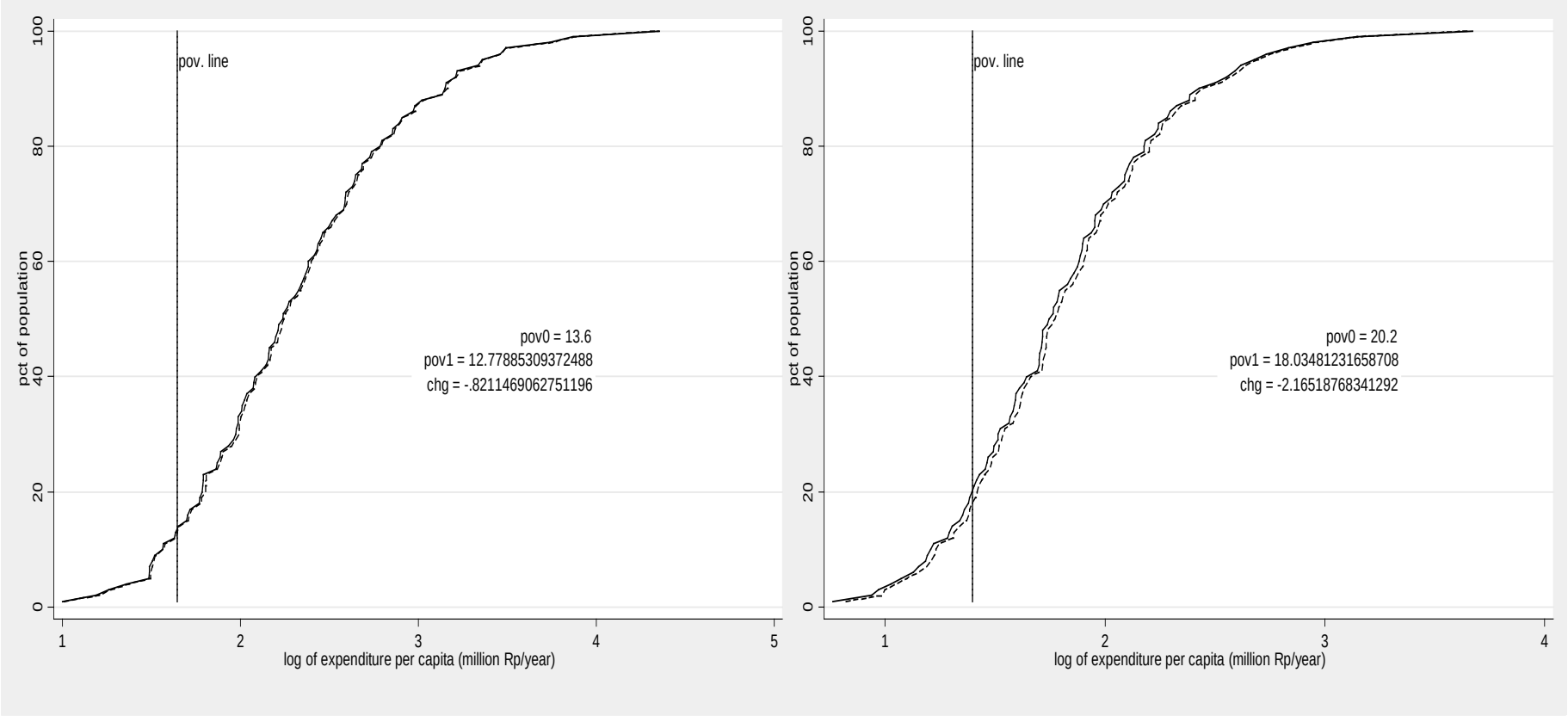


Figure 4. Price shocks and real expenditure: rural household on border of poverty line

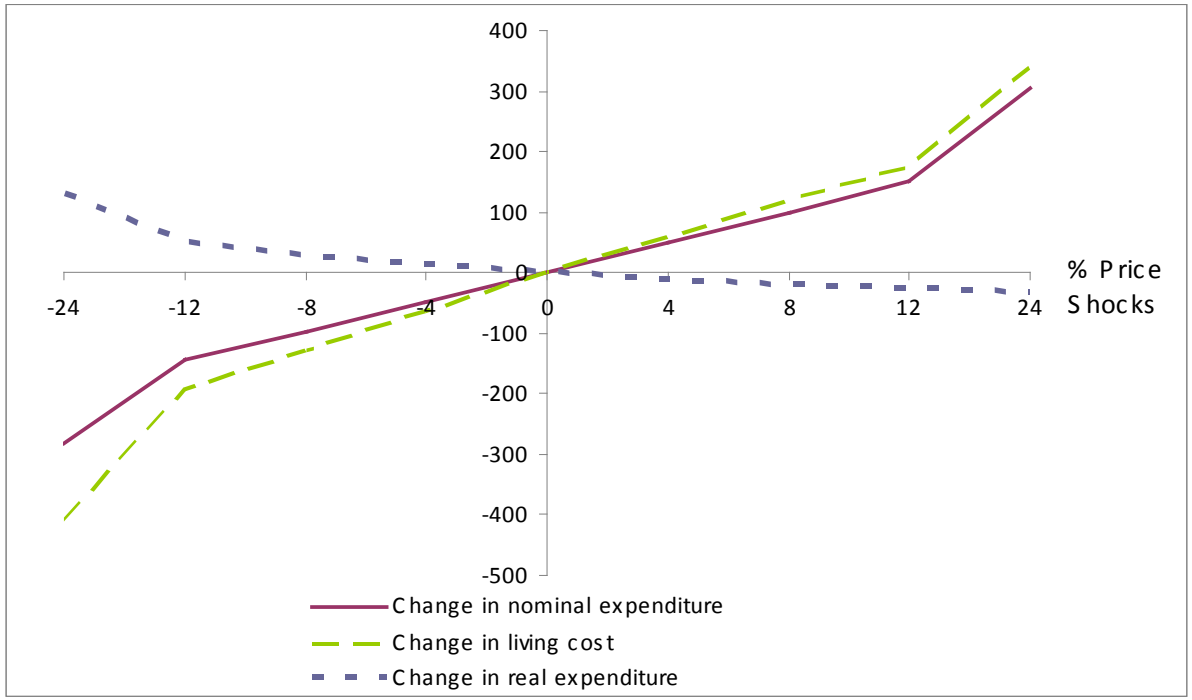
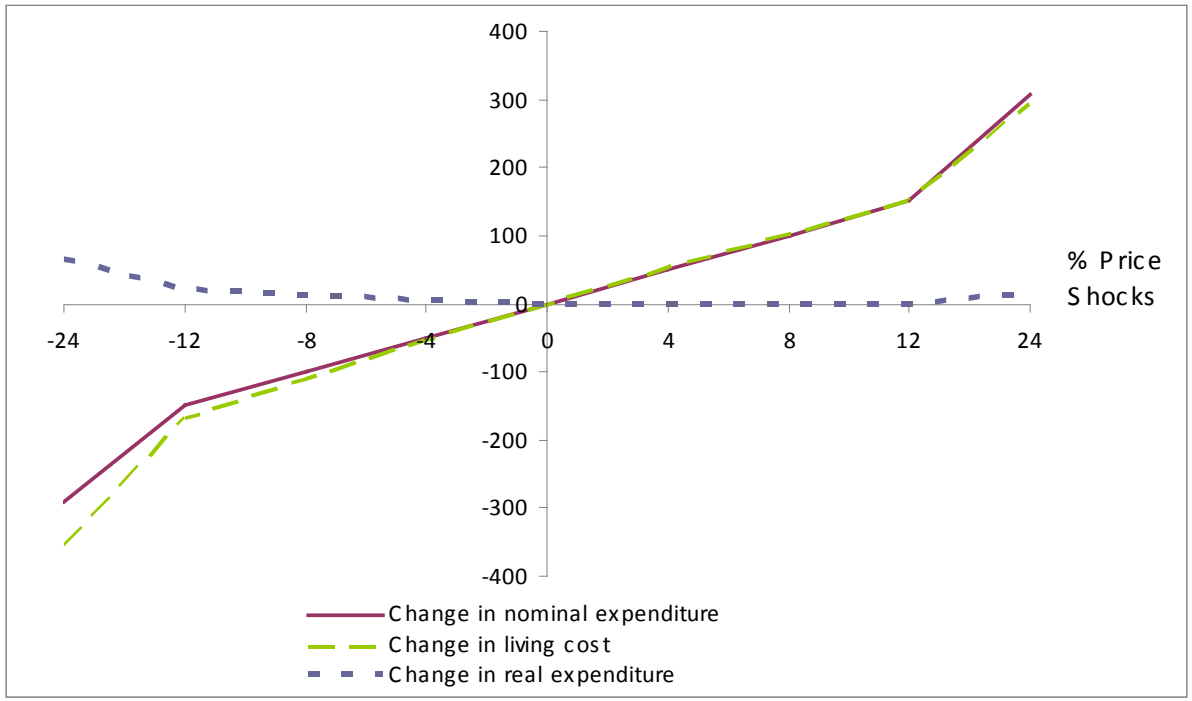


Figure 5. Price shocks and real expenditure: urban household on border of poverty line


400
300
200
100
0
-100
-200
-300
-400
-24
-12
-8
-4
0
4
8
12
24
% Price Shocks
Change in nominal expenditure
Change in living cost
Change in real expenditure

Appendix: Equation set

Demand for labor

$$l_i + a_i^L = x_i + \varepsilon_i^{LL}\left(w - a_i^L\right) + \varepsilon_i^{LK}\left(r_i - a_i^K\right)$$

Demand for capital

$$k_i + a_i^K = x_i + \varepsilon_i^{KL}\left(w - a_i^L\right) + \varepsilon_i^{KK}\left(r_i - a_i^K\right)$$

Zero profit in production

$$p_i = C_i^L\left(w - a_i^L\right) + C_i^K\left(r_i - a_i^K\right)$$

Zero profit in exporting ($e \in EXP$)

$$p_c = \pi + p_c^* - 100\frac{VE_c + VRE_c}{VE_c}\Delta TE_c$$

Zero profit in importing ($e \in IMP$)

$$p_c = \pi + p_c^* + 100\frac{VM_c - VRM_c}{VM_c}\Delta TM_c$$

Market clearing for labor

$$SLH_h \cdot l_h^S = \sum_i S_i^L l_i$$

Market clearing for capital

$$VK_i \cdot k_i = \sum_i VKH_{hi} k_{hi}^S$$

Import

$$\sum_h VQ_{hc} q_{hc} = VX_c x_c + VM_c m_c$$

Export

$$\sum_h VQ_{hc} q_{hc} = VX_c x_c - VE_c e_c$$

Household factor income

$$y_h^0 = RLY_h\left(w + l_h^S\right) + \sum_i RKY_h\left(r_i + k_{hi}^S\right)$$

Tariff revenue

$$\Delta RM_c = \left(VM_c - VRM_c\right)\Delta TM_c + \frac{1}{100}VRM_c\left(\pi + p^* + m_c\right)$$

Export tax revenue

$$\Delta RE_c = (VE_c + VRE_c)\Delta TE_c + \frac{1}{100} VRE_c(\pi + p^* + e_c)$$

Tariff and tax revenue distribution

$$\Delta R_h = SR_h\left(\sum_{c \in IMP} \Delta RM_c + \sum_{c \in EXP} \Delta RE_c\right)$$

Household total income

$$VY_h y_h = VY_h^0 y^0 + 100\Delta R_h + 100\Delta J_h + VJ_h \pi$$

Household demand for commodity

$$q_{hc} = y_h - p_c$$

Current account balance

$$100\Delta B = \sum_{c \in EXP} (VE_c + VRE_c)(p^* + e_c) - \sum_{c \in IMP} (VM_c - VRM_c)(p^* + e_c)$$

Principal notation

Lowercase Roman letters indicate the proportional change in variables whose levels are indicated by uppercase Roman letters. Thus $x = dX / X$.

l_i	Proportional change in labor used in industry *i*
k_i	Proportional change in capital used in industry *i*
x_i	Proportional change in output of industry *i* = production of commodity *i*
a_i^L	Labor-saving technical change shifter in industy *i*
a_i^K	Capital-saving technical change shifter in industy *i*
w	Proportional change in wage rate
r_i	Proportional change in rental of specific factor in industry *i*
p_i	Proportional change in price of commodity *i*
C_i^L	Cost share of labor in industry *i*
C_i^K	Cost share of capital in industry *i*
π	Proportional change in nominal exchange rate